Progressing Zoo Conservation-Education Evaluation: Application of Theory to Practice

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Declaration

I, Sarah Mellish, declare that this thesis presents work carried out by myself and does not incorporate without acknowledgement any material previously submitted for a degree or diploma in any university; to the best of my knowledge it does not contain any materials previously published or written by another person except where due reference is made in the text; and all substantive contributions by others to the work presented, including jointly authored publications, is clearly acknowledged. I also declare that thesis was edited by Elite Editing, and editorial intervention was restricted to Standards D and E of the *Australian Standards for Editing Practice*.



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List of Abbreviations

ANCOVA	Analysis of Covariance
ANOVA	Analysis of Variance
CBSM	Community-Based Social Marketing
DIT	Diffusion of Innovations Theory
EPHPPQAT	Effective Public Health Practice Project Quality Assessment Tool
GLM	General Linear Model
IUCN	International Union for Conservation of Nature
MANOVA	Multivariate Analysis of Variance
NAM	Norm-Activation Model
PCG	Project Control Group
TPB	Theory of Planned Behaviour
US	United States
VBN	Value-Belief-Norm
WBF	When Balloons Fly
ZAA	Zoo and Aquarium Association

Thesis Summary

Humans are destroying Earth's biodiversity (Ceballos et al., 2015; Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services, 2019; Niemelä et al., 2000). Therefore, encouraging people to engage in behaviours that will conserve and protect nature is critically important to addressing biodiversity loss. Modern zoos are aptly placed to achieve this objective, given their potential to influence large numbers of people for conservation goals. In recent years, zoos have been increasingly functioning as conservation catalysts in response to shifts in public awareness of, and interest in, animal welfare and environmental issues (Minteer, Maienschein, & Collins, 2018; Zimmermann, Hatchwell, Dickie, & West, 2007). Likewise, conservation and education are now prominent goals among the mission statements of the Association of Zoos and Aquarium-accredited organisations (Patrick & Caplow, 2018). What zoos offer to biodiversity conservation is the opportunity to connect people with nature and foster care for it. Connection and care are both fundamental to pro-environmental behaviour; essentially, a person must 'give a damn' before they act with an intention to conserve (Clayton & Myers, 2015, p. 5). This is where zoo-based conservation-education experiences (hereafter referred to as 'zoo conservation education') can play a role.

Empirical outcome evaluations of zoo conservation-education programs are important tools for understanding their effectiveness in creating change and for tailoring the content of future initiatives (Shadish, Cook, & Leviton, 1991). Indeed, a growing body of work is seeking to assess how, and to what extent, zoo conservation-education initiatives are contributing to the conservation objectives of zoos. Guided by the field of conservation psychology and related theories and models, this program of research sought to contribute to the evaluation of zoo conservation education by a) identifying the quality of research methods and reporting practices of peer-reviewed zoo conservation outcome evaluations; b) applying best-practice research methods to a zoo conservation-education program outcome evaluation; and c) exploring the factors that affect conservation-education program development and implementation.

This thesis comprises two introductory chapters, three original research studies, and a discussion chapter. Chapter 1 provides an overview of the global environmental problem of biodiversity loss. In this chapter, it is argued that anthropogenic (human-caused) factors are the primary drivers of biodiversity loss. Key individual and socio-political influences that can serve as barriers to mitigation are unveiled and a knowledge-to-action gap is

explored; principally, that while the issue of biodiversity loss is widely acknowledged, environmentally friendly lifestyle changes among the broader community are less prevalent.

Chapter 2 describes the growing field of conservation psychology and the way its research aims can serve as a guide to overcoming this gap between knowledge about biodiversity loss and uptake of biodiversity-protective behaviours. It is argued that zoos have the potential to increase the prevalence of pro-environmental behaviours among the public. The chapter discusses the theory of planned behaviour (TPB; Ajzen, 1985, 1991, 2002) and the model of diffusion in service organisations (Greenhalgh, Robert, Macfarlane, Bate, & Kyriakidou, 2004) as the primary guiding theoretical frameworks for the thesis. Throughout these introductory chapters, examples are highlighted from within the Australian context and a marine environment perspective, to contextualise the empirical work of the thesis appropriately, as a program of study that is conducted in an Australian zoo context and based on a conservation-education program for marine wildlife.

Chapter 3 presents the first original research study of this thesis, which comprises a review of research methods and reporting practices in zoo and aquarium conservation-education evaluation research. Using a systematic search and coding strategy, as well as a validated methodological quality appraisal tool, the research methods and reporting practices of 47 articles (48 empirical studies) that evaluated a zoo conservation-education program or experience were reviewed to understand the quality of conservation-education research methods and completeness of reporting practices. The review examined elements of internal, external, construct, and statistical conclusion validity. In terms of method quality, the majority of studies (83.3%) held a ‘weak’ methodological quality rating; the remaining 16.7% had methods of ‘moderate’ quality. For example, a limited number (20.8%) of studies reported piloting measures prior to data collection, and only around one-half of keeper talks (just under 20% of all interventions) were standardised (i.e., used scripts). Reporting practices were generally incomplete; for example, less than half (43.8%, $n = 21$) of the studies reported effect sizes and only twenty-seven (56.3%) reported participant response rates. Overall, the findings highlighted consistent limitations in the way zoo conservation-education programs are evaluated and reported; for example, few evaluations tracked self-reported behaviour change post-visit; few evaluations conducted a pilot study regarding outcome measures; and few evaluations adopted a research design with a control or comparison group.

The second study (reported in Chapter 4) is a six-month outcome evaluation of Melbourne Zoo’s *When Balloons Fly* conservation-education program. The study sought to

overcome some of the traditional research limitations identified in Study 1 (in Chapter 3). The When Balloons Fly program seeks to address the problem of balloon-sourced marine debris by encouraging visitors to use wildlife-friendly bubbles instead of balloons at outdoor events. The results from Study 2 have provided new information about what Melbourne Zoo visitors know, and how they think and act, concerning balloon and bubble use, and balloon-sourced marine debris. Overall, the program is promoting greater depth of understanding among zoo visitors concerning the effects of outdoor balloon use on marine wildlife, encouraging more positive attitudes concerning balloon use outdoors post-visit, and inspiring intent to act, with visitors generally reporting an increased likelihood of using bubbles and a reduced likelihood of using balloons. In terms of post-visit conservation behaviour, visitors reported talking about the issue of outdoor balloon use and modifying their behaviours at outdoor events (by not using balloons, using bubbles, or using other alternatives to balloons e.g., biodegradable confetti). Importantly, more than two-thirds of the follow-up sample specified that the behaviours they reported changing at an outdoor event after their visit were influenced by their zoo experience.

Another major finding from Study 2 was the potential priming effect of pre-entry/baseline surveys in a zoo setting. Visitors who completed a pre-survey reported significantly more positive attitudes (p = .000) and significantly lower likelihood of using balloons (p = .000) than visitors who did not complete a pre-survey; this indicated a priming effect. This outcome provides an exemplar of how adopting best-practice research methods and reporting of results can uncover new evidence (at least within the context of zoo conservation education). Establishing such rigour is pertinent to alleviate threats to validity, especially in a field of inquiry that seeks to evaluate interventions that are inherently diverse in their scope and aims.

The third study, reported in Chapter 5, aimed to examine a range of other factors that can influence the efficacy of zoo conservation-education programs. In particular, it focused on factors related to the way such programs are implemented, through an in-depth evaluation of WBF's implementation evaluation processes. An online survey was completed by 24 Zoos Victoria staff who were involved in the When Balloons Fly program, four of whom participated in a follow-up interview. The model of 'diffusion in service organisations' was used as an interpretive lens to analyse the participants' responses. The findings revealed that the most influential factors in terms of creating challenges and successes were perceived primarily to originate in features of the organisation (e.g., culture and structure), rather than in individuals or characteristics of the program itself. Specifically,

the *organisational readiness for innovation* and *organisational antecedents for innovation* domains of the model (Greenhalgh et al., 2004), which sit within the broader theme of *inner (organisational) context,* were dominant themes for both the challenges and successes. In addition, successes frequently sat within the *implementation and routinisation process* domain. These findings suggested that attention to the organisational context is critical for promoting and evaluating the success of conservation-education programs, and must be given significant attention alongside program characteristics and staff capability to deliver them.

This thesis offers new knowledge about the way zoo conservation-education research methods and reporting practices shape what we know about conservation-education programs in zoos, as well as ways to overcome the limitations of the existing research in the field. It provides novel insights into the way organisational factors (which have not previously been examined in the zoo context) may shape zoo conservation-education program outcomes. In Chapter 6, these contributions are drawn together and an integrated approach to conservation-education evaluation is proposed. This approach suggests redefining the evaluation focus from being outcome-only to being one that includes 1) an outcome focus; 2) a process focus; and 3) attention to the quality of the evaluation research and reporting. Together, these contributions have potential to advance the way researchers and evaluation practitioners tackle the conservation-education evaluation process and ultimately, enhance the ability to measure, predict, and control outcomes of interest (e.g., knowledge, attitude, behaviour). These contributions are the foundation for the three recommendations that are suggested for future practice: 1) adopt a three-pronged approach to zoo conservation-education evaluation; 2) utilise the model of diffusion in conservation organisations for zoo conservation-education implementation evaluations; and 3) where possible, integrate robust research methodological and reporting rigour in zoo conservation-education evaluations. Implementing these recommendations will be necessary for zoos to reach their full potential as catalysts for conservation.

Dissemination of Thesis Findings

The following papers based on this thesis are under review, in press, or published:

Mellish, S., Ryan, J. C., Pearson, E. L., & Tuckey, M. R. (2019). Research methods and reporting practices in zoo and aquarium conservation-education evaluation. *Conservation Biology*, *33*(1), 40–52. doi:10.1111/cobi.13177

Mellish, S., Pearson, E. L., McLeod, E. M, Tuckey, M. R., & Ryan, J. C. (2019). What goes up must come down: An evaluation of a zoo conservation-education program for balloon litter on visitor cognition, affect, and behaviour. *Journal of Sustainable Tourism, 27*(9), 1393-1415. doi:10.1080/09669582.2019.1625908

Mellish, S., Ryan, J. C., McLeod, E. M., Tuckey, M. R., & Pearson, E. L. (under review). Challenges and successes to the implementation of a zoo conservation-education program. *Evaluation and Program Planning.*

The following conference presentation was given based on aspects of this thesis:

Mellish, S. (2018). Which outreach strategies work best for zoos? Outcomes from a conservation-education campaign. Paper presented at the *International Conservation Marketing and Engagement Congress*, October 25–27, Washington, DC.

Chapter 1: Human Influence on Biological Diversity

Summary: This thesis seeks to advance best-practice zoo conservation education. To understand why there is a critical need for effective zoo conservation-education, whereby people can connect to nature and be inspired to act to conserve biodiversity, it is first necessary to establish how and to what extent human behaviour is contributing to biodiversity loss. This chapter reviews the role of biodiversity in sustaining life on Earth, discusses key anthropogenic (human-caused) drivers of biodiversity loss, and outlines some of the major individual and socio-political barriers to mitigating biodiversity loss.

1.1 Introduction

> *To prevent widespread misery and catastrophic biodiversity loss, humanity must practice a more environmentally sustainable alternative to business as usual . . . . We must recognize, in our day-to-day lives and in our governing institutions, that Earth with all its life is our only home* (Ripple et al., 2017, p. 1026).

It is well established that rapid human population growth has facilitated unsustainable consumption of resources and placed immense pressure on Earth's capacity to support its inhabitants (Ehrlich & Holdren, 1971; Goudie, 2018). Population growth was relatively steady until the 20th century, taking almost seven centuries to increase from 0.25 to 0.5 billion (Roser & Ortiz-Ospina, 2018). But during the 1800s, after the industrialisation era ushered in increases in living standards, such as improved health care, per capita income, and education (Krausmann et al., 2009; Steckel & Floud, 2008), the world's human population doubled in just 37 years (1950–1987), increasing from 2.5 to 5 billion people (Roser & Ortiz-Ospina, 2018). While population growth rate has slowed substantially since then, the global human population is now estimated at 7.6 billion, and is expected to reach 9.2 billion by 2040 (Roser & Ortiz-Ospina, 2018). In the past half century, in response to the consumption demands of this fast-growing population, humanity has altered Earth's ecosystems more rapidly and extensively than any other period in human history (Millennium Ecosystem Assessment, 2005). This human influence on Earth's systems, made up of the hydrosphere, atmosphere, lithosphere, and biosphere, is so extensive that geologists and geomorphologists have asked for the addition to the Geological Time Scale of a new, human-dominated geological epoch. They suggest it should be called 'The Anthropocene' (from the Greek 'anthropo-' meaning human and '-cene' meaning period), to reflect the effect of human activity on nature (Crutzen & Stoermer, 2000; Lewis & Maslin, 2015; Smith & Zeder, 2013).

Measuring the human effect on biodiversity is an important first step in identifying priority areas for change. One seminal framework that seeks to operationalise the anthropogenic effect on the natural environment on a global scale is the planetary boundaries model (Rockström et al., 2009a, 2009b). This model proposes 'safe operating spaces' for nine geological processes that are essential for human development. The safe operating spaces represent biophysical *buffers,* which if transgressed, could trigger adverse environmental change and threaten human development. The nine geological processes are 1) stratospheric ozone depletion (concerns the amount of ultraviolet radiation reaching

ground level); 2) biosphere integrity (concerns species biodiversity loss and extinction); 3) chemical pollution and release of novel entities (e.g., release of toxic substances such as radioactive materials); 4) climate change (concerns the amount of carbon dioxide released into the atmosphere); 5) ocean acidification (i.e., lowered pH level of ocean water); 6) freshwater use (i.e., shifts in flow and vapour caused by land consumption of water); 7) land-system change (e.g., conversion of forests and grassland to agricultural land); 8) biogeochemical cycles (i.e., nitrogen and phosphorus flowing into the biosphere and oceans, resulting in, for example, oxygen-starved aquatic systems); and 9) atmospheric aerosol loading (i.e., aerosol interaction with water vapour, which can shift weather and climate systems). Ten years later, this model, and its boundaries, remain relevant and these have provided a focus for a variety of recent scientific explorations. Examples are the design of sustainable energy mixes (Algunaibet et al., 2019); the development of the Phosphorus Exceedance Footprint, an indicator for unsustainable phosphorus pollution (Li, Wiedmann, & Hadjikakou, 2019); the establishment of definitions for economic growth (Stoknes & Rockström, 2018); and the creation of a lifecycle impact assessment (Ryberg, Owsianiak, Richardson, & Hauschild, 2018).

An updated assessment of the model indicates that the boundaries of four geological processes (climate change, biosphere integrity, land-system change, and biogeochemical cycles) now exceed their respective ‘safe operating spaces’ (Steffen et al., 2015). As indicated by the colour red in Figure 1.1, the processes biosphere integrity and photochemical flows have reached a level of ‘high risk’, representing a level beyond the zone of uncertainty. Given the empirical components of this thesis pertaining to zoos and their role in wildlife conservation, low biosphere integrity (biodiversity loss and extinction) is the most relevant geological process to the scope of this thesis. Thus, this element informs the focus of the following sections, which discuss in more detail the concept of biodiversity, the anthropogenic drivers for biodiversity loss, and the barriers to biodiversity-protective behaviours at the individual and socio-political levels.

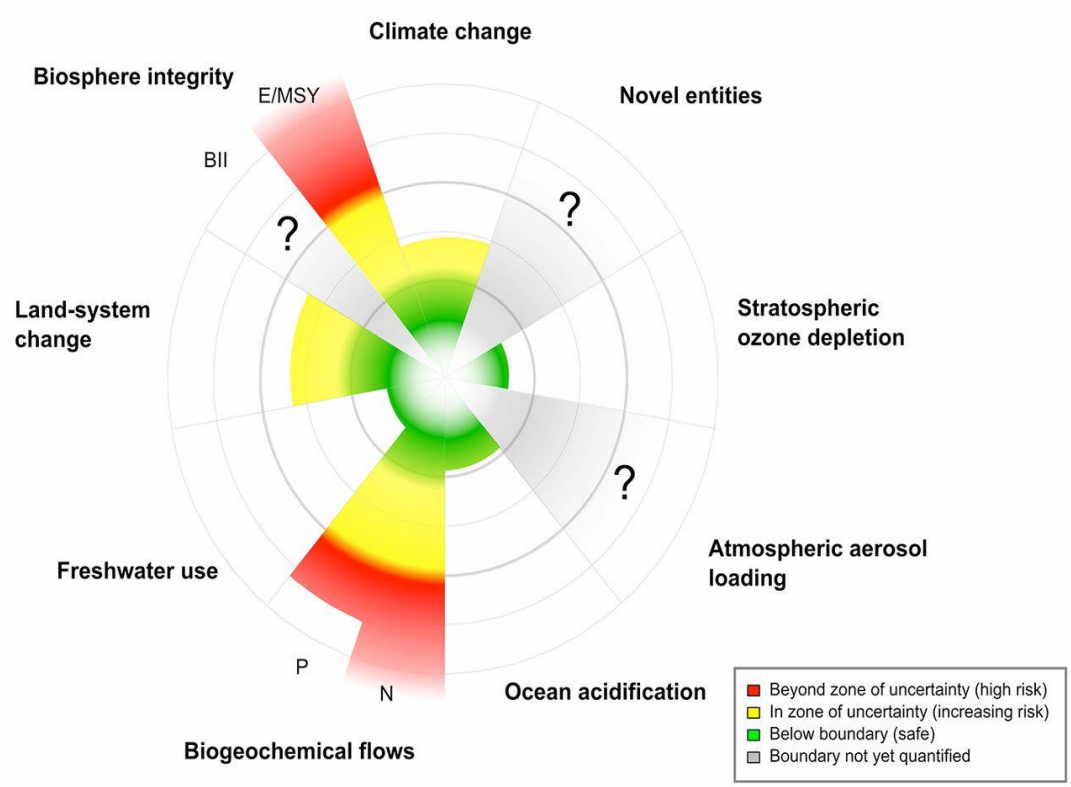


Figure 1.1. The updated planetary boundaries model. Climate change, biosphere integrity, land-system change, and biogeochemical cycles have all exceeded their respective safe operating spaces (Steffen et al., 2015; © 2018 American Association for the Advancement of Science). Please note: permission to use this image has not yet been granted, and if permission is not received from the copyright owners, the image will be removed before a digital copy of the Thesis is made available.

1.2 Biological Diversity

Biological diversity or 'biodiversity' describes the total amount and variability of all living organisms on Earth (DeLong, 1996; Morton, Sheppard, & Lonsdale, 2014). Biodiversity encompasses species diversity (variety of different species in the world, from plants, to animals, to micro-organisms), genetic diversity (variety of genes among plants, animals, and micro-organisms), and ecosystem diversity (range of habitats in which plants, animals, and micro-organisms live; Morton et al., 2014). Together, these dimensions of biodiversity regulate the global ecosystem that supports life and quality of life on Earth (Morton et al., 2014). Ecosystem services are the suite of functions regulated by biodiversity, and biodiversity, in turn, provides services to benefit and sustain human well-being (Haines-Young & Potschin, 2010; Millennium Ecosystem Assessment, 2005). In fact, biodiversity has been described as the 'engine room' for ecosystem services (Close, Zammit, Boshier, Gainer, & Mednis, 2009, p. 4). These services offer a variety of functions, from cultural benefits (which describe any non-tangible advantage, such as aesthetic inspiration and cultural identity), to life-supporting services, including nutrient dispersal and cycling,

and climate regulation (United Nations Convention on Biological Diversity, 2006; see Figure 1.2 in this thesis). Ultimately, these services are critical to human health and safety, psychosocial well-being, and the human capacity to access essential resources, food, medicines, and building materials (United Nations Convention on Biological Diversity, 2006).

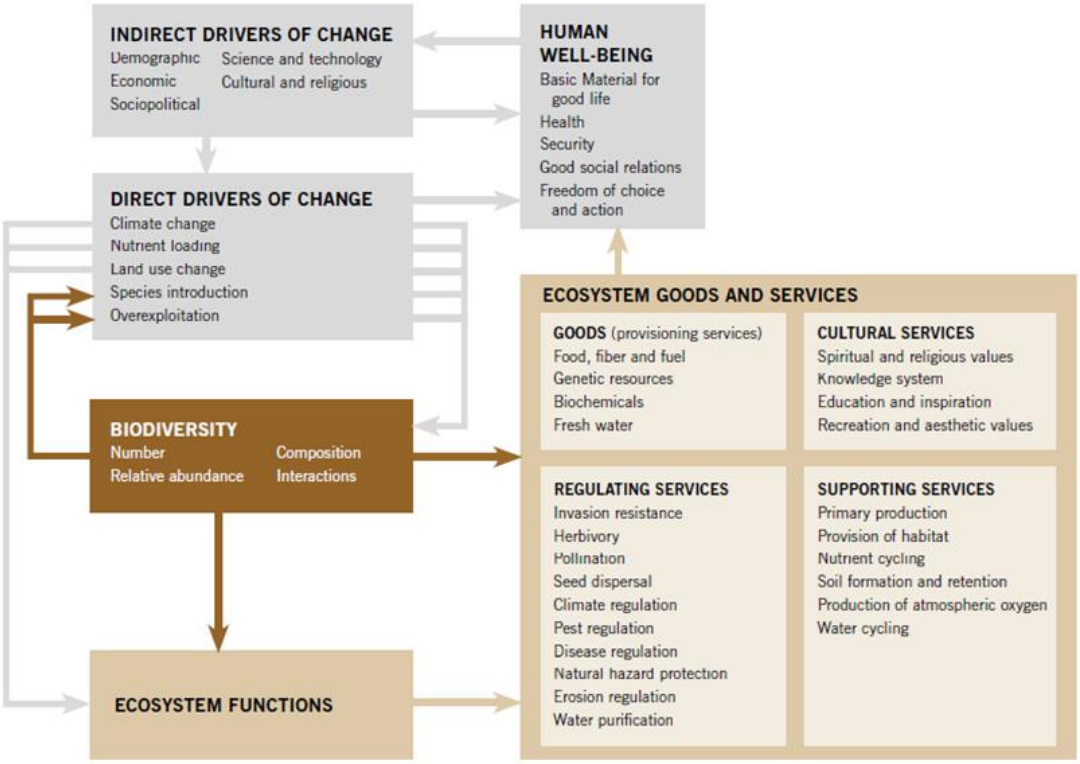


Figure 1.2. The link between biodiversity and ecosystem services (United Nations Convention on Biological Diversity, 2006; © Secretariat of the Convention on Biological Diversity). Please note: permission to use this image has not yet been granted, and if permission is not received from the copyright owners, the image will be removed before a digital copy of the Thesis is made available.

Through a multitude of processes such as urban development, transport, and resource extraction (to name a few), human activity now poses substantial adverse threats to biodiversity abundance (Butchart et al., 2010; Davenport & Davenport, 2006; Goudie, 2018; McDonald, Marcotullio, & Güneralp, 2013; Meyer & Meyer, 1996). Approximately 60% of herbivores and 59% of carnivores are now threatened with extinction (Ripple et al., 2014; Ripple et al., 2015). More broadly, species extinction rates are estimated to be 100 to 10,000 times faster than the natural geological rate, depending on whether calculations include known species or take into account the predicted extinctions hundreds of years into the future (Barnosky et al., 2011; Millennium Ecosystem Assessment, 2005; Pimm et al., 2014). In fact, the results from the recent Intergovernmental Science-Policy Platform on

Biodiversity and Ecosystem Services Global Assessment (2019) provide overwhelming evidence that the health of Earth's ecosystems is deteriorating more rapidly than previously thought. Having established that biodiversity is a major influencer of global ecosystem change, this discussion now turns to the anthropogenic drivers of this problem.

1.3 Anthropogenic Drivers of Biodiversity Loss

At the population level, an anthropogenic 'driver' describes a human-origin factor that changes an aspect of an ecosystem (Millennium Ecosystem Assessment, 2005). There are direct and indirect anthropogenic drivers of biodiversity loss. Direct drivers are measurable, explicit influences on ecosystem functions; indirect drivers are the underlying causes of direct drivers. Indirect drivers operate more broadly and can alter several direct drivers (Nelson, 2005). The Millennium Ecosystem Assessment (2005) identifies five *indirect* driver categories of ecosystem change: demographic; economic; socio-political; scientific and technological; and cultural and religious (see Figure 1.3):

1. The *demographic* driver group recognises that a growing human population, as well as the geographical distribution of people, influences human consumption patterns and subsequently their effects on the natural environment (Nelson, 2005). The issues of human population abundance and distribution are particularly pertinent, since many areas of biodiversity richness comprise larger numbers of threatened species and lower socio-economic communities (Mainka, 2002).
2. An *economic* driver describes any human activity that attempts to create goods and/or services that can benefit human well-being (Nelson, 2005). For example, the income that a person receives could determine the nature and extent of their energy and food consumption.
3. *Socio-political* drivers refer to factors that influence societal decision making. This might include the level of public participation in national decision making (e.g., authoritarian government vs democracies) and strategies that a nation might use to resolve disputes (e.g., international co-operation vs war; Millennium Ecosystem Assessment, 2005).
4. *Cultural and religious* drivers define the values, beliefs, and norms, shared within a group, that are influential to decision making concerning the natural environment. These influences can determine what a group of people consider important and guide what measures are (or are not) adopted to conserve nature (Millennium Ecosystem Assessment, 2005).

5. *Science and technology* encompasses the development and dissemination of knowledge and technology to increase productivity in acquiring natural resources. This includes, for example, the creation and dissemination of international agreements (e.g., patents, copyright laws) and genetic modification of food crops for higher potential yield (Millennium Ecosystem Assessment, 2005; Nelson, 2005).

Indirect drivers are deeply interwoven. For example, the location and abundance of human populations (a demographic driver) is moderated by resource availability (an economic driver) and the way a population decides to use the available resources (a socio-political and cultural driver; Millennium Ecosystem Assessment, 2005; Nelson, 2005). Similarly, resource availability, an economic driver, is moderated by a population's capacity to acquire the material, which is a science and technology driver (Millennium Ecosystem Assessment, 2005; Nelson, 2005). The combined effect of these indirect drivers has shaped human activities and the detrimental flow-on effects for the natural environment. These activities are the cornerstone of the direct drivers of biodiversity loss mentioned (in different capacities) by the Millennium Ecosystem Assessment (2005) and United Nations Convention on Biological Diversity (2006), and provide structural guidance for the preceding overview of ways humanity directly influences the natural environment. In the next section, the different terms used by the Millennium Ecosystem Assessment and United Nations Convention on Biological Diversity to label the direct drivers have been synthesised and are discussed below as 1) habitat change (comprising habitat loss and habitat fragmentation); 2) pollution; 3) invasive alien species; 4) climate change; and 5) overexploitation. Figure 1.3 provides example human actions and the consequences of biodiversity loss related to these direct drivers. For example, human actions related to pollution include littering, transport, landfill, and runoff from urban and agricultural backgrounds, which can yield adverse consequences such as nutrient loading and marine wildlife entanglement in, and ingestion of, waste products and debris. To highlight the severity of the biodiversity crisis, and thus provide a strong grounding for the critical importance of the empirical research components of this thesis, the next section of this chapter discusses each of these direct drivers in further detail.

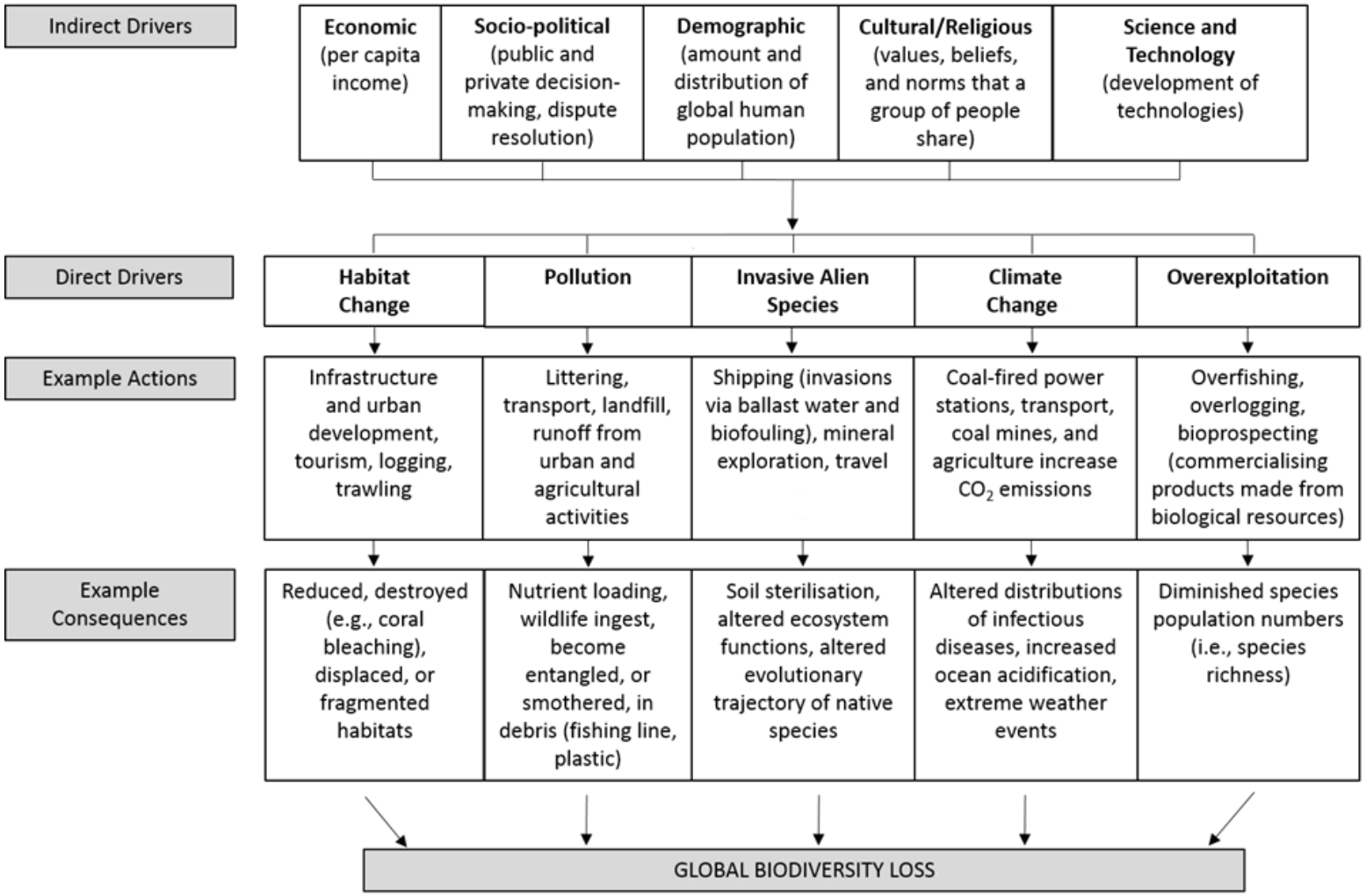


Figure 1.3. Anthropogenic indirect and direct drivers of global biodiversity loss with example human actions and their consequences.

1.3.1 Habitat change. Habitat change encompasses shifts in the composition (*habitat loss* or *degradation*) and/or the spatial configuration (*habitat fragmentation*) of natural living spaces (e.g., land, coral reef). There are subtle differences in the types of habitat change, which can influence the extent of their effects. Habitat loss or degradation describes the process of a wild space degrading from habitable to inhabitable (Morrison & Mathewson, 2015). In contrast, habitat fragmentation is a pattern that occurs when large habitable environments are reduced, leaving multiple smaller, more isolated habitable patches (Fahrig, 2003, 2017; Morrison & Mathewson, 2015; see Figure 1.4 following).

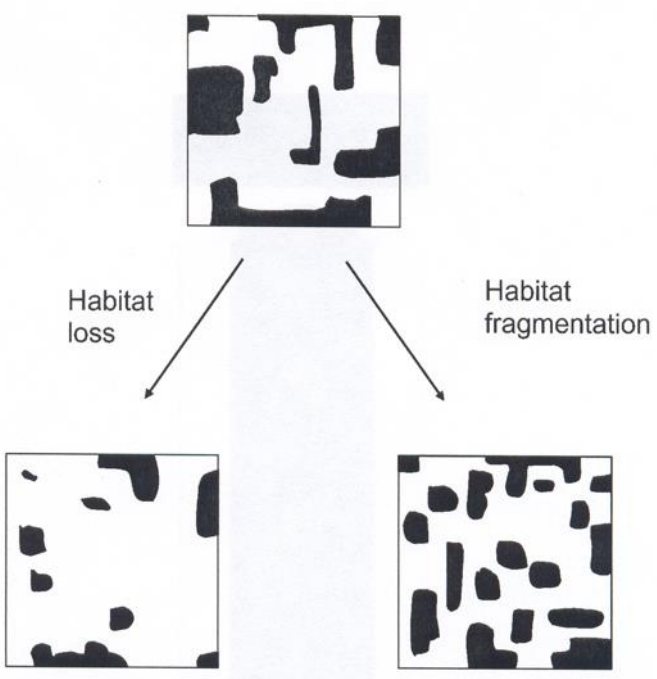


Figure 1.4. Difference between habitat loss and habitat fragmentation (adapted from Fahrig, 2003). Please note: permission to use this image has not yet been granted, and if permission is not received from the copyright owners, the image will be removed before a digital copy of the Thesis is made available.

