



The role of a nature-based program in fostering multiple connections to nature

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Abstract

Reconnecting to nature is imperative for the sustainability of humans on Earth, offering a leverage point for system change. Connections to nature have been conceptualized as a typology of five types as follows: material; experiential; cognitive; emotional; and, philosophical, ranging from relatively shallow to deeper connections, respectively. Educational programs that immerse individuals in nature have been designed to build an appreciation for places travelled, awareness of environmental issues and to promote pro-environmental behaviours. Using quantitative and qualitative data from 295 individuals who participated in National Outdoor Leadership School (NOLS) programs ranging from 14 to 90 days, we tested hypotheses to understand whether and to what extent NOLS influenced the five types of connections to nature. We further investigated whether deeper connection types were associated with greater intentions for pro-environmental behaviours. Findings showed that individuals generally reported greater connections to nature after the NOLS program, with emotional and material connections increasing the most. While intentions for pro-environmental behaviour increased from pre- to post-program, deeper connections to nature did not correspond to greater intention for pro-environmental behaviour. The strongest predictor of intention for pro-environmental behaviour was a cognitive connection, though an emotional connection was also a significant predictor. Ultimately, we found that the NOLS program fosters multiple connections to nature and increases intentions for pro-environmental behaviour. We call for more research to understand the relationships among connection to nature types and how those interactions may influence intentions for pro-environmental behaviour—in nature-based educational programs and in other contexts.

Keywords Connections to nature · NOLS · Pro-environmental behaviour

Introduction

(Re)connecting to the biosphere and becoming active stewards is a prerequisite for sustainability of the Earth System (Folke et al. 2011). Disconnections between humans and nature have fostered perspectives in which human actions are perceived as external interventions, separate from ecosystem functioning (Folke et al. 2011). These disconnects have occurred for a variety of reasons, including physical lack of access, technology, and reliance on imported goods (Turner et al. 2004; Soga and Gaston 2016; Doring et al. 2017). A lack of connection between humans and nature has been linked to ‘living in overshoot’ of a safe operating space within the planet’s boundaries (Lade et al., 2020; Fischer and Riechers 2019).

Connecting, or reconnecting, to nature is critical for acknowledging the interconnected reality of social systems and ecological systems (i.e., social-ecological system (SES))

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(Berkes and Folke 1998; Folke et al. 2016). In parallel to earth system science, which recognises the need for human societies to function within ecological limits, other bodies of scholarship have emphasised the importance of people's lived experiences and perceptions of nature. According to Mackay and Schmitt (2009), nature connection “refers to a subjective sense of “oneness” with nature that arises from incorporating nature into one's self-definition”. The theoretical basis of the connection to nature concept can be traced from the biophilia hypothesis (Wilson 1984; Kahn and Kellert 2002), ecopsychology, and the psychology of interpersonal relationships (Whitburn et al. 2020). While related concepts such as sense of place (Eaton et al. 2019), “extinction of experience” (Pyle 1993; Soga and Gaston 2016), and “nature deficit disorder” (Louv 2005) have been developed in other fields, the connection to nature concept has been extensively conceptualized and operationalised within psychology (Restall and Conrad 2015; Ives et al. 2017). Psychological researcher Schultz (2002, p. 67), for example, views a connection to nature as “the extent to which an individual includes nature within [their] cognitive representation of self”. Mayer and Franz (2004) emphasize the affective and experiential aspects of connection. Perrin and Benassi (2009) focus on individuals' beliefs and attitudes regarding their connection (Geng et al. 2015).

There are at least 17 different scales used to measure connection to nature (Whitburn et al. 2020; Restall and Conrad 2015; Tam 2013), most of which focus on feelings toward nature (affect), cognition (knowledge and beliefs about nature), and behaviour (actions and experiences). Some scales assess connection to nature as a single measure often defined as emotional attachment (Whitburn et al. 2020). Additionally, other research has emphasised multiple pathways to strengthening nature connection, including direct contact with nature, emotional engagement, meaning formation, and appreciation of beauty and compassion (Lumbar et al. 2017). Ives et al. (2018) contend that the term ‘connection’ has been used to represent a spectrum of concepts and experiences of nature, and that there is a need to define and operationalise a more expansive concept that can encompass understandings from earth system science, sociology, psychology and grounded analytical approaches. As a result, they sought to capture this range by conceptualizing five categories of nature connections along a spectrum from external to internal experience. These categories recognize different scales of social aggregation (from the individual to society), and include the following: (1) material (consumption of nature's materials and goods), (2) experiential (direct interaction with the natural environment), (3) cognitive (knowledge or awareness of the environment and attitudes/values toward nature), (4) emotional (feelings of attachment or empathy), and (5) philosophical (worldview on nature: what it is, why it matters, and our relationship to it) (Ives et al. 2018).

Reconnecting to nature encompasses shifts in worldviews and understanding of the function of systems (Abson et al. 2017). Thus, reconnecting to nature, at both the individual and the societal level, may offer a potential leverage point for broader system change (cf Meadows 1999; Abson et al. 2017; Richardson et al. 2020; Riechers et al. 2021). One of the mechanisms by which reconnection to nature effects change is by “shap[ing] the values and paradigms that underpin human action” (Abson et al. 2017: 34). Nature connections span a spectrum from deep to shallow (Ives et al. 2018), yet they may be especially important for influencing deeply rooted paradigms and beliefs, with Richardson et al. (2020) suggesting that nature-based interventions can be powerful as deep leverage points that shape meanings and emotions associated with nature.

