Nurturing connection with nature: the role of spending time in different types of nature

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ABSTRACT
Connection with nature has been associated with greater participation in a range of biodiversity conservation behaviours, and is increasingly being recognised as a potentially useful policy tool to address conservation outcomes. Yet, understanding of how connection with nature may be nurtured remains poorly understood. This research investigates the extent to which spending time in nature, and in different types of nature, predicted change in connection with nature (captured by the CN-12) over a 12-month period. Data were from a representative sample (based on age, gender, and metropolitan/regional residence) of the adult population in the state of Victoria, Australia, collected via an online survey. Results of analyses of variance and paired-samples t-tests suggested spending time in nature at least monthly was associated with higher connection with nature scores. Results from multiple linear regression and mediation analyses suggested that more time spent in nature (generally), and more time spent in protected areas, waterways, and urban parks (specifically), predicted small increases in connection with nature. These findings suggest that policies that encourage spending more time in nature, including in protected areas, waterways, and urban parks, could be useful for increasing connection with nature and, in turn, addressing biodiversity conservation outcomes. The findings of this research should be of interest to policymakers interested in addressing biodiversity conservation issues.

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1. Introduction
In recent decades, relationships between humans and nature have gained increased prominence in the conservation literature, with calls to (re)connect people with nature to foster conservation outcomes and sustainability transformations (Zylstra et al. 2014; Ives et al. 2018; Riechers et al. 2021). Researchers have considered human relationships with nature using a range of definitions and constructs, including nature connectedness (Richardson et al. 2020), environmental identity (Clayton 2003), inclusion with nature (Schultz 2002), nature relatedness (Nisbet et al. 2009), and human-nature connection or connectedness (Ives et al. 2017, 2018; Barragan-Jason et al. 2021; see also Tam 2013; Restall and Conrad 2015). While there is nuance in these constructs, commonalities can also be noted, with definitions typically referring to a sense of interrelationship between humans and the natural world that is subjective and personal, relatively stable across time, and includes thoughts, emotions, and behaviours (Hatty et al. 2020). Following Ives et al. (2017), we seek to capture the range of terminology and constructs in the literature, adopting the term connection with nature (CN) ‘because it evokes the subtle yet important idea that (1) humans are already an intimate part of nature and (2) that the state imbues a sense of reciprocity and mutualism’ (Zylstra et al. 2014, pp. 121–122).
Some have argued that CN is an important driver of behaviours that protect the natural environment (Schultz 2002; Zylstra et al. 2014; Otto and Pensini 2017). Recent work supports this notion, with positive relationships described between CN and a broad range of pro-environmental behaviours (PEB) (Mackay and Schmitt 2019; Whitburn et al. 2019), and between CN and behaviours that specifically protect and enhance biodiversity, or pro-biodiversity behaviours (PBB) (Prévet et al. 2018; Martin et al. 2020; Richardson et al. 2020).
In recent years, policymakers internationally are increasingly recognising human-nature relationships in conservation. The Convention on Biological Diversity (CBD) includes the vision ‘living in harmony with nature’ (Convention on Biological Diversity [CBD] Secretariat 2011, 2021), while the importance of nurturing CN for conservation has been presented at a recent CBD Convention of the Parties meeting (Convention on Biological Diversity [CBD] 2018) and appears in the Global Biodiversity Outlook 5 report (Convention on Biological Diversity [CBD] Secretariat 2020). Such ideas are also reflected in the biodiversity conservation
strategies of countries such as New Zealand (Department of Conservation 2020) and Malaysia (Ministry of Natural Resources and Environment 2016). In Australia, the role of (re)connecting people with nature to leverage biodiversity conservation has been recognised by both federal and state governments, with the assumption that doing so will enhance Australians’ valuing of, and willingness to protect, nature (Department of Environment, Land, Water and Planning [DELWP], 2017; Australian Government 2019). For (re)connection with nature to be a useful tool in environmental policy and management, however, it is necessary to understand the factors that influence CN over time (Restall and Conrad 2015; Hughes et al. 2019).