It is important to differentiate between these types of habitat changes because they can have different effects on biodiversity richness. Habitat fragmentation, independent of habitat loss, has weaker adverse effects on biodiversity (Fahrig, 2003, 2017). In fact, a recent review of the adverse effects suggests that where there is no overall loss of habitat, significant habitat fragmentation is related to less, rather than more, biodiversity loss (Fahrig, 2017). In contrast, habitat loss generally has strong, consistent negative effect on biodiversity (Fahrig, 2003, 2017). For example, habitat loss can lead to declines in species richness/population abundance (Bender, Contreras, & Fahrig, 1998; Helm, Hanski, & Pärtel, 2006; Schipper et al., 2008; Thompson, Rayfield, & Gonzalez, 2017), genetic diversity (Gibbs, 2001), and

breeding success (Kurki, Nikula, Helle, & Lindén, 2000). Indeed, according to Evans et al., 2011), habitat loss is the greatest threat, affecting 81% of extant Australian threatened species.

An iconic example of the effects of habitat loss in the Australian marine environment is the decline in coral cover on the Great Barrier Reef. Over the past 27 years, this coral reef system has faced a damaging level of deterioration in hard (stony, reef-building) coral cover from 28 to 14%, representing loss of habitat for tens of thousands of species (De'ath, Fabricius, Sweatman, & Puotinen, 2012). Declines in hard coral cover can be attributed to mass coral bleaching, which is directly ascribable to rising atmospheric greenhouse gases from carbon dioxide emissions (Hoegh-Guldberg et al., 2007) and increased levels of oxybenzone, a UV filter and reef-destroying chemical found in sunscreen (Danovaro et al., 2008) and fertiliser (Tillett, 2009).

Alongside the global increase in greenhouse gas emissions and dispersion of oxybenzone, destructive fishing is another key anthropogenic activity causing habitat loss in the marine environment. Common intensive fishing methods to acquire greater food yields, or to collect fish for the aquarium trade, include bottom trawling, dynamiting, and poisoning (Jones, 1992; Pusceddu et al., 2014; Thrush & Dayton, 2002). Bottom trawling involves dragging large weighted fishing nets across the seabed (with spreads of up 55 metres wide and 12 metres long; Morgan & Chuenpagdee, 2003), disturbing most objects in their path (Stiles, Stockbridge, Lande, & Hirshfield, 2010). Dynamite or blast fishing uses shock waves from explosives detonated in water to kill or stun fish (Coral Reef Alliance, 2005). This process can shatter coral skeleton completely, making it difficult for affected reefs to recover (Alcala & Gomez, 1987; Fox & Caldwell, 2006; Fox, Pet, Dahuri, & Caldwell, 2003). Poisoning (or cyanide fishing) is used primarily to collect live fish for the aquarium trade, stunning the fish by scattering cyanide onto reefs (Jones & Steven, 1997). The dispersion of this chemical slows down photosynthesis, resulting in bleached or destroyed coral skeleton (Jones & Steven, 1997). Together, these practices either partially disturb or completely obliterate the marine habitat structures (e.g., coral skeletons, burrows) that are important for functioning marine environments.

1.3.2 Pollution. Pollution describes any solid, liquid, or gaseous substance that enters the natural environment and causes adverse effects on living organisms and/or habitat structures (Russell, 1974). Through a variety of activities, including the burning of fossil fuels, agricultural practices (use of fertilisers), illegal waste dumping, and transport, humans are

polluting natural living spaces with harmful substances that hinder the capacity for marine species to eat, mate, and communicate (Gordon, 2018). Bagad (2009) classified physical pollutants according to their degradability:

- *degradable or non-persistent* pollutants decompose rapidly by natural processes (e.g., sewage, food waste)
- *slowly degradable* pollutants decompose slowly by natural processes (e.g., plastics)
- *non-degradable* pollutants cannot be degraded by natural processes (e.g., nuclear waste).

Regardless of the level of degradability, all pollutants can degrade both terrestrial (e.g., forest, grassland) and aquatic (e.g., ocean, rivers, streams, lakes, ponds) ecosystems. The remaining sections of this thesis focus on pollution relative to aquatic ecosystems. Oil pollution, marine debris, and noise pollution are discussed next, as examples of the broader issue of environmental pollution. Together, these three forms of pollution are significantly altering the structure of the marine environment and the behaviours of its inhabitants, contributing to global biodiversity loss.

1.3.2.1 Oil pollution. Crude oil is the primary energy source for humans. According to the World Ocean Review (2014), it accounts for 33% of the world's energy consumption, followed closely by coal (30%) and natural gas (24%). Largely driven by population growth, a rise in demand for this form of energy for transportation, heating, and electricity has resulted in the development of advanced techniques to recover oil reserves in less reachable locations, principally offshore (i.e., under the seabed) and at greater depths. Offshore deep-water oil drilling is much more complex than traditional onshore (land-based) oil extraction methods, with a greater risk for accidents, including oil spills. One of the largest marine oil spills in recent history was the 2010 Deepwater Horizon oil spill. Over more than 87 days, approximately 4 million barrels (779,037,745 litres) of oil leaked from BP's Deepwater Horizon oil rig, located 5,000 ft below the ocean surface in the Gulf of Mexico (National Commission on the BP Deepwater Horizon Oil Spill and Offshore Drilling, 2010). The Deepwater Horizon environmental disaster has had catastrophic implications for local marine biodiversity, including the depletion of nearby deep-water coral communities (White et al., 2012).

Oil in aquatic environments can harm organisms in several ways. Animals can ingest oil (either directly or via consumption of other animals that have encountered the substance), causing ulcers, bleeding, and digestive problems (Ober, 2010). Oil that comes in to contact

with, and/or is absorbed through, the skin (see the oil-drenched pelican in Figure 1.5, top right) can result in irritation, burns, infections, and damage to the liver and kidneys, which in turn, can lead to a weakened immune system and reproductive failure (Ober, 2010). Further, inhalation of oil chemicals can cause respiratory inflammation, emphysema, and pneumonia, and is of particular concern for air-breathing aquatic animals exposed to vapours when they surface to take breaths: for example, whales and sea turtles (Ober, 2010).



Figure 1.5. Effects of marine pollution on marine wildlife. Top left: Australian fur seal (Arctocephalus pusillus) with a neck laceration scar from entanglement in fishing gear (Zoos Victoria, 2019; © Zoos Victoria). Top right: Oil-drenched brown pelican (Pelecanus occidentalis) after the 2010 BP Deepwater Horizon oil spill (Hiltzik, 2014; © Carol Cole). Bottom left: Deceased Laysan albatross (Phoebastria immutabilis) with plastic-filled stomach (van Mensfoort, 2009; © Chris Jordan). Bottom right: Deceased Common Thresher shark (Alopias vulpinus) entangled in a discarded gill net (Smithsonian Institution, 2018; © Brian Skerry). Please note: permission to use these images has not yet been granted, and if permission is not received from the copyright owners, the image will be removed before a digital copy of the Thesis is made available.

1.3.2.2 Marine debris. According to Gray (1997), marine debris is a major threat to marine biodiversity. Marine debris is any persistent, manufactured, or processed solid substance that is discarded, disposed of, or abandoned in aquatic environments (Coe & Rogers, 1997). Gall and Thompson (2015) noted that 690 known species had encountered marine debris, with 92% of the interactions being with plastic. Marine debris can threaten marine life in several ways, including entanglement and ingestion (Gall & Thompson, 2015; Gregory, 2009; Laist, 1997; Sheavly & Register, 2007). Entanglement most often occurs when an animal encounters discarded fishing nets (‘ghost nets’), line, rope, balloon attachments, and other

string-like debris (Gall & Thompson, 2015; Kühn, Rebolledo, & van Franeker, 2015). These forms of debris can trap or smother animals, causing skin lesions and sores (see Figure 1.5, top left), and drowning (see Figure 1.5, bottom right; Gall & Thompson, 2015). Ingestion of debris can occur when an animal mistakes an item of debris for food; for example, sea turtles likely ingest plastic bags because they resemble jellyfish, a typical prey item (Schuyler, Wilcox, Townsend, Hardesty, & Marshall, 2014). Consequences of ingestion include blockage of the digestive tract and stoppage of the gut, which can lead to starvation and death (see Figure 1.5, bottom left).

1.3.2.3 Aquatic noise pollution. Aquatic noise pollution is receiving increasing recognition as an emerging major threat to marine biodiversity (Nabi et al., 2018; Rako-Gospić & Picciulin, 2019; Simmonds et al., 2014). In water, sound waves travel nearly 4.5 times faster than in air (1500 m/s vs 340 m/s, respectively); therefore, the reduction in noise level is less over the same distance in water compared with air (Studds & Wright, 2007). This means that sound can travel across larger areas and maintain a higher amplitude in water than in air, magnifying the potential to harm marine inhabitants.

Aquatic noise pollution can be attributed to three key anthropogenic sources: vessel traffic; seismic exploration (an assessment method to find oil and gas by emitting loud noise pulses into water from compressed air guns); and sonar (the use of sound pulses to detect objects below the ocean surface; Hildebrand, 2004; Gordon, 2018). Exposure to aquatic noise pollution can cause temporary or permanent hearing damage; conceal communications related to mating and predator–prey interactions (acoustic masking); impede an animal's capacity to navigate, resulting in displacement; and induce stress (Clark et al., 2009; Gordon, 2018). Further, sonar noise pollution likely induces unnatural behavioural responses in deep-diving animals (such as repetitive shallow diving), leading to decompression sickness, which occurs when a rapid decrease in pressure produces an accumulation of gas bubbles in the blood and tissue (Zimmer & Tyack, 2007). Ailments of decompression sickness include haemorrhaging in the hearing structures, which has been found among mass groups of stranded (yet otherwise unharmed) beaked whales (*Hyperoodontidae*; Cox et al., 2006).

1.3.3 Invasive alien species. Another direct driver of biodiversity loss is the effect of invasive alien species. These are organisms that are non-native to an ecosystem and have a negative effect on it, forming biological pollution (Russell & Blackburn, 2017). Invasive alien species are a sub-set of (and should not be confused with) 'alien species', which

describes non-native species of an ecosystem that can produce both positive *and* negative consequences (Russell & Blackburn, 2017). When invasive alien species enter an environment in which they would not appear organically, they out-compete native populations and alter the function and composition of the invaded ecosystem (United Nations Convention on Biological Diversity, 2010a). In the invaded area, this invasion can have devastating effects on species biodiversity, human health, and economic value (e.g., producing food or attracting tourism; Hewitt & Campbell, 2010; see review in Shackleton, Shackleton, & Kull, 2019). Globally, invasive alien species have been a contributing factor in 91 species extinctions (53.5% of all species extinctions), and the only factor in 34 (20.0%) of species extinctions where the cause of extinction is listed on the *International Union for Conservation of Nature* (IUCN) Red List of Threatened Species (Clavero & García-Berthou, 2005). This estimate, coupled with the finding that one-sixth of the world's land surface is categorised as 'highly vulnerable' to invasive alien species (Early et al., 2016, p. 2), makes it no surprise that the issue of invasive alien species is now recognised as the current second-greatest threat to global biodiversity after habitat loss (Clavero & García-Berthou, 2005; Simberloff et al., 2013).

Hewitt and Campbell (2010) found that the leading vectors of marine invasive alien species in the Australian context are biological fouling (or biofouling) and ballast water. Biofouling describes the event of organisms moving around the world by attaching themselves to submerged elements of vessels, such as hulls, propellers, and anchors. They noted that of the invasive alien species that have entered the Australian marine environment, 60% could be attributed to this transport method. Ballast water is water that vessels draw from the sea and store on board to aid structural integrity and control buoyancy of the ship during loading or unloading of cargo, as well as in bad weather (Gollasch & David, 2019; World Wildlife Fund [WWF], 2009). When seawater is collected, marine organisms (commonly crustaceans, algae, invertebrates, and bacteria) are taken up as well. Then, when the vessel releases the seawater, these marine organisms are discharged, typically into a new aquatic environment or ecosystem (WWF, 2009). Organisms moving around via both of these transport methods pose substantial invasion threats to Australian marine waters.

One example invasive alien species that has established itself in areas of Victoria and Tasmania, likely via biofouling or ballast water, is the Northern Pacific seastar (*Asterias amurensis;* Byrne, O'Hara, & Lawrence, 2013). This species of starfish is native to China, North and South Korea, Russia, and Japan, and is considered invasive because in the Australian marine environment it has no natural predators, has plentiful access to its

preferred food (principally, commercial shellfish such as oysters, scallops, and mussels), and reproduces rapidly (Agüera & Byrne, 2018; Byrne et al., 2013). The seastars' predation on bivalve species, including commercial shellfish, is likely responsible for the decline in biodiversity in affected areas (e.g., the Derwent River Estuary, southeast of Tasmania; Ross, Johnson, Hewitt, & Ruiz, 2004). This poses potentially profound consequences for Tasmanian and Victorian wild-catch and aquaculture industries, valued at AU$913 million and AU$85 million, respectively (Department of Agriculture and Water Resources, 2016).

1.3.4 Climate change. Climate change describes a range of events attributed to the increase of anthropogenically produced greenhouse gases (Cook et al., 2013; Mann, 2012; Mapstone, 2011; Oreskes, 2018). Typically, heat energy from the sun enters the atmosphere, passes through a cover of greenhouse gases, and is absorbed by the planet's land and ocean surfaces. Some of this heat is radiated back towards space, with a portion of it passing back through the layer of greenhouse gases, but much of it remains trapped in the Earth's atmosphere. This process is known as the natural greenhouse effect and it has an important ecological function in regulating Earth's unique habitable atmospheric temperature (Zillman & Sherwood, 2017). However, when the concentration of the greenhouse gas layer increases (e.g., through increased anthropogenic burning of fossil fuels, such as oil and natural gas, for energy), less heat can escape the atmosphere, causing the Earth's temperature to rise. This outcome has been coined the *enhanced greenhouse effect* and is considered the primary anthropogenic driver of climate change (Zillman & Sherwood, 2017).

Climate change events triggered by the enhanced greenhouse effect are the previously mentioned rising temperature patterns (global warming), as well as sea level rise, ice mass and glacier loss, ocean acidification (lowered ocean pH levels), and extreme climatic events such as intense storms and heatwaves (National Aeronautics and Space Administration, 2018). There is well-established evidence that such ecological events are contributing to global biodiversity loss (Bálint et al., 2011; Bellard, Bertelsmeier, Leadley, Thuiller, & Courchamp, 2012; Hillebrand et al., 2018; Thomas et al., 2004; Urban, 2015; Willis & Bhagwat, 2009). Increasing sea temperatures and extreme weather events, in particular, are threatening the survival of marine life (Hoegh-Guldberg & Bruno, 2010; Wernberg et al., 2011). To date, climatic changes have been observed and/or are predicted to alter marine species behaviour, location, and distribution substantially (Doney et al., 2011; Poelss & Krivickaite, 2009; Poloczanska et al., 2013; Wernberg et al., 2011; Wernberg et al., 2013). Australia is extremely vulnerable to climate-related species

extinctions. However, between 2017 and 2018, Australia's climate protection effort (i.e., the nation's annual efforts to combat climate change) was ranked in the bottom five of 56 countries and the EU. In the Climate Change Performance Index (2018), Australia scored 'low' or 'very low' across all 11 indicators, including renewable energy use, greenhouse gas emissions, and national policy, which together are responsible for more than 90% of the world's greenhouse gas emissions.

1.3.5 Overexploitation. Overexploitation refers to the unsustainable use of natural resources, including animals, plants, minerals, water, and soil, for human benefits such as food, medicine, and shelter (Reynolds & Peres, 2005). The consumption of resources faster than they can naturally self-replenish yields outcomes that are localised and widespread, ranging from the loss of specific habitats (e.g., deforestation via overlogging; Brook, Sodhi, & Ng, 2003) to the disruption in productivity of an entire ecosystem (e.g., transformed marine food chains from overfishing; Scheffer, Carpenter, & de Young, 2005). It is estimated that overexploitation affects 42% of all the mammal species that are listed by the IUCN, as well as 30% of all the bird species, and 15% of all the reptile species (Ducatez & Shine, 2017). Of the species listed as 'threatened' or 'near threatened', 72% are recorded as being overexploited for benefits related to commerce, recreation, and subsistence (Maxwell, Fuller, Brooks, & Watson, 2016).

Overexploitation is a primary threat to marine species (WWF, 2016). The Food and Agricultural Organization of the United Nations (2018) found that 52% of the world's fish stocks are *fully exploited*; that is, the fishery is operating at, or close to, a maximum sustainable production level, with no room for expansion. A further 17% are classified as *overexploited*; that is, the fishery is exploited beyond a sustainable production level, with no room for expansion and a high risk of stock collapse. A current case of overfishing-induced population decline is that of the Southern Bluefin Tuna *(Thunnus maccoyii).* It has been intensively fished since the 1950s and the species is now listed as 'critically endangered' (Collette et al., 2011).

Overfishing has indirect effects as well. A well-studied Australian example is that of a Tasmanian rocky reef system. In response to rising ocean temperatures in eastern Tasmanian waters, the long-spined sea urchin *(Centrostephanus rodgersii)* has migrated to nearby rocky reef systems that host kelp beds. Typically, the spiny lobster *(Jasus edwardsii),* a native predator to the kelp forest, would prey on the sea urchins, regulating their population. However, a reduction in lobster population numbers from overfishing has

enabled the sea urchins to thrive among the overgrazed kelp beds. This is resulting in decreased productivity and biodiversity richness within the reef system, which is subsequently threatening Tasmanian wild-catch fisheries (Filbee-Dexter & Scheibling, 2014; Johnson et al., 2011; Ling, Johnson, Frusher, & Ridgway, 2009).

One way to measure human (over)exploitation is the *Ecological Footprint*, which quantifies humanity's demand on nature to provide resources and absorb waste (WWF, 2016). It comprises the following six aspects of demand: 1) cropland footprint (demand for land to produce food for humans, feed for livestock, oil crops and rubber); 2) grazing land footprint (demand for land to raise livestock); 3) fishing ground footprint (demand for aquatic ecosystems to support wild-catch and aquaculture fish); 4) forest production footprint (demand for forests to provide wood and timber products); 5) built-up land footprint (demand for areas required for infrastructure); and 6) carbon footprint (demand for forests to absorb carbon not otherwise absorbed by the oceans). Together, these six demand categories determine *Earth Overshoot Day*, which marks the estimated annual date when humans consume more ecological resources and services than nature can theoretically 'regenerate' in a year. In 2019, Earth Overshoot Day lands on July 29 (Global Footprint Network, 2019). This means that from July 30 to December 31 2019, environmental resources and services consumed by humans will essentially be 'borrowed' from the future (and thus, from future generations).

As shown in Figure 1.6, Earth Overshoot Day can be broken down further by country, to represent the different average Ecological Footprint scores across nations. *Country Overshoot Day* represents the dates on which Earth Overshoot Day would fall if all of humanity consumed like the people in that country. The earlier in the year that Earth Overshoot Day occurs in a particular country, the greater the 'borrowed' consumption of that country. Of concern (relative to the positioning of this thesis) is that in 2019, Australia's Overshoot Day was 31 March.

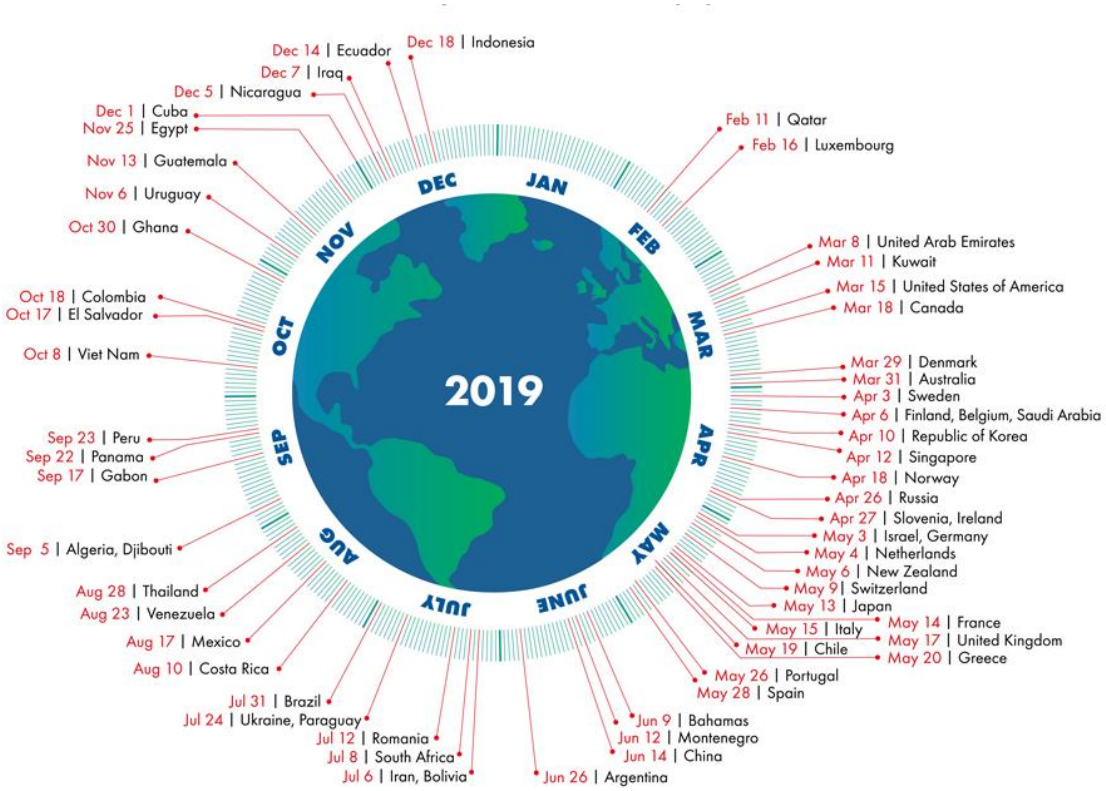


Figure 1.6. Country Overshoot Days in 2019 (Global Footprint Network, 2019; © 2019 Earth Overshoot Day). Please note: permission to use this image has not yet been granted, and if permission is not received from the copyright owners, the image will be removed before a digital copy of the Thesis is made available.

1.4 Driver Synergy An important aspect to consider when exploring the effects of anthropogenic drivers of biodiversity loss is that they do not act in isolation. The interactions between the drivers discussed in this chapter create *synergies*. This term describes the effect of two separate processes that when combined, is greater than their individual effect (Brook, Sodhi, & Bradshaw, 2008). That is, when drivers occur concurrently, their effect is amplified and thus poses a pronounced threat to global biodiversity (Bennett, Peterson, & Gordon, 2009; Brook et al., 2008; Côté, Darling, & Brown, 2016; Sala et al., 2000). There are several examples that illustrate this synergistic effect, including the previously mentioned situation in eastern Tasmanian waters, where overexploitation, teamed with climate change, together have reduced biodiversity richness around rocky reef systems. Another case is the depletion of the critically endangered Chinese Crested Tern *(Thalasseus bernsteini)*; overharvesting of the seabird's eggs, coupled with increased frequency of storms as a result of climate change, is reducing the abundance of the species (Chen et al., 2015). Other synergistic effects have been observed between aspects of land-use change (i.e., habitat loss and fragmentation; Bartlett, Newbold, Purves, Tittensor, & Harfoot, 2016), and between habitat modification and species invasion (Didham, Tylianakis, Gemmell, Rand, & Ewers, 2007).

Echoing the opening quote to this chapter (Ripple et al., 2017), this review has shown that human activity is central to the biodiversity loss problem; therefore, mitigating biodiversity depletion requires changing environmentally detrimental human behaviour. Despite this growing recognition, human lifestyle choices and economic activity remain detrimental to the preservation of biodiversity (Leadley et al., 2014). Examples of this are trends in disposal behaviour regarding e-waste (Borthakur & Govind, 2017) and patterns in global agricultural land use (Ramankutty et al., 2018). Evidently, there is a fundamental knowledge-to-action gap with regard to mitigating global biodiversity loss. The key to explaining this gap rests within a complex and interacting web of individual and socio-political barriers to action, which are considered in the next section.

1.5 Barriers to Mitigating Global Biodiversity Loss

1.5.1 Individual-level barriers. At the individual level, obstacles to environmental action can be structural (i.e., are objective or external and beyond control of the individual) or psychological (Gifford, 2011). Structural barriers include area of residence (e.g., for people living in central Australia where temperatures often exceed 40°C, reducing their consumption of air conditioning-based energy is limited), income, and availability of

environmentally friendly resources (e.g., availability of public transport in rural regions, or infrastructure for cycling). For people who are less affected by structural barriers (and for whom, therefore, uptake of pro-environmental behaviours is more feasible), a number of psychological barriers can hinder their capacity or willingness to uptake pro-environmental behaviours. Psychological barriers can include limited cognition (e.g., lack of knowledge, ignorance, uncertainty); ideologies (e.g., political and religious practices that do not support environmental protection); the influence of significant others (factors related to the human tendency to compare, such as social norms, social comparison, perceived inequity); sunk costs (e.g., existing financial investments, habits, goals and aspirations, place attachment); discredence (pre-existing disbelief in experts or authority); and perceived risks, including functional, physical, financial, social, psychological, and temporal risks (Gifford, 2011; Gifford, Lacroix, & Chen, 2018). Whereas structural barriers may be overcome by legislation and urban development, it will largely be up to social and behavioural scientists to find ways to help people overcome the psychological barriers (Gifford, 2011).

1.5.2 Socio-political barriers. Beyond individual-level barriers, there are socio-political factors that serve as obstacles to widespread uptake of pro-environmental behaviours. The news media, including news-broadcasting programs (radio and television), tabloid and broadsheet newspapers, news magazines, and the Internet (online newspapers, news blogs), have long had a major role in producing and distributing information to the public concerning environmental problems (Schoenfeld, Meier, & GriYn, 1979; Spector & Kitsuse, 1977). These outlets have great power over shaping public opinion and perception about the possible risks and importance of an environmental issue, which subsequently inform political action to address conservation issues (Carvalho, 2010; Weber & Stern, 2011).

The power of the news media to influence public opinion stems from three fundamental journalistic norms that underpin the selection and content of news production. The first norm, ‘dramatisation’, describes the tendency of journalists to ‘emphasise crisis over continuity, the present over the past or future, conflicts’ and ‘downplay complex policy information’ (Bennett, 2002, p. 46). Reporting on an environmental problem through this lens can trivialise the content of the issue, whereby the information that does not produce excitement or controversy is withheld (Boykoff & Boykoff, 2007). Diluting the complexity of an environmental issue in this way can lead to misunderstanding and incorrect expectations or assumptions about the characteristics and effects of the problem (Weber & Stern, 2011). The second norm, ‘personalisation’, refers to the ‘downplay [of] the big social,

economic, or political picture in favour of the human trials, tragedies, and triumphs that sit at the surface of events' (Bennett, 2002, p. 45). In other words, compelling news favours people and personalities over structural or institutional analyses (Gans, 1979). From this perspective, reporting of an environmental issue could be scripted as a battle of 'personalities' between science and politics, where both are fighting for social and political prestige and leverage (Boykoff & Boykoff, 2007). The last norm is 'novelty', which points to the need for news to be new or surprising (Bennett, 2002; Hilgartner & Bosk, 1988). This is problematic because environmental problems typically continue and accumulate over time and as a result, can easily 'slide out of sight', since there is frequently nothing new or surprising to communicate to the broader public (Stocking & Leonard, 1990, p. 40).

These norms can inform the narrative of environmental problems as viewed by the public and serve as a key barrier to fostering an environmentally supportive society. A timely exemplar of the effects of a complex environmental issue being presented in the news media is climate change perception in the United States (US). Despite scientific recognition that climate change is happening (Maibach, Myers, & Leiserowitz, 2014), the topic of whether human activity plays a role in climate change is being polarised (Cook, 2016). Research suggests that the disparity in opinions is likely symptomatic of US mass media misrepresenting the issue to the public (Boykoff, 2008; Boykoff & Boykoff, 2004, 2007).

At a political level, addressing biodiversity loss involves the implementation of evidence-informed conservation policy. Several international and national policies address biodiversity loss, including Australia's Biodiversity Conservation Strategy 2010–2030 (Commonwealth of Australia, 2010) and more broadly, the Strategic Plan for Biodiversity 2011–2020 and its Aichi Biodiversity Targets (United Nations Convention on Biological Diversity, 2010b). The latter is the current global framework that guides biodiversity management and policy development for the United Nations system. The Aichi Targets encompass goals to address the causes of biodiversity loss, improve the status of biodiversity, and enhance the benefits to all from biodiversity and ecosystem services. For example, Target 1 of Strategic Goal A posits, 'By 2020, at the latest, people are aware of the values of biodiversity and the steps they can take to conserve and use it sustainably' (United Nations Convention on Biological Diversity, 2010b, p. 1). However, a mid-term assessment of the progress towards achieving the Aichi Targets suggests that despite growing biodiversity-related policy efforts, the outcomes of these endeavours are unlikely to positively affect trajectories of change in biodiversity by 2020 (Tittensor et al., 2014).

This limited success of the Aichi Targets could be symbolic of the various challenges in implementing conservation policy. The greatest perceived barriers identified by professionals in policy positions (e.g., politicians, civil servants), practitioners (people implementing conservation on the ground), and research scientists are 1) lack of funding for conservation science; 2) conservation not being a political priority; and 3) prioritisation of the private sector's agenda over conservation (Rose et al., 2018). Another identified barrier is the mismatch between conservation and policy timescales (Rose et al., 2018). Moreover, conservation is a long-term issue and is contradictory to the typical short-term focus taken by policymakers, meaning that conservation policy efforts are often put aside when more imminent or popular issues arise (Lawton, 2007; Rose et al., 2017; Rose et al., 2018). Poor communication between scientists and policymakers is another prominent barrier; poor communication can limit access to scientific articles and impede a clear translation from research into policy (Marshall et al., 2017; Rose et al., 2018; Walsh, Dicks, & Sutherland, 2015). Rose et al. (2018) point out that overcoming these obstacles will involve mainstreaming conservation, which will likely involve a revolution in societal attitudes and the establishment of advisory bodies to curate a long-term mindset to environmental policy.

1.6 Conclusion

Ultimately, since biodiversity loss is rooted in human action, a clear strategy for mitigating this problem is to address the net of barriers against pro-environmental human behaviour, such as lack of knowledge, misinformation, and environmentally detrimental social norms. One way this goal can be achieved is by using alternative information platforms to news media. Platforms that are not bound by journalistic norms but are still widely accessible to the general public, such as conservation organisations (e.g., well-run modern zoos; Gray, 2017), are uniquely placed to achieve this goal. Zoos, as conservation-education platforms, have enormous potential to help to reduce the collective human effect of environmentally detrimental behaviours by increasing the level and quality of public understanding concerning the causes of biodiversity loss, promoting pro-environmental social norms and attitudes, and promoting widespread uptake of pro-environmental behaviours. The next chapter discusses the field of conservation psychology and the way its application to the zoo setting could be one part of the solution to addressing biodiversity loss.

Chapter 2: Conservation Psychology and Zoos

Summary: The previous chapter explored the way human activity is contributing to global biodiversity loss and described key individual and socio-political factors that prevent pro-environmental behaviour. Chapter 2 describes the critically important role of psychology (principally, conservation psychology) as a key mechanism to address anthropogenic effects on biodiversity through behaviour change. Key theories and models that have been applied to research projects guided by conservation psychology are discussed, including the theory of planned behaviour (TPB) and the model of diffusion in service organisations (Greenhalgh et al., 2004; an applied model of the diffusion of innovations theory, DIT; Rogers, 1962, 1998, 2010). These serve as the primary theoretical frameworks that guide the empirical research elements of this thesis. It is then argued that zoos are uniquely positioned to promote pro-environmental behaviour to support the aims of conservation psychology. The chapter concludes by drawing together the literature review and theoretical framework that has been discussed in the introductory chapters to provide a concept map of how the present research program seeks to progress zoo conservation-education evaluation best practice and support zoos' missions to address biodiversity conservation more broadly.

