Received: 22 January 2020 | Accepted: 9 August 2020

DOI: 10.1002/pan3.10148

RESEARCH ARTICLE

PEOPLE AND NATURE
BRITISH ECOLOGICAL SOCIETY

# No evidence of an extinction of experience or emotional disconnect from nature in urban Singapore

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**Handling Editor:** Russell Hitchings

## Abstract

1. It is widely believed that people living in cities have fewer and poorer daily experiences of nature, and that this contributes to the biodiversity crisis on the basis that if people do not know nature, they will not care for its conservation. In 1978, Pyle coined the term 'extinction of experience' to reflect the loss of opportunities to experience nature as urbanization progresses.
2. However, evidence of an emotional disconnect from nature arising from an extinction of experience remains poorly documented. Here we repeat a study conducted in 1996 comprising household surveys and bird surveys in a neighbourhood of Singapore, one of the world's most densely populated cities. We investigate empirically whether experiences of nature, opportunities to experience nature and the emotional connection between people and nature have changed across 22 years.
3. We discover that emotional connection with nature has actually increased among greenspace users and non-users, while the frequency and duration of greenspace visits remained unchanged. Among greenspace users, the number of different nature elements experienced also remained unchanged and more frequent users demonstrated a stronger emotional connection with nature. We further found an increase in opportunities to experience local nature, as measured by bird species richness and abundance.
4. While we found no evidence for an extinction of experience or an emotional disconnect from nature in this particular setting and timeframe in urban Singapore, similar studies elsewhere are necessary to explore whether there may be geographical, cultural or temporal variations.

KEYWORDS

connection to nature, extinction of experience, greenspace, nature relatedness

## 1 | INTRODUCTION

More than half the world's population lives in cities, and this proportion could increase to nearly 70% by 2050 (United Nations, 2018). Cities represent extreme examples of human influence where built infrastructure has largely replaced or modified natural ecosystems and processes (Grimm et al., 2008; Turner, Nakamura, & Dinetti, 2004). From a biodiversity perspective, cities have therefore been viewed as places 'separate from nature', where biodiversity has been reduced or deleted, and remaining ecosystems are in poor ecological condition (Miller & Hobbs, 2002). Given this heavily reduced biodiversity in cities, it is also widely believed that people living in cities have fewer and poorer daily experiences of natural environments, and that this contributes to the biodiversity crisis on the basis that if people do not experience nature, they will not care about its conservation (Pyle, 2003; Soga & Gaston, 2016).

A loss of daily experiences of nature as urbanization progresses was termed the 'extinction of experience' by Robert Pyle (1978). Pyle posited that local extinctions of common species of flora and fauna in an individual's everyday environment equate to an 'extinction' of the opportunity to experience nature, and eventually results in people becoming emotionally disconnected from nature. This reinforces a positive feedback loop in which the decline in experiences of nature results in reduced emotional affinity for nature, degrades the motivation to gain further experiences of nature and ultimately alienates humans from nature (Pyle, 1993). Pyle provided evidence for the first tenet of the extinction of experience hypothesis (i.e. loss of species) through measurements of local extinctions among urban butterflies. He concluded that opportunities for experiencing nature have declined in cities, particularly in cities undergoing the most intense urbanization (Pyle, 2002).

Opportunities to experience nature in cities are potentially reduced by (a) spatial barriers to accessing nature, (b) reduced species richness and (c) changes in human behaviour. First, the increased physical distance between people living in cities and natural ecosystems could function as a spatial barrier to nature experiences. Indeed, individuals living further away from natural areas interact less frequently with nature (Lin, Fuller, Bush, Gaston, & Shanahan, 2014; Neuvonen, Sievänen, Tönnes, & Koskela, 2007; Zhang, Goodale, & Chen, 2014). Second, when compared to natural ecosystems, intensely urbanized areas generally have reduced species richness (Goddard, Dougill, & Benton, 2010; Hansen et al., 2005; Marzluff, 2001; Tratalos et al., 2007), constraining the breadth of nature available to be experienced. Given that neighbourhood environments are frequently the major arena where most people encounter nature daily (Turner et al., 2004), these local extirpations of species could deprive current and future generations of direct experiences of nature (Soga, Gaston, & Kubo, 2018). Third, behavioural changes relating to a modern urban lifestyle could also accelerate the extinction of experience since many people are now spending more time indoors (Hartig & Kahn, 2016). There are documented increases in sedentary behaviour among adults, especially television viewing, across the United States, United Kingdom, Brazil, China and India (Ng & Popkin, 2012). Canadian adults and youths are spending more time indoors, and preferences for indoor activities are strengthening (Leech, Wilby, McMullen, & Laporte, 1996; Matz et al., 2014).

These concerns have led to the widespread perception that there has been a decline in experiences of nature in everyday life, and consequently a weakening of the emotional connection between people and nature (Miller, 2005; Pyle, 1993). This disconnect has increasingly been viewed as a fundamental obstacle towards reversing global environmental degradation since the strength of individual's connection to nature predicts engagement in pro-environmental behaviour (Whitburn, Linklater, & Abrahamse, 2019). However, rather than people experiencing less contact with nature, opportunities to experience nature may in fact be relatively high in cities. Cities are typically located in highly biodiverse areas (Cincotta, Wisnewski, & Engelman, 2000; Luck, 2007) and can support substantially more species per unit area, at least in low and moderate urban intensities, in comparison with non-urban areas (Tratalos et al., 2007). European cities have higher species richness of native vascular plants than rural areas (Knapp, Kühn, Mosbrugger, & Klotz, 2008; Wania, Kühn, & Klotz, 2006) in part because of the higher geological diversity in urban areas that remains unaltered (Kühn, Brandl, & Klotz, 2004). Plant diversity in North American cities was best predicted by socio-economic factors as urban residents preferred to occupy, or create, biodiverse landscapes (Hope et al., 2003).