Despite increasing recognition of the important role CN may play in fostering PEB/PBB, understanding how a stable sense of CN develops, is maintained, or may be nurtured, is somewhat limited (Cleary et al. 2018; Ives et al. 2018). While researchers have identified a number of factors that predict CN (e.g. Lumber et al. 2017; Chawla 2020; Richardson et al. 2020), of particular interest is time spent in nature.

Early research proposed that frequency of time spent in nature (TIN) was among the strongest predictors of CN (Kals et al. 1999). Indeed, both frequency of visits to nature (Cleary et al. 2018; Prévot et al. 2018) and longer duration of TIN (e.g. hours per day/week: Dornhoff et al. 2019; Pérez-Ramírez et al. 2021) have been associated with greater CN. Further, environmental education programs of longer duration may facilitate higher CN scores post-program than shorter programs (Braun and Dierkes 2017; Barrable and Booth 2020).

Another question is what types of nature may best facilitate CN. Much research to date has considered CN as a generic construct without considering the context or type of nature people connect to (Ives et al. 2017; Giusti et al. 2018). Yet, there are many different types of natural spaces where human-nature interactions occur, such as domestic, urban and botanic gardens; beaches and waterways; and protected areas including national parks (Clayton and Myers 2009; Keniger et al. 2013). People likely perceive, interact with, and respond to these different types of natural spaces in different ways (Davis et al. 2016; Pasca et al. 2020) which may have implications for how and when they connect with nature (de Bell et al. 2018).

Some researchers have explored relationships between time spent in different types of nature and CN. Schultz and Tabanico (2007) reported increased CN following a day at a wildlife park, and positive correlations between CN and the amount of time spent at a beach or hiking trail, but not a golf course. Scopelliti et al. (2016) noted that users of parks with higher natural values (i.e. greater biodiversity) tended to have higher CN scores than users of parks with lower natural values (i.e. less biodiversity), while Mena-García et al. (2020) reported that walking in the countryside was associated with greater increase in CN than walking in urban parks. Wyles et al. (2019) described higher CN following visits to rural than to urban natural areas, and for visits to protected areas than to non-protected areas. Together, these studies suggest that time spent in different types of natural environments may influence CN in different ways, with time spent in areas with higher natural values, such as national parks, likely to have a greater influence on CN than time spent in areas with lower natural values, such as urban parks.

Yet, with increasing urbanisation and decreasing opportunities to experience wilder-type nature (United Nations Department of Economic and Social Affairs 2019; Australian Bureau of Statistics 2020), connecting urban residents with nature may require spending time in ‘managed’ contexts such as zoos or urban parks (Clayton 2017; Cleary et al. 2018). Indeed, future conservation efforts may depend on fostering relationships with urban nature, as this is where nature is most likely to be encountered (Dunn et al. 2006; Gaston and Soga 2020). Thus, understanding the relationship between time spent in different types of nature and CN may have utility in informing policy and programs intended to (re)connect people with nature (e.g. DELWP, 2017), particularly in urban contexts.

The primary aim of this research is to explore relationships between time spent in nature, and in different types of nature, and CN. While previous research has used cross-sectional (e.g. Cleary et al. 2018) or pre-post experimental methodologies (e.g. Braun and Dierkes 2017), this research will consider change over a 12-month period without an experimental manipulation but allowing for natural variation in experience.

It has been suggested that repeated experiences in nature over time are required to develop a stable sense of CN (Chawla 2020; Salazar et al. 2020; Carr and Hughes 2021; Clayton et al. 2021). This research, therefore, considers whether greater frequency of spending time in nature – generally and in different types of nature – over a 12-month period predicts an increase in CN over the same time period.

We propose two hypotheses:

**H1** More time spent in nature over the 12-month period – generally and in different types of nature – will be associated with increased CN.

**H2** The frequency of time spent in nature (generally and in different types of nature) will mediate the relationship between CN at Time 1 (baseline) and CN at Time 2 (12-months later).

