

## Human-nature connection: a multidisciplinary review

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### Abstract

In sustainability science calls are increasing for humanity to (re-)connect with nature, yet no systematic synthesis of the empirical literature on Human-Nature Connection (HNC) exists. We review 475 publications on HNC and find that most research has concentrated on individuals at local scales often leaving ‘nature’ undefined. Cluster analysis identified three subgroups of publications: (1) *HNC as mind*, dominated by the use of psychometric scales, (2) *HNC as experience*, characterised by observation and qualitative analysis; and (3) *HNC as place*, emphasising place attachment and reserve visitation. To address the challenge of connecting humanity with nature, future HNC scholarship must pursue cross-fertilization of methods and approaches, extend research beyond individuals, local scales, and Western societies, and increase guidance for sustainability transformations.

### Keywords

Nature connection, sustainability transformation, environmental psychology, nature experience, place attachment.

37 **Introduction**

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39 The relationship between people and nature has attracted rising interest among scientists, given  
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60 evidence of health and well-being benefits from human interaction with nature [1–3] and to the  
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81 contribution of natural experiences to addressing sustainability challenges [4–6]. Indeed, while  
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112 humanity is ultimately dependent on natural resources, the urgent need for human populations  
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13 (particularly those in the West) to be reconnected to nature or embedded within ecological limits  
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154 has been recently emphasised by many sustainability scientists [7–12]. These calls for  
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185 (re)connection to and embeddedness within nature have implied more than physical dependence,  
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2046 but active development of cognitive, emotional and biophysical linkages that positively shape  
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237 human-nature interactions. Research on this topic has been characterised by a plurality of  
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2548 disciplinary and conceptual perspectives, language, methods and research approaches. With this  
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289 heterogeneity, the literature has become fragmented, compromising the consolidation of ideas and  
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30 their application to practice. A first step towards consolidation is to generate a coherent overview of  
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331 existing scholarship.

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373 In reviewing this literature, clear terminology is critical. We adopt the term ‘Human Nature  
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404 Connection’ (HNC) as an umbrella concept, encompassing a broad range of terms from different  
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425 disciplines and applications [13], for instance connectedness with nature [14] or nature relatedness  
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456 [6] in environmental psychology and (re-)connection to the biosphere [7,11] in sustainability  
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477 science. Some reviews of HNC have emerged recently [3,5,15], but they are couched within  
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508 particular disciplinary perspectives and use narrow definitions of ‘connection’. In this study we  
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529 elected not to prescribe a strict definition of ‘nature’, but were guided by the perspective of articles  
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550 reviewed. Reviewed literature reported on places, landscapes and ecosystems that are not  
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571 completely dominated by people, but also include non-human organisms, species and habitats. With  
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62 this review we intend to provide a multidisciplinary space for academic and cultural integration,  
63 extension and cross-fertilization.

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65 We report the findings of systematic review of scholarly publications from a range of disciplinary  
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86 backgrounds that have empirically investigated HNC. We sought to (i) assess the diversity of  
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169 distinguishing characteristics; and (iii) consider how future research on HNC can better inform  
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## 232 **Methods**

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284 The Scopus database was queried with a search string comprised of 41 components that combined a  
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336 full search string). The search was applied to Abstract, Title and Keywords on 16 November 2015  
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89 Each paper was coded for: (a) descriptive information about the article (e.g. country, journal and  
 2 discipline); (b) conception of ‘nature’; (c) social group analysed (e.g. individuals vs communities);  
 30 4 (c) class of HNC(s) studied; (d) methodological details; and (e) the purpose for the study. Response  
 5 81 categories for all questions were developed iteratively by the author team. The final typology  
 7 82 distinguished between five classes of HNC: material (e.g. resource extraction), experiential (e.g.  
 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65  
 103 distinguished between five classes of HNC: material (e.g. resource extraction), experiential (e.g.  
 104 activities), cognitive (e.g. attitudes, values), emotional (e.g. fear, joy) and philosophical (e.g.  
 105 ontological frameworks) (see Supplementary appendix 1c for full details and definitions). The first  
 106 10% of papers were coded by multiple authors, and response categories were clarified where  
 107 inconsistencies were found.