Similarly, daily experiences of nature could be maintained (or even increased) because of direct and indirect provision of urban greenspaces, and conservation measures directed at urban nature. There is increasing recognition of the positive contribution of nature experiences to human health and wellbeing, with associated increases in the development, conservation and restoration of natural habitats within or directly adjacent to cities. These urban spaces vary in size and governance, ranging from small wetlands governed by NGOs (e.g. London Wetland Centre in central London; Peberdy, 2019) to city-wide park networks managed by park agencies and municipal authorities (e.g. central Sydney: Byrne & Sipe, 2010; Seoul: Hwang, 2015) and larger ecosystems such as the 25,000 ha Table Mountain National Park in Cape Town, South Africa (van Wilgen, 2012). European cities have a broad diversity of habitats in urban regions formally designated as protected areas (Knapp et al., 2008). Many cities have mandatory targets for the provision of parks and greenspaces within a certain distance of people's homes. In Scotland, the East Dunbartonshire Council defines standards for the quantity, quality and accessibility of parks, gardens, play areas and nature reserves for its population (East Dunbartonshire Council, 2015), while Singapore aims to provide 0.75 ha of park space per 1,000 residents (Tan, Wang, & Sia, 2013). The provision of greenspaces has been complemented by the development of local and global programs to engage people from all walks of life with nature such as Australia's ClimateWatch national citizen science programme (Parks Victoria, 2013) and global Bioblitz projects that challenge people to notice and learn about the common, often urban, species around them (Pollock et al., 2015).

Substantial environmental concern has been documented among city residents (Dietz, Stern, & Guagnano, 1998), and was in fact equal to that reported by rural residents in a study comparing attitudes towards wilderness in Canada (Lutz, Simpson-Housley, & Deman, 1999). Other studies have reported stronger pro-environmental attitudes and support among urban residents than those living in rural areas (Arcury & Christianson, 1990; Howell & Laska, 1992; Yu, 2014), and support from urban residents in the USA for greater spending on environmental protection increased across time (Howell & Laska, 1992). Moreover, cities are the origin of many conservation movements (Wang, 2010). China's environmental civilian activism began in the cities of Xiamen and Guangzhou, where citizens successfully demonstrated against the construction of a petrochemical plant and trash incinerator (Moore, 2009). Global environmental activism has recently been brought to the fore in highly industrialized nations (Dalton, 2005, 2015), exemplified by the recent Global Climate Strike (Global Climate Strike, 2019) and the rise of the Extinction Rebellion movement (Extinction Rebellion, 2019). Local urban communities are also now leading and creating successful environmental solutions. The Needmore Tract in North Carolina, which started out as a grassroots residential campaign, has transformed into a partnership with government and industries with a $19 million purchase and conservation of 5,000 acres of land previously earmarked for development (Morse, 2010).

The extinction of experience hypothesis rests on the assumption that fewer experiences of nature, likely arising because of living in urban areas, will result in an emotional disconnect from nature. Yet there is little empirical evidence supporting this assumption. Most existing studies quantifying the strength of human–nature connection rely almost exclusively on cross-sectional data (Whitburn et al., 2019) and often do not include measures of people's experiences of nature. Some studies assess changes in nature experiences across time, but this is usually not accompanied by a simultaneous assessment of change in attitude towards nature (e.g. Hofferth & Sandberg, 2001; Imai, Nakashizuka, & Kohsaka, 2018, 2019). Moreover, studies that do quantify experiences of nature have generalized experiences of nature to the frequency of visiting 'natural environments' or engagement in 'outdoor play' (Pergams & Zaradic, 2008), or typically measured overall site-specific species richness. Yet, this is different from the actual interactions between people and types of nature, such as the number of species and type or intent of interactions. We therefore have a limited understanding of how the types and frequency of direct interaction with neighbourhood biodiversity (i.e. plants and animals) have changed across time, and whether these changes are associated with changes in emotional connection to nature.

Here we investigate empirically whether experiences of nature, the opportunities to experience nature and the emotional connection between people and nature have changed across 22 years in a neighbourhood of Singapore, one of the world's most densely populated cities. We do this by repeating a study conducted in 1996 (Briffet, Sodhi, Yuen, & Kong, 2004) that used structured interviews with householders to measure (a) the frequency and duration of visits to urban greenspaces, (b) the types and amount of nature observed by visitors in an urban greenspace and (c) the strength of individuals' emotional connection to nature. We also repeated a series of bird surveys that measured bird species richness and abundance in the local greenspace in the study neighbourhood as an index of opportunities to experience nature.

Our results show that avian species richness and abundance did not significantly decrease between 1996 and 2018. Similarly, the frequency and duration of visits to an urban greenspace also remained unchanged, and respondents' emotional connection to nature markedly strengthened. We conclude that an extinction of experience and an emotional disconnect from nature are not inevitable in urban Singapore.

## 2 | MATERIALS AND METHODS

### 2.1 | Study site

This study was conducted in Singapore (1°22′N, 103°48″E; Figure 1a). Singapore has undergone extensive ecological transformation since the 1800s, when large scale deforestation began, followed by a period of rapid urbanization and human population growth (Corlett, 1992). More than 95% of Singapore's original forest cover has now been cleared, with unlogged forest occupying <2.4 km$^2$ (Ng, Corlett, & Tan, 2011). Brook, Sodhi, and Ng (2003) estimated an overall 28% loss of species, with many extinctions documented among butterflies, freshwater fish, birds and mammals (34%–43% of species). Turner et al. (1994) reported a 39% and 29% decline in coastal and inland plant species respectively. Singapore's land cover has also changed significantly. While the country's original land area was 523 km$^2$, it currently has a total land area of 725.75 km$^2$ as a result of conversion of tidal flats and shallow seas to dry land through reclamation (Glaser, Haberzettl, & Walsh, 1991). Of this, 38.9% comprises built infrastructure such as sealed surfaces, buildings and roads, 56% comprises managed or unmanaged vegetation, while the remaining 5.1% comprises waterbodies (Yee, Corlett, Liew, & Tan, 2011). About 10% of Singapore's land area is formally designated as greenspace, and 5% is protected as nature reserves. Between 1986 and 2007, green cover in Singapore increased from 36% to 47%, despite a 68% growth in the human population (Ministry of Environment, 2009). The population density of Singapore in 2018 was 7,804 individuals per km$^2$ (Singapore Department of Statistics, 2018a).

The study site was located in the residential district of Clementi, which has an area of 9.52 km$^2$ and 30.8% vegetation cover (Tan et al., 2013). Originally an area of swamps, mangroves, rubber plantations and fruit tree cultivations, with low-density settlements (Singapore Mapping Unit, 1982, 1992, 2000), Clementi was developed as a residential district in the 1970s (Housing & Development Board, 2017). The resident population in Clementi increased by a modest 2% between 2000 and 2017 (Government of Singapore, 2017; Singapore Department of Statistics, 2018b), although this number fails to capture the non-residents living in the district (non-residents formed 16% and 29% of Singapore's national population in 1996 and 2019 respectively; Singapore Department of Statistics, 2020). There was no significant change in the extent or configuration of urban greenspaces and urban cover in Clementi between 1996 and 2018 (Figure 1b,c).