### 2. Method

#### 2.1. Participants and procedure

We used data described by Meis-Harris et al. (2019) and Hatty et al. (2020), that were part of a larger study
exploring attitudes toward, and use of, the natural environment in the state of Victoria, Australia. These surveys were intended to capture a benchmark of Victorians’ attitudes toward and experiences of the natural environment in a broad sense, rather than of specific places or locations. Data were collected using an online panel survey company with participants responding to questionnaires at two time points: September/October 2018 (Time 1) and September/October 2019 (Time 2). The total sample ($N = 1069$) was broadly representative of the Victorian adult (18+ years) population relative to age, gender, and metropolitan/regional residence. Survey questions captured CN, TIN, and demographics, as described below (Appendix A). The age range of the final sample ($n = 1036$) was 19 to 88 years ($m = 53.065, SD = 14.790$) and comprised 48.8% females ($n = 506$).

2.2. Measures

2.2.1. Connection with nature (CN)
The CN-12 was used to capture CN at Time 1 and Time 2. This scale (Appendix B) comprises three dimensions (CN-Identity, CN-Experience, CN-Philosophy) that are strongly correlated yet contribute to a higher order construct (CN-Total) (see Hatty et al. 2020 for exploratory and confirmatory factor analyses of the data). Responses are provided on a 7-point Likert scale (1 = strongly disagree, 7 = strongly agree). Items were averaged to create a composite score (Cronbach’s $\alpha$: Time 1 = 0.928, Time 2 = 0.924).

2.2.2. Time spent in nature in the past year
The frequency of time spent in nature in the previous 12 months (captured at Time 2) was assessed using seven items. Participants reported how often they had generally spent time in nature in the past year (TIN past year) on a 9-point ordinal scale (1 = never to 9 = every day). Responses were recoded into four categories (1 = never/rarely [twice yearly or less]; 2 = sometimes [monthly]; 3 = often [weekly/fortnightly]; 4 = very often [daily/every other day]) to ensure consistency of response options with questions assessing time spent in different types of nature.

Participants also reported how often they spent time in six different types of natural areas in the past year on a 5-point ordinal scale (1 = never to 5 = very often [e.g. daily or every other day]): 1) a protected or wilderness area (TIN wilderness); 2) the beach or coastal areas (TIN beach); 3) a lake, river or other waterway (TIN waterway); 4) a zoo, wildlife park, or botanical garden (TIN zoo); 5) an urban park (TIN urban park); and 6) your garden at home, or the garden of a friend, neighbour or family member (TIN garden). No further description or examples of these natural areas were provided, allowing participants to infer their own meanings of these different types of nature. Each variable was recoded to create a 4-point scale (1 = never/rarely [twice yearly or less]; 2 = sometimes [monthly]; 3 = often [weekly/fortnightly]; 4 = very often [daily/every other day]).

2.2.3. Demographics (age, gender, urbanicity)

Previous research has suggested that age and gender are both associated with CN and TIN (e.g. Dornhoff et al. 2019; Hughes et al. 2019; Richards et al. 2020). Therefore, following Cleary et al. (2018) and Richardson and Hamlin (2021), we included age (in years) and gender (male, female, other) as control variables. In addition, time spent in different types of nature is likely influenced by the level of access to different natural areas. We therefore included urbanicity (self-reported place of residence: inner city, urban/suburban, peri-urban, rural) as a control variable.

2.2.4. Data analyses

We ran descriptive statistics and correlations to provide an overview of the data. We initially explored whether spending time in nature (i.e. at least monthly) was associated with higher or lower CN (Time 1 and Time 2) using one-way analysis of variance (ANOVA) across TIN categories, with planned contrasts (never/rarely vs sometimes + often + very often) (Table 1). We then explored whether CN scores increased or decreased over the 12-month period using paired samples t-tests (two-sided $p$ using CN scores (Time 1 and Time 2) for each frequency category (never/rarely, sometimes, often, very often) (Figure 2 and Appendix C).

To assess H1, we conducted two hierarchical multiple linear regression analyses. In both regressions, age, gender, and urbanicity were entered at Step 1, and CN at Time 1 entered at Step 2. In the first regression, time spent in nature (generally) was entered at Step 3; in the second regression, time spent in the six types of nature were entered together at Step 3. To assess H2, we conducted two mediation analyses with 95% bootstrap confidence intervals of indirect effects (5000 bootstrap samples) using the PROCESS v4.1 macro (Hayes 2022). Analyses were conducted using IBM SPSS Statistics Version 28 (IBM Corp 2021).

