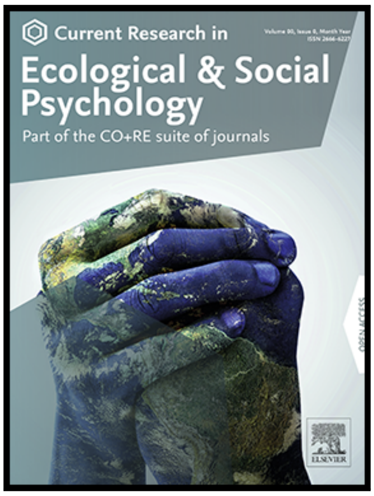
Journal Pre-proof



Factors associated with nature connectedness in school-aged children

Eluned Price , Sarah Maguire , Catherine Firth , Ryan Lumber , Miles Richardson , Richard Young

PII: S2666-6227(22)00004-1
DOI: https://doi.org/10.1016/j.cresp.2022.100037
Reference: CRESP 100037

To appear in: *Current Research in Ecological and Social Psychology*

Received date: 14 September 2021
Revised date: 10 December 2021
Accepted date: 24 January 2022

Please cite this article as: Eluned Price , Sarah Maguire , Catherine Firth , Ryan Lumber , Miles Richardson , Richard Young , Factors associated with nature connectedness in school-aged children, *Current Research in Ecological and Social Psychology* (2022), doi: https://doi.org/10.1016/j.cresp.2022.100037

Factors associated with nature connectedness in school-aged children

Eluned Price[1,*], Sarah Maguire[1], Catherine Firth[1], Ryan Lumber,[2] Miles Richardson[3] and Richard Young[1]

[1]Durrell Wildlife Conservation Trust

[2]De Montfort University

[3]University of Derby

*Correspondence to: Eluned C. Price, Durrell Wildlife Conservation Trust, Les Augrès Manor, Trinity, Jersey JE3 5BP, Channel Islands. Eluned.Price@durrell.org

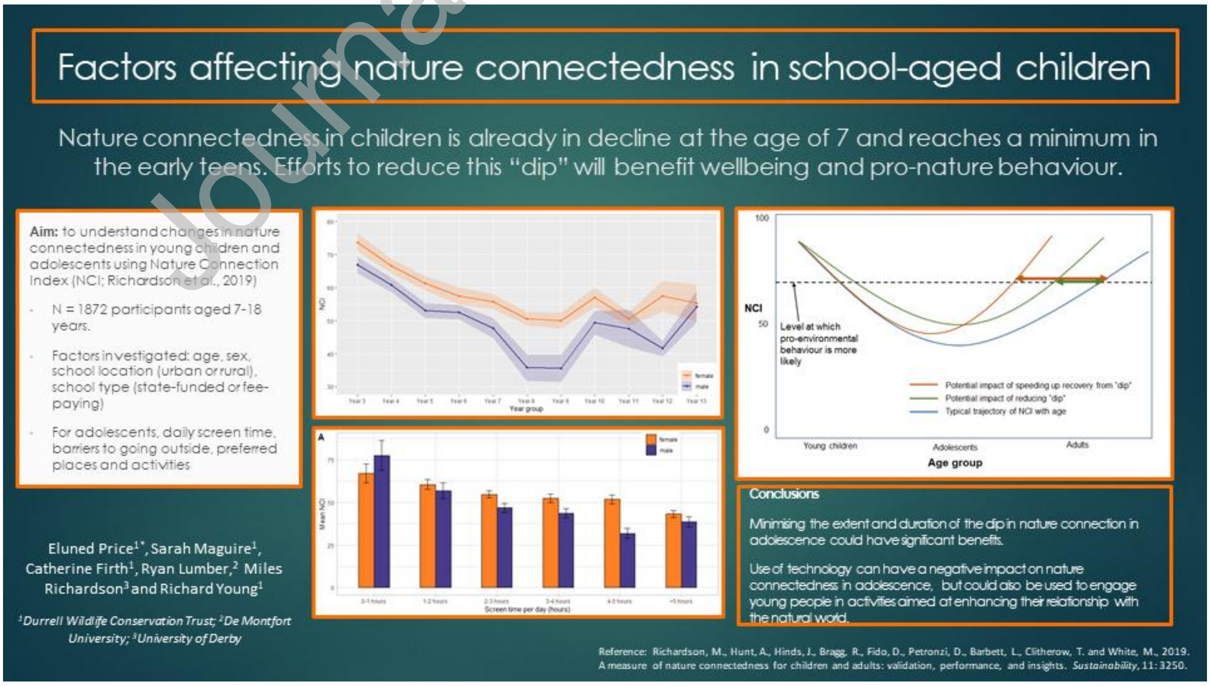
Research Hhighlights

- Nature connectedness is consistently higher in girls than in boys.
- Nature connectedness declines with age into the early teens, then levels off.
- Children in urban schools are less connected to nature than those in rural schools.
- Daily screen time is negatively related to nature connectedness in adolescents.
- Reducing the adolescent dip in nature connectedness could benefit wellbeing and behaviour change.

Abstract

Increasing people's sense of connectedness to nature has the potential to be a powerful tool in driving pro-conservation behaviours, as well as improving physical and mental health. Multi-age cross-sectional studies have shown that nature connectedness signicantly dips after early childood before recovering in adulthood. However, the precise pattern of this age-related decline is not well-described or understood. We conducted a questionnaire survey of children living on the island of Jersey, Channel Islands, using the Nature Connection Index (NCI) to identify biological, behavioural and social factors associated with nature connectedness levels. Using an information-theoretic approach, we analysed data from 17% of all Jersey's children aged between 7-18 years (N=1872) to investigate the effects of age, gender, school location and funding type. NCI levels were consistently higher in girls than in boys, and declined with age in both sexes into the early teens. Children attending schools in urban areas, particularly at primary level, had a lower mean NCI than those in rural locations. In adolescents (11-18 years), self-reported daily screen time was negatively correlated with NCI scores. Most students reported that their home was the place they preferred to relax, but the majority chose a natural environment as their favourite place. Our results confirm the marked decline in nature connectedness after early childhood but also point to interventions that may help reduce this deterioration, with associated wellbeing and behaviour change benefits.

Graphical Aabstract



Key words: adolescence, nature connectedness, nature conservation, school children, wellbeing

Running head: Nature connectedness in children

1. Introduction

An increasing disconnect between people and the natural world is viewed as one of the fundamental reasons for the current biodiversity and environmental crisis facing our planet (Miller, 2005; Zylstra et al., 2014). The relationships between people and nature are complex (Clayton et al., 2017; Giusti, 2019), but promoting attitudinal and behaviour change is likely to be central to successful strategies for combatting these problems (Pyle, 2003; Soga and Gaston, 2016; Reddy et al., 2017; Whitburn et al., 2020). In response, nature conservation organisations have typically conducted education and awareness campaigns to promote desirable attitudes and behaviours (e.g. Dolins et al., 2010; Howe et al., 2012; Jiménez et al., 2015; Chua et al., 2021; Cox et al., 2020). However, while educational initiatives clearly have a role to play in increasing "ecological literacy" (Pitman and Daniels, 2020), evaluations show that simply increasing knowledge about conservation and environmental issues does not necessarily lead to behaviour change (Steg and Vlek, 2009; Moss et al., 2017; Otto and Pensini, 2017; Charles et al., 2018; Green et al., 2019).

In contrast, the field of conservation psychology (Clayton and Myers, 2015), and in particular the psychological construct of "nature connectedness", is rapidly becoming central to our understanding of the factors affecting both our own wellbeing, and that of the global environment and its biodiversity (Tam, 2013; Zylstra et al., 2014; Soga and Gaston, 2016; Richardson et al., 2020a). Nature connectedness is a multi-dimensional psychological trait that refers to a person's belief about the extent to which they are part of the natural environment, their emotional relationship with it, and their experience within it (Schultz, 2002; Mayer and Frantz, 2004).

An expanding body of research has shown that helping people to develop a stronger connection with nature is associated with an increased likelihood of exhibiting both pro-environmental behaviour such as recycling (e.g. Hoot and Friedman, 2011; Zelenski et al., 2015; Mackay and Schmitt, 2019; Martin et al., 2020), and pro-nature conservation behaviour, including supporting conservation charities (Martin et al., 2020; Richardson et al., 2020b). Data presented by Richardson et al. (2019), for example, suggest that scores over 62 (out of a maximum of 100) on the Nature Connection Index (Hunt et al., 2017) are associated with pro-environmental behaviour and pro-conservation behaviours, with those behaviours that require greater commitment, for example conservation volunteering, being associated with higher scores (over 70). In children, Hughes et al. (2018) found that a high probability of performing conservation behaviours was only reached at strong levels of connection. Increasing the proportion of the population that are sufficiently connected to nature to be likely to exhibit pro-environmental behaviours and attitudes therefore has the potential to be a powerful tool in reducing impacts on the natural world (Hughes et al., 2018; Evans et al., 2018; Giusti et al., 2018; Barrera-Hernandez et al., 2020).

A close relationship with nature has also been found to have strong positive impacts on hedonomic and eudaimonic wellbeing (e.g. Pritchard et al., 2019; Martin et al., 2020).

Importantly, nature connectedness has benefits above and beyond simple contact with nature for mental wellbeing outcomes (e.g. Martin et al., 2020; Richardson et al., 2021; Richardson and Hamlin, 2021). Interventions focused on increasing nature connectedness have been found to deliver sustained and clinically significant improvements in mental health (e.g. McEwan et al., 2019; Keenan et al., 2021).

1.1 The importance of nature connectedness in young people

The disconnect between today's children and nature is especially worrying (Bragg et al. 2013; Sobel, 2017), as a lack of a sense of responsibility and caring for the natural world in childhood may lead to behaviour that has a negative impact on the environment in later life. Children who have positive experiences in nature have a deeper relationship with it in adulthood (Charles et al., 2018; Cleary et al., 2018; Rosa et al., 2018). Positive engagement with nature in childhood may also lead to a greater likelihood of engaging in pro-environmental behaviour in adulthood (Evans et al., 2018; Rosa et al., 2018; Molinario et al., 2020).

It is also important to address the phenomenon of environmental generational amnesia (Kahn, 2002) or shifting baseline syndrome (Jones et al., 2020): younger, less experienced people are less aware of historical ecological conditions, having grown up in a very different world from their antecedents, and are therefore less likely to recognise the dramatic losses that have taken place. As a result, younger people may not appreciate the need for conservation action to help support threatened species.

The benefits of nature connectedness for wellbeing have great potential for tackling mental health problems, which are of particular concern in children. Adolescents are at increased risk of developing such disorders (Keshavan et al., 2014; Lamblin et al., 2017; Archer et al., 2018), which can go on to have a lifelong impact – half of all lifetime disorders start by the age of 14, and three quarters by the age of 24 (Kessler et al., 2005). Several studies have found that while levels of nature connectedness are high in young children, they have declined by the middle of the teenage years, only recovering in adulthood (Chawla, 2020; Hughes et al., 2019; Richardson et al., 2019). Adolescent girls also consistently report lower levels of wellbeing than boys (e.g. Bisegger et al., 2005; Michel et al., 2009; Meade and Dowswell, 2016; Viejo et al., 2018). However, there is increasing evidence that a close connection with the natural environment can have a positive impact on mental health and wellbeing in children (Piccininni et al., 2018). Focusing efforts on increasing nature connectedness in children and young people, and thus potentially improving their mental health, is likely to be of major public health significance.

Few studies, though, have looked directly and in detail at nature connectedness in children and the factors affecting it (Cleary et al., 2020). Previous research (Kaplan and Kaplan, 2002; Hughes et al., 2019: Richardson et al., 2019) has found that girls have higher nature connectedness levels than boys, and that nature connectedness scores decline with age, at least until the mid-teens. Income inequality has been shown to affect adolescent wellbeing (Elgar et al. 2016), and studies indicate that people of higher socioeconomic status have greater access to green spaces (Wolch et al., 2014; Jennings et al., 2017; Rigolon et al., 2018), and that deprivation has a negative impact on nature connectedness (Passmore et al., 2020). Experiences in nature in childhood, and parental attitudes and behaviour, also influence pro-environmental behaviour in adulthood (Wells and Lekies 2006; Evans et al., 2018; Giusti et al., 2018; Rosa et al., 2018). Parent or guardian influence is a major factor in determining nature connectedness levels in children (Barrable and Booth, 2020; Passmore et al., 2020), and this relationship is bidirectional, with young people able to influence their parents' environmental attitudes in turn (Žukauskienė et al., 2021). Some results have been surprising, however. A survey of 1,200 children in the UK by the Royal Society for the Protection of Birds (RSPB, 2013) concluded that children in urban areas were more highly connected to nature than children in rural areas, while Luck et al. (2011) found little evidence of a relationship between nature connectedness and environmental variables such as species richness.

