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Feature networks: The environmental features that are central to nature-connectedness experiences

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HIGHLIGHTS

- Wilder nature had the greatest positive link to nature connectedness.
- Human-influence had the greatest negative link to nature connectedness.
- Trails, wild nature and mountains were central to nature connectedness experiences.

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ABSTRACT

Landscape planning and design holds the potential to contribute to efforts toward repairing our growing psychological disconnection with nature. To do so, however, it is important to know what types of environmental features impact how connected to nature certain environments make us feel. The present study used a novel application of network analysis to identify which environmental features are most important for nature connection experiences. In this research, 205 participants completed online surveys in which they reported the presence or absence of a variety of environmental features during four previous nature connection experiences. They also indicated their level of recalled nature connectedness for each experience. The network analysis revealed that the most positively important features were those commonly found in rural nature (e.g., wild nature, animals, and mountains or hills). Features reflecting human presence (e.g., buildings, paved roads, vehicles) were most negatively important. Features commonly found in semi-rural nature (e.g., trees and meadows) were seemingly only important insofar as they were associated with the wilder features. Additionally, trails, wild nature, and mountains or hills were three of the features most central to nature connection experiences, suggesting that they are particularly important for how they support other parts of the network. Overall, from a purely nature-connection perspective, these findings support the need for increased rewilding efforts—more than simply increasing basic access to urban nature—and also limiting the overt presence of human development. Other more nuanced findings are also discussed.

1. Introduction

Repairing our relationship with nature has become one of the defining tasks of the century (UN Climate Change News, 2020). One way in which the human–nature relationship has been studied from the perspective of psychology is through the construct of nature connectedness—broadly speaking, the closeness of one's relationship with nature (Lengieza, Aviste, & Richardson, 2023; Lengieza & Swim, 2021b; Schultz, 2002). Extensive research has shown that nature connectedness is influenced by features of the surrounding environment (see Lengieza & Swim, 2021b, for a review), such as the presence of blue space (Hatty et al., 2022; Stehl et al., 2024; Wyles et al., 2019) or the quality of the space (i.e., protected status; Wyles et al., 2019). Thus, there is a clear opportunity for landscape and urban planning to contribute to global efforts aimed at reversing the growing disconnect between people and nature by designing for features that promote a psychological connection to nature (Hatty et al., 2022; Ives et al., 2018; McEwan et al., 2020).

For the most part, the research on environmental factors that influence nature connectedness often focuses on a limited set of features, for example type (i.e., blue vs. green vs. grey space) or quality (i.e.,

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protected or not protected; e.g., Wyles et al., 2019). Yet, landscapes and environments are not single-faceted nor are individuals' experiences of them always aligned with objective reality (Yuille et al., 2024). In other words, individual's experiences of landscapes are often subjective and involve a variety of natural features which may or may not routinely co-occur. In order to address this, more holistic investigative methods accounting for subjectivity and multiplicity are useful for understanding how environments impact our personal relationships with nature. Therefore, the purpose of this research is to explore the situational network of natural features that potentially impact nature connectedness using a novel application of network analysis based upon subjective nature experience data. In employing this highly generative, exploratory methodology (see Lengieza et al., 2025), our aim is to catalyse a flurry of new research investigations aimed at testing a variety of causal hypotheses implied by the network.

2. Nature connectedness

2.1. Nature connectedness is an important outcome

Recently, nature connectedness and the human–nature relationship has seen a surge in international and global interest (Convention on Biological Diversity, 2022; EEA, 2022; Natural England, 2020; SEI & CEEW, 2022). A great deal of this interest comes from considerable *meta*-analytic evidence linking nature connectedness to both wellbeing (see Barragan-Jason et al., 2023; Capaldi et al., 2014; Pritchard et al., 2020) and pro-environmental behaviour (see Barragan-Jason et al., 2022; Barragan-Jason et al., 2023; Mackay & Schmitt, 2019; Whitburn et al., 2020). Thus, it is becoming quite clear that nature connectedness is a valuable target, one that can potentially benefit both people and the planet.

2.2. Antecedents of nature connectedness

If nature connectedness is an important target, then it becomes important to know what kinds of psychological phenomena and situational factors impact it. Nature connectedness has both a trait and state form (see Tiscareno-Osorno et al., 2023). That is, while some people have a relatively-stable tendency to feel more connected to nature than others (trait nature connectedness), any given individual can feel more connected to nature in one moment compared to how they do in another (state nature connectedness). However, regardless of the type of nature connectedness (trait vs. state), the antecedents of nature connectedness can generally be broken into three broad categories (see Lengieza & Swim, 2021b): individual differences, psychological states, and situational factors. Each are briefly reviewed below.

2.3. Individual differences

Several studies have shown that nature connectedness is influenced by individual differences (Lengieza & Swim, 2021b). Some notably influential individual differences are based on personality, whilst others are more to do with world views and attitudes. For example, individuals with higher levels of openness to experience and agreeableness tend to be more connected to nature. Additionally, individuals with self-transcendent attitudes also show higher levels of nature connectedness (Tam, 2013). Finally, demographic characteristics such as age (e.g., Hatty et al., 2022; Hughes et al., 2019)—and sometimes gender (see Lengieza & Swim, 2021b)—seem to be associated with nature connectedness, but not factors like socioeconomic status (Walters et al., 2014; Wyles et al., 2019) or race (e.g., Weinstein et al., 2009; Whitburn et al., 2019). In other words, our level of nature connectedness depends, in part, upon who we are as individuals (i.e., our backgrounds and individual differences).

2.4. Psychological states

In addition to who we are, what we feel and think in any given moment can also influence our sense of nature connectedness (Lengieza & Swim, 2021b). For example, there are strong links suggesting that being mindful can increases our sense of nature connectedness (see Schutte & Malouff, 2018, for a *meta*-analysis). Similarly, experiencing positive emotions can impact our sense of nature connectedness (see Capaldi et al., 2014; Nisbet & Zelenski, 2011). Certain ways of reflecting—whether it be introspection (e.g., Mayer et al., 2009; Richardson & Sheffield, 2015) or reflection on meaning and growth (Lengieza, 2024)—can also make us feel more connected to nature (Frantz et al., 2005; Lengieza & Swim, 2021a). Thus, like individual differences, our inner psychological and subjective experiences can also impact our connection to nature.

2.5. Situational factors

Finally, there are also situational factors that influence nature connectedness. This means that nature connectedness is influenced by both *where* one is and *what* one is doing (Lengieza & Swim, 2021b). For example, anthropomorphizing nature can make us feel more connected to it (Tam et al., 2013), as can activities like gardening or planting trees (Beery, 2013; Sanguinetti, 2014; Whitburn et al., 2019) and deliberately noticing the 'good things' in nature (Richardson & Sheffield, 2017). Such activities, which are sensory, emotional, caring or meaningful, fall within a typology termed the pathways to nature connectedness (Lumber et al., 2017). However, whilst it matters what you do, it also matters where you are doing it. Most relevant for the present paper, the natural features present in the environment can impact how connected to nature we feel.

2.6. Features

Indeed, the external situational context itself is an important determinant of nature-connectedness (Lengieza & Swim, 2021b). In the most general sense, exposure to nature has positive effects on nature connectedness (granted, there are many factors that can strengthen this effect; see Barragan-Jason et al., 2022, for a *meta*-analysis). However, other environmental factors are important as well. For example, the presence of active wildlife (Richardson et al., 2015) and phenomena like weather and season impact nature connectedness—with nature connectedness being lower on rainy days and in the winter months (Duffy & Verges, 2010). Unsurprisingly, different physical environments also have an effect on nature connectedness. In general, rural green spaces (i.e., natural areas with lots of plants and vegetation) tend to better promote nature connection than urban grey spaces (i.e., urban areas typically found in the city; Wyles et al., 2019). Rural green spaces also seem to be more nature-connective than coastal blue spaces (Stehl et al., 2024; Wyles et al., 2019), but blue spaces do seem to have a positive impact on nature connectedness (Hatty et al., 2022).

However, what is not well studied is which of the more granular features of the situational environment are most important despite explicit calls for more of such research (e.g., Lengieza & Swim, 2021b). Consequently, one might wonder, "Are forests and trees more common and important in nature-connection experiences or are meadows and fields?" According to Prospect–Refuge Theory, which suggests that we have an evolutionary preference for places that provide safety (i.e., refuge) while also allowing us to see opportunities for meeting basic needs (i.e., prospect; see Dosen & Ostwald, 2016), such a distinction should be important—as forests are typically consistent with the opportunity for obscurement characteristic of 'refuge' whereas meadows are typically consistent with the open sightlines characteristic of 'prospect' (Appleton, 1984)—but the nature of the difference is far from clear. Or, one might ask, "Is there a difference between coastal blue spaces (e.g., oceans and beaches) and inland blue-spaces (e.g., rivers and

lakes)?" Right now, while we know that rural green spaces impact nature connectedness more than coastal blue-spaces (Wyles et al., 2019), the literature has little to say on the topic of other kinds of blue spaces—especially compared to each other. Yet, blue spaces should be important for nature connection according to the combined perspectives of Prospect–Refuge and the Biophilia hypothesis, which suggests that our relationship with nature is ingrained in our ancestral past and reflects the evolutionary relationship between humans and nature (i.e., we prefer and should connect more easily to places that are part of our evolutionary past; see Lengieza & Swim, 2021b). And still further, someone interested in the potential relationship between biodiversity and nature connectedness might want to know, "Do interactions with wildlife or interactions with plants occur more frequently in nature-connective experiences? Do they tend to occur together? Or do they belong to two distinct types of nature-connection experiences? And how are they related to the presence of wild and manicured nature?". Such questions have yet to be answered in the literature but can be readily answered by analysing these environmental features as a network using the principles of social network analysis (see Lengieza et al., 2025, for a much more elaborate explanation of this approach). This is the approach adopted here.