Pro-environmental behaviours are human actions taken for the environment, which may be underpinned by connections to nature. Many efforts have been made to understand the relationship between connectedness to nature and pro-environmental behaviour (PEB) (i.e., behaviours that consciously attempt to minimize negative environmental impacts; Kollmuss and Agyeman 2002). A recent meta-analysis of 37 studies on connections to nature and PEB identified a positive association between the two (Whitburn et al. 2020). However, the nature of this relationship is not always straightforward. Multiple factors influence PEB, including childhood experiences, personality, knowledge, education, norms and habits, attitudes, values, worldviews, place attachment, and demographic factors, among others (Gifford 2014). When focusing specifically on the relationship of connections to nature and PEB, not all connections to nature have equal relationships to behaviour. Scales measuring different types of connections to nature vary with respect to their correlation with pro-environmental behaviour, with the strongest correlation for ‘commitment to the environment’ and the weakest for ‘inclusion of nature in self’ (Whitburn et al. 2020:187).

The ‘extinction of experience’ is a particularly important cause of a widespread societal experiential disconnection to nature (Pyle 1993; Soga and Gaston 2016). People—particularly those in urban areas—are less and less likely to engage directly with nature, which in turn has negative consequences for how we perceive nature as well as our tendency towards PEB (Soga and Gaston 2016). Nature experiences or physical contact/engagement with nature, particularly outdoor programs, may enhance connectedness to nature (Lumber et al. 2017; Meltzer et al. 2018).

Outdoor program participants do not universally have positive experiences with their surroundings and the programs do not necessarily increase responsible environmental behaviour (Haluza-DeLay 1999). However, other studies of outdoor programs and experiences have shown promise in improving pro-environmental attitudes and related concepts (Ewert and McAvoy 2000). Examples include developing new meanings

connected to nature (Palmberg and Kuru 2010), increased knowledge of natural areas (Gillett et al. 1991), and delineating how appreciative outdoor experiences early in life may influence views toward the environment later (Ewert et al. 2005). One longitudinal research study demonstrated that an appreciation of nature is part of a suite of long-term outcomes for those who participated in a NOLS (formerly the National Outdoor Leadership School: <https://www.nols.edu/en/>) outdoor program, which is the program we focus on for this study (Sibthorp et al. 2008). Other studies on NOLS have also shown short-term positive results on outcomes related to human–nature connection including improving attitudes toward wilderness areas and supporting the development of an environmental ethic and a sense of place (Gress and Hall 2017; Hutson et al. 2019; Waage et al. 2012). Yet, the potential pathways for how future PEBs may or may not link to these human–nature concepts remains unclear. We build specifically on the exploratory work of Baird et al. (2020) to understand connections to nature described from NOLS and expressed intentions for PEB.

For the current study, we used Ives et al.’s (2017; 2018) conceptualization and typology of connections to nature to examine how a range of connections to nature, from shallow to deep, may be related to participation in a NOLS course. The objectives of this study were as follows: (1) to test the potential for an outdoor experience to enhance connections to nature; and, (2) to examine the relationship between connection type and intention for future pro-environmental behaviour. We hypothesized that an experiential ‘intervention’ (in the form of an intensive outdoor program) would result in increased connections to nature. We further hypothesized that deeper connections to nature (e.g., emotional connection) would have a stronger relationship with intention for future PEB than shallow connections to nature (e.g., material). There are three ways in which this study makes a contribution to research on human–nature connection and sustainability as follows: (1) NOLS represents a holistic, immersive, sustained nature connection ‘intervention’ which is different from other studies focused on testing the effects of a nature experience; (2) we study nature connection in a multi-dimensional way; and, (3) we investigate relationships between the multi-dimensional nature connections and intentions to change behaviour.

Materials and methods

Participants

A total of 295 (137 females, 153 males, 4 non-binary, 1 transgender) individuals who had recently completed a NOLS course between June 2019 and January 2020 participated in this study. Participants ranged in age from 16 to 63 with a mean age of 23 years ($SD = 8.1$). The majority of

participants lived in the United States ($N = 276$; 93.6%) and participated in one of the Summer NOLS courses ($N = 253$; 85.8%). Approximately 38% of respondents ($N = 111$) reported that they had previously participated in a NOLS excursion. Of the 295 participants, 21 did not complete all of the questionnaire items as instructed, and thus the number of participants varied for each analysis. Participation in the study took approximately 20 min and was voluntary (unpaid). All participants provided informed, written consent prior to participating. This study was approved by the Human Research Ethics Board at Brock University and conducted in accordance with Tri-Council ethical guidelines.

NOLS program

NOLS is a leading source and teacher of wilderness skills and leadership that serves people and the environment. NOLS facilitates extended wilderness expeditions across the world for participants of many ages who wish to learn expeditionary and leadership skills. The NOLS expedition curriculum centers on leadership, environmental studies, outdoor skills, and risk management. The NOLS curriculum is delivered through backpacking, mountaineering, rock climbing, sea kayaking, and many other outdoor activity types (NOLS 2016). NOLS programs teach students experientially through facilitating the knowledge and skill development required to lead others competently in a variety of wilderness and community environments (NOLS 2016). The teaching of environmental studies at NOLS begins with building a scientific foundation of ecological concepts and processes. Activities and classes with themes related to ecology, appreciation of places traveled, and minimum impact practices parallel classes on land management and environmental issues within areas visited. These activities and classes are framed to help students to make curricular connections and promote pro-environmentalism in everyday life (O’Donnell 2014).