1.2 Study aims

To help address these knowledge gaps, we conducted an extensive survey of school students on the island of Jersey, Channel Islands, to measure their levels of nature connectedness and investigate factors that might influence these. Studying a single, tightly-defined community meant that geographic, social and cultural factors were largely were held constant. Our specific aims were to:

1. Determine the detailed trajectory of nature connectedness levels in a large fraction of the young population (7-18 years) in a single community.
2. Evaluate the relative impact of other external factors influencing nature connectedness.
3. Evaluate individual factors that might be associated with nature connectedness in adolescence (11-18 years), namely children's preferences for particular locations, and time spent using screens.
4. Gain an insight into barriers to engaging with nature in adolescence.
5. Identify potential areas for intervention to increase nature connectedness levels in young people.

2. Methods

2.1. Population characteristics

Jersey is an island (approximately 45 square miles) and British Crown Dependency off the coast of Normandy, France. Jersey is a self-governing parliamentary democracy under a constitutional monarchy and is not part of the United Kingdom or the European Union. The island's culture is British and although separate from the UK, it follows the school curriculum of England.

Jersey's environment consists of built-up urban areas (24% of the total land surface) and land dedicated to agriculture (52%) , with 18% for natural environments (States of Jersey, 2021a). The island's natural space is concentrated around the coastline, including coastal footpaths and intertidal zones that are accessible due to the island's large tidal ranges. The natural environments consist mainly of land owned by the Government of Jersey, some in the form of Sites of Scientific Interest (SSIs), as well as sites belonging to the National Trust for Jersey and Jersey Heritage where the land is managed for nature conservation and is accessible to visitors.

The most recent published population estimate, completed in 2016, was 104,200 (States of Jersey, 2021b). Two thirds of the total resident population are of working age (women/men aged 16-59/64 years), with a further sixth above working age and another sixth below working age (States of Jersey, 2021b). The population density is approximately double that of England (States of Jersey, 2021b).

The island's median income is around 50% higher than in the UK, averaging at a household weekly income of £860 before housing costs (States of Jersey, 2015). Nevertheless, there is significant income inequality in the island, with over half (56%) of one-parent families having relatively low income after housing costs (States of Jersey, 2015), and income inequality has increased since 2009/10.

2.2. Participants

Students from 16 of the island's 31 primary schools, nine of the 10 secondary schools and Jersey's further education college contributed to the survey – in all, 62% of primary and secondary level institutions. The total number of responses received was 1879. With approximately 1000 children per year group in Jersey's population, we therefore reached about one sixth of all school-age children on the island.

As the number of participants who gave the answers "do not identify as either boy or girl" or "prefer not to say" was very small (52/1879, or 2.7% - comparable to the figures reported by States of Jersey, 2019), we decided to exclude them from the statistical analysis. We also dropped the very few responses from students aged over 18 years. In the resulting sample of 1827 students, 59% were male and 41% female, with a mean of 166 (± 74.0 SD, range 44–259) children per school year group (Supplementary Material, Table 1).

2.3. Design

2.3.1. Primary school children

This phase of the study was carried out in 2018. A questionnaire was designed using Smart Survey (www.smartsurvey.co.uk), and all primary schools in Jersey (n = 31) were invited to participate via a web link. The survey questions were limited to the six-statement Nature Connection Index plus metadata (see below).

Details of the background to the study and guidance on how to complete the survey were sent via email. We also offered the option to complete the survey on paper, either in class, or on a visit to Jersey Zoo's education department; one school selected this option, and their data were entered manually into Smart Survey by Durrell staff. We restricted the survey to Key Stage 2 (school years 3-6, which includes children aged 7-11 years), as we felt that Key Stage 1 children may have found it more difficult to complete the questionnaires and the NCI has not been tested in this younger age group.

2.3.2. Secondary school children

We expanded the survey in 2019-20 to secondary level students (11 secondary schools and one further education college). The questionnaire was restricted to students in full time education. All secondary schools and colleges were invited to participate via email, and we received at least some responses from all but one.

Initial discussions were held with teachers from various secondary schools to establish the questionnaire design and review the ethics of the study. Following these reviews, questions on mental health and wellbeing were removed from the questionnaire as a precaution for high-risk students. In addition to the NCI and metadata, the final design included questions about activities, favourite places, and any barriers students perceived were preventing them from going outdoors.

Schools were offered three options: (1) a visit from the Durrell Education team to the school to run in a teaching session, including completing the questionnaire; (2) a class visit to Jersey Zoo, again incorporating the survey into a teaching session; (3) completing the questionnaire online. All year groups from KS3 to KS5 (year groups 7-13; ages 11-18 years) were invited to take part.

To ensure that students completing the survey as part of a learning session participated only once, they were asked if they had answered the questionnaire before. If they had, an additional activity was supplied while the remaining students completed the survey. The questionnaire was completed at the beginning of the teaching session to avoid influencing the students' responses. On average, the survey took 15 minutes to complete. Questionnaires completed on paper were entered manually into Smart Survey by Durrell volunteers and staff. Copies of the questionnaires and guidance notes are provided in the Supplementary Materials. Each individual school's results were reported only to that school and to the States of Jersey Education Department.

2.4. Ethical procedures

2.4.1. Primary schools

Consent was obtained from the States of Jersey Education Department, head teachers and class teachers. Initial discussions were held with senior Education Department staff, and Durrell staff also gave a presentation to a meeting of primary head teachers to explain the background to the project and describe the methods to be used. As we considered completion of the questionnaire to pose minimal risk to children, surveys were completed as part of the normal school routine, and data were anonymised at source, we did not seek parent/guardian consent. This approach meets the criteria of the British Psychological Society's Code of Human Research Ethics (2014) in regard to research in school settings.

2.4.2. Secondary schools

As we extended the questionnaire to include more personal information from each student, we extended our consent process for secondary schools. Students were explicitly asked for their consent for us to use the data they provided before starting the survey. In addition, we included a means by which parents or students could request that their data be removed from the analysis at any point, while still remaining anonymous to the researchers. Students were either assigned a code number by their class teacher, or selected a username themselves, and provided this with their responses. The list relating real names to codes was retained by teachers. An information letter was sent to parents via schools describing the project and making it clear that parents or students could request withdrawal from the study at any point by letting class teachers know. Teachers could then pass on the student's code number or username to Durrell. In practice, no students were withdrawn from the study.

2.5. Measures

2.5.1. Nature Connection Index (NCI)

A variety of techniques are now available for assessing nature connectedness (Tam, 2013; Bragg et al., 2013; Chawla, 2020). We chose the Nature Connection Index (NCI), developed and tested by Natural England (Hunt et al., 2017), as a large database has now been collected using this measure in the UK, enabling useful comparisons, and it has been validated across a range of age groups (Richardson et al. 2019, 2020b).

The NCI questionnaire asks repondents to rate the following six statements on a seven-point scale, from 1 (strongly disagree) to 7 (strongly agree):

- I always find beauty in nature
- I always treat nature with respect
- Being in nature makes me very happy
- Spending time in nature is very important to me
- I find being in nature really amazing
- I feel part of nature

The scores for each statement are weighted and summed to give an overall score ranging from zero to 100, where zero is least connected, and 100 most connected to nature (Hunt et al., 2017; Richardson et al. 2019). Correlations with two other measures of nature connectedness are high (> 0.5; P < 0.01), confirming that the NCI is a valid measure of nature connectedness (Richardson et al. 2019). Furthermore, exploratory factor analysis on three different samples found that the items included in the NCI measure one factor and show high internal consistency, demonstrating its reliability (Richardson et al. 2019).

2.5.2. Factors affecting NCI in all age groups

All participants were asked for their school and year group, their age in years, and their gender (boy, girl, do not identify as either boy or girl, or prefer not to say). The following data were collected for each school:

- **Type of funding**: To look for a relationship between income and nature connectedness, we studied students at both fee-paying and non-fee-paying schools; we reasoned that type of funding was likely to reflect the average income level of families whose children attended a given school, as previous work has found that attendance is fee-paying schools is associated with a higher family income level (Bradfield and Crowley, 2019). There were 14 fee-paying schools (including private schools and fee-paying state schools; nine primary and five secondary), and 28 non-fee-paying schools (including the further education college; 22 primary and six secondary). We did not have sufficient data to subdivide the fee-paying schools into the two sub-categories. All but one of the fee-paying schools from which we received responses were single sex; all non-fee-paying schools were mixed sex.
- **Location**: schools were classed as "urban" or "rural" based on an inspection of each school's site on Google maps. Schools that were bordered on at least one side by countryside (woods, agricultural fields etc; playing fields were excluded) were classed as rural (10 primary schools and five secondary schools). The remaining schools were classed as urban.
- **Activities and facilities around nature and the environment**: We asked schools directly (via phone or email) for information on other activities and facilities around nature and the environment that they offered. These included membership of the Eco Schools programme (https://www.eco-schools.org.uk), forest school activities (primary schools only), award schemes such as Duke of Edinburgh, John Muir (secondary schools only), clubs (eco, nature, gardening), gardens (natural or food production), ponds, woodlands or other natural areas, and other facilities or activities (e.g. mud kitchens, weekly plastic-free days). Schools were given a score of 1 for each activity/facility, and these were summed to give a single score representing the level of each school's activities and facilities. Scores ranged from 3 to 8 for primary schools and from 2 to 5 for secondary schools, as secondary schools typically offered fewer options.

Preliminary analysis showed that there was a clear, and probably unsurprising, difference between rural and urban schools in the facilities and activities they offered, with rural schools scoring higher for both primary and secondary levels (primary: rural schools mean = 5.7, urban mean = 3.7; secondary: rural schools mean = 3.6, urban mean = 2.5). We therefore included school location rather than level of activities in the final statistical analysis.

2.5.3. Analysis of additional questions for years 7-13 (ages 11-18) only

We asked secondary level students to estimate the time they spent each day using screens (of any type, i.e. including TV, computers, tablets and phones) in 1-hour time intervals (0–1 hours to 5+ hours per day). We also asked them open-ended questions to tell us (1) what their favourite place was, (2) where they liked to go to relax, (3) where they went to socialise, and their favourite activities, both (4) in general and (5) when they were socialising. Finally, we asked (6) what, if anything, they felt prevented them from going outside.

To categorise the responses to the questions around students' preferred places and activities, we used inductive coding and a hierarchical coding frame (Richards and Richards, 1995; Thomas, 2003), with two tiers for each question: a main category and a sub-category. Codes were initially brainstormed by two people (SM and a research assistant) using a sample of 60 questions. Each person decided on codes for each question individually; they then compared results to develop a final coding system. A spreadsheet was used to keep track of codes, examples of answers, their meaning and their relationship to other questions. One author (SM) then coded all responses to ensure consistency. A second author then reviewed the codes to account for human error when working on a large data set. Answers that were missed, unreadable or contained information not relevant to the question were grouped together as "not answered".

Many participants included more than one category of location; our final list of categories to include in statistical analyses was therefore: home; natural; urban; natural and urban; and other. Participants with missing values for some questions were dropped from the analyses. Full details of categories are provided in Supplementary Material, Table 2.

2.6. Statistical analysis

Year group and age were obviously very highly correlated. We reasoned that children of different numerical ages in the same year group were likely to have more similar experiences around nature and the environment than children of the same numerical age in different year groups, and we therefore chose to include year group rather than age as a factor in the analysis.

We used generalised linear mixed models (GLMMs) to control for the fact that children were nested in classes, which were in turn nested in schools. Following the method described by Thomas et al. (2013), we used comparison of AIC scores to select the most appropriate combination of random factors (school and class). Class alone and class nested in school provided equally good fits, so we used class alone as a random factor in the model.

We ran two analyses. First, we included all age groups and investigated the effects of gender, age, school location and school type, including all interaction terms, on NCI scores. Second, we used only the data from secondary level students to look at the additional effects of screen time and preferred places. As interactions did not have a strong influence in the first analysis (see results), we did not include interaction terms in these models.

We found that many students had not answered the questions around places to socialise, and so we omitted this factor from the analysis to maintain the sample size. In addition, the answers to the questions around activities and barriers to going outside were very varied, and many students gave several different answers. We therefore could not code these data for use in statistical analysis. However, we used this information to identify areas in which interventions might be most fruitfully designed to increase nature connectedness levels in this age group. Responses to questions 4 (general activities) and 5 (social activities) produced similar lists of activities with considerable overlap, so we only used responses to question 4.

