DEPARTMENT OF PLANNING, INDUSTRY & ENVIRONMENT

Assessment of an indicator of community appreciation of biodiversity

environment.nsw.gov.au

Cover photo: Birrawanna walking track, Ku-ring-gai Chase National Park. Elinor Sheargold/DPIE

Authorship and citation: This document was prepared by Kelly Fielding[1], Suzanne Prober[2], Kristen Williams[2] and Angela Dean[3]

[1] The University of Queensland, Brisbane

[2] CSIRO Land and Water, Canberra and Perth

[3] The Queensland University of Technology, Brisbane

This document should be cited as: Fielding KS, Prober S, Williams K & Dean A 2020, *Assessment of an indicator of community appreciation of biodiversity*, Biodiversity Indicator Program Implementation Report, Department of Planning, Industry and Environment NSW, Sydney, Australia.

Published by:

Environment, Energy and Science
Department of Planning, Industry and Environment
Locked Bag 5022, Parramatta NSW 2124
Phone: +61 2 9995 5000 (switchboard)
Phone: 1300 361 967 (Environment, Energy and Science enquiries)
TTY users: phone 133 677, then ask for 1300 361 967
Speak and listen users: phone 1300 555 727, then ask for 1300 361 967
Email: info@environment.nsw.gov.au
Website: www.environment.nsw.gov.au

Report pollution and environmental incidents
Environment Line: 131 555 (NSW only) or info@environment.nsw.gov.au
See also www.environment.nsw.gov.au

ISBN 978-1-922493-56-9
EES 2021/0071
October 2021

Contents

List of tables

List of figures

Acknowledgements

The authors would like to thank the following people for their invaluable contribution to the workshop discussions that underpinned the development of the Community appreciation of biodiversity indicator. Erin Anderson, Laura Babian, Meaghan Burkett, Alana Burley, Tom Celebrezze, Neva Frecheville, Lawrence Franklin, Lee Huuskes, Mark Littleboy, Alice McGrath, David Nipperess, Tina Wong (Department of Planning, Industry and Environment, DPIE); and Dan Faith (Australian Museum).

External reviewers, Louise Askew (Natural Resource Commission); Zoe Leviston (Edith Cowan University); and Matthew Selinske (RMIT University). DPIE reviewers, Lee Huuskes, Lawrence Franklin and Claudine Moutou.

Thanks to Donella Andersen, Nature Edit, for her work editing and formatting this report.

Acronyms and glossary

ANOVA	Analysis of variance
BC Act	*Biodiversity Conservation Act 2016*
CATI	Computer-assisted telephone interview
CSIRO	Commonwealth Scientific and Industrial Research Organisation
DPIE	Department of Planning, Industry and Environment
IBRA	Interim Biogeographic Regionalisation of Australia
IUCN	International Union for Conservation of Nature
M	Mean
NSW	New South Wales
SD	Standard deviation
SEED	Sharing and Enabling Environmental Data
UK	United Kingdom

Protected areas: Public reserves established in perpetuity under the *National Parks and Wildlife Act 1974* at 2012.

Sydney metropolitan area: In 2015, the local government areas that made up the Sydney metropolitan region were: Ashfield, Auburn, Bankstown, Blacktown, Blue Mountains, Botany Bay, Burwood, Camden, Campbelltown, Canada Bay, Canterbury, Fairfield, Hawkesbury, Holroyd, Hornsby, Hunters Hill, Hurstville, Kogarah, Ku-ring-gai, Lane Cove, Leichhardt, Liverpool, Manly, Marrickville, Mosman, North Sydney, Parramatta, Penrith, Pittwater, Randwick, Rockdale, Ryde, Strathfield, Sutherland Shire, Sydney, The Hills Shire, Warringah, Waverley, Willoughby, Wollondilly and Woollahra.

Context

The goals of the New South Wales (NSW) Government's *Biodiversity Conservation Act 2016* (the BC Act) include the conservation of biodiversity at bioregional and state levels, a reduction in the rate of species loss, and effective management to maintain or enhance the integrity of natural habitats. To contribute to assessing the performance of the legislation, the former Office of Environment and Heritage NSW established the Biodiversity Indicator Program to report on the status of biodiversity and ecological integrity at regular intervals. Responsibility for implementing this program now rests with the Environment, Energy and Science Group within the Department of Planning, Industry and Environment (DPIE).

Monitoring of biodiversity across New South Wales is a large, complex task requiring novel approaches to data collection and use, including the application of models to help track change. The overarching monitoring framework, or method, which outlines how indicators are related and derived, is presented in *Measuring Biodiversity and Ecological Integrity in New South Wales: Method for the Biodiversity Indicator Program* (OEH & CSIRO 2019).

The method for the Biodiversity Indicator Program established a nested design within which all **indicators**, as they are developed, have a place. Each indicator is nested with others of its type in an **indicator family**, and each family is nested within one of five **themes** which are associated with either the biodiversity or ecological integrity **class** of indicators (as shown in Figure 1). Some indicators may have multiple **dimensions** to fully characterise how they are measured and reported.

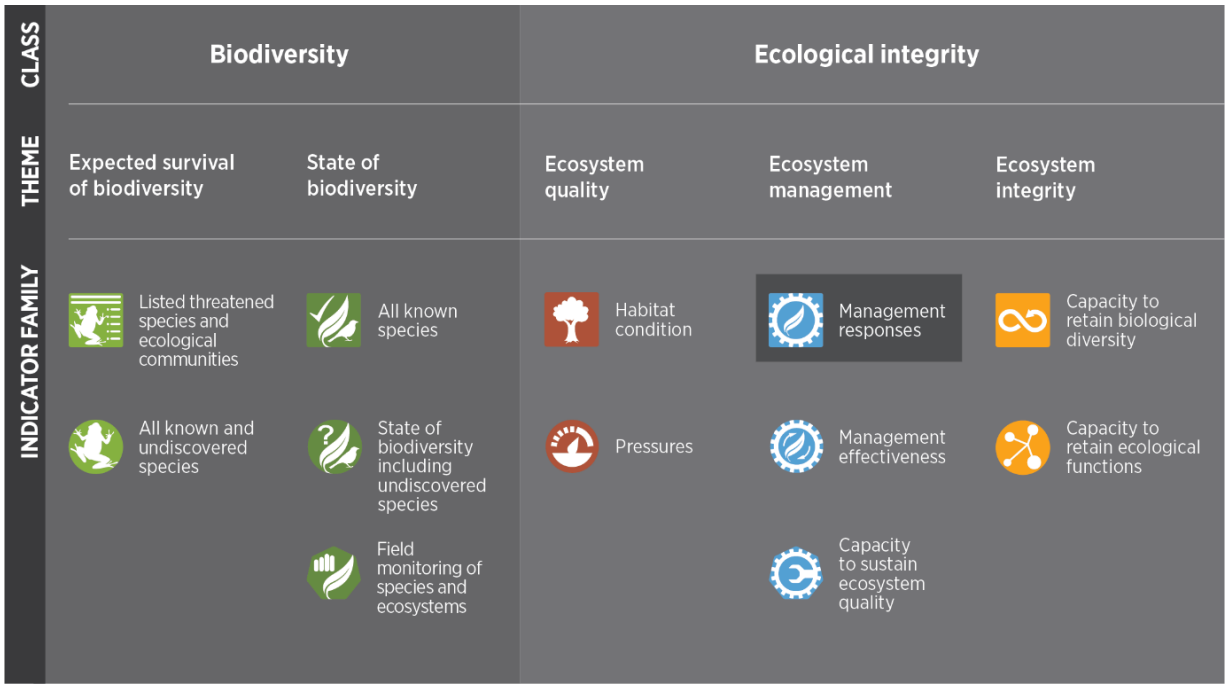


Figure 1 **Nested structure used to arrange and link indicators for measuring biodiversity and ecological integrity in New South Wales. This implementation report addresses an indicator in the management responses indicator family (shown by the darker grey box).**

The indicators in the **ecosystem management** theme assess the effectiveness of local-scale conservation management actions (such as through private land conservation programs) and responses (such as the introduction of new policies or actions) to prevent or reduce biodiversity loss and community awareness of these.

The **management responses** indicator family provides information about what policies or actions are implemented and how they will prevent or reduce biodiversity loss. The indicators assess changes in management responses, including community understanding of and support for biodiversity conservation.

This indicator implementation report details how an indicator for **community appreciation of biodiversity** was measured/assessed. The indicator detailed in this report sits within the nested framework as follows:

Class:	**Ecological integrity**
Theme:	**4. Ecosystem management**
Indicator family:	4.1 Management responses
Indicator:	4.1c Community appreciation of biodiversity *The level of community understanding of and support for biodiversity conservation*
Readiness category:	3

The method for the Biodiversity Indicator Program (OEH & CSIRO 2019) identified three categories of indicators based on their level of 'readiness' to implement. Some indicators were ready to implement in the first assessment (category 1), but others required further development (categories 2 and 3).

The key results and highlights of the category 1 indicators are presented in one of several report cards in the first *NSW Biodiversity Outlook Report* (DPIE 2020). For readiness category 2 and 3 indicators, supplement report cards will be prepared.

Summary

Approach

This report describes the conceptualisation of the **community appreciation of biodiversity** indicator. It reports on the 'first assessment' (i.e. prior to the commencement of the *Biodiversity Conservation Act 2016*, the BC Act) using data from the 2015 'Who cares about the environment?' survey. A dual-frame recruitment strategy (i.e. contacting both landline and mobile phones) was used to recruit 2000 people in New South Wales to participate in the telephone survey.

The community appreciation of biodiversity indicator was conceptualised as comprising three dimensions:

1. **Cognitive appreciation** of biodiversity which reflects the level of awareness that people have about biodiversity, including the benefits of biodiversity.
2. **Affective appreciation** of biodiversity which reflects the extent to which people positively value biodiversity.
3. **Behavioural appreciation** of biodiversity which reflects the extent to which people engage in behaviours that could help to protect biodiversity, either directly or indirectly.

Each dimension was measured with multiple items from the 'Who cares about the environment?' survey: five questions for cognitive appreciation, five questions for affective appreciation, and 12 questions for behavioural appreciation.

The study also compares the community appreciation indicator dimensions across demographic and geographic areas, and identifies community appreciation of biodiversity groups and profiles those groups.

Summary of key findings

Average levels of community appreciation of biodiversity

The average score on the cognitive appreciation dimension was 68%, indicating a reasonably high level of basic awareness of biodiversity in the sample. Similarly, the average score of 77% on the affective appreciation dimension suggests that people positively value biodiversity. In contrast, in terms of behavioural appreciation, respondents on average engaged in 40% of the environmental activities that could help to protect biodiversity. The behavioural appreciation score suggests there are opportunities to improve and expand programs which communicate and engage with people to promote appreciation of biodiversity.

Demographic and spatial differences in community appreciation of biodiversity

Some statistically significant but small demographic and spatial differences emerged on the community appreciation of biodiversity dimensions.

- Males reported slightly higher behavioural appreciation than females.
- Respondents in the 45–59 year old age group had greater cognitive appreciation than the 15–29 or 60+ year age group and had greater affective appreciation than the 60+ age group. Respondents across the age groups spanning 15–59 had greater behavioural appreciation than the 60+ age group.

- Respondents with higher education (i.e. diploma or degree) had greater cognitive and behavioural appreciation than respondents who had lower levels of education (secondary school, trade/technical qualification), and those with higher education had greater affective appreciation than those with secondary education.
- Spatially, respondents living in bioregions with greater than 10% of the area in protected areas (i.e. public reserves established in perpetuity under the *National Parks and Wildlife Act 1974* at 2012) had greater cognitive and affective appreciation than those living in regions with less than 10% in protected areas. No difference emerged between the regions on behavioural appreciation.
- Respondents living in the Sydney metropolitan region (see definition in Acronyms and glossary section) engaged in lower levels of behavioural appreciation (e.g. conservation lifestyle behaviours such as choosing environmentally friendly household products, land stewardship behaviours such as tree planting, etc.) than those living outside of Sydney (DPIE 2021).

Community appreciation of biodiversity groups and their profiles

Six appreciation of biodiversity groups emerged from the analysis. Two groups were defined by high or modest appreciation on all three appreciation dimensions (Highly appreciative and Modestly appreciative, respectively). One group was defined by low appreciation across all dimensions (Unappreciative). The other three groups demonstrated a disjunction between the different appreciation dimensions:

- positively valuing biodiversity but not having awareness or engaging in environmental behaviours (Concerned only)
- positively valuing biodiversity and engaging in environmental behaviours despite low awareness (Unaware but active)
- some awareness of biodiversity that is not associated with positively valuing or acting to protect biodiversity (Aware but unconcerned).

The groups were then profiled based on demographics and responses to other questions from the ‘Who cares about the environment?’ survey (i.e. questions that were not used to assess the three dimensions of community appreciation of biodiversity). The questions included the importance of national parks, use of national parks, the condition of the natural environment in New South Wales, concern about extreme weather events and perceptions on environmental regulations.