Data were screened for assumptions (Field 2013). Thirty-three cases identified as outliers (CN at Time 1 and/or CN at Time 2 with z scores $<-2.58$), with missing data, and/or with standardised residuals greater than 3.29 were removed (final $n = 1036$). Inspection of P-P and ZPRED*ZRESID plots suggested the assumptions of normality of residuals, linearity, and homoscedasticity (respectively) were met. Durbin-Watson (1.999–2.007), VIF (1.030–1.401), and tolerance (0.718–0.983) statistics indicated the assumptions of independent errors and multicollinearity were met (Field 2013). An a priori power analysis suggested the sample would be adequate
to detect a small effect \((n = 818\) required for \(f^2 = 0.020, \alpha = 0.050\), power = 0.800, with 10 predictor variables).

3. Results

Descriptive statistics suggested a relatively even distribution of participants spending time in nature generally and in urban parks. In contrast, a majority of respondents had never/rarely spent time in wilderness areas or zoos/wildlife parks/botanic gardens, while most had spent time in domestic gardens often or very often (Figure 1).

Levene statistics for one-way ANOVA indicated homogeneous variances (Appendix C). ANOVA results suggested that spending time in nature at least monthly (i.e. sometimes, often, or very often) was associated with higher CN scores (Time 1 and Time 2) than spending little or no time in nature (i.e. never/rarely). This finding was consistent for all TIN variables, with the exception of spending time at a zoo/wildlife park/botanic garden for CN at Time 2 (Table 1 and Appendix B).

Paired samples t-tests suggested significant increases in CN (Time 1 to Time 2) for all time spent in nature variables: TIN past year (often); TIN wilderness, TIN beach, TIN zoo (sometimes), TIN waterway (sometimes, often), TIN urban park (often, very often), and TIN garden (very often) (Figure 2).

### Table 1. One-way ANOVA comparing CN scores (Time 1 and Time 2) across time spent in nature categories (never/rarely, sometimes, often, very often) for the seven time spent in nature variables. Planned contrasts (never/rarely vs sometimes + often + very often) are shown \((n = 1036; df = \text{degrees of freedom})\).

|                  | ANOVA      |                                   |                  | Contrasts        |                                   |
|------------------|------------|-----------------------------------|------------------|-------------------|-----------------------------------|
|                  | \(F\)      | \(df = 3\) | \(p\) | \(\eta^2\) | \(F\)      | \(df = 1\) | \(p\) | \(\eta^2\) |
| TIN past year    |            |                      |                |                  | 102.865 | <0.001 | 0.091 |
| Time 1           | 53.847     | <0.001               | 0.135           | Time 2            | 139.861 | <0.001 | 0.119 |
| Time 2           | 73.323     | <0.001               | 0.176           |                  | 30.689  | <0.001 | 0.029 |
| TIN wilderness   |            |                      |                |                  | 33.214  | <0.001 | 0.031 |
| Time 1           | 32.310     | <0.001               | 0.086           | Time 2            | 43.131  | <0.001 | 0.040 |
| Time 2           | 36.112     | <0.001               | 0.095           |                  | 64.224  | <0.001 | 0.059 |
| TIN beach        |            |                      |                |                  | 11.893  | <0.001 | 0.032 |
| Time 1           | 23.651     | <0.001               | 0.064           | Time 2            | 90.952  | <0.001 | 0.081 |
| Time 2           | 34.768     | <0.001               | 0.092           |                  | 4.761   | <0.029 | 0.005 |
| TIN water        |            |                      |                |                  | 12.134  | <0.001 | 0.025 |
| Time 1           | 16.181     | <0.001               | 0.045           | Time 2            | 2.565   | <0.110 | 0.002 |
| Time 2           | 26.867     | <0.001               | 0.072           |                  | 47.624  | <0.001 | 0.044 |
| TIN zoo          |            |                      |                |                  | 8.878   | <0.001 | 0.034 |
| Time 1           | 38.780     | <0.001               | 0.101           | Time 2            | 21.832  | <0.001 | 0.021 |
| Time 2           | 41.861     | <0.001               | 0.108           |                  | 26.853  | <0.001 | 0.025 |

