UNDERSTANDING AND PLANNING FOR THE ENVIRONMENTAL BENEFITS OF COMMUNITY ENGAGEMENT PROGRAMS

Prepared for Parks Victoria

by

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Executive Summary

An organisation may have many reasons to embark on environmental engagement initiatives. Typically, these relate to increasing environmental issue awareness, including how people can interact with the world in more pro-environmental ways, building social capital and promoting community health and well-being. Environmental engagement includes an array of approaches that range from information dissemination to environmental education, including citizen science and activities that involve participation within nature, and also for nature through volunteer conservation.

Environmental engagement programs have the capacity to provide benefits to biodiversity, either directly as a result of participant activities, or by influencing behaviour subsequent to the program. Many environmental education programs deliberately promote pro-environmental behaviour in this way. Where the goal of a program goal is to deliver biodiversity benefits, the mechanism by which this is to be achieved should be considered; this may be via participant activity, through influencing behaviour, or via a combination of both. However, the wider goals and priorities of the program, and the available resources, will ultimately influence program design.

Education-oriented programs that are ongoing and which use active learning within a natural setting are more likely to be effective at promoting positive attitudes towards pro-environmental behaviours, particularly where empathy and a connectedness to nature is developed. Allowing student autonomy and encouraging personal responsibility can also be effective, and programs aimed towards children can be more effective at influencing their behaviour, including that of their parents, and thus potentially more effective at delivering indirect biodiversity benefits via behaviour change.

Because many of the potential benefits to biodiversity arising from environmental engagement programs may result indirectly from a program’s influence on participant behaviour, greater reference to the behaviour change literature may help program managers develop engagement programs that more strategically target factors that influence biodiversity-relevant behaviours. As such, lessons both from the engagement and education literature, as well as the behaviour change literature are valuable when considering the design of engagement programs.

Participant activities that are intended to benefit biodiversity can be measured directly (e.g. 100 trees planted, 200 weeds removed, 10km of walking trails maintained), although suitable process models will be needed to link on-ground outcomes with key biodiversity objectives. Because indirect benefits are achieved by participants’ future actions, subsequent behaviours of participants should be measured in order to evaluate a program. Behaviour can be measured via observation, although this is often impractical, with participant self-report more commonly used (although this can be unreliable). Most commonly, various attitudes towards the promoted behaviour are measured as an indication of likely future behaviour, and it is assumed that greater pro-environmental attitudes indicate a greater likelihood of performing those behaviours. While useful, this approach is not always reliable. However, there is greater correlation between attitudes and behaviour where the attitudes measured relate to a specific behaviour, and where participants’ intentions to carry-out the behaviour are also measured. By measuring a participant’s behavioural beliefs, norms, and
control beliefs, it can be possible to use the theory of planned behaviour to better predict behaviour, and thus the indirect biodiversity benefits resulting from an engagement program.

In general, evidence for biodiversity benefits arising from environmental engagement programs is difficult to find, hampered by poor evaluation practices and little consideration of the range of factors that might deliver indirect benefits. Better program evaluation practices are needed to develop a substantive evidence base by which to improve program design. However, based on the evidence that does exist, including our review of the environmental education and engagement and environmental behaviour change literatures, we make the following recommendations for Parks Victoria to consider when designing environmental engagement programs to deliver biodiversity benefits:

• Citizen science and conservation volunteering deliver the most easily observed correlation between participation and biodiversity benefits, and may provide the basis of a multi-faceted approach that delivers both direct and indirect benefits. Provided appropriate program design and training, citizen science can deliver data of sufficient quality to resolve uncertainty and inform management. However, a potential challenge for program designers lies in maintaining a gratifying experience for participants while ensuring targeted ecological objectives are met.

• Simply spending time in nature or providing information is unlikely to be sufficient to deliver indirect benefits to biodiversity. Education-oriented programs that are ongoing and which use active learning within a natural setting are more likely to be effective at promoting positive attitudes towards pro-environmental behaviours, particularly where empathy and a connectedness to nature is developed. Allowing student autonomy and encouraging personal responsibility can also be effective, and programs aimed towards children can be more effective at influencing their behaviour, including by influencing parental behaviour.

• Programs that incorporate multiple strategies for achieving biodiversity benefits are likely to be required.

• Appropriate evaluation approaches and methods are important for measuring program effectiveness, including the use of counterfactual thinking in which measured outcomes are compared against a control that provides information about the outcomes that could have been expected if the program had not been implemented.
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**Introduction**

Environmental engagement is a form of community engagement that is focused on environmental issues. It lacks a precise definition, but may include any organised activity that seeks to promote the community’s understanding and awareness of the environment (or a specific aspect of it), including their own place within it. Environmental engagement programs include a range of approaches, such as information campaigns, volunteer programs, education programs and combinations of these. Different organisations may have different goals for their engagement strategies. For example, government engagement strategies are often focused on building community awareness about the government’s specific policy about an issue (e.g. ACT Government’s Community Engagement Strategy on climate change) or encouraging and facilitating community participation in policy making (e.g. Hobson Bay City Council Environmental Engagement Strategy). Organisations with environmental or conservation interests are often interested not only in promoting issue awareness, but also in empowering people to participate in conservation. For example, Zoos Victoria uses a number of information, education and volunteer programs to promote threatened species conservation beyond the boundaries of their facilities. Parks Victoria similarly uses a variety of engagement techniques to promote connections between people and parks in order to, amongst other things, promote the many values of nature, both generally, and specific to Victoria’s parks.

Environmental engagement programs contribute a range of social and learning benefits, including building social capital (West 2014), better health and well-being (Bowler et al. 2010) and the possibility of improved cognitive ability (Malone and Tranter 2003). There is also an assumption that environmental engagement programs will contribute environmental benefits; however the mechanisms by which this occurs are not well understood, particularly in the case of biodiversity.

Parks Victoria administers a number of community engagement programs, including Park Champions, Junior Rangers and Friends of Parks, under the Healthy Parks Healthy People banner. These programs are likely to deliver a range of social and well-being benefits to the participants, which are currently being examined through the Applied Visitor Research Program. However, the specific benefits of these programs to parks, such as any associated improvements to biodiversity, are unknown. As a result, it is not possible for administrators to demonstrate the success of these programs for delivering biodiversity benefits.

There are a range of ways in which environmental engagement programs can lead to environmental benefits. For example, tree-planting and weeding associated with conservation volunteering may directly improve habitat and increase species diversity, while contributions to datasets collected through citizen science activities provide indirect benefits by helping inform conservation research and management (e.g. Miller-Rushing et al. 2012). Other indirect benefits may result from increased environmental literacy, and promotion of specific or general pro-environmental behaviour (Carleton-Hug & Hug 2010). This may include greater environmentally-friendly behaviour within parks themselves (e.g. keeping to tracks, not feeding animals, etc.) as well as more generally, such as in purchasing sustainably-sourced and produced food and other consumer products, donating to conservation causes, and voting based on conservation issues. Figure 1 illustrates how different types of engagement strategies have the potential to give rise to direct and indirect biodiversity and related benefits.
Given that many of the potential benefits of engagement programs rely on indirect benefits that result from influencing the future behaviour of participants, it is useful to understand the factors that influence pro-environmental behaviour change. A range of factors are known to influence human behaviour (refer to the glossary of key terms and factors as the end of this document), including motivational factors, contextual factors (e.g. opportunity or capacity to undertake particular behaviours) and habitual factors (see Steg and Vlek 2009 for an overview, and also Schwarz, Graymore and Freeland 2012 for a review of literature concerning sustainable behaviour change from a local government context). Environmental engagement strategies that seek to influence behaviour chiefly rely on influencing motivation to promote pro-environmental behaviours, but greater consideration of other factors may be helpful in designing engagement strategies that are more effective at delivering indirect biodiversity benefits.

While some environmental benefits of environmental engagement programs have been well studied (e.g. reduction in consumption of energy, water, etc.), the specific biodiversity benefits of environmental engagement are less well understood, particularly those associated with attempts to promote pro-environmental behaviour change. This review provides a summary of current knowledge about the key approaches to environmental engagement, the means by which this engagement can lead to biodiversity benefits, and options for evaluating the biodiversity benefits of environmental engagement programs. We begin by providing an outline of the way in which engagement programs can deliver environmental benefits, and then provide an overview of the different approaches to environmental engagement, including how they are believed to promote
pro-environmental behaviours. We then outline the ways in which behaviours can be measured or inferred as a proxy for environmental benefits.