To measure change across time, we replicated as closely as possible the methods which were previously deployed in Singapore in 1996 (Briffet, Sodhi, Kong, & Yuen, 2000; Briffet et al., 2004). This comprised repeating (a) household surveys in the residential estate of Clementi and (b) structured bird surveys in Ulu Pandan Park in 2018 and 2019. Ulu Pandan Park is a 7.1 km linear greenspace (National

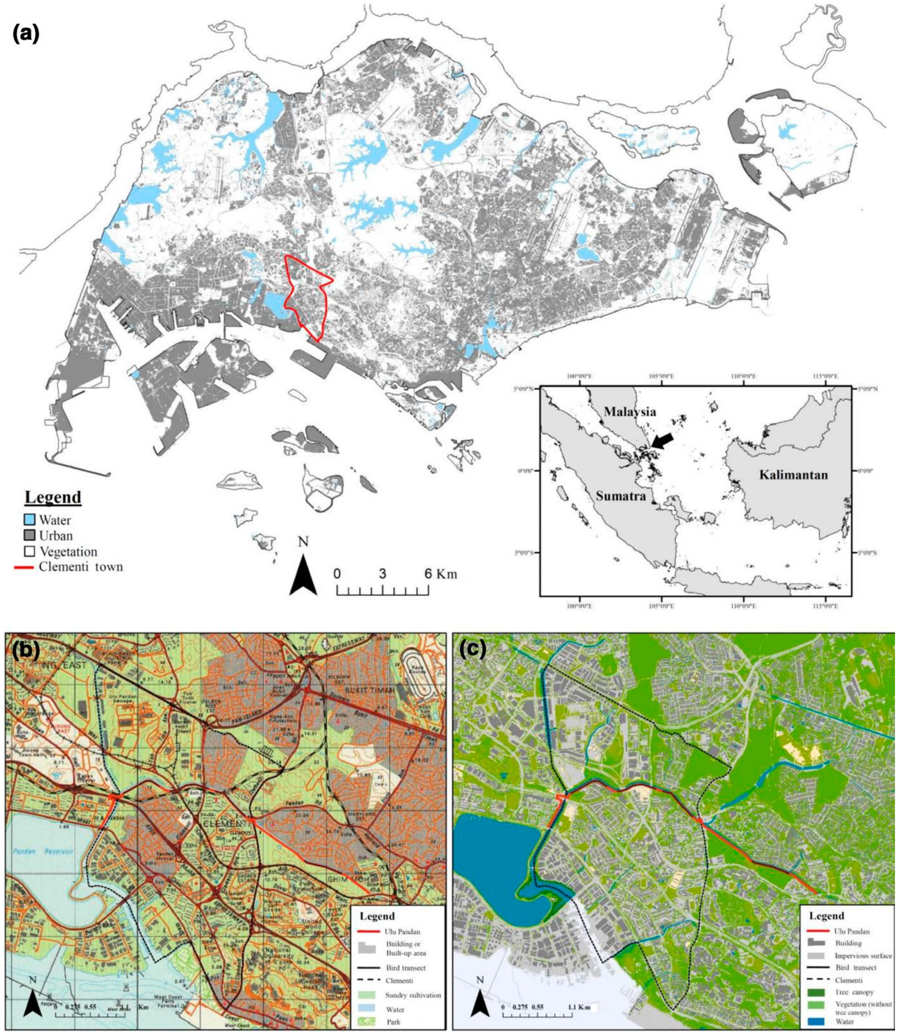


**FIGURE 1** (a) A map of Singapore indicating cover by urban built form, vegetation and waterbodies. The red boundary delineates the residential district of Clementi. More detailed views of Clementi, along with the locations of the four bird transects are shown on (b) a topographic map from 1996 at 1:50,000 scale, obtained from the Urban Redevelopment Authority of Singapore and (c) an adapted landcover map from Gaw, Yee, and Richards (2019) using Worldview and QuickBird satellite imagery from 2018

Parks Board, 2019b) bordered by secondary forests (1–2 ha) and a semi-restored water culvert (Figure 1).

## 2.2 | Household surveys

We conducted 311 household surveys between November 2018 and January 2019, in accordance with the Institutional Human Research Ethics Approval, University of Queensland (project number 2018001775) and the Animal Ethics Committee, University of Queensland (reference 420/18). Following Briffet et al. (2004), we used type of residence as a surrogate for socio-economic status (SES) to stratify the respondents. For public residential buildings, we obtained the proportion of people living in each major type of residential building from the 2017 census data (Government of Singapore, 2018). The household surveys were then delivered in the residential estate of Clementi. Residential buildings in which surveys would be conducted were randomly chosen from all the public housing buildings present in Clementi. If the chosen building was multi-storied, then one storey was randomly chosen as the starting point to deliver the door-to-door survey. All households present on that storey were approached, and this strategy continued for all subsequent storeys until a maximum of five surveys were completed per building. Survey administration commenced approximately at 5 p.m. on weekdays, and between 9 a.m. and 5 p.m. on weekends, and lasted about 4 hr. Each survey was delivered in English and respondents had the option to either complete the survey personally, or have it read out and completed by the researcher. The structured survey was administered to only one resident per household, with each respondent being at least 18 years of age. Respondents provided informed consent prior to the beginning of the survey. The researcher was careful to avoid giving specific instructions or background information that might influence responses, particularly to avoid sending any signals that strong emotional connection to nature is desirable. With reference to Ulu Pandan Park, the questionnaire first asked if the respondent knew of, and visited the park. If yes, the respondent was directed to an additional section of the questionnaire that collected information on the frequency and duration of greenspace visitation, type of activities conducted within the greenspace, direct experiences of 15 different types of organisms or elements of the natural environment, and reasons for, and barriers to, greenspace use. All respondents were invited to respond to questions on perception of public greenspace in Singapore, preference for type of recreational activity, emotional connection to nature, preference for greenspace design and several socio-demographic variables that could influence greenspace usage (the full survey is provided in Appendix B of the Supporting Information).