3. Present research

The purpose of this research was to explore the nature and structure the situational network of natural features that impact nature connectedness using a novel application of network analysis to subjective nature experience data. In particular, we were interested in three broad research questions. First, we were interested in (RQ1) Which environmental features might be most influential in nature-connectedness experiences? Importantly, there are multiple ways to conceptualize influence. As outlined in the initial validation of this approach (Lengieza et al., 2025), elements that appear in positive (i.e., connective) experiences with a greater relative frequency compared to negative (i.e., non-connective) experiences can be seen as positively influential. However, elements can also be important because they are highly connected to many other elements in the network. This is called centrality. Therefore, we were also interested in (RQ2) whether there are environmental features that are highly central to nature-connectedness experiences? Finally, the primary reason we were interested in the *network* of natural features is because we were interested in (RQ3) how the environmental features subjectively influence each other and (RQ4) whether there are distinct sub-groups of natural features that tend to co-occur in nature-connectedness experiences.

Again, as noted above, our aim in using network methodology is to capitalize on its highly generative capability as an exploratory research method (see Lengieza et al., 2025). Thus, while this methodology is inherently correlational—and cannot *confirm* causal relationships—our ultimate interest is in identifying *potential* causal relationships (i.e., hypotheses) that will be addressed in future research that is better suited to address causality but is also inherently narrower in focus.

4. Methods

4.1. Participants

As this is a new approach, the only guidance on sample size was the original validation (Lengieza et al., 2025). Like the validation, 250 UK participants were recruited from Prolific for the sample in order to achieve an intended final sample of 200 participants after allowing for a 20 % buffer to account for exclusions. Participants were excluded following established procedures (i.e., Lengieza, Aviste, & Swim, 2023b). Specifically, 21 participants who reported that they rushed, were distracted or did not take the survey seriously were excluded. Another 15 Participants were excluded for taking too long on the survey (greater than 1.5x the Interquartile range for the sample; more than 24.37 min. when 75% of the sample took less than 15 min) and 1 person was excluded for going too fast (less than 4 min when the median was 10 min. Additionally, 8 participants experienced unsalvageable glitches on the sorting task Thus, the final sample included 205 participants. The sample was a majority white (87%) with an average age of 40.1 (SD = 12.84) and was balanced between men and women (48% men).

4.2. Materials and procedure

4.2.1. Experience selection

The procedure closely followed that of Lengieza et al. (2025). First, participants provided informed consent, as per institutional ethics approval, and were then asked to select four experiences which they would reference later during the card-sorting task. Participants were initially presented with the instructions displayed in Fig. 1. Afterward, participants advanced to a second page asking them to specify a title for the experience they had selected for each category (see Fig. 2). Three connective experiences were selected to increase the variety and richness of the network, and an underwhelming experience was included as a comparison context that still included nature but was not particularly impactful on the participants' sense of nature connectedness. This allows us to separate features directly related to nature connectedness from items simply related to nature.[1]

4.2.2. Card sorting task

After titling the experiences, participants completed a drag-and-drop card-sorting task. First, following Lengieza et al. (2025), participants were presented with a set of pre-instructions explaining the nature of the categories they would encounter on the following page. They were then brought to another page (see Fig. 3) and presented with a pool of cards reflecting the natural features of interest in this study (see Table 1). They were asked to place each card into one of four categories depending on its level of relevance to each of their experiences. Experience order and item order were randomized, and the item pool only displayed a portion of the entire set at a time.[2] The drop-bins were coded after the fact from 0 ("not at all present") to 3 ("very present").

Deviating from Lengieza et al. (2025), the bins were changed to reflect actively noticing or interacting with the item at the time (e.g., "Features that I VERY MUCH interacted with or noticed at the time." vs. the original "Emotions that were VERY present") This was done because, unlike emotions (which are internal), natural features are external. Thus, for external features, simply because something was objectively present does not mean that it was noticed or interacted with at the time of the experience.

The features were selected based upon common features encountered in outdoor settings (e.g., McEwan et al., 2020). They were selected to reflect a range of features from green (e.g., plants, trees, meadows), blue (e.g., oceans, rivers, ponds), and grey (e.g., roads, buildings, cars) spaces. Additionally, items that were relevant to distinctions in the literature, such as the wildness of nature (Colley & Craig, 2019),

[1] A multi-level model with random intercepts tested for differences in INS scores by experience type using effect coding to compare each group to the grand mean. The model revealed that nature connectedness differed significantly between experience type, $F(3, 612) = 239.45$, $p < .001$. Specifically, 'important' nature-connection experiences had higher reported nature connectedness than the mean, $\beta = 0.50$, $(612) = 17.39$, $SE = 0.03$, $p < .001$. 'Ideal' nature-connection experiences likewise had higher reported nature connectedness than the mean, but to a smaller extent, $\beta = 0.24$, $(612) = 8.49$, $SE = 0.03$, $p < .001$. 'Common' nature connection experiences, however, were no different from the mean, as one might expect, $\beta = -0.05$, $(612) = -1.80$, $SE = 0.03$, $p = .072$. Finally, 'Underwhelming' nature connection experiences were significantly lower than the mean nature connectedness score, $\beta = -0.24$, $(612) = -8.49$, $SE = 0.03$, $p < .001$.

[2] Given the underlying code for the task, participants were required to complete the task on non-mobile devices.

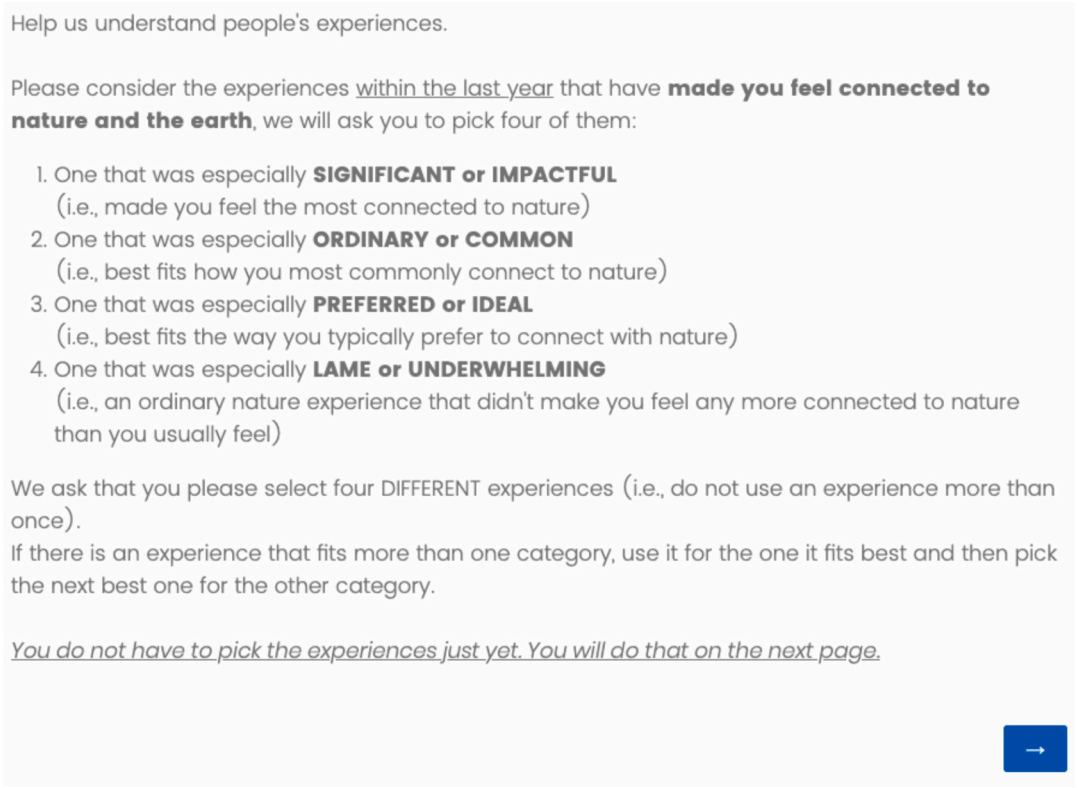

Fig. 1. Experience Selection Instructions.