2.1 Role of Psychology in Mitigating Biodiversity Loss

As noted in Chapter 1, human activities are the primary cause of, and solution to, the issue of biodiversity loss. Thus, psychology, the discipline most devoted to the scientific study of human thought, feeling, and behaviour (Passer & Smith, 2015), is fundamental to fostering biodiversity conservation (Koger & Scott, 2007; Oskamp, 2000; Saunders, Brook, & Myers, 2006; Stern, 2000). Psychological science, with its extensive and longstanding toolkit of theoretical frameworks, constructs, and strong empirical research methodologies, can help to explain, model, and predict why and to what extent people engage in pro-environmental behaviours. Such knowledge can inform the evaluation of pro-environmental behaviour-change interventions, including zoo conservation education, and the design of effective conservation policy (Clayton & Brook, 2005). A little over 15 years ago, a new field of psychology—conservation psychology—emerged in response to the expanding body of work that sought to investigate conservation-related problems with a psychological underpinning, and the need for interdisciplinary thinking to address environmental problems (Saunders, 2003).

2.2 Conservation Psychology

Conservation psychology is a growing interdisciplinary field of inquiry that organises a collection of research streams with the shared goal to investigate why people act in harmful or helpful ways towards the natural environment, and to promote conservation behaviour (Clayton & Myers, 2015; Saunders, 2003). Importantly, conservation psychology did not emerge as a new area of study, nor as a sub-discipline of psychology. Rather, it offered a new label (and 'identity'; Clayton & Myers, 2015, p. 12) for researchers and practitioners from various disciplines interested in this mission (e.g., economics, ecology, anthropology, conservation biology), including sub-disciplines of psychology (e.g., environmental psychology), to understand and promote a healthy relationship between people and the planet (Clayton & Brook, 2005; Saunders, 2003). In other words, conservation psychology is designed to bring together a strong network of natural and social scientists, to foster a synergistic relationship between theory, research, and practice (i.e., each informing one another), and to encourage collaboration between the social sciences (Saunders, 2003). For example, in the context of zoo conservation education, zoo practitioners are needed to implement and promote a conservation-education program or experience; psychologists are needed to measure scientifically the self-

reported behaviour changes that have resulted from a zoo conservation-education program; and natural scientists are needed to determine whether these behaviour changes may have had a positive effects on relevant species population numbers or habitat quality.

The value basis of conservation psychology is another important aspect to consider when seeking understanding of the characteristics of the field. At its core, conservation psychology is explicitly value driven, since conservation represents the active management and sustainable use of resources (Saunders, 2003). Therefore, the related research is inherently guided by questions grounded in the worth of (and advocacy for) nature. Yet the role of science and the researcher is traditionally that of a 'neutral, value-free truth seeker' (Howard, 1985, p. 255). Thus, the potential threat that values pose to the scientific legitimacy of inherently normative research fields, such as conservation psychology, has been a topic of debate (e.g., regarding conservation biology; Barry & Oelschlaeger, 1996). It is therefore necessary to clarify how the values that guide research in conservation psychology are not in conflict with the scientific merit of related research. Conservation psychology research is value driven *and* scientifically legitimate when analyses are conducted objectively (Saunders, 2003) and researchers explain the full context whereby the new knowledge can be applied (Barry & Oelschlaeger, 1996).

2.2.1 Conservation psychology research areas and aims. Figure 2.1 provides a framework for organising the different types, areas, and levels of analysis concerning research in conservation psychology. In this model, Saunders (2003) posits two broad outcome categories that shape conservation psychology research questions: 1) how humans *behave toward* the natural environment (focusing on what people do to/for nature); and 2) how humans *care about/value nature* (focusing on what nature means to people).

The focal level of the research questions vary as well. Some research addresses factors at the individual level: for example, individual knowledge, attitudes, and behaviour concerning an environmental issue (e.g., shark conservation; Apps, Dimmock, & Huveneers, 2018). Other research addresses factors at the group level, including external influences on groups of people and/or social systems (e.g., accessibility of recycling facilities on recycling behaviour; Zhang, Zhang, Yu, & Ren, 2016). Further, research might adopt a theoretical approach or take the form of an applied and/or evaluative study (Saunders, 2003). Concerning the former, conservation

psychology can add to and/or integrate theoretical models and frameworks with a focus on conservation-related behaviours (e.g., the TPB; Ajzen, 1991). In the case of this theory, principles of conservation psychology can be applied to develop behaviour-change strategies, create methodologically sound measures to quantify psychological variables (e.g., cognition, affect, behaviour), and evaluate behaviour-change interventions (e.g., zoo conservation-education programs or experiences).

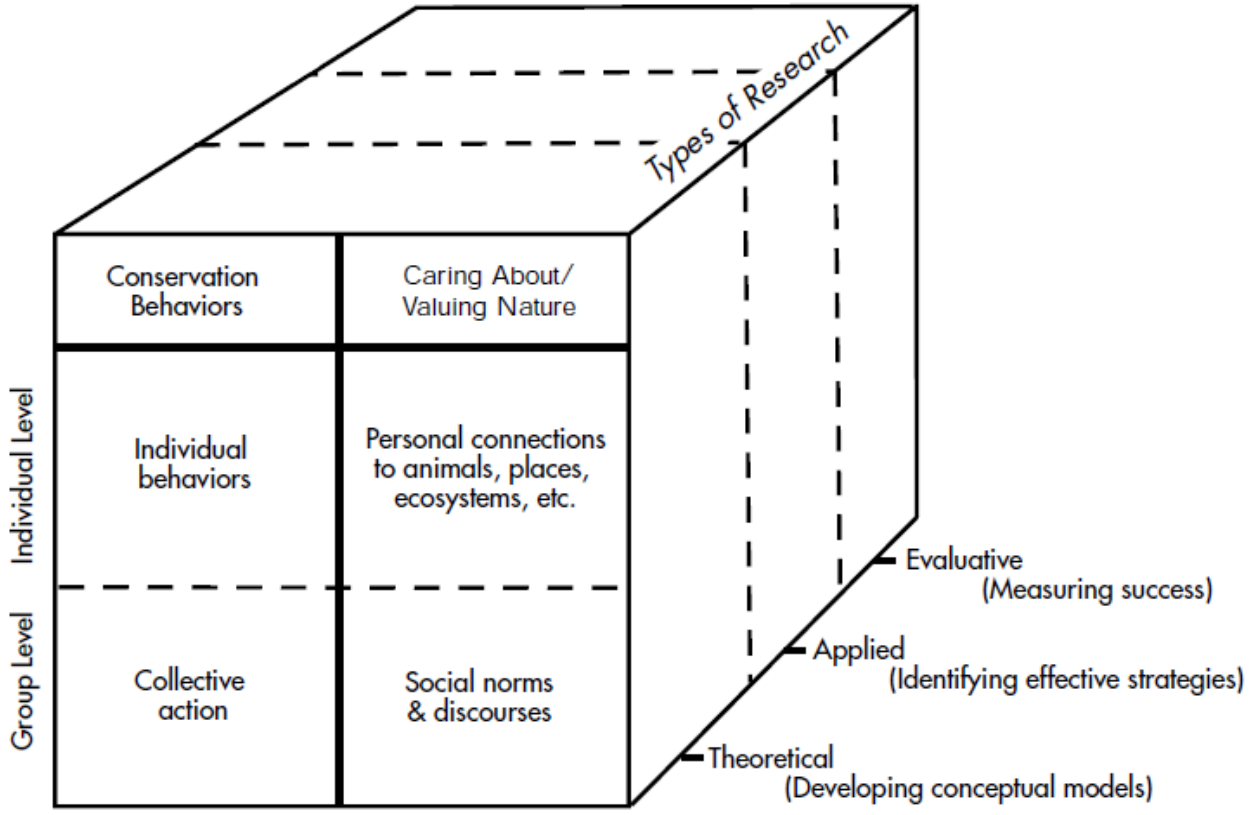


Figure 2.1. A suggested model for organising the types and areas of research in the field of conservation psychology (Saunders, 2003, p. 141). Please note: permission to use this image has not yet been granted, and if permission is not received from the copyright owners, the image will be removed before a digital copy of the Thesis is made available.

Confusion between conservation psychology and other established areas of inquiry with a conservation-focused mission has been cited (Clayton & Brook, 2005). Therefore, it is important to distinguish conservation psychology from similar fields, particularly conservation biology and environmental psychology. Conservation psychology research is oriented towards the human factors involved in environmental conservation (Clayton & Myers, 2015; Saunders, 2003), while conservation biology research is traditionally concerned with the development of principles and strategies for *preserving* biodiversity (where preservation means *maintaining the present state* of an area of nature; Fiedler, 1992). An example of this is maintaining species richness through forest management (Fiedler, 1992; see Saunders, 2003 for a comprehensive overview of the relationship between the two areas). Environmental psychology explores the different ways the *natural environment affects humans*, Conservation psychology research focuses mainly on the opposite: the way *humans affect the natural environment* (Saunders, 2003). Other distinctions rest in environmental psychology's sub-focus on built environments (as opposed to the natural world) and its functioning as a sub-discipline rather than a field (Saunders, 2003). Ultimately, these areas of expertise are often complementary and at times, overlapping fields that contribute to our understanding of the bi-directional relationship between people and the planet (Clayton, 2012).

2.2.2 Behaviour-change approaches in conservation psychology. Addressing the widespread and interdisciplinary areas and aims of conservation psychology is a complex task and hence, investigations that seek to understand and promote conservation behaviour are often informed by a collective of frameworks and models with different perspectives. While many frameworks overlap each other, none is considered comprehensive (Akintunde, 2017). Akintunde (2017), Osbaldiston (2013), and Vining & Ebreo (2002) review processes, models, and theories that can be helpful in examining the concept of pro-environmental behaviour.

A selection of five seminal frameworks are summarised in Table 2.1, as well as examples of ways these approaches have been applied in a conservation context. The five frameworks are 1) the TPB (Ajzen, 1991, 2002); 2) the value-belief-norm (VBN) theory of environmentalism (Stern, 2000); 3) the norm-activation model (NAM; Schwartz, 1975); 4) the DIT (Rogers, 1962, 1998, 2010); 5) and community-based social marketing (CBSM; McKenzie-Mohr, 2000). Although this list of possible theories is not exhaustive, each of these

approaches puts forward key variables and concepts that can provide important insights about the relationship between humans and the natural world. In summarising these approaches, these models/frameworks typically address at least one aspect of cognition (e.g., understanding, awareness, knowledge), affect (e.g., attitudes, social norms, values, motivations), and behaviour (e.g., behavioural intention or actual behaviour).

Table 2.1

Key Theoretical or Conceptual Frameworks and Models that are Utilised in Conservation Psychology Research

Key theoretical or conceptual framework, model, or process	Description	Example application
TPB (Ajzen, 1991, 2002)	TPB asserts that a person's engagement in a specific behaviour in a specific context can be predicted by their behavioural intentions and perceived behavioural control, which are influenced by the individual's attitudes towards the behaviour and subjective norms.	TPB is often used to explain or predict a population's intention to engage in a behaviour. Most recently, TPB has been utilised to predict people's intentions to visit a green hotel (Verma & Chandra, 2018), purchase organi food (Yazdanpanah & Forouzani, 2015), purchase houses with a sustainability certification (Judge, Warren-Myers, & Paladino, 2019), and engage shared bicycle travel choices (Xin, Liang, Zhanyou, & Hua, 2019).
VBN theory of environmentalism (Stern, 1999, 2000)	VBN is a conceptual framework for advancing theories of environmentally significant individua behaviour. The framework brings together value theory, norm-activation theory, and the New Environmental Paradigm, by offering a causal chain of five variables that result in individual behaviour. These variables include personal values, belief about general conditions in the biophysical environment, and personal norms for pro-environmental action.	VBN can help scientists to understand personal norms that shape behaviour. It has been used as a framework t test variables that influence stakeholders' intentions to adopt pro-environmental behaviour in marine protected areas (Wynveen, Wynveen, & Sutton, 2015); to model the psychological antecedents to pro-sustainable behaviours among US travellers (Landon, Woosnam, & Boley, 2018); and to explain sustainable travel mode choices among the Norwegian urban public (Lind, Nordfjærn, Jørgensen, & Rundmo, 2015).
NAM (Schwartz, 1975)	NAM posits that values may influence pro-environmental behaviour by activating personal norms; i.e., values trigger feelings of moral obligation to act.	NAM is typically used to examine or predict the way people's altruistic or moral norms influence and pro-environmental behaviours. Recently, it been used to explore how daily transport among Danish adolescents

		is influenced by the denial of consequences and responsibility for own behaviour (Møller, Haustein, & Bohlbro, 2018); and to investigate consumer acceptanc of electric vehicle policies (Nordlund, Jansson, & Westin, 2018).
DIT (Rogers, 1962, 1998, 2010)	DIT seeks to explain how and why ideas are adopted. The theory asserts that the passive sprea of new ideas is influenced by features of the innovation itself, communication methods, time, and social systems (Rogers, 1962, 1998, 2010).	DIT is commonly applied to help understand the diffusion processes of environmentally friendly innovations. For example, DIT has been used to: understand public adoption rates of renewable heating systems among households in Italy (Franceschinis et al 2017) and solar energy among households in Western Australia (Simpson & Clifton, 2017); to guide the development of policy to help overcome barriers to innovation and diffusion of cleaner technologies in the UK (Foxon & Pearson, 2008); and to guide a review that sought to explain why entomophagy campaigns (those that encourage people to eat insects) are unsuccessful (Shelomi, 2015).
CBSM (McKenzie-Mohr, 2000)	CBSM is a 5-step process that can be used to create social marketing campaigns. The process involves 1) carefully selecting specific behaviour to be promoted; 2) identifying the barriers and benefits associated with the selected behaviour; 3 designing a strategy that applies behaviour-chang tools to the relative barriers and benefits; 4) piloting the strategy with the relevant community and 5) evaluating the effectiveness of the progran	CBSM has been used to help design a program to encourage boot-cleaning practices in the Kosciuszko National Park, NSW, Australia (Gill, McKiernan, & Annunciato, 2018); to design a program aimed at changing the recycling knowledge and behaviours of tailgaters during home football events (Martin, Ross, & Irwin, 2015); and to change behaviours associated witl significant carbon emissions at Oberlin College, Ohio US (Frantz et al., 2016).

2.3 Thesis Theoretical Framework

The TPB (Ajzen, 1985, 1991, 2002) and the model of diffusion in service organisations (Greenhalgh et al., 2004) were the guiding theories used for the empirical research components of this thesis. The TPB served as a starting point for creating eligibility criteria for a methodological review of zoo conservation-education evaluation research (Study 1, Chapter 2) and for developing survey material for an evaluation of a zoo conservation-education program (Study 2, Chapter 4). TPB was deemed the most appropriate framework in this psychologically-grounded thesis given its standing as a well-established theory of behaviour, as opposed to other, more recent frameworks including Community Based Social Marketing, which is a process for implementation and evaluation. The model of diffusion of service organisations was re-contextualised to guide the interpretation of survey and interview data in Study 3 (see Chapter 5). The following sections provide a detailed overview of the theory of planned behaviour (TPB) and the model of diffusion in service organisations, before discussing the important role of zoos as a platform to achieve the key aims of conservation psychology.

2.3.1 Theory of planned behaviour. Figure 2.2 displays the core concepts and relationships in the TPB (Ajzen, 1985, 1991, 2002), which asserts that a person's engagement with a specific behaviour in a specific context can be predicted by their intention to engage in the behaviour. Behavioural intentions represent motivational factors that shape how much people will try to perform the behaviour. Intentions are informed by a combination of attitudes towards the behaviour (the overall positive or negative evaluation of engaging in the behaviour); subjective norms (a person's perception of whether performing the behaviour is acceptable or wanted by significant others); and perceived behavioural control (the extent to which a person perceives the target behaviour to be under their volitional control).

In contrast, attitudes contain cognitive, affective, and behavioural (conative) components, where the affective (feelings and emotions towards the attitude object) and cognitive (belief or knowledge about the attitude object) elements shape decision making (Petty, Wegener, & Fabrigar, 1997). Indeed, knowledge is a necessary (albeit insufficient) precondition for pro-environmental behaviour (Kaiser & Fuhrer, 2003; McKenzie-Mohr, Lee, Kotler, & Schultz, 2011). Thus, attitudes can be influenced by new information about the attitude object,

which can be delivered as part of environmental education strategies (Heimlich & Ardoin, 2008).

Perceived behavioural control not only acts as a proxy for behavioural intention but also is likely a direct predictor of actual behaviour (Ajzen, 1985, 1991, 2002; Sheeran, Trafimow, & Armitage, 2003). The inclusion of perceived behavioural control in this model distinguishes the TPB from its predecessor, the theory of reasoned action (Fishbein & Ajzen, 1975). Taken together, based on the TPB, attitudes towards a behaviour that are more positive, subjective norms concerning a behaviour that are more favourable, and a greater perceived behavioural control, can curate a stronger intention to perform a behaviour (Ajzen, 1985, 1991, 2002).

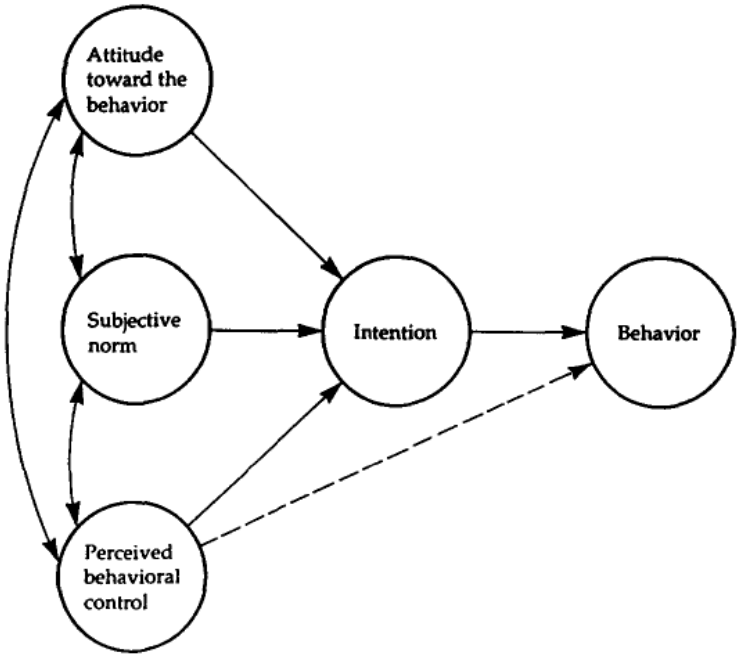


Figure 2.2. TPB (Ajzen, 1991, p. 182). Please note: permission to use this image has not yet been granted, and if permission is not received from the copyright owners, the image will be removed before a digital copy of the Thesis is made available.

The TPB is a popular framework and it has been widely applied in both conservation and public health research (see Hagger, 2015). It is often applied to pro-environmental behaviours as well, as shown in Table 2.1 (Chng, Abraham, White, Hoffmann, & Skippon, 2018; Kormos & Gifford, 2014). These applications of the TPB to environmental behaviours can be useful in several ways. Verma and Chandra (2018) used the TPB to reveal that of all the TPB components, attitude was the most significant predictor of intention to visit a green hotel in

young Indian consumers, accounting for 44% of the variance in behavioural intentions. This information can inform hotel marketing professionals to develop better marketing material, incorporating a greater attitudinal component. Similarly, Yazdanpanah and Forouzani's (2015) application of the TPB found that TPB variables accounted for 56% of variance in young adults' intentions with regard to purchasing organic foods, providing justification for integrating attitudes, subjective norms, and perceived behavioural control dimensions into policies and programs that intend to encourage young adults to engage in organic-purchasing behaviours.

However, the TPB has some limitations. As evident from the body of work exploring the 'intention–behaviour gap' (Grimmer & Miles, 2017; Rhodes & de Bruijn, 2013; Sheeran, 2002; Sheeran & Webb, 2016), which holds that behavioural intentions do not always translate into action, the TPB cannot be considered a comprehensive theory of behaviour. Sniehotta, Presseau, and Araújo-Soares (2014) discussed key concerns related to the validity and practical utility of the theory. Regarding validity, Sniehotta and colleagues argued that seeking to explain behaviour based on four predictor variables is misleading. The authors further argued that the theory's lack of practical utility is reflected in the tens of 'extended' models, suggesting limited applicability of the original model to various settings. In the context of environmental behaviour, the TPB has been extended to include additional predictors such as self-identity, moral norm, personal norm, and descriptive norm. (For recent examples of extended versions of the TPB for environment-related behaviours, see Graham-Rowe, Jessop, & Sparks, 2015; Kumar, 2019; Li, Zuo, Cai, & Zillante, 2018; Maichum, Parichatnon, & Peng, 2016; Wang, Fan, Zhao, Yang, & Fu, 2016; Yadav & Pathak, 2016). In defending the TPB, Hagger (2015) explained that while there is still much use for, and relevancy of, the theory, its role and function in science has changed. What was once a central paradigm is now a precursor that offers an empirically supported starting point to guide the way scientists and people alike investigate some of the influential processes of, and mechanisms for, behaviour change.

As the TPB seeks to predict and explain human behaviour in a *specific* context (Ajzen, 1991), it was selected as the most suitable and established framework to guide the first two studies in this research: 1) to review research methods and reporting practices in zoo conservation-education evaluation; and 2) to investigate the effect of zoo conservation-education experiences on specific zoo visitor psychosocial outcomes, including knowledge, attitudes, and behaviours.

2.3.2 Model of diffusion in service organisations. Innovation is ‘an idea, practice, or project that is perceived as new by an individual or other unit of adoption’ (Rogers, 2003, p. 12). The model of diffusion in service organisations is a conceptual framework that extends the DIT (Rogers, 1962, 1998, 2010), as previously outlined in Table 2.1, to consider the diffusion, dissemination, and implementation of innovations within health care settings. Diffusion describes the passive spread of information, while dissemination describes the active and planned efforts to persuade target groups to adopt an innovation. Implementation represents the active and planned efforts to mainstream the innovation within an organisation (Greenhalgh et al., 2004).

With regard to the innovation process, the model of diffusion in service organisations covers the following six broad aspects that are likely to affect its success: 1) the innovation itself; 2) adoption and assimilation (including the sub-components of *adoption by individuals* and *assimilation by organisations*); 3) communication and influence through interpersonal networks; 4) the inner organisational context (including *organisational antecedents for innovation* and *organisational readiness for innovation*; 5) the outer interorganisation context; and 6) implementation and routinisation. Table 2.2 describes each of these components in detail.

Zoos can be considered a service organisation in the sense that they provide an educational service to visitors, as well as a conservation or preservation service to species and their habitats through in-situ (e.g., management of invasive species) or ex-situ (e.g., captive breeding) conservation. Thus, the model of diffusion in service organisations can provide a helpful lens for interpreting and understanding the factors that shape the implementation of programs in zoo organisations, which was the focus of the third study in this research project.

The model of diffusion in service organisations was considered suitable for guiding Study 3 of this thesis (interpretation of survey and interview data) because it provides a theoretically grounded interpretive lens for making sense of the organisational-related challenges and successes to implementing a zoo conservation-education program (Chapter 5 extends Table 2.2 by providing application definitions to zoo conservation education). Indeed, Mascia and Mills (2018) have highlighted that a diffusion of innovations approach may allow academics to make better sense of the paucity of research on the trends in conservation interventions. Given the focus of this research program on the zoo environment, the next section

explores the way conservation psychology can be applied in this context and reviews existing evaluation efforts in zoo conservation-education.

Table 2.2

Description of the Model of Diffusion in Service Organisations Components

Major component	Sub-component	Brief description per model (Greenhalgh et al., 2004)
The innovation itself		Features of the innovation itself can explain adoption rates. Examples of contributing attributes are relative advantages (clear advantages in effectiveness o cost effectiveness); compatibility with adopters' values, norms, needs; and complexity (simple innovations are more easily adopted).
Adoption and assimilation	Adoption by individuals	Adopters do not innovate passively; rather, they interact with (e.g., find meaning i and develop feelings about) an innovation. Therefore, it is necessary to consider the individual characteristics of the adopters. Some example factors are general ar context-specific psychological antecedents (e.g., motives, values, specific skills), concerns at the pre-adoption stage, and concerns during early use.
	Assimilation by organisations	Changes that will be required by team, department, or organisational structures, to allow innovation.
Communication and influence through interpersonal networks (diffusion and dissemination)		Interpersonal communication and social networks influence the diffusion and dissemination of an innovation. Various influences that promote the spread of innovation include homophily (the extent to which members of the same social network share values, norms, and experiences can encourage adoption of innovation); mass media (to create awareness); and expert and peer opinion leaders.
The inner (organisational) context	Organisational antecedents for innovation	Existing structural and cultural features of the organisation that might influence th successful assimilation of an innovation. For example, structurally, organisations that are large, mature, functionally differentiated (i.e., have departments), and specialised are more likely to innovate. Culturally, organisations with clear goals and priorities, strong leadership, and vision are more likely to innovate.

	Organisational readiness for innovation	Organisation is ready and willing to assimilate innovation. Elements of readiness include dedicated time and resources, capacity to evaluate, and support and advocacy for the program.
The outer (interorganisation) context		External influences to innovation, including the extent to which similar organisations have adopted an innovation and political directives (must-do's, mandates).
Implementation and routinisation		Adaptive and flexible organisational structures and processes that support decisior making. Examples are effective communication processes across departments; leadership and management support and advocacy; feedback on progress; human resource issues (e.g., early and widespread involvement of staff); and training.

2.4 Application of Conservation Psychology to the Zoo Setting

With hundreds of millions of annual visitors worldwide (Gusset & Dick, 2011; Smith, 2013), zoos and aquariums are ideal platforms for applying the principles of conservation psychology and related theories (e.g., the TPB and the model of diffusion in service organisations). They offer a social environment in which large numbers of people can develop a caring relationship with nature, which is critical to fostering conservation behaviours (Clayton & Myers, 2015).

The structure and purpose of zoos and aquariums have changed considerably in recent years, from being places of entertainment and specimen collections held in cages to prioritising naturalistic settings (Zimmermann et al., 2007), education and conservation, as highlighted in the Association of Zoos and Aquarium's accredited-organisation mission statements (Patrick, Matthews, Ayers, & Tunnicliffe, 2007; Patrick & Caplow, 2018). While acknowledging the ethical debate with regard to the existence of zoos (see Gray, 2017, for a comprehensive examination of the ethical arguments for and against the existence of zoos), this thesis focuses on his concept of 'well-run modern zoos' or aquariums (hereafter 'zoo'). This type of zoo 'uses the best available knowledge and technology to make evidence-based decisions, listens to public sentiment and is committed to animals, as individuals and as species' (p. 35). Well-run modern zoos are typically members of a professional peak accreditation body (e.g., for Australasia, the Zoo and Aquarium Association [ZAA], for North America, the Association of Zoos and Aquariums [AZA], and Canada's Accredited Zoos and Aquariums [CAZA]). In the context of ZAA, potential members are eligible if they hold wildlife for the purposes of conservation education, presentation, and breeding, and abide by ZAA's code of conduct, constitution, and duly adopted resolutions, as well as supporting its objectives (ZAA, 2018).

One way that zoos work towards their conservation and education objectives outlined in their mission statement is through conservation-education programs or experiences (sometimes referred to as *community campaigns* or *community education initiatives*). Zoo conservation education can be viewed as a type of environmental education, a process defined as one that provides the opportunity to learn about environmental issues and encourages participation in pro-environmental action (US Environmental Protection Agency, 2017). In the context of this thesis, zoo conservation education differs from other forms of zoo-based education that are limited to interesting facts about species, in that it focuses on enhancing visitors' ability to act on behalf of a species.

The structure of zoo conservation education efforts vary but typically, programs or experiences focus on a specific environmental issue and promote a specific pro-environmental behaviour through multiple interpretive mediums, such as static signage displays, videos, and keeper/animal presentations. Examples include Zoos Victoria's program Don't Palm Us Off, which addresses the effect of unsustainable production of palm oil on orang-utan habitat (see https://www.zoo.org.au/get-involved/act-for-wildlife/dont-palm-us-off) and the Monterey Bay Aquarium Seafood Watch® program, which seeks to support visitors to choose sustainably sourced seafood (see http://www.montereybayaquarium.org/conservation-and-science/our-programs/seafood-watch). To develop a comprehensive understanding about the conservation effect of such programs and to refine zoo-based conservation-education strategies for the future, program outcome evaluations are necessary. Unfortunately, such evaluations are infrequently published in peer-reviewed journals and of the published work, efficacy outcomes vary. The following section reviews the inconsistencies in the outcomes of zoo conservation-education evaluation research, before offering some suggestions for future research that might provide explanations for these results.

2.5 Zoo Conservation-Education Evaluation

The results of research that has investigated the efficacy of conservation education in zoos on visitor conservation-related cognitive, affective, and behavioural (intentions and change) outcomes have been mixed. The term 'conservation-related' refers to an outcome that is likely to enhance a visitor's ability to act on behalf of a species directly (e.g., conservation-related knowledge might include knowledge about a species conservation status or the effects that humans have on species' habitats). To illustrate the mixed results that have emerged in zoo conservation-education evaluation research, the following sections focus on the commonly measured outcomes: visitor knowledge, attitudes, and behaviour (intentions and actions).

Outcomes concerning the extent to which zoo visitors construct knowledge differ greatly. Some authors have reported strong post-experience knowledge. For example, following a presentation about orang-utan conservation, 83.4% of the visitors could recall that the production of palm oil is destroying orang-utan habitat (Perdue, Stoinski, & Maple, 2012); and after engaging with signage in a zoo-based primate research centre, there was a significant increase in cognitive gain at $p = 0.005$ in comparison to the baseline level (Waller, Peirce, Mitchell, & Micheletta, 2012). Other authors have reported mid-level

knowledge scores post-visit. For example, a study by Pearson, Dorrian, and Litchfield (2013) found that visitor mean scores ranged from 5.74 to 6.33 out of 10 on knowledge about orang-utans and their conservation. Further, in a study by Lukas and Ross (2005), an average of only 60% of knowledge questions about ape conservation were answered correctly following a visit to an African ape exhibit at Chicago's Lincoln Park Zoo.

Differences in the amount and duration of attitude change following conservation-education experiences have emerged as well. For instance, Adelman, Falk, and James (2000) reported that the significant increases in general attitude towards conservation ($p < 0.001$) observed immediately following a visit to the National Aquarium in Baltimore had returned to baseline six to eight weeks following the visit. In surveys following several wildlife-tourism experiences, including a marine theme park and an aquarium, Ballantyne, Packer, and Falk (2011) reported a *decrease* in overall mean attitude scores towards nature and environmental protection from the post-visit survey ($M = 3.43$ out of 4) to a 4-month follow-up ($M = 2.33$ out of 4). In contrast, Miller et al. (2013) found that significant changes in attitudes towards dolphins and their conservation immediately following a dolphin presentation ($p < 0.01$) persisted at the 3-month follow-up ($p < 0.05$, in comparison to baseline). However, Mann-Lang, Ballantyne, and Packer (2016) found no increase in visitors' attitudes regarding dolphin conservation immediately following a dolphin presentation at uShaka Sea World in South Africa.

Variances in outcomes have been found with regard to visitor conservation-related behavioural intentions and change. Some authors have concluded that behaviour intentions do not translate into behaviour change. For example, Dierking et al. (2004) reported that while there were significant ($p < 0.001$) short-term increases in intentions to perform 11 conservation actions (e.g., reduce waste, donate) immediately following a visit to the Conservation Station experience at Disney's Animal Kingdom, when visitors were contacted two to three months following the visit, they typically had not initiated their intended actions. Similarly, people who reported making lifestyle changes six to eight weeks after a visit to the National Aquarium in Baltimore most commonly mentioned having greater respect for land and animals, as well as being more informed and aware of issues, but they did not explain how these concepts were translated into behaviours (Adelman et al., 2000). Mann, Packer, and Ballantyne (2018) reported mid-level behaviour change following a visit to uShaka Sea World's African penguin (*Spheniscus demersus*) exhibit that hosts the Penguin Promises campaign for general environmental behaviour change; 49.4% of the visitors who responded to the one-year follow-up survey could mention at least one

conservation behaviour they had engaged in and attributed this to the campaign. In contrast, MacDonald (2015) reported that six weeks after a trip to a Wellington Zoo animal presentation that asked people to keep their cats indoor at night, all (100%) of the respondents who pledged on-site to keep their cats indoor at night self-reported changing their behaviour. In a similar time frame, Ballantyne, Packer, Hughes, and Gill (2018) presented outcomes to support zoo conservation-education efficacy, reporting that 91.8% of the treatment group (who visited a Zoo Action website following their zoo visit) self-reported increasing the frequency of at least one of 18 common environmental actions as a result of their zoo visit. Taken together, the nature and extent of the effect that zoo conservation-education experiences have on visitor knowledge, attitude, and behaviour varies greatly.