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 109 Data on all reviewed publications were analysed in R [16] to generate descriptive statistics,  
 110 multivariate clusters, and an ordination. Agglomerative hierarchical clustering was performed using  
 111 the ‘agnes’ function in the ‘cluster’ package using a Euclidian measure of dissimilarity and Ward’s  
 112 clustering method. ‘Indicator species analysis’ was used to identify which variables most influenced  
 113 these groups using the ‘indval’ function within the ‘labdsv’ package. Ordination of data was  
 114 performed via Detrended Correspondence Analysis using the ‘decorana’ function in the ‘vegan’  
 115 package.

## 116 117 **Results**

### 118 119 *Overview*

120 Research on HNC is increasing (Figure 1), with 345 papers (72.6%) published from 2010 onwards.  
 121 Nondescript or “unspecified” forms of nature were most commonly studied (30.9%), followed  
 122 studies on human connections to urban nature (14.1%), and protected areas (11.9%) (Figure 2).  
 123 Most HNC research targeted individuals (76%), especially local people (24.3%). Most research has

114 studied cognitive (35.9%), experiential (22.0%), emotional (21.8%), and philosophical (13.9%)  
115 connections to nature, whereas material connections (6.5%) have received less attention (Figure 2).  
116 Most studies addressed one (161 papers; 33.9%) or two (169 papers; 35.6%) types of HNC; 97  
117 papers (20.4%) studied three types of connections, 38 papers (8.0%) four types, and 10 papers  
118 (2.1%) studied five types of connection.

119 < Insert Figure 1 >

### 120 121 *Methodological patterns*

122 Empirical research on HNC has been biased towards western countries. The top five countries  
123 represented were USA (152 papers; 32.0%), Australia (54 papers; 11.4%), Canada (42 papers;  
124 8.8%), United Kingdom (27 papers; 5.9%) and The Netherlands (22 papers; 4.6%). HNC has been  
125 mostly observed (87.8%), rather than experimentally tested (12.2%), using quantitative (48.8%),  
126 qualitative (32.0%), or mixed datasets (19.2%) (Figure 2).

127 Similar numbers of studies explored HNC as a predictor variable (31.2%), response variable  
128 (26.7%), or both a predictor and response (17.3%), suggesting that scholars have been equally  
129 interested in the drivers and effects of HNC. However, 24.8% of papers studied HNC as a variable  
130 in itself (i.e. neither as a predictor nor response). Substantial proportions of studies used  
131 psychometric scales (24.6%) or assessed place attachment (28.6%). Psychology was the most  
132 represented discipline in the literature (29.4%), followed by the social sciences (21.4%),  
133 environmental disciplines (15.2%), tourism (10.4%), education (10.3%), planning (7.0%), and  
134 health (6.4%).

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138 < Insert Figure 2 >

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142 Cluster analysis revealed three distinct subgroups of publications (Figure 3), characterised by  
143 different indicator variables (Table 1). We labelled the clusters as follows: *HNC as mind* (145  
144 papers), *HNC as experience* (178 papers), and *HNC as place* (152 papers). The fastest growth in  
145 research over time occurred in publications in the *HNC as mind* cluster (Figure 1), characterised by  
146 studies that address cognitive and philosophical aspects of HNC at the individual level. These  
147 studies commonly investigated students using quantitative research methods to explain, describe,  
148 and predict psychological dynamics and pro-environmental behaviours. However, in this cluster the  
149 concept of nature was generally undefined, and policy guidance was less common than in other  
150 clusters. In contrast to HNC as mind, both HNC as experience and HNC as place focussed on  
151 relationships between specific peoples and places. *HNC as experience* described qualitatively  
152 people’s experiences of particular local areas and were characterised by an observational research  
153 approach. An example of this is Cosquer et al.’s study of people’s interactions with everyday nature  
154 as part of a butterfly citizen science programme in France [17]. In contrast, research in the *HNC as*  
155 *place* cluster typically used quantitative questionnaires to study emotional connections to specific  
156 natural spaces, often at the landscape scale. These studies often also provided policy guidance to  
157 address sustainability issues. For example, Tonge et al. [18] applied place attachment concepts to  
158 explore how visitors related to the Ningaloo Marine Park in Australia and how this influenced  
159 conservation actions.