Materials and procedure

A questionnaire was created to collect data about participant demographics (age, gender, place of residence) and their experiences with, and connections to, nature using a mix of quantitative and qualitative questions¹ (see Appendix 1 for questions analysed for this study). The questionnaire was administered using Qualtrics, an online survey

¹ Note that many of qualitative questions included in the questionnaire are part of a separate study, and thus were not included in this paper.

software. It was shared as a link in an email sent to all participants from the NOLS program, directly after completing NOLS courses. Courses ranged in length from 14 to over 90 days and took place at 13 different NOLS locations including wilderness areas in the United States, Canada, Mexico, Chile, Scandinavia, New Zealand, and India.

The questionnaire was designed to capture pre- and post-course responses using a single-assessment retrospective pretest–posttest design (Little et al. 2020) as a result of program constraints (Hill 2020). That is, the questionnaire was administered only after the course was complete, but asked about both pre- and post-course connections to nature. This approach, querying respondents' pre-course responses along with their post-course responses after the completion of the course, has benefits (e.g., less onerous for participants; may reduce response-shift bias where the respondents' understanding of the constructs changes over time) and challenges including the potential for several biases (e.g., acquiescence, social desirability, effort justification) (Geldhof et al. 2018; Hill 2020; Little et al. 2020; Thomas et al. 2019). In this case, the design was used out of necessity due to program constraints. However, this approach reflects a broader interest in retrospective pretest–posttest design as a mechanism to alleviate a common concern about response shift bias in traditional pre- and posttest designs (e.g., Moore and Tananis 2009). The exception to collecting both (retrospective) pre- and post-course data was the demographic information (which would not have changed pre- to post-course) and some questions that focused on post-course outcomes (e.g., changes in behavioural intentions) which were of interest only at that time period. Further, philosophical connection to nature was only assessed using quantitative measures post-course due to a questionnaire design issue.

Connection to nature questionnaire

Four of the five connection to nature types from Ives et al.'s (2018) typology were operationalized adhering as closely as possible to the definitions set out in their work. We recognize that, in parallel to our work to operationalize this typology, other efforts to do so were developed (Riechers et al. 2020; Meis-Harris et al. 2021). Some of our measures overlap with those of Meis-Harris et al. (2021); however, those developed by Riechers et al. (2020) are qualitative and thus distinct. Future work to define a standard set of scales to measuring the connections to nature would be useful to advance this framework.

Philosophical connection to nature was derived from De Groot and van den Born (2003) and Van den Born (2008). Participants were presented with four statements (e.g., “People are entrusted with nature; we are stewards of it. We have a responsibility to manage it responsibly”), and were asked to select the one that most closely aligned with their

perspective. Individuals received a score of 4 if they selected the statement that represented the most ecocentric perspective (i.e., strongest philosophical connection to nature), a score of 3 if they selected the statement that represented the second most ecocentric perspective, and so on.

Emotional connection was assessed using Kals et al.'s (1999) emotional affinity toward nature scale. Participants received 10 statements (e.g., “When I spend time in nature, I feel carefree.”), and used a 5-point Likert scale (1 = strongly disagree; 5 = strongly agree) to rate how well each statement described their own feelings. Scores were averaged (correcting for reverse-keyed items) for a total mean emotional connection score out of 5, with higher scores indicating greater emotional connection.

Cognitive connection was divided into two factors based on the description in Ives et al. (2018). The first factor was environmental awareness using the revised new ecological paradigm (NEP) scale (Dunlap et al. 2000) based on the prior use of the scale for this purpose by Schultz et al. (2002). The second factor was environmental attitude, using statements from Bradley et al. (1999). The awareness and the attitude subscales consisted of 15 statements each (e.g., “Humans are severely abusing the environment” for the awareness scale, and “Laws regarding water quality should be stricter” for the attitude scale). Participants were asked to rate their level of agreement with each statement using a 5-point Likert scale (1 = strongly disagree; 5 = strongly agree). An “awareness” score was derived by averaging (correcting for reverse-keyed items) scores across the items from the awareness subscale, for a total score out of 5. Similarly, an “attitude” score was calculated by averaging the scores across the items in the attitude subscale, for a maximum total score out of 5. Higher scores indicated a greater cognitive connection.

Two questions were included to assess experiential connection to nature. Participants were asked to indicate whether they had previously completed a NOLS-like course (yes/no), as well as the frequency with which they visited parks and wilderness areas. These responses were then used to examine whether previous experiences mediated the relationship between participating in a NOLS course and connection to nature (see “results” below).

Material connection was measured using two items that directly related to material consumption from Karp (1996). Participants used a 5-point Likert scale (1 = never; 5 = very often) to rate how often they would likely engage in two behaviours (“Buy organic foods” and “Purchase environmentally friendly and/or energy efficient products”). Scores were averaged for a total mean material connection score out of 5, with higher scores indicating a higher material connection.