Variance in outcomes is not surprising given the diversity in conservation-education program characteristics. These programs can differ substantially in their goals and target conservation messages (e.g., variations in the level of difficulty in undertaking the targeted conservation behaviours), resources available to develop and implement the programs (e.g., funding, expertise), educational components (e.g., presentations, signage), and the settings wherein they are delivered. This variety makes it difficult to produce a cohesive picture regarding the efficacy of zoo conservation education. However, several elements of a program lifecycle can be addressed to maximise the potential for reliable and valid program evaluation results. These components include the use of rigorous evaluation research methodology, the complete reporting of the research process and results, and the consideration of factors that shape program implementation. The remaining sections of this chapter put forward two fundamental problems that presently exist in the peer-reviewed literature regarding zoo conservation-education evaluation. The first problem is the diversity in, and limitations of, research methods and incomplete reporting practices in relevant evaluation research. The second topic is the lack of research on the factors that help and hinder the implementation of zoo conservation-education programs.

2.5.1 Research methods and reporting practices. In addition to the challenges posed by contextual factors, there is no clear consensus about the quality of evaluation methods and reporting practices in zoo conservation education. Establishing the current state of methodology and reporting practices in this field is critical to identifying developmental needs. Identifying developmental needs is a first step in creating an evaluation approach with maximum validity and reliability potential, which in turn, could help to more accurately

identify trends in program effect, leverage the generalisability of research findings, capture the complexity of zoo educational experiences more holistically, and generate new areas of interest for future studies. The next paragraphs illustrate the diversity in the ways that visitor psychosocial outcomes are measured in zoo conservation-education evaluation.

Diversity in zoo conservation-education evaluation research methods makes it difficult to ascertain clearly how evaluation methods might influence the evaluation results. A case in point is the variety of ways that outcome variables are measured and the different study designs that are adopted to track changes over time. For example, some authors have measured behaviour-related outcomes using retrospective pre-entry questions to collect baseline data for comparisons (e.g., to measure how visitors felt they would have rated their ability to effect change before their visit; Falk, Heimlich, & Bronnenkant, 2008). Others have measured behavioural intention immediately post-visit (e.g., visitors' willingness to support elephant conservation; Swanagan, 2000). A small number of authors have measured self-reported behaviour change at varying time points, including six to eight weeks post-visit (MacDonald, 2015; Ballantyne et al., 2018), three months post-visit (Miller et al., 2013), and 12 months post-visit (Mann et al., 2018). It is difficult to reach an accurate consensus about the effect of zoo conservation-education programs on behaviour from these markedly different approaches.

Another example of diversity in research methods is the way outcome variables are operationalised. Where programs or experiences seek to raise awareness and/or promote attitudes and behaviours related to a specific conservation issue, it is seldom possible to use standardised measures. Thus, researchers often create and employ custom-designed scales to reflect the specific outcome they are seeking to measure; for example, attitude scales to assess attitudes towards orang-utans (Pearson et al., 2013, 2014), and chimpanzees and gorillas (Lukas & Ross, 2005). When similar constructs are measured in different ways and/or at different points in time, it is difficult to compare outcomes across studies.

A further issue is incompleteness in reporting practices among peer-reviewed zoo evaluation research. For instance, while recording a response rate can help readers to understand whether the sample is representative of the target population, many zoo conservation-education evaluation papers do not include this information (e.g., Adelman et al., 2000; Bruni, Fraser, Schultz, 2008; Hayward & Rothenberg, 2004; Kemmerly & Macfarlane, 2009; Kutska, 2009; Lindemann-Matthies & Kamer, 2006; Mann-Lang et al., 2016; Marseille, Elands, van den Brink, 2012; Perdue et al., 2012; Povey & Rios, 2002). Moreover, while reporting an effect size is necessary to communicate the magnitude of an

effect, several studies do not contain this information (e.g., MacDonald, Milfont, & Gavin, 2016; Mann-Lang et al., 2016; Swanagan, 2000; Smith, Broad, & Weiler, 2008). Incomplete reporting of results can impede future attempts to replicate the research findings and subsequently, hinders the validity of research in this field.

The variety of research methods and reporting practices in zoo conservation-education research is likely a reflection of the growing and continually evolving nature of this area of inquiry. While variation in zoo research is largely unavoidable and difficult to overcome, given logistical and contextual factors (e.g., time constraints, funding, and co-located behavioural science evaluation experts), such diversity can make it difficult to pinpoint exactly what element of a program contributed to its efficacy, and how, and thus it hampers the confidence that outcomes accurately represent the conservation effect. Therefore, important first steps for improving evaluations would be to establish the state of research methods in the field and apply best-practice methods to a test case. Thus, two key aims of this research program were to 1) critically appraise the research methods and reporting practices in zoo conservation-education research and 2) present a test case for adopting best-practice evaluation methodology and reporting of evaluation results. This has helped to provide a clearer understanding of state of the field, to underscore areas that require improvement, and to offer a best-practice exemplar.

2.5.2 Program implementation evaluation. Effective program implementation is associated with greater program success (Durlak & DuPre, 2008) and increased validity of results (Durlak, 1998). Thus, understanding the factors that shape successful program implementation in a zoo context must be considered when seeking to progress best-practice zoo conservation-education evaluation. However, research exploring influential factors for the successful implementation of a program within a zoo context is scarce. Durlak and DuPre (2008) identified 23 contextual influences that shape implementation, most of which relate to organisational factors such as organisational functioning, training, and technical assistance. The next paragraphs define the relevant organisational factors in zoos and examine the research on this topic that has been conducted.

Generally, organisational factors that affect organisational functioning are organisational culture and structure; communication channels; strategy; policies and procedures; and external business environment factors (Project Management Institute, 2013; Scott & Vessey, 2002). In the context of zoos, these factors can operate at different stages of a conservation-education program or experience lifecycle, as follows: initiation (the project

idea is explored and a project proposal is approved); definition (project requirements, scope, and expectations are identified); design (design choices are made, such as the design of signage); development (suppliers or subcontractors are arranged, materials are ordered, schedules are created); implementation/execution (the program is put into action/moved to production); and follow-up/evaluation (a post-implementation assessment is performed to determine the project's success with regard to relevant outcomes such as visitor behaviour; Archibald, Di Filippo & Di Filippo, 2012; Baars, Harmsen, Kramer, Sesink, & van Zundert, 2006).

To date, studies on this topic as related to zoos appear to have focused exclusively on the *evaluation* stage of the program lifecycle, highlighting issues regarding evaluation design and resourcing. In their seminal review concerning the challenges and successes faced during the evaluation of environmental education programs, Carleton-Hug and Hug (2010) discovered three major issues that hindered the quality of program evaluations: short evaluation time frames; lack of diverse research approaches, including overreliance on short-term, objective-focused evaluations; and overlooking differences in participant background variables. They identified as opportunities the growing interest in understanding the effects of environmental education among evaluators, the need to have an informed population, and a national interest in education accountability. A similar focus was taken by Luebke and Grajal (2011), who investigated challenges when evaluating operational performance (e.g., visitor satisfaction) and mission-related learning outcomes (e.g., cognitive gains, affective reactions, or intended conservation action) among Association of Zoo and Aquarium-accredited conservation organisations. The following themes that emerged from their work: inadequate staffing, or few staff having the appropriate expertise; no (or limited) budget; lack of understanding about when/what/how to evaluate; difficulty attaining good response rates/poor survey completion rates; and limited technology to aid data analysis. Similarly, a study by Roe, McConney, and Mansfield (2014) revealed that time, cost, and expertise were challenges in research assessing the evaluation processes of school or curriculum-aligned zoo-education efforts. Further, Khalil, Ardoin, and Wojcik (2017) explored the way zoo education professionals engaged with each other during evaluation, highlighting that open flow of information and easy opportunities for collaboration were the most valued mechanisms when performing tasks. Evidently, there are several challenges to overcome when evaluating different types of conservation- and environmental-education interventions (Monroe, 2010).

Less is known about the organisational factors that may help or obstruct the *development* and *implementation* stages of a zoo conservation-education program lifecycle. The lack of research investigating implementation processes in this context is problematic, given that such knowledge could help to 1) obtain a more holistic understanding of the mechanisms that can influence the success of zoo conservation education; 2) provide future developers with an evidence base for which conservation-education strategies and practices to embrace or avoid; 3) discover alternative or new methods and tools for implementation; and 4) pinpoint areas for improvement and/or change. A key aim of this thesis is to identify, through exploration of a test case, the organisational factors that affect the development and implementation stages of a conservation-education program lifecycle.

2.6 Thesis Map

Figure 2.3 shows the way each original research component of this thesis fits within the 'bigger picture' of addressing biodiversity loss, as discussed throughout these introductory chapters. In sum, zoo conservation education is one possible strategy for overcoming individual and socio-political barriers to mitigating biodiversity loss. A body of evidence already supports the idea that zoo visits can affect visitor cognitive, affective, and behavioural domains; however, the outcomes of these studies are not always consistent. To progress best-practice zoo conservation-education evaluation and increase the capacity of zoos to contribute to biodiversity conservation requires a) identifying and addressing problems in research methods and reporting practices (Studies 1 and 2); and b) identifying factors that shape the program (or experience) implementation processes (Study 3).

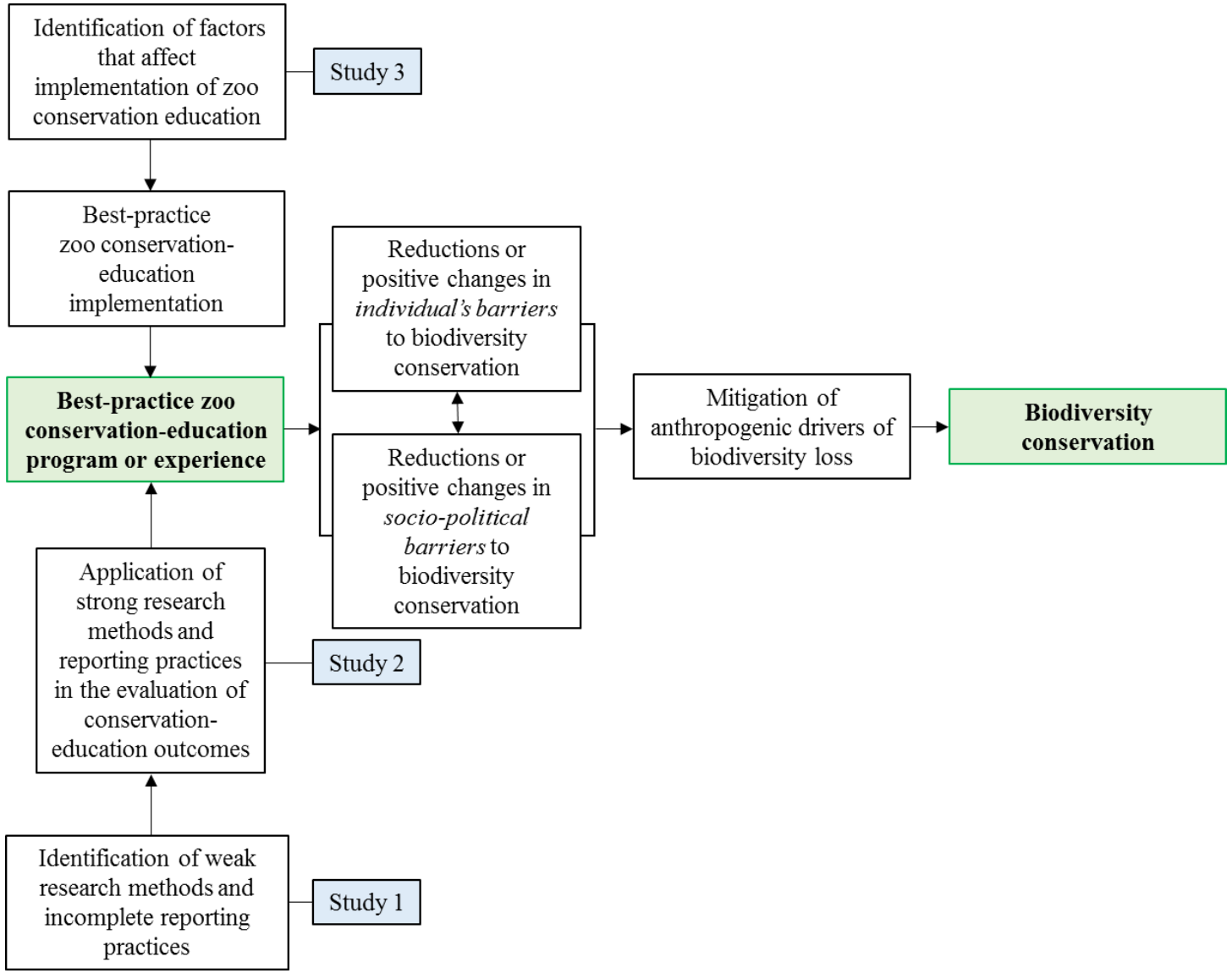


Figure 2.3. Map of the research program.

2.7 Conclusion

This chapter has reviewed the role of conservation psychology in addressing biodiversity loss and described relevant theories and principles that are typically applied in this field. It has been argued that while zoos are a potential platform to promote environmental stewardship, two fundamental gaps may be inhibiting best-practice zoo conservation education: 1) methodological shortcomings and incomplete reporting practices of outcome evaluation work; and 2) lack of understanding of the factors that shape the development and implementation processes. The next chapter addresses the first of these gaps by systematically reviewing and quantifying the quality and characteristics of research methods and reporting practices in the evaluation of zoo conservation-education.

Chapter 3: Study 1—Review of Research Methods and Reporting Practices in Zoo and Aquarium Conservation-Education Evaluation

Summary: Chapter 2 showed that outcome evaluations of zoo conservation-education programs yield mixed results with regard to visitor knowledge, attitudes, and behaviour. This makes it difficult to ascertain clearly how, and to what extent, evaluation methods influence the outcomes of such work. Scholarly insights regarding research methodology and the reporting practices of outcome evaluation work could address this knowledge gap and help to advance the rigour and quality of research in this area. Therefore, Study 1 aimed to systematically identify and review the research methodology and reporting practices in peer-reviewed articles (published in English from May 1998 to June 2016) that focused on adult visitor samples (47 articles, 48 studies). Elements of internal, external, construct, and statistical conclusion validity were examined using the Effective Public Health Practice Project Quality Assessment Tool (EPHPPQAT; National Collaborating Centre for Methods and Tools, 2008). Each study was coded as either strong (no weak ratings), moderate (1 weak rating), or weak (≥ 2 weak ratings). The quantitative methods of 83.3% of the studies analysed were weak. The remaining 16.7% had methods of moderate quality. Research in this field could be improved with the increased application of repeated-measures designs, mixed-methods approaches, and reporting practices that are more complete (e.g., inclusion of effect sizes and response rates).

This chapter contains the thesis version of a published journal manuscript (see Appendix A). Author contributions for this manuscript are detailed in Appendix B.

3.1 Rationale

Global biodiversity loss is accelerating rapidly (Barnosky et al., 2011; Dirzo et al., 2014; Pimm et al., 2014) and is largely driven by human activity (Ceballos et al., 2015; Niemelä et al., 2000; Vitousek, Mooney, Lubchenco, & Melillo, 1997). With their diverse and plentiful visitorship, there is increasing recognition of the potential role of zoos in the conservation of global biodiversity (Clayton, Fraser, & Saunders, 2009; Grajal et al., 2017; Packer & Ballantyne, 2010; Patrick & Caplow, 2018).

In recent years, zoos have increased their involvement in conservation education; however, as reviewed in Chapter 2 of this thesis, it is difficult to draw confident conclusions about the efficacy of these efforts because evaluation research is heterogeneous in terms of methodological approaches and rigour. To enhance conservation education in zoos, it is important to form a nuanced picture of the methods and reporting practices that comprise research on this topic. Uncovering the limitations in research methods and reporting practices offers a path forwards for research in this area. In turn, improving research and reporting will build a better stock of knowledge regarding which zoo-based educational strategies are most effective and how they work, ultimately to advance the preservation of biodiversity. Thus, the aim of this study was to use a systematic search strategy to identify and quantify the quality and characteristics of research methods and reporting practices in published empirical studies that evaluate zoo conservation education.

3.2 Methods

3.2.1 Systematic search strategy. In June 2016, with the help of an academic librarian, ProQuest, PsycINFO, Scopus, and Web of Science databases were searched for terms associated with three key concepts: zoo or aquarium visitors, conservation, and psychosocial outcomes. The key concepts and search terms are displayed in Table 3.1.

Table 3.1

Search Strategy Concepts and Associated Search Terms

Concept	Search terms
Zoo visitor/aquarium visitor	(‘visitor*’ AND ‘zoo*’ OR ‘aquarium*’)
Conservation	(‘threaten*’ OR ‘endanger*’ OR ‘conservation’) NEAR/3[a] (‘animal*’ OR ‘wildlife’ OR ‘species’ OR ‘biodiversity’)
Psychosocial outcomes	(‘knowledge’ OR ‘understand*’, ‘attitud*’ OR ‘behav*’ OR ‘learn’* OR ‘belief’* OR ‘emotion*’)

Note: proximity operator ‘NEAR/3’ was altered based on database used (i.e., W/3, N/3).

Full-text (i.e., the entire journal article is available), English-language, empirical studies published in peer-reviewed journals (representing evaluations of a generally higher quality) from May 1998 to June 2016 were included in this review. Guided in part by the TPB (Ajzen, 1985, 1991, 2002) and outcomes of interest identified in behaviour theories typically applied to conservation psychology research, eligible articles measured at least one conservation-related psychosocial outcome (e.g., conservation-related knowledge, conservation-focused attitudes or social norms, and conservation-related behaviours or behavioural intentions) within a population of general, adult zoo visitors on a general-admission visit. An outcome was classified as *conservation related* if it was likely to enhance a visitor’s ability to act on behalf of a species directly (e.g., conservation-related knowledge might include knowledge about a species conservation status or the effects that humans have on species’ habitats). An example of an outcome classified as not directly related to conservation is visitor learning about animal biology. Affective measures were categorised as *conservation focused* (rather than conservation related) in recognition that affective measures may directly or indirectly influence visitor ability to act on behalf of a species. The year 1998 was selected as the cut-off year because Broad and Weiler (1998) were among the earliest researchers to evaluate the conservation-education outcomes of a zoo exhibit directly, and because their article was published at the time conservation psychology was emerging in the early 2000s (Saunders, 2003).

There was a range of exclusion criteria (see Table 3.2). Given the ethical complexity of captive wildlife-tourism experiences (i.e., wildlife conservation and public education v. animal welfare and public entertainment trade-offs), if articles included different types of wildlife-tourism experiences in captive and noncaptive settings (e.g., Moscardo, 2007;

Ballantyne, Packer, & Falk, 2011; Ballantyne, Packer, & Sutherland, 2011), only data representing the conservation effects at the captive site(s) were extracted. As the focus of this research was to quantify the conservation effect of general-admission visits (the most frequent type of zoo visit with the largest reach to inspire conservation behaviour), studies with exclusive sample demographics (e.g., children only) or those that evaluated experiences available for additional fees (e.g., behind-the-scenes tours) were not included.

Table 3.2

Inclusion and Exclusion Eligibility Criteria and Example Articles in Review

Inclusion criteria	Exclusion criteria	Examples of excluded articles
Full-text, English-language empirical studies, published in peer-reviewed academic journals between 1998 and May 2016	Conference proceedings, book chapters, theses/dissertations, internal/commissioned reports, brief reports, research notes.	Falk et al., (2007); Balmford et al., (2007)
Studies that measured *at least one* conservation-related psychosocial outcom	Studies that measured psychosocial outcomes *not* directl conservation-focused (e.g., knowledge about animal biology; facts about animal characteristics; focus not specified).	Anderson, Kelling, Pressley-Keough, Bloomsmith & Maple (2003); Altman (1998); Penn (2009); Spotte & Clark (2004)
Studies with general zoo visitor samples	Studies with samples not representative of general admission visitor population.	Randler, Baumgärtner, Eisele, & Kienzle (2007); Jensen (2014)
Studies that measured a typical zoo/aquarium experience available for general visitor (e.g., show; exhibit)	Studies that measured experiences available for addition fees (e.g., behind-the-scenes tours, safari park tours).	Hacker & Miller (2016); Kruse & Carc (2004)

The study-selection process is displayed in Figure 3.1. First, citations were downloaded to EndNote and titles and abstracts were screened independently, in duplicate, by two researchers for eligibility. The full texts of the remaining articles were examined, as were the reference lists of included studies.

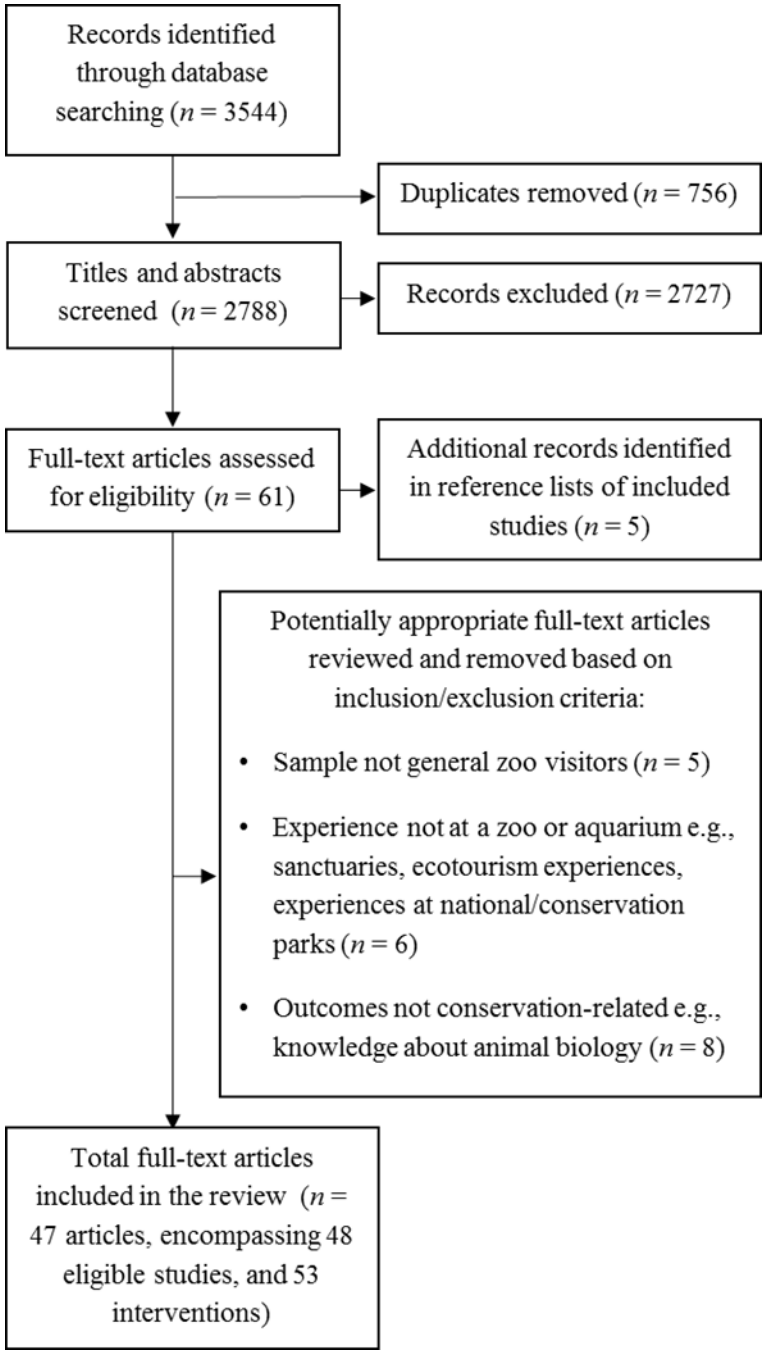


Figure 3.1. Flow diagram for the article-selection process for an examination of zoo conservation-education evaluation research.

3.2.2 Data analyses. Data extraction and coding were completed by two researchers. For each article in the final sample, the following data were extracted independently, in duplicate, by both coders: study characteristics; and threats to the construct validity, external validity, internal validity, and statistical conclusion validity. In addition, the coders rated the overall methodological quality of each study, again under independent-duplicate conditions. The features of studies included in the analysis were guided by the variables coded in two previous methodological reviews (Casper, Eby, Bordeaux, Lockwood, & Lambert, 2007; Neall & Tuckey, 2014), as well as the initial appraisal of the 47 eligible articles. The level of inter-rater agreement is detailed within the Results section of this chapter (Section 3.4). The following section presents definitions of each validity type assessed.

3.3 Measures

3.3.1 Methodological validity.

3.3.1.1 Construct validity. Construct validity refers to the extent to which a measure tests the construct being measured (Cronbach & Meehl, 1955). Threats to construct validity included in this review were data collection methods and measurement instruments (e.g., questionnaire, interview; observation; multimedia), which were exhaustively coded.

3.3.1.2 Internal validity. Internal validity is the extent to which causal inferences can be concluded from the data (Cozby, 2007); in the case of this review, this was whether any changes observed in visitors were a result of the conservation-education experience itself or other factors. Elements of internal validity were time horizon (the length of time over which the study is conducted; exclusively coded, number of times specified) and level of control (exclusively coded as randomised controlled trial, controlled comparison, cohort analytic, interrupted time series, cohort, and one group cross-sectional survey).

3.3.1.3 External validity. External validity describes the extent to which findings apply to other populations and settings (Cozby, 2007); in this case, whether another zoo was likely to produce similar results. Variables related to external validity were setting (exclusively coded as zoo-only, aquarium-only, or multiple sites/not specified), sample country of origin (exhaustively coded), and response rate (coded as reported/not reported).

3.3.1.4 Statistical conclusion validity. Statistical conclusion validity defines the level of accuracy with which conclusions about the relationship between two variables can be inferred (Busk, 2010; Cook & Campbell, 1979). Indicators of statistical conclusion validity coded in this review were data analysis techniques (exhaustively coded); reporting of effect

sizes (coded as reported/not reported); data triangulation (coded as reported/not reported); and piloting of measures (coded as reported/not reported).

3.3.2 Methodological quality appraisal.

3.3.2.1 Quality of qualitative methods. There is growing recognition that mixed-methods designs are better able to answer research questions than mono-method designs (Johnson & Onwuegbuzie, 2004). Qualitative methods allow researchers to examine phenomena in greater depth, which can reveal complexities about problems that may be missed by quantitative-only analyses. However, data quality is greatly affected by the skills of the researcher and analysis can be time consuming, meaning that rigour in qualitative research is often difficult to maintain and assess (Anderson, 2010).

For the exploration of qualitative methods in this study, relevant items were adopted from an existing set of criteria used to provide guidance for authors and reviewers to prepare and review qualitative research papers (Anderson, 2010). For each study, it was determined whether the following aspects were described: qualitative methods (explicitly stated); methods for recording data (e.g., audio or visual recording, or written); procedures for transcribing data, where applicable (e.g., interviews); examples of methods (e.g., interview guides); methods for analysing data (e.g., thematic analysis, content analysis); methods for verifying data (e.g., inter-rater reliability); and qualitative data examined through quantitative analysis (i.e., frequency of responses used in statistical models as opposed to exploring depth or nature of detail in the response).

3.3.2.2 Quality of quantitative methods. In the absence of a systematic tool or protocol that specifically evaluates the study methods of zoo conservation education, the EPHPPQAT (1998) was used to rate overall methodological quality of quantitative items. Based on the evaluation of six aspects of design and methodology, each study was coded as either strong (no weak ratings), moderate (one weak rating), or weak (two or more weak ratings). The coding guide for this resource is available from http://www.ephpp.ca/PDF/Quality%20Assessment%20Tool_2010_2.pdf (accessed April 2019). Each quality-scoring component and paired coding description (as per the Tool dictionary), with application examples, is outlined in Appendix C. This tool underwent validity appraisal (yielding accepted standards for content validity, construct validity, and inter-rater reliability; Thomas et al., 2004) and testing processes that involved experts appraising study quality (National Collaborating Centre for Methods and Tools [NCCMT], 2008). This tool has been applied in the fields of psychology and environmental behaviour

change (e.g., Fraser & Lock, 2011; Randal et al., 2015). It examines selection bias (sample representativeness of the target population, response rate); study design (type of design, use and method of randomisation); confounders (identification and control of potential differences between groups prior to the intervention); blinding (to assessor awareness of participant intervention status and participant awareness of the research question); data collection methods (validity and reliability of data collection tools); and withdrawals and dropouts (reporting of withdrawals and dropouts in terms of numbers or reasons; percentage of participants completing the study).

3.4 Results

Forty-seven journal articles (identified with an asterisk [*] in References) measuring the conservation effect of zoos were reviewed. They encompassed 48 studies and 53 interventions (programs or experiences). The studies had been published in journals across several disciplines: tourism and visitor studies (e.g., *Journal of Sustainable Tourism* [*n* = 3], *Tourism Management* [*n* = 2], *Tourism Review International* [*n* = 1], *Visitor Studies* [*n* = 5]); museum studies (e.g., *Curator: The Museum Journal* [*n* = 6]), education (e.g., *Science Education* [*n* = 1], *Environmental Education Research* [*n* = 3]); and conservation (e.g., *Biodiversity Conservation* [*n* = 1], *Conservation Biology* [*n* = 1]). Almost one-quarter (20.8%, *n* = 10) of the studies were published in *Zoo Biology*. There was high inter-rater point-by-point agreement (range 88.9–100%) across all study features coded. For methodological-quality scoring (with EPHPPQAT), coding was initially completed independently and resulted in a mean inter-rater reliability score of 0.62. All discrepancies were discussed until 100% agreement was reached. These results were then used as the final coding in the analyses.

3.4.1 Study characteristics. The most frequently evaluated intervention or experience was an entire site or overall visit (24.5%, *n* = 13), followed by a presentation or keeper talk (17.0%, *n* = 9). Seven studies (13.2%) did not specify or describe the type of intervention material that was being evaluated (see Table 3.3). Interestingly, five of the nine studies (55.6%) that evaluated a presentation or keeper-led talk further reported that the experience had been standardised (e.g., used scripts). Conservation-related behavioural outcomes were assessed by just under half of the eligible studies (47.9%, *n* = 23), while conservation-related cognitive measures and conservation-focused affective measures were assessed by 79.2% (*n* = 38) and 72.9% (*n* = 35) of articles, respectively (see Appendix D).

Table 3.3

Frequency and Type of Intervention Evaluated in Review

Intervention type	Frequency (%
Overall visit (specified)	13 (24.5%)
Intervention type not specified (e.g., 'aspects of visit')	2 (3.8%)
Specific exhibit/section of the site (interpretative material type not specified)	7 (13.2%)
Specific exhibit/section of site (interpretative material type specified: e.g., including banners, graphics, maps, posters, petition cards)	8 (15.1%)
Presentation/keeper talk	9 (17.0%)
Multimedia (e.g., video presentation/kiosk, touch tables/touch screens)	6 (11.3%)
Bus tour	1 (1.9%)
Animal interaction (available with entry fee)	1 (1.9%)
Bio facts cart (e.g., cart with items made from an elephant)	1 (1.9%)
Exhibit aesthetics (e.g., naturalistic/unnaturalistic, immersive)	2 (3.8%)
Seafood Watch Program pocket guide	1 (1.9%)
Walkway/path area	1 (1.9%)
Use of docents to disseminate conservation messages	1 (1.9%)

3.4.2 Methodological validity.

3.4.2.1 Construct validity. Just over three-quarters (77.1%, *n* = 37) of the included studies used surveys or questionnaires to collect data; 29.2% (*n* = 14) collected data with interviews (see Table 3.4).

Table 3.4

Frequency of Data Collection Methods Used in Eligible Research

Data collection method	Frequency (%)
Survey/questionnaire (including Personal Meaning Mapping)	37 (77.1%)
Interview	14 (29.2%)
Observation (e.g., recorded typology of verbal responses)	7 (14.6%)
Multimedia (e.g., via playing a game)	1 (2.1%)

Note: Data collection methods were exhaustively coded so frequency represented the proportion of studies (n = 48) that reported each method.