Since the 2018 data were collected from a new group of respondents and not those who participated in 1996, we conducted a Kruskal–Wallis test to determine whether the socio-demographic composition of respondents had changed between the 1996 and 2018 surveys. We did this for each socio-demographic variable—gender (male; female), age (younger: 18–40 years old; older: more than 40 years old), employment status (employed; unemployed) and type of residence (low socio-economic status: public housing with 1- to 3-room flats; middle socio-economic status: public housing with 4- or 5-room flats; and high socio-economic status: private apartments or house). We separately computed overall percentages for five ethnic categories (i.e. Chinese, Malay, Indian, Caucasian and Others) to understand whether the ethnic composition among respondents reflected that of the national census. All statistical analyses were carried out in R (version 3.5.1; R Development Core Team, 2017).

## 2.3 | Quantifying experiences of nature

Respondents who used Ulu Pandan (thereby termed greenspace users) provided a measure of their nature dose (i.e. frequency and duration of greenspace usage). Frequency was estimated based on the respondent's self-reported usual frequency of visits to Ulu Pandan, while duration was estimated based on self-reported total time spent at Ulu Pandan per visit. There were seven options for frequency: 1 = Daily, 2 = Every 2 to 3 days, 3 = Once a week, 4 = Once every 2 to 3 weeks, 5 = Once a month, 6 = Once every 2 to 3 months and 7 = Only been there once. Correspondingly, four options were provided for duration: 1 = >1 hr, 2 = 1–2 hr, 3 = >2–3 hr and 4 = 3+ hr. For frequency of greenspace use, responses from the categories of 'Daily', 'Every 2 to 3 days' and 'Once a week' were aggregated to create a combined category of 'At least once a week'. Similarly, responses from the categories of 'Once every 2 to 3 weeks' and 'Once a month' were aggregated to create a category of 'Approximately once a month'. Responses from categories 'Once every 2 to 3 months' and 'Only been there once' were combined into the 'Infrequently' category. We treated the frequency and duration of greenspace use as categorical data, and ran a Pearson's Chi-squared test to assess whether frequency and duration of greenspace use was significantly different between the 1996 study and this study. To understand the extent to which Ulu Pandan was providing greenspace users their direct experiences of nature, we further asked greenspace users whether they were using any other type of urban greenspaces, such as neighbourhood parks, town parks, regional parks, the beach or golf clubs, more frequently than Ulu Pandan.

Greenspace users were also asked about their direct experiences of 15 different elements of the natural environment, and if they had (a) noticed each of them from afar and (b) voluntarily come into close contact with each of them. These organisms or elements comprised: birds, mosquitoes, ants, butterflies, rats, snakes, frogs/toads, cats, dogs, squirrels, trees, shrubs, grass, flowering plants and water. As per the 1996 study (Briffet et al., 2004), the responses for each nature element were converted into a binary response (1 if they had seen/come into contact with the element and 0 if not) and then summed up to obtain the total number of respondents who had encountered each nature element. We then conducted a Pearson's Chi-squared test, one for observations from afar and another for close contact, to test whether the number of respondents who had experienced each nature element differed significantly across the 22 years.

## 2.4 | Connection to nature

Respondents provided a measure of their connection to nature through a set of seven items administered by Briffet et al. (2004; Appendix B, Supporting Information). Scores for five positively worded items (e.g. I enjoy contact with greenery) were rated on a 3-point Likert scale (−1: Disagree; 0: Neutral; 1: Agree). Scores for two negatively worded items (e.g. I prefer to walk through tidy and well-trimmed greenery rather than naturally growing greenery) were reverse coded. A total connection to nature score for each respondent was calculated by summing the responses to each item. We recognize that these items are not a comprehensive measure of 'connection to nature' as per more recent validated scales (e.g. Nature Relatedness; Nisbet, Zelenski, & Murphy, 2009 or Connectedness to Nature; Mayer & Frantz, 2004), imposing limits on its interpretation. However, we were constrained to using this instrument so that the findings from 2018 could be directly compared with the 1996 survey. We believe the measure is a useful, albeit incomplete, indication of connection to nature, since the items listed in this survey are similarly worded to those from the Nature Relatedness and Connectedness to Nature scales, and had an adequate Cronbach's alpha statistic of 0.65.

We constructed two GLMs to determine whether experiences of nature predicted connection to nature. The first global model was constructed with a Poisson error distribution and investigated whether greenspace users and non-users differed in their connection to nature score. The connection to nature score from all respondents across both survey years ($n = 612$) formed the response variable, while the six candidate predictors were: year of study (1996; 2018), greenspace usage (non-users who do not know of the greenspace; non-users who know of but do not use the greenspace; greenspace users), gender (male; female), age (younger; older), ethnicity (Chinese, Malay, Indian, Caucasian, Others) and type of residence (low, middle and high socio-economic status). All predictors were treated as categorical, and the model fitted was checked for overdispersion.

Since only greenspace users provided responses about their experiences of 15 different elements of nature, we constructed a second global GLM with a Poisson error distribution, using only data from greenspace users from both 1996 and 2018 ($n = 270$). This was to investigate whether different types of direct experiences of nature predicted connection to nature scores among greenspace users. The response variable was the connection to nature score, and the eight candidate predictors were: year of study, frequency of greenspace use, duration of greenspace use, total number of nature elements observed from afar (out of 15 types), gender, age, ethnicity and type of residence. All predictors were treated as categorical (and followed categories specified in the previous model), except total number of nature elements (continuous). We also re-analysed the second GLM by replacing 'total number of nature elements observed from afar (out of 15 elements)' with 'total number of nature elements observed from afar (out of eight elements)' as it was possible that some elements of nature (e.g. mosquitoes) might imply a negative experience of nature, therefore confounding the results from the models. The choice of the eight elements was informed by literature (e.g. Dallimer et al., 2012) where greenspace users have reported neutral or positive responses of birds, butterflies, squirrels, trees, shrubs, grass, flowering plants and water. The retained parameters and parameter estimates were very similar to the full analysis which we report here, with the results from the analysis of eight elements reported in the Supporting Information.

We calculated the variance inflation factor for each predictor (VIF; Zuur, Ieno, & Elphick, 2010), using the *vif* function from the *car* package, and all VIFs were less than three, indicating no major problems with multicollinearity (Zuur et al., 2010). We conducted model simplification using an ANOVA Chi-square test as appropriate for GLMs with a count response variable and categorical predictors (Crawley, 2012).