Data were analysed using an information-theoretic approach with the statistical software R (version 3.5.1; R Core Development Team, 2018) and the packages nlme (Pinheiro et al., 2018), lme4 (Bates et al., 2015), arm (Gelman and Su, 2018) and MuMIn (Barton, 2015). We followed the method outlined by Grueber, Nakagawa, Laws, & Jamieson (2011) for model averaging of GLMMs, and considered models with $\Delta AIC_c < 2$ as having strong support, and those with a ΔAIC_c of >2 to have less support (Burnham and Anderson, 2002). For each analysis, we constructed a standardized global model containing all factors of interest. We then used the dredge function in MuMIn to obtain a list of all models with a ΔAIC_c <2 from the best model, and used model averaging to obtain estimates and 95% confidence intervals for each factor, considering CIs that did not overlap zero as representing significant effects. We calculated relative importance of each variable or combination of variables (RVI) by summing the weights of each model in which it occurred.

3. Results

3.1. Factors affecting nature connectedness in all age groups

Four models contributed to the averaged model of NCI scores across all age groups (Table 1). All four main variables influenced NCI scores and had RVI scores of 1, indicating that they were included in all four models with ΔAIC_c <2 (Table 2). As Figure 1 shows, girls had higher NCI scores on average than boys. NCI score also dropped steadily with age until Year 8-9, but appeared to level off after this point.

Interactions had only limited effects (Tables 1 and 2), with each of three two-way interactions appearing in a single component model, and confidence intervals overlapping zero. No other interactions appeared in the component models. On average, both male and female students in urban schools had lower NCI scores than those in rural schools (Figure 2). However, boys in rural feepaying schools had particularly low NCI scores, while girls in those schools had markedly higher scores.

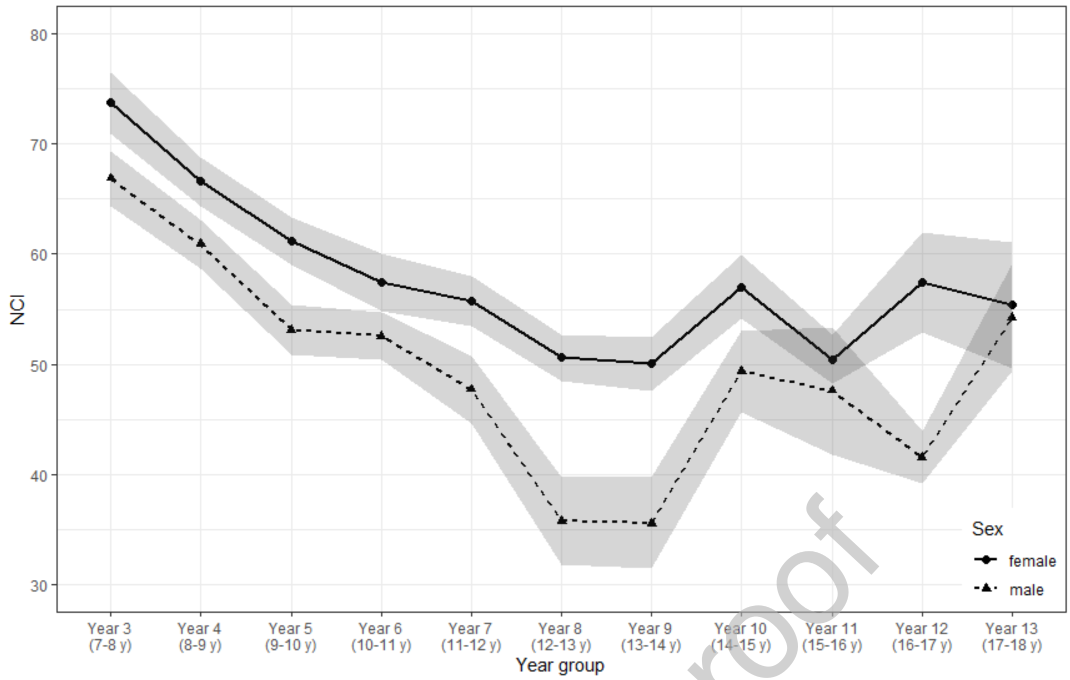


Figure 1. Effects of age and gender on mean NCI scores across all age groups. Shaded areas represent standard errors. Age ranges (in years) covered by each year group are given below the x-axis in parentheses.

Table 1. Component models (ΔAIC_c <2) for analysis of NCI in all age groups. All models included Class (school ID combined with year group) as a random factor.

Model	**df**	**logLik**	**AIC_c**	**ΔAIC_c**	**Weight**
School location + School type + Gender + Yeargroup	16	-8435.31	16902.91	0.00	0.42
School location + School type + Gender + Yeargroup + School type*Gender	17	-8434.89	16904.12	1.21	0.23
School location + School type + Gender + Yeargroup + School type*School location	17	-8435.12	16904.58	1.67	0.18
School location + School type + Gender + Yeargroup + School location*Gender	17	-8435.18	16904.70	1.79	0.17

Table 2. Model-averaged coefficients, standard errors, 95% confidence intervals, and relative variable importance (RVI) for variables included in averaged model for NCI in all age groups.

			Confidence intervals		RVI
Variable	**β**	**SE**	**2.5%**	**97.5%**	
(Intercept)	69.236	2.532	64.269	74.202	
School location (reference level = rural)	-5.977	2.492	-10.865	-1.089	1
School type (reference level = fee-paying)	-5.643	2.403	-10.355	-0.930	1
Gender (reference level = female)	-7.696	1.502	-10.642	-4.750	1
Year group (reference level = Year 3)					1
Year 4	-5.266	3.370	-11.877	1.344	
Year 5	-11.974	3.374	-18.591	-5.357	
Year 6	-14.875	3.449	-21.640	-8.110	
Year 7	-17.064	4.441	-25.773	-8.354	
Year 8	-24.167	4.270	-32.542	-15.791	
Year 9	-26.405	4.107	-34.459	-18.351	
Year 10	-12.789	4.286	-21.195	-4.384	
Year 11	-21.172	4.538	-30.073	-12.270	
Year 12	-18.873	4.810	-28.306	-9.440	
Year 13	-10.975	5.461	-21.684	-0.265	
School type*Gender	0.753	2.207	-3.767	10.344	0.23
School type*School location	-0.737	3.260	-17.229	9.105	0.18
School location*Gender	-0.239	1.272	-6.888	4.098	0.17

3.2. Factors associated with nature connectedness in secondary level students

Six models contributed to the averaged model for NCI scores in secondary level students (Table 3). Year group had no effect, confirming that the decline in nature connectedness levels off but does not begin to increase markedly during adolescence. The type of favourite and relaxing places reported by students, and the amount of time per day they spent using screens, had strong effects, all variables appearing in all models and most CIs not crossing zero (Table 4). On the other hand, while gender, school location and school type had some influence, their effects were not as strong. There was a clear relationship between screen time and NCI score, with NCI decreasing as screen time increased (Figure 3A). Students reporting that their preferred places included natural areas also had higher NCI scores (Figure 3B, C). There was a difference in the places participants reported as being favourite

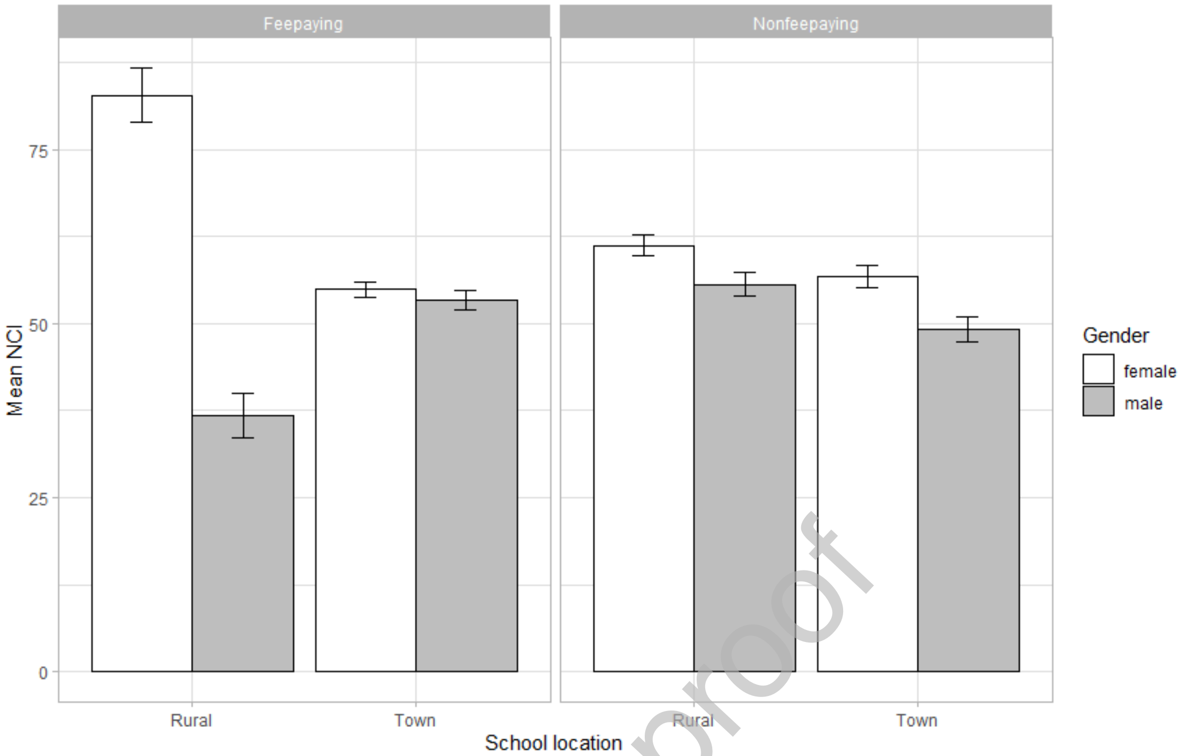


Figure 2. Effect of gender, school location and type on NCI scores in all age groups. Vertical bars indicate standard errors.

as opposed to the place they went to relax; the majority of students reported that their preferred relaxing place was their home, whereas more students reported that their favourite place was natural (Figure 4).

Table 3. Component models with ΔAICc < 2 for NCI in secondary level students.

Component model	df	logLik	AIC_c	ΔAIC_c	Weight
School location + School type + Gender + Favourite place + Relaxing place + Screen time	19	-3343.77	6726.58	0.00	0.22
School location + Gender + Favourite place + Relaxing place + Screen time	18	-3344.98	6726.90	0.31	0.19
School location + Favourite place + Relaxing place + Screen time	17	-3346.09	6727.01	0.43	0.18
Favourite place + Relaxing place + Screen time	16	-3347.26	6727.26	0.68	0.16

Gender + Favourite place + Relaxing place + Screen time	17	-3346.32	6727.48	0.90	0.14
School location + School type + Favourite place + Relaxing place + Screen time	18	-3345.39	6727.7	1.12	0.12

Table 4. Model-averaged coefficients, standard errors, 95% confidence intervals, and relative variable importance (RVI) for variables included in averaged model for NCI in secondary level students.

			Confidence intervals		
	β	**SE**	**2.5%**	**97.5%**	**RVI**
(Intercept)	55.676	4.389	47.056	64.293	
School location (reference level = Rural)	3.997	3.570	-0.086	11.424	0.71
School type (reference level = Fee-paying)	1.215	2.235	-1.386	8.480	0.34
Gender (reference level = Female)	-1.704	2.040	-6.630	0.363	0.55
Favourite place (reference level = Home)					1
Natural	14.780	2.156	10.546	19.013	
Natural/urban	10.745	4.173	2.553	18.937	
Other	6.382	2.770	0.944	11.821	
Urban	-3.079	2.693	-8.366	2.209	
Relaxing place (reference level = Home)					1
Natural	10.960	2.174	6.692	15.228	
Natural/urban	4.360	2.564	-0.674	9.393	
Other	6.537	3.087	0.477	12.597	
Urban	-0.7690	4.190	-8.994	7.457	
Screen time (reference level = 0–1h)					1
1–2 h	-8.7080	4.372	-17.290	-0.125	
2–3 h	-15.017	4.279	-23.417	-6.618	
3–4 h	-17.694	4.335	-26.205	-9.183	
4–5 h	-21.657	4.479	-30.451	-12.864	
5+ h	-22.1360	4.439	-30.850	-13.422	