160 < Insert Figure 3 >  
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162 **Discussion**  
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164 Our findings suggest that research on HNC is receiving increasing interest, but, being highly  
165 heterogeneous, has yet to reach its full potential in supporting humanity on a pathway towards

1 6 6 sustainability. To this end, we propose three key priorities: (i) greater integration of complementary  
1 6 7 perspectives in HNC research; (ii) further extension of HNC research; and (iii) more targeted  
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1 6 8 application of insights to foster sustainability transformation.  
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### 1 7 0 *Complementarity and integration*

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1 7 2 The research clusters identified highlighted disciplinary, methodological and contextual differences  
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1 7 3 (Table 1), which seem to represent co-existing epistemological positions in HNC research. The  
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1 7 4 *HNC as mind* cluster typically encapsulates an objectivist epistemology. These publications draw  
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2 1 5 upon theory and methods from psychology to understand nature connection as a real psychological  
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2 3 6 entity that affects behaviour [see ,6,14]. In contrast, the *HNC as place* largely operates within a  
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2 5 7 constructionist epistemology, with knowledge of nature connection derived through exploring  
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2 8 8 relational interactions between people and specific places [see also ,19]. The *HNC as experience*  
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3 0 9 cluster often adopts a subjectivist epistemology, observing and describing the uniqueness of  
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3 3 0 individuals' experiences of nature. These epistemological differences suggest that resolving the  
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3 5 1 longstanding challenge of defining nature (and non-nature) [see ,20] in a way that unifies  
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3 8 2 disciplines is likely to be difficult.  
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4 2 4 These perspectives are fundamentally different but they contribute complementary insights that may  
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4 5 5 be integrated in future research. First, since *HNC as mind* rarely specifies the type of nature that  
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4 7 6 people are connected to and focuses predominantly on individuals, *HNC as place* can contribute to  
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5 0 7 this literature with an understanding of how HNC of communities is situated in geographical  
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5 2 8 locations, while *HNC as experience* may offer deeper understandings via qualitative descriptions.  
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5 4 9 Second, research on *HNC as place* could be enhanced by the quantitative and more generalisable  
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5 9 0 perspectives of *HNC as mind*, along with the deep and nuanced insights offered by *HNC as*  
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5 9 1 *experience*. Finally, the *HNC as experience* literature could benefit from the statistical rigour of  
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192 *HNC as mind* and the applied focus of *HNC as place*. Full integration of these perspectives is likely  
193 to be difficult [21] and may not be feasible or even appropriate in every case. However, it would be  
194 worth exploring how sustainability science could facilitate cross-fertilization of HNC knowledge in  
195 order to pursue “theoretically and empirically rich solutions-oriented research” [22].

### 196 197 *Extension*

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199 An integrated HNC research agenda for sustainability must address key gaps in the current  
200 literature. Of particular concern for sustainability is the relatively minor focus on material  
201 connections to nature (Figure 2). While there are many fields that study material connections to  
202 nature (e.g. natural resource management), our study focussed on the specific subset that explores  
203 human connections. Material HNC must be better understood as it shapes patterns of resource  
204 consumption, which in turn drive environmental sustainability outcomes [12,23,24]. Moreover,  
205 understanding the relationships between material connections and other ‘internal’ connections to  
206 nature (e.g. cognitive, emotional) will help to explore potential feedbacks and points of intervention  
207 for sustainability transformation [see 20].