Finally, we reviewed responses to the survey question, “Please elaborate on how your connection to nature did

or did not change as a result of participating in a NOLS course.” This question was included to understand how respondents perceived their own connection to nature. Only those responses that reported a change in level of connection to nature were analysed ($n=35$). Responses were coded using the Ives et al. (2018) typology and a second round of coding identified emergent themes outside of the typology. Frequencies were calculated for each code.

Pro-environmental behaviour

Since the questionnaire was designed to capture changes immediately after the experiential intervention (NOLS course), pro-environmental behaviour was not feasible to collect (i.e., there was no time to engage in PEB after the course and before the questionnaire was administered). Accordingly, future intentions for PEB were measured instead. This represents a different, but related, construct. Intent and behaviour are moderately correlated (Grimmer and Miles 2017), and there is evidence that this relationship is mediated by the formulation of a plan, and moderated by factors including the extent to which the individual has behavioural control, the shopping context, and environmental involvement (e.g., support for environmental groups) (Carrington et al. 2010; Grimmer and Miles 2017). Future intentions for PEB were measured pre- and post-course using items adapted from Karp (1996), Halpenny (2010), and Cooper et al. (2015). Participants received a list of 17 PEBs (e.g., “Talk to others about environmental issues”), and were asked to indicate how often they would likely engage in these behaviours (1 = never; 5 = very often). An overall PEB score was calculated by averaging across the 17 items for a total mean score out of 5, with higher scores indicating a greater pro-environmental intent. There is a relationship between PEB and material connections to nature, and we separate the two by strictly scoping material connections as *directly* related to material consumption, while PEB are not, and are more broadly defined.

Data analysis

The quantitative data were analysed using a variety of techniques (see below) including paired-samples t-tests, correlations, and multiple regression in IBM® SPSS Statistics. Qualitative data were analysed using a deductive coding approach, using Ives et al.’s (2018) connections to nature as a primary source for codebook development. Responses were assigned one or more connection types and frequencies were calculated. Further, themes among responses to common connection types were identified using an inductive approach. For any analysis based on gender, only those who identified as female or male were included, as the number of respondents identifying otherwise was very small ($n=5$).

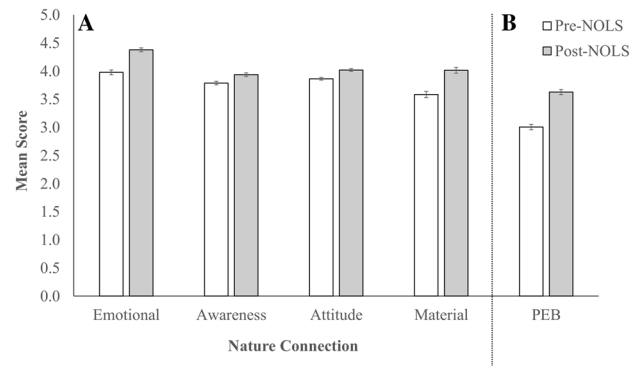


Fig. 1 Mean scores on the **A** emotional, awareness, attitude, and material connectedness to nature scales and **B** the pro-environmental behaviour (PEB) scale before and after completing the NOLS course. Error bars represent the standard error for each condition mean

Results

NOLS and connection to nature

First, a series of paired-samples t-tests with Bonferroni corrections were conducted to examine whether connectedness to nature (emotional connection, material connection, attitude and awareness (attitude and awareness together constituted the cognitive connection but were treated separately for the analysis)) changed as a result of participation in a NOLS course. Quantitative measures of philosophical connections were not included in this analysis because only post-course data were collected, and experiential connections were not included because the course was considered a consistent experiential connection across all respondents. All four connectedness to nature measures used in this analysis significantly increased from retrospective pre-test to post-test (see Fig. 1a), all p 's < 0.001; all d 's > 0.588, indicating that participation in a NOLS course was associated with an increase in connectedness to nature.

In addition, a qualitative analysis of responses to the following survey question was undertaken in an effort to understand how respondents articulated their own nature connections: “Please elaborate on how your connection to nature did or did not change as a result of participating in a NOLS course.” Respondents were more likely to identify emotional (15) or experiential connections (11) than cognitive (3) or philosophical connections (6). No material connections were described in response to the question. Responses categorized as cognitive connections generally mentioned appreciation of beauty, appreciation of complexity, awe of nature, and understanding of nature’s importance. Emotional connections were classified as such because emotional language was present, rather than reasons or explanations. Examples included the following:

Whenever I look around me at vast mountain ranges or a sparkling lake, I just feel joy of the memories of this course and I know I will carry that and grow from that for the rest of my life.

I have fallen in love with nature and wildlife.

Rarely were statements categorized as experiential connections simply statements of experience; rather, they were statements of experience paired with language that characterized another type of connection. For example:

I have never been in such a remote area for such an extended period of time [*experiential*]. It was very humbling [*philosophical*].

I gained a greater respect for the joy and pain it can bring by simply existing [*philosophical*]. Some days hiking were terribly hard, yet at night it soothes you once you get to camp [*experiential*].

Philosophical connections generally mentioned something that impressed the respondent and directly prompted reflection on their personal role in nature. For example:

My perspective on the importance and scale of nature has increased and I have a greater respect for it than I previously did. I also realized how fragile each ecosystem is and the importance of protecting them.