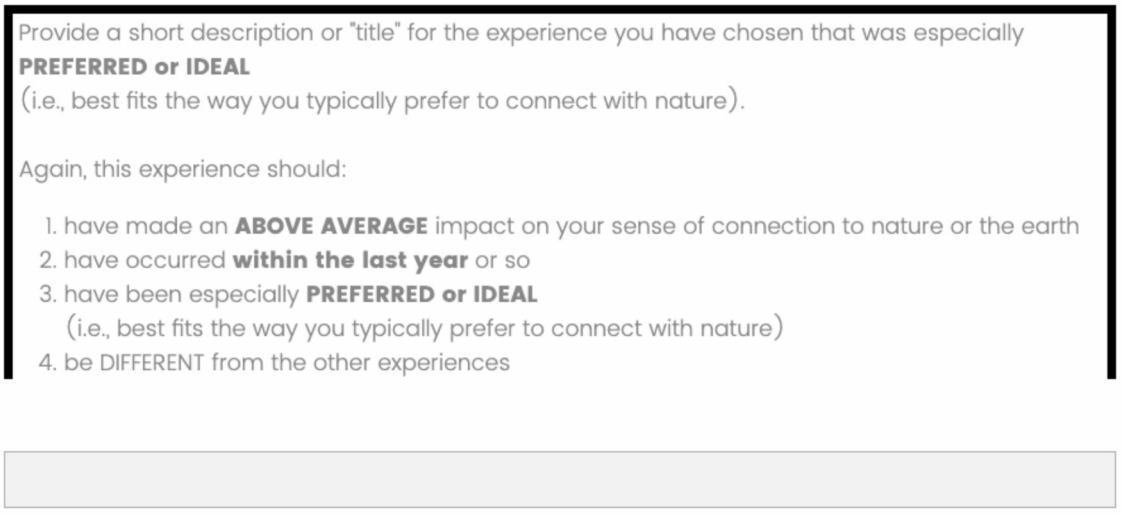

Fig. 2. Experience Selection Title-Input Example.

interpretive signage (Burbach et al., 2012), aversive parts of nature (e.g., "the bugs and mud of nature"; Lengieza & Swim, 2021b), and the presence of other people (Lengieza & Swim, 2021a). Food was included as a potential default reference point which was expected to be equally present across experience types.

4.2.3. Nature connectedness

After sorting for each experience, participants completed a sliding-scale version of the Inclusion of Nature in Self scale (INS; Schultz, 2002). Following the procedure used in past research (i.e., Lengieza, Aviste, & Swim, 2023b; Lengieza & Swim, 2021a), participants were presented with a sliding-scale and two circles—one labelled 'self', the other 'nature'—and asked to use the slider to indicate how connected to nature they felt during the specific experience by moving the circles to overlap.

4.2.4. Exit items

At the end of the survey, participants were presented with a series of items designed to assess data quality (see Lengieza, Aviste, & Swim, 2023b). Participants self-reported whether they rushed, were distracted, or did not take the survey seriously. Prior to answering these questions, participants were explicitly informed that their answers would not affect their credit. Responses were used to identify and exclude low-quality responses, as noted in the participant's section.

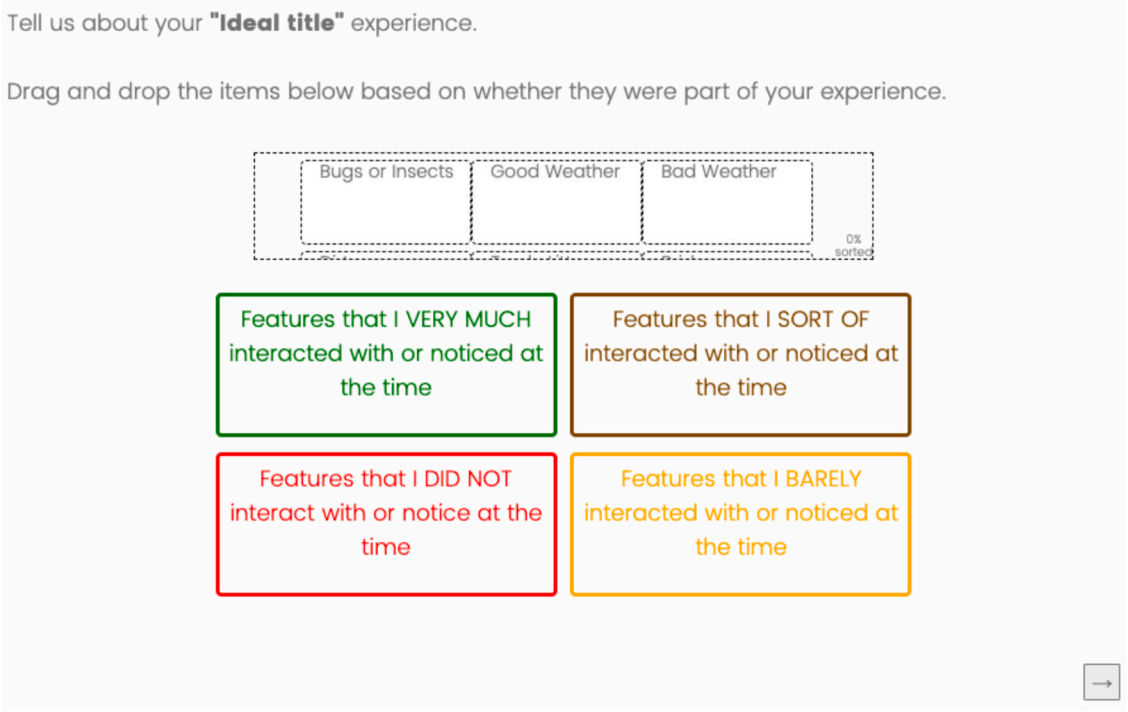

Fig. 3. An example trial of the card sorting task.

Table 1
Items presented to participants and their labels, importance, and centrality.

Item	Node Label	Importance	Centrality
Wild nature (minimal human management)	Wild	0.30	1.31
Good Weather	Nice Out	0.28	0.93
Mountains or Large Hills	Mountains	0.21	1.26
Small Animals or Wildlife	Small Animals	0.20	1.02
Meadows or open fields	Meadows	0.18	0.44
Oceans or Beaches	Beaches	0.17	0.14
Large Animals or Wildlife	Large Animals	0.16	0.90
Plants or Wildflowers	Plants	0.15	0.94
Sand	Sand	0.15	0.38
Rivers or Streams	Rivers	0.14	0.68
Trails	Trails	0.11	1.56
Ponds or Lakes	Ponds	0.09	0.75
Trees or Large Bushes	Trees	0.08	0.80
Docks or Piers	Docks	0.08	0.95
Stars or The Night Sky	Stars	0.08	0.00
Food	Food	0.07	0.46
Bugs or Insects	Insects	0.06	0.39
Educational Signs	Edu Signs	0.05	0.07
Benches	Benches	0.02	0.01
Bridges	Bridges	0.01	0.60
Dirt	Dirt	−0.04	−0.57
Other people	People	−0.05	0.00
Mud	Mud	−0.06	−0.30
Manicured nature (high human management)	Manicured	−0.08	−0.36
Technology	Tech	−0.10	−0.91
Bad Weather	Grey Out	−0.16	−1.43
Human-made buildings or structures	Man-made	−0.17	−1.54
Cars or Other motorized vehicles	Vehicles	−0.20	−2.34
Paved roads	Paved	−0.22	−1.96
Trash, Litter, or Pollution	Trash	−0.22	−0.93

5. Data analysis

A more thorough explanation of the analytical decisions adopted here can be found in the original validation of this approach (Lengieza et al., 2025). However, key information needed to interpret the output of the network is reiterated here.

5.1. Node importance

Node importance, as one metric of influence, was operationalized as the frequency of any given node in nature experiences relative to the frequency in non-nature experiences accounting for the strength of presence. The final values could range between −1 (indicating the feature was much more common in non-nature experiences) and + 1 (indicating the feature was much more common in nature experiences); a value of 0 indicates that the feature was equally present in both types of experiences. Consistent with the validation of this approach, these values were strongly correlated with the values derived from typical inferential approaches (i.e., regression coefficients from the association between a specific feature and INS scores correlated strongly with our metric of node importance; $r[28] = 0.98$; see Lengieza et al., 2025).

The sample level aggregate of this relative-frequency value for each node was used to determine both the color and size of nodes. Nodes with negative importance values were colored red—reflecting their negative influence. Nodes with positive importance values were colored green—reflecting their positive influence. Node size was influenced by the node importance's absolute deviation from zero with higher values resulting in larger nodes. Additionally, to help visually separate sometimes hard-to-differentiate degrees of importance, the nodes are also given different shapes depending on the degree of importance. Specifically, the top third (i.e., most influential) of the positive nodes were assigned a triangle, the middle third are assigned a square, and the bottom third (i.e., least influential) were assigned a circle. The same was done separately for the negative nodes. To put it as plainly as possible, large green triangles indicate a node had an important positive impact on nature connectedness; large red triangles indicate a node had an important negative impact on nature connectedness.