208  
209 Second, HNC should be studied in and communicated across a greater diversity of cultural contexts.

210 Of the published articles included in this review, the vast majority has largely been undertaken in  
211 post-industrial, Anglo-Saxon countries. However, this result may be biased due to restricting our  
212 review to articles in English. Relevant literature in non-western cultures might be published in other  
213 languages and express conceptualisations of HNC that are altogether different from those dominant  
214 in Anglo-Saxon cultures [26]. Thus, given the key sustainability challenges at play in the Global  
215 South [27], there is an urgent need for more research from these countries, increased support for  
216 publication of these studies in international journals, and extending HNC research beyond western  
217 cultural framings.



219 Third, future research (particularly in psychology) must specify the characteristics of nature that  
 220 people are connected to. Without such information, it is difficult to know how policies and  
 221 decisions for sustainability should be formulated. For example, there is scant evidence on whether  
 222 interactions with forests, rivers, grasslands or urban parks are more effective in promoting health  
 223 and well-being, or pro-environmental attitudes and behaviours.

224  
 225 Fourth, our review revealed an underrepresentation of research at the community or society level.  
 226 Theories of sustainability transformation highlight the critical importance of action and change at  
 227 this level [28–31]. Therefore, we encourage future exploration of how groups of people, initiatives  
 228 and organisations within society are connected to nature as a way of moving beyond the current  
 229 focus on individuals.

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 231 Finally, there is a need to more strongly relate HNC to specific sustainability issues. Only a small  
 232 portion of the literature addressed the importance of HNC for sustainability. Most literature simply  
 233 described or explained people’s connection to nature, and only publications within the *HNC as*  
 234 *place* cluster regularly offered policy guidance. Directing future research to pressing sustainability  
 235 challenges and explicitly offering practical recommendations appears important.

#### 236 237 *Application*

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 239 There are increasing calls in the literature for a “biosphere-based sustainability science” [8]  
 240 whereby human development progress is intimately connected with stewardship of the planet. We  
 241 affirm these calls, and suggest that such an integrated sustainability science could greatly benefit  
 242 from incorporating the diverse insights from literature on HNC. These insights are critical for  
 243 identifying which social-ecological settings can allow people to enhance their connection with

244 nature, how the multiple types of HNC can foster pro-environmental behaviours, and defining both  
245 the characteristics of a sustainable future and the pathways by which it can be reached.

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247 A strong connection between people and nature is emphasised in key global sustainability  
248 agreements. For example, one target under Goal 12 (responsible consumption and production) of  
249 the Sustainable Development Goals is to “ensure that people everywhere have...awareness  
250 for...lifestyles in harmony with nature”. Similarly, Goal 11 (sustainable cities) includes a target to  
251 provide “universal access to safe, inclusive and accessible, green and public spaces”. The recent UN  
252 New Urban Agenda also seeks to promote “healthy lifestyles in harmony with nature” [32, s 14c].  
253 The implementation of these goals should draw on HNC research.

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255 Finally, HNC research can help inform transformative or transitional pathways towards  
256 sustainability. Scholars have highlighted that the scale of change needed to reach a sustainable  
257 future is beyond what can be achieved via incremental adjustments to current systems [25,33].  
258 Accordingly, theories of social change have considered socio-technological transitions [34] and  
259 social-ecological transformations [35]. In this context, incorporating knowledge of how HNC  
260 influences environmental worldviews, values, attitudes and behaviours may help identify effective  
261 ‘seeds’ of change [29], ‘protected niches’ [36] and ‘deep leverage points’ [25] for sustainability  
262 transformation. For example, insights from HNC research could inform the Smart Cities (IT-based  
263 sustainable cities) discourse, which has inadequately considered how technological solutions may  
264 affect people’s interactions with nature. This is especially important for children, as deep seated  
265 environment-related attitudes are acquired during childhood [37] and persist through adulthood  
266 [38]. Furthermore, rapid land conversion for urbanisation, combined with increased internet access,  
267 population density and new technologies challenge people’s direct sensory experience of nature,  
268 and will likely have negative implications for human health and well-being [39,40].