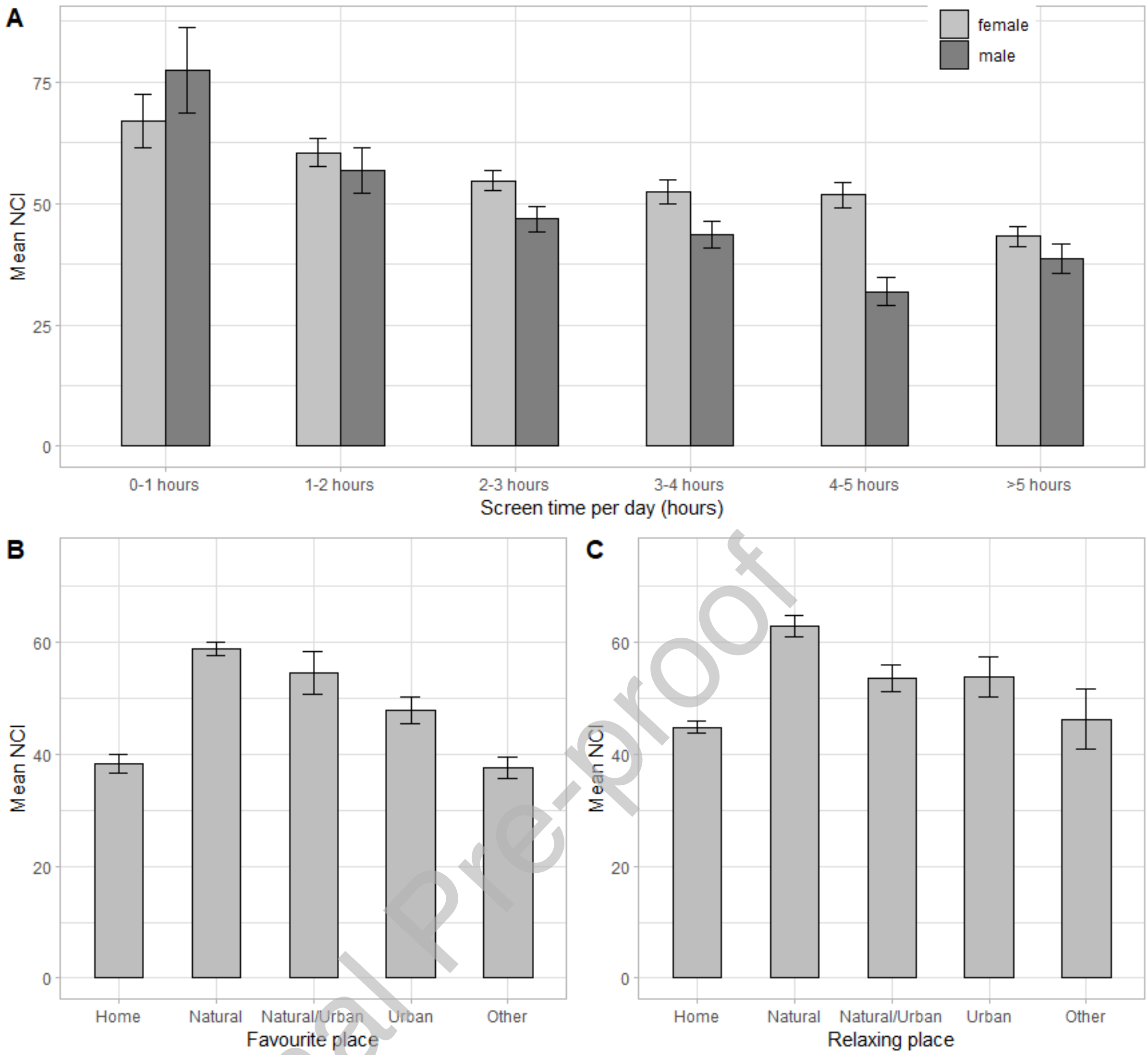


Figure 3. A. Relationship between NCI, gender and screentime in secondary level students. B. Relationship between favourite place and NCI in secondary level students. C. Relationship between relaxing place and NCI in secondary level students.

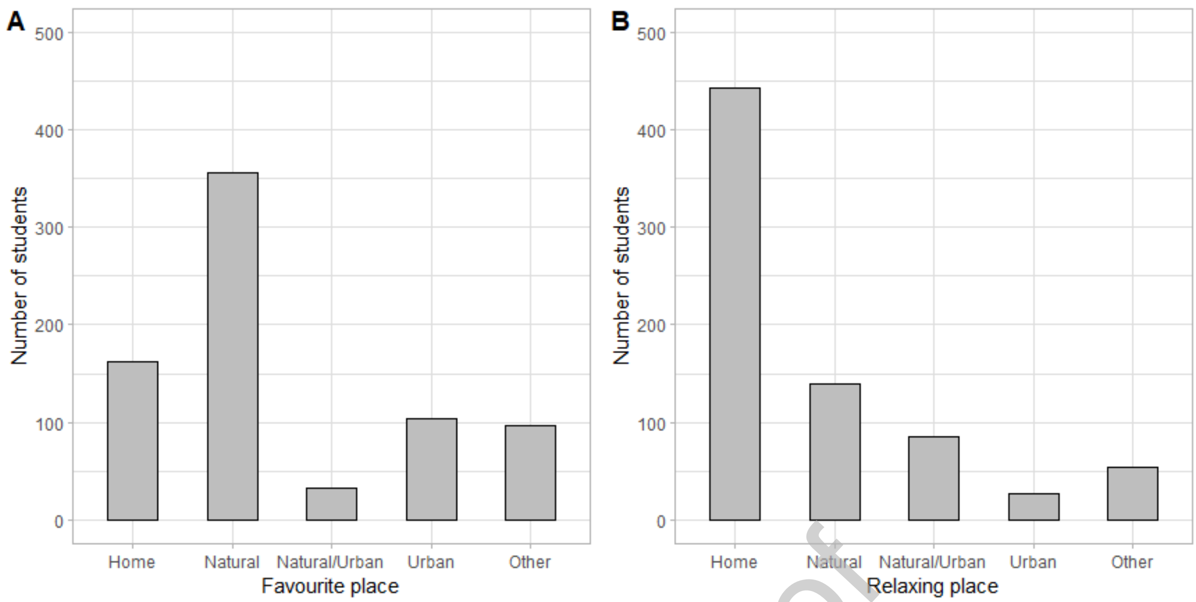


Figure 4. A. Favourite places reported by secondary level students. B. Relaxing places reported by secondary level students.

3.3. Barriers to going outside and preferred activities in secondary level students

We classified barriers into 12 categories (see Supplementary Materials, Table 3). When asked about barriers, the most frequent responses from the students (42.6% of participants) was that nothing was preventing them from going outside. The second largest category was weather (20.9%), followed by health (10.5%), school/work (9.3%) and safety (5.2%). Other barriers were mentioned by less than 5% of participants. No answer was given by 12.6% of participants.

Secondary school students reported a wide range of preferred activities, with sports the most frequently mentioned (56.4% of participants). Arts and crafts (including drawing, painting, music, cooking, etc) were also popular (34.6%), along with fitness (25.8%) and games other than sports, e.g. computer games (17.8%). Other activities were mentioned by less than 10% of participants (for details, see Supplementary Materials, Table 4). No answer was given by 11.1% of participants.

4. Discussion

Nature connectedness in children is known to broadly decline from the early years onwards, reaching a low point in adolescence, with consequences for their wellbeing but also for pro-conservation attitudes and behaviours in later life. Tackling this “dip” in nature connectedness that we see in children and young adults could bring a higher proportion of the adult population to the level at which pro-environmental and pro-conservation behaviours are more likely at an earlier age (Figure 5), with consequent benefits for global wellbeing and conservation.

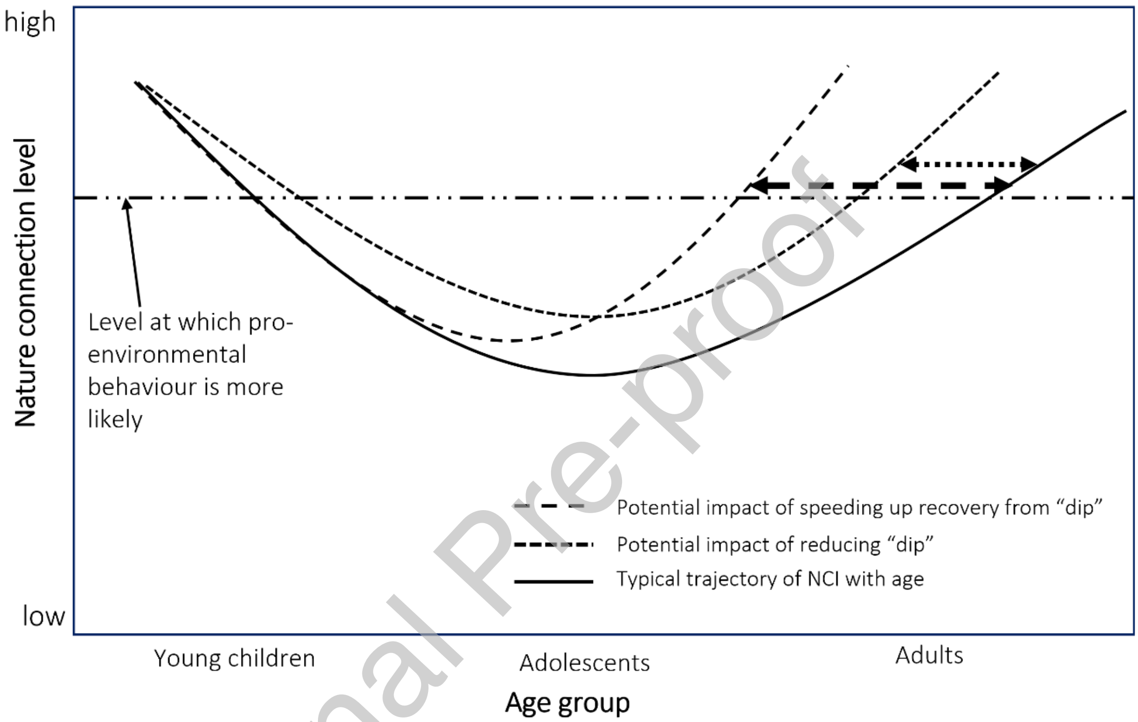


Figure 5. Potential effects of altering the trajectory of nature connectedness with age.

In order to help identify potential interventions to tackle this issue, more evidence is needed to build a detailed picture of the course of these changes in nature connectedness with age, and a greater understanding of the factors associated with this decline. Our study therefore examined nature connectedness levels in a single population of school-age children and how they may be affected by age, gender, school characteristics, and behavioural factors such as screen use. Our survey included approximately 17% of the children in the community we studied, an unprecedented level of participation for this type of study, and we found some potentially important effects.

While we worked with one community, our large sample size leads us to believe that our results are generalisable to the UK and other similar cultures. Our mean scores for different ages were also extremely close to those reported for the UK by Richardson et al. (2019) (7-9 years: Jersey 63.86 ± 26.36SD, UK 63.80 ± 24.29; 10-12 years: Jersey 54.18 ± 25.44, UK 55.60

± 24.08; 13-15 years: Jersey 47.66 ± 23.95, UK 47.64 ± 24.82; 16-18 years: Jersey 49.69 ± 22.89, UK 47.63 ± 24.82).

4.1. Individual factors affecting nature connectedness

A number of studies (for a review, see Chawla, 2020) with participants ranging in age from young children to elderly adults have shown that 7–12 year olds typically have the highest levels of nature connectedness, and adolescents the lowest (Hughes et al., 2019; Krettenauer et al., 2019; Richardson et al., 2019). However, these studies typically have not described the details of changes in nature connectedness within narrower age classes. Our results showed that nature connectedness levels decreased from school year 3 (age 7–8 years) onwards, indicating that they were already in decline in the youngest children we studied. This decrease then levelled off in the mid teens. It is important to note that, as yet, there have been few comparative studies of changes in nature connectedness with age in different cultures, though Krettenauer et al. (2019) did find that age was inversely associated with connectedness with nature in a similar way in both Canadian and Chinese young people (age range 9-21).

However, our study provides evidence that we need to focus on young children as well (see also Barrable, 2019). Research into nature connectedness in early childhood is therefore crucial (Beery et al., 2020); the difficulty is finding a measure that is appropriate for comparison across such a wide age range. Rice and Torquati (2013) and Sobko et al. (2018) have developed measures for preschool children (2-5 years), but, although the NCI has been tested in people aged 7 to over 90 years old, there is no single measure that can cross all age ranges. Rice and Torquati (2013) reported that biophilia increased with age in their sample of preschool children in the US; the crucial age at which the trajectory of nature connectedness reverses therefore seems to be at 5-7 years old, in other words, around the age that children start school. Further research to clarify when and why nature connectedness begins to decline at this stage in childhood is needed.

One of the other main results of our survey was that girls had higher NCI scores than boys, consistent with previous reports (e.g. RSPB, 2013; Richardson et al., 2019; Chawla, 2020). This gender difference was maintained across age groups, though it was less clear in older children, with boys reaching similar levels to girls at the age of 17-18. This result is similar to that reported by Keith et al. (2021). We may be picking up the beginning of a narrowing in the gender gap in nature connectedness in adulthood. Some other studies (e.g. DiFabio and Rosen, 2019; Kleespies and Dierkes, 2020) have found no difference in male and female adults, while others have reported that women maintain higher levels of nature connectedness than men (e.g. Tam, 2013; Hughes et al., 2019; Cervinka et al., 2012; Martin et al., 2020). Gender as a factor in relationships with nature is understudied, and the reasons for the gender gap in children, and why it may narrow in adulthood, are as yet unclear. Further research using mixed-methods approaches are needed to help understand this gender gap more clearly, by considering not only individual nature connectedness scores but the wider context that may be affecting their relationship with the rest of nature.