5.2. Edges & thresholds

The ties within the network were calculated following the Extended BIC graphical lasso methodology (EBIC GLASSO; see Costantini et al., 2019) which effectively models the partial correlations between all nodes in the network. Variables were centered within-subject for this analysis. However, we also utilized the twinned-node approach to account for the fact that some nodes might be aliased (see Lengieza et al., 2025). This approach effectively allows us to see whether two closely associated nodes (e.g., $|r| > 0.7$) have differential associations with other nodes *without* ignoring their strong similarity. To limit the density of the network and reduce the presence of trivial relationships, we used a threshold of $|r_{\text{pseudo-partial}}| < 0.10$ and removed all edges below this value (see Neuman et al., 2022).

In the resulting network, nodes with stronger ties have thicker bands connecting them. Positive correlations are denoted with green bands; negative correlations are denoted with red bands.

5.3. Centrality

As an additional way of capturing the influence of a given node in the network, we also considered nodes' centrality using a similar procedure to the *strength()* function in the package *igraph* (Csardi, 2013) but accounting for the relative importance of the other nodes. In short, this valanced measure of centrality reflects how well connected a node is within the network based upon how strongly tied it is to other important nodes in the network. Put simply, nodes with positive valanced centrality are strongly connected to a large number of other positively important nodes in the network; nodes with negative valanced centrality are strongly connected to a large number of negatively important nodes in the network. Here, instead of fully standardizing centrality scores (as Lengieza et al., 2025, did), we have simply divided them by their standard deviation (i.e., standardized without centering) to put them on a similar scale to z-scoring while preserving the sign of the original scores.

5.4. Clustering & network simplification

We use *cluster_optimal()* from the *igraph* package to identify clusters in the network based on the weighted ties between nodes as is common in network analyses (Neuman et al., 2022). Nodes with positive associations were treated as closer together; nodes with negative associations were treated as further apart (see Lengieza et al., 2025).

We subsequently used the identified clusters to simplify the network by aggregating common nodes belonging to the same cluster. As described above, we re-accounted for potential aliasing for the ensuing network analysis. At this juncture, since this network was (a) much smaller and (b) we were not interested in further clustering, no thresholding was done for edges. Given the limited set of variables at this stage, we opted to calculate the partial associations—but using similar principles as the twinned node approach—between the aggregate cluster values and nature connectedness as the metric for node importance. This was done using the standardized within-subjects coefficients for each cluster value in multi-level regression predicting nature connectedness (i.e., INS score) from all cluster values simultaneously with random intercepts (see Lengieza et al., 2025). Variables were centered within-subject for this analysis.

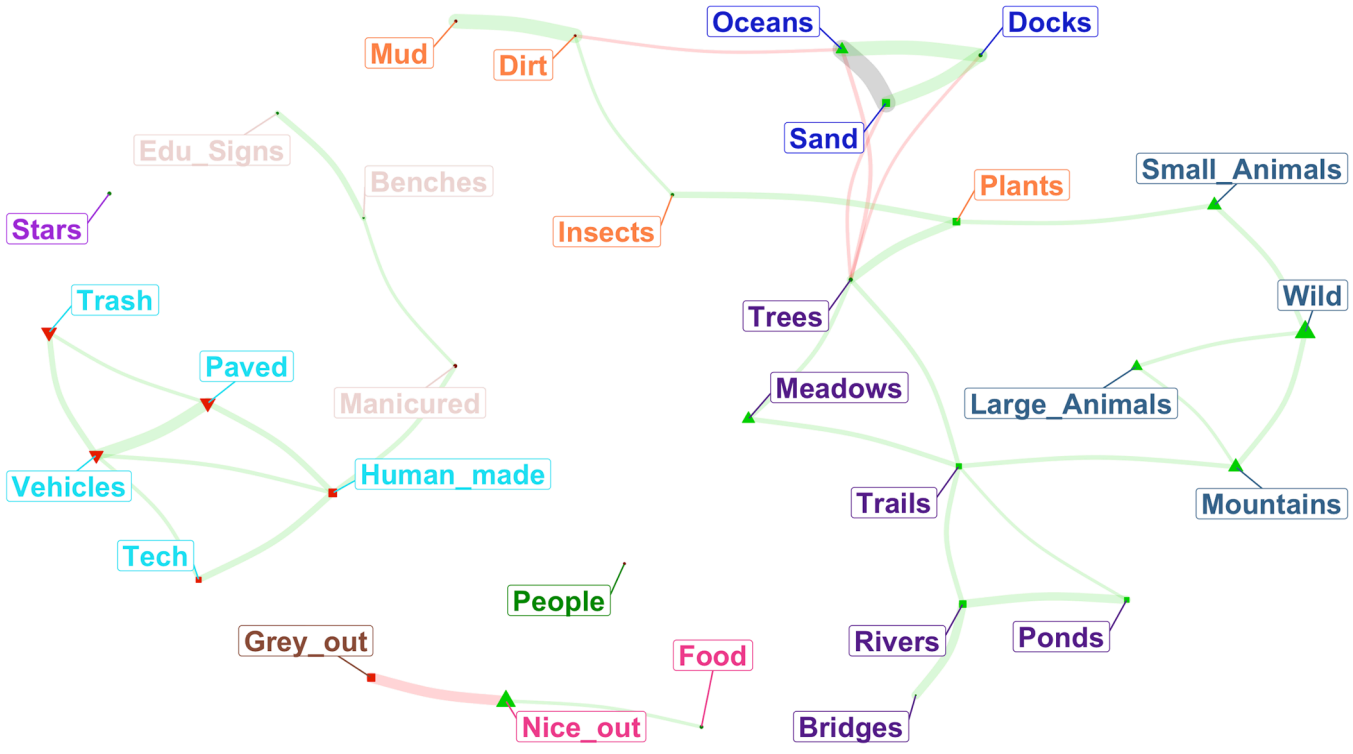

Fig. 4. The detailed situation network of environmental features that impact nature connectedness.
Note. The following explains how to interpret the visual network. ***Nodes****: Larger nodes indicate greater importance; Green nodes had a positive importance for connectedness; Red nodes had a negative importance for connectedness. The top third, middle third, and bottom third of the positive and negative nodes are indicated with a triangle, square, or circle, respectively.* ***Edges:*** *Thicker bands indicate stronger relationships between nodes after accounting for all other, non-aliased nodes* (i.e., *the unique association); No bands indicate no relationship* ($|r_{\text{pseudo-partial}}| < 0.10$) *after controlling for other nodes; Green bands indicate a positive relationship; Red bands indicate a negative relationship; Grey bands indicate that two nodes shared* $\geq$ *50 % of their variance and might be aliased.* ***Label color****: The color of labels was determined by the cluster assignment derived from the network community structure. Color-blind friendly versions can be found in supplemental materials.*

6. Results

6.1. Important members

The most notable positive members of the network (see Fig. 4) were nice weather, wild nature, meadows, mountains, small and large animals, and oceans. In essence, these features were highly and uniquely present in peoples' nature-connection experiences. Rivers, ponds, trails, sand, and plants had a medium positive influence, but their importance was notably weaker than the aforementioned items.

The most notable negative members of the network were paved roads, motor vehicles, and trash. In essence, these features were highly and uniquely absent from people's nature-connection experiences. Poor weather, technology, and human-made buildings and structures had a medium negative importance.

The presence of several other features in the network seemed to have little importance. Most surprisingly, trees had little importance for the nature-connectivity of an experience. This seemed to be because trees were relatively ubiquitous regardless of the type of experience ($Frequency_{connective}$ = 73.1%; $Frequency_{control}$ = 64.7%) especially compared to the average for all features ($Frequency_{connective}$ = 23.7%; $Frequency_{control}$ = 38.6%). The presence of other people ($Frequency_{connective}$ = 59.7%; $Frequency_{control}$ = 64.2%) was also not important, seemingly because it was similarly characteristic of all experiences.

Mud, Dirt, Docks, Bridges, Benches, Educational Signs, Stars, and Food were also all relatively unimportant. Like trees, this was not because they had no occurrences in these experiences but rather that they occurred relatively equally across both types of experiences. That is, the lowest average frequency for any one of these items across experiences was 22%. However, unlike trees, these items were not as universally common (maximum Frequency = 47.2%).

6.2. Central members

The three most central components of the network (see Table 1) were trails, wild nature, and mountains/large hills, respectively. In other words, more so than other parts of the network, when people interacted with trails, wild nature, or mountains, the greatest number of other *important* features were more likely to be present; when any one of these three were present, multiple other important features were also likely to be present as well. For trails, it seems equally likely that they serve either a radiating role or a converging role, as noted below. On the one hand, it may be that when people use trails, they are more likely to encounter and interact with many other important features (trails → many other features), reflecting a radiating case. On the other hand, it may be that there are many activities that require trails, and therefore, cause people to use them (many other features → trails), reflecting a converging case. This, however, does not alter the fact that trails are very central to the network, and adding (or removing) them is likely to influence people's engagement with many other parts of the network.