Next, we examined whether the magnitude of increase in connectedness to nature differed amongst the four connection types measured (emotional, material, attitude, and awareness). For each of the connection types, we created a normalized pre/post difference score ($[\text{post} - \text{pre}] / \text{pre}$) and then conducted a repeated-measures ANOVA with a Bonferroni-corrected post-hoc test. There was a significant effect of type of nature connection, $F(3,804) = 39.04$, $p < 0.001$, $\eta^2_p = 0.13$, such that the increase in both emotional and material connection was significantly larger than the increase in either awareness or attitude, with material connection showing the largest numerical increase (see Fig. 2a).

Understanding changes in connectedness to nature

We then conducted a series of one-way ANOVAs with Scheffe post-hoc to examine whether demographics (i.e., age, gender, previous NOLS experience) and responses to the post-NOLS experience questions (i.e., “Has participating in a NOLS course changed how you will live in everyday life?” and “Has your connection to nature changed as a result of participating in a NOLS course?”, both of which were “yes/no” questions) were associated with variations in both baseline connectedness to nature scores (i.e., pre-NOLS scores) and normalized pre/post differences for the four connectedness variables.

For the demographic variables, age was significantly associated with pre-NOLS scores for emotional

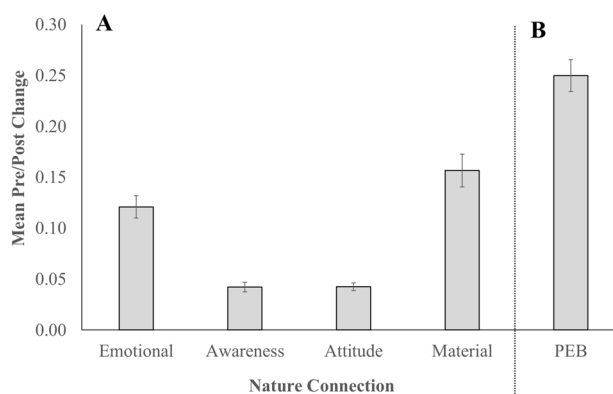


Fig. 2 Mean normalized pre/post difference ($[\text{post} - \text{pre}] / \text{pre}$) scores for the **A** emotional, awareness, attitude, and material connectedness to nature scales, and **B** pro-environmental behaviour (PEB) scale. Error bars represent the standard error for each condition mean

connection, $F(2,282) = 9.72$, $p < 0.001$, $\eta^2 = 0.07$, awareness, $F(2,280) = 4.27$, $p = 0.03$, $\eta^2 = 0.03$, and attitude, $F(2,284) = 19.38$, $p < 0.001$, $\eta^2 = 0.14$, such that older individuals had higher baseline connectedness scores than younger individuals. However, age was unrelated to baseline material connection scores, $F(2,280) = 2.51$, $p = 0.26$, $\eta^2 = 0.01$. Age was also associated with pre/post-course changes in emotional connection, $F(2,281) = 3.06$, $p = 0.049$, $\eta^2 = 0.02$, awareness, $F(2,279) = 3.55$, $p = 0.03$, $\eta^2 = 0.03$, and material connection, $F(2,279) = 3.59$, $p = 0.03$, $\eta^2 = 0.03$, indicating older individuals showed smaller changes in connectedness to nature as a result of participating in NOLS.

Gender was also associated with pre-NOLS scores for all four measures of connectedness to nature (all t 's > 2.8 ; all p 's < 0.005 ; all d 's > 0.34), indicating females had higher connectedness to nature scores than did males; however, gender was not associated with changes in any of the four connectedness measures (all F 's < 1.7 ; all p 's > 0.20). Due to a low number of non-binary ($n = 4$) and transgender ($n = 1$) respondents, they were not included in this statistical analysis.

Previous experience with a NOLS course was associated with baseline (pre-NOLS) scores on all four connectedness to nature variables (all t 's > 2.4 ; all p 's < 0.02 ; all d 's > 0.29), such that individuals with previous experience had higher connectedness scores. Previous experience was negatively associated with changes in emotional connection, $F(1,279) = 9.62$, $p = 0.002$, $\eta^2 = 0.04$, awareness, $F(1,278) = 11.85$, $p = 0.001$, $\eta^2 = 0.04$, and material connection, $F(1,279) = 4.16$, $p = 0.04$, $\eta^2 = 0.01$, indicating individuals who had previously participated in NOLS showed smaller increases in connectedness from pre to post as compared to first-time participants. Change in attitude, however, was not associated with previous NOLS experience, $F(1,281) = 0.68$, $p = 0.41$, $\eta^2 = 0.002$.