Figure 2 below summarises the profiles of the different groups.

Appreciation of biodiversity

Group	Profile
Group 1 **Highly appreciative** 	**High appreciation of all three appreciation dimensions** • more highly educated • less likely to live in Sydney • dissatisfied with the condition of NSW natural environment • think national parks are important • concerned about extreme weather • less likely to think environmental regulation is too strict • more likely to use national parks for camping/overnight stays
Group 2 **Modestly appreciative** 	**Modest appreciation of all three appreciation dimensions** • more likely to have university education • less likely to speak a language other than English at home • more likely to rate national parks as important • more concerned about extreme weather events
Group 3 **Concerned only** 	**Positively values biodiversity but lacks awareness and is not engaged in environmental behaviours** • less likely to have university education • more likely to speak a language other than English at home • less likely to use national parks for climbing or water activities (fishing, canoeing, swimming)
Group 4 **Unaware but active** 	**Positively values biodiversity and engages in environmental behaviours despite low awareness** • more likely to think environmental regulations are too strict • more likely to use national parks for walks/picnics and for climbing
Group 5 **Aware but unconcerned** 	**Some awareness of biodiversity that is not associated with positively valuing or acting to protect biodiversity** • younger • more likely to be satisfied with the condition of NSW natural environment • less likely to be concerned about extreme weather events
Group 6 **Unappreciative** 	**Low appreciation of all three appreciation dimensions** • less likely to have university education • more likely to live in Sydney and less likely to live in a bioregion with higher proportion of protected areas • more likely to be satisfied with the condition of NSW natural environment • less likely to rate national parks as important • less likely to be concerned about extreme weather events • less likely to use national parks for camping / overnight stays

Figure 2 **Community appreciation of biodiversity groups and their demographic and psychographic profiles.**

Future directions

The research described in this report represents a first step in developing and assessing the community appreciation of biodiversity indicator. One main limitation of the research is the reliance on an existing survey and the questions it contains to assess the indicator dimensions. Because the questions were not developed specifically to measure the indicator, the dimensions were not able to be measured as comprehensively as they could be. Future surveys should include additional questions to comprehensively test each of the community appreciation of biodiversity indicator dimensions for future assessments. A report by Fielding et al. (2020) has developed a set of questions that could more comprehensively assess the three dimensions of community appreciation of biodiversity.

1. Introduction

The former Office of Environment and Heritage NSW collaborated with the Commonwealth Scientific and Industrial Research Organisation (CSIRO), Macquarie University and the Australian Museum to develop a method for the collection, monitoring and assessment of biodiversity information in New South Wales at regional and statewide scales (OEH & CSIRO 2019). The technical implementation of the method specifically detailed in this report establishes a 'first assessment' (i.e. prior to the commencement of the *Biodiversity Conservation Act 2016* (the BC Act)) for the **community appreciation of biodiversity** indicator in the management responses indicator family.

Globally, nature has been significantly altered by multiple human drivers with the great majority of indicators of ecosystems and biodiversity showing rapid decline (IPBES 2019). In fact, it has been argued that biodiversity intactness has been reduced beyond the proposed planetary boundary (Newbold et al. 2016) and that the Earth is experiencing a biodiversity extinction crisis (IPBES 2019). Australia is not an exception to this pattern. The 2016 Australia State of the Environment report concluded that Australia's biodiversity is increasingly threatened and exhibiting signs of decline (Jackson et al. 2017). According to the report, invasive species, fragmented and degraded habitats, and climate change are just some of the factors putting pressure on species and in most areas the outlook for threatened species is poor.

There is no denying that threats to biodiversity are in large part due to human activity. Humans have radically altered our environment through modification of landscapes, unsustainable use of species and natural resources, and moving species across environments (IPBES 2019). It is therefore not surprising that the need to promote pro-environmental behaviours, including actions that help to protect biodiversity and natural areas, is becoming increasingly urgent (Byerly et al. 2018; Fischer et al. 2012).

Accordingly, increasing community awareness and engagement in biodiversity and nature is a centrepiece of many biodiversity strategies. For example, Aichi Target 1 of the Convention on Biological Diversity's *Strategic Plan for Biodiversity 2011–2020* promotes people being aware of the value of biodiversity and the steps they can take to conserve it (Secretariat of the Convention on Biological Diversity 2010).

In Australia, the State of New South Wales has recently proposed an indicator for **community appreciation of biodiversity** as part of a comprehensive framework for measuring and reporting on the status and trends in different aspects of biodiversity and ecological integrity (i.e. the capacity of ecosystems to retain biodiversity and adapt to change) (DPIE & CSIRO 2019). The recent Commonwealth of Australia's Strategy for Nature aims to connect all Australians with nature through, for example, increasing understanding of the value of nature, encouraging people to get out into nature and empowering people to be active stewards of nature (Commonwealth of Australia 2019). Increased awareness and action can lead to both direct positive impacts of individuals on biodiversity and increased support for policies that protect biodiversity (Whitburn et al. 2019). These goals reflect Australia's commitment to the Convention on Biological Diversity which has as five strategic goals, one of which is the mainstreaming of biodiversity across government and society (Secretariat of the Convention on Biological Diversity 2010).

To ensure we are able to track whether programs and policies that aim to increase community engagement with biodiversity are effective, it is crucial to develop indicators that measure community engagement and involvement over time. In this report we propose greater societal engagement is reflected by the appreciation that community members have for biodiversity. Moreover, based on earlier research (Dean et al. 2016; Lorenzoni et al. 2007), we propose three dimensions of appreciation be reflected in the indicator: cognitive, affective and behavioural appreciation of biodiversity. In the following section, the theoretical

and empirical logic for a community appreciation of biodiversity indicator is outlined. We then show how the indicator can be developed and implemented using data from 2000 respondents to the 2015 'Who cares about the environment?' survey (OEH 2017) and recommend future enhancements to the measurement of the indicator.

1.1 Community appreciation of biodiversity

We conceptualise community appreciation as the extent of engagement people have with biodiversity. The tripartite conceptualisation of appreciation that we propose is consistent with previous research (Dean et al. 2016; Lorenzoni et al. 2007) and recognises that to appreciate biodiversity, individuals need to understand what biodiversity is and why it is important (the **cognitive** dimension). However, knowledge and awareness are not enough. To fully appreciate biodiversity, it is also important to care about and value biodiversity (the **affective** dimension) and be willing to support biodiversity policy and to take personal and civic actions to protect biodiversity (the **behavioural** dimension).

This tripartite model of people's connection to an environmental issue is reflected in past research. For example, Lorenzoni et al. (2007) examined the cognitive, affective and behavioural engagement of the United Kingdom (UK) public with climate change and found that there was widespread knowledge and concern about climate change amongst their participants, however, this largely did not translate into behavioural engagement. Dean et al. (2016) explored Australians' cognitive, affective and behavioural engagement with water-related issues and used these dimensions to create five community profiles of water-related citizenship. Of the five profiles one group was highly cognitively, affectively and behaviourally engaged and one was low on all three dimensions. The remaining three groups showed a disjunction between the three dimensions, for example, aware but not active, or active but low on knowledge and attitudes.

The tripartite model is also reflected in data that is collected by government and non-government agencies to track the awareness and engagement of communities with biodiversity. Many surveys assess public awareness of the concept of biodiversity including those conducted by the European Commission (2015), UK Department for Environmental, Food, and Rural Affairs (DEFRA 2011), and the Union for Ethical Biotrade (Union for Ethical Biotrade 2019). Recent data shows that awareness has increased, with 71% of Europeans reporting that they had heard of the term 'biodiversity' in 2018 compared to 60% in 2015 (European Commission 2019). Other research shows between 71% and 95% of respondents from selected Asian countries say they are familiar with the term and in some countries familiarity with the term has increased over time, for example, in Japan familiarity with the term has increased by 8% since 2010 (Union for Ethical Biotrade 2019). Perhaps not surprisingly, a smaller percentage of respondents say they actually know what the concept means (41% of Europeans and 16–56% of respondents from Asia). Data from an Australian survey showed that only around half of respondents knew what biodiversity meant (Kiley et al. 2019) although other data on Australians' views of nature showed that the overwhelming majority (95%) are aware of the importance of a healthy natural environment (Meis-Harris et al. 2019).

Surveys have also assessed concern about biodiversity through, for example, assessing concern for the decline and possible extinction of animals, plants and ecosystems. A total of 76% of Europeans thought this was a serious problem in their country (European Commission 2015) and 78% of British respondents were worried about loss of native animals and plants (DEFRA 2011). Other surveys show that 47% of American respondents said that stemming the loss of species was personally important to them (Novacek 2008), and an average of 89% of respondents across selected countries in Europe, Asia and the Americas agreed that humans have an obligation to protect nature (Union for Ethical Biotrade 2018).

Finally, some surveys have also assessed the extent to which community members have engaged in actions that could help to protect biodiversity. A majority (92%) of European respondents respected nature protection by not leaving waste in natural areas, 65% bought eco-friendly products, 49% looked for information and made lifestyle choices that reduce possible negative impacts on nature and biodiversity, and 11% participated in biodiversity projects (European Commission 2015). A similarly small percentage (13%) of respondents reported engaging in conservation volunteering in the United Kingdom (DEFRA 2011). Surveys of Asian respondents indicate that 70% report buying products from companies that respect biodiversity and people (Union for Ethical Biotrade 2019). In Australia, a majority (70%) of respondents who live on a rural property or have a garden report at least sometimes managing pest plants and animals and planting native plants (68%) (Meis-Harris et al. 2019).

Although these surveys provide some insights into the knowledge, attitudes and behaviour of people in relation to biodiversity, the research has described average responses to isolated questions. The questions have not been conceptualised or evaluated as dimensions of an indicator of community appreciation of biodiversity.

Some theoretical frameworks of environmental decision-making highlight a sequential relationship between knowledge, concern and behaviour. For example, the value-belief-norm model proposes that individuals' awareness of the consequences of an environmental issue (e.g. effects of biodiversity loss) and belief that they can take responsibility for action, will lead to a personal obligation to act that motivates actual behaviour (e.g. Stern 2000).

Meta-analyses of the environmental psychology literature have also demonstrated that awareness of the problem and positive attitudes are precursors to environmentally protective behaviours (Bamberg & Möser 2007; Klöckner 2013). However, there is also recognition that knowledge and attitudes do not always lead to behaviour (e.g. Nilsson et al. 2019). Features of the context may prevent attitudes from being translated into action (e.g. Kollmus & Agyeman 2002) and there is widespread acceptance that knowledge is a necessary but not sufficient condition for behaviour change (e.g. Kaiser & Fuhrer 2003). Hence, a linear relationship between knowledge, attitudes and behaviour is not inevitable. It is possible for community members to have awareness and understanding of biodiversity issues and feel a strong sense of concern about biodiversity, but take little or no action to protect biodiversity; and some may even engage in actions that degrade biodiversity. The survey results described above support this conclusion with most people highly concerned about biodiversity loss but few reporting undertaking meaningful actions to conserve biodiversity.

1.2 Assessing community appreciation of biodiversity

The key aim of the current study was to develop a conceptualisation of an indicator of community appreciation of biodiversity and to use data from a sample of Australians to establish a 'first assessment' of the indicator. To do this, we used a rigorous dataset from the 2015 'Who cares about the environment?' survey (OEH 2017) conducted in the State of New South Wales (NSW). The survey included questions related to biodiversity, although it is important to note that the questions were not originally developed to assess a community appreciation of biodiversity indicator.

In addition to describing levels of community appreciation of biodiversity along the three indicator dimensions (i.e. cognitive, affective, behavioural), the study addressed whether there are differences in appreciation dimensions across demographic and geographic areas. Some previous research has shown that biodiversity-related knowledge, attitudes and behaviour differ across countries and according to the education and gender of community members (e.g. European Commission 2015). As a part of this first assessment, the study identified community appreciation of biodiversity groups within the community, and profiled the groups using multi-variate analyses. This analysis provides a way to understand how

different parts of the community appreciate biodiversity and to track whether there are changes in those groups across time.

This study also has important implications for communication and engagement on biodiversity. Novacek (2008), for example, highlights the need to craft biodiversity messages to appeal to diverse audiences. Segmentation and profiling of a respondent community can provide important insights to inform communication and engagement efforts that more effectively involve different community members with biodiversity.

Connecting people with biodiversity is a central goal in biodiversity conservation strategies and so it is not surprising that government and non-government agencies seek to track community awareness, concern and action in relation to biodiversity. As noted above, previous surveys have taken a descriptive approach whereby average responses to individual questions are reported. A key contribution of this study is our conceptual development of a tripartite framework for what a community's appreciation of biodiversity might look like, at least from the perspective of its members; and we use existing data to test the conceptualisation. Further, our study draws on a rigorously conducted regional survey and connects its findings to previous international research focused on community engagement with biodiversity.