Our results contrast with the gender differences frequently reported for wellbeing. A recent survey by the States of Jersey (2019) found that girls in Jersey consistently rated their wellbeing on a number of measures as lower than boys; this reflects the pattern reported in other studies (e.g. Bisegger et al., 2005; Michel et al., 2009; Meade and Dowswell, 2016; Viejo et al., 2018). Given the relationship between higher levels of nature connectedness and greater wellbeing found in adults, this is difficult to explain and clearly requires further study of the factors that affect nature connectedness, wellbeing and the relationship between the two. For example, Piccininni et al. (2018) found that greater time spent outdoors was positively associated with a 24% lower prevalence of psychosomatic symptoms, but this effect did not appear in boys, while self-esteem in girls has been found to be more negatively affected by social pressure than in boys (Helfert and Warschburger, 2013).

The question of why adolescence is a period of relatively low connectedness to nature has previously been investigated in several ways. Adolescence is a time of plasticity and change when young people acquire the skills and experience they need and develop relationships with others and their environment (Perry and Pauletti, 2011; Viejo et al., 2018). Interacting with others is a crucial part of the learning process, helping children to understand both what they can and what they want to do (Chawla, 2009). Peer support becomes increasingly important as children get older (Clark and Uzzell, 2005). The development of social networks is closely intertwined with changes in the body and in brain structure and function (Lamblin et al., 2017; Blakemore, 2019). Notably, the areas of the brain devoted to social relationships are more active in adolescents than in adults (Dumontheil, 2016).

This period where children develop an identity and form social relationships may conflict with a close connection with nature as priorities change (Richardson et al., 2019). We found that although adolescents' favourite places were natural spaces, their average nature connectedness is low. This suggests that although adolescents appreciate nature, its role in their everyday lives is diminished, whether because of the school environment or changes associated with perception of peers. There is a clear need for further work in this area. The emphasis on social relationships might help to explain the lower levels of nature connectedness in this age group. Early research by Balling and Falk (1982) showed that 15-year-olds were much less likely to express an interest in visiting or living in natural environments than either older or younger subjects. Kaplan and Kaplan (2002) reviewed a series of similar studies and found a consistent pattern: adolescents showed a lower preference than other age groups for natural environments, and a higher interest in more developed areas, especially those that were associated with activity. On the other hand, Owens (1988) found that older adolescents (aged 14-18) preferred natural spaces, although there is evidence of a loss of interest in adolescence (Bell et al., 2003). It seems that as children get older, their use of and requirements for natural spaces will change (Richardson et al., 2019); during the critical developmental phase of adolescence, when children are forming their identity (Crocetti, 2017), nature may simply be less of a priority. Nonetheless, in our study, young people who preferred natural places both in general or for relaxation had the highest nature connectedness levels, and those selecting home, the lowest. This could indicate that high levels of nature connectedness are important for natural space preferences in adolescence, and may counter the loss of interest found previously. However, it is also possible that children who prefer natural spaces, and therefore may spend more time in nature, have higher nature connectedness scores as a result.

Some of the variation in these results may be due to methodological differences. Our study showed that adolescents in Jersey had different preferences for locations depending on the question asked. When describing their favourite place, the most common category reported was natural spaces, or a combination of natural and urban locations. However, the vast majority of children reported that the place they went to relax was their home. Understanding the various needs of adolescents, in terms of opportunities for relaxation, socialisation and stimulation, is therefore important in interpreting responses to their environment (Nightingale and Wolverton, 1993; Owens, 2017).

We also found a strong negative relationship between self-reported screen time and NCI score, and this was consistent across all age groups at secondary level, and in both sexes. Similar results have been reported for adults by Richardson et al. (2018), and for young people by Larson et al. (2018) and Michaelson et al. (2020). There is increasing evidence that the more time young people spend on screen, the more likely they are to have decreased wellbeing in general, and the higher the risk of psychological difficulties such as behavioural problems, reduced prosocial behaviour and hyperactivity (Allen and Vella 2015; Suchert et al., 2015; Twenge and Campbell, 2018). The effect appears to be stronger in adolescents than in younger children (Twenge and Campbell, 2018). However, positive aspects of social media use have also been reported (Weinstein, 2018). Our study was not able to clarify whether higher nature connectedness level leads to a preference for more natural places and less screen use or vice versa, but the strong focus on social relationships in adolescence, and the opportunities to develop and reinforce these that the use of social media offers to the current generation, may lead to changes in how they use the spaces available to them (Owens, 2017).

4.2. School factors affecting nature connectedness

As most children spend a large part of their time in school, it is perhaps not surprising that factors relating to the school environment emerged as important influences on nature connectedness levels in our study group. We found that children in schools in rural settings had higher average NCI scores than children in schools in urban areas, though this effect was not as strong when we considered only secondary level students. This is in contrast to the results reported from the UK by the RSPB (2013), who found higher levels of nature connectedness in urban children. However, it was clear that rural schools, particularly at primary level, provided a greater range of facilities than their urban equivalents, including, for example, woodland or ponds. This is almost certainly simply a function of the available space, which is much more limited in town schools. Similarly, Hobin et al. (2013) found that levels of physical activity were higher in secondary school students in rural areas than in those living in urban or suburban areas. Urban schools are able to offer fewer opportunities and facilities for physical outdoor activities. However, children attending urban and suburban schools in areas that provided more opportunities for social interaction had higher levels of physical activity (Hobin et al., 2013).

We also found that children attending fee-paying schools had higher nature connectedness levels than those at non-fee-paying schools, particularly at primary level. It is reasonable to assume that attendance at fee-paying schools reflects higher household income and our results are therefore consistent with a positive relationship between socioeconomic status and nature connectedness. Li et al. (2018) reported that adolescents from families with higher socioeconomic status had more contact with nature, although it is important to note that greater contact with nature does not necessarily translate into greater connectedness (Richardson et al., 2021).

However, one limitation of our study is that all but one of the fee-paying schools that participated were single sex (with an equal number of all-male and all-female schools), whereas all non-fee-paying schools were mixed sex. We are not able to explore the relative impacts of co-educational versus single sex schooling in detail, but there is evidence that single-sex education promotes gender-specific norms (Halpern et al., 2011), and this may be one explanation for the large difference we found in NCI scores between girls and boys attending rural fee-paying schools. It is possible that gender stereotypes and play themes for girls and boys are not being challenged in single-sex fee-paying schools to the same extent as in mixed gender schools. Children in these schools may be encouraged, whether consciously or not, to engage more in activities and behaviour that are perceived as appropriate for their gender, while children in mixed-sex schools are exposed to a greater variety of influences. However, the same effect did not appear in urban fee-paying schools, so further work is clearly required.

4.3. Designing interventions to increase nature connectedness in children and adolescents

Encouraging contact with nature in childhood, and particularly experiences that directly engage the pathways to nature connectedness, may lead to the formation of preferences and habits that increase the likelihood that people will seek out experiences with nature as adults. Experiences in childhood, e.g. exposure to nature, and parental attitudes and behaviour, have also been shown to influence pro-environmental behaviour in adulthood (Collado et al., 2017; Evans et al., 2018; Rosa et al., 2018). Along with other research, our study suggests several elements that are important in engaging children and young people with nature. These are likely to differ with age; we found, for example, that the influence of age and gender decrease in older children. Each age group will therefore need a carefully tailored programme of activities that takes account of its needs and preferences (Sobel, 2008, 2017), but there are some factors that are likely to apply across childhood and adolescence.

Tackling inequalities in access to nature in young people is a first step to effect considerable change in levels of nature connectedness. The benefits of increased engagement with nature are likely to be greatest for those who currently have the least (McEwan et al., 2019).

The difference we found between urban and rural schools, and between fee-paying and non-fee-paying schools, suggests that interventions designed to provide children with increased access to nature might well have a positive impact. Approaches that address the barriers schools face to taking children out into natural environments, for example by providing free transport, should be investigated.

However, providing access alone is not enough to build a closer relationship with nature. Passmore et al. (2020) found that simple contact with nature did not predict children's levels of nature connectedness, while Williams et al. (2018) reported that an intensive outdoor adventure experience had no short or medium-term effect on student wellbeing or nature connectedness. In contrast, activities that encourage noticing elements in nature are much more effective (Richardson and Sheffield, 2017). Recent work (Lumber et al., 2017; Richardson et al., 2020a) has identified five "pathways to nature connection": contact, emotion, meaning, compassion, and beauty (for example, walking in the countryside, paying attention to beautiful natural surroundings and thinking about how what you see makes you feel). In subsequent work designed to activate the pathways, the first interventions to bring sustained increases in nature connectedness have been developed, implemented in ways as varied as smartphone apps (Schneider and Schaal, 2018; McEwan et al., 2019), walks (Lumber et al., 2017) and audio meditations (Muneghina et al., 2021).

There is therefore a need for carefully designed engagement programmes for children; these can involve quite simple activities such as noticing the good things in nature (McEwan et al., 2019). Even in urban environments, interventions have been developed that lead to sustained changes in nature connectedness (McEwan et al., 2020b), highlighting that much could be done on school grounds.

Natural environments can provide many levels of experience and challenge that can tap into the nature connectedness pathways and be tailored for each age group's knowledge and abilities (Chawla, 2009). For the youngest children, the most important elements of an intervention programme are likely to be focused on "noticing nature". Such interventions have revealed themes of engagement that can inform intervention design (Harvey et al., 2019). More broadly, activities should operationalise the sensory contact, emotion and beauty pathways, ensuring that children retain their pleasure in being in natural environments, and their interest in finding out about the world around them. Children could be encouraged to be outside in all weathers, and to collect natural objects such as flowers or stones (Sobel, 2008, 2017). Attending nature-based nursery school predicted higher nature connectedness in young children studied by Barrable and Booth (2020). Even uncomfortable experiences such as being out in bad weather could potentially increase children's ability to cope with such conditions instead of avoiding them (Chawla, 2009). Taking notice of the natural world could easily be prompted in younger children with simple activities such as charting the changing seasons and the weather and life cycle changes that accompany them. There is already a growing movement towards outdoor education in the early years (Sobel, 2017; Gray, 2018; Gray and Pigott, 2018), and the further development of this approach is likely to bring great benefits.

Compared to younger children, adolescents' free time is much less structured by adults, and they are able to seek places which meet their particular needs (Passon et al., 2008). Social relationships are central to adolescents' lives – this is the time of life when we learn about positive social relationships and working as groups, and adolescents need places to develop these skills (Clark and Uzzell, 2005; Owens, 2017). Urban and commercial settings may be preferred as they offer places to meet and socialise easily, whereas natural settings may be less obviously desirable. Adolescents also seek time and space to be alone; in our study, most adolescents reported that their home was the place that they went to to relax. Home is often seen as a place of retreat, where children have control over their environment (Owens, 1988; Clark and Uzzell, 2005). In our study, however, children in this group had the lowest levels of nature connectedness. Tying opportunities to interact with nature into social experiences, and promoting natural spaces as attractive places to both relax and to socialise, may help encourage adolescents to engage with the natural world more effectively.

As children grow older, the concept of environmental stewardship can be introduced, activating the compassion and care pathway to nature connectedness (Lumber et al., 2017). Encouraging the belief in young people that they can influence sustainable behaviour is likely to lead to increased pro-environmental behaviour (Uitto et al., 2014, 2015). Within schools, "climate change teams", for example, can foster a sense of control in young people (Sobel, 2008).

Providing opportunities for adolescents in particular to contribute in a positive way to conservation and the environment, for example through volunteering programmes, may well be beneficial (Chawla, 2021). Adolescents have little influence in planning their environments and communities (Passon et al., 2008), but need opportunities to develop a role within society (Nightingale and Wolverton, 1993). Activating the meaning pathways through participating in community activities is good for adolescents' development (Passon et al., 2008), and as Fuligni (2019) describes, increasing engagement with their communities leads to the need for adolescents to make contributions to them. Thus, socially focused, community based events that give young people a voice in decision-making may be more likely to engage them than individual activities that require little interaction (Chawla, 2009). Obtaining enjoyment and satisfaction from being outside is more likely to sustain pro-environmental behaviour (Chawla, 2009).