Table 1 Hierarchical regression analysis examining predictors of change in pro-environmental behaviour following a NOLS course

	Predictor	sr ²	Beta	<i>t</i>	<i>P</i>
Step 1 $R^2 = 0.109^{**}$	Age	0.024	− 0.155	− 2.64	0.009*
	Experience	0.023	− 0.156	− 2.62	0.009*
	Connectedness	0.016	0.129	2.18	0.030*
	Life change	0.025	0.159	2.69	0.008*
Step 2 $R^2 \Delta = 0.351^{**}$	Age	0.004	− 0.065	− 1.27	0.204
	Experience	0.004	− 0.064	− 1.21	0.228
	Connectedness	0.001	0.032	0.63	0.532
	Life change	0.008	0.089	1.74	0.083
	Emotional	0.025	0.180	3.18	0.002*
	Awareness	0.063	0.302	5.01	< 0.001**
	Attitude	0.025	0.189	3.15	0.002*

* $p < 0.05$ ** $p < 0.001$

Next, perceived change in overall connectedness to nature was positively associated with changes in emotional connection, $F(1,275) = 11.38$, $p = 0.001$, $\eta^2 = 0.04$, awareness, $F(1,272) = 8.08$, $p = 0.005$, $\eta^2 = 0.03$, and attitude, $F(1,276) = 5.85$, $p = 0.02$, $\eta^2 = 0.02$, indicating individuals who believed that they had increased their connection to nature showed a concomitant pre/post change for these connection types. Change in material connection, however, was not associated with perceived changes in nature connectedness $F(1,276) = 1.65$, $p = 0.20$, $\eta^2 = 0.01$.

Finally, the belief that NOLS would change how individuals lived their lives going forward was positively associated with changes in emotional connection, $F(1,277) = 4.31$, $p = 0.04$, $\eta^2 = 0.02$, awareness, $F(1,275) = 4.77$, $p = 0.02$, $\eta^2 = 0.02$, attitude, $F(1,279) = 5.39$, $p = 0.02$, $\eta^2 = 0.02$, and material connection, $F(1,278) = 6.85$, $p = 0.01$, $\eta^2 = 0.03$, such that participants who indicated that NOLS was life-changing showed larger pre/post differences in connectedness.

Predicting changes in intentions for pro-environmental behaviour

Intentions for pro-environmental behaviour (PEB) scores significantly increased from pre-test to post-test, $t(284) = -21.17$, $p < 0.001$, $d = 0.76$ (see Fig. 1b). We conducted a correlational analysis to examine whether changes in our four connectedness variables were associated with pre/post changes in intentions for PEB ([post−pre]/pre; see Fig. 2b). Change in material connection had the strongest relationship with PEB ($r = 0.574$), followed by awareness ($r = 0.492$), attitude ($r = 0.412$), and emotional connection ($r = 0.391$; all p 's < 0.001). The high correlations prompted us to conduct a series of confirmatory factor analyses to determine whether these constructs

were distinct. In all cases, with the exception of material connection which was virtually assessing the same underlying construct as PEB, these distinctions were confirmed (see electronic supplementary material for PCA results). Accordingly, material connections were not included in any further analyses.

To further explore these relationships between emotional and cognitive connections to nature (awareness and attitude) and future intentions for PEB, we ran a multiple regression with change in intentions for PEB as the criterion and change in emotional connection, awareness, and attitude as the predictors. Overall, the model explained a significant 31.9% of the variance in PEB change, $R = 0.565$; $F(3,272) = 42.51$, $p < 0.001$. Change in emotional connection ($sr^2 = 0.04$), awareness ($sr^2 = 0.08$), and attitude ($sr^2 = 0.02$) each emerged as significant unique predictors of intentions for PEB change.

Age, previous experience, perceived change in connectedness, and belief that how individuals live their lives will change (i.e., intended future PEB) following NOLS, were all associated with changes in two of three connectedness variables. As such, we ran a hierarchical multiple regression to examine whether the three predictors identified here (emotional connection, awareness, and attitude) still explained unique variance in intentions for PEB once these other factors had been statistically controlled. Age and the three post-NOLS experience questions were entered as predictors in Step 1, followed by the three connectedness variables in Step 2 (see Table 1). Ultimately, change in emotional connection, awareness, and attitude remained as unique predictors of intentions for PEB change, with no other predictors reaching significance, suggesting that their relationship with intended PEB is unrelated to demographic factors, previous experience, or beliefs about how the experience affected the participant.

Discussion

(Re)connecting to nature is relevant to deeper structures and paradigms that underpin behaviours as an emergent system property and offer a promising pathway to system level sustainability. However, individuals connect to nature in different ways and not all connection types hold the same potential as levers for broader system change (Ives et al. 2018). In this study, we examined the changes in connectedness to nature before and after an intensive outdoor program, hypothesizing that connectedness to nature would increase as a result of participation in this program. We further hypothesized that deeper connections to nature would correlate more strongly with greater future intention for PEB than would shallower connections. Here, we interpret the results using these two hypotheses to organize the discussion.

H1: Connectedness to nature will increase with an intensive outdoor program experience

All types of connections to nature showed a significant increase after participating in a NOLS program. Emotional and material connections showed the greatest numerical increase among the four types measured quantitatively. This finding provides evidence that an experience in nature (and in particular, NOLS courses which included an educational component) has a positive effect on multiple connection to nature types, providing a ‘pathway to nature connectedness’ (Lumber et al. 2017; Richardson et al. 2020).