**Delivering environmental benefits**

A key focus of this review is understanding how environmental engagement programs can deliver benefits for biodiversity. Here, we describe biodiversity benefits from environmental engagement programs as either direct or indirect. Direct benefits are those that occur as a direct result of participants’ activities within the program itself. These include, for example, tree planting, invasive species control and data collection about species presence, absence or counts. These types of direct benefits are typical of the volunteering, citizen science and active learning engagement models (Figure 1). Because participants need relatively little training and expertise, data collection (or other participation outcomes) may be achieved at a greater scale or for lower cost than if undertaken by paid experts. Citizen science and conservation volunteering can contribute to various types of ecological programs and research, such as species range shifts, phenology, effects of habitat loss and fragmentation on biodiversity, detection and tracking of infectious diseases, distribution of invasive species, monitoring effects of bio-contaminants (Whittington and Trinastic 2013).

Some prominent Australian examples include:

- **The Reef Life Survey** ([http://reeflifesurvey.com/](http://reeflifesurvey.com/)) is a good example in which volunteer recreational divers gather valuable data about marine biodiversity at scales impossible by researchers alone. This contributes to valuable data that has informed scientific publications and conservation management.
- **Knox City Council’s Gardens for Wildlife** ([http://www.knox.vic.gov.au/g4w](http://www.knox.vic.gov.au/g4w)) program empowers residents and businesses to manage their gardens to provide suitable habitat and food for wildlife.
- **The Friends of the Fitzroy’s Aquila Project** ([https://friendsofthefitzroy.com.au/?page_id=24](https://friendsofthefitzroy.com.au/?page_id=24)) enables anybody to be “a vital part of the largest most successful weed eradication program in Australia, if not the World” by searching aerial photographs on their computers for infestations of rubber vine in the West Kimberley region. This provides valuable information for on-ground teams to remove the infestations.

Programs that employ citizen science or conservation volunteering will primarily deliver direct benefits, but also indirect benefits by promoting issue awareness (Couvet et al. 2008) and building knowledge (Bonney et al. 2009). However, the degree to which these programs may also promote positive attitudes and encouraging pro-environmental behaviour have, to date, received little attention in the literature.
Indirect biodiversity benefits refer to benefits that occur outside participation in the engagement program and which rely on the future behaviour of participants. Environmental education programs generally aim to deliver indirect benefits by encouraging participants’ subsequent pro-environmental behaviours. This is generally intended to be achieved through the generation of environmental knowledge, and promotion of positive attitudes, which are assumed to promote the pro-environmental behaviour (e.g. Sellmann and Bogner 2013; Byrka et al. 2010; Smith-Sebasto and Semrau 2004). Such programs may intend to promote general pro-environmental knowledge, attitudes and behaviours (e.g. Kruse and Card 2004), or relate to specific issues and behaviours, such as complying with conservation practices and regulations (e.g. Leisher et al. 2012). Active learning programs may also include hands-on experience that additionally deliver direct environmental benefits, similar to those generated by citizen science and conservation volunteering, and citizen science and volunteering programs may themselves include environmental education elements, or be a component of a broader environmental education program.

**Influencing behaviours for biodiversity benefits**

Biodiversity loss occurs as a direct result of human activities (Maxwell et al. 2016), and therefore human behaviour change is an essential component of strategies to achieve biodiversity conservation outcomes. Few engagement programs have been designed with explicit consideration of the range of factors known to influence behaviour and, as a result, environmental engagement programs may be failing to reach their full potential for delivering indirect biodiversity benefits. Better understanding and consideration of factors to consider when aiming to encourage pro-environmental behaviour may therefore help to improve program design, implementation and evaluation. While individual choices and behaviours can lead to biodiversity benefits (eg. wildlife gardening), the biggest benefits are arguably associated with behaviours addressing collective human consumerism and other general behaviours heavily influenced by modern ways of life (eg. styles of urban development, agricultural activity (Maxwell et al 2016)).

Various models have been proposed for explaining the drivers of human behaviour in different settings. These range from the assumption that humans are rational utility-maximisers, as in the traditional *homo economicus* model (Persky 1995), to more nuanced models such as the norm activation model (Schwartz 1977). Values-beliefs-norms theory (Stern 2000) recognises behaviour does not necessarily result solely from a person’s internal cost-benefit analysis, but rather that it is influenced by that person’s underlying values, beliefs and cultural context (Schwartz 1992). In general, people who hold less self-interested values such as pro-social, altruistic, biospheric or self-transcendant values, are thought to be more likely to engage in pro-environmental behaviours (De Groot and Steg 2007, 2008; Steg and Vlek 2009). However, values are not easily changed (Manfredo et al. 2016), and thus much of the effort to promote pro-environmental behaviour has focussed on attempts to influence attitudes, relying on the assumption that attitudes are key drivers of behaviour.

One of the most successful behavioural models is the Theory of Planned Behaviour (TPB) (Ajzen 1991). This posits that a person’s intention to perform a particular behaviour is the immediate antecedent of that behaviour, and is therefore the best predictor of behaviour. This ‘behavioural intention’ is itself influenced by interplay between a person’s ‘behavioural beliefs’ (i.e. their beliefs about the behaviour and its consequences – this is essentially a person’s attitude towards the
behaviour), their ‘normative beliefs’ (i.e. their beliefs about the normative expectations of others, and their ‘control beliefs’ (i.e. their perception of their ability to perform a given behaviour). As such, TPB suggests that an individual’s attitudes towards a particular behaviour will be affected by their subjective perception of a range of factors that influence motivation (for example, a person’s values, knowledge and personal experiences), but that other factors (such as cultural practices and the opportunity or personal capacity to undertake the behaviour) will influence their intentions to actually undertake the behaviour.

The factors that influence behaviour can be divided into several categories: i) motivational factors (e.g. costs and benefits, norms, attitudes, etc.); ii) contextual factors (e.g. capacity and opportunity to undertake certain behaviours); and iii) habitual behaviour (e.g. those actions that are guided by automated cognitive processes and do not result from elaborate reasoning) (Steg and Vlek 2009).

Environmental engagement strategies chiefly rely on influencing motivation to promote pro-environmental behaviour. By informing (or educating) people about a particular issue, engagement strategies can influence behavioural motivation in a number of ways, chiefly by:

- making the costs and benefits of a particular behaviour salient, such that the promoted benefit is seen as having greater value than the existing behaviour;
- making a moral case for action;
- empowering people to undertake the behaviour (i.e. promoting self-efficacy);
- promoting positive feelings towards nature; and
- influencing social and cultural norms.

In addition, engagement strategies that involve active hands-on or place-based elements may also empower participants to undertake pro-environmental behaviours by improving self-efficacy for undertaking particular behaviours (e.g. distinguishing between native and exotic species, planting trees, removing weeds, etc.). More broadly, education can encourage critical and independent thinking that empowers participants to question, interact with and transform the world around them in a way that goes well beyond undertaking specific behaviours in a defined context.
Approaches to environmental engagement

There are numerous approaches to environmental engagement. While a few (e.g. citizen science, conservation volunteering, environmental education) can deliver direct biodiversity benefits through on-ground activities, most rely on promoting pro-environmental attitudes and behaviours to deliver indirect benefits to biodiversity. In this section, we outline the key approaches to environmental engagement and discuss the mechanistic and theoretical pathways for delivering biodiversity benefits. These are summarised in Table 1. Note that in the absence of explicit studies of the biodiversity benefits of different engagement approaches, we discuss pro-environmental behaviours more generally.

Dissemination of information

This involves informing the public about an environmental issue, and may be aimed at developing the public’s (or other target group’s) understanding of the issue and/or what actions they may take to improve the situation (i.e. specific behaviours, donating to a conservation organisation, choosing political candidates on environmental commitments, etc.). Such programs have typically relied on the knowledge-deficit model to influence behaviour. This model assumes that people will change their behaviour after they are educated about the harms caused by their current behaviour and the benefits of an alternative behaviour are known (e.g. Owens and Driffl 2008). For example, much of the campaigning around climate change has been focussed on convincing people that it is actually real and problematic. Sustainability Victoria’s energy efficiency campaign (www.sustainability.vic.gov.au/services-and-advice/households/energy-efficiency) is largely predicated upon this model, although it does emphasise financial benefits and provide practical advice to empower consumers to make energy efficient choices. More sophisticated approaches may aim to change perceptions, knowledge, motivations and norms in order to foster general or specific pro-environmental behaviour (for example, the ‘I want to be recycled’ campaign www.iwanttoberecycled.org; also see Schultz (2002b) for a useful discussion in the context of recycling information campaigns).