2. Method

2.1 Sample

Respondents to the 2015 ‘Who cares about the environment?’ survey are the sample for the study (DPIE 2021). Although the ‘Who cares about the environment?’ survey was conducted every three years from 1994 to 2015, only the 2015 survey included biodiversity-related questions. A computer-assisted telephone interview (CATI) was conducted with 2000 NSW residents aged 15 years and over. The survey took on average 25 minutes to complete. The survey was outsourced to a social research company that adopted a ‘Total Survey Error’ approach (Groves & Couper 2009) aiming to reduce error in design, collection, processing and analysis of survey data.

The research entailed a stratified random probability sample that ensured a minimum of 100 respondents across 14 geographic regions (based on NSW Department of Premier and Cabinet regional classifications at the time), with the remaining 600 respondents distributed across the State proportionate to population in the different regions. Because of the increasing number of households without a fixed landline telephone connection, a dual-frame sampling design was adopted that sampled 70% of the respondents from randomly generated landline telephone numbers, and 30% from randomly generated mobile phone numbers to approximate the proportion of mobile-only households in Australia at the time. The response rate was calculated using the American Association of Public Opinion Research calculation, that is, number of complete interviews divided by number of interviews plus number of non-interviews plus all cases of unknown eligibility (The American Association of Public Opinion Research 2016). The response rate for the 2015 survey was 14.7% overall (16.4% for landlines and 12.0% for mobile phones). The overall cooperation rate (i.e. the proportion of all people interviewed of all eligible people contacted) was 52.6% (59% for landlines and 42.2% for mobile phones).

2.2 Sample demographics

A full breakdown of the sample demographics can be found in Appendix A (note that the data are unweighted). Of the 2000 respondents, 1079 (54%) were female and 921 (46%) were male, with a mean age of 54.12 years (standard deviation, SD = 18.56 years) and an age range of 15 to 94 years. In terms of level of education, 41.7% had secondary education, 18.4% had a trade or technical qualification and 43.7% had higher education (i.e. diploma or degree). The majority (66.5%) of respondents had a household income of up to $150,000, and close to a majority were in paid employment (47.2%). Most respondents (55.8%) resided in the Sydney metropolitan area, most were born in Australia (74.7%) and only a small percentage spoke a language other than English in their homes (13%). Compared to 2011 Australian Bureau of Statistics Census data, there was a small over-representation of females (54% compared to 51% in the Census), an over-representation of people with university degrees and diplomas (43.7% compared to 30.9% in the Census) and an under-representation of people who speak a language other than English in the home (13% compared to 31.5% in the Census).

2.3 Survey and measures

The overall ‘Who cares about the environment?’ survey was developed through a rigorous process involving initial feedback from topic area and survey methodology experts (DPIE 2021). As noted above, the survey was first conducted in 1994 and continued till 2015. During this time there were eight waves of the survey covering issues of water and air quality, threatened species, climate change, energy, water, waste and litter, and in 2015,

biodiversity. The 2015 survey, like previous iterations, included a broad range of questions assessing respondents' views on environmental issues in New South Wales. Only a subsample of these questions w selected for application to the community appreciation of biodiversity indicator (see below), drawing from biodiversity and other sections of the original survey.

Cognitive testing of the survey was conducted with nine community members (from the neighbouring state of Victoria). This process involves respondents providing feedback on their understanding of question wording and response options as a way to develop clear and comprehensible questions that capture valid and reliable data. The survey was revised on the basis of the feedback and pilot tested with 30 respondents from the same population. The pilot testing identified that the survey was too long and so some questions were excluded to ensure the survey took no longer than 25 minutes. The subset of questions from the survey used in the current study are described below. Appendix B provides a detailed description of the questions used to measure cognitive, affective and behavioural appreciation as well as a discussion of the reasoning for excluding some of the questions from the survey. Because the questions were not created for the purpose of measuring the indicator, they are not comprehensive in their coverage of each indicator dimension. We discuss the limitations of the measures in more detail in the Discussion section of this report and recommend enhancements.

2.3.1 Cognitive appreciation of biodiversity – knowledge

Cognitive appreciation of biodiversity reflects the level of knowledge and awareness that people have about biodiversity and biodiversity-related issues. An awareness of and understanding of environmental problems is considered an important cognitive element in environmental psychology models (e.g. Bamberg & Möser 2007). In total, we identified five questions from the 2015 'Who cares about the environment?' survey that were suitable for assessing this dimension (see Appendix B, Table 7). One question (Are you familiar with the term biodiversity?) assessed self-reported understanding of what biodiversity is. Note that this question has been used in previous international community surveys to assess knowledge of biodiversity (e.g. European Commission 2019; Union for Ethical Biotrade 2019). Two questions assessed awareness of the state of local biodiversity, that is, whether plants and animals in New South Wales are in serious decline and at risk of becoming extinct.

Two further questions assessed understanding of the link between biodiversity and important outcomes, such as food/medicine production, ensuring clean air and water, and tackling climate change. Comprehending the interrelationships between social and environmental systems and the issues that can arise from the interrelationship is considered an important aspect of environmental knowledge (e.g. Pe'er et al. 2007). Respondents were judged to demonstrate cognitive appreciation (i.e. knowledge) if they had heard of biodiversity and reported that they knew what it meant, had an awareness of biodiversity loss in New South Wales, and understood the benefits of biodiversity to people.

2.3.2 Affective appreciation of biodiversity – attitudes

Affective appreciation of biodiversity indicates that respondents positively value biodiversity and what biodiversity can provide. With the focus on positively valuing biodiversity, this dimension reflects the attitudinal dimension of appreciation, as attitudes are defined as positive or negative evaluations of psychological objects (Ajzen 2001; Bohner & Dickel 2011). Within the environmental domain, environmental attitudes are usually conceptualised as the extent to which people care for and are concerned about the environment (Schultz 2001. Common measures of environmental attitudes assess the orientation of people's belief system as either ecocentric (i.e. see humans as just one part of nature) or anthropocentric

(i.e. believe that humans are separate from and superior to other parts of nature) (Milfont & Duckitt 2010). People with an ecocentric orientation prioritise preserving nature and natural systems, wanting them protected from human use.

Five questions were identified as suitable for assessing the affective (i.e. attitudinal) dimension (see Appendix B, Table 8). Three questions reflect respondents' valuing of nature and biodiversity protection. Respondents were considered to express affective appreciation when they: 1) agreed that nature and biodiversity should be protected for future generations, 2) agreed that nature and biodiversity should be protected regardless of whether they themselves visit natural places, and 3) judged that there was not enough emphasis on protecting natural habitats for biodiversity. Affective appreciation was also considered to be reflected by agreement that nature and biodiversity were important for personal recreation, relaxation and spiritual renewal. Although this fourth question reflects a valuation of nature and biodiversity for personal benefit, it nevertheless suggests a positive evaluation of nature and biodiversity. Finally, the fifth question reflected respondents' level of concern regarding the effect of environmental problems on nature (native plants, animals and ecosystems). Affective appreciation was indicated if respondents were concerned a great deal or a fair amount.

2.3.3 Behavioural appreciation of biodiversity – actions

A total of 12 questions were used to assess behavioural appreciation of biodiversity (i.e. conservation or environmental actions) (see Appendix B, Table 9). Only some of the behaviours or actions referred to in these questions can be thought of as directly helping to protect biodiversity. The other behaviours have an indirect influence on biodiversity conservation through reducing an individual's ecological footprint, or through promoting more collective environmental engagement. This aligns with *Australia's Strategy for Nature 2019–2030* (Commonwealth of Australia 2019) which highlights the importance of measuring collective efforts to demonstrate progress in protecting biodiversity through everyday decisions.

Drawing on a recent typology of pro-environmental behaviours (Larson et al. 2015) some of the 12 actions mapped onto *conservation lifestyle behaviours* included bringing one's own bags for shopping, choosing environmentally friendly household products, and picking up litter from public spaces. These are relatively easy behaviours with a relatively high level of opportunity and frequency. Other actions mapped onto *land stewardship behaviours* including taking part in tree planting or restoration projects and rescuing wildlife. Another set of behaviours mapped onto *social environmentalism* including encouraging others to change behaviours that could harm the environment, collecting information on natural environments for scientific projects, getting information about an environmental issue/topic, and voluntary activities that benefit the environment. This type of pro-environmental behaviour involves promoting the value of conservation and pro-environmental actions via social interaction or communication. Signing petitions and participating in local development issues aimed at protecting the environment mapped onto *environmental citizenship*. Visiting national parks does not map onto any of these types of pro-environmental behaviour but is included because it represents and potentially generates behavioural appreciation through spending time in nature (Rosa & Collado 2019). Appendix B (Table 9) shows the response options for each of the questions and which options were chosen as reflecting behavioural appreciation.

2.3.4 Profiling appreciation

One of the aims of this study was to conduct a segmentation of the sample to identify groups who vary in their appreciation of biodiversity and then to create a profile of each of those groups. A number of variables from the survey (additional to those above) were used to segment and profile groups. The full list and coding of the profiling variables can be found in

Appendix C. Note that income was not included in the analysis because of the high level of missing data on the measure.

Demographic and social variables included:

- age
- gender
- whether university educated
- whether born in Australia
- whether a language other than English is spoken at home
- whether employed
- living in Sydney metropolitan area versus the rest of New South Wales
- living in a bioregion where greater than 10% of the area is in protected areas (i.e. public reserves established in perpetuity under the *National Parks and Wildlife Act 1974* at 2012) compared to a region with less than 10% in protected areas
- perception and satisfaction with the condition of NSW natural environment
- concern about extreme weather events
- perceptions that environmental regulation is too strict
- perceived importance of national parks
- ways respondents use national parks including for bushwalks/picnics, climbing, camping and overnight stays, bike/horse riding, and water-related activities.

3. Data analysis

Cognitive, affective and behavioural appreciation dimensions were computed by summing responses to each of the questions. Thus, for the cognitive and affective appreciation dimensions which were assessed using five questions each, scores could range from 0 to 5. For the behavioural appreciation dimension which was assessed against 12 questions, scores could range from 0 to 12. The scores were then converted to percentages of the respective dimensions' total maximum scores.

Socio-demographic and spatial comparisons across the dimensions were conducted using t-tests (gender, spatial comparisons) or one-way analysis of variance (ANOVA) (age groups, education levels). Where a significant *F*-value emerges for the ANOVA, Bonferonni corrected multiple comparisons were conducted to investigate which group means (e.g. which age groups) differ from each other. To assess the size of the effect of the demographic and spatial variables, effect sizes were reported. For consistency, we use Cohen's *d* across all analyses with the following rule of thumb for values: 0.2 is small, 0.5 is medium and 0.8 is large.

Ideally, spatial comparisons across Interim Biogeographic Regionalisation of Australia, or IBRA, bioregions (Thackway & Cresswell 1995; Department of the Environment 2012) in New South Wales would have been conducted consistent with the objective of the BC Act and other indicator assessments (OEH & CSIRO 2019).

> 'Bioregions are relatively large land areas characterised by broad, landscape-scale natural features and environmental processes that influence the functions of entire ecosystems.' (www.environment.nsw.gov.au/bioregions/BioregionsExplained.htm)

However, the number of respondents in some NSW bioregions was too low (i.e. 0 in some bioregions and less than 30 in 12 of the remaining 15 bioregions). To have spatial groups of a sufficient and comparable size, we compared respondents who lived in the Sydney metropolitan area (the State capital and the most populous city in Australia) versus those living in the rest of New South Wales. We also compared respondents residing in bioregions with greater than 10% of the land in protected areas to those living in regions with less than 10% of land in protected areas. Appendix C outlines the coding process to assign respondents to the two groups.

Hierarchical agglomerative cluster analysis was used to identify biodiversity appreciation clusters using Ward's method and squared Euclidean distance. In contrast to other analysis approaches where clusters are identified *a priori*, this approach allows clusters to emerge from the data, and is preferable when limited data is available to pre-identify groups. Clustering was conducted on all cases using the following variables:

- cognitive appreciation
- affective appreciation
- behavioural appreciation.

To conduct a cluster analysis using three variables, recommendations indicate that the sample must exceed 40 cases, indicating that our sample N = 2000 is adequate for analysis (Dolnicar 2002). All variables were standardised using *z* scores. Potential clustering solutions were identified by a series of processes. First, the dendrogram, which graphically displays splitting of clusters, showed potential solutions of three, six, eight or ten clusters. Second, the agglomeration coefficient quantifies the benefit of considering additional cluster numbers, where a large change in coefficient indicates a large benefit of adding a cluster. Third, the standardised means of the clustering variables for each potential solution were examined: the six-cluster solution generated the most meaningful distinctions between groups, optimising both parsimony and richness. Based on this, the six-cluster solution was selected as most suitable for further analyses.

Analyses were then conducted to create a profile of each of the six cluster groups based on demographic variables and responses to other survey questions (e.g. age, gender, national park usage, satisfaction with the environment, etc.). For categorical variables (i.e. coded as 0 or 1), chi-square analyses were used to test for differences in the variable across the clusters. For scaled variables (e.g. where response options were on Likert-type scales), an ANOVA was used to compare differences in the variable across the clusters.