**Figure 1.** Percentage of respondents spending time in nature over the past year (never/rarely, sometimes, often, very often): generally (TIN past year); in protected or wilderness areas (TIN wilderness); at beach or coastal areas (TIN beach); at a lake, river or other waterway (TIN waterway); at a zoo, wildlife park, or botanical garden (TIN zoo); at an urban park (TIN urban park); and at a garden at home, or the garden of a friend, neighbour or family member (TIN garden) \((n = 1036)\).
time spent in nature making a small but significant contribution to CN at Time 2 (Step 3: $\Delta R^2 = 0.017$).

For time spent in different types of nature (protected/wilderness area, beach/coast, lake/rive/other waterway, zoo/wildlife park-botanic garden, urban park, domestic garden), the full regression model (Table 2) accounted for 66% of the variation in levels of CN at Time 2 (adjusted $R^2 = 0.662$). As in the previous analysis, CN at Time 1 made the largest contribution to CN at Time 2 (Step 2: $\Delta R^2 = 0.603$), with time spent in different types of nature together making a small but significant contribution to CN at Time 2 (Step 3: $\Delta R^2 = 0.023$). Among the different types of nature, three significantly predicted CN at Time 2: time spent in wilderness/protected...
### Table 2. Hierarchical multiple linear regression analyses predicting connection with nature at Time 2 (CN at Time 2), from time spent in nature in the past year (TIN past year: Step 3, left), and time spent in different types of nature (wilderness, beach, waterway, zoo, urban park, garden: Step 3, right) [SE=standard error, 95% confidence intervals in brackets] \(n=1036\).

|            | Step 1 | Step 2 | Regression 1: TIN (past year) | Regression 2: TIN (different types) |
|------------|--------|--------|-----------------------------|-------------------------------------|
| **Constant** | 4.367  | 0.152  | 0.124  | 0.983  | 0.121  | 0.968  |
|             | (4.069,4.665) |        | (0.725,1.210) | (0.746,1.220) | (0.725,1.210) | (0.725,1.210) |
| **Age**     | 0.006  | 0.002  | 0.001  | 0.002  | 0.001  | 0.002  |
|             | (0.002,0.010) |        | (0.000,0.005) | (0.000,0.005) | (0.000,0.005) | (0.000,0.005) |
| **Gender**  | 0.277  | 0.058  | 0.036  | 0.088  | 0.035  | 0.089  |
|             | (0.163,0.391) |        | (0.038,0.178) | (0.019,0.156) | (0.019,0.156) | (0.019,0.156) |
| **Urbanicity** | 0.089  | 0.035  | 0.022  | -0.101 | 0.021  | 0.035  |
|             | (0.019,0.158) |        | (0.009,0.052) | (-0.052,0.032) | (-0.052,0.032) | (-0.052,0.032) |
| **CN at Time 1** | 0.769  | 0.018  | 0.788  | 0.722  | 0.019  | 0.968  |
|             | (0.733,0.806) |        | (0.733,0.806) | (0.684,0.760) | (0.684,0.760) | (0.684,0.760) |
| **TIN past year** |        |        | 0.968  |        |        | 0.124  |
| **TIN wilderness** |        |        |        |        |        | (0.725,1.210) |
| **TIN beach** |        |        |        |        |        | (0.725,1.210) |
| **TIN waterway** |        |        |        |        |        | (0.725,1.210) |
| **TIN zoo** |        |        |        |        |        | (0.725,1.210) |
| **TIN urban** |        |        |        |        |        | (0.725,1.210) |
| **TIN garden** |        |        |        |        |        | (0.725,1.210) |

\[ F_{(3,1032)} = 14.100, \text{ Adj. } R^2 = 0.037, \ p < 0.001, \hat{f}^2 = 0.041 \]

\[ \Delta F_{(1,1031)} = 1737.367, \Delta R^2 = 0.603, \ p < 0.001, \hat{f}^2 = 1.519 \]

\[ \Delta F_{(1,1030)} = 50.625, \Delta R^2 = 0.017, \ p < 0.001, \hat{f}^2 = 0.017 \]

\[ \Delta F_{(1,1029)} = 11.572, \Delta R^2 = 0.023, \ p < 0.001, \hat{f}^2 = 0.024 \]
areas (TIN wilderness: $\beta = 0.045$); lake/river/other waterway (TIN water: $\beta = 0.051$); and urban parks (TIN urban park: $\beta = 0.096$).