The importance of role models or mentors in developing both social skills and empathy and caring behaviour has been emphasised by Sobel (2017) and D'Amore and Chawla (2020). Events such as family nature clubs, designed to foster nature connectedness through direct contact with nature, give parents opportunities to model such behaviour and convey environmental values indirectly. Parents as well as children appreciate the chance to notice and engage with nature themselves, and also value watching their children interact with natural environments (D'Amore and Chawla, 2020). Indeed, Passmore et al. (2020) found that it was the level of parents' and guardians' nature connectedness that best explained children's levels.

Our survey highlighted other activities teenagers enjoy which could be used to design interventions focused on those with low nature connectedness levels. Sports and fitness were commonly mentioned, but many sports activities take place either indoors or in highly managed outdoor areas with generally low biodiversity (Norton et al., 2019). However, there is evidence that nature-based sporting activities can increase nature connectedness levels (Eigenschenk et al., 2019). Arts and crafts were also mentioned quite frequently, suggesting that this route may a helpful one to follow, engaging the "beauty" pathway and meaning through pursuits such as poetry and song writing (see the Tune into Nature Music Prize). Arts-based activities are ideal for exploring the pathways to nature connectedness and have been shown to positively influence nature connectedness (Bruni et al., 2015; Gray and Birrell, 2015; Gray and Thomson, 2016), and the relationship between arts and the environment in education is receiving increasing attention (Bertling and Moore, 2020).

The increasing focus of teenagers on interacting through screens is potentially a barrier to engaging them with the natural world, particularly as references to nature in video games, fiction and film have been declining since the middle of the 20th century (Kesebir and Kesebir, 2017). It does, however, also offer the possibility of using technology and social media in innovative ways to increase engagement with the natural world at this crucial stage of life. We found that greater screen time was associated with lower nature connectedness levels across all adolescent age groups and in both sexes. Despite this, our results suggest that teenagers in Jersey do not in fact perceive major barriers to going outside. Technology could therefore potentially be used as a means to engage teenagers in nature; the use of apps and activities that encourage noticing nature (McEwan et al., 2019, 2020a) may well be particularly helpful in adolescence. For example, projects such as "My NatureWatch", which supports young people to build camera traps and capture images of wildlife (Phillips et al., 2019, 2020), can increase engagement with and awareness of nature, while games can be designed specifically to encourage players to spend more time in nature (Schneider and Schaal, 2018) or to increase their knowledge of local wildlife (Phillips and Kau, 2019).

5. Conclusions

Despite the headlines made by young environmental leaders, the reality is that young people overall do not always perceive environmental issues as particularly pressing, and may be reluctant to acknowledge the need to change their own behaviour (e.g. Goldman et al., 2015; Lehnert et al., 2020). Although young people do understand the importance of environmental issues (Owens, 2017), and may value natural places and see beauty in them (Owens, 1988), over the past three decades, measures of environmental concern among adolescents have in fact declined (Wray-Lake et al., 2010). Our results show that while children's favourite places are natural spaces, their relationship with nature does not reflect that. To increase nature connectedness and form a closer relationship with nature, there is a need for nature to be more than a special place with a part-time role.

It is vital that we create renewed, early and lifelong relationships with nature, making it an essential element of everyday life, at home, at school, and enjoyed with friends. Yet, levels of nature connectedness in children as young as seven are already in decline, reaching a minimum in early adolescence. A complex range of factors influences how this relationship changes with age. Longitudinal, prospective, controlled research, will be essential to evaluating changes in nature connectedness as a result of carefully designed interventions. Young people may be particularly sensitive to certain types of interventions, such as those that involve social interactions, or that increase their sense of control over their own and the global environment, and so giving them opportunities to voice their opinions about the value of nature to them, and how they would prefer to engage and interact with it, are also vital (Chawla, 2021). Like Keith et al. (2021), we believe that if by using these approaches we can reduce the depth and duration of the “dip” in nature connectedness that we see in children and young adults, it will not only benefit their wellbeing, but will bring a higher proportion of the adult population to the level at which pro-environmental and pro-conservation behaviours are more likely at an earlier age. This in turn will benefit global biodiversity and environmental health, and create a sustainable future for us all.

Declaration of interests

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

Acknowledgements

Many thanks to the children, teachers and head teachers of the schools that participated in the survey, and to the States of Jersey Education Department for its support. Fiona Marchant was immensely helpful in communicating with schools. Thank you to Tahnee Blakemore and Anita Dunlop, who assisted with categorising responses; and Mike Hudson, who provided statistical advice. This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

References

Archer, G., Kuh, D., Hotopf, M., Stafford, M. and Richards, M., 2018. Adolescent affective symptoms and mortality. *The British Journal of Psychiatry,* 213(1), 419-424.

Balling, J.D. and Falk, J.H., 1982. Development of visual preference for natural environments. *Environment and behavior*, 14(1), 5-28.

Barrable, A., 2019. The case for nature connectedness as a distinct goal of early childhood education. *International Journal of Early Childhood Environmental Education*, *6*(2), 59-70.

Barrable, A. and Booth, D., 2020. Nature connection in early childhood: a quantitative cross-sectional study. *Sustainability*, *12*(1), 375.

Barrera-Hernández, L.F., Sotelo-Castillo, M.A., Echeverría-Castro, S.B. and Tapia-Fonllem, C.O., 2020. Connectedness to nature: its impact on sustainable behaviors and happiness in children. *Frontiers in Psychology*, *11*, 276.

Barton, K., 2015. MuMIn: multi-model inference. R package 1.15. 6.

Bates, D., Maechler, M., Bolker, B. and Walker, S., 2015. Fitting linear mixed-effects models using lme4. *Journal of Statistical Software* 67, 1-48.

Beery, T., Chawla, L. and Levin, P., 2020. Being and Becoming in Nature: Defining and Measuring Connection to Nature in Young Children. *International Journal of Early Childhood Environmental Education*, *7*(3), 3-22.

Bell, S., Thompson, C.W. and Travlou, P., 2003. Contested views of freedom and control: Children, teenagers and urban fringe woodlands in Central Scotland. *Urban Forestry and Urban Greening*, *2*, 87–100.

Bertling, J.G. and Moore, T.C., 2020. US art teacher education in the age of the Anthropocene. *Studies in Art Education*, *61*(1), 46-63.

Bezold, C.P., Banay, R.F., Coull, B.A., Hart, J.E., James, P., Kubzansky, L.D., Missmer, S.A. and Laden, F., 2018. The association between natural environments and depressive symptoms in adolescents living in the United States. *Journal of Adolescent Health*, *62*(4), 488-495.

Bisegger, C., Cloetta, B., Von Bisegger, U., Abel, T. and Ravens-Sieberer, U., 2005. Health-related quality of life: gender differences in childhood and adolescence. *Sozial-und Präventivmedizin*, *50*(5), 281-291.

Blakemore, S.J., 2019. Adolescence and mental health. *The lancet*, *393*(10185), 2030-2031.

Bradfield, T. and Crowley, F., 2019. The demand for fee-paying secondary schools in the Republic of Ireland. *Irish Educational Studies*, *38*(3), 359-375.

Bragg, R., Wood, C., Barton, J. and Pretty, J., 2013. Measuring connection to nature in children aged 8-12: a robust methodology for the RSPB. University of Essex and RSPB.

Bruni, C.M., Winter, P.L., Schultz, P.W., Omoto, A.M. and Tabanico, J.J., 2015. Getting to know nature: evaluating the effects of the Get to Know Program on children's connectedness with nature. *Environmental Education Research*, *23*(1), 43-62.

Burnham, K.P. and Anderson, D.R., 2002. *Model selection and multimodel inference, A practical information-theoretic approach.* 2nd ed. Springer, New York.

Cervinka, R., Röderer, K. and Hefler, E., 2012. Are nature lovers happy? On various indicators of well-being and connectedness with nature. *Journal of health psychology*, *17*(3), 379-388.

Charles, C., Keenleyside, K., Chapple, R., Kilburn, B., Salah van der Leest, P., Allen, D., Richardson, M., Giusti, M., Franklin, L., Harbrow, M. and Wilson, R., 2018. *Home to us all:*

how connecting with nature helps us care for ourselves and the Earth. Minneapolis: Children & Nature Network.

Chawla, L., 2009. Growing up green: Becoming an agent of care for the natural world. *The Journal of Developmental Processes*, *4*(1), 6-23.

Chawla, L., 2020. Childhood nature connection and constructive hope: A review of research on connecting with nature and coping with environmental loss. *People and Nature*.

Chawla, L., 2021. Knowing Nature in Childhood: Learning and Well-Being Through Engagement with the Natural World. In *Nature and Psychology* (153-193). Springer, Cham.

Cheng, J.C.H. and Monroe, M.C., 2012. Connection to nature: Children's affective attitude toward nature. *Environment and Behavior* 44, 31-49.

Chua, M.A., Tan, A. and Carrasco, L.R., 2021. Species awareness days: Do people care or are we preaching to the choir? *Biological Conservation*, *255*, 109002.

Clark, C. and Uzzell, D.L., 2005. The socio-environmental affordances of adolescents' environments, in Spencer, C. and Blades, M.(eds.), Children and their Environments, Cambridge: Cambridge University Press.

Clayton, S., Colléony, A., Conversy, P., Maclouf, E., Martin, L., Torres, A.C., Truong, M.X. and Prévot, A.C., 2017. Transformation of experience: Toward a new relationship with nature. *Conservation letters*, *10*(5), 645-651.

Clayton, S. and Myers, G., 2015. *Conservation psychology*. 2nd edition. Chichester: Wiley.

Cleary, A., Fielding, K.S., Murray, Z. and Roiko, A., 2020. Predictors of nature connection among urban residents: Assessing the role of childhood and adult nature experiences. *Environment and Behavior*, *52*(6), 579-610.

Collado, S., Staats, H. and Sancho, P., 2019. Normative influences on adolescents' self-reported pro-environmental behaviors: the role of parents and friends. *Environment and Behavior*, *51*(3), 288-314.

Cox, D., Pintea, L., Poaty, P., Nsafou, A., Sitou, A., Turmo, F., VillaMarin, E. and Atencia, R., 2020. Commentary: Challenges of evaluating the effectiveness of public awareness campaigns in Congo Republic. *American Journal of Primatology*, e23205.

Cox, D.T., Shanahan, D.F., Hudson, H.L., Fuller, R.A. and Gaston, K.J., 2018. The impact of urbanisation on nature dose and the implications for human health. *Landscape and Urban Planning*, *179*, 72-80.

Crocetti, E., 2017. Identity formation in adolescence: The dynamic of forming and consolidating identity commitments. *Child Development Perspectives*, *11*(2), 145-150.

D'Amore, C. and Chawla, L., 2020. Significant life experiences that connect children with nature: A research review and applications to a family nature club. *Research Handbook on Childhoodnature: Assemblages of Childhood and Nature Research*, 799-825.

Di Fabio, A. and Rosen, M.A., 2019. Accounting for individual differences in connectedness to nature: Personality and gender differences. *Sustainability*, *11*(6), 1693.

Dolins, F.L., Jolly, A., Rasamimanana, H., Ratsimbazafy, J., Feistner, A.T. and Ravoavy, F., 2010. Conservation education in Madagascar: three case studies in the biologically diverse island-continent. *American Journal of Primatology*, *72*(5), 391-406.

Dornhoff, M., Sothmann, J.N., Fiebelkorn, F. and Menzel, S., 2019. Nature relatedness and environmental concern of young people in Ecuador and Germany. *Frontiers in psychology*, *10*, 453.

Dumontheil, I., 2016. Adolescent brain development. *Current Opinion in Behavioral Sciences*, *10*, 39-44.

Eigenschenk, B., Thomann, A., McClure, M., Davies, L., Gregory, M., Dettweiler, U. and Inglés, E., 2019. Benefits of outdoor sports for society. A systematic literature review and reflections on evidence. *International journal of environmental research and public health*, *16*(6), 937.

Ekins, P. and Gupta, J., 2019. Perspective: a healthy planet for healthy people. Global Sustainability 2, e20, 1–9. https://doi.org/10.1017/sus.2019.17

Elgar, F.J., Gariépy, G., Torsheim, T. and Currie, C., 2016. Early-life income inequality and adolescent health and well-being, *Social Science & Medicine*, doi: 10.1016/ j.socscimed.2016.10.014.

Engemann, K., Pedersen, C.B., Arge, L., Tsirogiannis, C., Mortensen, P.B. and Svenning, J.C., 2019. Residential green space in childhood is associated with lower risk of psychiatric disorders from adolescence into adulthood. *Proceedings of the National Academy of Sciences*, *116*(11), 5188-5193.

Ernst, J. and Theimer, S., 2011. Evaluating the effects of environmental education programming on connectedness to nature. *Environmental Education Research* 17, 577-598.

Evans, G.W., Otto, S. and Kaiser, F.G., 2018. Childhood origins of young adult environmental behavior. *Psychological science*, 29(5), 679-687.