3.4.2.2 Internal validity. Table 3.5 presents the frequency of research design characteristics in eligible zoo conservation-education evaluation research. In most studies, the data were collected at only one point in time (e.g., when a visitor exited the zoo; 54.2%, n = 26). The most commonly used levels of control were single-group cross-sectional surveys (e.g., surveying one group of visitors at the end of their visit; 39.6%, n = 19) and controlled comparisons (e.g., where outcomes for an exhibit-only group were compared with an exhibit+presentation group and the groups were not randomly assigned to these conditions; 37.5%, n = 18).

3.4.2.3 External validity. The majority of the 48 studies were from zoo-only settings (62.5%, n = 30); aquarium-only settings accounted for 16.7% (n = 8) of the sample. Seven (14.6%) studies contained samples from a zoo and an aquarium and 6.3% (n = 3) did not specify the setting. Most samples originated from countries with a majority English-speaking population (i.e., Australia, Canada, New Zealand, North America, United Kingdom; see Table 3.6). Twenty-seven (56.3%) studies reported participant response rates.

Table 3.5

Frequency of Research Design Characteristics in Eligible Research

Characteristic	Frequency (%)*
Time horizon	
1 time	26 (54.2)
2 times	13 (27.1)
3 times	8 (16.7)
4 times	1 (2.1)
Level of control	
randomised control trial (≥ 2 conditions, 1 time, random allocation)	1 (2.1)
controlled comparison (≥ 2conditions, 1 time, non-random allocation)	18 (37.5)
cohort analytic (2 conditions, 2 times, same sample)	2 (4.2)
interrupted time series (≥ 1 condition, ≥ 2 times, different samples)	2 (4.2)
cohort (1 condition, 2 times)	6 (12.5)
1 group cross-sectional survey (1 condition, 1 time)	19 (39.6)

*Research design characteristics were exhaustively coded so that frequency represented the proportion of studies (*n* = 48) that reported each method.

Table 3.6

Frequency of Sample Populations Used in Eligible Research, by Country of Origin

Country of origin	Frequency (%)
North America	29 (60.4%)
Australia	11 (22.9%)
United Kingdom	4 (8.3%)
Canada	2 (4.2%)
South Africa	2 (4.2%)
Switzerland	2 (4.2%)
New Zealand	2 (4.2%)

Note: As some studies reported multiple countries of origin, *frequency* represents the proportion of studies (n = 48) that reported each country. Countries of origin reported for one sample (2.1%) included Argentina, Brazil, Chile, Colombia, Germany, Hong Kong, India, Japan, Latin America, Mexico, Netherlands, Russia, Singapore, Sweden, and Uganda.

3.4.2.4 Statistical conclusion validity. Simple inferential statistics (e.g., correlation, chi square, *t* test) were reported by most studies (91.7%, *n* = 44). Analysis of (co)variance (ANOVA/ANCOVA) models were the most commonly used techniques to examine one dependent variable with a single relation (50.0%, *n* = 24). Few studies used techniques to examine multiple dependent variables with a single relation (e.g., multivariate analysis of variance [MANOVA]; 4.2% *n* = 2) or multiple relations with both independent and dependent variables (e.g., structural equation modelling, 6.3%, *n* = 3). The structure of the data (i.e., relationships among subsets of the data) was investigated in five studies, and 17 studies included a quantitative technique to explore data (see Table 3.7). Less than half (43.8%, *n* = 21) of the studies reported effect sizes. Ten studies (20.8%) reported that measures were tested prior to data collection. Twelve studies (25.0%) validated data by utilising two or more sources (e.g., surveys and in-depth interviews).

Table 3.7

Frequency of Data-analysis Techniques Used in Eligible Research

Technique	Frequency (%)[a]
Simple inferential statistics	
correlations	5 (10.4)
chi square (or equivalent e.g., Fisher's exact test)	21 (43.8)
t tests (or equivalent, e.g., Mann Whitney *U*)	18 (37.5)
One DV with single relation	
ordinary least squares regression	1 (2.1)
general linear model (GLM)	1 (2.1)
multiple linear regression	5 (10.4)
logistic regression	4 (8.3)
discriminant regression or discriminant function analysis	2 (4.2)
Analysis of Variance	
ANOVA or ANCOVA (including linear mixed models)	24 (50.0)
Multiple DVs with a single relation	
MANOVA	2 (4.2)
Multiple relations with both IVs and DVs	
structural equation modelling	3 (6.3)
Structure of data	
confirmatory factor analysis	2 (4.2)
exploratory factor analysis	1 (2.1)
cluster analyses	1 (2.1)
principal component analysis	1 (2.1)
Qualitative analyses (i.e., thematic analysis, content analysis)	23 (47.9)

Notes:
Abbreviations: DV = dependent variable; IV = independent variable.
[a]As some studies reported multiple analysis techniques, frequency represents the proportion of studies that reported each analysis type (n = 48).

3.4.3 Methodological quality appraisal.

3.4.3.1 Quality of quantitative methods. Eight (16.7%) studies were awarded a moderate methodological quality (i.e., scored 1 weak rating across all criteria) and the remaining 40 studies (83.3%) were awarded a weak methodological quality (i.e., scored 2 or more weak

ratings). No studies were awarded an overall strong methodological quality (i.e., no weak ratings across all criteria).

The individual methodological design features that were rated as most rigorous were selection bias (28 studies, 58.3%, rated as moderate or strong) and study design and data collection methods (27 studies, 56.3%, rated as moderate or strong for both these features). Typically, the confounders, blinding, and withdrawal and dropouts criteria were rated as weak (see Table 3.8).

3.4.3.2 Quality of qualitative methods. Twenty-three of the studies had included qualitative data. All of them explicitly described the methods used and over half (60.9%; $n = 14$) reported the method of recording data (e.g., audio or video recording, written). Where transcription had been applicable (e.g., audio recording or interviews), 3 of the 14 eligible articles (21.4%) had detailed the transcription procedure. Eight studies (34.8%) had reported the way data verification had been performed and 16 (69.6%) had discussed methods for identifying or extrapolating themes and concepts from the data. Fifteen studies (65.2%) had treated qualitative data with a quantitative analysis (i.e., frequency of responses was used to interpret data or was used in statistical models, as opposed to exploring the depth or nature of detail in the responses).

Table 3.8

Methodological Quality Component Sub-scores and Overall Global Score Frequencies for Eligible Studies

Methodological quality componen	Selection bias frequency (%)	Study design Frequency (%	Confounders[a] Frequency (%)	Blinding Frequency (%)	Data collection methods Frequency (%)	Withdrawals and dropouts[b] Frequency (%)	Overall global score Frequency (%)
Weak	20 (41.7)	21 (43.8)	20 (41.7)	43 (89.6)	21 (43.8)	11 (22.9)	40 (83.3%)
Moderate	17 (35.4)	14 (29.2)	-	5 (10.4)	12 (25.0)	3 (6.3)	8 (16.7%)
Strong	11 (22.9)	13 (27.1)	12 (25.0)	-	15 (31.3)	2 (4.2)	0 (0%)

Notes:

[a]As per the EPHPPQAT guidelines, 16 (33.3%) studies were coded as ‘can’t tell’ because there was not sufficient information to determine whether confounding variables had been controlled for in the study design or in the analyses.

[b]As per the EPHPPQAT guidelines, 32 (66.7%) studies were coded as ‘not applicable’ because the study had been a one-time interview or survey or no follow-up data had been reported.

3.5 Discussion

3.5.1 Study characteristics. The most common type of intervention evaluated was an entire site or overall visit (24.5%). This approach presents a major challenge to determining the effect of such experiences because little information can be gleaned about the specific influential aspects of the intervention (i.e., program or experience). By more frequently isolating variables of interest (i.e., specific interpretative medium, such as a presentation), the effect of an intervention (and in particular, the active ingredients of the intervention) can be understood more accurately.

Despite changes in visitor behavioural intention and action being a key motivation for many of these interventions, less than one-half of the studies (47.9%) had included a conservation-related behavioural outcome measure. Assessing visitor engagement in conservation behaviours following an experience could increase accuracy of quantification of the length of effect of zoos on public conservation behaviour. Around one-half of keeper-led talks (just under one-fifth of all interventions) had been standardised (i.e., used scripts). Evaluating a non-standardised intervention makes it difficult to pinpoint components of the intervention that contributed to outcomes of interest. Ensuring that elements of a program are delivered consistently with the aid of materials (e.g., scripts), and staff training or briefing (about program messaging and key touch points) where feasible, could help overcome this challenge. Table 3.9 summarises the key methodological concerns, noting exemplary work that addressed existing barriers and making recommendations for future research.

Table 3.9

Summary of Methodological Barriers and Recommendations for Future Practice and Evaluations, With Examples

Methodological and/or reporting barrier	Validity threat	Recommendations for future practice and evaluation research	Articles that overcame methodological barriers
Overreliance on self-report measures	Construct	Apply intensive longitudinal measures (e.g., daily diary)	N/A See Bolger, Davis, & Rafael (2003) for an overview of diary methods
Lack of examining reliability of measures	Construct	Examine and report reliability estimates of measures	Clayton, Luebke, Saunders, Matiasek, & Grajal (2014); Moss, Jensen, & Gusset (2015)
Overuse of zoo-only samples	External	Incorporate aquarium-only and/or mixed (i.e., aquarium and zoo) samples more frequently	Skibins & Powell (2013); Skibins, Powell, & Hallo (2013)
Overuse of Western country-of-origin sample	External	Incorporate samples from non-Western populations more frequently	Moss et al. (2015)
Lack of reporting response rate	External	Report response rates	Smith & Broad (2008); Clayton, Fraser, & Burgess (2011)
Overuse of controlled comparisons	Internal	Employ randomised controlled trials, time series designs, and/or cohort analytic designs	Lindemann-Matthies & Kamer (2006)
Underuse of complex dat analysis techniques	Statistical conclusio	Apply statistical analysis techniques that allow researchers to explore complex models of causal effects	Skibins & Powell (2013); Skibins et al. (2013)
Underuse of qualitative measures	Statistical conclusio	Incorporate qualitative measures into research methodology	Pearson et al. (2013)
Analysis of overall visit or entire site	Statistical conclusio	Measure intervention/ interpretative medium of interest (e.g., a presentation) in isolation	Perdue et al. (2012)
Lack of standardised interventions	Statistical conclusio	Employ scripts for presentations	Perdue et al. (2012); Mann-Lang et al. (2016)

Lack of reporting effect-size estimates	Statistical conclusio	Calculate and report effect-size estimates	Wagner, Chessler, York, & Raynor (2009); Clayton et a (2014)
Reliance on one source o data	Statistical conclusio	Use multiple data collection methods	Briseño-Garzón, Anderson, & Anderson (2007); Falk et al. (2008)
Lack of piloting measure	Statistical conclusio	Pilot measures	Lindemann-Matthies & Kamer (2006); Lukas & Ros (2005)

3.5.2 Methodological validity.

3.5.2.1 Construct validity. Consistent with earlier statements about overreliance on self-reporting measures in zoo research (e.g., Jensen, 2014), it was observed in this study that the conservation effect of zoos was most frequently assessed with surveys or questionnaires (77.1%) or interviews (29.2%). Such methods have limitations, including social desirability bias (respondent's tendency to provide answers deemed more desirable by others) and consistency motif (respondents' attempt to remain consistent in thoughts and feelings; Grimm, 2010).

Although overreliance on self-reporting measures is likely in response to the unique barriers of objectively measuring visitor outcomes, future research could be strengthened by supplementing self-reported data with intensive longitudinal methods (i.e., collection methods that require participants to provide systematic self-reporting at random occasions, such as a diary) to facilitate in-depth analysis of psychological processes (Fraley & Hudson, 2014). In future research, validated measurement tools should be used where possible and the reliability of measurement tools should be examined more frequently (e.g., item analysis), as well as reporting on reliability estimates.

3.5.2.2 Internal validity. There was only one randomised controlled trial in the sample of studies reviewed. This result likely reflected the inherent challenges in conducting randomised controlled trials at a zoo (e.g., high cost, difficulty in allocating paying visitors to a condition). This is problematic, given the effect of visitor sociodemographic variables (e.g., age, gender, pet ownership, vegetarian status, prior visit; Driscoll, 1995; Ross & Gillespie, 2009; Signal & Taylor, 2007) on their pre-existing knowledge, attitudes, and interactions with the interpretive elements.

Where feasible, adopting a random allocation of visitors or participants to conditions would allow zoos to assess more accurately the level of effect of particular intervention elements on changes in visitors' conservation-related psychosocial outcomes and to refine

future conservation-education initiatives based on this knowledge. One solution to facilitate random allocation might be to invite visitors upon zoo entry to be allocated randomly to a particular experience or condition in return for a small incentive (e.g., discount voucher for zoo shop or café purchases). If randomised controlled trials were impractical in some cases, cohort analytic designs, controlled comparisons, and time series designs could serve as appropriate alternatives (in conjunction with analyses to explore differences in participant demographic), to facilitate scholarly knowledge about the effects of community interventions (Biglan, Ary, & Wagenaar, 2000).

The most frequent research design type (37.5% of studies) found in this review was the comparison of two visitor groups who experienced different educational content (e.g., an exhibit experience compared with an animal presentation experience) at one point in time (coded: controlled comparison). Including time series designs more frequently would have offered additional contributions to the field, given that 54.2% of the studies examined had only one data collection time point. For instance, time series designs could offer much-needed insights regarding the extent to which zoo conservation-education strategies translate into behaviour change and for how long, or to what extent, such behavioural change persists. Consistent with Khalil and Ardoin (2011), who expressed concern about the lack of research investigating longer-term effects of zoos, the direction of research in this field should focus on evaluating the sustained effects of zoo conservation-education interventions.

3.5.2.3 External validity. Studies often comprised zoo-only samples (62.5%), as opposed to aquarium-only samples (16.7%) or studies that included both sample types (14.6%). Although zoos and aquariums are commonly considered one entity, demographic differences between zoo and aquarium visitors are evident (e.g., aquariums may attract more tourists and first-time visitors than zoos; aquarium visitors may be more likely to display motivations towards learning than zoo visitors do; Mann, Ballantyne, & Packer, 2014).

Differences in learning motivations are of particular importance when considering the perceived role of learning and discovery elements of a wildlife-tourism experience (captive and noncaptive) among visitors, because they are considered integral to their enjoyment of, and engagement with, the experience (Packer & Ballantyne, 2005). Developing a more comprehensive understanding of the similarities and differences between typical zoo and aquarium audiences could shape the type of initiatives delivered across sites in terms of content and delivery method.

Although it is likely that the exclusion criterion of non-English publications contributed to the limited number of studies with a non-Western country of origin, the study

results suggested that peer-reviewed research exploring the conservation effect of zoos is concentrated in Western countries. Given the widespread nature of biodiversity loss and the range of cultural factors that underpin environmental attitudes and behaviours (e.g., beliefs; Schultz & Zelezny, 1999), understanding the way these factors influence the conservation effect of zoo education programs among non-Western samples is important and warrants further research.

A final issue concerning external validity was the proportion of studies (43.8%) that failed to report a response rate. Response rates are critical when evaluating the value of research findings because higher response rates increase confidence that the sample is representative of the broader population (e.g., Rogelberg & Stanton, 2007). Further, reporting response rates can help to identify potential sources of bias (i.e., research with a large non-response rate may potentially represent only those who are more motivated to reply or those who have a more extreme perspective). Therefore, it is critically important that future research report this information, to indicate the extent to which the results are generalisable to the broader zoo-visiting population.

3.5.2.4 Statistical conclusion validity. Zoo conservation-education evaluation is an emerging field of enquiry in which there are few established or clearly defined measures. Thus, it is unsurprising that a key problem with statistical conclusion validity was identified, owing to the paucity of studies that adopted data analysis techniques with multiple relations or that examined the structure of data. These techniques (e.g., path analysis or structural equation modelling) offer researchers the opportunity to explore complex models of causal effects (e.g., Hair, Ringle, & Sarstedt, 2011; Kline, 2011) and could be applied more frequently in future zoo conservation-education evaluation research. This is particularly relevant given that previous work has been concerned that zoos are focusing on their immediate influence on knowledge, attitude, and behavioural outcomes instead of exploring the way these components interact with each other over time (e.g., Khalil & Ardoin, 2011).

In light of this study's finding that qualitative measures had been utilised in only 50% of studies, future zoo research could benefit from more frequently including measures of this type. Qualitative measures could unveil topical areas not initially considered and inform understanding of why people engage (or do not engage) in particular conservation behaviours. For example, including qualitative behaviour measures in post-experience visitor surveys in time series designs could yield explanations for why zoo visitors do (or do not) maintain the uptake of a behaviour.

Effect-size estimates are important for empirical research because they indicate the practical significance of a result. In comparison to statistical significance (where statistical probabilities are used to reject or accept a null hypothesis), practical significance helps to quantify how important or large the study results are, regardless of the sample size (e.g., Hojat & Xu, 2004). This is particularly relevant to applied research, which focuses on the practical application of science to real-world problems (e.g., biodiversity conservation). Yet only 43.8% of the studies in this review reported effect sizes. Increasing the frequency of reporting the magnitude of differences would advance zoo conservation-education experiences because they could be used to calculate sample size for future or follow-up analyses or to make comparisons between effects across studies (Lakens, 2013).

In addition, data triangulation and testing of measures were considered. Only 25% of the studies had validated data by utilising two or more sources. Designing and conducting mixed-methods research in zoos could yield broader insights with regard to the conservation effect of an intervention. The way zoos triangulate research largely depends on the research aims, but combining different techniques (e.g., focus groups v. individual interviews) and techniques that suit a research setting (e.g., diaries v. e-workshops for remote or indirect projects) could be useful ways for zoos to cross-verify research outcomes. A limited number (20.8%) of studies had reported testing measures prior to data collection. Pilot studies would allow for pretesting of research instruments and could highlight problems with procedures, thereby facilitating a more robust study design (e.g., van Teijlingen & Hundley, 2002).

3.5.2.5 Quality of qualitative methods. Generally, methods for recording data and methods for extrapolating data had been appropriately reported in the studies, but only a minority of studies had reported data verification methods. Because qualitative research is highly influenced by the experiences of each individual researcher, informing readers about the way the data were identified and validated strengthens the reproducibility and stability of the data (Anderson, 2010). In addition, there had been a tendency in some studies to treat qualitative data with quantitative methods. This is problematic because such methods can contribute to a loss of the richness of the data.

Although choosing which analytic approach to apply largely depends on the research question, analysing text without coding or counting allows a more raw interpretation of the data (Bernard, 1996). For example, when considering knowledge, a qualitative approach could identify patterns or sequences in narrative accounts more accurately to explain why (or why not) conservation messaging translated into action, as well as to discover more precisely visitor knowledge gaps concerning a conservation issue. Such information would

be useful when developing messaging strategies for future campaigns (e.g., use of post-visit action resources such as take-home information sheets; Ballantyne & Packer, 2011).

3.5.2.6 Quality of quantitative methods. Overall, the studies included in this review were generally of weak methodological quality as determined by the EPHPPQAT (83.3%). The categories of section bias, study design, data collection method, and withdrawal and dropout held methodological integrity that was more robust. For example, individuals selected to participate in the studies had a moderate likelihood of being representative of the target population and there was a moderate use of stronger study designs across samples.

Based on these results, future research should control for demographic differences between groups, blind the study participants to the research question (along with increased reporting of this information), and use more reliable and valid measurement instruments (together with reporting reliability and validity information).

3.6 Strengths and Limitations

A key strength of this review was the rigorous systematic search protocol, which was developed with input from researchers and an academic librarian to maximise the potential to capture all relevant literature. In addition, data collection, extraction, and quality rating were undertaken independently, in duplicate, by two researchers.

Nonetheless, there are limitations to this review. While measures were taken to capture all relevant literature, eligible articles may have been missed. When rating methodological quality in these articles, poor or unclear reporting meant that for many studies, instances of blinding were recorded as unclear, which automatically eliminated the article from receiving a strong global score. Further, when considering publication bias, it is possible that outcomes from the sample of peer-reviewed articles underrepresented the degree to which methodological limitations truly undermined the conclusions of research in this area. Over two-thirds of the included literature had a Western country of origin (likely a result of our selection criteria to exclude non-English publications). Future research may wish to include non-English studies to reduce the possibility of bias by cultural influences. Peer-reviewed journal articles were selected because they represented research of relatively high quality. Future research may wish to examine grey literature that could offer additional insight with regard to the extent of methodological challenges.

3.7 Practical Implications

Conducting field research with zoo visitors to evaluate their conservation efforts is not an easy task. The outcomes from this review have highlighted consistent methodological shortcomings and incomplete reporting of outcomes in the body of zoo conservation-education evaluation research. For researchers, the findings from this review could serve as a guide during critical decision-making stages of research design and raise the bar for the standard of reporting completeness in published work. For practitioners, these outcomes could help to build the knowledge and skills to evaluate and critically assess the quality of an evaluation research paper, which could inform the educational components to adopt (or not adopt). Moving forward, results from this review can further serve as a point of reference for evaluation practitioners when choosing key methodological problems to address. Ultimately, capacity to overcome methodological limitations will be dependent upon the available resources (e.g., training, lack of funds, resistance from visitors) and will likely vary between organisations.

The implications of this review extend further to policy. Representative bodies (e.g., ZAA and World Association of Zoos and Aquariums [WAZA]) are well positioned to use the outcomes from this research to develop a research and evaluation agenda for the field; provide training and support for zoo staff to evaluate conservation-education programs more accurately; publish zoo-specific guidelines for conducting evaluations to facilitate improvements in evaluation quality; establish a research and evaluation repository and dissemination system for the global zoo community; and facilitate collaborations between industry and academia to bridge knowledge gaps in relation to rigorous scientific research methods. Through these processes, the potential for zoos to contribute to global biodiversity conservation could be realised.

3.8 Conclusion

Rigorous evaluation of zoo conservation-education is a challenging task, but it could be enhanced by utilising best-practice research methods and reporting practices. This study has provided evidence of the areas of evaluation methodology that need development. This information can guide study design in future evaluation research to strengthen confidence in the research outcomes. Positively, research published since the literature search for this study (June 2016–2019) has provided exemplars for overcoming some of the challenges mentioned in this study. Examples are the use of mixed methods, such as using questionnaires and interviews along with qualitative and quantitative measures (e.g.,

Bueddefeld & Van Winkle, 2017); investigations with non-Western samples (Mann et al., 2018); the use of control and treatment groups (Chalmin-Pui & Perkins, 2017); and the evaluation of an experience in isolation (e.g., a zoo theatre performance; Spooner, Jensen, Tracey, & Marshall, 2019).

The next chapter of this thesis seeks to advance this field of work by addressing a series of problems that emerged from this review, using an outcome evaluation of a zoo conservation-education program delivered at Melbourne Zoo (Victoria, Australia).

Chapter 4: Study 2—What Goes Up Must Come Down: An Evaluation of a Zoo Conservation-Education Program About Balloon Litter

Summary: Zoo conservation-education has enormous potential to contribute to biodiversity conservation by connecting people with nature. In light of the methodological shortcomings and incomplete reporting practices identified in Chapter 3, advancing best-practice zoo conservation education clearly requires more outcome evaluations that have robust research methodology and report outcomes comprehensively. Accordingly, this chapter conducts an outcome evaluation of a conservation-education program (When Balloons Fly; WBF), informed by new scholarly knowledge gleaned from the previous chapter. By surveying zoo visitors over a 6-month period, this outcome evaluation of the program revealed that WBF appeared to be having positive effects on visitor conservation-related knowledge, attitude, and behaviour with regard to balloon debris. Importantly, two-thirds of the follow-up sample reported that behaviours they had changed while hosting or attending an outdoor event since their visit were influenced by the WBF experience. A major finding from this evaluation was the likely priming influence of a pre-survey. These discoveries could be useful for further refining evaluation methodology.

This chapter contains the thesis version of a published journal manuscript (see Appendix E). Author contributions are detailed in Appendix F.

4.1 Rationale

As shown in Chapters 2 and 3, the current body of work that seeks to evaluate zoo conservation education is characterised by methodological limitations and incomplete scientific reporting of outcomes (Mellish, Ryan, Pearson, & Tuckey, 2019). These limitations make it difficult to draw confident conclusions about if, how, and to what extent, zoo conservation education is contributing to global biodiversity conservation. Clearly, there is a compelling case for conducting more evaluation research that employs robust research methods and provides reporting of outcomes that is more complete.

The research reported in this chapter addressed key gaps that emerged from the previous chapters by evaluating Zoos Victoria's WBF conservation-education program, which targets balloon litter. Specifically, this study addressed limitations in construct validity by validating all survey items in a pilot study and reporting their reliability estimates. To address the issue of threats to external validity that were identified in the previous chapter, the response rates for final survey were collected and reported.

This new survey of the WBF program addressed problems related to internal validity (principally, that the majority of evaluations collect data at only one point in time) by employing a time series design that encompassed four time points over six months. To close gaps regarding statistical conclusion validity within this field of inquiry, this research project reported effect sizes and implemented a mixed-method approach for both statistical analyses (i.e., between-group and within-group differences were analysed simultaneously, using the Univariate GLM function) and data collection (quantitative items were complemented by open-ended questions).

Priming theory asserts that exposure to a stimulus can unintentionally function as a filter or interpretive frame and influence the way a person responds to subsequent stimuli (Bargh & Chartrand, 2000). Priming can impede statistical conclusion validity. In the context of zoo research, it is possible that a pre-survey (i.e., a survey that is distributed to potential participants prior to their experience, to generate baseline data) could influence the way visitors interpret, engage with, and/or respond to specific educational components of a zoo conservation-education experience or program. This study addressed this threat to statistical conclusion validity by examining whether there was a priming effect from the pre-survey that was implemented as part of this research.

Beyond the goal of addressing methodological shortcomings and incomplete reporting practices previously uncovered in this thesis, this study sought to provide Zoos Victoria with important information about the efficacy of their conservation-education

program. Guided by the TPB and input from the wildlife conservation team at Zoos Victoria, the outcome variables of interest were visitor cognition (i.e., visitor understanding with regard to the effect of balloon litter on marine wildlife), affect (i.e., visitor attitudes and social norms with regard to balloon use outdoors), and behaviour. Specifically, this last aspect focused on behavioural intentions to reduce balloon use and increase wildlife-friendly bubble (hereafter 'bubble') use at outdoor events, and self-reported post-visit conservation behaviour in this regard. This study was guided by the following research questions:

1. How and to what extent does WBF influence visitor understanding about the impact of balloon litter on marine wildlife before and after their Wild Sea experience?
2. How and to what extent does WBF influence visitor attitudes concerning balloon use outdoors?
3. How and to what extent does WBF influence visitor behavioural intentions to reduce their balloon use outdoors and increase their wildlife-friendly bubble use outdoors?
4. Following their WBF experience, to what extent do visitors self-report post-visit conservation behaviour pertaining to the reduction of balloon use outdoors and uptake of bubble use?
5. How and to what extent does the completion of a pre-survey prime visitor responses?

4.2 Zoos Victoria's When Balloons Fly Program

Balloons and their attachments pose 'considerable entanglement risk' to marine wildlife (Wilcox, Mallos, Leonard, Rodriguez, & Hardesty, 2016, p. 111). Perhaps because of its visual similarity to typical prey items such as jellyfish, balloon litter is commonly ingested by marine wildlife, with the potential to block sections of the gastro-intestinal tract, affecting the victim's ability to breathe and threatening death by starvation (Acampora, Schuyler, Townsend, & Hardesty, 2014). Indeed, balloons and their attachments are one of the most common identifiable items found in the stomachs of flesh-footed shearwater chicks (*Puffinus carneipes*), a species native to Victoria's coastline, whose population decline has been associated with high levels of plastic ingestion (Lavers, Bond, & Hutton, 2014).

In response to these hazards, in February 2017, AZA-accredited conservation organisation Zoos Victoria (Melbourne, Australia) launched the conservation-education program WBF. WBF seeks to a) raise awareness about the anthropogenic threat of marine debris affecting marine and aquatic species, and b) promote the use of wildlife-friendly bubbles (hereafter 'bubbles') as alternatives to using balloons outdoors (McLeod, Sanders, & Wilson, 2018).

The Zoological Parks and Gardens Board (Zoos Victoria) is the governing body of three zoos in the Australian state of Victoria: Healesville Sanctuary, Werribee Open Range Zoo, and Melbourne Zoo. Zoos Victoria employ their Connect-Understand-Act (C-U-A) behaviour-change model to guide the development of programs (Zoos Victoria, 2010). This model has three key steps for promoting behaviour change within the zoo context: 1) *Connect* visitors and the broader public with species through emotionally engaging experiences; 2) facilitate *understanding* of conservation issues through innovative and educational displays; and 3) encourage people to *act* through education about specific, well-known behaviours, thus reducing threats to species and habitats (Lowry & Grey, 2009). Information about Zoos Victoria's approach to developing conservation-education programs and experiences can be found in Zoos Victoria Conservation Science Plan (see https://www.zoo.org.au/sites/default/files/conservation-science-plan-zoos-victoria.pdf).

Melbourne Zoo is well positioned to deliver a conservation-education program about marine debris (i.e., balloon litter), given its dedicated Wild Sea precinct, an area of the zoo with multiple exhibits that showcase some of Victoria's iconic marine wildlife, such as Australian fur seals (*Arctocephalus pusillus doriferus*), little penguins (*Eudyptula mino*r), Australian pelicans (*Pelecanus conspicillatus*), Port Jackson sharks (*Heterodontus portusjacksoni),* and Fiddler rays *(Trygonorrhina*). At the time of data collection, multiple interpretive mediums were installed in the Wild Sea precinct, including static signage displays with information about balloon litter hazards (see Figure 4.1) and a short (approximately four minutes) animation projected onto a 20-metre indoor screen depicting the journey of a balloon that floated away from an outdoor party, entered the ocean, and entangled marine wildlife (see Figure 4.2; this can be viewed at https://www.youtube.com/watch?v=9i41eW5TzxY).



Figure 4.1. A static signage display at the penguin tide pool, Melbourne Zoo, Australia (Image: Sarah Mellish).



Figure 4.2. The final scene of a 4-minute animation of a balloon that floated away from an outdoor event and entered the marine environment. Melbourne Zoo, Australia (Image: Sarah Mellish).

The WBF program included a 15-minute zookeeper-led seal presentation that told the story of a seal that encountered a balloon floating in the ocean. To begin, the keeper guided the seal to demonstrate typical behaviours performed in the wild, such as aquaplaning and diving. During this (and unknown to the audience), a balloon-like prop was thrown into the water by the keeper. The keeper then 'spotted' the balloon and instructed the seal to retrieve it from the water. The seal presented the balloon to the keeper, who held it up for audience viewing. The keeper identified the object as a balloon and explained to the audience the entanglement and ingestion threats that balloons pose to marine wildlife. The seal was then guided to place the balloon in a bin. To conclude, the keeper suggested bubbles as an alternative to using balloons at outdoor events. To end, the seal leaped back into the water (with visitors invited to shout, 'Bubbles not balloons').

Consistent with research that suggests sensory impressions can enhance the effect of the zoo experience, and subsequently the uptake of environmental behaviours (Ballantyne, Packer, & Sutherland, 2011), a bubble machine was turned on as the visitors exited the presentation arena. As the area filled with bubbles, visitors were encouraged to make a pledge upon exiting the Wild Sea precinct to use bubbles at their next outdoor event, either by signing a pledge book (see Figure 4.3) or by writing their name on a magnetised bubble and placing it on a pledge board (see Figure 4.4). At the time of this research, whiteboard markers were provided for visitors to write their name on the bubbles, which were wiped clear each day for re-use.



Figure 4.3. WBF pledge book, Wild Sea area of Melbourne Zoo, Australia (Image: Sarah Mellish).