4. Results

4.1 Average levels of cognitive, affective and behavioural appreciation

The mean scores (M) and standard deviation (SD) for each of the appreciation dimensions were as follows:

- cognitive appreciation M = 3.39, SD = 1.25 (maximum score possible = 5)
- affective appreciation M = 3.83, SD = 1.06 (maximum score possible = 5)
- behavioural appreciation M = 4.74, SD = 2.60 (maximum score possible = 12)

As Figure 2 shows, this equates to an average score of 68% for knowledge of biodiversity, and 77% for positively valuing biodiversity. On average, respondents engaged in 40% of the behaviours that could help to protect biodiversity.

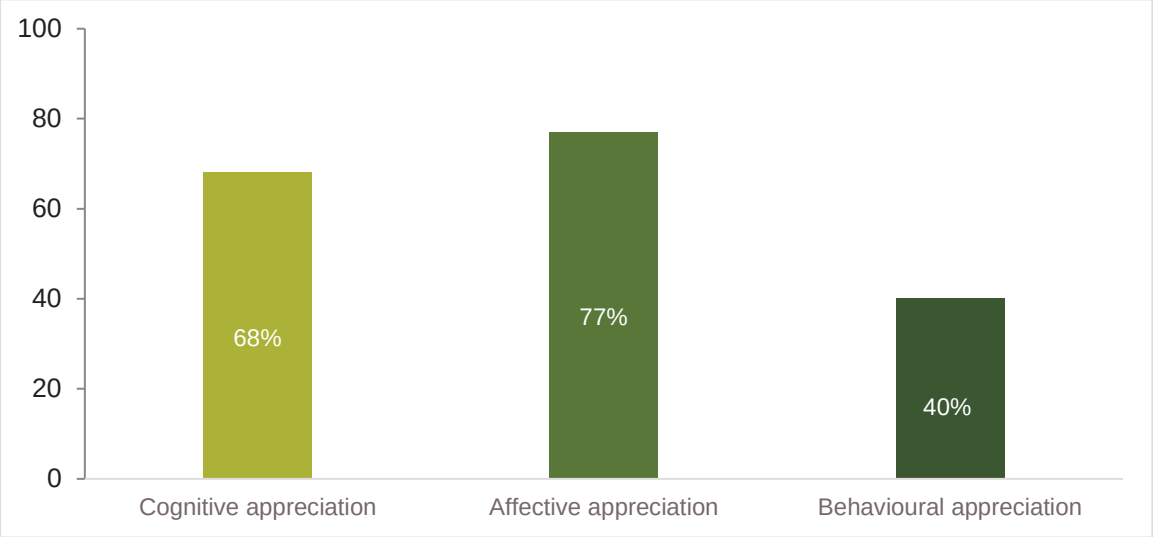


Figure 2 **Average percentages for cognitive appreciation (knowledge), affective appreciation (attitudes) and behavioural appreciation (actions).**

4.2 Bioregional and demographic comparisons of community appreciation of biodiversity

4.2.1 Gender comparisons

Means and standard deviations for the gender comparisons can be found in Table 1. Males and females were compared on their level of cognitive, affective and behavioural appreciation of biodiversity. No statistically significant differences emerged between males and females in terms of their knowledge of biodiversity, $t(1998) = -0.62$, $p = 0.154$, $d = 0.03$, or the extent to which they positively valued biodiversity, $t(1998) = 1.58$, $p = 0.114$, $d = 0.03$. A small but statistically significant difference emerged on behavioural appreciation, $t(1998) = -2.00$, $p = 0.046$, $d = 0.09$, with males reporting more positive behaviours towards biodiversity than females. Considering that a Cohen's d of 0.2 is a small effect, the effect of gender on behavioural appreciation ($d = 0.09$) is very small. Given the very small size of this effect and the fact that there were no gender differences on the other appreciation dimensions, this finding should be treated with caution.

Table 1 Comparison of males and females on community appreciation of biodiversity dimensions

Appreciation dimension	Males (n = 921) M% (SD)	Females (n = 1079) M% (SD)
Cognitive appreciation	68.17 (25.44)	67.47 (24.61)
Affective appreciation	75.81 (21.02)	77.31 (21.39)
Behavioural appreciation	40.53 (21.25)	38.59 * (22.01)

* Denotes a significant difference between the means. n = sample size; M = mean; SD = standard deviation.

4.2.2 Age comparisons

Means and standard deviations for the age comparisons can be found in Table 2. Dimensions of community appreciation of biodiversity were compared across four age groups: 15–29 years old, 30–44, 45–59, and 60+. Statistically significant differences between the age groups emerged on all dimensions:

- cognitive appreciation: $F(3,1953) = 7.83$, $p < 0.001$, $d = 0.20$
- affective appreciation: $F(3,1953) = 6.33$, $p < 0.001$, $d = 0.20$
- behavioural appreciation: $F(3,1953) = 10.38$, $p < 0.001$, $d = 0.29$.

Considering that a Cohen's *d* of 0.20 is a small effect, the effect of age on appreciation is small.

The 45–59 year age group had the highest level of knowledge of biodiversity (M = 71.93%) followed by the 30–44 year age group (M = 67.84%), the 15–29 year age group (M = 66.92%), with the 60+ age group (M = 65.39%) the lowest. Post hoc analyses revealed that the 45–59 year age group had significantly higher levels of knowledge than the 15–29 year olds and the 60+ year olds, with no other significant differences emerging between age groups.

For affective appreciation, again, the 45–59 year age group (M = 79.56%) were highest followed by the 15–29 year age group (M = 76.92%), the 30–44 year age group (M = 76.49%) with the 60+ age group (M = 74.54%) showing the lowest affective appreciation. Post hoc analyses revealed that the 45–59 year age group positively valued biodiversity more than the 60+ age group.

Finally, for behavioural appreciation, the 45–59 age group (M = 42.55%) had highest behavioural appreciation followed by the 30–44 age group (M = 41.16%), the 15–29 age group (M = 40.42%), with the 60+ age group (M = 36.38%) showing lowest levels of behaviour. The three younger age groups did not significantly differ from each other, but they were all significantly different from the 60+ age group.

Table 2 Comparison of age groups on community appreciation of biodiversity dimensions

Appreciation dimension	15–29 (n = 260) M% (SD)	30–44 (n = 296) M% (SD)	45–59 (n = 548) M% (SD)	60+ (n = 853) M% (SD)
Cognitive appreciation	66.92_{a} (24.12)	67.84_{ab} (24.16)	71.93_{b} (23.88)	65.39_{a} (25.91)
Affective appreciation	76.92_{ab} (21.52)	76.49_{ab} (21.05)	79.56_{ac} (20.09)	74.54_{b} (21.64)
Behavioural appreciation	40.42_{a} (21.62)	41.16_{a} (20.26)	42.55_{a} (21.74)	36.38_{b} (21.65)

Notes: Means with different subscripts are significantly different from each other. n = sample size; M = mean; SD = standard deviation.

4.2.3 Education comparisons

Means and standard deviations for the education comparisons can be found in Table 3. Dimensions of community appreciation of biodiversity were compared across three education levels: secondary school, trade/technical qualification, and higher education (diploma, degree). Statistically significant differences between education levels emerged on all three dimensions:

- cognitive appreciation: $F(2,1961) = 83.33$, $p < 0.001$, $d = 0.59$
- affective appreciation: $F(2,1961) = 18.22$, $p < 0.001$, $d = 0.29$
- behavioural appreciation: $F(2,1961) = 53.99$, $p < 0.001$, $d = 0.29$.

Considering conventions for eta-squared effect sizes, the effects of education on appreciation dimensions was small to medium.

The pattern for all three dimensions of biodiversity appreciation was the same: those with higher education had the highest level of knowledge (M = 75.49%), the greatest positive valuation of biodiversity (M = 79.86%) and engaged in the most environmental behaviours (M = 45.00%). Those with a trade/technical qualification had the second highest knowledge (M = 67.26%), positive valuation (M = 76.83%) and environmental behaviour (M = 39.22%). Respondents with secondary school education had the lowest knowledge (M = 60.55%), positive valuation (M = 73.75%) and environmental behaviour (M = 34.38%). In terms of statistically significant differences between the groups, all three education levels differed significantly from each other on knowledge and on behaviour. On positively valuing biodiversity, those with higher education differed significantly from those with secondary education.

Table 3 Comparison of groups with differing levels of education on community appreciation of biodiversity dimensions

Appreciation dimension	Secondary school (n = 832) M% (SD)	Trade/Technical qualification (n = 259) M% (SD)	Higher education (diploma/degree) (n = 873) M% (SD)
Cognitive appreciation	60.55_a (24.69)	67.26_b (23.56)	75.49_c (23.23)
Affective appreciation	73.75_a (21.97)	76.83_{ab} (21.08)	79.86_b (19.77)
Behavioural appreciation	34.38_a (21.17)	39.22_b (21.19)	45.00_c (21.68)

Notes: Means with different subscripts are significantly different from each other. n = sample size; M = mean; SD = standard deviation.

4.2.4 Spatial comparisons

Means and standard deviations for the spatial comparisons can be found in Tables 4 and 5. The first spatial analysis compared respondents who lived in the Sydney metropolitan area with those who lived in other areas of New South Wales. There was no significant difference between the two regions on cognitive appreciation, $t(1998) = -0.77$, $p = 0.443$, $d = 0.03$, or affective appreciation, $t(1998) = 1.57$, $p = 0.112$, $d = 0.07$. But there was a significant difference on behavioural appreciation, $t(1998) = -3.83$, $p < 0.001$, $d = 0.17$, such that those living in Sydney engaged in fewer environmental behaviours (M = 37.83%) than those living in the rest of New South Wales (M = 41.55%). This represents a small effect of region on behavioural appreciation.

The second spatial analysis compared respondents who lived in regions that have greater than 10% of land in protected areas compared to regions with less than 10%. There was a significant difference between the two regions on cognitive appreciation, $t(1998) = -2.33$, p

=0.020, *d* = 0.16, and affective appreciation, *t*(1998) = –.2.79, *p* = 0.006, *d* = 0.21, but not on behavioural appreciation, *t*(1998) = –0.12, *p* = 0.904, *d* = 0.01. Respondents living in regions with proportionally more protected areas had higher awareness of biodiversity and positively valued biodiversity more than respondents living in regions with less land in protected areas. This represents a small effect of region on cognitive and affective appreciation.

Table 4 Comparison of respondents living in Sydney vs the rest of New South Wales on community appreciation of biodiversity dimensions

Appreciation dimension	Sydney (n = 1115) M% (SD)	Rest of NSW (n = 885) M% (SD)
Cognitive appreciation	67.41 (24.95)	68.27 (25.05)
Affective appreciation	77.29 (20.33)	75.77 (22.30)
Behavioural appreciation	37.83 (21.08)	41.55 * (22.25)

Notes: * Denotes a significant difference between the means. n = sample size; M = mean; SD = standard deviation.

Table 5 Comparison of respondents living in a region with less than 10% area in protected areas vs regions with >10% in protected areas

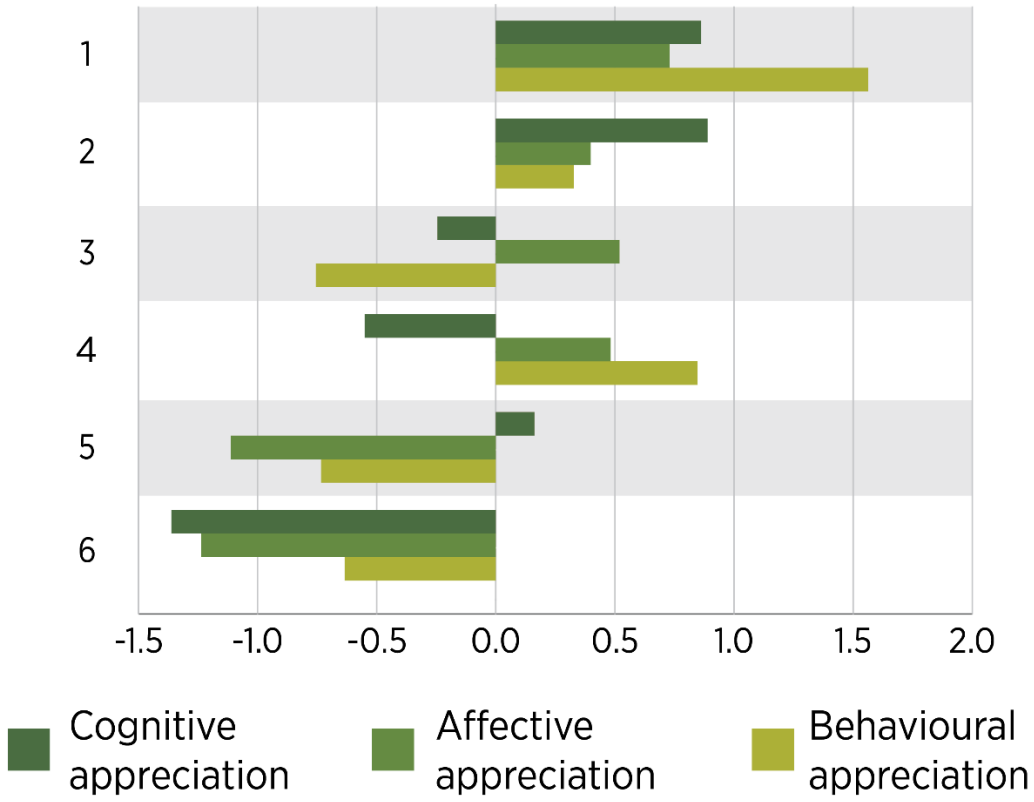
Appreciation dimension	Region with <10% protected (n = 217) M% (SD)	Region with >10% protected (n = 1783) M% (SD)
Cognitive appreciation	64.06 (26.43)	68.24 * (24.78)
Affective appreciation	72.35 (24.24)	77.14 * (20.78)
Behavioural appreciation	39.32 (19.72)	39.50 (21.91)

Notes: * Denotes a significant difference between the means. n = sample size; M = mean; SD = standard deviation.