### 2.5 | Opportunities to experience nature

Briffet et al. (2004) and Sodhi, Briffett, Kong, and Yuen (1999) conducted nine monthly bird surveys to determine species richness and abundance in 1996. We resurveyed these same transects, with each bird survey encompassing four 660-m transects set up along Ulu Pandan Canal (Figure 1). This was conducted from November 2018 to July 2019, forming a total of nine monthly bird surveys, across 26.4 ha, as a measure of change in opportunities for experiences of nature. All birds seen or heard between 07:00–09:00 hr, and within 50 m of both sides of the transect, were recorded. The start of a transect was alternated (north or south) for subsequent surveys. As each block of 660-m transect was arranged consecutively, each transect was separated from the next transect by 100 m. Sodhi et al. (1999) chose these transects to represent different types of vegetation/habitat within each site. We determined that the transects actually measured 660 m in length instead of the 400 m as detailed in Briffet et al. (2004).

## 3 | RESULTS

### 3.1 | Demographics of the 1996 and 2018 respondents

In 1996, Briffet et al. (2004) surveyed 301 respondents, and in 2018 we surveyed 311 respondents. Across both years, Chinese formed the largest ethnic group (79.7% in 1996; 77.8% in 2018), followed by Malays (11.3% in 1996; 6.75% in 2018), Indians (6.6% in 1996; 8.7% in 2018), Caucasians (0.33% in 1996; 0.96% in 2018) and Others (2.0% in 1996; 5.7% in 2018). This closely reflects the ethnic composition of Singapore's resident population in 2018 where Chinese form the majority of the population 74.3%, followed by Malays 13.4%, Indians 9.0% and Others 3.2% (Singapore Department of Statistics, 2018a). Respondents in the 2018 survey were significantly older, more likely to be employed and differed significantly in socio-economic status (less likely to be from an advantaged socio-economic background; Figure S1). Respondents across both years were similar in gender ratio.

### 3.2 | Changes in direct experiences of nature between 1996 and 2018

The percentage of respondents who knew of the greenspace and actively used it was 41.53% in 1996 and 44.37% in 2018. The percentage of respondents who knew of the greenspace but did not use it was 28.24% in 1996 and 26.37% in 2018, and the percentage of respondents who did not know of the greenspace was 30.23% in 1996 and 27.01% from 2018. Across both years, most of the greenspace users preferred to visit the greenspace alone (41.6% in 1996; 51.0% in 2018), followed by going with family (32% in 1996; 33.8% in 2018) and friends (25.6% in 1996; 13.1% in 2018). Greenspace users from both 1996 and 2018 were also getting their direct experiences of nature mostly from Ulu Pandan over other urban greenspaces. In 1996, only 6.6% of greenspace users were visiting other types of urban greenspaces more frequently than their visits to Ulu Pandan, and in 2018, only 2.5% of greenspace users were doing so.

The number of people using the greenspace at least once a week was marginally higher in 2018 than in 1996, and greenspace users in 2018 used the greenspace for a longer duration compared to users from 1996. However, neither of these differences was statistically significant (Figure 2; $p$-value = 0.476 and 0.238).

Of the 2018 respondents who knew of Ulu Pandan, 60.7% used the greenspace at least once a week, a small but non-significant increase on the 56% who did so in 1996 ($p$-value = 0.476). The duration of park use did not differ significantly between the two survey periods ($p$-value = 0.238), with 51.7% from 2018 using the greenspace for 1–2 hr compared with 48% in 1996 (Figure 2). There was no significant difference in the number of respondents who had experienced each nature element from afar (Figure 3; $p$-value > 0.05) or up-close (Figure 3; $p$-value > 0.05) across the 22 years. Vegetation

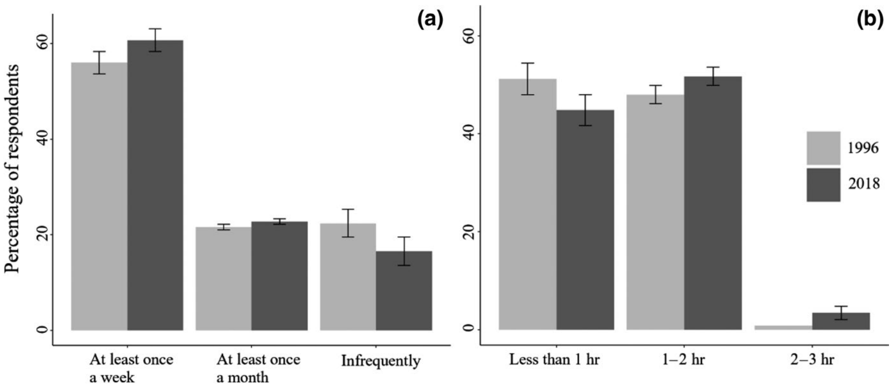


**FIGURE 2** The percentage of greenspace users from 1996 and 2018 in relation to (a) frequency (at least once a week, at least once a month, infrequently); and (b) duration (<1, 1–2, 2–3 hr) of greenspace use. There were no significant differences in frequency or duration of greenspace use

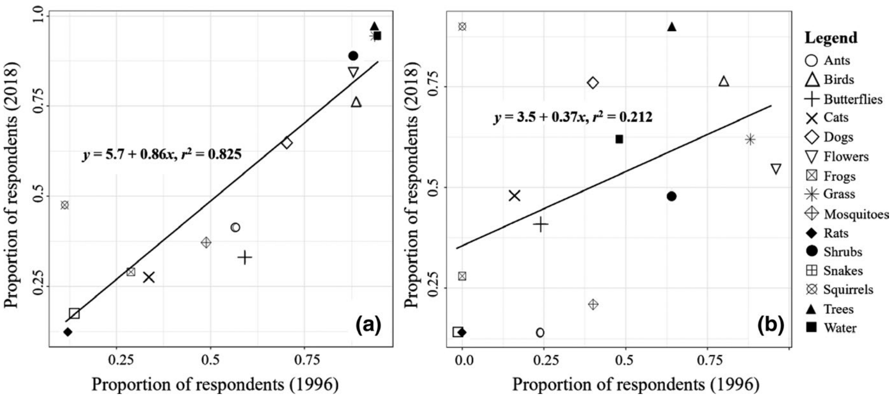


**FIGURE 3** Regression of the proportion of respondents from 1996 who observed each nature element against the proportion of respondents who did so in 2018 (a) from afar and (b) from up-close. The line of best fit is represented by the solid black line