Strategies that involve dissemination of information are likely to be most effective at influencing behaviour where the behaviour is reasonably convenient to perform, when there are few constraints on adopting the preferred behaviour, and where the preferred behaviour is not costly in terms of money, time, effort or social disapproval (Steg and Vlek 2009). This is because they do not alter the external context in which people make choices. For the same reason, this may also be true of many environmental education strategies; the dissemination of information could be considered as a form of passive environmental education. However, information campaigns are often used in conjunction with programs that also tackle contextual factors, for example early campaigns to promote household recycling were coordinated with the roll-out of kerbside recycling services that made the behaviour more convenient, and by putting this recycling behaviour on display for the neighbourhood, created strong norms to participate in recycling (though this was likely a happy coincidence rather than a strategic decision).

Spending time in nature

One approach to environmental engagement is to encourage and facilitate people to spend more time in nature. It is commonly suggested in the environmental engagement literature that people
need to spend time in natural places, particularly as a child, to form lasting connections and appreciation for natural environments (Miller 2005). This appreciation for nature may be crucial to gain public support for biodiversity conservation (Miller 2005). However, rapid and increasing urbanisation has resulted in an increasing separation of people from nature, such that people are spending less time in natural settings and increasingly consider nature to be something that is separate from them (Vinning and Price 2008). This separation from nature has been termed the ‘extinction of experience’, the consequences of which include a reduced emotional affinity of people towards nature, including decreased pro-environmental attitudes and behaviours (Soga and Gaston 2016; Chawala 2007).

It is commonly assumed that increasing exposure to nature will increase pro-environmental behaviours. For example, Stewart and Craig (2000) suggest that people who have frequent exposure to natural, functioning ecosystems are more likely to hold positive attitudes towards conservation and engage in pro-environmental behaviour than those who spend more time in a constructed environment. However, the causal mechanism linking time spent in nature and pro-environmental behaviours is not clear. Some researchers suggest that people who feel they have a personal connection with nature have greater motivation for protecting the environment (Bragg 1996; Schultz 2000; Mayer and Frantz 2004). Schultz (2000) explains this chiefly in terms of fostering a sense of empathy for nature and argues that a personal connection may best be established through activities that reduce an individual’s perceived separation between self and nature, such as spending time hiking or camping, taking a class trip to a national park, or creating birdhouses or a garden. One mechanism by which experience in nature may lead to greater connection to and care for nature may relate to the concept of psychological distance. This concerns the distance from themselves in which they think about an object (i.e. a person, event, issue, outcome, etc.). When psychological distance is greater, people tend to think about the object in a more abstract fashion (Bar-Anan, Liberman and Trope 2006), and can be less motivated to take individual action (Jones, Hines and Marks 2016; Spence, Poortinga and Pidgeon 2012).

Another suggested mechanism is that spending time in nature may build place attachment, defined by Jorgensen and Stedman (2001, pp 238) as “an individual’s cognitions, beliefs, perceptions or thoughts that the self is invested in a particular spatial setting”. While only a handful of empirical studies have explored the link between place attachment and pro-environmental intentions and behaviours, these suggest that greater place attachment is linked to the taking of actions to protect the place (Tonge et al. 2015 Halpenny 2010). In one example, Borrie and Roggenbuck (2001) found that visitors to a US wilderness area reported greater ‘care for the wilderness’ at the end of their visit than upon entry. Halpenny (2010) provides some evidence that the attachment of park visitors for a particular place may transfer to the environment in general, and argues that prolonged interaction with the wilderness may serve to raise individuals’ attachment to the environment. However, the degree to which these ‘spill-over’ effects occur is unclear. Context may play a role in how place attachment influences behaviour, for example, it has been shown to have no relationship with the pro-environmental management behaviours of Victorian farmers (Gosling and Williams 2010).
Others suggest that because spending time in natural places encourages people to develop an appreciation for nature, and may increase children’s scientific literacy, that it will also encourage environmentalism (Wight et al. 2016). For example, Tanner (1980) showed that politically-active professional conservationists attributed memorable experiences of playing outdoors as a commonly reported influence in choosing conservation-oriented careers. According to Bixler, Floyd, and Hammitt (2002) this finding has been replicated by a number of studies (Chawla, 1999; Palmer, Suggate, Bajd and Tsaliki 1998; Palmer and Suggate 1996; Palmer 1993; Sia, Hungerford and Tomera 1986; Sia 1984), although the methods used have generally involved retrospectively questioning adults who have become active professional conservationists about significant life experiences that stimulated their interest in conservation related careers. Bixler, Floyd, and Hammitt (2002) confirmed this association by having youth participants complete a number of quantified scales about different aspects of nature, including environmental and recreational preferences and also fears about nature. While their results confirmed a relationship between those who engage in childhood play in natural environments and later affinity for and understanding of the environment, it did not necessarily result in an increased interest in environmental sciences or environmentalism later in life (Bixler, Floyd, and Hammitt 2002).

Darner (2009) observes that other (mostly qualitative) research has identified a range of experiences that are generally shared in some combination by environmentalists (i.e., citizens with pro-environmental attitudes): having childhood experiences in natural, relatively pristine, undeveloped areas; being influenced by family, peers, or role models who cared for nature; witnessing the destruction of a beloved natural area or having a similar negative experience involving environmental destruction; and participating in formal environmental education. As such, spending time in nature as a child seems to be an important part of promoting pro-environmental behaviour, but is not sufficient in itself.

While these studies appear to demonstrate a correlation between exposure to nature and pro-environmental behaviours, such associations should be viewed with caution. They may represent personal preferences and not be illustrative of a causative mechanism. Gosling and Williams (2010) showed that measures taken to protect native vegetation by a sample of Victorian farmers increased with their connectedness to nature, but that this relationship was mediated by the perceived importance of the environmental benefits of the measures taken. In fact, emerging research in Brisbane has found no connection between the time people spend in nature and pro-conservation attitudes (Lara Franco et al., manuscript in preparation). So, while there is some evidence of a correlation between an individual’s connection to nature and pro-environmental behaviours, there is no conclusive causal evidence to suggest that reversing the ‘extinction of experience’ by spending time in nature will lead to pro-conservation attitudes or behaviour.

Nature-based tourism

Nature-based tourism can be an effective means of drawing visitor attention to environmental issues of relevance (Higham and Carr 2002). As such, nature-based tourism may potentially be used both as a means of issue promotion, as well as a mechanism to encourage the spending of time in nature. There is some evidence that the site-specific recreational experiences of eco-tourists are significantly affected by the education, aesthetics, and escapism of the recreation experience, suggesting the possibility of a role for nature-based tourism to facilitate these via specifically designed and targeted
activities (Lee, Jan and Huang 2015). This may be particularly useful for helping young people to establish connections between natural world and their everyday lives (Dunkley 2016).

Environmental education

Early environmental education researchers assumed that if the experiences associated with environmentalists could be reproduced, then such environmental education programs would promote positive environmental attitudes and foster pro-environmental behaviours. While this approach has provided evidence of environmentalists sharing common experiences (see ‘Spending time in nature’ above), these in themselves are insufficient to explain (and promote) pro-environmental behaviour (Darner 2009). Below we outline some key approaches to environmental education that have been shown to be effective at promoting environmental knowledge and attitudes, and in some cases behaviour, although this is often difficult to measure and less often reported. As such, there are few specific biodiversity benefits of environmental education that can be identified with confidence, with most benefits being inferred from participant attitudes.

Active learning

It is widely agreed that students learn more through active learning approaches (Freeman et al. 2014), and active, hands-on place-based environmental education has been shown to be more effective at building relevant knowledge than passive classroom-based education approaches delivering the same subject matter (Damerell, Howe, and Milner-Gulland 2013). This presumably occurs by better engaging and stimulating students, as well as as a result of practical and interactive learning experiences, resulting in greater retention of information. Active learning approaches are becoming increasingly used in teaching programs to generate greater student engagement (Michel, Carter and Varela 2009).

Place-based environmental education

Place-based environmental education is one form of ‘active learning’ in which students (typically children) spend time in nature (typically in a place that is local to the community) whilst participating in an education program, the goal of which is usually to develop and promote students’ environmental knowledge, attitudes and pro-environmental behaviours (Sellmann and Bogner 2013; Smith-Sebasto and Semrau 2004). Many studies indicate that place-based programs can positively influence general pro-environmental attitudes, but there is less research examining how attitudes relate to the location of a program. This is particularly so with respect to the ways in which children develop attitudes toward specific geographical sites and how these attitudes might be generalised and transferred to similar sites or to general pro-environmental behaviour (known as ‘spill-over’ effects – see ‘place attachment’ above).

Weilbacher (1993) argues that a person will only miss a species if they know it and have developed a relationship with it. This is consistent with the views of Schulz (2000), and is supported by Lindemann-Matthies (2002) who found that the number and diversity of species that 8- to 16-year old participants noticed on the way to school significantly increased, with positive effects increasing with time spent in the program. This suggests that environmental education can enhance the pro-environmental attributes of people spending time in nature.