270 **Conclusion**

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272 The importance of HNC for sustainability is increasingly recognized. The task of sustainability  
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273 scientists now is to establish how different types of nature connections may contribute to positive  
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274 change for sustainability. This review has provided a foundation for this agenda. It has shown that a  
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275 substantial body of empirical research has accrued, yet has remained disparate. We call for  
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276 researchers and practitioners to take stock of this existing evidence, integrate insights across  
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277 methodological, epistemological and geographic boundaries, and pursue novel interdisciplinary  
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278 research that can generate knowledge for a sustainable future characterised by strong connections  
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279 between humanity and the biosphere.  
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287 \* Of special interest

288 \*\* Of outstanding interest

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411 **Table**

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413 **Table 1.** Results of the ‘indicator species analysis’ showing the most pertinent distinguishing  
 414 characteristics of three clusters of papers on Human-Nature Connection (HNC). The coded  
 415 variables are listed as being either concerned with the content of the study, or methodological  
 416 aspects for all of three clusters identified: *HNC as mind*, *HNC as experience*, *HNC as place*.  
 417 Indicator value coefficients are listed (only those  $\geq 0.2$  reported), and denoted as follows: \*\*\* if  
 418 coefficient  $\geq 0.4$ ; \*\* if  $0.4 > \text{coefficient} \geq 0.3$ ; \*  $0.3 > \text{coefficient} \geq 0.2$ .

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Variable	HNC as mind	HNC as experience	HNC as place
CONTENT			
Type of nature	*** Undefined (0.45)		
People studied	*** Students (0.44)	* Other (0.21)	** Locals (0.31) * Tourists (0.27)
Type of connection	* Cognitive (0.29)	* Experiential (0.21)	* Emotional (0.22)
Purpose	* Other (0.22)		
HNC related to other variables	* HNC as a variable in itself (0.23)		
Research on Place attachment	*** No (0.46)		*** Yes (0.47)
Spatial scale	*** Unspecified (0.52)	* Local (0.28)	* Landscape (0.22)
Policy guidance	* No policy guidance (0.28)		* Provides policy guidance (0.22)

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METHODS			
Discipline	*** Psychology (0.50)	* Social sciences (0.26)	* Environmental studies (0.22)
Research approach	* Experimental research (0.28)	** Observational research (0.37)	
Data Type	*** Quantitative (0.45)	*** Qualitative (0.81)	
Data collection		** Structured interviews (0.36) * Open interviews (0.21)	*** Set response survey (0.45)
Unit of analysis	** Individual (0.38)		
Type of analysis	*** Quantitative analysis (0.47)	*** Qualitative analysis (0.56)	
Use of psychometric scales	*** Yes (0.54)	*** No (0.44)	

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421 **Figure captions**

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**Figure 1.** Increase in the number of published studies on Human-Nature Connection (HNC) by year. Colours within bars relate to the three groups as identified by the cluster analysis: HNC as mind, HNC as experience, and HNC as place.

**Figure 2.** Overview of the proportions of studies focusing on particular content or using particular methods. Each bar represents a question that was applied to reviewed papers.

**Figure 3.** (a) Dendrogram of the papers on Human-Nature Connection (HNC) coded in this review. Each coded paper is represented by a vertical line at the bottom of the chart. The similarity between papers is indicated by their distance from one another along the lines of the ‘tree’. (b) Ordination of reviewed papers highlighting three distinct clusters of articles: *HNC as mind* (blue diamonds), *HNC as experience* (green circles), and *HNC as place* (red triangles).

Figure 1.