4.3 Identifying and profiling community appreciation of biodiversity groups

Figure 3 shows the outcome of the cluster analysis. The first cluster represents a high appreciation group of respondents who have high awareness of biodiversity, positively value biodiversity and engage in actions that could protect biodiversity. This group accounts for 14% of the sample. The second cluster represents a moderate appreciation group of respondents who show modest awareness, valuing and behaviour in relation to biodiversity. This group accounts for 24% of the sample. The third cluster represents a group who positively value biodiversity but do not show high awareness or high behavioural appreciation. This group accounts for 23% of the sample. The fourth group represents a group of respondents who positively value biodiversity and are engaging in behaviours that could protect biodiversity, but they have low awareness of biodiversity. This group accounts for 9% of the sample. The fifth cluster represents a group of respondents who have some awareness of biodiversity but do not positively value it or engage in behaviours that could help to protect biodiversity. This group accounts for 12% of the sample. Finally, the sixth cluster represents a group who have low awareness, do not positively value biodiversity and do not engage in behaviours that could protect biodiversity. This group accounts for 18.3% of the sample.

Tables showing the percentage or mean value for each of the cluster groups on each of the profiling variables as well as the outcomes of the chi-square or ANOVA can be found in Appendix 4.



Group 1: Highly appreciative	(n = 281; 14%)
Group 2: Modestly appreciative	(n = 480; 24%)
Group 3: Concerned only	(n = 453; 23%)
Group 4: Unaware but active	(n = 181; 9%)
Group 5: Aware but unconcerned	(n = 240; 12%)
Group 6: Unappreciative	(n = 365; 18%)

Figure 3 **Cluster analysis of community appreciation of biodiversity dimension variables into groups. Note: Variables are standardised to highlight variation; all standard errors are < 0.05.**

The following profiles of each of the cluster groups emerge based on the chi-square and ANOVA analyses[1].

Group 1 – Highly appreciative:

- more likely to have university education
- less likely to live in Sydney
- more likely to perceive that NSW natural environment is in poorer condition and less satisfied with NSW environment
- more likely to think that national parks are important
- more concerned about extreme weather events
- less likely to think that environmental regulations are too strict
- more than twice as likely to use national parks for camping / overnight stays.

Group 2 – Modestly appreciative:

- more likely to have tertiary education
- less likely to speak a language other than English at home
- more likely to rate national parks as important
- more concerned about extreme weather events[2].

Group 3 – Concerned only:

- less likely to have tertiary education
- more likely to speak a language other than English at home
- less likely to use national parks for climbing or water activities (fishing, canoeing swimming).

Group 4 – Unaware but active:

- more likely to think environmental regulations are too strict
- more likely to use national parks for walks/picnics and for climbing.

Group 5 – Aware but unconcerned:

- younger
- more likely to be satisfied with condition of NSW environment
- less likely to be concerned about extreme weather events.

Group 6 – Unappreciative:

- less likely to have tertiary education
- more likely to live in Sydney and less likely to live in a bioregion with higher proportion of protected areas
- more likely to be satisfied with NSW environment
- less likely to rate national parks as important
- less likely to be concerned about extreme weather events
- less likely to use national parks for camping / overnight stays.

A graphic of the community appreciation of biodiversity profiles can be found in Figure 4.

---

[1] As noted in Section 3, for the variables that are categorical the analyses involved chi-square analysis, whereas those measured on Likert-type scales involved analysis of variance (ANOVA).

[2] Note that this analysis was marginally significant ($p = 0.051$) and therefore did not quite reach conventional levels of significance.

Appreciation of biodiversity

Group	Profile
Group 1 	**High appreciation of all three appreciation dimensions** • more highly educated • less likely to live in Sydney • dissatisfied with the condition of NSW natural environment • think national parks are important • concerned about extreme weather • less likely to think environmental regulation is too strict • more likely to use national parks for camping / overnight stays
Group 2 	**Modest appreciation of all three appreciation dimensions** • more likely to have university education • less likely to speak a language other than English at home • more likely to rate national parks as important • more concerned about extreme weather events
Group 3 	**Positively values biodiversity but lacks awareness and is not engaged in environmental behaviours** • less likely to have university education • more likely to speak a language other than English at home • less likely to use national parks for climbing or water activities (fishing, canoeing, swimming)
Group 4 	**Positively values biodiversity and engages in environmental behaviours despite low awareness** • more likely to think environmental regulations are too strict • more likely to use national parks for walks/picnics and for climbing
Group 5 	**Some awareness of biodiversity that is not associated with positively valuing or acting to protect biodiversity** • younger • more likely to be satisfied with the condition of NSW natural environment • less likely to be concerned about extreme weather events
Group 6 	**Low appreciation of all three appreciation dimensions** • less likely to have university education • more likely to live in Sydney and less likely to live in a bioregion with higher proportion of protected areas • more likely to be satisfied with the condition of NSW natural environment • less likely to rate national parks as important • less likely to be concerned about extreme weather events • less likely to use national parks for camping / overnight stays

Figure 4 **Community appreciation of biodiversity groups and their demographic and psychographic profiles.**

5. Discussion and conclusions

Our aim was to conceptualise an indicator of community appreciation of biodiversity and to use data from a sample of Australians to undertake the first assessment of the indicator. Specifically, we drew on the data from the 2015 New South Wales 'Who cares about the environment?' survey (OEH 2017). Consistent with previous research, we conceptualised community appreciation of biodiversity as comprised of three dimensions: cognitive, affective and behavioural appreciation (Dean et al. 2016; Lorenzoni et al. 2007). Respectively, these dimensions assess the extent to which community members have an awareness of biodiversity and the benefits it delivers, positively value or care about biodiversity, and engage in activities that could directly or indirectly protect biodiversity.

Overall, we found that respondents had a relatively high level of basic awareness of biodiversity with an average score of 68% on this scale. It was also clear that respondents positively valued biodiversity with an average score of 77% on the affective appreciation scale. On the other hand, respondents only engaged in an average of 40% of the 12 environmental behaviours that could help to protect biodiversity directly or indirectly. These findings are consistent with previous surveys that have shown a relatively high level of familiarity with the term 'biodiversity', but varying levels of engagement in environmental actions, with low levels of engagement in groups or projects specifically aimed at protecting biodiversity (e.g. DEFRA 2011; European Commission 2015, 2019; Union for Ethical Biotrade 2018, 2019).

Although some demographic and spatial differences emerged on the indicator dimensions, the differences were small, and the pattern of relatively high awareness, high positive valuation, and low engagement in behaviour was consistent across all demographic or spatial groups[3]. An unexpected finding was that males showed slightly but significantly higher behavioural appreciation than females whereas most research shows the opposite pattern (e.g. Hunter et al. 2004). If this finding can be confirmed, one potential explanation may relate to the context of environmental behaviours measured. In particular, gender differences are usually more evident for environmental behaviours enacted in the home (i.e. conservation lifestyle behaviours) whereas most of the behaviours in the current study were stewardship/social/citizenship behaviours where gender differences are less likely to emerge (Hunter et al. 2004).

Demographic comparisons showing that the 45–59 year age group (in 2015) had higher appreciation of biodiversity across all dimensions contrasted somewhat with other studies that have shown that younger generations have higher awareness of biodiversity (Union for Ethical Biotrade 2018). Respondents living in regions where more land was in formally protected areas also had higher awareness and positively valued biodiversity, whereas those living in the Sydney metropolitan area engaged in fewer activities that could directly or indirectly help to protect biodiversity, perhaps because of fewer opportunities. Consistent with our results, previous research has also shown that those with higher education have greater awareness of biodiversity (European Commission 2015).

As a way of identifying the diversity of appreciation within the community we conducted a cluster analysis to identify community biodiversity appreciation groups and associated profiles. Six groups emerged from the analysis, two of which were defined by high or modest appreciation and one by low appreciation across all dimensions. The other three demonstrated a disjunction between the different appreciation dimensions: positively valuing biodiversity but not having awareness or engaging in environmental behaviours, positively valuing biodiversity and engaging in environmental behaviours despite low awareness, and

[3] As described in Section 3 Data analysis and Section 4 Results, these were univariate comparisons that did not control for other variables.

having some awareness of biodiversity that is not associated with positively valuing or engaging in environmental behaviours.

The variables that distinguish between these groups tell us something about how we might better engage the different groups. Level of education is one variable that distinguishes many of the groups, highlighting the need to promote biodiversity-related issues to people who do not undertake tertiary education. Level of concern about environmental and climate issues more broadly also distinguished some of the groups. This finding suggests the need to raise awareness of environmental and climate issues more broadly and how they intersect with biodiversity.

It was clear that views on and use of national parks also played a role in distinguishing between groups. Those who were appreciative were more likely to use national parks for camping and overnight stays (highly appreciative group) and were more likely to see national parks as important (modestly appreciative group). On the other hand, the low appreciators were less likely to see national parks as important and to use them for camping or overnight stays. The way in which respondents reported using national parks also distinguished other groups that showed some level of appreciation. The nature connection literature is relevant in interpreting these findings which shows that spending more time in nature is associated with greater connection to nature and nature connection in turn is related to more pro-environmental behaviours (for reviews see Ives et al. 2018; Klanlecki et al. 2018; Whitburn et al. 2019). It is possible that longer stays in national parks, especially during childhood, help people to develop a greater connection to nature which is reflected in their greater appreciation of biodiversity (e.g. Rosa & Collado 2019).

The finding that the region in which people live distinguished the high from the low appreciators might also align with this argument. That is, high appreciators were less likely to live in Sydney, a highly urbanised setting where people have less chance to interact with nature; whereas low appreciators were more likely to live in Sydney or a region that had a smaller proportion in protected areas (c.f. Pyle 2003). We need to be cautious, though, in the conclusions we can draw from our data as there is currently limited evidence for simple causal pathways between nature use and appreciation (although see Evans et al. 2018). For example, individuals in Group 4, unaware but active, reported higher rates of use of national parks for walks, picnics and climbing, but had limited cognitive appreciation of biodiversity.

Overall, the findings align with programs and approaches that allow people to spend more time in nature as a way to develop greater connection to nature which could in turn be translated into pro-environmental action (e.g. IUCN's #NatureForAll program, The Wildlife Trusts' '30 Days Wild' campaign). The findings from this study suggest that enabling greater engagement with national parks might be one avenue to achieve this. Finally, the finding that one of the groups who showed affective, but not cognitive or behavioural appreciation, was characterised by being less likely to speak English at home highlights the importance of considering culture and language in programs aiming to increase appreciation of biodiversity.

From an applied perspective, the community appreciation of biodiversity indicator provides a simple tool for visualising and tracking community appreciation over time. The conceptualisation of appreciation as comprising three dimensions allows for a more nuanced understanding of how people relate to biodiversity. It recognises that while some people have reached a point where they know and care about biodiversity and are taking individual environmental actions, others are still on that journey. The tripartite conceptualisation also provides a way to understand the diversity within the community and a way to understand what programs might be most effective and who they should target.

5.1 Limitations

Although the use of data obtained through a random probability sampling procedure and from a rigorously designed survey is a strength of the research, we acknowledge a number of key limitations. One is that the categorical nature of the questions assessing each indicator dimension (i.e. coded 1 or 0) meant we were not able to empirically test the dimensional structure of the indicator. Another important limitation is that we relied on a pre-existing survey which was not designed specifically for the indicator purpose and hence constrained our ability to comprehensively measure each dimension. For example, in relation to the cognitive dimension of biodiversity there were only two questions relating to knowledge of the benefits of biodiversity for humans. Future research could expand this measure so that it adequately assesses knowledge of the range of benefits of biodiversity and could potentially measure deeper knowledge of this concept. In relation to affective appreciation, the items assessed positive valuation of biodiversity at a relatively superficial level asking participants whether they agree or disagree, for example, with the need to protect nature and biodiversity for future generations. These are easy statements to agree with in the abstract sense. Finally, there was a relatively large set of questions used to measure the behavioural appreciation dimension, although not many could be considered to directly influence biodiversity conservation outcomes. It can be difficult to pinpoint behaviours that have a specific and direct effect on biodiversity (Selinske et al. 2018), although coming up with a more context-specific list could increase the sensitivity of the behavioural appreciation dimension. Another issue with the behavioural component is that respondents self-reported their behaviour which means that responses may not accurately reflect what people actually do. A meta-analysis (i.e. statistical research synthesis) quantifying the association between self-reported and objective measures of pro-environmental behaviour showed a strong association, but also that a lot of the variation in objective behaviour was not explained by the self-reported measures (Kormos & Gifford (2014). Suggestions for improving the accuracy of self-reported behaviour questions are discussed further below.