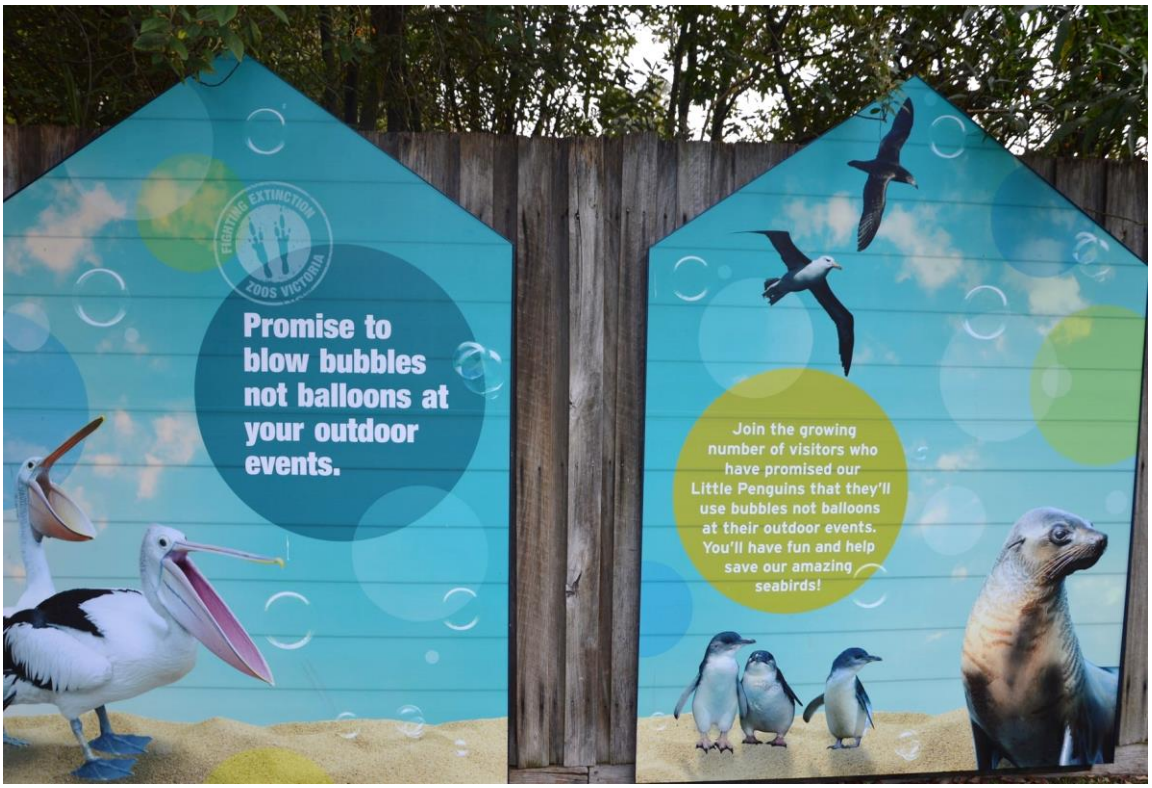


Figure 4.4. Bubble pledge board on which visitors could place magnetised bubbles. Melbourne Zoo, Australia (Image: Sarah Mellish).

4.3 Methods

This research was granted ethical approval by the University of South Australia Human Research Ethics Committee (Application ID: 0000036359) and was conducted in compliance with the Zoos Victoria Code of Conduct for Scientific Research Practice.

4.3.1 University–industry research partnership. This study was grounded in collaborative decision making by the University of South Australia and Zoos Victoria, which was fundamental to the success of this evaluation project. Therefore, it is important to outline the interests of each partner and explain the way these informed the study design. From a research perspective, the primary interest of this study was twofold: 1) to develop data collection materials that were informed by established theory pertaining to behaviour (e.g., TPB); and 2) to develop a study design that would address key methodological gaps revealed in Chapter 3. From an industry perspective, in addition to the aforesaid interests, it was important to create a study design that would measure the experiences available to zoo visitors (in this instance, exhibit-only and exhibit+presentation); include questions that related to the objectives developed by the organisations (e.g., increase awareness); and involve a survey that could be completed quickly and thus, would not be detrimental to the zoo visitors' experiences.

4.4 Design

Figure 4.5 depicts the study design. The Wild Sea presentation area was located in the centre of the exhibit, which meant visitors could not reach the presentation area without first walking through a portion of the exhibit (thus viewing a portion of related program material). Given this layout, exhibit-only and exhibit+presentation experiences (but not presentation-only experiences) were the two possible experiences available for visitors.

Accordingly, comparisons were made between two groups: 1) exhibit-only (i.e., visitors who walked through the Wild Sea area, *did not* view the seal presentation, but had completed a pre-survey); and 2) exhibit+presentation (i.e., visitors who walked through the Wild Sea area, *did* view the seal presentation, and had completed a pre-survey). To account for the way completing the pre-survey could have primed visitor interaction/engagement with the exhibit, and thus influenced visitor outcomes, we collected data from an exhibit post-only group (i.e., visitors who walked through the Wild Sea area, *did not* view the seal presentation, and *had not* completed a pre-survey; hereafter referred to as *control*). Visitors

could be surveyed before entering the Wild Sea area (T1), immediately exiting the Wild Sea area (T2), three months post-visit (T3), and six months post-visit (T4).

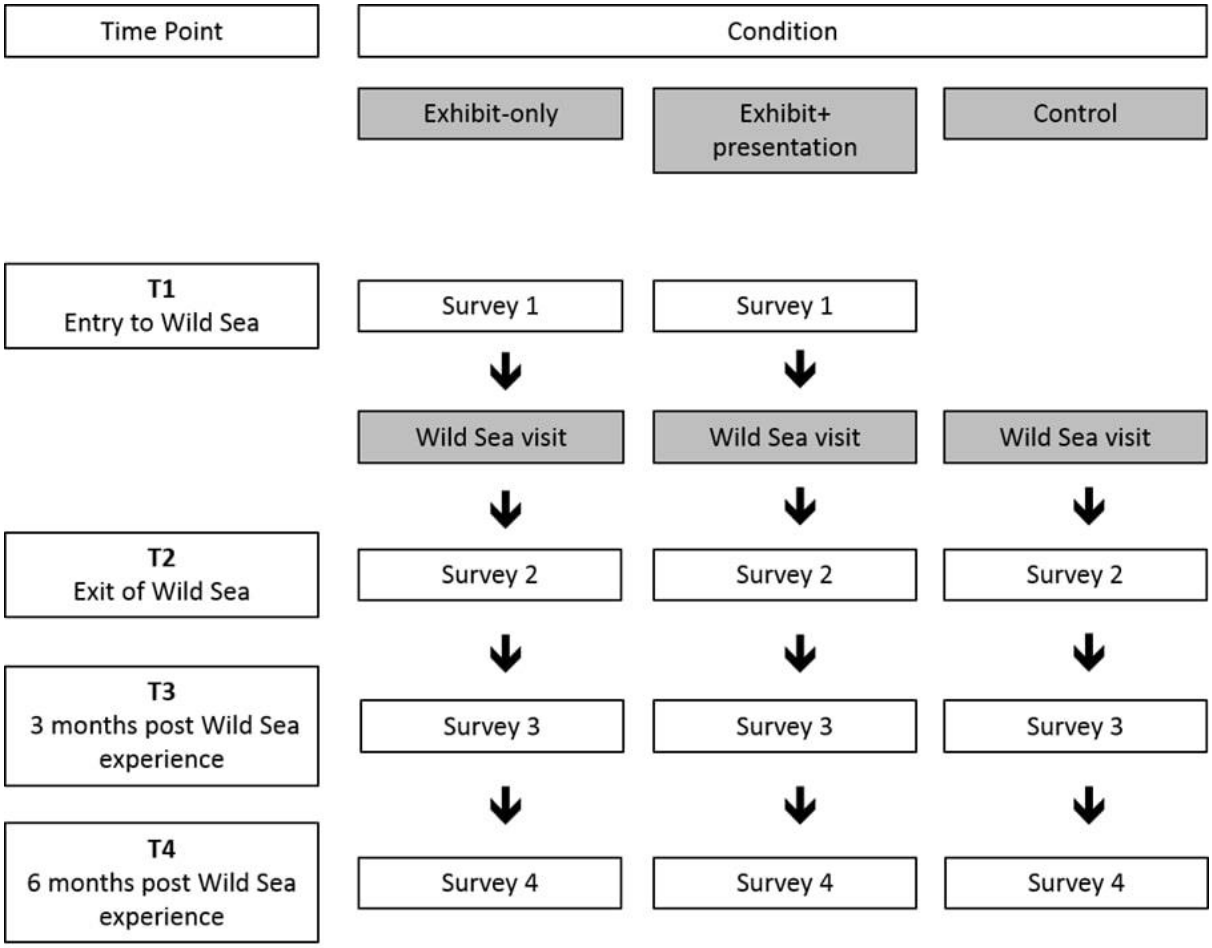


Figure 4.5. Study design with time points and visitor group conditions.

4.5 Procedure

Potential participants were approached on a *next-to-pass* basis, wherein on completion of approaching a visitor for recruitment, the next person to pass the survey point was approached to participate. Visitors were eligible if aged over 18 years and proficient in English. Participants in the exhibit-only and exhibit+presentation groups were given a paper survey pack as they entered the Wild Sea area. This pack contained a take-home information sheet (see Appendix G), a consent form to sign and return to the researchers on-site (see Appendix H), a pre-experience survey printed on green paper (see Appendix I), and a post-experience survey printed on blue paper (see Appendix J). The control group was approached immediately upon exiting the Wild Sea area with the survey pack (minus the pre-survey).

The data collectors were aware of the project objectives. The visitors were not told the specific purpose of the research, only that it was a study about knowledge and attitudes towards wildlife. Once given the pack, exhibit-only and exhibit+presentation visitor groups were instructed to complete the pre-survey at T1 and to complete the post-survey when they saw the second researcher, who was positioned at the exhibit exit waiting to accept completed surveys (T2). On the last page of the post-survey, participants were invited to provide contact information to be sent a short (five-minute) online follow-up survey (see Appendix K) via SurveyMonkey at T3 and T4. Participants who completed assessments at all four time points were eligible for a prize draw (3 x $100 Visa Prepaid gift cards); this incentive was specified in the post-survey and information sheet.

At T1 and T2, the data were collected over an equal number (eight) of week and weekend days, as well as during non-school-holiday periods, to reduce potential differences in visitor sociodemographic characteristics. The surveys were collected between 10:00 am and 4:00 pm. Exhibit-only data collection ceased during exhibit+presentation data collection times (11:00 am–11:25 am daily). The keeper presentation was delivered once daily; thus, the capacity to recruit to the presentation condition was limited, yielding uneven condition sample sizes. During T3 and T4 data collection, respondents were emailed once a week for three weeks (one initial email to participate and then two reminder emails if they had not yet participated).

4.6 Measures

4.6.1 Piloting of survey items. One gap that emerged from the methodological review (Chapter 3, Study 1) was the limited number of zoo conservation-education evaluations that reported piloting their measures. Therefore, piloting the survey for this research (in particular, the unstandardised scale that was created specifically for this project to measure attitudes towards the use of balloons outdoors) was critically important to advancing methods in existing conservation-education evaluation research. Prior to the WBF program launch, the primary researcher (Sarah) flew from Adelaide to Melbourne Zoo to conduct a pilot survey with N = 82 visitors to the Wild Sea precinct. The piloting trip had a second valuable purpose to test the data collection protocol (e.g., decide specific locations to disseminate survey material to potential participants) prior to the full-scale research. This pilot yielded an unacceptable ($\alpha = .58$) internal consistency parameter for the attitude scale, specific to the issue of outdoor balloon use. Following modifications, a second pilot study (attitude scale only; N = 80) was conducted, this time with a paid SurveyMonkey sample,

and yielded acceptable internal consistency (α = .72). Each item of this revised scale is detailed in the Materials section of this chapter (Section 4.6.3).

4.6.2 Visitor demographic characteristics. Drawing upon previous literature and contextual factors (e.g., location), demographic information that could influence pro-wildlife attitudes and conservation behaviours was collected (Driscoll, 1995; Lukas & Ross, 2005; Ross & Gillespie, 2009; Signal & Taylor, 2007). The categories were gender (male/female; interdeterminate/intersex/unspecified; prefer not to say); age (open-ended); vegetarian status (yes/no); pet ownership (yes/no); Zoo Victoria member (yes/no); mean social norm score with regard to balloon use outdoors (agreeance rated on a scale from 1 = strongly disagree to 7 = strongly agree with the statement 'my friends and family consider using balloons outdoors not harmful to marine wildlife'); prior zoo visit in past 12 months (yes/no); level of education (high school; certificate/diploma/TAFE; undergraduate degree [i.e., Bachelor]; post-graduate degree [i.e., Honours, Masters, PhD, Graduate Certificate]); prior outdoor balloon use (yes/no), and visit motivation, such as learning and discovery, social interaction, passive enjoyment, self-fulfilment, and restoration (each coded as reported/not reported; Packer & Ballantyne, 2002). Descriptions of each motivation are detailed in Table 4.2. Since WBF was exclusive to the state of Victoria at the time of the research, visitors were asked to indicate if they were an international visitor (yes/no) or an interstate visitor (yes/no).

4.6.3 Visitor understanding about the impacts of using of balloons outdoors. Given the necessary precondition for pro-environmental behaviour being knowledge about an issue (i.e., if we do not know, we cannot act; Kaiser & Fuhrer, 2003; McKenzie-Mohr et al., 2011), as well as the cognitive component of attitudes (belief or knowledge about the attitude object) that shapes decision making (Petty et al., 1997), the following three cognitive items were measured:

- Understanding about the effects of using balloons outdoors: At T1 and T2, visitors were asked to describe any effects that they were aware of concerning outdoor balloon use (open-ended).
- Post-visit message recall: To assess post-visit recall of the primary conservation message (to use bubbles, not balloons, at outdoor events), at T3 and T4, visitors were asked to report any conservation behaviours they had learned about during their Wild Sea visit (open-ended). The open-ended response for post visit message recall was

exhaustively coded to understand the variety of messages that visitors recalled., including those outside of the key ‘bubbles not balloons’ message (e.g., not littering, recycling).

- Identification of bubbles as an alternative to balloons for outdoor events: At T1 and T2, visitors were asked to describe alternatives to balloons that could be used at outdoor events (open-ended); this item was coded as either reporting or not reporting bubbles as an alternative to balloons.

4.6.4 Visitor attitudes towards the use of balloons outdoors. The TPB asserts that behavioural intentions are informed by a person’s attitudes towards the behaviour (the overall positive or negative evaluation of engaging in the behaviour). Attitudes towards the use of balloons outdoors was measured at all time points (1 = strongly disagree, 7 = strongly agree). A 7-point scale (rather than a 5-point scale) was employed for all scale items, as a higher number of categories can yield greater test-retest reliability and internal consistency (Preston & Coleman, 2000; Lozano, García-Cueto, & Muñiz, 2008; Weng, 2004) and it is rated more favourably in terms of respondent preference (Preston & Coleman, 2000). Attitude items were adapted from previous research (Pearson, Lowry, Dorrian, & Litchfield, 2014; Pearson, Mellish, Sanders, & Litchfield, 2014). The final attitude scale comprised six items: 1) Balloons are marine-wildlife-friendly outdoor decorations; 2) I do not see anything wrong with using balloons outdoors; 3) I am concerned that balloons can be harmful to marine wildlife when used outdoors; 4) Bubbles provide a marine-wildlife-friendly alternative to balloons for outdoor events; 5) I prefer that outdoor events I attend do not use balloons; and 6) I care about marine wildlife and the effect of plastic pollution on marine wildlife. Items 1 and 2 were reverse-coded prior to data analysis. Possible total scores ranged from 6 to 42, with a higher score indicating a more positive attitude towards ceasing the use of balloons.

4.6.5 Visitor behaviour concerning the use of balloons outdoors. Drawing on the TPB and the role of behavioural intentions, which represents the extent of a person’s motivation to engage in a behaviour (Ajzen, 1985, 1991, 2002), visitor behavioural-related outcomes included behavioural intentions and post-visit conservation behaviour with regard to using balloons at future outdoor events.

Behavioural intentions were measured at all four time points. Visitors rated a) how likely they were to use balloons at future outdoor events and b) how likely they were to use bubbles at future outdoor events (1 = extremely unlikely, 7 = extremely likely).

4.6.6 Self-reported post-visit conservation behaviour. Post-visit conservation behaviours were measured at T3 and T4, relating to discussions about the effect of using balloons at outdoor events, purchases of wildlife-friendly bubbles, and new behaviours that had been engaged while hosting or attending an outdoor event. Specifically, visitors were asked the following questions:

1. Since your visit to Wild Sea, have you discussed with anyone the impact of using balloons outdoors on marine environments (yes/no)?
    a) If yes, what was the discussion about (open-ended)?
2. Since your visit to Wild Sea, have you purchased wildlife-friendly bubbles (yes/no)?
3. Since your visit to Wild Sea, have you hosted or attended an outdoor celebration since your zoo visit (yes/no)?
    a) If yes, did your zoo visit impact your behaviour at this event in any way (yes/no)?
    b) If yes, how? (open-ended)

At T4, visitors were asked, 'Since the completion of this survey three months ago, have you discussed with anyone the impact of using balloons on marine environments?'

4.7 Participants

All participants who participated in T1 participated at T2 as well, resulting in N = 624 visitors across T1 and T2. Of these, 67 respondents additionally participated at T3, and 42 at T4 (see Table 4.1).

The initial follow-up response rate of 10.7% at T3 was lower than the response rates in previous research assessing post-visit effects of zoo conservation-education programs with matched samples (16–24%; Adelman et al., 2000; Dierking et al., 2004; MacDonald, 2015). There was a relatively even proportion of males to females (female: 50–69%) and participants' mean age was 31 (SD = 12.4). Around two-thirds (57–64%) of the sample were prior balloon users (see Table 4.2 for participant demographic information).

Table 4.1

Total Sample Numbers for Each Visitor Group, by Time Point

Category	T1	T2	T3	T4
Exhibit-only	249	249	29	23
Exhibit+presentation	125	125	23	10
Control		250	15	9
Total Sample *n*	374	624	67	42

Table 4.2

Visitor Demographic Characteristics, by Visitor Group

	Visitor group				
	Control valid % (n)	Exhibit-only valid % (*n*)	Exhibit+ Present-ation valid % (*n*)	χ^2 /F valı	*p* value
Total *n*	250	249	125		
Gender					
Male	48.8 (122)	48.6 (120)[b]	30.6 (38)[c]	19.15	.004*
Female	50.4 (125)	49.8 (123)[b]	69.4 (86)[c]		
Interderminate/Intersex/ Unspecified	-	1.2 (3)[b]	-		
Prefer not to say	.4 (1)	.4 (1)[b]	-		
Mean Age in Years (SD)	30.0 (12.5)	30.8 (11.9)	31.8 (12.8)	.7	.498
Vegetarian Status (Yes)	6.9 (17)[a]	8.1 (20)[b]	6.5 (8)[c]	.4	.804
Pet Ownership (Yes)	67.3 (167)[a]	60.3 (149)[b]	66.9 (83)[c]	3.1	.215
Zoos Victoria Member (Yes)	14.1 (35)[a]	17.0 (42)[b]	33.1 (41)[c]	20.4	.000*
Prior Visit in Past 12 months (Yes)	22.2 (55)[a]	30.8 (76)[b]	40.3 (50)[c]	13.6	.001*
International Visitor (Yes)	21.8 (54)[a]	23.9 (59)[b]	15.3 (19)[c]	3.7	.161
Interstate Visitor (Yes)	26.6 (66)[a]	22.3 (55)[b]	22.6 (28)[c]	1.5	.480
Highest Level of Education					
High School	25.0 (62)[a]	21.9 (54)[b]	22.8 (28)[d]	4.3	.634
Certificate/Diploma/TAFE	21.4 (53)[a]	22.7 (56)[b]	21.1 (26)[d]		
Undergraduate Degree (e.g., Bachelor)	39.5 (98)[a]	38.1 (94)[b]	34.1 (42)[d]		
Post-graduate Degree (e.g., Honours, Masters, PhD, Graduate Certificate)	14.1 (35)[a]	17.4 (43)[b]	22.0 (27)[d]		
Prior Balloon Use (Yes)	56.8 (138)[a]	62.8 (155)[b]	63.7 (79)[c]	2.5	.292
Mean Social Norm Score at baseline (SD)	3.8 (1.6)	3.9 (1.7)	4 (1.7)	.8	.501
Motivation for Visit					
Learning and Discovery (Yes) *(to expand understanding, desire to discover new things)*	40.0 (100)	31.6 (78)[b]	46.0 (57)[c]	12.4	.015*
Social Interaction (Yes) *(to spend time with friends/family)*	61.2 (153)	52.6 (130)[b]	64.5 (80)[c]	10.4	.034*
Passive Enjoyment (Yes) *(to enjoy oneself, be pleasantly occupied)*	54.4 (136)	47.0 (116)[b]	40.3 (50)[c]	10.7	.030*
Self-Fulfilment (Yes) *(to make things more meaningful, feel a sense of achievement)*	21.2 (53)	13.0 (32)[b]	11.3 (14)[c]	8.8	.012*
Restoration (Yes) *(to relax, have a change from routine)*	34.0 (85)	18.6 (46)[b]	22.6 (28)[c]	16.2	.000*

Notes:
Owing to missing data: [a]248; [b]247; [c]124; [d]123; [e]243
*Significance level: $p < .05$

4.8 Analysis of Quantitative Data

Statistical analyses were performed with IBM SPSS Statistics (v25). To identify and control for possible demographic between-group differences, ANOVA and Chi Square Test of Independence (or Fisher's Exact Test of Independence) were performed. The analyses revealed significant between-group differences on eight demographic variables ($p < .05$; see Table 4.2). The GLM procedure was used to analyse the quantitative repeated-measures variables assessed across all time points for 1) attitudes towards the use of balloons outdoors; 3) likelihood of using balloons at future outdoor events; and 4) likelihood of using bubbles at future outdoor events.

The univariate GLM procedure provides regression analysis and ANOVA for one dependent variable on one or more predictor variables. This procedure was considered the most appropriate method for these repeated-measures items because it accommodated analysing non-normal data; prevented listwise deletion due to missing data or dropouts (i.e., retained the people who had data for only some time points, rather than deleting the entire case); and accounted for unbalanced sample sizes (Cnaan, Laird, & Slasor, 1997; Gelman & Hill, 2007; Krueger & Tian, 2004; Pinheiro & Bates, 2000).

To identify and account for only significant predictor variables and thus optimise model fit, a purposive selection method was applied during data analysis (Bursac, Gauss, Williams, & Hosmer, 2008). Prior to generating the final model, the models were run first with all eight significant demographic variables and then with those that did not significantly contribute to the model and/or influence other variables excluded. The final models included, as fixed effects, time point, completion of pre-survey (yes), viewed a presentation (yes), and all significant covariates relative to each outcome variable. Owing to having insufficient cases for between-group comparisons, for these analyses gender was recoded as reporting/not reporting female. The maximum likelihood method was used to estimate variance components. An alpha level of .05 was used for all statistical tests.

4.9 Analysis of Qualitative Data

Thematic analysis (Braun & Clarke, 2006) was employed to identify and organise patterns in the qualitative data, with a complete-coding method adopted to account for visitor responses that contained multiple themes (and therefore, the valid item *n* could exceed the total sample *n*). All cases were included in the inter-rater reliability (Cohen's Kappa [κ]) assessments. Cases were independently coded by two coders (S. M. and J. R.). Kappa is reported for each outcome variable individually in the Results section of this

chapter. Based on Landis and Koch's (1977) guidelines, the Kappa values were as follows: 0.0 to 0.20 = slight agreement, 0.21 to 0.40 = fair agreement, 0.41 to 0.60 = moderate agreement, 0.61 to 0.80 = substantial agreement, and 0.81 to 1.0 = almost perfect/perfect agreement.

4.10 Results

Owing to the low follow-up response rate for open-ended knowledge and behaviour items at T3 and T4, the *total* most frequently reported themes (i.e., across both follow-up time points [T3–T4] were reported, and all three visitor groups; total valid $n = 109$). A table of response themes and proportions itemised by visitor group and time point for each relevant outcome variable is provided in Appendix L.

4.10.1 Understanding of the effects of using balloons outdoors. The analyses of the open-ended question about the effects of using balloons outdoors at the T1 pre-survey revealed three main themes: balloons becoming general litter (26.2–27.0%); balloons becoming marine litter (26.6–31.5%); and balloons posing a general/non-specified hazard to wildlife (20.2–20.8%). At T2, of the visitors who reported additional understanding, the most commonly reported effects from exhibit-only and exhibit+presentation groups were balloons posing a general/non-specified hazard to wildlife (21.0–29.6%); and balloons posing an entanglement hazard to wildlife (12.6–21.8%). The exhibit+presentation group were nearly twice as likely to report the specific entanglement threat than were the exhibit-only visitors (21.8% v. 12.6%). Only 2.8% of control group responses contained this theme ($\kappa = 0.68$; see Table 4.3 for response themes and proportions).

Table 4.3

Response Themes and Proportions for Visitor Understanding Regarding Effects of Using Balloons Outdoors at T1 and T2, by Visitor Group

Response theme		T1		T2		
		Exhibit-only % (*n*)	Exhibit+ presentation % (*n*)	Exhibit-only % (*n*)	Exhibit+ presentation % (*n*)	Control % (*n*)
		Valid item *n* = 252	Valid item *n* = 168	Valid item *n* = 262	Valid item *n* = 142	Valid item *n* = 316
Balloons become general litter	"pollution", "waste that negatively impact the environment"	27.0 (68)	26.2 (44)	5.7 (15)	5.6 (8)	22.8 (72)
Balloons become marine litter	"ends up in the water", "blows away into water"	26.6 (67)	31.5 (53)	9.2 (24)	7.7 (11)	21.5 (68)
Balloons pose a hazard to marine life: general/non-specified	"animals could be affected", "danger to wildlife"	20.2 (51)	20.8 (35)	21.0 (55)	29.6 (42)	12.7 (40)
Balloons pose a choking/ingestion hazard to animals	"balloon string is a choking hazard", "animals swallow them"	4.4 (11)	4.8 (8)	6.1 (16)	4.9 (7)	20.9 (66)
Balloons pose entanglement hazard to animals	"seals become entangled", "string can trap and entangle penguins"	6.7 (17)	5.4 (9)	12.6 (33)	21.8 (31)	2.8 (9)
Balloons are non-biodegradable	"don't break down", "doesn't decompose"	4.0 (10)	3.0 (5)	1.1 (3)	-	5.1 (16)
Don't know/None	"not sure", "don't know"	6.7 (17)	6.5 (11)	2.7 (7)	5.6 (8)	12.7 (40)
Nothing additional (for T2 pre-post groups only)	"nothing additional", "no more than I already knew"			41.2 (108)	24.6 (35)	
Other	"get caught on electricity line", "visually unattractive"	4.4 (11)	1.8 (3)	0.4 (1)	-	1.6 (5)

4.10.2 Post-visit message recall. When asked in an open-ended question to describe any conservation behaviours they had learned about during their Wild Sea visit, participant responses most frequently contained a 'do not litter/reduce/recycle' theme (20 of 74 total valid responses; 27.0%). 'Using bubbles/using bubbles instead of balloons' was the second most frequently reported theme (identified 19 times out of 74 valid responses; 25.7%; $\kappa = 0.62$).

4.10.3 Identification of using bubbles as an alternative to balloons for outdoor events. Figure 4.6 displays the percentage of each visitor group that reported identifying bubbles as an alternative to using balloons at outdoor events at T1 and T2. The rate of this had increased from T1 to T2, for the exhibit-only and exhibit+presentation groups. Further, visitors groups who had completed a pre-survey were almost twice as likely to report this at T2 than visitors in the control condition, who did not complete a pre-survey. Notably, the difference between the exhibit-only and exhibit+presentation groups (21%) in the identification of bubbles as an alternative at T1 became smaller at T2 (4%; $\kappa = 1.0$).

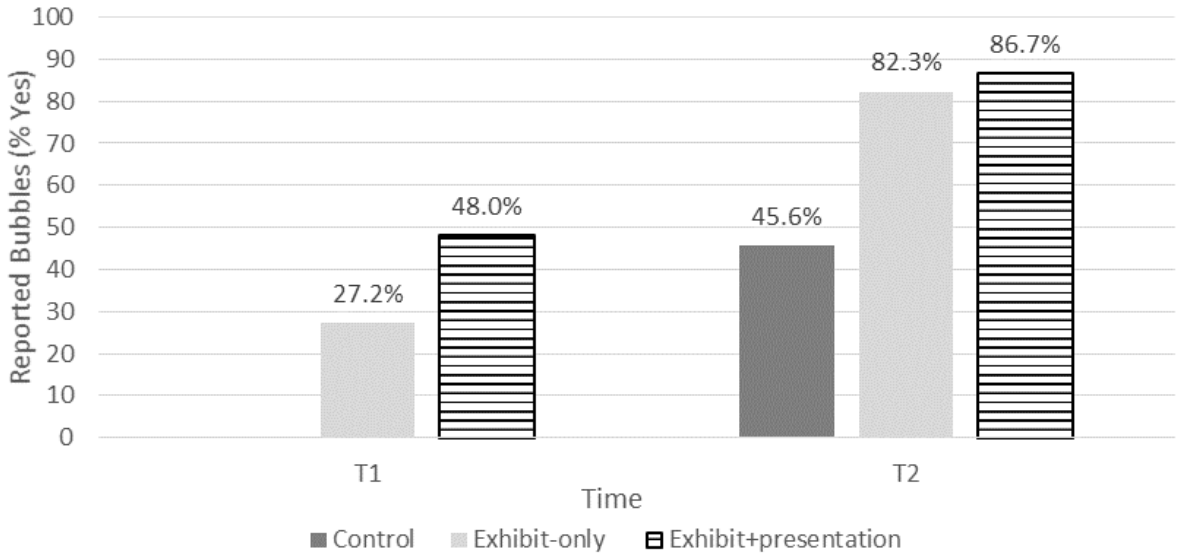


Figure 4.6. Percentage of each visitor group that reported identifying using bubbles as an alternative to using balloons at outdoor events at T1 and T2.

4.10.4 Visitor attitudes towards the use of balloons outdoors. In this study, the attitude scale yielded an internal consistency estimate of α = .76. As depicted in Figure 4.7, mean attitude scores were already high at T1 for visitor groups (34.0–34.8 on a 42-point scale) and these scores increased to 37.8–39.1 by T4; exhibit+presentation visitors consistently reported higher attitude means than both the exhibit-only and control groups. A univariate GLM revealed that WBF significantly affected visitor attitudes towards not using balloons outdoors, $F[11, 9.63] = 9.63$, $p = .000$, adjusted $R^2 = 0.65$. Time point was a significant predictor of more positive attitudes ($p = .000$). Attitudes were significantly more positive among visitors who completed a pre-survey ($p = .000$); viewed a presentation ($p = .001$); reported a learning and discovery motivation ($p = .000$); and reported self-fulfilment motivation ($p = .039$), than among those who did not. There were no significant differences concerning zoo membership ($p = .061$). There was a significant interaction effect on attitudes between time point and viewing the presentation ($p = .000$), indicating that for people who viewed a presentation, as time progressed their attitudes become more positive. The full univariate GLM outputs for each outcome variable can be found in Appendix M.

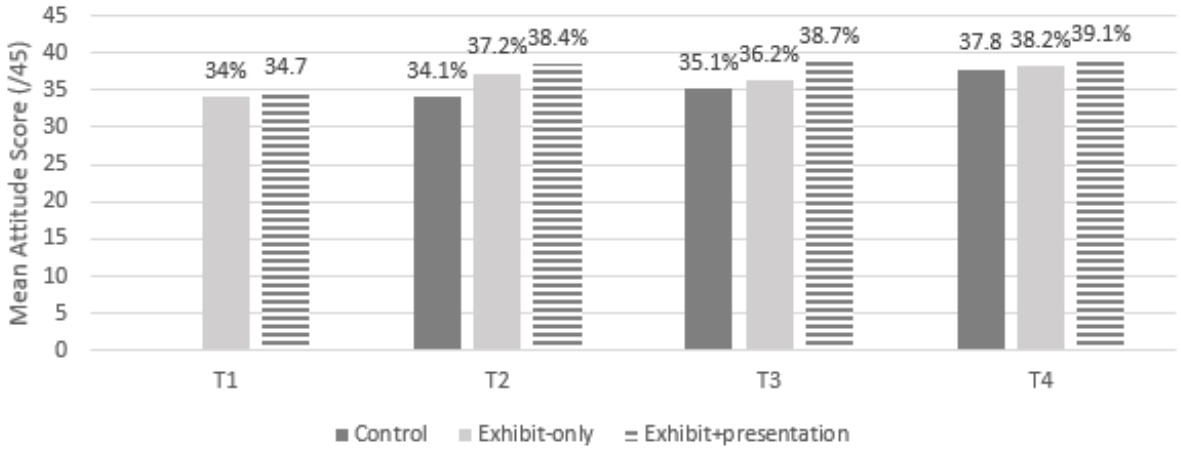


Figure 4.7. Mean scores for each visitor group on attitudes with regard to the use of balloons outdoors, across time.