Gelman, A. and Su, Y.-S., 2018. *arm: Data Analysis Using Regression and Multilevel/Hierarchical Models.* R package version 1.10-1. https://CRAN.R-project.org/package=arm

Giusti, M., 2019. Human-nature relationships in context. Experiential, psychological, and contextual dimensions that shape children's desire to protect nature. *PloS one*, *14*(12), e0225951.

Giusti, M., Svane, U., Raymond, C.M. and Beery, T.H., 2018. A framework to assess where and how children connect to nature. *Frontiers in psychology*, 8, 2283.

Goldman, D., Pe'er, S. and Yavetz, B., 2015. Environmental literacy of youth movement members–is environmentalism a component of their social activism?. *Environmental Education Research*, *23*(4), 486-514.

Gray, T., 2018. Outdoor learning: Not new, just newly important. *Curriculum Perspectives*, *38*(2), 145-149.

Gray, T. and Birrell, C., 2015. 'Touched by the Earth': a place-based outdoor learning programme incorporating the Arts. *Journal of Adventure Education and Outdoor Learning*, *15*(4), 330-349.

Gray, T. and Pigott, F., 2018. Lasting lessons in outdoor learning: a facilitation model emerging from 30 Years of reflective practice. *Ecopsychology*, *10*(4), 195-204.

Gray, T. and Thomson, C., 2016. Transforming environmental awareness of students through the arts and place-based pedagogies. *LEARNing Landscapes*, *9*(2), 239-260.

Green, K.M., Crawford, B.A., Williamson, K.A. and DeWan, A.A., 2019. A meta-analysis of social marketing campaigns to improve global conservation outcomes. *Social Marketing Quarterly*, *25*(1), 69-87.

Greenwood, A. and Gatersleben, B., 2016. Let's go outside! Environmental restoration amongst adolescents and the impact of friends and phones. *Journal of Environmental Psychology*, *48*, 131-139.

Grueber, C.E., Nakagawa, S., Laws, R.J. and Jamieson, I.G., 2011. Multimodel inference in ecology and evolution: challenges and solutions. *Journal of Evolutionary Biology*, *24*(4), 699-711.

Gupta, J., Hurley, F., Grobicki, A., Keating, T., Stoett, P., Baker, E., Guhl, A., Davies, J. and Ekins, P., 2019. Communicating the health of the planet and its links to human health. *The Lancet Planetary Health*, *3*(5), e204-e206.

Halpern, D.F., Eliot, L., Bigler, R.S., Fabes, R.A., Hanish, L.D., Hyde, J., Liben, L.S. and Martin, C.L., 2011. The pseudoscience of single-sex schooling. *Science*, *333*(6050), 1706-1707.

Harvey, C., Hallam, J., Richardson, M., & Wells, R., 2019. The good things children notice in nature: An extended framework for reconnecting children with nature. *Urban Forestry & Urban Greening*, 126573.

Helfert, S. and Warschburger, P., 2013. The face of appearance-related social pressure: gender, age and body mass variations in peer and parental pressure during adolescence. *Child and Adolescent Psychiatry and Mental Health*, *7*(1), 1-11.

Hobin, E.P., Leatherdale, S., Manske, S., Dubin, J.A., Elliott, S. and Veugelers, P., 2013. Are environmental influences on physical activity distinct for urban, suburban, and rural schools? A multilevel study among secondary school students in Ontario, Canada. *Journal of School Health* 83, 357-367.

Hoot, R.E. and Friedman, H., 2011. Connectedness and environmental behaviour: sense of interconnectedness and pro-environmental behaviour. *International Journal of Transpersonal Studies* 30, 89-100.

Hughes, J., Richardson, M. and Lumber, R., 2018. Evaluating connection to nature and the relationship with conservation behaviour in children. *Journal for Nature Conservation*, 45, 11-19.

Hughes, J., Rogerson, M., Barton, J. and Bragg, R., 2019. Age and connection to nature: when is engagement critical? *Frontiers in Ecology and the Environment*, doi:10.1002/fee.2035.

Hunt, A., Stewart, D., Richardson, M., Hinds, J., Bragg, R., White, M. and Burt, J., 2017. *Monitor of Engagement with the Natural Environment: Developing a Method to Measure Nature Connection Across the English Population (Adults and Children)*. Natural England Commissioned Reports Number 233; Natural England publications: York, UK.

IPBES, 2019. Summary for policymakers of the global assessment report on biodiversity and ecosystem services of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services. S. Díaz, J. Settele, E. S. Brondízio E.S., H. T. Ngo, M. Guèze, J. Agard, A. Arneth, P. Balvanera, K. A. Brauman, S. H. M. Butchart, K. M. A. Chan, L. A. Garibaldi, K. Ichii, J. Liu, S. M. Subramanian, G. F. Midgley, P. Miloslavich, Z. Molnár, D. Obura, A. Pfaff, S. Polasky, A. Purvis, J. Razzaque, B. Reyers, R. Roy Chowdhury, Y. J. Shin, I. J. Visseren-Hamakers, K. J. Willis, and C. N. Zayas (eds.). IPBES secretariat, Bonn, Germany. https://doi.org/10.5281/zenodo.355357

Jennings, V., Floyd, M.F., Shanahan, D., Coutts, C. and Sinykin, A., 2017. Emerging issues in urban ecology: Implications for research, social justice, human health, and well-being. *Population and Environment*, *39*(1), 69-86.

Jiménez, A., Díaz, M.J., Monroe, M.C. and Benayas, J., 2015. Analysis of the variety of education and outreach interventions in biodiversity conservation projects in Spain. *Journal for Nature Conservation*, *23*, 61-72.

Jones, L.P., Turvey, S.T., Massimino, D. and Papworth, S.K., 2020. Investigating the implications of shifting baseline syndrome on conservation. *People and Nature, 2(4)*, 1131-1144. DOI: 10.1002/pan3.10140

Kahn Jr, P.H., 2002. Children's affiliations with nature: Structure, development, and the problem of environmental generational amnesia. In Kahn P.H. and Kellert S., eds. *Children and Nature: Psychological, Sociocultural, and Evolutionary Investigations*, 93-116.

Kaplan, R. and Kaplan, S., 2002. Adolescents and the natural environment: A time out. In Kahn PH and Kellert S eds. *Children and nature: Psychological, sociocultural, and evolutionary investigations,* 227-257.

Keenan, R., Lumber, R., Richardson, M. and Sheffield, D., 2021. Three good things in nature: a nature-based positive psychological intervention to improve mood and well-being for depression and anxiety. *Journal of Public Mental Health*, https://doi.org/10.1108/JPMH-02-2021-0029

Keith, R.J., Given, L.M., Martin, J.M. and Hochuli, D.F., 2021. Urban children's connections to nature and environmental behaviors differ with age and gender. *Plos one*, *16*(7), e0255421.

Kesebir, S. and Kesebir, P., 2017. A growing disconnection from nature is evident in cultural products. *Perspectives on Psychological Science*, *12*(2), 258-269.

Keshavan, M.S., Giedd, J., Lau, J.Y.F., Lewis, D.A. and Paus, T., 2014. Changes in the adolescent brain and the pathophysiology of psychotic disorders. *The Lancet Psychiatry* 1, 549-558.

Kessler, R.C., Berglund, P., Demler, O., Jin, R., Merikangas, K.R. and Walters, E.E., 2005. Lifetime prevalence and age-of-onset distributions of DSM-IV disorders in the National Comorbidity Survey Replication. *Archives of General Psychiatry* 62, 593-602.

Kleespies, M.W. and Dierkes, P.W., 2020. Impact of biological education and gender on students' connection to nature and relational values. *PloS one*, *15*(11), e0242004.

Krettenauer, T., Wang, W., Jia, F. and Yao, Y., 2019. Connectedness with nature and the decline of pro-environmental behavior in adolescence: A comparison of Canada and China. *Journal of Environmental Psychology*, 101348.

Lamblin, M., Murawski, C., Whittle, S. and Fornito, A., 2017. Social connectedness, mental health and the adolescent brain. *Neuroscience & Biobehavioral Reviews*, *80*, 57-68.

Larson, L.R., Szczytko, R., Bowers, E.P., Stephens, L.E., Stevenson, K.T. and Floyd, M.F., 2019. Outdoor time, screen time, and connection to nature: Troubling trends among rural youth? *Environment and Behavior*, *51*(8), 966-991.

Lehnert, M., Fiedor, D., Frajer, J., Hercik, J. and Jurek, M., 2020. Czech students and mitigation of global warming: beliefs and willingness to take action. *Environmental Education Research*, *26*(6), 864-889.

Li, D., Deal, B., Zhou, X., Slavenas, M. and Sullivan, W.C., 2018. Moving beyond the neighborhood: Daily exposure to nature and adolescents' mood. *Landscape and Urban Planning*, *173*, 33-43.

Liefländer, A.K., Fröhlich, G., Bogner, F.X. and Schultz, P.W., 2013. Promoting connectedness with nature through environmental education. *Environmental Education Research* 19, 370-384.

Luck, G.W., Davidson, P., Boxall, D. and Smallbone, L., 2011. Relations between urban bird and plant communities and human well-being and connection to nature. *Conservation Biology*, *25*(4), 816-826.

Lumber, R., Richardson, M. and Sheffield, D., 2017. Beyond knowing nature: Contact, emotion,compassion, meaning, and beauty are pathways to nature connection. *PLoS ONE* 12(5), e0177186.

Mackay, C.M. and Schmitt, M.T., 2019. Do people who feel connected to nature do more to protect it? A meta-analysis. *Journal of Environmental Psychology*, *65*, 101323.

Martin, L., White, M.P., Hunt, A., Richardson, M., Pahl, S. and Burt, J., 2020. Nature contact, nature connectedness and associations with health, wellbeing and pro-environmental behaviours. *Journal of Environmental Psychology*, *68*, 101389.

Mavoa, S., Lucassen, M., Denny, S., Utter, J., Clark, T. and Smith, M., 2019. Natural neighbourhood environments and the emotional health of urban New Zealand adolescents. *Landscape and Urban Planning*, *191*, 103638.

Mayer, F.S., & Frantz, C.M., 2004. The connectedness to nature scale: A measure of individuals' feeling in community with nature. *Journal of Environmental Psychology*, 24(4), 503–515.

McEwan, K., Richardson, M., Sheffield, D., Ferguson, F.J. and Brindley, P., 2019. A smartphone app for improving mental health through connecting with urban nature. *International Journal of Environmental Research and Public Health*, *16*(18), 3373.

McEwan, K., Richardson, M., Brindley, P., Sheffield, D., Tait, C., Johnson, S., Sutch, S. and Ferguson, F. J. 2020a. Shmapped: Development of an app to record and promote the wellbeing benefits of noticing urban nature. *Translational Behavioural Medicine*, 10, 723–733.

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

Michaelson, V., King, N., Janssen, I., Lawal, S. and Pickett, W., 2020. Electronic screen technology use and connection to nature in Canadian adolescents: a mixed methods study. *Canadian Journal of Public Health*, 1-13.

Michel, G., Bisegger, C., Fuhr, D.C. and Abel, T., 2009. Age and gender differences in health-related quality of life of children and adolescents in Europe: a multilevel analysis. *Quality of Life Research*, *18*(9), 1147-1157.

Miller, J.R., 2005. Biodiversity conservation and the extinction of experience. *Trends in ecology & evolution*, *20*(8), 430-434.

Molinario, E., Lorenzi, C., Bartoccioni, F., Perucchini, P., Bobeth, S., Colléony, A., Diniz, R., Eklund, A., Jaeger, C., Kibbe, A. and Richter, I., 2020. From childhood nature experiences to adult pro-environmental behaviors: An explanatory model of sustainable food consumption. *Environmental Education Research*, *26*(8), 1137-1163.

Moss, A., Jensen, E. and Gusset, M., 2017. Probing the link between biodiversity-related knowledge and self-reported proconservation behaviour in a global survey of zoo visitors. *Conservation Letters* 10:33-40.

Muneghina, O., Barrows, P., Van Gordon, W. and Richardson, M. 2021. Evaluation of a novel mindful nature connectedness intervention: effects on paranoia and anxiety in a non-clinical population. *Ecopsychology*.

Nightingale, E.O. and Wolverton, L., 1993. Adolescent rolelessness in modern society. *Teachers College Record*, *94*, 472-472.

Nisbet, E.K. and Zelenski, J.M., 2013. The NR-6: a new brief measure of nature relatedness. *Frontiers in Psychology,* 4, article 813.

Otto, S. and Pensini, P., 2017. Nature-based environmental education of children: Environmental knowledge and connectedness to nature, together, are related to ecological behaviour. *Global Environmental Change*, *47*, 88-94.

Owens, P.E., 1988. Natural landscapes, gathering places, and prospect refuges: Characteristics of outdoor places valued by teens. *Children's Environments Quarterly*, 17-24.