More broadly, the reliance on a survey to assess the indicator means that limitations of survey research apply. No matter how rigorously the questions are designed, there is always the possibility that responses are influenced to some extent by social desirability, that is, the desire to project a positive image of the self that conforms to prevailing societal norms. This type of bias is more pronounced in telephone surveys and less so with online surveys (Kreuter et al. 2008). The fact that the biodiversity questions were embedded in a survey about environmental views more broadly may also accentuate the social desirability bias. Researchers have recently been turning to digital data as an alternative way to track community engagement with biodiversity. Cooper et al. (2019) used keyword searches of online newspapers, and Twitter and Google searches to form an indicator of the extent to which the public is engaged with biodiversity-related topics. They showed that there were substantial differences in the keyword usage across countries, languages and platforms, and significant regional and thematic variability in the indicator overall. Other research has drawn on digital searches of news articles to examine what biodiversity-related topics are most commonly covered in the news and to compare biodiversity media interest across countries (Chevallier et al. 2019). These studies showed that conservation policies, biodiversity loss, environmental education and citizen participation made up the majority of the focus in the media articles and that media coverage was increasing in some countries (e.g. Brazil) but decreasing in others (e.g. Australia). Similar to survey research, these methods have their limitations but there may be merit in thinking about how survey data could be integrated with digital data to overcome the inherent limitations of any one methodology or different lines of evidence. Another important supplement to survey data would be the use of qualitative data (e.g. interviews, focus groups) to develop a deeper understanding of participants' survey responses.

5.2 Future directions

We noted above that a key limitation of the current research is that the survey questions used to assess the indicator dimensions were not created for the purpose. We propose a further development of the indicator measures that retains the current questions, for comparison and continuity, and incorporates additional questions allowing the indicator to be more comprehensively assessed (Fielding et al. 2020). In relation to the cognitive dimension, Kaiser and Fuhrer (2003) argue that the influence of knowledge on people's environmentally related behaviour is likely underestimated because past research has not comprehensively measured different types of knowledge. They outline four different types of ecological knowledge including:

1. declarative knowledge (i.e. factual knowledge about the ecological issue such as biodiversity)
2. procedural knowledge (i.e. how to achieve a specific conservation goal such as protecting biodiversity)
3. effectiveness knowledge (i.e. knowledge about the relative effectiveness of an ecological action)
4. social knowledge (i.e. the motivations and intentions of others in relation to the issue).

Developing questions that assess all of these types of knowledge would provide a more comprehensive measure of cognitive appreciation of biodiversity and offer valuable insights for education and engagement initiatives.

In relation to measuring the affective dimension, questions that ask people to prioritise biodiversity relative to other issues or ask what type of trade-offs people are willing to make to protect biodiversity may give a deeper and less abstract sense of how much people positively value biodiversity. Existing valid and reliable measures of connection to nature might also be appropriately used as measures of the affective element of biodiversity appreciation, for example, the nature relatedness scale (Nisbet & Zelenski 2013) or the connectedness to nature scale (Mayer & Frantz 2004).

Developing behavioural questions that align more closely with biodiversity outcomes will also be important for future indicator measurements/assessments. In terms of increasing the accuracy of self-reported questions and reducing the influence of social desirability bias, Kormos and Gifford (2014) make the following recommendations from previous research:

1. Consider open-response formats (e.g. how many minutes a day do you spend in nature).
2. Avoid using vague response scale labels (e.g. sometimes, often) to assess frequency.
3. Use scales where all scale points are labelled in meaningful ways that divide the scale into equal units.
4. Collect data via self-administered questionnaires to reduce socially desirable responding.

It could also be worth exploring with a more rigorous measure of behavioural appreciation whether a single score best reflects appreciation or whether behavioural appreciation might be multi-dimensional reflecting the different types of behaviour that make up the dimension. For example, it may be that community members engage more in lifestyle conservation behaviours (e.g. using environmentally friendly household products) than stewardship or citizenship behaviours.

More broadly, future research should also consider expanding the variables that are used to profile the appreciation groups. For example, research has shown a link between political ideology and environmental attitudes and behaviour (e.g. Hornsey et al. 2016) and this variable might therefore be important for distinguishing between different appreciation groups in the community. Finally, establishing the validity of the measures is recommended through survey research that can establish concurrent (i.e. whether it agrees with similar measures) and predictive validity (i.e. whether it predicts future behaviour) of the indicator measure.

5.3 Conclusions

Increasing community awareness and engagement with biodiversity is a central goal of biodiversity strategies seeking to address the underlying causes of biodiversity loss. Therefore, developing an indicator of the extent to which community members appreciate biodiversity (cognitively, affectively and behaviourally) is an important step in being able to track efforts and make policy adjustments to meet biodiversity strategy goals. Our key contribution to current research is a conceptualisation of what it means to appreciate biodiversity, using a tripartite methodological approach.

This assessment shows differing levels of appreciation depending on the indicator dimension and demonstrates diversity within the community in terms of their appreciation ‘profiles’. This conceptualisation and measurement of appreciation of biodiversity allows practitioners and policy makers to track the effects of their policies and programs across time and the profiles of appreciation groups can provide insights to guide policies and programs. Future research should seek to further develop the measurement of the indicator so that it more comprehensively assesses each dimension of community members’ appreciation of biodiversity.

6. Data products

The data used (where licences allow) and derived as a product of this analysis will be publicly available through the CSIRO Data Access Portal (data.csiro.au). The following data package will be available for download:

> Fielding K, Prober S, Williams KJ, Dean A 2020, *Assessment of an indicator of community appreciation of biodiversity*, data packages for the Biodiversity Indicator Program: First assessment, *SEED Portal*, datasets.seed.nsw.gov.au/dataset/biodiversity-indicator-program-data-packages.

The data package forms part of a collection hosted on the Sharing and Enabling Environmental Data (SEED) Portal (seed.nsw.gov.au). The collection includes links to all available data packages for the first assessment of the Biodiversity Indicator Program:

> Department of Planning, Industry and Environment 2020, Data packages for the Biodiversity Indicator Program: First assessment, *SEED Portal*, Sydney, Australia, datasets.seed.nsw.gov.au/dataset/biodiversity-indicator-program-data-packages.

Appendices

Appendix A. Key demographics of the survey sample

Table 6 Key demographics of the survey sample

Demographic variables	Responses	n	n%
Gender	Male	921	46.1
	Female	1,079	54.0
Age	15–29 years old	260	13.0
	30–44 years old	296	14.8
	45–59 years old	548	27.4
	60+ years old	853	42.7
Education	Some secondary	465	23.3
	Completed secondary	367	18.4
	Trade/technical qualification	259	13.0
	Diploma/degree	873	43.7
Household income	<$30,000 (AUD)	434	21.7
	$30,000 to less than $50,000	214	10.7
	$50,000 to less than $150,000	681	34.1
	>$150,000	263	13.2
Using LOTE at home	Yes	270	13.0
Region	Sydney metropolitan region	1,115	55.8
	Rest of New South Wales	885	44.3
Employment status	Paid work	943	47.2
	Retired	769	38.5
	Student	124	6.2
	Other	164	8.2
Country of birth	Australia	1,494	74.7
	Other	506	25.3

Note. Numbers do not add to 2000 because of missing data on some variables. LOTE: Language other than English.

Appendix B. Questions used to assess the three community appreciation of biodiversity dimensions, and logic for excluding some survey questions

Table 7 Questions assessing the *cognitive* appreciation of biodiversity and the percentage of responses for each response option

Questions	Response options	Score	%
1. Are you familiar with the term biodiversity? Would you say….	I've heard about it and I know what it means*	1	46.5
	I've heard about it but I'm not sure what it means	0	39.8
	I've never heard about it	0	13.4
	Don't know	0	0.4
2. Thinking about PLANTS, as far as you know, would you say…	There ARE native plants species in NSW in serious decline and at risk of becoming extinct*	1	49.8
	There are NO native plants species in NSW in serious decline and at risk of becoming extinct	0	3.7
	Not sure/don't know	0	46.3
3. Thinking about native ANIMALS, as far as you know, would you say…	There ARE native animal species in NSW in serious decline and at risk of becoming extinct*	1	67.7
	There are NO native animal species in NSW in serious decline and at risk of becoming extinct	0	3.8
	Not sure/don't know	0	28.4
4. Nature and biodiversity are essential to the production of food, clean air and water, and medicines for people.	Strongly agree*	1	54.3
	Agree*	1	39.7
	Neither agree or disagree	0	2.5
	Disagree	0	1.2
	Strongly disagree	0	0.1
5. Nature and biodiversity are important for tackling climate change	Strongly agree*	1	44.4
	Agree*	1	36.6
	Neither agree or disagree	0	5.3
	Disagree	0	5.5
	Strongly disagree	0	2.0
	Not sure/don't know	0	5.9

* Denotes the response that represents cognitive appreciation. Note that not all percentages add to 100 because some participants (between 0.1 and 0.4%) refused to answer some questions. Scores for this dimension range from 0 to 5.

Table 8 Questions assessing the *affective* appreciation of biodiversity and the percentage of responses for each response option

Questions	Response options	Score	%
1. Now a question on protecting natural habitats for native plants and animals in NSW. There are various competing needs for the use of land in NSW. Sometimes decisions need to be made to either protect areas of natural habitat, or, to use the land for other needs. Overall, do you think there is…	Too much emphasis on protecting natural habitats	0	7.6
	Not enough emphasis on protecting natural habitats*	1	41.3
	Or, you think the balance is about right in NSW	0	46.7
	Don't know	0	4.4
2. We have a responsibility to look after nature and biodiversity for future generations	Strongly agree*	1	71.6
	Agree*	1	26.5
	Neither agree nor disagree	0	1.0
	Disagree	0	0.4
	Strongly disagree	0	0.1
3. Nature & biodiversity are important for my personal recreation, relaxation & spiritual renewal	Strongly agree*	1	36.8
	Agree*	1	44.4
	Neither agree nor disagree	0	10.7
	Disagree or	0	5.7
	Strongly disagree	0	0.7
	Not sure/Don't know	0	1.7
4. Whether I visit these natural places or not, it is important for me to know nature and biodiversity is looked after in NSW	Strongly agree*	1	56.4
	Agree*	1	38.3
	Neither agree nor disagree	0	3.1
	Disagree	0	1.3
	Strongly disagree	0	0.2
	Not sure/Don't know	0	0.7
5. To what extent would you say you are concerned about the effect of environmental problems on the following Nature - plants, animals and ecosystems	A great deal*	1	45.2
	A fair amount*	1	22.9
	A little	0	4.6
	Not at all	0	0.8
	Don't know	0	0.4
	Negative response to prior question – are you concerned about environmental problems?	0	26.2

*Denotes the response that represents affective appreciation. Note that not all percentages add to 100 because some participants (between 0.1 and 0.3%) refused to answer some questions. Scores for this dimension range from 0 to 5.

Table 9 Questions assessing the *behavioural* appreciation of biodiversity and the percentage of responses for each response option

Questions	Response options	Score	%
1. Use your own bags to carry shopping	Always*	1	32.7
	Mostly*	1	22.6
	Sometimes	0	21.3
	Rarely	0	9.3
	Never	0	13.1
	Not applicable/Don't know	0	1.3
2. Choose household products that you think are better for the environment	Always*	1	29.2
	Mostly*	1	33.7
	Sometimes	0	23.8
	Rarely	0	6.3
	Never	0	4.2
	Not applicable/Don't know	0	2.7
3. Cleaned up litter in public space, park, or forest	Yes*	1	58.8
	No	0	41.2
	Don't know	0	0.1
4. Taken part in Landcare, bushcare, tree planting or other restoration project	Yes/done*	1	15.0
	No/not done/don't know	0	84.9
5. In the last 12 months rescued wildlife	Yes*	1	27.3
	No	0	72.5
	Don't know	0	0.2
6. Tried to encourage someone else to change an activity or practice that you thought was harmful to the environment	Yes/done*	1	50.3
	No/not done/don't know	0	49.7
7. In the last 12 months collected information on the environment for scientific projects or databases	Yes*	1	12.8
	No	0	87.0
	Don't know	0	0.3
8. Tried to find information about an environmental topic or issue	Yes/done*	1	44.3
	No/not done/don't know	0	55.7
9. Any other voluntary activity – without getting paid – that benefits the environment	Yes*	1	17.6
	No	0	81.9
	Don't know	0	0.5
10. Signed an online petition in support of protecting the environment	Yes*	1	31.1
	No	0	68.1
	Don't know	0	0.9
	Yes/done*	1	28.8

Questions	Response options	Score	%
11. Participated in local development or environmental issues with the aim of protecting/improving environment	No /not done/don't know	0	71.2
12. In the last 12 months how many times have you visited a national park?	Never	0	30.2
	1–5 times*	1	46.9
	6–12 times*	1	13.0
	More than 12 times*	1	9.8
	Don't know/can't recall	0	0.2

*Denotes the response that represents affective appreciation. Note that not all percentages add to 100 because some participants (0.1%) refused to answer some questions. Scores for this dimension range from 0 to 12.