The three most negatively central features were motor vehicles, paved roads, and human-made structures. These items, however, were all largely connected to themselves. Thus, this indicates that when one negative network member is present, the rest are also likely to be present. This is important to note because, for example, it implies that attempts to make nature areas more accessible (e.g., with roads) could also be likely to increase the presence of other negative features (e.g., trash, motor vehicles, technology, human-made structures).

6.3. Clusters

Several distinct clusters emerged in this network which appeared to be broken into two primary higher-order facets. The first and largest facet is nature-type features. This was comprised of what seems to be "aversive nature" (bugs, mud, insects, and plants), "lowlands nature" (trees, meadows, trails, ponds, rivers, and bridges), "highlands nature" (mountains, wild nature, and small and large animals), and "coastal nature" (oceans, sand, and docks). These terms are discussed in greater detail in the general discussion section.

The second largest facet was infrastructural-type features. This was comprised of "human-influence features" (trash, paved roads, motor vehicles, technology, and human-made buildings) and "municipal-type features" (educational signs, benches, and manicured nature). While lowlands nature, for example, also contained elements of human influence (e.g., bridges and trails), the fact that these human-influence features were completely disconnected from the other obvious human-influence items makes them seem like they are experienced as a wholly different type of feature. This disconnection may suggest that (foot) bridges and trails tarnish the wildness of a setting less than other human-influence features.

6.4. Aggregate network

The simplified aggregate network is shown in Fig. 5. Above and beyond the other aggregated clusters in the network, highlands nature had a strong positive importance for reported nature-connectedness scores. Coastal nature also had a relatively strong positive importance, whereas lowlands nature only had a trivial importance for nature connectedness. Human-influence features and a unique negative importance for nature connectedness, whereas aversive nature had a trivial negative importance for nature connectedness. Pleasant weather seemed to have a comparatively moderate importance for nature connectedness. Municipal features, and the presence of other people had no effect.

Highlands nature and lowlands nature shared a strong association and, interestingly, aversive nature seemed to be far more tied to lowlands nature than it was to highlands nature. Similarly, highlands nature was negatively associated with human influence more so than lowlands nature.

6.5. Human influence

As noted in the previous section, human influence had a notable negative association with nature connectedness. Overall, when human features were present, nature connectedness was lower. It would be easy, then, to conclude we need more spaces with pristine nature lacking any human influence at all. Yet, given that this may be an unrealistic standard, we further explored which of the human-influence features most contributed to this effect—under the suspicion the primary culprit might have been the presence of trash and litter. A multi-level regression was run predicting nature connectedness scores from (a) the presence of trash, (b) an aggregate of the non-trash nodes, and (c) the other aggregate nodes from the simplified network (e.g., coastal nature, aversive nature, etc.). The outcome of this analysis revealed that trash, had a unique negative association with nature connectedness, $\beta = -0.18$, $(607) = -6.14$, $SE = 2.37$, $p < .001$. However, it also revealed that non-trash human-presence features had a similar sized negative association, $\beta = -0.17$, (607) = -5.91, $SE = 2.91$, $p < .001$. In other words, the negative importance of human presence is *not* simply reducible to the presence of litter.

7. General discussion

The purpose of the present paper was to explore the network of environmental features that potentially impact nature connectedness. The three most notable sets of important factors were those that reflect what we call highlands nature (i.e., small and large animals, wild nature, and mountains), coastal nature (oceans, docks, and sand), and human presence (trash, vehicles, paved areas, human-made buildings, technology and litter). Whereas the former two had a positive relationship with nature connectedness and mirror the 'good things' people report in nature (McEwan et al., 2020), the latter had a negative relationship,

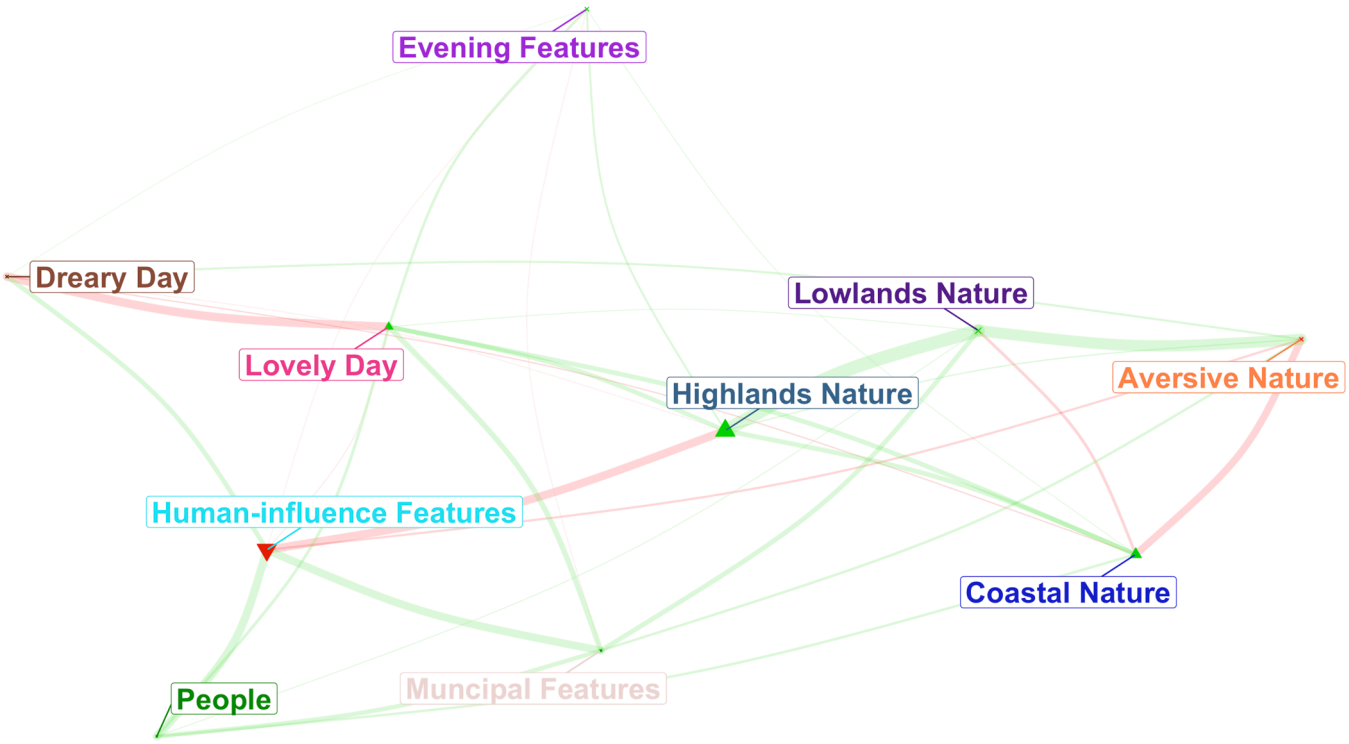

Fig. 5. The simplified aggregate network of features that impact nature connectedness.
Note. The only differences in interpretation of this simplified graph versus the detailed graph are (a) that ***node-importance*** *is based upon the standardized within-subjects effect when controlling for the importance of other nodes, (b)* ***no bands*** *indicate no relationship at all (i.e., there was no thresholding for these networks), (c)* ***label color*** *is determined by the cluster assignment used in the detailed network, and (d) nodes with an X indicate trivial influence ($|\beta| < 0.10$). Otherwise, the remaining components of interpreting the graph remain the same as those noted for the detailed networks. Colour-blind friendly versions can be found in supplemental materials.*

consistent with past research showing grey spaces are less nature-connective than green spaces and blue spaces (e.g., Hatty et al., 2022; Stehl et al., 2024; Wyles et al., 2019). Similarly consistent with past work, pleasant weather also had a positive relationship with nature connectedness (Duffy & Verges, 2010). These factors based on individual responses also have broad parallels from ecological data showing that type of land, abundance of wildlife, bad weather, technology and urbanisation are macro factors that predict country-level nature connectedness across nations (Richardson et al., 2022).

It is also, however, interesting to note two unimportant types of features in particular. First, it seems that while features of lowlands nature (meadows, trees, trails, rivers, ponds, and bridges) are somewhat more frequent in nature-connective experiences than non-connective experiences, they are not uniquely important above and beyond the absence of human-presence and the presence of highland nature. That is, when controlling for these two more important clusters of features, lowlands nature only had a trivial positive relationship with nature connectedness (see Fig. 5). Second, aversive nature (in particular, bugs, mud, and dirt) were notably unimportant, providing a tentative answer to an open question in the literature of whether aversive nature negatively impacts nature connectedness (see Lengieza & Swim, 2021b). The implications of these findings are discussed below (in a slightly different order).

7.1. Highlands nature

Highlands nature—which we simply use to mean the features that are commonly present in such settings but not necessarily the distinct geographic region itself—was especially important, suggesting that relatively more wild nature is an important factor in the nature connectivity of landscapes. In fact, wild nature, along with mountains, was a central component in the network—that is, when they were present, multiple other important features were likewise present. This would tentatively suggest that natural habitats that are wild and, most likely, that have a high degree of *visible* biodiversity are potentially an important target for efforts to increase nature connection. Thus, it would seem that global policies now targeting nature connectedness and the human–nature relationship (see Lengieza, Aviste, & Richardson, 2023, for a review of such policies) may need to focus on increasing the wildness of local nature and increasing access to rural and more wild nature. In other words, building a new park (or sprucing up old ones) or a campaign to simply get people out and into urban nature might not be as valuable as serious re-wilding efforts or increasing the accessibility of wilder rural nature—the latter, of course, must be balanced against conservation impact.