Owens, P.E., 2017. A place for adolescents. In Bishop, K. and Corkery, L. eds., *Designing Cities with Children and Young People: Beyond Playgrounds and Skate Parks.* Taylor & Francis, 65-78.

Passon, C., Levi, D. and Del Rio, V., 2008. Implications of adolescents' perceptions and values for planning and design. *Journal of Planning Education and Research*, *28*(1), 73-85.

Passmore, H.A., Martin, L., Richardson, M., White, M., Hunt, A. and Pahl, S., 2020. Parental/guardians' connection to nature better predicts children's nature connectedness than visits or area-level characteristics. *Ecopsychology*. https://www-liebertpub-com.iclibezp1.cc.ic.ac.uk/doi/10.1089/eco.2020.0033

Patel, V., Flisher, A.J., Hetrick, S. and McGorry, P., 2007. Mental health of young people: a global public-health challenge. *The Lancet* 369, 1302–1313.

Patton, G.C., Sawyer, S.M., Santelli, J.S., Ross, D.A., Afifi, R., Allen, N.B., Arora, M., Azzopardi, P., Baldwin, W., Bonell, C. and Kakuma, R., 2016. Our future: a Lancet commission on adolescent health and wellbeing. *The Lancet*, *387*(10036), 2423-2478.

Pensini, P., Horn, E. and Caltabiano, N.J., 2016. An exploration of the relationships between adults' childhood and current nature exposure and their mental well-being. *Children, Youth and Environments*, *26*(1), 125-147.

Perry, D.G. and Pauletti, R.E., 2011. Gender and adolescent development. *Journal of Research on Adolescence*, *21*(1), 61-74.

Phillips, R., Abbas-Nazari, A., Tooze, J., Gaver, B., Boucher, A., Ovalle, L., Sheen, A., Brown, D., Matsuda, N. and Vanis, M., 2019. Design and deploying tools to 'actively engaging nature'. In *International Conference on Human-Computer Interaction*. Springer, Cham, 513-531.

Phillips, R., Anderson, R., Abbas-Nazari, A., Gaver, B. and Boucher, A., 2020. Urban and suburban nature interactions, impacts and serendipitous narratives of the My Naturewatch project. In *Proceedings of the Design Society: DESIGN Conference Vol. 1*. Cambridge University Press, 2109-2118.

Phillips, R. and Kau, K., 2019. Gaming for active nature engagement. Animal Diplomacy Bureau: designing games to engage and create player agency in urban nature. *The Design Journal*, *22* (suppl. 1), 1587-1602.

Piccininni, C., Michaelson, V., Janssen, I. and Pickett, W., 2018. Outdoor play and nature connectedness as potential correlates of internalized mental health symptoms among Canadian adolescents. *Preventive Medicine*, *112*, 168-175.

Pinheiro, J., Bates, D., DebRoy, S., Sarkar, D., and R Core Team, 2018. *Nlme: Linear and Nonlinear Mixed Effects Models.* R package version 3.1-137, https://CRAN.R-project.org/package=nlme

Pitman, S.D. and Daniels, C.B., 2020. Understanding how nature works: Five pathways towards a more ecologically literate world–A perspective. *Austral Ecology*, *45*(5), 510-519.

Pritchard, A., Richardson, M., Sheffield, D, & McEwan, K., 2019. The relationship between nature connectedness and eudaimonic wellbeing: a meta-analysis. *Journal of Happiness Studies*, 1-23.

Pyle, R.M., 2003. Nature matrix: reconnecting people and nature. *Oryx*, *37*(2), 206-214.

R Core Development Team 2018. *R: A language and environment for statistical computing.* Vienna: R Foundation for Statistical Computing. www.R-project.org

Reddy, S.M., Montambault, J., Masuda, Y.J., Keenan, E., Butler, W., Fisher, J.R., Asah, S.T. and Gneezy, A., 2017. Advancing conservation by understanding and influencing human behavior. *Conservation Letters*, *10*(2), 248-256.

Rice, C.S. and Torquati, J.C., 2013. Assessing connections between young children's affinity for nature and their experiences in natural outdoor settings in preschools. *Children Youth and Environments*, *23*(2), 78-102.

Richards, T. and Richards, L., 1995. Using hierarchical categories in qualitative data analysis. In Kelle, U. and Bird, K. eds., *Computer-Aided Qualitative Data Analysis: Theory, Methods and Practice.* Sage, 80-95.

Richardson, M. and Hamlin, I., 2021. Nature engagement for human and nature's wellbeing during the corona pandemic. *Journal of Public Mental Health*. DOI: 10.1108/JPMH-02-2021-0016

Richardson, M., Hussain, Z. and Griffiths, M.D., 2018. Problematic smartphone use, nature connectedness, and anxiety. *Journal of Behavioral Addictions*, 1-8.

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

Richardson, M., Hunt, A., Hinds, J., Bragg, R., Fido, D., Petronzi, D., Barbett, L., Clitherow, T. and White, M., 2019. A measure of nature connectedness for children and adults: validation, performance, and insights. *Sustainability*, 11, 3250.

Richardson, M., Dobson, J., Abson, D.J., Lumber, R., Hunt, A., Young, R. and Moorhouse, B., 2020a. Applying the pathways to nature connectedness at a societal scale: a leverage points perspective. *Ecosystems and People*, *16*(1), 387-401.

Richardson, M., Passmore, H.A., Barbett, L., Lumber, R., Thomas, R. and Hunt, A., 2020b. The green care code: How nature connectedness and simple activities help explain pro-nature conservation behaviours. *People and Nature*, *2*(3), 821-839.

Richardson, M., Passmore, H. A., Lumber, R., Thomas, R., & Hunt, A. 2021. Moments, not minutes: The nature-wellbeing relationship. *International Journal of Wellbeing*, *11*(1).

Rigolon, A., Browning, M.H., Lee, K. and Shin, S., 2018. Access to urban green space in cities of the Global South: A systematic literature review. *Urban Science*, *2*(3), 67.

Rosa, C.D., Profice, C.C. and Collado, S., 2018. Nature experiences and adults' self-reported pro-environmental behaviors: the role of connectedness to nature and childhood nature experiences. *Frontiers in Psychology*, *9*, 1055.

Rosa, C.D., Collado, S., Profice, C.C. and Larson, L.R., 2019. Nature-based recreation associated with connectedness to nature and leisure satisfaction among students in Brazil. *Leisure Studies*, *38*(5), 682-691.

RSPB, 2013. *Connecting with Nature: Finding Out How Connected to Nature the UK's Children Are.* Available at: www.rspb.org.uk/connectionmeasure.

Schneider, J. and Schaal, S., 2018. Location-based smartphone games in the context of environmental education and education for sustainable development: fostering connectedness to nature with Geogames. *Environmental Education Research*, *24*(11), 1597-1610.

Schultz, P.W., 2002. Inclusion with nature. Understanding human-nature interactions. In P. Schmuck & W.P. Schultz (eds.), *The Psychology of Sustainable Development*. New York: Kluwer, 61–78.

Schultz, P.W. and Tabanico, J., 2007. Self, identity, and the natural environment: exploring implicit connections with nature 1. *Journal of Applied Social Psychology*, *37*(6), 1219-1247.

Schuttler, S.G., Stevenson, K., Kays, R. and Dunn, R.R., 2019. Children's attitudes towards animals are similar across suburban, exurban, and rural areas. *PeerJ*, *7*, e7328.

Sobel, D., 2017. Outdoor school for all: Reconnecting children to nature. In *EarthEd* (23-33). Island Press, Washington, DC.

Sobko, T., Jia, Z. and Brown, G., 2018. Measuring connectedness to nature in preschool children in an urban setting and its relation to psychological functioning. *PloS one*, *13*(11), e0207057.

Soga, M. and Gaston, K.J., 2016. Extinction of experience: the loss of human–nature interactions. *Frontiers in Ecology and the Environment*, *14*(2), 94-101.

States of Jersey. 2015. *Jersey Household Income Distribution 2014/15.* Jersey: States of Jersey.

States of Jersey. 2019. *Jersey Children and Young People's Survey Report*. Jersey: States of Jersey.

States of Jersey. 2021a. Size and land cover of Jersey. https://www.gov.je/Government/JerseyInFigures/Environment/Pages/SizeLandCover.aspx (accessed on 7 May 2021).

States of Jersey. 2021b. Population characteristics. https://www.gov.je/Government/JerseyInFigures/Population/Pages/PopulationStatistics.aspx (accessed on 17 February 2021).

Suchert, V., Hanewinkel, R. and Isensee, B., 2015. Sedentary behavior and indicators of mental health in school-aged children and adolescents: A systematic review. *Preventive Medicine*, *76*, 48-57.

Tam, K.-P., 2013. Concepts and measures related to connection to nature: similarities and differences. *Journal of Environmental Psychology* 34, 64-78.

Thomas, D.R., 2003. *A General Inductive Approach for Qualitative Data Analysis*. Auckland: School of Population Health, University of Auckland. http://www.fmhs.auckland.ac.nz/soph/centres/hrmas/aboutus/default.aspx (accessed 9 April 2021)

Thomas, R., Vaughan, I. and Lello, J., 2013. *Data Analysis with R Statistical Software.* Cardiff: Eco-explore.

Tillmann, S., Tobin, D., Avison, W. and Gilliland, J., 2018. Mental health benefits of interactions with nature in children and teenagers: A systematic review. *Journal of Epidemiology and Community Health*, *72*(10), 958-966.

Twenge, J.M. and Campbell, W.K., 2018. Associations between screen time and lower psychological well-being among children and adolescents: Evidence from a population-based study. *Preventive Medicine Reports*, *12*, 271-283.

Uitto, A., Boeve-de Pauw, J. and Saloranta, S., 2014. Educational factors explaining 9th graders self-efficacy in ecological sustainable behaviours. In *E-Book Proceedings of the ESERA 2013 Conference: Science Education Research For Evidence-based Teaching and Coherence in Learning. Part 9 (co-ed. Graca Garvalho and Marianne Mortensen Foss) Strand 9: Environmental, health and outdoor science education*. European Science Education Research Association (ESERA).

Uitto, A., Boeve-de Pauw, J. and Saloranta, S., 2015. Participatory school experiences as facilitators for adolescents' ecological behavior. *Journal of Environmental Psychology*, *43*, 55-65.

Viejo, C., Gómez-López, M. and Ortega-Ruiz, R., 2018. Adolescents' psychological well-being: A multidimensional measure. *International Journal of Environmental Research and Public Health*, *15*(10), 2325.

Waylen, K.A., McGowan, P.J., Milner-Gulland, E.J. and Pawi Study Group, 2009. Ecotourism positively affects awareness and attitudes but not conservation behaviours: a case study at Grande Riviere, Trinidad. *Oryx*, *43*(3), 343-351.

Weinstein, E., 2018. The social media see-saw: Positive and negative influences on adolescents' affective well-being. *New Media & Society*, *20*(10), 3597-3623.

Wells, N.M. and Lekies, K.S., 2006. Nature and the life course: Pathways from childhood nature experiences to adult environmentalism. *Children Youth and Environments*, *16*(1), 1-24.

Whitburn, J., Linklater, W. and Abrahamse, W., 2020. Meta-analysis of human connection to nature and proenvironmental behavior. *Conservation Biology*, *34*(1), 180-193.

Williams, I. R., Rose, L. M., Raniti, M. B., Waloszek, J., Dudgeon, P., Olsson, C. A., ... & Allen, N. B. 2018. The impact of an outdoor adventure program on positive adolescent development: a controlled crossover trial. *Journal of Outdoor and Environmental Educatio*n, 21(2), 207-236.

Wolch, J.R., Byrne, J. and Newell, J.P., 2014. Urban green space, public health, and environmental justice: The challenge of making cities 'just green enough'. *Landscape and Urban Planning*, 125, 234-244.

Wray-Lake, L., Flanagan, C.A. and Osgood, D.W., 2010. Examining trends in adolescent environmental attitudes, beliefs, and behaviors across three decades. *Environment and behavior*, *42*(1), 61-85.

Zelenski, J.M., Dopko, R.L. and Capaldi, C.A., 2015. Cooperation is in our nature: nature exposure may promote cooperative and environmentally sustainable behavior. *Journal of Environmental Psychology* 42, 24-31.

Žukauskienė, R., Truskauskaitė-Kunevičienė, I., Gabė, V., & Kaniušonytė, G. 2021. "My words matter": The role of adolescents in changing pro-environmental habits in the family. *Environment and Behavior, 53*(10), 1140–1162.

Zylstra, M.J., Knight, A.T., Esler, K.J. and Le Grange, L.L., 2014. Connectedness as a core conservation concern: An interdisciplinary review of theory and a call for practice. *Springer Science Reviews*, *2*(1-2), 119-143.