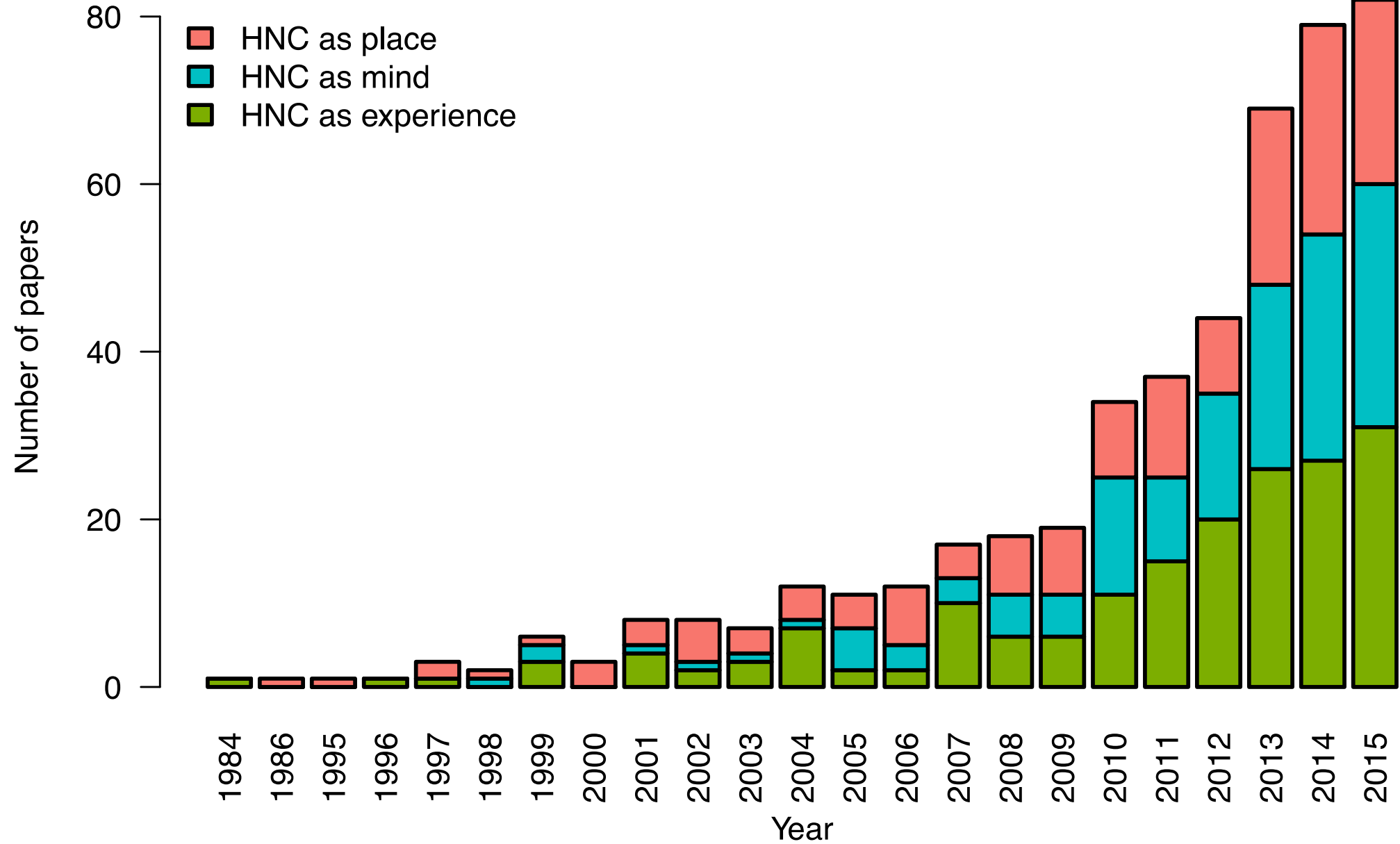


Figure 2.