While there is some evidence that place-based environmental education programs do result in increased pro-environmental behaviour (Kruse and Card 2004; Leisher et al. (2012); Damerell, Howe,
and Milner-Gulland 2013), these are relatively few. This does not indicate the lack of such a link, but simply emphasises how difficult it is to prove a causal relationship between environmental education (and engagement) and subsequent behaviours (Damerell, Howe, and Milner-Gulland 2013; Bride 2006).

**Ongoing programs are more effective**
There is evidence that ongoing environmental education programs have a greater influence on promoting connectedness to nature and pro-environmental behaviour than one-off programs (Braun and Dierkes 2016; Stern, Powell, and Ardoin 2008; Bogner 1998), and that the effect on pro-environmental behaviour from participation in multiple programs may be cumulative (Kruse and Card 2004). However, one should exercise caution in relying on this conclusion, as it is possible that participants who have participated in more programs simply have a greater understanding of what the ‘desired’ responses are in assessment questionnaires, and where participation is voluntary, that self-selection bias results in the participants of multiple programs having a stronger inherent interest in conservation matters.

**Child-focussed education**
Many environmental education programs are aimed at children. Children are a good target audience for environmental engagement for a number of reasons. First, a child’s attitude towards the environment starts to develop at a young age and once formed they are not easily changed (Damerell, Howe, and Milner-Gulland 2013). Children are also less likely to have formed harmful environmental behaviours that must be ‘unlearned’ (Damerell, Howe, and Milner-Gulland 2013). In a study of the effect of an environmental education program on both primary and secondary students’ nature connectedness, students aged seven to nine exhibited the strongest shifts towards nature (Braun and Dierkes 2016). In addition, children’s participation in environmental education programs can also positively influence the knowledge and behaviours of their parents, and possibly other non-participants (Leeming and Porter 1997; Damerell, Howe, and Milner-Gulland 2013).

Alberta Emerald Foundation (2008) provides a comprehensive guide to engaging youth in environment and sustainability.

**Responsibility**
When children view biodiversity conservation as a problem for which they have some responsibility, and where they have the ability to make a difference, they are more likely to make a commitment to protect biodiversity (Menzel and Bogeholz 2010). This may reflect an interaction between the students’ self-efficacy (i.e. perceived behavioural control) and their personal norms. It has been suggested that moral norms are an important predictor of behavioural intention (Rivis, Sheeran and Armitage 2009; de Leeuw et al 2015). This is consistent with the norm activation model (Schwartz 1977) and value-belief-norm theory (Stern 2000), and suggests that moral appeals that urge people to take responsibility for biodiversity may be useful for environmental engagement and education, particularly with respect to low-cost behaviours motivated by environmental intent (Steg and Vlek 2009).

**Self-efficacy**
An important aspect of much of the research outlined above is the role of self-efficacy, with people being more likely to engage in conservation or pro-environmental behaviours where they are empowered to do so, and where they believe that it will make a difference (Sampaio et al. 2012;
Menzel and Bogeholz 2010). Hope has also been shown to have a positive influence on pro-environmental behaviour in the context of climate change (Ojala 2012), and may prove useful in a biodiversity context. Hope may simply be one specific approach for enhancing self-efficacy.

**Student autonomy**
Self-determination theory reinforces the need for students to feel competent in order to undertake pro-environmental behaviours (Darner 2009). In addition, students also need a sense of autonomy. This suggests that engagement and education activities should provide students with opportunity to actively solve environmental problems of their choosing, that relate to issues they themselves consider important, and from this to make their own decisions about how to act, rather than receiving directions from someone else about how to behave (Darner 2009).

**Commitment strategies**
Commitment strategies are relevant to behaviour change aspects of any engagement strategy, and despite being well-suited to use in conjunction with an environmental education strategy, seem to be little reported on in this context. Commitment strategies involve participants making a verbal or written commitment to perform the target behaviour (Steg and Vlek 2009; Lehman and Geller 2004). After making a commitment, people are more likely to perform the behaviour, particularly when the commitment is public and made voluntarily (Cialdini 2001; Lehman and Geller 2004). This approach is likely effective because of the social norm of consistency that creates a motivation for people to be seen to be internally and externally consistent (Cialdini 2001; Lehman and Geller 2004). However, its effectiveness may be enhanced by asking participants how they plan to undertake the behaviour (Bamberg 2002), as this helps form the specific behavioural intention. In addition, for settings in which a behaviour is more difficult to perform, this may force the participant to contemplate how they will perform the behaviour, and thereby enhance perceived behavioural control.

There is likely to be value in programs that include multiple strategies; a meta-analysis by Hines, Hungerford and Tomera (1987) of environmental behaviour research found that the variables associated with responsible environmental behaviour were knowledge of issues, knowledge of action strategies, locus of control (i.e. behavioural control in TPB), attitudes, verbal commitment, and an individual's sense of responsibility.

**Citizen science and conservation volunteering**
Citizen science is a form of environmental engagement that directly involves members of the public in scientific research (Couvet et al. 2008), and generally has both scientific and educational objectives (Bonney et al. 2009). An example of this is involving the public in biodiversity monitoring, which can make it possible to collect the large number of observations needed to inform on factors such as global change and habitat fragmentation (Couvet et al. 2008). Conservation volunteering is substantially similar to citizen science, but rather than collecting data about the environment as part of scientific research, participants are directly involved in pro-environmental activities such as planting trees, removing weeds, etc. (see Randall 1996). These forms of engagement have the most easily observed correlation between participation and biodiversity benefits.

Cooperative studies such as these have a broad range of benefits, including: bringing conservation and biodiversity issues to the attention of a large audience of participants and their peers; the ability to collect large sample sizes that would not otherwise be possible; and increasing the stability of
long term studies, as data collection is less heavily reliant on continual financial backing (Couvet et al. 2008). Citizen science contributes a large amount of data about species occurrence and distribution around the world (Bonney et al. 2009) and in some cases has been the backbone of long-term species population monitoring programs (Couvet et al. 2008). Despite some concerns about poor data quality, citizen science programs (provided appropriate training and education) can deliver data of equivalent quality to trained scientists (Danielsen et al. 2014) and inform conservation policy (Bonney et al. 2014). In addition, data collections, including from citizen science, have been shown to deliver benefits unanticipated at the time of their establishment. For example, historical collections such as those of museums and herbaria have more recently been used to gain insights into long term ecological changes, and thus providing a benefit not contemplated when the collections were established (Miller-Rushing et al. 2012). The value of such unanticipated future benefits cannot easily be accounted for in the contemporary evaluation of a program, although there is arguably some value in the establishment and maintenance of any reliable dataset, even if that value has not yet been realised (Wintle et al. 2010).

Citizen science programs vary greatly, and it is likely that program objectives and design, as well as the motivations of participants, will all influence the actual outcomes of a given program (Jordan et al. 2011). Citizen participation can promote engagement with policy making (Weber 2000), and increased knowledge of, and involvement with civic processes (Nerbonne and Nelson 2004). Although a citizen science program can directly contribute to biodiversity outcomes and may have aspirations for educational and behavioural outcomes, it does not necessarily lead to indirect outcomes via behaviour change. A project undertaken by the Cornell Laboratory of Ornithology showed no participant increase in knowledge or attitudes to science or the environment (Brossard, Lewenstein and Bonney 2005). In a project that involved data collection on invasive plants, participants demonstrated increased knowledge and ability to identify invasive plants, but did not demonstrate an increased scientific literacy or translate to behaviour change with respect to invasive plants (Jordan et al. 2011).

Kruse and Card (2004) found that the addition of an animal husbandry component to a zoo-based conservation education program increased the youth participants’ knowledge, attitudes and environmental behaviour. This may simply be an example of the effect that a good interactive component within an active learning program can have. Alternatively, it may be particularly effective as a result of creating stronger connections to nature through empathy (e.g. Schulz 2000) or by making the idea of conservation less abstract through tangible experience, and thereby decreasing the psychological distance between participants and the problems of conservation and related behaviours. Interestingly, Abbot et al. (2001) showed that outreach programs which directly influenced behaviour in turn shifted attitudes. Together, this hints at the potential for hands-on citizen science and conservation volunteering programs to deliver direct benefits whilst also empowering citizens to actively engage in conservation (i.e. enhancing self-efficacy) and promoting positive conservation attitudes.