3.2. H2: The frequency of time spent in nature (generally and in different types of nature) will mediate the relationship between CN at Time 1 (baseline) and CN at Time 2 (12-months later).

We conducted a simple mediator analysis to determine whether time spent in nature (generally) mediated the relationship between CN at Time 1 and CN at Time 2. The final model suggested positive and significant direct and indirect effects; the total effect of CN at Time 1 on CN at Time 2 was 0.769 ($t = 41.682, p < 0.001$), with a direct effect ($c$) of 0.722 ($t = 37.556, p < 0.001$), and indirect effect ($ab$) of 0.047 ($t = 5.875, 95\% CI [0.032, 0.065]$) (Figure 3).

We then conducted a parallel multiple mediator analysis to determine whether time spent in different types of nature mediated the relationship between CN at Time 1 and CN at Time 2. The final model suggested positive and significant direct and indirect effects. The total effect of CN at Time 1 on CN at Time 2 was 0.769 ($t = 41.682, p < 0.001$), with a direct effect ($c$) of 0.712 ($t = 36.240, p < 0.001$). CN at Time 1 predicted all time spent nature variables ($a_1$-$a_9$). Results suggested specific indirect effects of three mediators (in the presence of other mediators): TIN wilderness ($a_1b_1 = 0.013, t = 2.167, 95\% CI [0.001, 0.026]$); TIN water ($a_2b_3 = 0.013, t = 2.600, 95\% CI [0.003, 0.024]$); and TIN urban park ($a_5b_5 = 0.021, t = 4.200, 95\% CI [0.011, 0.031]$) (unstandardized coefficients) (Figure 4).

4. Discussion

For CN to be useful in conservation policy and management, understanding how a stable sense of CN may be nurtured is essential. This research sought to determine the extent to which time spent in nature, and in different types of nature, contributed to an increase in CN over a 12-month period.

As CN is relatively stable over time (Nisbet et al. 2011; Hatty et al. 2020), it is important to note that small changes in CN at Time 2 were expected. Overall, the findings suggest that more time spent in nature was associated with slightly higher CN scores at Time 2. Among those who spent time in nature at least monthly over the 12-month period, CN scores tended to increase over the same time period, while among those who spent little or no time in nature (i.e. less than monthly), CN scores did not change over the year. Results further suggested that participants who spent more time in wilderness/protected areas, along rivers/lakes or other waterways, and in urban parks tended to have slightly higher CN at Time 2, regardless of CN at Time 1.

Previous research has suggested that areas with higher natural values (e.g. those with greater biodiversity) may be more useful for nurturing CN than areas with lower natural values (Scopelliti et al. 2016; Wyles et al. 2019; Mena-Garcia et al. 2020). The present findings suggest that while spending time in wilder-type areas (i.e. wilderness/protected areas and waterways) does predict an increase in CN over time, so too does spending time in urban parks. These results are consistent with those of Lumber et al. (2017) and Restall et al. (2021) who also reported positive relationships between CN and time spent in both urban and protected areas. These findings also provide support for the notion that repeated experiences in nature over time are needed to foster an enduring sense of CN (e.g. Richardson et al. 2020; Clayton et al. 2021).

Also consistent with previous research (Lin et al. 2014; Colléony et al. 2017, 2020; Cox et al. 2018), results of the two mediation analyses suggest that those higher in CN tended to spend more time in nature – generally, in protected areas, along waterways, and in urban parks – than those lower in CN. While not explicitly tested, it is possible that a bidirectional relationship between TIN and CN may also be present, as has been suggested previously (Rosa and Collado 2019; Martin et al. 2020) (see also Limitations and future research below).