7.2. Human influence

Building on the implication of the last section, the presence of human influence was likewise important for nature connectedness—but with a distinct negative impact. Moreover, not only was it negatively important, it also had a strong negative tie to highlands nature; when there was a great deal of human presence, there was often a low degree of highlands nature, which mirrors the negative human influence on nature itself (Zeller et al., 2024). Yet, the simplified network also revealed that the association between human presence and nature connectedness was not simply attributable to the absence of highlands nature. When controlling for highlands nature, human presence had a negative association. Put simply, even if an area had a high degree of wild nature, mountains, and animals, the presence of human features would likely have a negative impact on how connected the landscape would make people feel. That is, compared to a fully protected forest, one with a paved road cutting through it, for example, is likely to harm our relationship with nature—in addition to whatever ecological impacts such a

planning decision might engender. From a landscape planning perspective, this implies that not only are rewilding efforts needed to increase access to wild nature, but so too is there a need to potentially limit the human presence as much as practically possible.

An important caveat to this is that it is likely important that the space simply *feel* natural and wild (see Lengieza, Aviste, & Swim, 2023a). That is to say, the objective wildness of the area is likely less important than subjective impressions of the area's wildness with evidence showing perceptions matter and can differ to the reality (Hepburn et al., 2021). A heavily forested park that obscures nearby buildings and the sound of roads may very well be enough to feel subjectively wild to participants. This principle, however, applies both ways. Even an objectively wild landscape could be subjectively perceived as tainted if there are a few notable traces of human impact (e.g., parking lots visible in the distance). Thus, future research will want to further investigate the factors that influence the subjective wildness of a space, and also the 'human-made-ness' of the space.

7.3. Aversive nature

Further building on the implications for land management and planning, aversive nature seemed to have little importance for nature connectedness. Additionally, municipal features (e.g., benches, manicuring, and educational signs) had little influence as well. Coupled with the notable positive importance of highlands nature and negative importance of human presence, this (fortunately) suggests that there may be a large margin for error in letting spaces grow wild. That is, at the very least, there is little evidence that nature must be managed for it to make people feel connected to nature, although moves to less managed greenspaces can sometimes be unpopular depending on personal traits (Tan et al., 2024). In the context of the present study, letting nature be wild seems less likely to have a backfire effect for nature connection; even if wild nature becomes muddy, or buggy, or becomes perceived as unmanicured, the network suggests there will not likely be a difference.

7.4. Lowlands nature

As noted at the beginning of the discussion, it is notable that lowlands nature did not seem to have a meaningful association with nature connectedness when accounting for the other types of features. Importantly, this is not to say that supporting areas with these features is unnecessary. Rather, they are clearly important in the detailed network, but the simplified network reveals this is only insofar as they are associated with the presence of wilder nature (i.e., highlands nature) and the absence of human presence, which presents an important degree of nuance for practical guidance. That is, they are not important in their own right (i.e., do not have an independent effect), but, to the extent that they can be used to create wilder nature *and* decrease human presence, then they are likely fruitful features to target. Consistent with this, trails were one of the three most central features in the network. While the causal direction of this centrality is unclear (as noted earlier), it does highlight that walking trails might play an important role in the network *specifically* because of how it supports engagement with other features.

The surprising lack of influence of trees in the detailed network (compared to the notable influence of meadows) is also an important discussion point in the context of lowlands. The presence and density of trees are often associated with positive perceptions of a place (Hepburn et al., 2021) and a key feature in nature connection interventions (Richardson et al., 2015). However, the present finding hints that prospect (e.g., meadows) may be more important than refuge (trees; Dosen & Ostwald, 2016), at least when it comes to nature connectedness. Thus, it could be useful for future research to more carefully differentiate between these two types of environmental features. Additionally, as noted in the previous paragraph, it is also possible that trees may still be important for nature connectedness, but in a more indirect way. That is, given the strong tie between the presence of trees and the presence of plants (which was comparatively more influential), trees—or forested areas, rather—might still be important for nature connectedness because they support other key elements of nature connectedness. Finally, in relation to this last point, it is worth noting that the ties here are based upon subjective awareness of these features. The lack of connection between trees and wildlife, for example, in no way indicates that forests do not support wildlife. Rather, the absent connection simply indicates that when people noticed wildlife, they were no more or less likely to also notice trees. That is, this is all to say that this network should not be taken as indicating there is no value of trees in the context of nature connectedness. Rather, it indicates that trees themselves are not a directly differentiating factor when it comes to nature connectedness; thus, one should not expect nature connectedness to suddenly change simply by increasing the number of trees alone.

The grouping of plants and wildflowers with 'aversive' aspects of nature is also a noteworthy finding. It is important to note two things about this finding. First, plants were relatively removed from the other features within the aversive category and were also tightly connected to other positive features in the network (e.g., small animals). Thus, it would seem that their primary link to the aversive features is through the presence of insects (which turn out to not be especially aversive in this data). Second, consistent with past research showing that plants, and wildflowers in particular, are associated with positive engagement with nature (Stagg & Dillon, 2022), plants were distinctly and positively important in the detailed network relative to mud and dirt.

7.5. Coastal nature

Finally, the introduction raised the question of whether there is a worthwhile distinction between different types of blue-spaces. Based on the evidence from the network, it seems that the distinction is worthwhile; interactions with oceans and beaches seem to make up a distinct type of experience from those that involve ponds or rivers. Moreover, it seems that the coastal blue spaces might be more important than the inland blue spaces, contributing to the literature on nature connectedness more broadly. This could be for a few reasons. For example, perhaps coastal blue spaces are more likely to be novel (as there is inherently less coastline than there is non-coastal land). From a human–nature-relationships-as-relationships perspective (see Lengieza, Aviste, & Richardson, 2023; Lengieza & Aviste, 2025), novelty should influence the impact of the experiences on nature connection (Lengieza, Aviste, & Richardson, 2023). Alternatively, coastal blues spaces might be more likely than other blue spaces to inspire key emotions that impact nature connectedness—most notably awe (see Lengieza et al., 2025), given the distinct vastness of the ocean (Yan et al., 2024).

7.6. Recommendations

As acknowledged in the introduction, there is an opportunity for landscape and urban planning to contribute to restoring human-nature connections. While such efforts will undoubtedly need to be combined with approaches to targeting psychological states, such as mindfulness and eudaimonic reflection (Barragan-Jason et al., 2022; Lengieza, 2024), and situational factors such as activity design (Lumber et al., 2017; Sheffield et al., 2022; see also Lengieza, Aviste, & Richardson, 2023, for theory-driven policy recommendations), the present research does support a few broad suggestions in regard to the environmental features that are likely to impact nature connectedness. First, it suggests that increasing access to wild nature through engagement programmes and transport links while limiting overt human impact (e.g., litter) and presence (e.g., buildings and roads)—through codes of use, 'do not disturb' campaigns and zoning—is likely necessary to support the repairing of the human–nature relationships. Second, it suggests that walking trails are potentially important because of how they support

interactions with other important features and therefore something that might warrant prioritization. Third, it suggests that municipal features (e.g., benches, maintaining nature, and educational signs) might not be especially important and should likely only be used when absolutely necessary—lest they unnecessarily increase overt human presence.

Additionally, although the work suggests re-wilding efforts and increasing the accessibility of wilder rural nature will potentially be more powerful than getting people out and into urban nature, the reality is that access to wild nature is not an everyday solution for those living in urban locations. With this in mind, this work also suggests that urban design may benefit from disguising or decreasing human visibility as much as reasonably possible, for example by obscuring nearby buildings and noise with trees to make urban parks feel subjectively wild. This principle also applies to objectively wild landscapes. This needs to be balanced with perception of safety for some users, suggesting zonal approaches that include quiet, wilder areas. Although, increasing the number of trees is a useful approach to screening noise and buildings, one should not expect nature connectedness to increase because of the presence of trees alone. Different landscape types have a role, such as meadows, especially those spaces that promote interactions with wildlife.

8. Limitations

Two limitations of this work are that it is correlational and retrospective—granted, in regard to the former, experimental research manipulating the entire network of possible features is not necessarily a practical standard. The correlational nature of the data means that, for some associations, there is the possibility that people who tend to be connected with nature are more likely to engage with certain types of spaces. Fortunately, however, this research used a repeated measures design and variables were centered within-subjects. Accordingly, the associations reported here reflect the relationship between deviations from each individual's own average level of engagement with a feature (i.e., the positive association between highlands nature and nature connectedness reflects that when someone engages with highlands nature more than is usual *for them,* they tend to feel more connected to nature), making it less likely that it is simply certain types of people engage with certain types of spaces. Even still, research deliberately testing the causal influence of any one of the notable nodes identified here would be well-warranted.