Logic for excluding survey questions from the community appreciation of biodiversity indicator

Cognitive appreciation of biodiversity

Note that in relation to Question 1 (see Table 7 above), a third of respondents who said that they had heard of biodiversity and knew what it meant were also asked an open-ended question assessing their actual understanding of the term. As this follow-up question was only asked of a third of 46.5% of respondents (i.e. those who said they knew what it meant), it was not included as a question to assess the cognitive appreciation indicator.

Affective appreciation

The survey included other questions that assessed environmental attitudes including whether respondents were concerned about environmental problems and how concerned they were about them, and satisfaction with different aspects of the local environment. As these questions were not specifically related to biodiversity, they were not used to assess affective appreciation of biodiversity. As noted above, one general question (question 5 in Table 8 above) was able to be used because it asked how concerned respondents were about the effect of environmental problems on six aspects (e.g. your health, your financial situation) and one of the aspects was nature (plants, animals and ecosystems). A follow-up question asked respondents to choose which of six aspects they were most concerned about regarding the effects of environmental problems. Although choosing nature over the other options could be considered to reflect a prioritisation of biodiversity and therefore positive attitudes, the idea that respondents would prioritise biodiversity over all other issues sets a very high bar for affective appreciation and for this reason it was not used as a measure of affective appreciation.

Behavioural appreciation

A number of environmental behaviour questions were not included in the behavioural appreciation measure. Questions that relate to waste were not included (e.g. limiting food waste, recycling electronic waste), nor was a question about limiting household water use included. It was considered that the link between these behaviours and biodiversity protection was too tenuous to include them. Reducing energy use and eating organically grown food were also not included because there are multiple motivations for engaging in these behaviours such as saving money (for reducing energy use) and protecting health (for eating organic products). In addition, a question about controlling the movement of pets to keep them away from native birds and animals was not included because the question was not applicable to 47.6% of respondents. The aim of this measure was to only include behaviours that are clearly underpinned by environmental protection motives and where a pathway (either direct or indirect) can be mapped between the behaviours and biodiversity protection.

Appendix C. Description of the variables and survey questions used to profile the six community appreciation of biodiversity groups

Socio-demographic variables

- Age: The mean of the continuous age variable.
- Gender: Females coded as 0 and males as 1.
- Living in Sydney: Respondents living in postcodes in the Sydney metropolitan area were coded as living in Sydney (1) with all other postcodes coded as making up the rest of New South Wales (2).
- Living in an IBRA bioregion with less than or more than 10% of the area within protected areas: Postcodes were first coded into the 15 NSW bioregions. Where a postal area overlapped with more than one bioregion, the bioregion with the greatest area represented was selected for analysis. The bioregions were then coded in terms of the percentage of the region in protected areas. Those with bioregions that had greater than 10% protected were coded as 1, and bioregions with less than 10% protected were coded 0. For a map of the bioregions and the designation of the percentage of protected area see: www.epa.nsw.gov.au/soe/soe2012/chapter5/map5.4.htm. The bioregions with greater than 10% protected area were: Australia Alps, South East Corner, South Eastern Highlands, Sydney Basin, NSW North Coast, South Eastern Queensland, and Simpson Strzelecki Dunefields.
- University education: Responses to the education question were coded as 1 for those who had a diploma or degree and 0 for all other education levels.
- Currently employed and retired variables: The employment variable was dummy coded with student as the reference category. This creates two new variables:
    - Currently employed, whereby those who are in paid employment are coded as 1; and those who are retired or students are coded as 0.
    - Retired, whereby those who are retired are coded as 1 and those in paid employment or students are coded as 0.
- Born in Australia: Respondent who reported being born in Australia were coded as 1 and those born outside of Australia were coded as 0.
- Language other than English (LOTE) spoken at home: Respondents who reported speaking a language other than English at home were coded as 1 and those that did not were coded as 0.
- Long time in neighbourhood: Respondents who reported having lived in their current neighbourhood for more than 10 years were coded as 1, and other options were all coded 0 (i.e. less than 1 year, more than 1 but less than 5 years, more than 5 but less than 10 years, don't know).
- Has children: Respondents who reported having children were coded as 1 and those without were coded as 0.

Other survey questions used to profile groups

Importance of national parks

Participants were presented with a statement: 'It is important to have national parks in New South Wales', with the following response options: 1 = strongly disagree, 2 = disagree, 3 = neither agree/disagree (or don't know), 4 = agree, 5 = strongly agree.

National park uses

Participants were asked how many times they had visited a national park in New South Wales in the last 12 months. For those who reported having visited a national park, they were then asked to choose from a list any activities they had done in the national park. Responses were coded as 1 if they had chosen the activity, or 0 if not (or if they had not visited a national park).

- bushwalk/picnic
- climbing (for rock climbing/abseiling)
- camp/sleep (for camping/overnight accommodation)
- horse/bike (for horse riding/bike riding)
- fish/canoe/swim (for fishing/canoeing/swimming/surfing)

Perception and satisfaction with NSW natural environment (mean)

Respondents were asked how they rate the condition of the natural environment in New South Wales. Response options were coded as: 1 = very poor, 2 = poor, 3 = neither good nor poor (or don't know/not sure), 4 = good, 5 = very good.

Respondents were also asked how satisfied or dissatisfied they were with the following aspects of their local environment: 1) air quality; 2) water quality of rivers or lakes in their area; 3) access to green spaces such as parks, forests, and natural areas; 4) cleanliness of beaches and oceans; 5) the management of litter in their area. For each aspect they chose an option from the following response scale: 1 = very dissatisfied, 2 = dissatisfied, 3 = neither satisfied nor dissatisfied, 4 = satisfied, 5 = very satisfied, 3 = not applicable, don't know/not sure.

- The mean of the responses to the perception of condition question and the five aspects of satisfaction was computed as the measure of satisfaction with NSW environment, providing a score out of 5, where higher scores represent perceived good condition and greater satisfaction.

Concern about extreme weather events (mean)

Respondents were asked how concerned they were with a range of extreme weather events directly affecting them or their family in the foreseeable future. The extreme weather events were: 1) heatwaves; 2) severe storms and floods; 3) frosts; 4) snow falls; 5) severe bushfire; 6) air pollution. They responded on the following scale: not at all, a little, a fair amount, a great deal, don't know.

'Don't know' responses were coded as 'unconcerned' based on the logic that if a respondent is not sure whether they are concerned is equivalent to the absence of concern.

- The mean of responses to the six extreme weather events was computed to measure this variable (range 1–4) where higher scores represent greater concern.

Perception that environmental regulations are too strict

Participants were asked whether environmental regulations for certain groups are much too strict, a bit too strict, about right, a bit too lax, or much too lax. The groups were: farming and agriculture, manufacturing industry, forestry industry, property development and construction industry, and mining industry.

- Responses of much too or a bit too strict were coded as 1 and all other responses were coded as 0. The response for each question was summed so that the score for the combined variable could range from 0 to 5.

Appendix D. Descriptive and inferential statistics relating to the cluster analysis

Table 10 Descriptive statistics and chi-square or *F* values comparing each cluster group (1–6, see Figure 2) on the profiling variables

	Group 1	Group 2	Group 3	Group 4	Group 5	Group 6	All respondents	Chi or *F*	*p*
Age (mean, years)	52.99	52.68	54.76	50.46	54.70	57.49	54.12%	4.71	0.000
Male %	43.8%	48.1%	41.3%	51.9%	49.6%	45.8%	46.1%	9.31[a]	0.097
Living in Sydney	48.4%	56.3%	61.8%	56.9%	55.4%	52.9%	55.8%	14.28[a]	0.014
Live in bioregion with >10% in protected areas	92.5%	89.2%	91.2%	89.5%	89.6%	83.6%	89.2%	17.08	0.004
University education	64.1%	55.6%	33.1%	45.3%	37.5%	28.5%	43.7%	133.99[a]	0.000
Currently employed	52.3%	52.7%	43.9%	54.1%	41.7%	40.0%	47.2%	24.78[a]	0.000
Currently retired	32.7%	33.1%	41.3%	30.9%	43.8%	46.6%	38.5%	28.50[a]	0.000
Born in Australia	74.4%	79.2%	71.5%	73.5%	78.8%	71.0%	74.7%	12.43[a]	0.029
Language other than English at home	8.9%	8.3%	16.6%	18.2%	11.3%	16.4%	13.0%	27.34[a]	0.000
Long time in neighbourhood	61.2%	64.4%	66.0%	65.2%	67.9%	67.7%	65.4%	3.98[a]	0.552
Has children	70.5%	74.0%	70.0%	70.7%	77.5%	72.6%	72.5%	5.83[a]	0.323
Importance of national parks	4.88	4.85	4.71	4.76	4.66	4.44	4.72	33.44	0.000
Perception and satisfaction with NSW environment (mean)	3.49	3.69	3.72	3.69	3.99	3.98	3.75	20.97	0.000
Concern about extreme weather events (mean)	2.47	2.23	2.21	2.31	1.82	1.70	2.12	58.15	0.000
Perception that environmental regulations are too strict	0.38	0.43	0.60	0.69	0.65	0.84	0.59	10.78	0.000
National park use – bushwalk / picnic	93.5%	91.3%	83.8%	94.3%	83.0%	77.6%	87.9%	45.11[a]	0.000
National park use – climbing	6.5%	5.5%	2.4%	11.9%	4.1%	6.5%	5.9%	17.15[a]	0.004
National park use – camping/sleeping	49.0%	36.4%	26.3%	39.0%	25.9%	26.9%	34.8%	43.61[a]	0.000
National park use – horse / bike	23.4%	20.3%	14.6%	25.2%	13.6%	13.9%	18.8%	16.97[a]	0.000
National park use – fish / canoe/ swim	54.8%	50.1%	38.1%	54.1%	37.4%	42.8%	46.9%	25.84[a]	0.000

Groups: Group 1 = Highly appreciative, Group 2 = Modestly appreciative, Group 3 =Concerned only, Group 4 = Unaware but active, Group 5 = Aware but unconcerned, Group 6 = Unappreciative.

Table 11 Logistic regression analysis comparing cluster groups on the categorical variables

	Group 1			Group 2			Group 3			Group 4			Group 5			Group 6		
	OR	L-CI	U-CI	OR	L-CI	U-CI	OR	L-CI	U-CI	OR	L-CI	U-CI	OR	L-CI	U-CI	OR	L-CI	U-CI
Age	1.01	1.00	1.02	1.00	0.99	1.01	1.00	0.99	1.01	1.00	0.99	1.01	0.98	0.97	0.99	1.00	0.99	1.01
Education – university	2.23	1.56	3.18	1.43	1.08	1.90	0.57	0.41	0.79	0.77	0.52	1.15	0.94	0.62	1.43	0.50	0.33	0.75
Employed	0.79	0.55	1.13	1.08	0.80	1.45	1.31	0.93	1.84	1.08	0.72	1.62	0.71	0.46	1.09	1.07	0.71	1.62
Born in Australia	1.00	0.66	1.50	1.32	0.93	1.86	0.92	0.63	1.34	0.86	0.54	1.37	1.04	0.63	1.70	0.68	0.43	1.07
LOTE at home	0.66	0.36	1.20	0.53	0.32	0.87	1.76	1.11	2.78	1.33	0.75	2.37	0.80	0.42	1.53	1.68	0.97	2.92
Lives in Sydney	0.52	0.37	0.74	1.14	0.85	1.53	1.25	0.89	1.77	0.96	0.63	1.46	1.12	0.73	1.72	1.54	1.00	2.37
Lives in bioregion with >10% in protected areas	2.27	1.00	5.19	0.87	0.47	1.61	0.98	0.47	2.05	0.70	0.33	1.52	1.33	0.49	3.64	0.45	0.21	0.98
Perception and satisfaction with NSW environment	0.49	0.38	0.63	1.02	0.82	1.25	1.07	0.83	1.37	0.85	0.64	1.14	2.02	1.42	2.86	1.82	1.31	2.54
Importance of national parks	1.66	1.05	2.60	1.43	1.01	2.04	1.06	0.76	1.49	1.05	0.71	1.56	0.81	0.54	1.21	0.44	0.32	0.61
Concern about extreme weather events	1.90	1.49	2.43	*1.22*	*1.00*	*1.50*	1.03	0.82	1.29	1.22	0.93	1.60	0.61	0.45	0.83	0.33	0.24	0.45
Perception that environmental regulations are too strict	0.77	0.62	0.95	0.85	0.72	1.01	1.04	0.88	1.23	1.23	1.03	1.47	1.07	0.87	1.33	1.12	0.93	1.35
NP use – bushwalks, picnics	1.53	0.80	2.95	1.11	0.70	1.75	0.88	0.56	1.38	3.82	1.50	9.75	0.63	0.36	1.08	0.64	0.39	1.06
NP use – climbing	0.64	0.31	1.32	0.92	0.51	1.65	0.30	0.11	0.87	2.43	1.32	4.50	0.77	0.29	2.06	2.00	0.93	4.30
NP use – camping/ sleeping	2.06	1.45	2.94	1.01	0.75	1.36	0.77	0.54	1.09	1.01	0.67	1.53	0.68	0.43	1.08	0.56	0.36	0.88
NP use – bike/horse	1.00	0.65	1.52	1.13	0.80	1.61	0.80	0.51	1.26	1.24	0.78	1.96	0.70	0.39	1.26	0.84	0.49	1.45
NP use – waterways	1.30	0.91	1.85	1.00	0.99	1.01	0.70	0.50	0.97	1.12	0.75	1.68	0.74	0.49	1.13	1.06	0.71	1.57

NP = national park, LOTE = Language other than English, OR = odds ratio, L-CI = lower confidence interval, U-CI = upper confidence interval.