It has also been shown that gratifying experiences in nature may motivate environmental protection (Kaiser, Hatig, Brugger and Duvier 2013), with different nature activities influencing different types of behaviours (Teisl and O’Brien 2003). Conceivably, gratifying experiences could occur within any active learning or hands-on engagement approach; here, the challenge for program designers is to make their programs as meaningful to participants as possible.
Multiple strategies

Engagement programs that use citizen science or volunteering necessarily also encourage the spending of time in nature as well as some degree of active learning. As such, citizen science and conservation volunteering approaches to environmental engagement may provide the basis of a multi-faceted approach that delivers both direct benefits (i.e. data collected, trees planted, etc.) as well as indirect benefits (i.e. later pro-environmental behaviour). A good example of a successful multi-faceted engagement strategy is provided by Leisher et. al (2012, pp 1006). This study involved “dissemination of conservation information and to support the revival of traditional marine management systems, convening village conservation groups to provide local input on [marine protected area] design, publishing a marine conservation-themed newspaper, developing locally relevant environmental curricula with school teachers, creating a community program of small grants for conservation activities, and developing village regulations to manage local terrestrial and marine resources” as well as social marketing activities. This resulted in markedly improved knowledge and attitudes related to compliance with marine protected area regulations.

Minimising impacts of nature-based recreation activities

One particular type of environmental education is that which seeks to minimise the impacts of visitors on parks and other natural areas that result from their participation in nature-based recreational activities. Rather than seeking to promote pro-environmental attitudes and behaviours generally, these programs target specific behaviours to minimise adverse impacts caused by visitors in particular settings, for example to encourage visitors to keep to walking or riding trails, bushwalkers to place rubbish in bins, campers to use only designated campsites, fishers to not discard fishing line, etc. Examples include the ‘Leave No Trace’ program (Marion and Reid 2001), ‘Minimal Impact Bushwalking’ guidelines (e.g. parkweb.vic.gov.au/learn/teachers/planning-an-excursion/minimal-impact) and are often referred to as ‘Codes of Conduct’ or ‘Environmental Guidelines for Tourists’ (Marion and Reid 2007). As such, these programs are aimed at reducing the impacts that occur as a result of recreating in nature, rather than to engage participants in activities that result in direct benefits, or to promote pro-environmental attitudes and behaviours in the context of people’s day to day lives. Such education strategies have become common approaches for managing visitor impacts (Marion and Reid 2007; Brown, Ham and Hughes 2010). At their most basic, these programs may comprise of information about ‘dos and don’ts’, but can also be designed to develop visitor judgement and decision making beyond context specific ‘rules’. Program information may be disseminated via numerous sources, including booklets, posters, signs, videos, ranger contacts and training courses (Marion and Reid 2007). A review by Marion and Reid (2007) found that many evaluated examples in the literature did effectively influence visitor knowledge, attitudes and behaviour in the manner intended.

In many respects, these education and engagement programs are similar to the ‘information dissemination’ approach outlined above, although here information about the targeted behaviour is provided in the actual setting of the behaviour, potentially enabling it to be better targeted and more effective. The same considerations about how to effectively influence behaviour are relevant here also, including for example eliciting positive attitudes towards the behaviour, use of morals and norms to promote the behaviour, and empowering visitors to identify and undertake an appropriate behaviour (as per TPB). As with all behaviour change programs, an understanding of the elements
that drive the problematic behaviour (or preclude a beneficial behaviour) is an important first step in targeting information and other strategies intended to deter or promote particular behaviour. For example, in some cases simply increasing visitor knowledge will promote targeted behaviours (e.g. Stubbs 1991 in Marion and Reid 2007; Thorn 1995 in Marion and Reid 2007), while in other cases the threat of sanctions (e.g. Johnson and Swearingen 1992; Martin 1992) may be more effective at influencing behaviour. Timing is also important; information about planning a trip to a park is unhelpful if it is provided upon arrival at the park, whereas a reminder on a picnic table not to feed the wildlife can provide a timely reminder that is more effective than if communicated sometime earlier (Marion and Reid 2007). As with all communications, different audiences will respond in different ways, and what is effective for one group of people may not be effective for another. Brown, Ham and Hughes (2010) demonstrate the value of taking the effort to understand the beliefs that underlie specific behaviours within the behavioural setting for the particular population of interest, as a first step in crafting persuasive communication interventions. See Marion and Reid (2007) for a valuable review of this literature and Ham (1992) for a comprehensive guide to environmental interpretation.
Table 1. Summary of key approaches to environmental engagement, how they can result in biodiversity benefits, the chief mechanisms by which they operate, and example references.

<table>
<thead>
<tr>
<th>Type of engagement</th>
<th>Potential biodiversity benefits</th>
<th>Mechanism</th>
<th>Example references</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dissemination of information</td>
<td>Informs and seeks to motivate general or specific pro-environmental behaviour (e.g. information about responsible cat ownership, or sustainable consumption of fish, paper products; palm oil, etc.).</td>
<td>Knowledge-deficit model of behaviour change. Seek to change knowledge, perceptions, motivations and norms in order to influence behaviour.</td>
<td>Schultz 2002b; Steg and Vlek 2009. Information on Sustainability Victoria’s website provides a good contemporary example (<a href="http://www.sustainability.vic.gov.au">www.sustainability.vic.gov.au</a>)</td>
</tr>
<tr>
<td>Spending time in nature</td>
<td>Spending time in nature, especially as a child is an important element of later interest in conservation and behaviour, but not necessarily sufficient to promote pro-environmental behaviour.</td>
<td>Building familiarity, empathy and connectedness to nature may lead to greater pro-environmental behaviour - Reduce psychological distance - Place attachment However, mixed results suggest that there may not be a direct causal link between spending more time in nature and an increase in pro-conservation attitudes.</td>
<td>Tanner 1980; Sia 1984; Sia, Hungerford and Tomera, 1986; Palmer 1993; Palmer and Suggate 1996; Palmer, Suggate, Bajd and Tsaliki 1998; Chawla 1999; Schulz 2000; Bixler, Floyd, and Hammitt 2002; Williams and Cary 2002; Gosling and Williams 2010; Tonge et al. 2015.</td>
</tr>
<tr>
<td>Nature-based tourism</td>
<td>Increased knowledge and pro-environmental attitudes are assumed to result in pro-environmental behaviour.</td>
<td>Building awareness and contextual relevance of conservation issues</td>
<td>Higham and Carr 2002; Lee and Jan 2015; Dunkley 2016.</td>
</tr>
<tr>
<td>Environmental education</td>
<td>Increased knowledge and pro-environmental attitudes are assumed to result in pro-environmental behaviour. Aims to encourage critical thought and Knowledge is a necessary precursor to care and empathy for nature. Active learning and place-based approaches are more effective than passive.</td>
<td></td>
<td>White and Jacobson 1994; Knapp &amp; Barrie, 1998; Jordan and Seger 2001; Lindemann-Matthies 2002; Kruse and Card 2004; Abbot et al. 2001; Leisher et al. 2012; Damerell, Howe, and Milner-Gulland 2013; Lieflander 2013; Collado 2013; Boudet et al. 2016.</td>
</tr>
<tr>
<td>Citizen science and community volunteering</td>
<td>Direct benefits to biodiversity, e.g. trees planted, data collected, weeds removed, etc.</td>
<td>Contributes directly to conservation activities via planting, weeding and other activities.</td>
<td>Randall 1996; Couvet et al. 2008; Newman, Buesching, and Macdonald 2003.</td>
</tr>
<tr>
<td>Minimising impacts of nature-based recreation activities</td>
<td>Reduces the environmental impact of recreation in natural areas.</td>
<td>Education and targeted messaging promotes or discourages specific behaviours (e.g. litter disposal, keeping to designated tracks, etc.).</td>
<td>Marion and Reid 2007 (review); Brown, Ham and Hughes 2010.</td>
</tr>
</tbody>
</table>
Evaluating Environmental Engagement Programs

Evaluation of environmental engagement programs is not trivial, and will likely require multiple approaches to address different objectives of the programs and to capture direct or indirect benefits. Evaluation of environmental education programs is notoriously lacking (Thomson, Hoffman and Staniforth 2010), and hampered by challenges such as the interdisciplinary nature of the field, a lack of clear program objectives or a mismatch between desired objectives and program activities, and compressed time frames for evaluation when compared to the expected time frames of program outcomes (Carleton-Hug & Hug, 2010). When evaluating the impact of a program, it is important to use counter-factual thinking. Because impact evaluation seeks to assess the degree to which measured outcomes can be attributed to the program, rather than to confounding factors that also influence outcomes, it is important to consider what would have occurred had the program not been implemented (Ferraro 2009). For example, the implementation of interpretive signage within a park, designed to deter hikers from venturing off marked paths, could be found to coincide with a marked reduction in trampled vegetation over the same period. This could be seen as evidence of the effectiveness of the signage program. However, it could also have been that the weather or some other factor had suppressed visitor numbers over the period, and that the reduction in trampled vegetation would have occurred anyway, as a result of the reduced visitor numbers. As such, it is important to know what would have occurred without the intervention (i.e. program implementation); this is typically achieved by use of experimental or quasi-experimental designs that compare the effects of an intervention against some other ‘control’ condition in which no intervention (or a different intervention) is implemented. Important in this is the establishment of causal hypotheses (often referred to as a ‘theory of change’) that can be explicitly tested (Ferraro and Hanauer 2014; Ferraro 2009). Such evaluation is particularly important in the context of implementing behavioural influences to effect biodiversity benefits, as the outcomes will likely be affected by numerous confounding factors. Despite this, empirical analyses of environmental program and policy evaluations make up only a minority of the environmental evaluation literature (Ferraro 2009). Notwithstanding the value of experimental design approaches to evaluation, this may not always be practical or appropriate, but the use of counterfactual thinking, even in the analysis of a case study for example, can provide for a more robust evaluation (Ferraro and Hanauer 2014; Ferraro 2009). (See Ferraro and Hanauer (2014) for detailed guidance on applying these concepts to the measurement of environmental and social impacts of environmental programs).