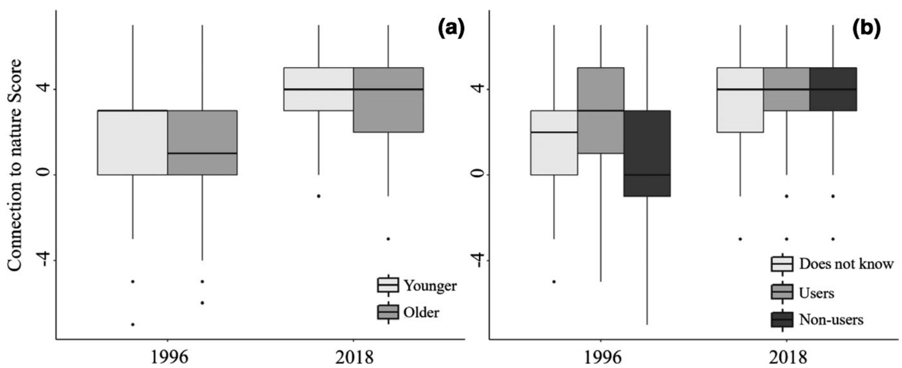


**FIGURE 4** Boxplots showing connection to nature in 1996 and 2018 for (a) different age groups (younger: aged 18 ≤ $x$ ≤ 40; older: aged ≥41 years) and (b) among three different categories of park use (users: greenspace users; non-users: greenspace non-users; does not know: respondents who do not know of the greenspace). Within each box, the full line represents the median value while the bottom whisker, bottom of box, top of box and top whisker represent 10th, 25th, 75th and 90th percentiles respectively

(i.e. trees, shrubs, grass and flowers), water and birds were the six most commonly observed elements of nature from afar for both years. However, the slope for experiences of nature elements from afar were steeper compared to experiences up-close, suggesting some decline in up-close experiences of nature between 1996 and 2018 (Figure 3).

## 3.3 | Predictors of connection to nature

Overall, respondents in 2018 were more strongly connected to nature than those in 1996, and this was consistent in younger (18 ≤ $x$ ≤ 40 years) and older (≥41 years) age groups (Figure 4a), as well as among greenspace users and non-users, and respondents who did not know of the greenspace (Figure 4b). In 1996, greenspace users had a stronger connection to nature than non-users and those who did not know of the greenspace, but this difference was not apparent in 2018 (Figure 4b).

In the GLM predicting connection to nature for all respondents, *use of greenspace* (0.08 ± 0.03 *SE*; Table 1a) and *year of survey* (−0.20 ± 0.03 *SE*; Table 1a) emerged as significant predictors, showing that greenspace users had significantly higher connection to nature scores when compared to non-users and those who do not know of the greenspace. In addition, respondents from the 1996

**TABLE 1** Final GLM models and retained predictors where the response variable was (a) connection to nature scores for all respondents from both 1996 and 2018 and (b) connection to nature scores for only greenspace users from both 1996 and 2018

| | Parameter estimate | *SE* | *p*-Value |
|---|---|---|---|
| (a) | | | |
| (Intercept) | 2.32 | 0.04 | 0.00* |
| Greenspace users | 0.08 | 0.03 | 0.01* |
| Greenspace non-users but who know it exists | −0.03 | 0.04 | 0.45 |
| Female | −0.03 | 0.03 | 0.29 |
| Malay | 0.05 | 0.05 | 0.26 |
| Indian | −0.01 | 0.05 | 0.84 |
| Caucasian | 0.04 | 0.16 | 0.81 |
| Others | 0.02 | 0.07 | 0.81 |
| Older respondents | −0.02 | 0.03 | 0.45 |
| Middle SES | 0.03 | 0.04 | 0.46 |
| High SES | 0.06 | 0.04 | 0.11 |
| Year of survey: 1996 | −0.20 | 0.03 | 0.00* |
| (b) | | | |
| Intercept | 2.38 | 0.06 | 0.00* |
| Female | −0.03 | 0.04 | 0.38 |
| Malay | 0.07 | 0.07 | 0.34 |
| Indian | 0.00 | 0.07 | 0.98 |
| Caucasian | 0.09 | 0.21 | 0.68 |
| Others | 0.00 | 0.11 | 0.98 |
| Older respondents | −0.01 | 0.04 | 0.96 |
| Middle SES | 0.00 | 0.05 | 0.90 |
| High SES | 0.01 | 0.06 | 0.82 |
| Year of survey: 1996 | −0.10 | 0.04 | 0.02* |

*$p < 0.05$.

surveys had significantly lower connection to nature scores than the 2018 survey respondents (Table 1a).

In the second GLM predicting connection to nature (of greenspace users only), only *year of survey* emerged as a significant predictor (−0.10 ± 0.04 *SE*; Table 1b), with greenspace users in 1996 having a lower connection to nature score than greenspace users in 2018.

### 3.4 | Changes in opportunities to experience nature

Bird species richness and abundance were both marginally higher in 2018 than 1996 (Table 2). Bird abundance remained higher even when a one-off large flock of Daurian Starlings was excluded (Table 2). There was a large turnover in species composition, with only 37 bird species being found in both the 1996 and 2018/9 surveys (Table S1).

**TABLE 2** Total bird species richness and average monthly abundance per hectare (with standard errors indicated within brackets) documented at the 26.4 ha Ulu Pandan Park from nine monthly bird surveys

| | |
|---|---|
| Total bird species richness | |
| In 1996 | 67 |
| In 2018 | 73 |
| Unique to 1996 | 30 |
| Unique to 2018 | 36 |
| Average monthly abundance per hectare | |
| In 1996 | 1.75 (0.48) |
| In 2018 (without Daurian Starlings) | 1.87 (0.5) |
| In 2018 (with Daurian Starlings) | 2.53 (1.0) |

## 4 | DISCUSSION

### 4.1 | Experiences of nature and connection with nature

We detected no significant reduction in the frequency and duration of greenspace use between 1996 and 2018. Instead, visits tended to be marginally higher in frequency and of a longer duration in 2018. Across both years, greenspace users were consistent in deriving the bulk of their daily nature experiences by visiting Ulu Pandan instead of other urban greenspaces. Connection with nature was significantly stronger in 2018 than in 1996, an effect that remained significant even after accounting for the effects of a number of sociodemographic variables.