Note that four variables were excluded from the logistic regression: Retired (because it correlated too highly with age); and gender, long time in neighbourhood and has children because they did not emerge as significantly different across the cluster groups.

References

Ajzen I 2001, Nature and operation of attitudes, *Annual Review of Psychology*, 52, pp.27–58.

Bamberg S & Möser G 2007, Twenty years after Hines, Hungerford and Tomera: A new meta-anlaysis of psycho-social determinants of pro-environmental behaviour, *Journal of Environmental Psychology*, 27, pp.14–25.

Bohner G & Dickel N 2011, Attitudes and attitude change, *Annual Review of Psychology*, 62, pp.391–417.

Byerly H, Balmford A, Ferraro PJ, Hammond Wagner C, Palchak E, Polasky S, Ricketts TH, Schwartz AJ & Fisher B 2018, Nudging pro-environmental behaviour: Evidence and opportunities, *Frontiers in ecology and environment*, 16(3), pp.159–168, doi: 10.1002/fee.1777.

Chevallier A, González-Roca F, Portflitt-Toro M, Fortt JA, Luna N, Cerda O, Carranza DM, Squeo FA & Gaymer CF 2019, National trends in the biodiversity interest in digital media, *Environmental Science and Policy*, 101, pp.106–115, doi.org/10.1016/j.envsci.2019.08.005.

Commonwealth of Australia 2019, *Australia's strategy for nature 2019–2030*, Australian Government, www.australiasnaturehub.gov.au/.

Cooper MW, Di Minin E, Hausmann A, Qin S, Schwartz AJ & Aleixo Correia R 2019, Developing a global indicator for Aichi Target 1 by merging online data sources to measure biodiversity awareness and engagement, *Biological Conservation*, 230, pp.29–36, doi.org/10.1016/j.biocon.2018.12.004.

Dean AJ, Lindsay J, Fielding KS & Smith LD 2016, Fostering water sensitive citizenship: community profiles of engagement in water-related issues, *Environmental Science & Policy*, 55, pp.238–247.

Department of the Environment (2012), Interim Biogeographic Regionalisation for Australia (Regions – States and Territories), v. 7 (IBRA) ESRI shapefile, available from: www.environment.gov.au/land/nrs/science/ibra.

DEFRA 2011, *Attitudes and knowledge relating to biodiversity and the natural environment, 2007–2011, from the survey of public attitudes and behaviour towards the environment*, Environment Statistics Service, Department for Environment, Food and Rural Affairs, London, United Kingdom.

Dolnicar SA 2002, *Review of unquestioned standards in using cluster analysis for data-driven market segmentation*, CD Conference Proceedings of the Australian and New Zealand Marketing Academy Conference 2002 (ANZMAC 2002), Deakin University, Melbourne, 2–4 December 2002.

DPIE 2020, *NSW Biodiversity Outlook Report: Results from the Biodiversity Indicator Program; first assessment*, Department of Planning, Industry and Environment, Sydney, www.environment.nsw.gov.au/research-and-publications/publications-search/biodiversity-outlook-report.

DPIE 2021, *Who cares about the environment? A survey of the environmental knowledge, attitudes, and behaviours of people in New South Wales in 2015, Technical Report*, Department of Planning Industry and Environment, Sydney, Australia, viewed 6 October 2021, www.environment.nsw.gov.au/research-and-publications/publications-search/who-cares-about-the-environment-2015-technical-report.

European Commission 2015, *Special Eurobarometer no. 436: Attitudes of Europeans towards biodiversity*, European Union, Directorate-General for Environment, Brussels, Belgium.

European Commission 2019, *Special Eurobarometer no. 481: Attitudes of Europeans towards biodiversity*, survey conducted by Kantar Belgium at the request of the European Commission, Directorate-General for Environment, European Union, https://ec.europa.eu/commfrontoffice/publicopinion/index.cfm/survey/getsurveydetail/instruments/special/surveyky/2194.

Evans GW, Otto S & Kaiser FG 2018, Childhood origins of young adult environmental behavior, *Psychological Science*, 29(5), pp.679–687.

Fischer J, Dyball R, Fazey I, Gross C, Dovers S, Ehrlich PR, Brulle RJ, Christensen C & Borden RJ 2012, Human behaviour and sustainability. *Frontiers in ecology and environment*, 10(3), pp.153–160, doi:10.1890/110079.

Groves RM & Couper MP 2009, *Nonresponse in household interview surveys*, John Wiley and Sons, New York.

Hornsey MJ, Harris EA, Bain PG & Fielding KS 2016, Meta-analyses of the determinants and outcomes of belief in climate change, *Nature Climate Change*, 6(6), pp.622–626.

Hunter LM, Hatch A & Johnson A 2004, Cross-national gender variation in environmental behaviors, *Social Science Quarterly*, 85(3), pp.677–694.

IPBES 2019, *Report of the plenary of the intergovernmental science-policy platform on biodiversity and ecosystem services on the work of its seventh session*, Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services, United Nations, Paris, France.

Ives CD, Abson DJ, von Wehrden H, Dorninger C, Klaniecki K, Fischer J (2018) Reconnecting with nature for sustainability, *Sustainability Science*, 13, pp.1389–1397.

Jackson W, Argent R, Bax N, Clark G, Coleman S, Cresswell, ID, Emmerson KM, Evans K, Hibberd MF, Johnston EL, Keywood MD, Klekociuk A, Mackay R, Metcalfe D, Murphy H, Rankin A, Smith DC & Wienecke B B 2017, *Australia: State of the environment 2016 overview*, independent report to Australian Government Minister for the Environment and Energy, Australian Government Department of the Environment and Energy, Canberra, Australia.

Kaiser FG & Fuhrer U 2003, Ecological behavior's dependency on different forms of knowledge, *Applied Psychology: An International Review*, 52(4), pp.598–613.

Kiley, H.M., Ainsworth, G.B., & Weston, M.A. (2019). Modest levels of interpretability of the term 'biodiversity' mediated by educational level, among the Australian public. *Pacific Conservation Biology*, *25*, 208-2010.

Klanlecki K, Leventon J, Abson DJ 2018, Human-nature connectedness as a 'treatment' for pro-environmental behaviour: making the case for spatial considerations, *Sustainability Science*, 13, pp.1375–1388.

Klöckner CA 2013, A comprehensive model of the psychology of environmental behaviour: A meta-analysis, *Global Environmental Change*, 23, pp.1029–1038.

Kollmuss A & Agyeman J 2002, Mind the gap: Why do people act environmentally and what are the barriers to pro-environmental behaviour?, *Environmental Education Research*, 8(3), pp.239–260.

Kormos C & Gifford R 2014, The validity of self-report measures of proenvironmental behavior: A meta-analytic review. *Journal of Environmental Psychology*, 40, pp.359–371.

Kreuter F, Presser S & Tourangeau R 2008, Social desirability bias in CATI, IVR, and web surveys the effects of mode and question sensitivity, *Public Opinion Quarterly*, 72(5), pp.847–865.

Larson LR, Stedman RC, Cooper CB & Decker DJ 2015, Understanding the multi-dimensional structure of pro-environmental behaviour, *Journal of Environmental Psychology*, 43*,* pp.112–124.

Lorenzoni I, Nicholson-Cole S & Whitmarsh L 2007, Barriers perceived to engaging with climate change among the UK public and their policy implications, *Global Environmental Change*, 17, pp.445–459.

Mayer FS & Frantz CM 2004, The connectedness to nature scale: A measure of individual's feeling in community with nature, *Journal of Environmental Psychology*, 24, pp.503–515.

Meis-Harris J, Saeri A, Boulet M, Borg K, Faulkner N & Jorgensen B 2019, *Victorians value nature: Survey results*, BehaviourWorks Australia, Monash University, Melbourne, Australia.

Milfont TL & Duckitt J 2010, The environmental attitudes survey: A valid and reliable measure to assess the structure of environmental attitudes, *Journal of Environmental Psychology*, 30, pp.80–94.

Newbold T, Hudson, LN, Arnell AP, Contu S, De Palma A, ... & Burton VJ 2016, Has land use pushed terrestrial biodiversity beyond the planetary boundary? A global assessment, *Science*, 353, pp.288–292.

Nilsson D, Fielding K & Dean A 2019, Achieving conservation impact requires shifting focus from human attitudes to behaviors, *Conservation Biology*, htpps://doi:10.1111/cobi.13363.

Nisbet EK & Zelenski JM 2013, The NR-6: a new brief measure of nature relatedness, *Frontiers in Psychology*, 4, doi:10.3389/fpsyg.2013.00813.

Novacek MJ 2008, Engaging the public in biodiversity issues, *Proceedings of the National Academy of Science*, 105, pp.11,571–11,578.

OEH 2017, *Who cares about the environment? A survey of the environmental knowledge, attitudes, and behaviours of people in New South Wales in 2015*, Office of Environment and Heritage, Sydney, Australia.

Pe'er S, Goldman D & Yavetz B 2007, Environmental literacy in teacher training: Attitudes, knowledge, and environmental behaviour of beginning students, *The Journal of Environmental Education*, 39(1), pp.45–59, doi: 10.3200/JOEE.39.1.

Pyle RM 2003, Nature matrix: reconnecting people and nature, *Oryx*, 37(2), pp.206–214.

Rosa CD & Collado S 2019, Experiences in nature and environmental attitudes and behaviors: Setting the ground for future research, *Frontiers in Psychology*, 10(763), doi: 10.3389/fpsyg.2019.00763.

Schultz PW 2001, The structure of environmental concern: Concern for self, other people, and the biosphere, *Journal of Environmental Psychology*, 21, pp.327–339.

Secretariat of the Convention on Biological Diversity 2010, *Strategic plan for biodiversity 2011–2020 and the Aichi Targets*, United Nations Environment Program, accessed on 22 October, 2019, www.cbd.int/sp/ or www.cbd.int/doc/strategic-plan/2011-2020/Aichi-Targets-EN.pdf.

Selinske MJ, Garrard GE, Bekessy, SA, Gordon A, Kusmanoff AM & Fidler F 2018, Revisiting the promise of conservation psychology, *Conservation Biology*, 32(6), pp.1464–468.

Stern PC 2000, Toward a coherent theory of environmentally significant behaviour, *Journal of Social issues*, 56(3), pp.407–424. doi:10.1111/0022-4527.00175.

Thackway R & Cresswell ID (eds.) 1995, *An Interim Biogeographic Regionalisation for Australia: A framework for establishing the national system of reserves, Version 4.0*, Australian Nature Conservation Agency Canberra.

The American Association of Public Opinion Research 2016, *Standard definitions: Final dispositions of case codes and outcomes rates for surveys*, 9th edition, AAPOR.

Union for Ethical Biotrade 2018, *UEBT Biodiversity Barometer*, accessed 24t October 2019, https://static1.squarespace.com/static/577e0feae4fcb502316dc547/t/5b51dbaaaa4a99f62d26454d/1532091316690/UEBT+-+Baro+2018+Web.pdf.

Union for Ethical Biotrade 2019, *UEBT Biodiversity Barometer: Special edition – Asia,* accessed 24 October 2019, https://static1.squarespace.com/static/577e0feae4fcb502316dc547/t/5d0b61d53df5950001ac0059/1561027031587/UEBT+Biodiversity+Barometer+2019+.pdf.

Whitburn J, Linklater W & Abrahamse W 2019, Meta-analysis of human connection to nature and proenvironmental behaviour, *Conservation Biology*, https://doi: 10.1111/cobi.13381