Additionally, a second limitation is that the data is retrospective and is, therefore, susceptible to biases in memory and temporal judgement. For example, it is possible that recalling multiple retrospective experiences within the same session might have biased participants to remember similar features across all experiences. Fortunately, inspection of the intra-class correlations between all features indicated that much more variability existed at within-subjects level ($\geq$ 70 %) compared to the between-subjects level ($\leq$ 30 %). Thus, in this dataset, this does not seem to be the case. Still, the nature of human memory means that participants may not have recalled experiences accurately, thereby introducing noise to the data. Therefore, it would be especially valuable for future research to replicate this work using a less-retrospective design (e.g., ecological momentary assessment) to capture these associations *in-situ*.

Finally, it is also worth noting that this data is from a western, English-speaking country (i.e., the UK). We selected this particular context because, according to recent data, the UK is one of the countries with the most severe disconnection from nature (Swami et al., 2024). Thus, it seemed important to focus research efforts where the problem is most severe. That said, it should be noted that these findings may not generalize to other cultural contexts as different landscape features might hold differential importance for human–nature relationships in other contexts. Accordingly, future research should consider a greater range of diverse samples and perspectives (e.g., indigenous people and non-western cultures).

9. Conclusions

The network analyses in this paper strongly suggest that there are several important features of the natural environment that influence people's connection with nature. Namely, the most important ones were highland features, coastal features, and human presence. Given the growing disconnect between people and nature (Beery et al., 2023), these analyses provide insight into how land management and planning can potentially contribute to global efforts to repair the human–nature relationship (Lengieza, Aviste, & Richardson, 2023). In particular, these analyses suggest that both rewilding and reducing the overt presence of human-made features are likely necessary to create landscapes that connect us with nature.

CRediT authorship contribution statement

Michael L. Lengieza: Writing – review & editing, Writing – original draft, Visualization, Formal analysis, Data curation, Conceptualization. **Miles Richardson:** Writing – review & editing, Conceptualization. **Jack P. Hughes:** Writing – review & editing.

Declaration of competing interest

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

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.landurbplan.2025.105362.

References

Appleton, J. (1984). Prospects and refuges re-visited. *Landscape Journal, 3*(2), 91–103. https://doi.org/10.3368/lj.3.2.91

Barragan-Jason, G., de Mazancourt, C., Parmesan, C., Singer, M. C., & Loreau, M. (2022). Human–nature connectedness as a pathway to sustainability: A global meta-analysis. *Conservation Letters, 15*(1). https://doi.org/10.1111/conl.12852

Barragan-Jason, G., Loreau, M., de Mazancourt, C., Singer, M. C., & Parmesan, C. (2023). Psychological and physical connections with nature improve both human well-being and nature conservation: A systematic review of meta-analyses. *Biological Conservation, 277*, Article 109842. https://doi.org/10.1016/j.biocon.2022.109842

Beery, T. H. (2013). Nordic in nature: Friluftsliv and environmental connectedness. *Environmental Education Research, 19*(1), 94–117. https://doi.org/10.1080/13504622.2012.688799

Beery, T. H., Stahl Olafsson, A., Gentin, S., Maurer, M., Stålhammar, S., Albert, C., Bieling, C., Buijs, A., Fagerholm, N., Garcia-Martin, M., Plieninger, T., & Raymond, M. C. (2023). Disconnection from nature: Expanding our understanding of human–nature relations. *People and Nature, 5*(2), 470–488. https://doi.org/10.1002/pan3.10451

Burbach, M. E., Pennisi, L., West, C. D., & Ziegler-Chong, S. (2012). The impact of environmental interpretation in developing a connection to nature in park visitors. *LARNet The Cyber Journal of Applied Leisure and Recreation Research, 15*(4), 13–30.

Capaldi, C., Dopko, R., & Zelenski, J. (2014). The relationship between nature connectedness and happiness: A meta-analysis. *Frontiers in Psychology, 5*(AUG), 1–15. https://doi.org/10.3389/fpsyg.2014.00976

Colley, K., & Craig, T. (2019). Natural places: Perceptions of wildness and attachment to local greenspace. *Journal of Environmental Psychology, 61*(December 2018), 71–78. https://doi.org/10.1016/j.jenvp.2018.12.007

Convention on Biological Diversity. (2022). *Kunming-Montreal Global Biodiversity Framework*.

Costantini, G., Richetin, J., Preti, E., Casini, E., Epskamp, S., & Perugini, M. (2019). Stability and variability of personality networks. A tutorial on recent developments in network psychometrics. *Personality and Individual Differences, 136*, 68–78. https://doi.org/10.1016/j.paid.2017.06.011

Csardi, G. (2013). *Package "igraph": Network analysis and visualization*. http://igraph.sourceforge.net.

Dosen, A. S., & Ostwald, M. J. (2016). Evidence for prospect-refuge theory: A meta-analysis of the findings of environmental preference research. *City, Territory and Architecture, 3*(1). https://doi.org/10.1186/s40410-016-0033-1

Duffy, S., & Verges, M. (2010). Forces of nature affect implicit connections with nature. *Environment and Behavior, 42*(6), 723–739. https://doi.org/10.1177/0013916509338552

EEA. (2022). Exiting the anthropocene? Exploring fundamental change in our relationship with nature. https://doi.org/doi:10.2800/37883.

Frantz, C., Mayer, F. S., Norton, C., & Rock, M. (2005). There is no "I" in nature: The influence of self-awareness on connectedness to nature. *Journal of Environmental Psychology, 25*(4), 427–436. https://doi.org/10.1016/j.jenvp.2005.10.002

Hatty, M. A., Mavondo, F. T., Goodwin, D., & Smith, L. D. G. (2022). Nurturing connection with nature: The role of spending time in different types of nature. *Ecosystems and People, 18*(1), 630–642. https://doi.org/10.1080/26395916.2022.2143570

Hepburn, L., Smith, A. C., Zelenski, J., & Fahrig, L. (2021). Bird Diversity Unconsciously Increases People's Satisfaction with Where They Live. *Land, 10*(2), 153. https://doi.org/10.3390/land10020153

Hughes, J., Rogerson, M., Barton, J., & Bragg, R. (2019). Age and connection to nature: When is engagement critical? *Frontiers in Ecology and the Environment, 17*(5), 265–269. https://doi.org/10.1002/fee.2035

Ives, C. D., Abson, D. J., Wehrden, H., Dorninger, C., Klaniecki, K., & Fischer, J. (2018). Reconnecting with nature for sustainability. *Sustainability Science, 13*(5), 1389–1397. https://doi.org/10.1007/s11625-018-0542-9

Lengieza, M. L. (2024). Eudaimonic self-expansion: The effects of eudaimonic reflections on nature connectedness. *Journal of Environmental Psychology, 94*, Article 102231. https://doi.org/10.1016/j.jenvp.2024.102231

Lengieza, M. L., & Aviste, R. (2025). Relationships between people and nature: Nature connectedness and relational environmental values. *Current Opinion in Psychology, 62*, Article 101984. https://doi.org/10.1016/j.copsyc.2024.101984

Lengieza, M. L., Aviste, R., & Richardson, M. (2023). The human–nature relationship as a tangible target for pro-environmental behaviour—guidance from interpersonal relationships. *Sustainability, 15*(16), 12175. https://doi.org/10.3390/SU151612175

Lengieza, M. L., Aviste, R., & Swim, J. K. (2023a). Connectedness to nature through outdoor environmental education: Insights from psychology. *International Explorations in Outdoor and Environmental Education, 12*, 49–81. https://doi.org/10.1007/978-3-031-29257-6_4

Lengieza, M. L., Aviste, R., & Swim, J. K. (2023b). Nature as community: An overlooked predictor of pro-environmental intentions. *Journal of Environmental Psychology, 91*, Article 102127. https://doi.org/10.1016/j.jenvp.2023.102127

Lengieza, M. L., Richardson, M., & Aviste, R. (2025). Situation networks: The emotions and activities that are central to nature-connectedness experiences. *Journal of Environmental Psychology, 101*, Article 102491. https://doi.org/10.1016/j.jenvp.2024.102491

Lengieza, M. L., & Swim, J. K. (2021a). Diminished public self-awareness in nature contributes to the positive effects of contact with nature on connectedness to nature. *Ecopsychology, 13*(3), 210–218. https://doi.org/10.1089/eco.2020.0047

Lengieza, M. L., & Swim, J. K. (2021b). The paths to connectedness: a review of the antecedents of connectedness to nature. *Frontiers in Psychology, 12*. https://doi.org/10.3389/fpsyg.2021.763231

Lumber, R., Richardson, M., & Sheffield, D. (2017). Beyond knowing nature: Contact, emotion, compassion, meaning, and beauty are pathways to nature connection. *PLoS One, 12*(5), 1–25. https://doi.org/10.1371/journal.pone.0177186

Mackay, C. M. L., & Schmitt, M. T. (2019). Do people who feel connected to nature do more to protect it? A meta-analysis. *Journal of Environmental Psychology, 65*, Article 101323. https://doi.org/10.1016/j.jenvp.2019.101323

Mayer, F. S., Frantz, C. M., Bruehlman-Senecal, E., & Dolliver, K. (2009). Why is nature beneficial? *Environment and Behavior, 41*(5), 607–643. https://doi.org/10.1177/0013916508319745

McEwan, K., Ferguson, F. J., Richardson, M., & Cameron, R. (2020). The good things in urban nature: A thematic framework for optimising urban planning for nature connectedness. *Landscape and Urban Planning, 194*, Article 103687.