The increase in nature connection could have arisen through growing awareness of environment-related issues in Singapore residents, driven by an increase in nature-oriented programs and policies in Singapore. Environmental issues are regularly communicated in the local media through the sharing of new opportunities for access to urban greenspaces, programs that facilitate such engagement with nature and the importance and necessity of integrating greenery within the built environment. For example, the park connector network in Singapore has been expanding since 1992 and will measure 360 km by 2020 (The Straits Times, 2015). Sky deck gardens and other forms of vertical greening of buildings are also popular in Singapore (National Parks Board, 2019a; Singapore Government Press Release, 2001). Mainstream media frequently reports on local environment-related news such as the construction of a subway line beneath the country's nature reserve (Channel News Asia, 2019), and the likely investment of S$100 billion to protect Singapore against sea-level rise (The Straits Times, 2019).

These recent developments could have further strengthened an already-existing social norm emphasizing the importance of urban greenery and its integration into residents' daily life. Singapore has nurtured an identity and culture where greenery is important since the nation's beginnings as an independent country in 1965. The city-state's motto has always revolved around being a 'garden' (e.g.

Singapore—City in a Garden; Beatley, 2012). Commitment to this vision is further evident in Singapore's considerable greening budget where total expenditure (on tree-planting and parkland beautification) by the Parks and Recreation Department between 1975 and 1993 was more than $700 million (Lee, 1995). This is a substantial budget given that Singapore then was a young nation confronting urgent infrastructural needs. The then Prime Minster Mr Lee Kuan Yew formed a tree-care unit that planted more than five million trees and shrubs from 1970 to 1992 (Geh & Sharp, 2008), and since the 1980s, Singapore has targeted park provision of 0.8 ha per 1,000 residents (Tan, 2006).

Increased connection to nature scores might also have resulted from Singapore's place identity-making polices that have generated positive public attitudes and subsequently, social norms that support the importance of integrating nature into everyday life. Place identity is a concept related to place attachment (i.e. the positive connection or cognitive/emotional bonds that form between a person and a particular place; Williams & Vaske, 2003) and has been shown to significantly predict environmentally responsible behaviour, since a strong attachment to a place intuitively implies a stronger tendency to care for it (Halpenny, 2010; Stedman, 2002). As such, Singapore residents might now hold the attitude that more urban greenspaces translate into a greater quality of life (Savage & Kong, 1993). This place identity-making and recognition of Singapore's green city vision has evidently been successful, since the citizens of Singapore have ranked parks and greenery as one of the most important elements of Singapore's quality of life and the topmost factor that makes Singapore special (Tan et al., 2013), and an increasing proportion of local communities are actively greening the city (Gulsrud, 2015).

We found no discernible decline among the individual elements of nature experienced from afar by greenspace users when in the greenspace, though greenspaces users from 2018 were markedly less inclined to voluntarily experience these types of nature up-close (Figure 3). This mirrored results from Novotný, Zimová, Mazouchová, and Šorgo (2020) who found no change in children's observation of nature elements and nature-related activities and observations between 1900 and 2015. Research by Imai, Nakashizuka, and Kohsaka (2019) also showed no change or an increase in direct interactions for five out of 12 flora and fauna groups over 14 years. Our findings, however, differed from Soga et al. (2018), who found a cross-generational decline in retrospectively reported childhood experiences of neighbourhood flowering plants in Japan, hinting at potential geographic, cultural or temporal variations in whether and how an extinction of experience plays out.

An individual's decision to interact with nature seems to be determined by both the availability of nearby nature (opportunity) and a person's motivation to interact with nature (orientation; Soga & Gaston, 2016). The increase in bird species richness and abundance documented by our bird surveys suggests that opportunities for at least some kinds of nature experience have increased across the 22 years in Ulu Pandan. This was surprising since birds are strongly affected by urbanization (Evans, Newson, & Gaston, 2009; Marzluff, 2001; Stagoll, Manning, Knight, Fischer, & Lindenmayer, 2010) and highly urbanized areas generally only support a few abundant species (McKinney, 2006) because of the relatively high density of built-up areas and high proportion of impervious surfaces (Tratalos et al., 2007). Yet, this outcome could have been buffered by the lack of change in the amount and configuration of greenspaces in the area surrounding Ulu Pandan (Figure 1; Neo, Yee, Chong, Kee, et al., 2013; Neo, Yee, Chong, Yeo, & Tan, 2013; Neo, Yee, Chong, Yeoh, & Tan, 2012).

We quantified bird species richness and abundance to align with Pyle's (1978) definition of extinction of experience. While this forms one definition of a nature experience, and accounts for variability in the natural environment, other ecological metrics could be used to measure specific components of natural environments that could have a considerable influence on the quality of people's nature experiences, and whether those experiences strengthen connection with nature. Biodiversity can be measured via a diverse suite of metrics including species richness and abundance, or habitat, structural and functional complexity (de Vries & Snep, 2019). Also, it remains unclear whether people respond to actual biodiversity or perceived biodiversity. For example, Dallimer et al. (2012) found that psychological wellbeing was positively related to participants' perceptions of species richness, with mixed results for the relationship between wellbeing and actual species richness. As such, greenspace users may be responding to other environmental cues rather than to actual species richness. This suggests that additional aspects of biodiversity could be assessed if we wish to improve our understanding of people's experiences of nature and the influence of biodiversity on outcomes such as connection with nature, environmentally protective attitudes and wellbeing.

Bird species composition had markedly changed between 1996 and 2018, with 30 of the 67 species documented in 1996 not detected in the 2018 surveys, and 36 species detected in 2018 not found in 1996. This turnover could result from changes to vegetation structure or composition. Indeed, while the study site has consistently been under the management of the National Parks Board of Singapore, and correspondence with the park managers ascertained that vegetation in the park has remained largely unchanged since the 1990s (L. Goh, pers. comm.), there was some planting of native tree species (e.g. *Hopea odorata*, *Cratoxylum cochinchinense*, *Cratoxylum formosum* and *Buchanania arborescens*) in 2015 to celebrate Singapore's 50th year of independence. This said, there were no obvious ecological traits uniting the species that were lost from, or added to, the assemblage across the 22 years, and a more detailed ecological study will be needed to understand why the assemblage is changing.