4.1. Characteristics of nature experiences

These findings highlight the role that time spent in nature may play in fostering CN, and suggest that policies and programs intended to encourage people to spend more time in nature, including different types of nature, could help to foster CN. Yet, the effect sizes were small, and the positive and significant direct ($c$) and indirect ($ab$) effects indicate complementary mediation (Zhao et al. 2010), together suggesting that other factors also likely influence change in CN over time. Such factors may include what people do while
they’re in nature, or how they experience nature (Colléony et al. 2020, 2020; Richardson et al. 2020).

Recent evidence suggests that intentional awareness while in nature (Schutte and Malouff 2018) and active engagement with nature through smell or touch (Lumber et al. 2017; Colléony et al. 2020; Carr and Hughes 2021) are associated with higher CN scores. Further, emotions such as wonder and excitement appear to play a role in fostering CN (Giusti et al. 2018; Richardson et al. 2020; Carr and Hughes 2021), perhaps by facilitating learning and openness to experience (Yang et al. 2018). Inducing positive emotions such as awe or feeling moved have been associated with higher CN (Moreton et al. 2019; Petersen and Martin 2020; Ambrose et al. 2021), while feeling emotions such as love while experiencing nature has been described as central to the lived experience of CN (Furness 2021). Learning something new and a sense of compassion for the natural environment while experiencing nature may also be important for nurturing CN (Lumber et al. 2017; Carr and Hughes 2021).

Given that CN comprises multiple dimensions (Ives et al. 2018), activities that target several dimensions may be most effective in fostering an enduring sense of CN (Zylstra et al. 2014). Indeed, Riechers et al. (2020) recently noted that emotional and experiential dimensions of CN appear to have multiple links to other dimensions, thus nurturing emotional and experiential connections could be important mechanisms for enhancing an overall sense of CN. Similarly, activities that involve simultaneous activation of different pathways to CN may be also be valuable (Richardson et al. 2020; Carr and Hughes 2021). Such activities may include those that encourage emotional reflection about nature while actually experiencing nature (e.g., Pennisi et al. 2017), arts-based activities (Muhr 2020; Raatikainen et al. 2020), or technology-based interventions (Mattijsen et al. 2020). These could be particularly useful if they encourage noticing ‘good things’ in nature (McEwan et al. 2020) or engagement with natural beauty (Richardson and McEwan 2018).

One group of activities that can activate multiple dimensions of, and pathways to, CN are conservation behaviours, and particularly those that occur in and with the natural environment. Research suggests that engaging with nature via meaningful, compassionate, and multisensory activities, such as environmental volunteering (Cosquer et al. 2012; Schultler et al. 2018) or litter clean-ups (Wyles et al. 2017) could play an important role in nurturing CN. Indeed, CN can also be an important motivator for engaging in these activities (Admiraal et al. 2017; Ganzevoort and van den Born 2020), highlighting that the relationship between CN and nature-protective behaviours is likely reciprocal (Hamlin and Richardson 2022).

In addition to CN, other drivers of nature-protective behaviours include feelings of care or nurturing, beliefs of inherent value in the activity, and a desire for a meaningful life (Admiraal et al. 2017;
Ganzevoort and van den Born 2020). Such motivations reflect relational values, or the ‘preferences, principles and virtues about human-nature relationships’ (Chan et al. 2018, p. A1) that can influence how people think about and interact with nature (Chan et al. 2016; Kleespies and Dierkes 2020; Mattijssen et al. 2020). Relational values reflect the many different types and qualities of relationships that people have with nature (e.g. responsibility, moral obligation, identity, a ‘good life’: Chan et al. 2016), and may provide a useful leverage point for conservation policy (Mattijssen et al. 2020).

4.2. Implications for conservation policy

While policymakers have begun to consider human-nature relationships in conservation planning and management, policies and land management practices that specifically nurture CN are needed (Richardson et al. 2021). This research suggests that policies and practices that facilitate spending time in nature, including urban parks, could be useful.