Some direct benefits of environmental engagement programs may be reasonably easily identified and measurable, such as through counting numbers of planted trees, weeds removed, and fences maintained. While monitoring programs may be used to assess the impact and effect of interventions that are intended to deliver on-ground biodiversity outcomes (e.g. Stem et al 2004), measuring the actual contribution of these actions to biodiversity may not be straightforward. Even in cases where environmental engagement programs deliver direct biodiversity outcomes, demonstrating a causal effect between program activities and the biodiversity benefits of interest may be difficult. For example, the construction of frog habitat, as is reported as an outcome of community engagement and monitoring programs by Victorian water agency Melbourne Water, presumably represents an objective to improve the status of certain frog species. Simply measuring the change in extent or number of frog bogs is not sufficient in this case to evaluate program impact on the fundamental objective (e.g. improving the persistence of species X). This can only be achieved
by direct observation of the outcome of interest, or by a theory or change or model that explicitly links the desired outcome (increase in persistence) to the measurable program output (i.e. number of or extent of frog bogs) (Ferraro 2009; Thomson et al. 2010). This highlights the need for a systematic approach to program design and evaluation in which program objectives are explicitly linked to program activities and measurable outcomes.

The measurement and evaluation of the indirect biodiversity benefits of environmental engagement presents additional challenges. The indirect contributions made by data collected via citizen science programs can be quantitatively assessed in terms of the extent to which it reduces specific uncertainty that is affecting management decisions (Runge et al. 2011), or the increase in effective sample size when compared to the variation that might be expected in data collected by experts (see Garrard et al. 2012). Indirect benefits to biodiversity that arise from the future behaviour of engagement program participants can be measured by way of participant self-report, participant observation or by measuring changes in attitudes and behavioural intent as an indicator of future pro-environmental or specific behaviours. It would also be theoretically possible to measure specific biodiversity attributes of an area (using appropriate indicators, as above) and monitoring any improvements over time, following the instigation of a community engagement campaign that sought to raise awareness and influence the behaviours of the local community as it relates to that area. However, this would be difficult for a number of reasons, not least because of the time scales and resources required, as well as the many confounding factors that would make a causal connection of any biodiversity benefits to the engagement program difficult to verify. To the best of our knowledge there is no research that directly evaluates indirect biodiversity benefits of environmental engagement programs by directly measuring biodiversity. Instead, most programs seek to gain some kind of indication of a change in participant behaviour, making the assumption that by promoting certain behaviours, the program will ultimately give rise to environmental benefits (few studies deal specifically within the realm of biodiversity). For example, a recent evaluation of the contribution of zoos and aquariums to Aichi biodiversity targets demonstrated that visitors’ understanding of biodiversity, including of actions to protect biodiversity, were increased as a result of zoo and aquarium visits, however the authors did not seek to measure any behaviour change, let alone any resulting biodiversity benefits (Moss, Jensen and Gusset 2015). In the following paragraphs, we describe key methods for evaluating the indirect benefits attributable to pro-environmental attitude- and behaviour change.

**Participant observation**

In some cases of indirect but specific benefits (for example, programs that promote reductions in energy or water usage), relevant metrics (i.e. water bills, utilities consumption information, etc.) may be easily obtained. In other cases, direct participant observation may be an appropriate method to record participants’ behaviour. This will be most practical where there are fewer participants, and where the behaviour of interest is a specific behaviour in a particular context. Observation is more difficult the more general the advocated behaviour (i.e. how does one monitor and quantify a person’s general pro-environmental behaviour?), and becomes more logistically intense with a greater number of participants. Where participants are aware that they are being observed, this may also influence their behaviour, particularly as a result of social-desirability bias (see self-reported behaviour below)
Self-reported behaviour (and attitudes)

Many environmental engagement studies (and most within environmental psychology) rely on participant self-reporting (via questionnaire) to measure changes in behaviour (Steg and Vlek 2009). This can be problematic due to social-desirability bias, in which the need to be seen to be ‘doing the right thing’ can overshadow honest responses (see Nederhof 1985 for a useful overview of social desirability). For example, it has previously been demonstrated that self-reported pro-environmental behaviour may be significantly higher than observed behaviour (Chao and Lam 2011; Corral-Verdugo 1997; Fujii, Hennesy and Mak 1985). Social-desirability is not limited to questions about behaviour, but is also relevant to questions about attitudes and opinions. However, this can be mitigated to some extent by ensuring participant confidentiality, including assurances that data will be de-identified and providing for anonymity through the use of self-administered surveys and questionnaires (i.e. mail-back or online) (Grimm 2010, although also see Lelkes et al. 2012). This is not to say that self-reported behaviour is never a useful indicator of behaviour (e.g. Warriner, McDougall and Claxton 1984), but that it cannot be relied upon as an accurate measure of actual behaviour.

Measuring attitudes

It’s been long accepted that attitudes can be a predictor of behaviour. However, as there are many factors that influence behaviour, attitudes cannot be assumed to be a perfect proxy for behaviour. For example, despite often holding more favourable environmental attitudes, young people can be more reluctant to commit to pro-environmental behaviour (Grønhøj and Thøgersen 2012) and researchers have routinely observed that even people who claim to possess pro-environmental attitudes often do not act in accordance with those attitudes (Darner 2009).

According to the theory of planned behaviour (Ajzen 1991), behaviour is determined primarily by three different kinds of cognition; these are the attitude towards the behaviour, normative pressure to perform (or not perform) the behaviour, and perceived behavioural control (i.e. self-efficacy) (Brown, Ham and Hughes 2010). This means that for a given set of norms and perceived behavioural control, more positive attitudes toward a behaviour will result in a greater likelihood of forming a behavioural intention. As such, attitudes are often used as an indicator for future behaviour. However, the actual performance of the behaviour (i.e. turning a behavioural intention into a behaviour) is mediated by ‘actual behavioural control’ which refers to the extent to which a person has the capacity (e.g. skills, resources, opportunity) to perform the behaviour (Figure 2). Intention to perform pro-environmental behaviour and a person’s perceived behavioural control are the immediate antecedents of behaviour and thus the best predictor of pro-environmental behaviour (de Leeuw et al. 2015). Generally speaking, where attitude to the behaviour and the subjective norm are more favourable, and where the perceived behavioural control is greater, the stronger should be a person’s intention to perform the behaviour. That is, a person’s intention to adopt a pro-environmental behaviour will increase to the extent that he/she holds favourable attitudes to it, thinks that significant others support the behaviour (i.e. an injunctive norm) or behaves in that way themselves (i.e. a descriptive norm) and perceives themselves to have control over the behaviour (de Leeuw et al. 2015).
Many behaviour change campaigns as well as environmental engagement programs seek to measure their effectiveness by measuring changes in attitudes, with the assumption that an increase in pro-environmental attitudes will result in an increased performance of the behaviours, and thus an indication of program success. Damerell, Howe, and Milner-Gulland (2013 pp1) point out though, in the context of environmental education, that “research on the topic has been biased towards qualitative analysis of ‘perceptions’ and ‘opinions’, limiting the ability to draw conclusions regarding the influence of knowledge acquisition on exhibited behaviour.”

Where environmental engagement studies have sought to measure participant attitudes to nature, this has generally been done via questionnaires, either administered by the researcher or self-administered. Responses are usually recorded via a Likert-like scale in which participants can choose one of several levels of agreement or disagreement to a proposition. For example, the new environmental paradigm scale (Dunlap, Van Liere, Mertig, and Jones 2000) asks respondents to indicate how strongly they agree (i.e. by choosing one of ‘strongly agree’, ‘agree’, ‘unsure’, ‘disagree’, ‘strongly disagree’) to statements such as:

- **We are approaching the limit of the number of people the Earth can support; and**
- **Humans have the right to modify the natural environment to suit their needs** (note there are 15 items in the new environmental paradigm scale).