## 4.2 | Extinction of experience

Our data suggest no discernible extinction of experience in the urban residents of Clementi across 22 years. Direct experiences of nature, specifically the frequency and duration of visits to greenspaces and experiences of different elements of nature were similar or marginally increased between 1996 and 2018. There was an increase in connection with nature and opportunities to experience nature. Results from the European Social Survey (2016) showed that modern society strongly values the environment, as reflected in the prioritization of biospheric and altruistic values over egoistic and hedonic values, and the effectiveness of using biospheric rather than financial benefits to motivate environmentally protective behaviour (Dogan, Bolderdijk, & Steg, 2014; Schwartz, Bruine de Bruin, Fischhoff, & Lave, 2015).

Some studies have perhaps conflated ecological illiteracy (i.e. the inability to name species and loss of traditional ecological knowledge) in modern societies with an emotional disconnect and disaffection for nature. This assumes that a regular, physical connection with nature cemented by ecological literacy, such as the way aboriginal cultures survive through foraging from nature and rural agricultural societies, is the only way to 'know' nature. Some studies have indeed shown a positive correlation between levels of environmental knowledge and pro-environmental attitudes (Bradley, Waliczek, & Zajicek, 1999) and/or behaviour (Beattie, Sale, & McGuire, 2011; Hofman & Hughes, 2018). Yet ecological illiteracy could be a benign by-product of modernity whereby the majority of individuals do not depend directly on harvesting natural resources for survival, and have instead developed new types of perceptions of nature and its place in human lives (Pilgrim, Cullen, Smith, & Pretty, 2008). It is plausible that the purpose of our interactions with nature has shifted from naming species to understanding processes and concepts. As such, perhaps caution should be applied in claims of a need to 'reconnect' people to nature, as this underestimation of the extent to which people value nature could impede further individual and collective environmentally protective action (Bouman & Steg, 2019).

Experience of nature as a single factor seems unlikely to result in an emotional disconnect and loss of concern for the environment given that as many as 18 categories of candidate predictors of environmental concern have been studied with no concrete agreement about which is the most important (see Gifford & Nilsson, 2014). Perhaps we need to reconsider our definition of 'experience of nature' in modern societies and move away from problematizing a shortage of time spent in nature that then prescribes 'experiencing nature' as a cure. Experiences of nature have largely been defined to be individual, direct contact with nature but this is simplistic given that there exists a complex relationship between humans and nature involving different social-cultural dimensions (Lutz et al., 1999; van den Born, Lenders, De Groot, & Huijsman, 2001). There are many ways of interacting with(in) nature, and societal changes in work, family life and technology could have driven a shift from direct to vicarious experiences of nature mediated by technology, evident in the increase in nature-based reality shows, documentaries and live footage from wildlife cameras that may serve to strengthen concern for the environment (Büscher, 2016; Fletcher, 2017).

### 4.3 | Limitations

This study is observational, and we are unable to determine the existence or direction of causality between experiences of nature and connection to nature. It is possible that a higher connection to nature score could drive a higher frequency and duration of greenspace use (Lin et al., 2014; Shanahan, Lin, Gaston, Bush, & Fuller, 2015) and that there are feedback loops between these variables. Moreover, while we replicated the methods used by Briffet et al. (2004) and statistically accounted for sociodemographic differences, our respondents were different individuals to those surveyed in 1996. We are also unable to determine whether the reported changes in experiences of nature represents a short-term fluctuation or an emerging long-term trend as our study used data sets obtained from two points in time instead of repeating the study at regular intervals.

### 4.4 | Future research

Future studies could focus on the extinction of experience thesis by conducting longitundinal studies that assess changes in individuals' level of nature experiences and their emotional connection with (or attitude towards) nature simultaneously. Such studies could be conducted regularly to assess whether changes, if any, represent a short-term fluctuation or an emerging long-term trend. We also recommend conducting similar studies in other cities to explore variation in context and culture, and across different types of nature experiences. While we found no evidence for the extinction of experience process in this specific context, the process could vary geographically, culturally and temporally. Focusing on quantifying actual interactions between individuals and nature might also give more precise estimates than measuring gross changes in a study site's biodiversity. For a more nuanced understanding of the causal relationship between experiences of nature and human connection to nature, experimental approaches could be used to explore the relationship between 'experiences of nature', and strength of connection to nature.

## 5 | CONCLUSION

Cities have been viewed as places with reduced biodiversity, with people living in cities having fewer and poorer daily experiences of natural environments. This is then perceived to contribute to the biodiversity crisis on the basis that if people do not experience nature, they will not act for its conservation. However, our study has shown that an extinction of experience and reduced connection with nature are not inevitable in urban landscapes. In fact, the amount of, and opportunities for, nature experiences in a Singaporean neighbourhood remained unchanged over a 22-year period, and this was accompanied by an increase, not a decrease, in connection with nature. These results provide hope in an era where the majority of world's human population lives in urban areas, and conservation of the wider natural environment is increasingly urgent.

**ACKNOWLEDGEMENTS**

R.R.Y.O. acknowledges scholarship support from the Commonwealth Government of Australia. The authors are indebted to Professor Lily Kong, President of the Singapore Management University of

Singapore, for sharing the 1996 survey data, to all colleagues who have helped in one way or another, and are very appreciative of the constructive feedback from the three anonymous reviewers.

## CONFLICT OF INTEREST

Nothing to declare.

## AUTHORS' CONTRIBUTIONS

R.R.Y.O. and R.A.F. conceived the ideas and designed methods; R.R.Y.O. collected and analysed the data, and led the writing of the manuscript. All authors contributed critically to the drafts and gave final approval for publication.

## DATA AVAILABILITY STATEMENT

The 2018 survey data used for this study have been made publicly available on Zenodo https://doi.org/10.5281/zenodo.4018225 (Oh, Fielding, Carrasco, & Fuller, 2020). The 1996 survey data used has been archived at https://doi.org/10.14264/834ba6f (Oh & Fuller, 2020).

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## SUPPORTING INFORMATION

Additional supporting information may be found online in the Supporting Information section.

**How to cite this article:** Oh RRY, Fielding KS, Carrasco RL, Fuller RA. No evidence of an extinction of experience or emotional disconnect from nature in urban Singapore. *People Nat*. 2020;2:1196–1209. https://doi.org/10.1002/pan3.10148