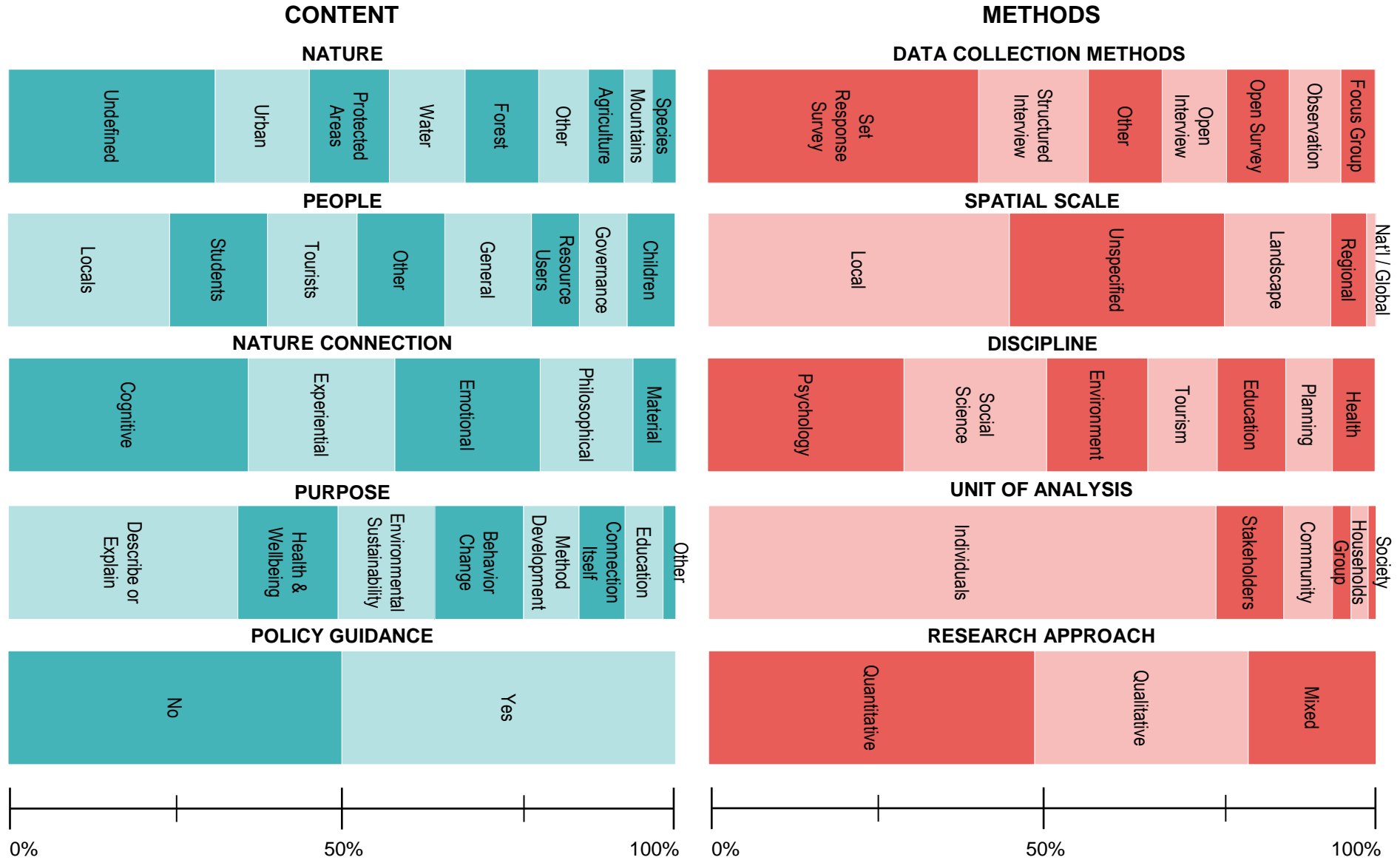


Figure 3.