These questionnaires (often referred to as ‘scales’) are often developed for the specific context of the particular education or engagement program, or adapted from scales previously used in other research. A number of scales have become relatively commonly used, including:

- **The Children’s Attitudes Towards the Environment Scale** (Musser & Malkus 1994), a 24-item scale to measure environmental attitudes of primary school children.
• The Connectedness to Nature Scale (Mayer and Frantz 2004), a 14-item scale that seeks to measure respondents’ affective, experiential connection to nature.
• The Inclusion of Nature in Self (INS) scale (Schultz 2002a), which is a single-item scale that asks respondents to choose one of seven pairs of circles that overlap to varying degrees labelled ‘me’ and ‘nature’ that best represents their sense of connection to the natural world.
• The Nature Relatedness scale (Nisbet, Zelenski and Murphy 2009), a 21 item self-report measure that assesses the affective (i.e. emotive), cognitive, and experiential aspects of individuals’ connection to nature.
• The new environmental paradigm (NEP) scale (Dunlap, Van Liere, Mertig, and Jones 2000; Dunlap and Van Liere 1978), a 15-item self-report measure that aims to measure individuals’ ‘primitive beliefs’ concerning their relationship to the natural world.
• Two Major Environmental Values (2-MEV) is a 20-item scale that measures participants’ intent to preserve the environment, and their usage of the environment (Bogner and Wiseman 2006).
• Motivation towards the environment scale (MTES), a 60-item self-report measure that evaluates an individual’s level of intrinsic and extrinsic motivation for environmental behaviours, as well as accounting for external constraints and influences on behaviour (Pelletier et al. 1998).

Using existing, and where possible, widely-used scales saves time, allows for direct comparison with other studies and can help ensure that the scale will be a reliable measure of the attitude construct of interest. However, available scales may not be suitable for the particular research contemplated, and many researchers develop their own scales tailored to their particular research needs. Different aspects of attitude have been developed for individual studies, including:

• Environmental preferences (e.g. Bixler, Floyd, and Hammit (2002); Lindemann-Matthies (2002));
• Desire for modern comforts (e.g. Bixler, Floyd, and Hammit (2002) following Helson (1959));
• Fear of nature (e.g. Bixler, Floyd, and Hammit (1995, 2002));
• Recreational activity preferences (e.g. Bixler, Floyd, and Hammit (2002));
• Preferences for environmental education (e.g. Bixler, Floyd, and Hammit (2002));
• Environmental perception (e.g. Bixler and Floyd (1999); Bixler, Floyd, and Hammit (2002); Lindemann-Matthies (2002); Kruse and Card (2004));
• Conservation knowledge (e.g. Leisher et al. (2012); Damerell, Howe, and Milner-Gulland (2013));
• Conservation attitudes (e.g. Abbot et al. (2001); Kruse and Card (2004)); and
• Conservation behaviour (e.g. Kruse and Card (2004); Leisher et al. (2012); Damerell, Howe, and Milner-Gulland (2013)).

There are no standard agreed-upon measures for measuring environmental attitudes. Rather, evaluation metrics should be tailored to the particular objectives of individual studies. The choice or design of the scale will depend on what is intended to be measured, and this will depend on the goals of the program. Many studies use quantified data that rely on responses to closed questions. However a combination of data collection methods can aid analysis, and closed questionnaires can
be usefully combined with open-ended questions (e.g. Damerell, Howe, and Milner-Gulland (2013)), group interviews (e.g. Abbot et al. (2001)), or participant observation (e.g. Higham and Carr (2002)) to collect data that may help to further explore variables of interest.

Numerous studies have assessed the effects of an engagement or education program on participants’ knowledge and attitudes (and also, but less often, behaviour) by measuring these before participation in the program, and then again afterwards (e.g. Lindemann-Matthies (2002); Kruse and Card (2004); Boudet et al. (2016)). Subsequent increases (or decreases) in these measures are attributed to the program and taken as a measure of its effectiveness. Some studies conduct both an immediate post-test, and a later post-test, in order to understand whether program benefits are relatively fleeting, or longer lasting (e.g. Jordan and Seger (2001 in Kruse and Card 2004); Kruse and Card 2004). However, this before and after testing of the same groups of participants can be unreliable. Although specific knowledge can be tested for before and after improvements and thus give some indication the effectiveness of education aspects of such engagement campaigns, measurement of attitudes will be subject to social desirability (and related) biases, including a tendency not only to give the socially ‘correct’ responses, but also to provide the ‘correct’ responses that they think the researcher is looking for. As such, by participating in the program, individuals are likely to gain a sense of what the ‘desired’ answers are, making it difficult to distinguish between these effects and the effectiveness of the program. A better approach is to test the knowledge and attitudes of different participants who have participated in different programs, including a control group (e.g. Damerell, Howe, and Milner-Gulland 2013; Boudet et al. 2016), though this may not always be practical.

Correlation between attitudes and behaviour is stronger where attitudes relate to a specific behaviour and where participants are asked if they plan to carry-out the specific behaviour (St John, Edwards-Jones and Jones 2011). Thus the measuring of specific behavioural intentions is likely to produce a better indication of future behaviour than measuring general attitudes. It is also possible to measure behavioural beliefs, norms, and control beliefs via questionnaire (e.g. de Leeuw et al. 2015), although this adds complexity and increases the number of questions needed to be asked. However, this information can be used with the TPB model to better predict intended behaviour. Contextual factors should also be born in mind (Steg and Vlek 2009; Poortinga, Steg and Vlek 2004). A conceptual overview of the ways in which environmental engagement activities may lead to biodiversity benefits is illustrated in Figure 3.
Environmental Engagement

- Citizen science
- Volunteering
- Env Education

Direct benefits to biodiversity through activities such as:
- planting,
- weed control,
- mapping,
- monitoring, etc.

Biodiversity Benefits

Indirect benefits to biodiversity associated with pro-environmental attitude and behaviour change

Evaluate impact using standard monitoring techniques and appropriate baselines

Figure 3. Conceptual model of the ways in which environmental engagement activities may lead to biodiversity benefits, including factors that may be measured to evaluate a program’s benefits or likely benefits.

Theory of Planned Behaviour (Ajzen 1991)
Conclusions

Environmental engagement covers a number of programs, including information campaigns, conservation volunteering, environmental education, citizen science and combinations of these. Environmental engagement programs have been shown to effectively deliver a range of benefits, particularly relating to improved social and learning outcomes. Programs aimed at reducing consumption of resources such as water and energy have also demonstrated environmental benefits. However, the capacity for environmental engagement programs to deliver benefits to biodiversity is poorly understood and evaluations of specific programs are rare.

Environmental engagement programs can deliver benefits to biodiversity either directly, through on-ground improvements that are the result of actions undertaken by program participants (e.g. habitat improvements from plantings or weed control), or indirectly, as a result of subsequent behaviour change (e.g. participants refrain from leaving marked tracks, support conservation organisations, or consider conservation issues when voting). While the direct benefits are more easily observed and recorded, the indirect benefits are arguably more significant, as they create the social and moral context in which biodiversity conservation may be given more weight in decision-making. A better understanding of the ways in which various environmental engagement approaches can promote pro-environmental behaviour change may therefore be useful for designing programs that are more effective at delivering indirect biodiversity benefits.

In general, evidence of biodiversity benefits arising from environmental engagement programs is difficult to find, hampered by poor evaluation practices and little consideration of the range of factors that might deliver indirect benefits. Direct biodiversity benefits may be inferred by assessing change in on-ground outcomes or effective value of the data collected, but demonstrating the resulting benefits to biodiversity may require strategic program design that explicitly links on-ground action and data collection to targeted outcomes of interest (e.g. increase in the persistence of a key species, or resolving critical uncertainties to improve management). Evaluating the effectiveness of programs to deliver benefits through pro-environmental behaviour change is also possible, but requires care to avoid common cognitive biases, such as social desirability bias, in which the desire to be seen to be doing the right thing can distort self-reported metrics of participant behaviour change. Measuring attitudinal change or behavioural intention may be more effective, when used in conjunction with surveys to assess the extent to which participants feel empowered to enact desired pro-environmental behaviours. A number of metrics and psychometric scale are available for this purpose, and may be tailored towards the specific evaluative needs of an environmental engagement program.