Researchers have investigated a range of different ways to encourage people to spend more time in nature, such as through biophilic urban design. Urban spaces that include different types of natural elements provide opportunities for incidental and intentional interactions with nature (Church 2018; Lin et al. 2018) which may enhance CN (Cox et al. 2017; Shanahan et al. 2017). Designing public natural spaces to include food plants and opportunities for urban agriculture (Palliwoda et al. 2017; Kingsley et al. 2021) and to facilitate interactive and sensory immersion with nature (Souter-Brown 2015; Pennisi et al. 2017; Pan et al. 2020) can also encourage citizens to spend more time in, actively engage with, and connect to nature in such spaces.

Involving citizens in the design, installation, and management of natural spaces may be another mechanism for encouraging time spent in nature and thus nurturing CN (Light 2006; Church 2018; Mattijssen et al. 2020). Citizen engagement in the design and management of natural spaces can increase psychological ownership of, and connection to, those spaces, as well as stewardship behaviours such as picking up litter (de Bell et al. 2018; Mullenbach et al. 2019; Preston and Gelman 2020; Peck et al. 2021). Psychological ownership has also been associated with enjoyment of, and connection to, natural areas as well as to PEB and PBB such as environmental volunteering (Ganzevoort and van den Born 2020; Kuo et al. 2021).

4.3. Limitations and future research

A number of limitations are evident in the current research. Firstly, the measures of time spent in nature were imprecise – memory limitations, for example, may impede accurate recollection of the frequency of time spent in nature over the previous 12-months. Further, time spent in specific types of nature, such as urban parks, does not capture differences in quality (e.g. amount of tree cover, level of biodiversity) of different, albeit similarly classified, types of nature. Future research would benefit from more refined measures of TIN.

Regarding connection with nature, CN scores were relatively high (Time 1: \(m = 5.263, SD = 0.969\); Time 2: \(m = 5.314, SD = 0.946\)) thus the small change may be due to a ceiling effect. Further, interventions designed to foster CN typically show the greatest increases among participants with lower CN scores pre-intervention than participants with higher CN scores (Braun and Dierkes 2017; Barrable and Booth 2020; Chawla 2020). While not explicitly tested here, it’s possible that participants with low CN scores at Time 1 who spent more time in nature over the year would show greater increases in CN than participants with higher CN scores at Time 1. Additional investigation is needed to tease out possible differences between people with low versus high CN at Time 1. In addition, evidence suggests that CN scores (e.g. Duffy and Verges 2010) and spending time in nature (e.g. Tester-Jones et al. 2020) can vary by seasons and weather patterns, thus further research is needed to determine whether CN scores increase or decrease in response to seasons and/or weather. Another area for future research relates to the frequency, total number, or type of nature experiences needed to facilitate a stable sense of CN. While it has been proposed that repeated experiences of nature are needed to develop an enduring trait-like CN (e.g. Richardson et al. 2020; Salazar et al. 2020; Clayton et al. 2021), such experiences may differ across groups. People with lower initial CN scores may, for example, require fewer or less intense experiences of nature to increase CN, while those with higher initial CN scores may require more or greater intensity experiences of nature, such as a multi-day wilderness expedition, to effect an increase in CN (Salazar et al. 2020).

Finally, future research should consider the broader socio-cultural and contextual factors that influence people’s experiences of natural environments. Cultural and social factors influence landscape preferences and attitudes to natural spaces (Buiks et al. 2009; Özgürer 2011; Clayton et al. 2017) which may impact the ways in which different people experience nature. Investigation of the role of socio-cultural and contextual factors (e.g. ethnicity, socio-economic status) in the TIN-CN relationship warrants further investigation.

5. Conclusion

Connection with nature is increasingly being recognised as a potentially useful policy tool to address
conservation issues. Understanding the mechanisms by which connection with nature may be nurtured can usefully inform conservation policies and programs for which nurturing connection with nature is an outcome. Policies that encourage people to spend more time in nature – generally, and in protected areas, waterways, and urban parks – could be useful for increasing a stable sense of connection among the general population which may, in turn, increase engagement in conservation.

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Data availability statement

The data and syntax for this research are available at Open Science Framework (https://osf.io/3ca7f/?view_only=82164315080249d49d0eec6e5a34e21f)

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