It is important to note that pre-NOLS scores were already high (the average across all connection types was ~4 on a scale of 5). Despite this initial high connectedness, connections to nature still increased after participating in a NOLS program. Those who had participated in previous experiences of this type showed higher pre-NOLS connectedness to nature and their connections increased less than others’. This indicates that connectedness to nature may be long-lasting and our results show a ceiling effect consistent with other NOLS research on wilderness attitudes (Gress and Hall 2017). Despite less additive advantage for building connections to nature, there may be other important benefits to participating in multiple outdoor programs. Stern et al. (2008) found that the length of environmental education programs had a positive effect on multiple variables including connectedness to nature, though they faded over time. The authors concluded that longer programs might enhance long-term outcomes, which is consistent with our results. Similarly, Schultz and Tabanico (2007) found a significant correlation between frequency of visits to natural places and implicit association test scores (which they determined measures implicit connections with nature) across a series of studies. Our study contributes the perspective of a longer, sustained

educational program in nature that is different from other studies. It highlights the potential for longer programs and longer periods in nature to influence multiple connections to nature. This is consistent with work by Høyem (2020) who emphasized a distinction between time in nature and reflection on the relationship between people and nature in supporting environmentally responsible behaviour. Only the latter was related to behaviour in their study. Høyem’s (2020) research provides an important perspective that not only were participants spending time in nature, but that they were actively engaged in an educational program. The relative importance, or interactions, of these two aspects of NOLS were not individually examined in this study. The disentangling of time in nature with educational programming would be a useful next step to understand the effect of each.

Further, we examined qualitative responses to an open question of how the respondents’ connection to nature had changed and coded these responses using Ives et al.’s (2018) typology. Here, respondents mentioned emotional and experiential connections more often than any other type, and material connections were not identified. This signals that the concept of connecting to nature, when left to the interpretation of respondents, did not include material connections, even though material connections were identified as the type that increased the most when specifically measured. Rather, respondents largely focused on the emotional and experiential types of connection when responding to the open-ended question. This finding lends further support for using a multi-dimensional typology of connections to nature and using specific tools to query each. Further work to develop methods for assessing material connections (e.g., through tracking resource flows) would be worthwhile along with exploring in more detail how different forms of material connection and consumption relate to physical environmental impacts. Related, but from a different perspective, the overlap between material connectedness and future intentions for PEB opens questions about whether others perceive material connections as a connection to nature at all, or rather as separate actions. Further research to interrogate this question would be valuable.

H2: Deeper connections to nature will be related to a greater intention for future pro-environmental behaviour

Independent of demographic factors, previous experiences, and respondents’ beliefs about how the experience affected them, changes in connections to nature—specifically, emotional and cognitive (both awareness and attitude)—were unique, positive predictors of change in intentions for PEB. However, we were unable to definitively identify whether

changes in deeper connections to nature were consistently related to a stronger future intention for PEB. The lack of quantitative data related to the philosophical connection pre-NOLS, as well as the strong correlation between material connection and PEB, resulted in a focus on two connections to nature as follows: emotional and cognitive. Material connections and PEB may indeed be a single construct; however, there is value in considering direct consumption (as a subset of the broad range of PEB) as a connection to nature in its own right, following Ives et al. (2018). We found that changes in awareness (part of the cognitive connection) was the strongest predictor of changes in future intention for PEB. This is consistent with previous studies and literature reviews focused on determinants of PEB (e.g., Kollmuss and Agyeman 2002; Blankenberg and Alhusen 2018). For example, in the context of action related to climate change, Masud et al. (2015) found that awareness was directly and indirectly (through attitudes) related to PEB. Müller et al. (2009) found that awareness of risks to nature contributed significantly to willingness for PEB in adolescents. A review of factors that influence PEB by Gifford and Nilsson (2014) identified problem awareness as a significant, indirect influence on PEB intentions. In line with the literature on determinants and factors related to PEB, we acknowledge that the relationship between connection to nature types and intentions for PEB may not be direct in all cases (e.g., between awareness or attitude and PEB) (Kollmuss and Agyeman 2002; and elaborated on in the limitations below); thus further research to assess the potential for mediation and/or moderation among connection types would be beneficial. Furthermore, it is possible that philosophical connections did not require as substantial a shift in order to support and facilitate behaviour change among participants, yet this may be different for alternative cohorts.

Changes in connection(s) to nature which most strongly predicted shifts in future intention for PEB have important implications. While the NOLS program most substantially increased emotional connection, this was not the connection type most strongly related to behaviour—cognitive and material connections were. Thus, the programs may be building deeper connections, but those emotional connections may not be connecting to actions and are thus potentially less effective in facilitating positive environmental change. However, emotional connections may be a slower variable; one that is less directly connected to action but more influential as an indirect factor leading to system change (a deeper leverage point). It may also be plausible that the emotional connection to nature served as scaffolding for other connection types to interact and grow. As other research indicates (Halpenny 2010; Schwass, et al. 2021), there are potential pro-environmental gains to be achieved from additional research on how people transfer an emotional connection from one area in nature to the environment

as a whole. Additionally, there is a need for future research to distinguish more carefully between types of PEB. Our findings contribute, and lend additional nuance, to discussions about connections to nature in relation to the goal of broader system changes. Future studies could compare actual behaviours that promote local, small-scale environmental benefits (e.g. litter picking) vs. those that target system-wide change (e.g. political campaigning). Klaniecki et al. (2018) suggest that both can be associated with connection to nature at different scales: from local places to globally significant ecosystems. It would be worthwhile for future research to consider how this concept of scale intersects with different forms of nature connection proposed by Ives et al. (2018).