When considering the use and design of environmental engagement programs to deliver biodiversity benefits, program designers should be mindful that:

- Indirect biodiversity benefits are unlikely to be delivered simply as a result of participants spending time in nature;
- Similarly, the simple dissemination of information is also unlikely to deliver (indirect) biodiversity benefits, although in some instances can be helpful to prompt biodiversity friendly behaviours within parks (i.e. prompts and rationales to keep to tracks, not feed wildlife, etc.);
• Education-oriented programs that are ongoing rather than ‘once-offs’, and which use active learning within a natural setting are more likely to be effective at promoting positive attitudes towards pro-environmental behaviours, particularly where empathy and a connectedness to nature is developed;

• Allowing student autonomy and encouraging personal responsibility may be more effective at changing attitudes, and programs centred on children can be more effective at influencing their behaviour, whilst also that of their parents, and thus potentially more effective at delivering indirect biodiversity benefits via behaviour change;

• Citizen science and conservation volunteering deliver the most easily observed correlation between participation and biodiversity benefits, and may provide the basis of a multi-faceted approach that delivers both direct and indirect benefits.

• Programs that incorporate multiple strategies for achieving biodiversity benefits are likely to be most effective; and

• Appropriate approaches and methods are important for proper evaluation program effectiveness, including the use of counterfactual thinking.
Glossary of some key terms and factors known to influence behaviour.

Although presented here as distinct concepts, when operationalized, these factors can overlap and interact.

**Affordances (opportunity)**
This relates to the situational context of what alternative behaviours are available (Clayton and Myers 2012), for example an intention to recycle waste is unable to be turned into actual behaviour if there is no infrastructure to support the recycling behaviour. As such, this relates to self-efficacy and is largely analogous to actual behavioural control in TPB.

**Attitudes**
As mentioned above, attitudes toward specific behaviours are more accurate predictors of future behaviour than attitudes towards general types of behaviour. Where a person already has a favourable attitude toward a specific behaviour they may be more likely to undertake that behaviour (subject to other factors, as discussed above), but where they have a negative attitude they must be persuaded to undertake the behaviour (Clayton and Myers 2012). Marketing campaigns use various persuasion techniques to promote positive attitudes towards certain behaviours (Clayton and Myers 2012).

**Emotions**
Emotions, like knowledge, influences attitudes, with emotions often having a greater influence on resultant behaviour (Shiv and Fedorikhin 1999). Kals and Maes (2002) argue that certain environment specific cognitions and emotions together, including control beliefs, ecological responsibility, environmental justice and environment-specific morals are the most powerful predictors for sustainable behaviour. Other factors such as an emotional affinity towards nature are also important. Emotions may also be used in appeals to motivate action, with both hope and fear often used. While both can be strong motivators, fear has often been associated with environmental issue campaigns (e.g. the impending doom of CFCs, climate change, biodiversity crisis, etc.). Such strategies may ultimately be counterproductive as it can lead individuals to avoid the fear-inducing information (Loewenstein et al. 2001).

**Feedback**
Feedback allows people to know how successful they are at performing the behaviour, for example by monitoring their own water or energy usage (Clayton and Myers 2012). As such, feedback likely influences behaviour in a large part via self-efficacy and response efficacy, and also interact with a motivation to achieve goals (e.g. to reduce water consumption by 10%).

**Habits**
Where certain behaviour is already learnt and regularly performed it becomes a largely automatic process that can be performed largely by the subconscious (Kahneman 2011). This can be a barrier to the undertaking of alternative behaviours. Habits must be unlearned and new behaviours learned and implemented in their place.
Incentives and disincentives
These are probably the most common public policy tools used to influence behaviour. For example, laws provide for punishment such as fines or loss of privileges and sometime freedom (as well as giving behavioural guidance and providing normative cues), while the market (underpinned by laws) is driven by the motivation to accrue profit. Incentives and disincentives are not limited to money and legal punishment and the kinds of things that fill this role will be influenced by a person’s values, motivations and needs, amongst other things. However, where somebody has an inherent interest in achieving pro-environmental outcomes (i.e. this relates to a person’s values), knowledge about behaviour (or set of behaviours) may be sufficient to provide motivation to perform the behaviour and achieve goals. Different kinds of things may act as incentives or disincentives to different people who hold different values.

Knowledge
Building knowledge is a key aim of environmental engagement programs, particularly education programs, with aims of increasing participant’s environmental awareness and awareness of the environmental impacts of their behaviour and the benefits of alternatives (Steg and Vlek 2009). It is assumed that the new knowledge results in changed attitudes, which in turn influence behaviour (Steg and Vlek 2009); indeed knowledge has been shown to be one of a number of factors that can predict pro-environmental behaviour (Hines, Hungerford and Tomera 1987). Knowledge-focussed approaches to behaviour change are likely to be most effective when relevant knowledge is low, and the targeted behaviour is convenient and not costly in terms of money, time, effort or social disapproval (Steg and Vlek 2009). Media campaigns aimed at persuasion often focus on providing knowledge in conjunction with promoting positive attitudes (above), which collectively may also influence efficacy.

Norms
Social norms are the codes of appropriate behaviour within a particular social group, and can have a strong influence on behaviour. Norms create a ‘pressure’ to act in a manner that is consistent with the norm, such as that which occurs in the case of peer-group pressure. This can encourage people to perform pro-environmental behaviours such as lowering their water or energy usage to be consistent with others in their neighbourhood (e.g. Schultz et al. 2007; Schultz, Khazian and Zaleski 1998), as well as to promote undesirable behaviour e.g. people are more likely to litter in an environment that is already littered because this indicates that littering is a normal behaviour in that context (Cialdini et al. 1990). A distinction can be made between ‘descriptive norms’ which describe the common behaviour of a relevant group, and ‘injunctive norms’ which refer to the approved behaviour within a group (Cialdini 2003).

Perceived barriers
In a study by de Leeuw et al. (2015), TPB related variables of school children were measured to investigate the influence of these on general (self-reported) pro-environmental behaviours. They found that perceived behavioural control was a strong influencer, which highlights the degree to which potential barriers influence pro-environmental behaviour (i.e. the perception of barriers can negatively influence attitudes and intentions).
Prompts
Prompts remind people about the opportunity and appropriateness to perform a particular behaviour, and can help break previous habits, for example signs on rubbish bins that say “please recycle” or by light switches or water taps that remind people to turn them off to save energy and water. Prompts are generally more effective where they are physically and temporally close to the prompted behaviour, and where they already have positive attitudes toward the behaviour (Clayton and Myers 2012).

Psychological distance
Psychological distance concerns the extent to which individuals think about an object (i.e. a person, event, issue, outcome, etc.), in reference to themselves. When an object is further away in distance, is more socially distant (i.e. relates to people or things different than themselves), is further away in time (i.e. past or future) or is more hypothetical (i.e. uncertain), then it has greater psychological distance. When psychological distance is greater, people tend to think about the object in a more abstract fashion (Barr-Anan et al. 2006) and are less likely to be motivated to take action to address a problem, even when they have positive attitudes (Trope and Liberman 2010). Emphasising those aspects that may be less distant, for example emphasising the close proximity of the effects of climate change, whilst avoiding emphasis on the more distant aspects, for example not highlighting that it may take many years for those effects to be experienced, can reduce psychological distance. Because psychological distance is related to the abstractness with which people construe the object or event, richer more emotive, or vivid descriptions of the object may help reduce psychological distance by creating a more concrete construal (Trope and Liberman 2010).

Self-efficacy (personal agency)
Self-efficacy (also known as ‘personal agency’) is the degree to which a person believes that they are able to undertake the specific behaviour, and is essentially the same as ‘perceived behavioural control’ in Ajzen’s (1991) Theory of Planned Behaviour (TPB). A related concept is ‘response efficacy’ which is a person’s sense that their actions will achieve the intended outcomes (Morton et al. 2011; LaRose, Rifon and Enbody 2008).

Values
Values have been described in a variety of ways, but at their most fundamental level they represent general preferences or goals that underlie (and influence) more specific attitudes, preferences and behaviours (Clayton and Myers 2012; Schwartz 1992). Values influence attitudes which in turn influence (and often used to try and predict) behaviour. For example, in relation to pro-environmental behaviour, people can tend to display three kinds of value oriented behaviours; ‘egoistic’ in which people tend to maximise payoff to themselves and are more likely to value more likely to value such things as social power, wealth, authority, influence and ambition; ‘social-altruistic’ in which people tend to maximise payoff to the group (or society) and likely to value such things as equality, peace, social justice and helping others; and ‘biospheric’ where people tend to maximise benefits to the biosphere and are more likely to value unity with nature, respecting the Earth and pollution prevention (De Groot and Steg 2007 following Schwartz 1992). Although it is not easy to change a person’s values, it is possible to promote those values that can lead to desirable behaviour (e.g. this is an approach advocated by Common Cause (www.commoncause.org.au), or to
appeal to other values in a way that will encourage the desirable behaviour (a typical marketing approach).
References


Schwarz, I., Graymore, M., Freeland , L. (2012). Building local government change agents for resilient and sustainable communities: Sustainable behaviour change literature review. University of Ballarat at