4.10.5 Visitor likelihood of using balloons or bubbles at future outdoor events. As displayed in Figure 4.8 (A), mean likelihood of using balloons scores were already low at T1 for all visitor groups (2.4–2.5 out of 7) and this decreased further across time (1.5–1.7 at T4). Analyses revealed that WBF significantly affected visitor likelihood of using balloons $F[10, 16.8] = 7.81$, $p = .000$, adjusted $R^2 = 0.59$. Mean likelihood scores overall reduced significantly across time ($p = .000$); compared with the mean scores at T1, significant

differences were observed at T2 (p = .000) and T4 (p = .000). Likelihood of using balloons scores were significantly lower among visitors who completed a pre-survey (p = .000); reported a learning and discovery motivation (p = .000); and reported a social interaction motivation (p = .022). Scores did not differ significantly on viewing a presentation (p = .476) and there was no significant interaction between time and viewing a presentation on likelihood of using balloons scores (p = .232).

Figure 4.8 (B) shows moderately high mean likelihood of using bubble scores at T1 (4.8–5.4/7) and these scores increased over time. Analyses indicated the WBF significantly affected mean likelihood of using bubbles scores, F[10, 20.42] = 5.10, p = .000, adjusted R^2 = 0.47. Likelihood of using bubbles scores were significantly higher among visitors who reported being a zoo member (p = .000) or being female (p = .001). Scores did not differ significantly on viewing a presentation (p = .177), completing a pre- survey (p = .157), reporting a learning and discovery motivation (p = .080) or time (p = .145), and there was no significant interaction between time and viewing a presentation on likelihood of using bubbles scores (p = .874).

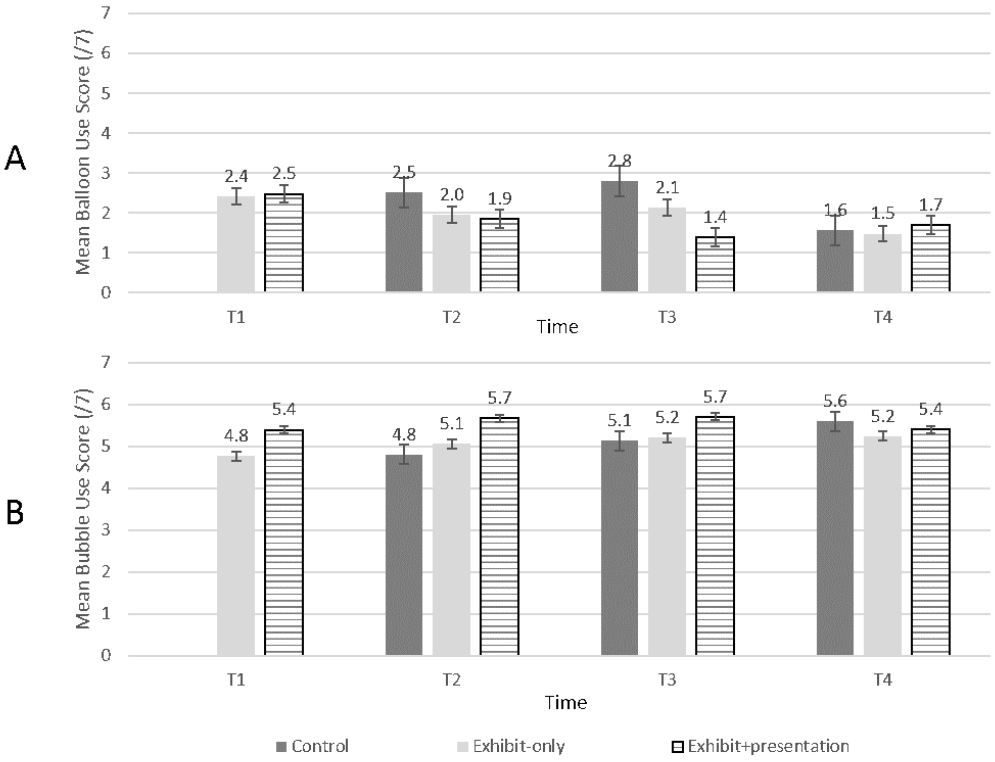


Figure 4.8. Mean scores for each visitor group on likelihood, across time, of using (A) balloons and (B) bubbles at future outdoor events.

4.10.6 Self-reported post-visit conservation behaviour. At T3, 50 participants (out of 67; 74.6%) reported having discussed a topic related to the effect of using balloons outdoors on the marine environment. Twenty-six participants (out of 46; 56.5%) reported having done so at T4 (see Table 4.4 for response proportions by visitor group). Of those who provided further detail in response to an open-ended question, the most common themes were discussions about general/non-specified hazards of balloons (e.g., "how harmful they can be" 51.6%; 32 out of 62 follow-up responses); balloon use ("avoiding balloons", "using balloons responsibly", "using balloons irresponsibly" 27.4%; 17 out of 62); and balloon alternatives (25.8%; 16 out of 62). Few participant responses detailed discussing the specific ingestion or entanglement hazards that balloons pose to marine wildlife (8.1%; 5 out of 62; $\kappa = 0.67$).

Purchase of bubbles was reported by 24 participants (out of 67; 35.8%) at T3 and by 8 visitors (out of 31; 25.8%) at T4 (see Table 4.4).

Table 4.4

Response Frequencies and Percentages for Quantitative Behavioural Outcome Measures at T3 and T4, Itemised by Time Point and Visitor Group

Post-visit behaviour change measure	T3			T4		
	Exhib-only *n* = 2[illegible] % (*n*)	Exhibit+ presentation *n* = 23 % (*n*)	Control *n* = 15 % (*n*)	Exhibit-only *n* = 23 % (*n*)	Exhibit+ presentation *n* = 10 % (*n*)	Control *n* = 9 % (*n*)
Discussed impact of using balloons outdoors on marine environments (Yes)	79.3 (23)	82.6 (19)	53.3 (8)	63.6 (14)	80.0 (8)	44.4 (4)
Purchased bubbles since visit (Yes)	41.4 (12)	34.8 (8)	26.7 (4)	22.7 (5)[h]	33.3 (3)[l]	-
Hosted or attended an outdoor celebration since zoo visit (Yes)	44.4 (12)[a]	52.2 (12)	57.1 (8)[c]	50.0 (10)	55.6 (5)[l]	33.3 (3)
Changed behaviour while hosting/attending an outdoor event (Yes)	50.0 (5)[b]	72.7 (8)[d]	85.7 (6)[f]	66.7 (4)[j]	75.0 (3)[g]	66.7 (2)[m]
Changed behaviour while hosting/attending an outdoor event was influenced by visit to Wild Sea (Yes)	85.7 (12)[c]	68.8 (11)[e]	75.0 (3)[g]	83.3 (10)[k]	50.0 (2)[g]	44.4 (4)

Notes:
Owing to missing data: [a]Valid *n* = 27; [b]Valid *n* = 10; [c]Valid *n* = 14; [d]Valid *n* = 11; [e]Valid *n* = 16; [f]Valid *n* = 7; [g]Valid *n* = 4; [h]Valid *n* = 22; [i]Valid *n* = 20; [j]Valid *n* = 6; [k]Valid *n* = 12; [l]Valid *n* = 9; [m]Valid *n* = 3

Attending or hosting an outdoor event was reported by 32 participants (out of 64; 50%) at T3 and by 18 (out of 38; 47.4%) participants at T4. Of these, 19 participants (out of 28; 67.9%) at T3 and 9 participants (out of 13; 69.2%) at T4 further reported that their visit to the Wild Sea precinct had influenced their behaviour at the outdoor event. Of those who additionally described in an open-ended response the way their behaviour had been influenced, the total most frequently reported themes were ‘did not use/purchase balloons’ (10 out of 25; 40.0%) and ‘encouraged others not to use balloons/use alternatives’ (8 out of

25; 32.0%). Four out of 25 (16.0%) responses specifically identified using bubbles as the way their visit had affected their behaviour: $\kappa = 0.67$.

4.11 Discussion

4.11.1 Main findings. This outcome evaluation established preliminary evidence that the WBF program was promoting greater depth of knowledge concerning the effects of balloon use outdoors and was encouraging attitudes that were more positive post-visit. The program was inspiring an intent to act, with visitors overall reporting increased likelihood of using bubbles and reduced likelihood of using balloons outdoors. In terms of post-visit conservation behaviour, Melbourne Zoo visitors reported talking about the issue of outdoor balloon use, as well as modifying their behaviours at outdoor events, with 67.9 to 69.2% of the follow-up sample specifying that the behaviours at an outdoor event they had changed after their visit had been influence by their Wild Sea experience. A final major finding from this evaluation was the priming influence on visitor psychosocial outcomes of a pre-survey. For example, visitors who had completed a pre-survey reported significantly more positive attitudes and significantly lower likelihood of using balloons outdoors than visitors who had not completed a pre-survey. These results could indicate that the completion of a pre-survey had influenced visitors to look for, or more fully engage with, the WBF program material.

4.11.2 Understanding of the effects of using balloons outdoors. WBF was facilitating greater depth of knowledge with regard to the threats of balloon use outdoors in the short term, with responses at T2 containing more detailed aspects of hazards than at T1 (e.g., balloons harm wildlife v. balloons pose entanglement hazards to wildlife). This was an important first step for WBF, given that knowledge is a necessary (albeit insufficient) precondition for pro-environmental behaviour (Kaiser & Fuhrer, 2003; McKenzie-Mohr et al., 2011). Visitors who had not completed a pre-survey did not demonstrate the same depth of understanding at T2 than those who had, indicating that the pre-survey likely primed visitors to interact with the educational material and/or absorb the information. Is it possible that that exposure to the pre-survey encouraged participants to seek out or be more likely to focus on the WBF materials (Bargh & Chartrand, 2000).

4.11.3 Post-visit message recall. Three to six months following their visit, only 25% of visitors recalled the primary conservation message to use bubbles not balloons at outdoor events. Since familiar concepts are easier to recall because of their long-term associative

links (Deese, 1960), it is possible that the novelty of bubble use at outdoor events affected *participants*' *abilities* to recall this behaviour. Another explanation for this outcome could be the communication 'noise', since multiple conservation-education programs were running at one time, with a variety of different educational components and messaging.

4.11.4 Identification of using bubbles as an alternative to using balloons for outdoor events. The results indicated that the WBF program was educating people about bubbles as a wildlife-friendly alternative to balloons in the short term. Consistent with group differences on understanding of the effects of using balloons outdoors (above), both exhibit-only and exhibit+presentation groups were twice more likely than the control group to report using bubbles as an alternative (refer to Figure 4.6). In contrast to previous research that has generally demonstrated enhanced conservation effects for presentations when compared with traditional exhibit experiences (Mellish et al., 2016; Miller et al., 2013), in this study there was no marked difference at T2 between exhibit-only and exhibit+presentation groups regarding identification of using bubbles as an alternative. Again, this outcome could be attributed to a pre-survey priming effect or alternatively, it could reflect the persuasiveness of the exhibit as a whole, including the indoor animation experienced by all visitors. Interestingly, at T2 20% of the control group reported risk of ingestion as opposed to 6.1% of exhibit-only and 4.9% of exhibit+presentation. There is no clear reason to explain this result, and as such, this outcome would need to be verified by future research.

4.11.5 Attitudes towards the use of balloons outdoors. Consistent with previous research measuring post-visit attitudes (e.g., Miller et al., 2013), increases in mean attitude scores concerning balloon use outdoors persisted over time (T2–T4). This was an important result for WBF, as it represented a possible success in changing the way people think or feel about outdoor balloon use, which is a difficult task for a behaviour symbolic of celebration and festivity (when used at birthday parties and weddings) and spiritual output (when released at funerals). The negative connotation of balloons harming wildlife is much less direct. Given that knowledge about an environmental problem can influence pro-environmental concern (Gifford & Nilsson, 2014), one possible explanation for this rise in mean attitude scores could have been the previously mentioned increased understanding of the effect of balloons on marine wildlife, which could have inspired concern for animals affected by balloon debris.

4.11.6 Likelihood of using balloons or bubbles at future outdoor events. Greater knowledge is associated with intention to act through increasing positive attitudes (e.g., in the context of zoo-based orang-utan conservation education; Pearson et al., 2013). This information, coupled with the previously mentioned increases in depth of understanding and positive attitudes, makes the overall rise in likelihood of using bubbles and decrease in likelihood of using balloons unsurprising.

It is interesting to note that the rise in likelihood of using bubbles was inconsistent with the low number of follow-up participants who actually reported using bubbles at outdoor events post-visit. There are several factors to consider when interpreting this outcome (discussed further in the post-visit conservation action section below), including, for example, the possibly limited opportunities to use bubbles for those who had not yet planned a party or memorial event.

4.11.7 Self-reported post-visit conservation behaviour. Many visitors reported that after their visit they had discussed the topic of balloons becoming marine litter and posing hazards to marine wildlife, as well as avoiding using balloons, using balloons responsibly, and using alternatives to balloons, with their friends and families. This finding lends some support to existing work, indicating that zoo experiences can influence interest in, and commitment to, talking to others about the target conservation issue (Dierking et al., 2004), which may also perpetuate social norms around balloon use or spread the effect of the program to an audience beyond the zoo visitors themselves.

The results suggested that the WBF program created some post-visit behaviour change at outdoor events, with 67.9% (T3) to 69.2% (T4) of the follow-up sample reporting that their visit to the Wild Sea precinct had influenced their behaviour at an outdoor event in some way. However, when asked how their behaviour was influenced, few responses containing the theme of using alternatives to balloons specifically mentioned bubbles. This was consistent with the limited number of follow-up participants who specifically reported purchasing bubbles post-visit. In addition to the explanation that the novelty of bubble use at outdoor events could have contributed to this outcome, as well as possible limited opportunities to use bubbles, contextual factors or personal preferences could explain the low uptake of bubble use. Costs associated with purchasing bubble-making equipment, limited knowledge or resources to make homemade equipment/bubble mix, and/or the variety of other wildlife-friendly alternatives available (e.g., paper streamers, biodegradable confetti), offer some further explanations for this result. Regardless, not using balloons and

the uptake of using wildlife-friendly alternatives (whether bubbles or otherwise) represented an overall reduced potential for balloon litter to enter the marine environment, and thus was a positive result.

4.12 Strengths and Limitations

This research addressed several methodological problems identified in reviews of related research (Khalil & Ardoin, 2011; Mellish et al., 2019). The use of a pilot study revealed reliability issues with the custom-designed attitude scale for balloon use outdoors, which facilitated the modification and re-piloting of the scale prior to conducting the full-scale research. Further, by adopting a repeated-measures design over six months, it was possible to assess if the changes at T2 had persisted over time and if behaviour modification had occurred post-visit, thus allowing for a more comprehensive assessment of the effects of the WBF program. It is further possible that visitors completed the post-survey prematurely or that they looked at the questions ahead of time, which may have affected their responses. Finally, by controlling for the completion of a pre-survey, it was possible to factor into the analyses the priming influence that completing a pre-survey likely has on visitor interaction with, and/or interpretation of, the program material.

Consistent with limitations of other post-visit evaluations (Smith et al., 2008), a key limitation to this research was the low follow-up response rate, which restricted the capacity to assess lasting effects thoroughly. Further, it was possible that the follow-up outcomes over-represented the broader visitor population, as those who provided contact information and completed the follow-up surveys could have been more environmentally oriented than those who did not. In addition, social desirability bias (i.e., participants providing socially favourable survey responses; King & Bruner, 2000) should be considered when interpreting these results. According to this type of response bias, it is possible that respondents over-stated, rather than under-stated, their post-visit behaviours. Moreover, while this research was informed by the TPB, it did not measure all of the sub-constructs that make up the theory.

4.13 Practical Implications

The outcomes from this work can inform several aspects of research and practice. A key learning is that inviting visitors to complete a survey prior to the intervention under evaluation likely has profound influences on how visitors interpret and engage with educational material and/or experiences. This is a useful discovery for a) refining evaluation

methodology, as it highlights the need to control for or consider pre-survey influences (or test for priming influences at the pilot study stage; Weiler, Moyle, Wolf, de Bie, & Torland, 2017) when exploring whether evaluation outcomes are attributable to program material; and b) implementing and empirically testing conservation-education resources that mimic the potential educational effect of a pre-survey. One suggestion for enhancing the conservation value of zoo experiences is making worksheets containing questions related to exhibit interpretation available to visitors at the entry point for an exhibit, or available to download prior to the visit. For the group of visitors who visit zoos with a learning and discovery motivation (31–46% across groups in this study), a worksheet could add to visitor enjoyment (i.e., learning for fun; Packer, 2006). A final note should be made concerning differences between visitor groups which were controlled for in analyses (e.g., exhibit+presentation group being distinctly zoo members and prior visitors). Implications of these differences are worthy of understanding in their own right and should be a point of interest for future research.

4.14 Conclusion

These findings build upon existing work indicating that zoo-based conservation-education programs have the potential to inspire visitors to modify their behaviour after the zoo visit (MacDonald, 2015; Mann et al., 2017; Miller et al., 2013). The research outcomes have yielded direct, on-the-ground implications for the WBF program, including modifications to the keeper-led seal presentation. In response to the T2 findings that indicated a generally low proportion of visitors reported a specific entanglement threat of balloon litter (13–22% across exhibit-only and exhibit+presentation groups), Zoos Victoria have introduced into their presentation more discussion around the risk of entanglement with balloon string and the subsequent effects on marine wildlife.

In addition, this work offers important methodological contributions for future zoo program evaluations that utilise repeated-measures designs. A key learning from this research is that inviting visitors to complete a survey prior to the intervention under evaluation likely influences the way visitors interpret and engage with educational material and/or experiences. As noted earlier, this is a useful discovery for refining evaluation methodology to control for/consider pre-survey influences (or test for priming influences at the pilot study stage) when exploring whether evaluation outcomes are attributable to program material, as well as for implementing and empirically testing conservation-education resources that mimic the potential educational effect of a pre-survey. Making

worksheets containing questions related to the exhibit interpretation available to visitors at the entry of an exhibit (or available to download prior to visit) could enhance the enjoyment of the significant group who visit zoos with a learning and discovery motivation

As outlined in Chapter 2, a best-practice outcome evaluation is one of two tasks that may advance zoo conservation education. Examining the implementation process of a conservation-education program or experience can cast further light on the active ingredients that might affect a program's level of effectiveness. Therefore, the next chapter examines the challenging and successful factors in implementing the WBF program, as perceived by Zoos Victoria staff.

Chapter 5: Study 3—Challenges and Successes in the Implementation of the When Balloons Fly Conservation-Education Program

Summary: The previous chapter demonstrated the application of best-practice research methods and reporting practices in an evaluation of zoo conservation-education outcomes. To ascertain a more holistic understanding of the influential factors that shaped the generally positive outcomes from this conservation-education program, this chapter appraises the development and implementation processes of the WBF program. Between April and May 2018, 24 Zoos Victoria professionals completed an online survey that focused on identifying the challenges and successes in implementing the WBF program. In addition, four participants completed a follow-up telephone interview. The emerging themes were identified and organised according to the model of diffusion in service organisations (Greenhalgh et al., 2004). The results from this study revealed that the features of the organisation (e.g., structure, culture), rather than the features of the individuals (e.g., skills, motivation) or characteristics of the conservation-education program itself (e.g., messaging) were most influential regarding implementation success. According to these findings, attention to the organisational context is critical for promoting and evaluating the success of conservation-education programs and must be given significant attention, alongside program characteristics and staff capability to deliver them.

5.1 Rationale

Given that the outcomes of zoo conservation-education programs are inconsistent, according to the evaluation evidence, research that seeks to evaluate these programs could benefit from a) understanding the challenges and successes that occur during the implementation phase of a program's lifecycle; and b) the provision of recommendations for the best course of action for future program implementation. As such, this study adopted a re-contextualised version of the model of diffusion in service organisations to triangulate the findings from the outcome evaluation presented in Study 2, Chapter 4 by 1) examining the challenges and successes to implementing the WBF program and 2) providing a practitioner-informed course of action for future conservation-education program implementation. The terms *challenge* and *success* refer to any human (e.g., labour, management) and non-human (e.g., technology, financial resources) tool or process that hindered or helped the implementation of the WBF program, respectively. Recognising that implementation can be a non-linear process, especially when setbacks are experienced, *implementation* is used to describe any activity, process, or task related to the 'how' and 'doing' components of implementation.

As outlined in Chapter 2, studies investigating zoo-related program evaluation from an organisational perspective appear to have focused exclusively on the *evaluation* phase of the program lifecycle, highlighting issues regarding evaluation design and resourcing (Carleton-Hug & Hug, 2010; Luebke & Grajal, 2011; Roe et al., 2014; Khalil et al., 2017). Less is known about the organisational factors that may help or obstruct the *development* and *implementation* stages of a zoo conservation-education program lifecycle. The development stage typically addresses the 'how' component of implementation and the implementation stage involves the 'doing' (or activation) element. Together, development and implementation processes are the steps undertaken to arrange, build, or produce each idea or concept generated in the *design* stage (Baars et al., 2006). For zoo conservation-education programs, these processes might involve developing a script, practising for a keeper-led presentation, assembling and placing signage or other interpretation material, and organising which partners will help to promote the program messaging.

Integrating both an outcome focus and a process focus into a single, more holistic evaluation could help to 1) obtain a more comprehensive understanding of the mechanisms that can affect the success of a conservation-education program; 2) provide future developers with an evidence base regarding what practices to embrace/avoid; 3) discover alternative or new methods and tools for implementation; and 4) pinpoint areas for

improvement and/or change. Indeed, school-based education innovations (e.g., Forman, Olin, Hoagwood, Crowe, & Saka, 2009; Plotner & Marshall, 2015) and health-related interventions (Ageberg, Bunke, Lucander, Nilsen, & Donaldson, 2019; Cotner, Ottomanelli, O'Connor, & Trainor, 2018; Kadu & Stolee, 2015) have benefitted from similar research approaches. Taken together, identifying helpful and unhelpful processes that might affect program implementation could help to create programs that have greater effects on visitors' cognition, affect, and behaviour, and subsequently mitigate biodiversity loss.

5.2 Diffusion of Innovations: A Framework for Organising the Challenges and Successes of Zoo Conservation-Education Program Implementation

A comprehensive understanding of the factors that influence the implementation of zoo conservation-education programs can be achieved if they are explored with the application of an existing framework. An existing framework can offer a robust and transferable methodology for investigating a longstanding phenomenon that is not unique to zoos (the challenges and successes in innovation) and can permit moving beyond simply describing to generalising about a phenomenon in the context of major determining factors of innovation (Grant & Osanloo, 2014). Drawing upon Roger's pioneering DIT, which explains that the spread of ideas during innovation is affected by features of the innovation itself, communication methods, time, and social systems (1962, 2010), one applicable determinant framework is the model of diffusion in service organisations (Greenhalgh et al., 2004).

The application of this model to zoo conservation education is suitable for two reasons. First, sustainability, a key goal of zoos, is considered an innovative idea (Dibra, 2015), broadly referring to any new changes or improvements to products and processes that could advance performance or outcomes (Rogers, 1998). Second, zoos are service organisations in the sense that they seek to provide several services to society, including public conservation education and in-situ and ex-situ wildlife conservation, both of which are critically important to preserving global biodiversity.

The model of diffusion in service organisations was developed from a review of theoretical and empirical studies concerning innovation (in this case, new behaviours and routines) in health care service delivery (Greenhalgh et al., 2004). This model is not a prescriptive formula, but rather, a conceptual framework that highlights key areas for consideration when seeking to explore the nuances of innovation in service organisations (Greenhalgh et al., 2004).

The model lists the following seven main components for consideration: innovation, adopters and adoption, dissemination and social influence, the organisational context, system readiness for innovation, the outer context, and implementation. Table 5.1 provides a detailed description of each component and the sub-topics of the model, as well as the definitions for a new re-contextualised version: the *model of diffusion in conservation organisations*, which was developed to guide the current research.

Table 5.1

Model of Diffusion in Service Organisations Component Descriptions, with Applications

Theme	Sub-topic(s)	Brief description per model (Greenhalgh et al., 2004)	Application to zoo conservation education
The innovation itself		Features of the innovation can explain adoption rates: e.g., relative advantages (clear advantages in effectiveness or cost effectiveness); compatibility with adopters' values, norms, needs; and complexity (simple innovations are more easily adopted).	Features of the conservation-education program can explain adoption rates: e.g., the nature and complexity of the chose conservation issue and conservation behaviour; the way messaging is communicated by educational components of the program, such as keeper presentations and static signag displays; advantages of the innovation and compatibility with visitor needs
Adoption and assimilation	Adoption by individuals	Adopters do not innovate passively; rather, they interac with (e.g., find meaning in, and develop feelings about) an innovation. Thus, it is necessary to consider individual characteristics of the adopters, such as gener and context-specific psychological antecedents (e.g., motives, values, specific skills), concerns at pre-adoption stage, and concerns during early use.	Individual characteristics of the conservation-education program implementer or developer; psychological antecedents including motives, values, specific skills, and concerns (e.g., about the way visitors might react to the program messaging or calls-to-action).
	Assimilation by organisations	Changes required by a team, department, or organisatio structures in order to innovate.	Changes required by a team, department, or conservation organisation structure more broadly, in order to implement the conservation-education program.
Communication and influence through interpersonal networks (diffusio and dissemination		Interpersonal communication and social networks influence the diffusion and dissemination of an innovation: e.g., homophily (the extent to which members of the same social network share values, norms, and experiences can encourage adoption of innovation); mass media (to create awareness); expert and peer opinion leaders.	External communication and influence via the interpersona influence within social networks of zoo professionals: e.g., mass media to communicate conservation messaging, external collaborations with other conservation organisations, expert opinion about a conservation topic.

The inner (organisational) context	Organisational antecedents for innovation	Existing structural and cultural features of the organisation can influence the successful assimilation o an innovation: e.g., structurally, organisations that are large, mature, functionally differentiated (i.e., have departments), and specialised are more likely to innovate. Culturally, organisations with clear goals and priorities, strong leadership, and vision are more likely to innovate.	Existing structural and cultural features of the conservation organisation can influence the successful implementation o a conservation-education program (e.g., have conservation-focused departments, clear goals and priorities, strong leadership, and vision).
	Organisational readiness for innovation	The organisation needs to be ready and willing to assimilate innovation: e.g., to have the dedicated time and resources, capacity to evaluate, and support and advocacy for the program.	The conservation organisation needs to be ready to implement a conservation-education program: e.g., to have the dedicated time and resources, capacity to evaluate the effect of the program on visitor psychosocial outcomes, an support and advocacy for the program.
The outer (interorganisation) context		External influences on innovation include the extent to which similar organisations have adopted an innovation and political directives (must-do's, mandates).	External influences on implementing conservation-educatio programs include having a localised conservation problem (i.e., specific to the home state/city of the conservation organisation); requirements of membership to an accreditation body; grants/funding.
Implementation and routinisation		Adaptive and flexible organisational structures and processes that support decision making are required: e.g., effective communication processes across departments, leadership and management support and advocacy, feedback on progress, human resource issues (e.g., early and widespread involvement of staff), and training.	Adaptive and flexible organisational structures and processes that support decision making in conservation-education implementation are required: e.g., effective communication processes across departments, leadership and management support and advocacy, human resource issues (e.g., early and widespread involvement of staff), an training.

5.3 Methods

This study was approved by the University of South Australia Human Research Ethics Committee (Application ID: 0000035677) and was conducted in accordance with Zoos Victoria Code of Conduct for Scientific Research Practice.

5.3.1 Materials. An online survey via SurveyMonkey was used to identify the challenges and successes in implementing the WBF program, as well as an unstructured follow-up telephone interview to explore the survey themes in more depth. In collaboration with Zoos Victoria, the following six questions were developed for the online survey, to examine areas of interest for the organisation:

1.
    a) Please describe any processes, practices, and/or tools that helped the successful completion of tasks while implementing the When Balloons Fly program (open-ended).
    b) Please explain how these processes, practices, and/or tools helped the successful completion of tasks (open-ended).
2.
    a) Please describe any processes, practices, and/or tools that may have hindered successful completion of tasks while implementing the When Balloons Fly program (open-ended).
    b) Please explain how these processes, practices, and/or tools hindered the successful completion of tasks (open-ended).
3.
    a) All things considered, in your opinion, what could be done differently for the next program? (open-ended).
    b) In your opinion, what existing processes, practices, and/or tools could be built on to maximise impact? (open-ended).

5.3.2 Participants, procedure, and sample. Following ethics approval, eligible staff involved in at least one aspect of the development and/or implementation stages of WBF and who were proficient in English were recruited via purposive sampling. In April/May 2018, an email containing information about the project (the Participant Information Sheet is detailed in Appendix N) and a link to SurveyMonkey was distributed to relevant zoo professionals by a female research manager at the organisation. This person was an

indispensable enabler for ensuring maximum reach to Zoos Victoria staff, who would have been otherwise inaccessible. Recruitment continued until all potential participants had been contacted a maximum of three times. Prior to beginning the online survey, participants were asked to read a consent form (online equivalent to Appendix O) and indicate their acceptance to participate in the research. The participants were aware of the research purpose and were offered a $25 eFlexi Gift Card upon completion of the survey.

Participants who opted to complete a follow-up interview were emailed and an interview time was arranged. To facilitate the telephone interviews, the individuals' survey responses were emailed to these participants, with tracked comments pinpointing concepts for further discussion. S. M. did not have any pre-existing relationship with the interviewees. Participants were able to complete both the initial online survey and the follow-up telephone interview at a time and location of their choice. Interviews typically lasted five to 10 minutes. Transcribed interview audios and notes were returned to the participants for comment and/or correction. There were no cases of misrepresentation identified by participants.

5.4 Data Analysis

At the time of this research, three of the five-member research team had academic appointments, one had an industry appointment in social science research management, and one was working towards her doctorate. Individually and collectively, the team was thus appropriately trained in qualitative research methods and reporting practices.

Thematic analysis was employed to organise content and identify patterns within the data, following guidelines by Braun and Clarke (2006). Responses were read and re-read to gain a preliminary understanding of the data. Given the exploratory nature of this research, an inductive approach to identifying initial (first-order) codes from the raw transcripts was utilised, with the first-order code production guided by the content of the participants' responses and not by a pre-existing theory or framework (Braun & Clarke, 2006). Initial codes were first developed by S. M. and then were refined through discussion among the research team.

To ensure inter-rater reliability, two researchers independently categorised the responses using these initial codes (Bachiochi & Weiner, 2002). Distinct challenges and successes were coded only once per participant, to avoid any one participant's perspective having undue influence on the overall dataset. Integrating these data helped to cross-check the information and facilitated elaboration of points of interest. Where a single participant

response contained multiple challenges, successes, or recommendations, all aspects were coded so that no text material was overlooked.

In collaboration with the author team, similar first-order codes were then grouped into second-order themes, with reference to the model of diffusion in service organisations (Greenhalgh et al., 2004). Specifically, the zoo conservation-education application descriptions of each theme and sub-topic that were created and outlined in Table 5.1 were used to organise the first-order codes. All discrepancies in coding were discussed until a consensus was reached; thus, the results presented below represent 100% inter-rater agreement. When reporting qualitative data, the consequence responses and effect responses were grouped together so that the consequences and effects could be discussed by each challenge and success sub-theme. Where participants did not report a response, the 'total valid participant *n*' is reported.

5.5 Results

As the participant sample was part of a small and well-connected Australian community of employment, there was a risk of inadvertent identity disclosure. To reduce this risk and maintain participant anonymity, the frequency of participants that were involved in specific aspects of implementation were not categorised nor calculated in the results. Broadly, the sample contained a group of professionals involved in a variety of roles during the implementation of WBF including management, education, marketing, and research. Of the 36 people invited to participate in this research, 24 completed the online survey (response rate 66.7%; no data collected on refusal). Four participants completed an unstructured follow-up telephone interview as well.

At the first-order code level, eight challenges and eight successes were identified in this research to describe the factors that had hindered and enabled implementation of the WBF conservation-education program. These are discussed in turn below, organised according to the following second-order themes (elements of the re-contextualised model of diffusion in conservation organisation framework): individual characteristics of the conservation-education program implementer or developer, the implementation and routinisation process, conservation organisation readiness for innovation, conservation organisation antecedents for innovation, features of the conservation-education program, communication and influence through interpersonal networks, and external influences on conservation organisations.

5.5.1 Challenges to program implementation. As depicted in Table 5.2, the combined survey and interview responses (total valid participant $n = 20$) revealed that challenges experienced by participants when implementing the WBF program most frequently sat within the model of diffusion in service organisations domains of organisational readiness for innovation (staffing, capital, support for target behaviour; $n = 16$) and organisational antecedents for innovation (changes to staff roles; $n = 5$). In other words, when thinking about factors that hindered the WBF program, the participants concentrated on organisational variables rather than on factors inherent to individuals or the campaign itself.