Our results are consistent with past outdoor program literature showing a positive change in human–nature concepts resulting from participation in an immersive, educational nature-based program (Gress and Hall 2017; Mittelstaedt et al. 1999; Sibthorp et al. 2008; Waage et al. 2012). Outdoor programs outside of NOLS can capitalize on our results by finding ways to unravel how emotional, cognitive, and material connections to nature exist within curricular structures to maximize the potential development of nature connection and future PEB. Paisley et al. (2008) showed that NOLS outdoor program participants generally learn through the following five domains: structure-oriented mechanisms (built into courses by curriculum planners), instructor-oriented mechanisms (the ways in which instructors teach and direct the flow of educational content), student-oriented mechanisms (independent participant learning), student-and-instructor-oriented mechanisms (learning resulting from student and instructor actions), and qualities of the environment (learning through engagement with both natural and social environments). These learning mechanism domains can be applied in future research to different outdoor program processes and learning activities to better understand how participants learn nature connection and develop intentions for PEB. Our results suggest identified learning mechanisms that relate most to emotional, cognitive, and material connections to nature should be carefully considered in curricula planning to best support connections to nature and future PEB.

Further, past research on learning mechanisms, and environmental education outcomes from participation in an outdoor education program demonstrate that opportunities for transformational learning depended on separation from normal life activities, the learning community, experiencing challenges, and time in nature (D’Amato and Krasny 2011). Each of these factors should be examined in terms of their effects on connections to nature and PEB development. More recent work on NOLS and transformational learning highlights the importance of participants needing to experience a challenge to their usual frame of reference to achieve perspective transformation (i.e., a permanent shift of

an individual's frame of reference or understanding of how the world works) (Meerts-Brandsma et al. 2020). Frames of reference share common characteristics with philosophical connectedness to nature. Additional research parsing out connections to nature and PEB and how they interact with a frame of reference challenge will be helpful in understanding short and potential long-term NOLS program learning outcomes, and the extent to which they can be situated within a connectedness to nature lens.

These findings also have potential to inform interventions to connect people to nature outside formal, immersive outdoor programmes. We suggest that landscape practitioners who design and curate natural spaces for people (such as national parks, reserves, and urban open spaces) should consider the potential of these spaces to enhance multiple forms of connections to nature. For example, providing space for appreciation of beauty and allowing places to evoke awe and wonder (enhancing emotional connections), as well as intentionally providing information that can educate and challenge (stimulating attitudinal connections). Doing so may result in a more holistic connection experience and effect and sustain behaviour change.

There are some limitations to our study. We queried pre- and post-NOLS connections to nature and intentions for PEB in a single instrument administered post-NOLS. While there are arguments for and against using this approach (e.g., Little et al. 2020; Moore and Tananis 2009), this decision was practical and we acknowledge that biases may exist in the dataset as a result (Geldhof et al. 2018; Hill 2020; Little et al. 2020; Thomas et al. 2019). Further, the lack of pre- and post-NOLS data for philosophical connections to nature limited our ability to assess the full suite of types of connections in our analyses. Nevertheless, while other studies have used Ives et al.'s (2018) typology in a quantitative approach (Meis-Harris et al. 2021), this was a first effort to quantitatively measure connections to nature in a longitudinal design. Finally, Gifford and Nilsson (2014) caution that self-reported intentions, and even self-reported behaviours, do not fully match actual behaviours. Although many researchers have documented a moderate-to-large statistical relationship between intended and actual behaviours (e.g., Albarracin et al. 2001; Armitage and Connor 2001; Azjen 1991; Oreg and Katz-Gerro 2006; Schwenk and Möser 2009; Webb and Sheeran 2006), there are significant interindividual variations in the strength of this relationship and a number of confounding variables that mediate the link between intentions and actions (e.g., Schwenk and Möser 2009; Webb and Sheeran 2006). Thus, we acknowledge that the future intentions for PEB expressed by respondents here may not necessarily reflect how actual behaviours have unfolded. Regardless, this study contributes to this body of scholarship and demonstrates the potential value of enhancing nature connection to bring about positive impacts for sustainability.

Conclusion

Respondents who participated in a NOLS outdoor program enhanced their connections to nature and increased their intentions for PEB. Using Ives et al.'s (2018) typology as a foundation for measuring changes in connections to nature, we identified changes in the following four connection types: material, experiential, cognitive (separated into awareness and attitude), and emotional. The greatest increase occurred in the emotional connection to nature; however, the connection type that best predicted changes in intentions for PEB was awareness (part of the cognitive connection type). We conclude that the NOLS program fostered multiple connections to nature and intentions for PEB. Thus, the NOLS program may act as an intervention, or lever, to build connections to nature which may ultimately bring about larger system change through PEB.

This research makes several contributions. First, the case study context is different than other studies focused on testing the effects of a nature experience. The NOLS context is unique because it represents a holistic, immersive, sustained nature connection 'intervention'. Second, we study nature connection in a multi-dimensional way that is just emerging as a focus in the literature (e.g., Meis-Harris et al. 2021). Finally, we use this multi-dimensional approach to investigate relationships between connection types and intentions to change behaviour, connecting these concepts with the notion of system change (e.g., leverage points) (Ives et al. 2018; Abson et al. 2017). Further empirical research is needed to confirm the theoretical positioning of the five types of connections to nature in terms of shallow to deep system leverage points (Ives et al. 2018), and their interactions and positioning as direct or indirect drivers of action that supports broader system change for sustainability.

Supplementary Information The online version contains supplementary material available at <https://doi.org/10.1007/s11625-022-01119-w>.

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