Natural England. (2020). *Building partnerships for Nature's recovery*. https://www.gov.uk/government/publications/natural-england-building-partnerships-for-natures-recovery/building-partnerships-for-natures-recovery.

Neuman, M., Jonsson, V., Calatayud, J., & Rosvall, M. (2022). Cross-validation of correlation networks using modular structure. *Applied Network Science, 7*(1). https://doi.org/10.1007/S41109-022-00516-5

Nisbet, E. K., & Zelenski, J. M. (2011). Underestimating nearby Nature. *Psychological Science, 22*(9), 1101–1106. https://doi.org/10.1177/0956797611418527

Pritchard, A., Richardson, M., Sheffield, D., & McEwan, K. (2020). The relationship between nature connectedness and eudaimonic well-being: A meta-analysis. *Journal of Happiness Studies, 21*(3), 1145–1167. https://doi.org/10.1007/s10902-019-00118-6

Richardson, M., Hallam, J., & Lumber, R. (2015). One thousand good things in nature: aspects of nearby nature associated with improved connection to nature. *Environmental Values, 24*(5), 603–619. https://doi.org/10.3197/096327115X14384223590131

Richardson, M., Hamlin, I., Elliott, L. R., & White, M. P. (2022). Country-level factors in a failing relationship with nature: Nature connectedness as a key metric for a sustainable future. *Ambio, 51*(11), 2201–2213. https://doi.org/10.1007/S13280-022-01744-W/TABLES/3

Richardson, M., & Sheffield, D. (2015). Reflective self-attention: A more stable predictor of connection to nature than mindful attention. *Ecopsychology, 7*(3), 166–175. https://doi.org/10.1089/eco.2015.0010

Richardson, M., & Sheffield, D. (2017). Three good things in nature: Noticing nearby nature brings sustained increases in connection with nature. *Psyecology, 8*(1), 1–32.

Sanguinetti, A. (2014). Transformational practices in cohousing: Enhancing residents' connection to community and nature. *Journal of Environmental Psychology, 40*, 86–96. https://doi.org/10.1016/j.jenvp.2014.05.003

Schultz, P. W. (2002). Inclusion with nature: The psychology of human-nature relations, 10.1007/978-1-4615-0995-0_4. In *Psychology of sustainable development* (pp. 61–78). US: Springer.

Schutte, N. S., & Malouff, J. M. (2018). Mindfulness and connectedness to nature: A meta-analytic investigation. *Personality and Individual Differences, 127*, 10–14. https://doi.org/10.1016/J.PAID.2018.01.034

SEI & CEEW. (2022). *Stockholm+50: Unlocking a Better Future*. https://doi.org/10.51414/sei2022.011.

Sheffield, D., Butler, C. W., & Richardson, M. (2022). Improving nature connectedness in adults: A meta-analysis. *Review and Agenda. Sustainability, 14*(19), 12494. https://doi.org/10.3390/su141912494

Stagg, B. C., & Dillon, J. (2022). Plant awareness is linked to plant relevance: A review of educational and ethnobiological literature (1998–2020). *Plants, People, Planet, 4*(6), 579–592. https://doi.org/10.1002/ppp3.10323

Stehl, P., White, M. P., Vitale, V., Pahl, S., Elliott, L. R., Fian, L., & van den Bosch, M. (2024). From childhood blue space exposure to adult environmentalism: The role of nature connectedness and nature contact. *Journal of Environmental Psychology, 93*, Article 102225. https://doi.org/10.1016/j.jenvp.2023.102225

Swami, V., White, M. P., Voracek, M., Tran, U. S., Aavik, T., Ranjbar, H. A., Adebayo, S. O., Afhami, R., Ahmed, O., Aimé, A., Akel, M., Al Halbusi, H., Alexias, G., Ali, K. F., Alp-Dal, N., Alsalhani, A. B., Álvarez-Solas, S., Soares Amaral, A. C., Andrianto, S., & Stieger, S. (2024). Exposure and connectedness to natural environments: An examination of the measurement invariance of the Nature Exposure Scale (NES) and Connectedness to Nature Scale (CNS) across 65 nations, 40 languages, gender identities, and age groups. *Journal of Environmental Psychology, 99*, Article 102432. https://doi.org/10.1016/j.jenvp.2024.102432

Tam, K.-P. (2013). Concepts and measures related to connection to nature: Similarities and differences. *Journal of Environmental Psychology, 34*, 64–78. https://doi.org/10.1016/j.jenvp.2013.01.004

Tam, K.-P., Lee, S.-L., & Chao, M. M. (2013). Saving Mr. Nature: Anthropomorphism enhances connectedness to and protectiveness toward nature. *Journal of Experimental Social Psychology, 49*(3), 514–521. https://doi.org/10.1016/j.jesp.2013.02.001

Tan, C., Chen, W. Y., Su, Y., Fritsch, A., Canu, P., Cao, Y., Vazhayil, A. M., & Wantzen, K. M. (2024). Wild or neat? Personal traits affect public preference for wildness of urban lakeshores in France and China. *Landscape and Urban Planning, 252*, Article 105190. https://doi.org/10.1016/j.landurbplan.2024.105190

Tiscareno-Osorno, X., Demetriou, Y., Marques, A., Peralta, M., Jorge, R., MacIntyre, T. E., MacIntyre, D., Smith, S., Sheffield, D., Jones, M. V., Beckmann, J., & Schönbach, D. M. I. (2023). Systematic review of explicit instruments measuring nature connectedness: What do we know and what is next? *Environment and Behavior, 55*(8–10), 551–608. https://doi.org/10.1177/00139165231212321

UN Climate Change News. (2020, December). *UN Secretary-General: "Making Peace with Nature is the Defining Task of the 21st century."* https://unfccc.int/news/un-secretary-general-making-peace-with-nature-is-the-defining-task-of-the-21st-century.

Walters, A. B., Drescher, C. F., Baczwaski, B. J., Aiena, B. J., Darden, M. C., Johnson, L. R., Buchanan, E. M., & Schulenberg, S. E. (2014). Getting active in the Gulf: Environmental attitudes and action following two Mississippi coastal disasters. *Social Indicators Research, 118*(2), 919–936. https://doi.org/10.1007/s11205-013-0428-2

Weinstein, N., Przybylski, A. K., & Ryan, R. M. (2009). Can nature make us more caring? Effects of immersion in nature on intrinsic aspirations and generosity. *Personality and Social Psychology Bulletin, 35*(10), 1315–1329. https://doi.org/10.1177/0146167209341649

Whitburn, J., Linklater, W., & Abrahamse, W. (2020). Meta-analysis of human connection to nature and proenvironmental behavior. *Conservation Biology, 34*(1), 180–193. https://doi.org/10.1111/cobi.13381

Whitburn, J., Linklater, W. L., & Milfont, T. L. (2019). Exposure to urban nature and tree planting are related to pro-environmental behavior via connection to nature, the use of nature for psychological restoration, and environmental attitudes. *Environment and Behavior, 51*(7), 787–810. https://doi.org/10.1177/0013916517751009

Wyles, K. J., White, M. P., Hattam, C., Pahl, S., King, H., & Austen, M. (2019). Are some natural environments more psychologically beneficial than others? The importance of type and quality on connectedness to nature and psychological restoration. *Environment and Behavior, 51*(2), 111–143. https://doi.org/10.1177/0013916517738312

Yan, Z., Liao, J., Dale, K. R., Arpan, L. M., & Raney, A. A. (2024). The effects of awe-inspiring nature videos on connectedness to nature and proenvironmental intentions. *Psychology of Popular Media*. https://doi.org/10.1037/ppm0000521

Yuille, A., Davies, J., Green, M., Hardman, C., Knight, J., Marshall, R., Armitt, H., Bane, M., Bush, A., Carr, V., Clark, R., Cox, S., Crotty, F., de Bell, S., Edwards, A., Ferguson, J., Fry, R., Goddard, M., Harrod, A., & White, P. (2024). Moving from features to functions: Bridging disciplinary understandings of urban environments to support healthy people and ecosystems. *Health & Place, 90*, Article 103368. https://doi.org/10.1016/j.healthplace:2024.103368

Zeller, K. A., Ditmer, M. A., Squires, J. R., Rice, W. L., Wilder, J., DeLong, D., Egan, A., Pennington, N., Wang, C. A., Plucinski, J., & Barber, J. R. (2024). Experimental recreationist noise alters behavior and space use of wildlife. *Current Biology, 34*(13), 2997–3004.e3. https://doi.org/10.1016/j.cub.2024.05.030