Table 5.2

Frequency of Perceived Challenges to Implementing the WBF Conservation-Education Program

Second-order themes (with reference to Greenhalgh et al., 2004)	First-order codes	Examples	Valid sample *n* = 20 % (n)
Individual characteristics of the conservation-education program implementer or developer	Support for target behaviour	Staff doubt about effectiveness of chosen target behaviour	5.0 (1)
The implementation and routinisation process	Timing of launch	Timing of launch occurred during busy school holiday periods when workload is typically already high	10.0 (2)
Conservation organisation readiness for innovation			
	Staffing	Limited staff/staff unavailability	40.0 (8)
		Competing priorities/lack of time to complete tasks	
	Capital	Limited audio-visual aid/support to maximise keeper presentation potential	40.0 (8)
		Limited funding for staff presentation training	
Conservation organisation antecedents for innovation	Continuity	Staff role changes	25.0 (5)

Features of the conservation-education program			
	Message clarity	Campaign message to reduce plastic incongruent with having plastic giveaways	10.0 (2)
		Incongruity between visual look and feel of new v. existing exhibit material	
	Multiple platforms	Communicate campaign messaging across multiple platforms (online, off-site, on-site)	5.0 (1)
Communication and influence through interpersonal networks	Identifying partners	Identifying suitable agency partners to support the program	5.0 (1)
External influences on conservation organisations	N/A	N/A	

5.5.1.1 Conservation organisation readiness for innovation. Within the major theme of organisational readiness for innovation (total valid $n = 16$), participants noted that the low number of staff and staff unavailability may have reduced the capacity to communicate the program information during busy times, as well as restricting communication opportunities between staff:

> "[Challenge] Staff time in manning the promise point on low staff days . . . [Consequence] Couldn't communicate as impactively [sic] with larger crowds of visitors." [P08]

> "[Challenge] Staff availability to dedicate to this project, and having the relevant staff available at the same time was a big challenge . . . [Consequence] This made it difficult to schedule regular catch ups, as one person or another would cancel and soon more than half of the people weren't there." [P20]

Some participants noted that competing priorities required multitasking but while this was challenging, it appeared not to adversely affect program implementation:

> "[Challenge] Competing priorities were a challenge at times, particularly as there were concurrent campaigns running . . . [Consequence] I think it just required us to juggle multiple projects, and this is all part of our job!" [P04]

> "[Challenge] Always competing priorities . . . [Consequence] Made it a little more complicated but not impossible." [P06]

A related concept was capital. First, the limited funding to support training for the keeper presentation made it difficult to prepare in time for the launch. One respondent reflected:

> "[Challenge] It was difficult to ensure [staff] were ready to deliver [talks] by campaign launch date as they are casual staff . . . [Consequence] We needed additional budget to ensure we could cover wages to get staff in to have dedicated time to learn the new talk." [P23]

Limited audio-visual support for presentations was perceived as a challenge that may have affected the quality of the presentation and reduced staff buy-in:

> "[Challenge] We are still lacking audio-visual support in the seal theatre . . . [Consequence] Having such structure in place would improve dramatically the value of the product being offered." [P15]

> "[Challenge] [Staff] weren't correctly supported to create the talk . . . many people across several areas had fantastic ideas for pledges and engagement but we were not able to make them work . . . [Consequence] Left the team pretty deflated." [P07]

5.5.1.2 Conservation organisation antecedents for innovation. Lack of continuity in staffing likely challenged the implementation of the WBF program (*n* = 5). Participants identified that staff role changes were perceived to reduce staff buy-in, distracted from public relations at the time of launch, triggered feelings of confusion and frustration, and led to shifts in priorities, and as a result, some planned campaign elements were not completed:

> "[Challenge] Changing of roles . . . [Consequence] Meant some of the planned on-site and off-site initiatives shifted priorities or were lost to other workload elements. A number of other staff working on the campaign left before or just after launch, which again impacted, particularly around efficiency and readjusting of priorities." [P12]
>
> "[Challenge] The changes in team members throughout [departments] in the launch phases of the campaign potentially compromised the implementation . . . [Consequence] limited buy-in and not a strong focus on PR [public relations] at the launch phase of the campaign." [P19]
>
> "[Challenge] Our team underwent a couple of changes during the planning and eventual roll-out of the program . . . . There seemed to be several different understandings by the [person], the [person] and [team], as to what stage all elements were at . . . [Consequence] This led to confusion and frustration between staff as it wasn't clear exactly which [staff] members were picking up which elements." [P21]

5.5.1.3 Features of the conservation-education program. Features of the conservation-education program itself (total valid *n* = 3) were perceived as a challenge during the implementation process; for example, the incongruity between new and existing material revealed a disconnect between styles:

> "[Challenge] [Team] often develop a visual look and feel of the campaign. This is often developed for the digital landscape, websites, social media, etc. It does not always transfer well to an on-site look and feel. Particularly when the campaign is going into an existing precinct that has its own graphic identity . . . [Consequence] There was a major disconnect between the two styles, which hadn't been picked up until the campaign was handed back to the [team]." [P21]

Concerns were raised about the campaign messaging to reduce plastic contrasting with having plastic giveaways:

> "[Challenge] Sometimes felt contradictory to be handing out plastic bubble items, while trying to avoid 'single-use plastics'." [P14]

A final feature of the innovation that was perceived to challenge implementation was being able to communicate program messaging effectively and coherently across on-site, off-site, and online platforms. It is possible that this affected the strength of the program message, as one participant explained:

> "[Challenge] Better thinking around on-site messaging versus outside campaign messaging. For example, on-site visitors are primed and I feel we can jump quicker to the action (pledge), whereas online need the education moment/part . . . [Consequence] [Needed] consistent look and feel across all audience touch points to reinforce/strengthen message and recall." [P24]

5.5.1.4 The implementation and routinisation process. Related to the implementation process, timing of the program launch was perceived as challenging (n = 2) because it created pressure, reduced work efficiency, and forced the readjustment of priorities:

> "[Challenge] We often launch a community conservation campaign at the same time as school holidays. [Consequence] This makes sense in terms of timing for maximum visitor exposure but creates a lot of pressure." [P10]
>
> "[Challenge] Timing of Feb launch created some difficulties with external stakeholders (website, designers/constructors) and timing with Dec/Jan break . . . [Consequence] Impacted particularly around efficiency and readjusting of priorities." [P12]

5.5.1.5 Communication and influence through interpersonal networks. Another less salient challenge to emerge was the identification of a suitable agency partner to support the program (n = 1):

> "[Challenge] Agency partners: how do we partner with the right agencies who are aligned and can help make our ideas fly higher? . . . and by agencies, I am referring to Creative and Media." [P18]

5.5.1.6 Individual characteristics of the conservation-education program implementer or developer. One participant described staff uncertainty about the efficacy of the program's call to action (ceasing the use of balloons and adopting alternatives) as a challenge to implementation because it took time to establish support for the chosen target behaviour:

> "[Challenge] Doubt about the campaign behaviour action not working—that is, that we couldn't get people to give up balloons. That we were being the 'fun police' . . . [Consequence] I spent a lot of time informing, convincing, persuading staff, volunteers that the campaign will work if we do it right." [P22]

5.5.2 Successes

Table 5.3 displays the frequency of staff-perceived successes in implementing the WBF program. Valid responses from 22 participants highlighted aspects within the domains of organisational readiness for innovation (e.g., use of a theoretical model; $n = 12$) and organisational antecedents for innovation (team structure, role allocation, clear objectives; $n = 8$) as major positive factors.

Table 5.3

Frequency of Perceived Successes in Implementing the WBF Conservation-Education Program

Second-order themes (adapted from Greenhalgh et al., 2004)	First-order codes	Examples	Valid sample *n* = 22 % (*n*)
Individual characteristics of the conservation-education program implementer or developer	N/A	N/A	
The implementation and routinisation process			
	Formative assessments	Ongoing assessment	9.1 (2)
	Staff training	Use of a staff-training video	9.1 (2)
	Communication	Meeting regularly, progress updates, inter-department communication, cross-functional teams	81.8 (18)
Conservation organisation readiness for innovation	Tools and resources	Use of a theoretical model (C-U-A), use of an interpretative matrix, use of shared program calendar, staff manning touch points (e.g., bubble play, promise points)	54.5 (12)
Conservation organisation antecedents for innovatio			

	Transparent role allocation	Establishing clear roles/clear role allocation, appointing a program lead	13.6 (3)
	Clear objectives	Working towards clear goals/milestones	4.5 (1)
	Team structure	Project control/working groups	18.2 (4)
Features of the conservation-education program	Messaging	Simple program messaging	4.5 (1)
Communication and influence through interpersonal networks	N/A	N/A	
External influences to conservation organisations	N/A	N/A	

5.5.2.1 Conservation organisation readiness for innovation. A major positive factor in the implementation of the WBF program was organisation readiness. Exclusive to this domain was the use of tools and resources (n = 12), such as an interpretive matrix, a shared campaign calendar, and a behaviour-change model (C-U-A; Zoos Victoria, 2010). These resources appeared to help guide and focus the development and implementation of several educational components of the program:

> "[Success] Interpretive planning processes, including focus on C-U-A and ensuring that the visitor experience utilised C-U-A tools in planning. We have an Interpretation Toolkit; it's an A5 polypropylene box that is filled with cards in four categories; Connect, Understand, Act, and Time to Engage . . . [Consequence] This helps us pace the experience and ensure we have it in the best order possible." [P21]
>
> "[Success] The one big campaign calendar over view . . . [Consequence] The tool being a shared, full-view calendar to remind the team their role in the project and their impact on the overall project." [P18]

Another tool (for delivery) was the involvement of staff in supervising interpretation areas, such as the bubble play areas and promise points. This strategy was perceived to facilitate visitor engagement and create a sense of ownership:

> "[Success] Many visitors were unaware of the impact of balloons on wildlife and the environment prior to the campaign. Staff facilitating the promise point helped support the communication process . . . [Consequence] Having staff available at the promise point engaged visitors about balloons/plastics in the environment, prompted wider conversations and helped visitors connect their understandings. Visitors would often relate their own experiences and thoughts, which stimulated deeper conversations." [P08]
>
> "[Success] Bubble play . . . [Consequence] Allowed for children and adults to experience the joy of bubbles hands-on." [P10]
>
> "[Success] The on-site activations were developed and implemented very well . . . [Consequence] This has facilitated the high take up of pledges on-site . . . and created a good sense of ownership at the property level." [P19]

5.5.2.2 Conservation organisation antecedents for innovation. Related to organisational antecedents for innovation, a small number (n = 4) of respondents expressed a preference for

project/working groups because these provided opportunities to discuss progress, overcome road-blocks, streamline tasks, and harness staff buy-in:

> "[Success] Participation in PCG [Project Control Group] . . . . The PCG allowed for all key staff involved in the project to meet regularly and discuss the program, issues and concerns and report on progress . . . [Consequence] This enabled us to not double up on key components and to ensure we remained focused on the campaign outcomes, especially for on-site promotion." [P23]

> "[Success] Presentation working group initially captured desired changes to messaging and new seal behaviours/props needed . . . [Consequence] Helped to streamline the process and remove the need to check in with different groups." [P12]

> "[Success] Working group meetings during campaign development and into the campaign period. [Consequence] Fostered buy-in and created ownership of campaign beyond campaign team." [P05]

Transparent role allocation was another aspect of system readiness that likely facilitated the implementation of the WBF program because it fostered staff buy-in (n = 3):

> "[Success] Clear role allocation in developing activities, targets, timelines across departments . . . [Consequence] Fostered buy-in and created ownership of campaign beyond campaign team." [P05]

One participant noted that setting goals and establishing milestones helped to disentangle complex tasks:

> "[Success] Established set milestones for pre-launch, launch, and post. Established key ideas, themes, and actions on a monthly basis . . . [Consequence] This broke down the actions to achievable parts." [P03]

5.5.2.3 The implementation and routinisation process. Communication within the organisation was the most frequently identified success factor related to the domain of the implementation and routinisation process (n = 18). Communication made it more likely that staff would receive appropriate support to perform their roles or tasks, obtain correct information about the program and its delivery timeline, and share information about aspects of the program that were not working, as well as fostering buy-in and streamlining development processes for the seal presentation:

> "[Success] Inter-department communication at [site] was good, with support being given to all who required . . . [Consequence] It ensured that everyone had the correct

> information in the required time frame and had sufficient knowledge and understanding of the campaign to perform their duties." [P17]
>
> "[Success] Collaboration from other departments also aided the process . . . [Consequence] We could pinpoint where things weren't working as designed; i.e., website and pledge numbers . . . ." [P09]
>
> "[Success] Multi-disciplinary meetings . . . [Consequence] Fostered buy-in and created ownership of campaign beyond campaign team." [P05]
>
> "[Success] Working collaboratively with [team] on the presentation script was successful. I also consulted with my team on the development of the theatrical character . . . [Consequence] Resulted in positive buy-in from the team." [P11]

Within this theme, staff training was perceived to help the development of a coherent storyline for the presentations, streamlined the presentation script development, and created staff buy-in and confidence (n = 2):

> "[Success] Producing a training video on the two new talks (seals/penguins) . . . [Consequence] Helped [staff] learn the new talk; helped [staff] in training the seals to do certain behaviour; helped bring together a more coherent storyline, especially for the new seal presentation. It brought together many of the key players in constructing a new set of talks." [P22]
>
> "[Success] Specific training about the campaign was highly valuable . . . [Consequence] Felt that we were kept in the loop . . . . Ensured that I felt confident when talking to school groups about the campaign." [P14]

One participant explained that formative assessments enabled staff to trial changes to overcome problems:

> "The ongoing assessment of what was and wasn't working through the activity relating to this campaign was crucial . . . . We could then test and implement the necessary changes in order to reach the desired outcome." [P09]

5.5.2.4 Features of the conservation-education program. With regard to design features of the program, one participant thought the simple message (to use bubbles, not balloons) was relevant to visitors:

> "[Success] The simple message . . . [Consequence] Visitors could relate to making one small change." [P09]

5.6 Recommendations

The participants' recommendations for strengthening the implementation of the WBF program, and zoo conservation-education programs more broadly, are listed in Table 5.4. Recommendation 1 (complete a pre-launch) pertains to a suggestion for improving implementation and routinisation processes. Recommendations 2 and 3 offer guidance to help streamline the implementation and routinisation processes: for example, adopting 'think tanks' and holding shorter, more frequent meetings. Recommendations 4 and 5 provide suggestions for increasing conservation organisation readiness for innovation by broadening the network of staff involved at the early stages of the implementation phase and defining a budget that accommodates for changes and adaptations. Recommendations 6 to 12 provide suggestions to improve features of the conservation-education program itself, such as where and how to display and design educational components of the program. The table describes possible advantages of engaging in the suggested strategies, as developed by the research team.

Table 5.4

Staff-informed Recommendations for Implementing Zoo Conservation Education and Their Possible Advantages

Theme (adapted from Greenhalgh et al., 2004)	Staff-informed recommendations	Potential advantages
The implementation and routinisation process	1. Complete a pre-launch prior to the official campaign launch	- Opportunity to identify and modify delivery problems prior to th official launch - Facilitates better-planned, manageable staff workloads at time o official launch (which often align with school holiday periods)
	2. Adopt 'think tanks' (e.g., workshops or group meetings) to brainstorm resolutions to a problem or to create ideas	- Opportunity for staff to address a specific issue in a structured, interactive workshop - Opportunity to capture foresight about problems
	3. Hold short meetings regularly	- Can resolve issues as they emerge - Increases productivity
Conservation organisation readiness for innovation	4. Broaden the network of staff involved a early stages of the implementation	- Ensures status and progress of campaign elements is known across multiple teams and individuals - Facilitates continuity when/if staff leave or are absent at critical moments during the campaign timeline - Fosters staff buy-in

	5. Define a budget that accommodates for changes and adaptations	- Can respond quickly when unforeseen threats to, or opportunitie for, campaign success arise
Features of the conservation education program	6. Employ multiple ambassador species of varying popularity or familiarity affecte by the same environmental problem; e.g for marine debris, use flesh-footed shearwater (*Puffinus carneipes*) and Australian fur seal (*Arctocephalus pusillus doriferus*)	- Opportunity to educate about less-known species while maintaining appeal to a broad audience - Opportunity for flexibility and creativity with conservation messaging - Offers greater flexibility for campaign interpretation content and delivery methods - Showcases the extent and nature of the environmental problem
	7. Display the same information in a variet of ways (e.g., signage, animation, presentation)	- Enables the campaign to reach a broader audience - Reinforces visitor recall about campaign messaging
	8. Create a consistent look and feel across all campaign elements (e.g., colour scheme, typeface, sounds)	- Helps visitors to recognise the campaign as the source of the message off-site, on-site, and online - Encourages brand empathy; helps visitors to remember and connect with the campaign and the conservation message - Advertises a powerful campaign message
	9. Promote on-site efforts off site (e.g., advertise on-site pledges online)	- Showcases extent of the environmental problem - Reaches a broader audience - Gives (staff) motivation to continue the work on-site

10. Source eco-friendly material connected to the campaign messaging for props an giveaways	- Demonstrates organisational role modelling - Communicates to visitors example behaviours to emulate beyon the zoo walls
11. Develop online campaign educational moments (e.g., online microsite)	- Encourages post-visit engagement with the conservation messag
12. Public display of visitor engagement with call to action (e.g., a cumulative scoreboard of total pledges)	- Creates a social norm around the call to action

5.7 Discussion

5.7.1 Main findings. The main finding suggests that the factors perceived as playing an influential role in program implementation primarily originated from within the organisation, rather than within individuals or in connection to the program itself. Notably, the *organisational readiness for innovation* and *organisational antecedents for innovation* domains, which sit within the broader theme of *the inner (organisational) context*, were dominant themes for both implementation challenges and successes for the WBF zoo conservation-education program. Successes frequently sat within the *implementation and routinisation process* domain as well, illustrating that adaptive, flexible organisational structures and processes that supported decision making (e.g., effective communication) were critical enabling features to the implementation of the WBF program. The results supported the application of the model of diffusion in service organisations as a framework for understanding the ingredients of zoo conservation-education implementation. Before considering the conceptual and practical applications of this work, each sub-topic of the model, in order of saliency, is discussed next and where relevant, links to recommendations that emerged from this research are made as possible strategies to help progress zoo conservation-education research outcomes.

5.7.2 Major influences on the implementation of the When Balloons Fly program.

5.7.2.1 Conservation organisation readiness for innovation. Organisational readiness for innovation was a very salient sub-topic that was perceived by staff to have a substantial influence on the implementation of the WBF program (challenges: $n = 16$; successes: $n = 12$). Consistent with previous work (Gustafson et al., 2003), these findings indicated that adequate resources, including specific tools and staffing, were key factors that helped implementation. This investigation identified several specific tools that could be of value to other conservation organisations when preparing and planning for their program implementation, thus achieving readiness for implementation. These resources were a shared program-implementation calendar, an interpretation matrix, and a zoo-focused behaviour-change theoretical framework (C-U-A; Zoos Victoria, 2010) to guide the development of program materials (e.g., the keeper presentation). In terms of staffing, staff manning the interpretation areas on-site (e.g., bubble play areas and pledge points) was perceived as a helpful technique to the ‘doing’ aspect of implementation, in the sense that it promoted visitor engagement and staff buy-in. This finding implied that the staff believed that the visitors enjoyed educational components that were supervised by staff, which has two

potentially important implications. The first implication is that staff involvement in delivering interpretations could be a key strategy for enhancing the efficacy of communicating program messaging (consistent with previous work supporting the efficacy of staff-lead interpretations, such as keeper presentations; Miller et al., 2013; Mellish, Pearson, Sanders, Litchfield, 2016). Second, staff involvement might serve as a means of generating informal/formative feedback to ascertain how certain elements of the program are received by visitors (and thus identify areas for change, improvement, or expansion).

In parallel, several areas were seen as lacking readiness and thus, were perceived as challenges in the implementation of the WBF program. Consistent with challenges identified by other AZA-accredited organisations when conducting evaluation research (Luebke & Grajal, 2011), these results highlighted that lack or unavailability of staff, lack of time to complete tasks, and limited funding and technological support likely hindered implementation to some degree. The prevalence of this sub-topic highlighted the need for an innovation to have a strong foundation in quality resources that can inform program planning and development; and that this could be further enhanced by increased staffing and resourcing, particularly at launch, which typically occurs during peak school holiday periods. The participating staff recommended the organisation defining a budget that would allow for changes or adaptations (Recommendation 5) and/or broadening the network of staff involved at the early stages of the implementation process (Recommendation 4).

5.7.2.2 Conservation organisation antecedents for innovation. Organisational antecedents for innovation was another prominent sub-topic perceived by staff as influencing the implementation of the WBF program (challenges: $n = 5$; successes: $n = 8$). The prevalence of this theme indicated that structural and cultural features of the organisation were very important to the completion of WBF implementation-related tasks.

A recurring factor within this sub-topic was the adoption of project control/working groups. These groups typically comprise key stakeholders who can influence the project and have an understanding of the way decisions may affect the organisation; they might include general/project managers, department heads/representatives, specialist consultants, contractors, and user groups. In light of the perceived helpfulness of these groups in this context, similar organisations seeking to deliver conservation-education programs who do not currently use such groups may wish to integrate similar methods to aid program implementation. For organisations already utilising these methods, optimising their approach (i.e., reviewing and/or revising, where necessary) would be merited.

Transparent role allocation was another common example within this sub-topic. In other studies, role allocation has been identified as a major factor that can influence implementation success (e.g., Kirwan & Ainsworth, 1992).

A leading challenge within this sub-topic was lack of continuity in staffing. The prevalence of this challenge and its perceived effects, including reduced staff buy-in and increased feelings of confusion and frustration, might point to the need to take proactive steps to boost staff retention and work engagement to prevent turnover. Building team resilience (team capacity to survive and thrive during a disruptive event; Horne & Orr, 1997) could be a valuable tool. Helpful strategies to strengthen resilience might include 1) conducting a debrief session post role change to facilitate reflection and create an action plan; and/or 2) developing tools or documents that contain step-by-step procedures for dealing with future staff role changes (see Alliger, Cerasoli, Tannenbaum, & Vessey, 2015 for a comprehensive list of recommendations and specific behaviours for building team resilience). Thus, conservation organisations may benefit from harnessing structural and cultural features of the organisation to foster project implementation processes.

5.7.2.3 Implementation and routinisation process. Factors within the *implementation and routinisation process* domain were seen as primarily being helpful to the implementation of WBF (successes: $n = 22$ v. challenges: $n = 2$). Within this theme, communication processes, formative assessments, and staff training supported the implementation process. Effective communication was the most frequently recorded factor ($n = 18$ of 22 successes). The high proportion of responses that contained an element of communication as a success, and the widespread benefits resulting from effective communication (e.g., opportunity to receive support to perform roles/tasks correctly, obtain correct information about the program and its delivery timeline, share information about aspects of the program that were not working, streamline development processes for the presentation), emphasised the extensiveness of the potential benefits that communication serves for assisting with implementation-related tasks in zoos. Indeed, communication has long been considered a critical factor in creating an atmosphere for successful program implementation (Pinto & Slevin, 1987). Thus, a priority area of focus when seeking to embark upon or improve program implementation in zoos should be ensuring that effective communication strategies are in place, made use of, and continually evaluated and evolved based on practitioner feedback.

The presence of other successes within this domain, including formative assessments and staff training, was consistent with previous research. Research has shown that formative

assessments can highlight impeding factors at an early stage and prompt changes or improvements (Stetler et al., 2006). Further, staff training is well documented as a feature that can effectively prepare practitioners to complete tasks relative to the implementation of the program. In fact, a review of over 500 empirical research articles (Durlak & DuPre, 2008) revealed that in relation to prevention and health promotion programs for children and adolescents, staff training received the most attention and empirical support as an influence in program implementation. For conservation organisations, reviewing and reforming training and formative assessment processes to enhance their conservation-education outcomes is warranted.

A challenge that emerged from this study concerning the *implementation and routinisation process* domain was the timing of the program launch during busy school holiday periods. School holidays are considered an optimal time in the zoo year calendar to launch an initiative because this can maximise visitor exposure to the program messaging. This research revealed that this calendar clash increased work pressure, was perceived to reduce work efficiency, and forced the readjustment of priorities. The findings highlighted the need to prioritise the planning of tasks and preparation of resources that are required for this stage of implementation. Based on the feedback gathered from their staff, Zoos Victoria integrated a pre-launch and staggered campaign launch dates into their recent program Safe Cat, Safe Wildlife, which aimed to protect wildlife and keep pet cats safe at home (see http://www.safecat.org.au/). For conservation organisations, this study's findings regarding the pre-launch (Recommendation 1) could assist staff to identify delivery problems prior to the full-scale launch and to modify the program (or launch process) where possible.

Overall, the most influential aspects of the WBF implementation process related to characteristics of the organisation, including its readiness to implement and its existing and adaptive structural and cultural features.

5.7.2.4 Other influences on the implementation of the When Balloons Fly program. The following section discusses the less salient factors and domains to emerge from this study. While these factors are not central to this study's findings, given the exploratory nature of this work, it is useful to examine them in detail.

5.7.2.4.1 Features of the conservation-education program. Specific attributes of an innovation can have an effect on the nature and extent of its implementation (Greenhalgh et al., 2004). In this research, features of the conservation-education program were most often cited as a challenge in the implementation process. Example challenges typically concerned

incongruities between the initial ideas and the end result, such as creating a consistent look and feel when integrating new program material into an existing exhibit.

Another challenge was the need to create an effective call to action that had the potential for widespread uptake, where the benefits of education, as well as affective and behaviour change, outweighed the potential risks. In the case of the WBF program, the giveaway of plastic bubble equipment was reserved for major events, such as Zoos Victoria's 2018 Guinness World Records attempt for *the most people simultaneously blowing bubbles for one minute*. This public event drew 11,500 visitors to the Melbourne Cricket Ground to raise awareness about wildlife-friendly bubbles as an alternative to using balloons outdoors (see https://www.youtube.com/watch?v=QP6cDZ8c7zM) and more than 160,000 people were exposed to the campaign message, either from the big screen at the Melbourne Cricket Ground or through television coverage (McLeod et al., 2018). Only bubble containers that were designed to be multiple use were disseminated and each bottle displayed a wildlife-friendly bubble-mix recipe to encourage re-use.

For conservation organisations more broadly, creating opportunities to reveal incongruities and share ideas about innovative calls to action, when benefits can outweigh costs, could be achieved by broadening the network of staff involved at early stages of the implementation (Recommendation 4).

5.7.2.4.2 Communication and influence through interpersonal networks. The model of diffusion in service organisations model asserts that an organisation's decision to innovate can be dependent upon a series of external influences, including interorganisational networks (Greenhalgh et al., 2004). Related to this concept, this study had one instance where sourcing suitable agency partners to expand the reach of the program was described as a challenging aspect of implementing the WBF program. This finding offered the insight that the partner-scoping process could influence the implementation of conservation-education programs; even in a large, well-networked organisation, collaboration is complex and it could affect implementation.

5.7.2.4.3 Individual characteristics of conservation-education program implementers or developers. Staff doubt about the program's target behaviour was a minor challenge that emerged from this research. This has not been identified previously in other investigations of challenges that impede organisational processes within the zoo context (e.g., Carleton-Hug & Hug, 2010; Luebke & Grajal, 2011). This finding could illustrate staff awareness of

the momentous task of shifting community norms surrounding outdoor balloon use (the focus of the WBF program), which is an activity that typically represents celebration or spiritual output, as opposed to harming wildlife. Such staff perceptions with regard to the way people may respond to a program's call to action could serve as an important instrument in improving planned interpretations. They could provide a focus for ways to communicate messaging that will account for social customs, traditions, and standards of behaviour that shape communities.

Taken together, these domains were less significant than others were, suggesting that these examples were not central to, nor created, any major impediments during the implementation of the WBF program. Nonetheless, these factors represented areas to be kept in mind when implementing conservation-education program in the future.

5.7.3 Lessons learned from this study and directions for future research.

5.7.3.1 Conceptual application. The application of the model of diffusion in service organisations model (Greenhalgh et al., 2004) provided a clear framework for categorising, interpreting, and communicating the influential factors regarding implementing a zoo conservation-education program. Drawing attention to the conceptual domains of this model offered a theoretically grounded lens for exploring and understanding the largely unknown area of implementation practice in zoos.

Future work could benefit from further defining and refining the application definitions provided here for the zoo conservation-education context, as well as by framing research questions against these domains. This would provide a common lens through which zoos can understand ways of enhancing the implementation and evaluation of conservation-education initiatives. In addition, future research could build on the findings of Study 3 by investigating the causal relationships among the major *inner (organisational) context* components identified in this study. An investigation of this nature would empirically identify the organisational-related predictors of zoo conservation-education implementation success.

5.7.3.2 Practical application. The outcome evaluation of the WBF program (Study 2) found evidence that, overall, this conservation-education program increased visitor understanding of the effects of balloon use outdoors, promoted positive attitudes and social norms concerning outdoor balloon use, fostered intention to reduce balloon use and increase wildlife-friendly bubble use, and encouraged people to change their behaviour at post-visit outdoor events. The results of Study 3 provided information about on the components of the

implementation process that led to this outcome. Thus, these findings offer practical suggestions for implementers seeking to advance the efficacy of conservation-education initiatives or experiences For example, the findings offered specific tools that could be of applied value, including the use of a zoo-based theoretical framework (C-U-A; Zoos Victoria, 2010) to guide the production of program material. Having project control/working groups was another strategy that could facilitate effective communication and program planning. Guided by the model of diffusion in service organisations, another noteworthy implication for conservation-education practice was the unveiling of a new focus for organisations when seeking to enhance or investigate the quality of a program. Specifically, when seeking to advance program efficacy, organisations need to focus on organisational-level factors (i.e., culture and structure), in addition to individual-level or program-related factors.

5.8 Strengths and Limitations

This study had several strengths and limitations. A strength was that challenges and successes were interpreted both quantitatively and qualitatively, and the triangulated data analysis helped to yield greater insights because the interpretations could be integrated into the significance of each model domain, without overlooking the complexity of each response.

In general, assessments of intervention processes that are conducted only by external evaluators can produce fragmented data, because of lack of context, and result in an incomplete understanding of the mechanisms that shape successes or pitfalls (Conley-Tyler, 2005). Therefore, a strength of this study was the university–industry research partnership that encouraged shared decision making and the exchange of ideas during important stages of the project. For example, the project's survey was circulated among the stakeholders to ensure that the questions were suitable for the intended sample. Further, the recruitment of potential participants was led by a staff member at the organisation, to maximise the number of potential participants approached to be involved in the research, who were otherwise unknown to the researchers.

A limitation is that while the results of this study embodied diversity in views and experiences, the generalisability of the findings to other organisations is somewhat limited because the data were representative of only one high-profile conservation organisation with experience in implementing conservation-education programs. Different themes, in different capacities, may have emerged from data collected at other (e.g., smaller, independent)

organisations. In addition, to protect participants' anonymity, demographic information about their job roles was not reported. This restricted the capacity of this research to identify any between-department differences in the challenges and successes noted. Lastly, the response rate of this study was lower than anticipated. It is possible that this research attracted participants who had greater satisfaction with implementing the WBF program, resulting in extreme perspectives, which could have skewed this study's data. Moreover, the pool of potential participants contained casual and part-time visitor-facing staff, which could have influenced the likelihood of participation.

5.9 Conclusion

Identifying the ingredients for successful program implementation can support the development of effective zoo conservation-education programs. By re-contextualising the model of diffusion in service organisations (Greenhalgh et al., 2004) to the zoo environment, Study 3 has illuminated that features of the conservation organisation, rather than features of the individuals or program, have particular influence on the success of conservation-education implementation. Importantly, the lack of responses among the other model domains might not suggest they are less relevant for zoos, but rather that they did not present a challenge in this instance. It is unlikely that a standardised or prescriptive protocol for implementing conservation-education programs across conservation organisations would be useful in this context, since each site has its own unique physical characteristics and access to resources. However, the re-contextualised *model of diffusion in conservation organisation*s could act as a general guide for avoiding possible pitfalls and for advancing success in program implementation. As the zoo community continues to develop the nature and extent of their involvement in conservation education, it will be imperative to create a strong scholarly evidence base of the factors that can influence implementation practice and program efficacy.

Chapter 6: General Discussion

Summary: Increasingly, zoos and aquariums are becoming recognised as places to educate the public about environmental problems and promote conservation behaviours. Despite their role as conservation organisations, literature that seeks to evaluate the efficacy of zoo conservation-education efforts is in its infancy and outcomes have been mixed. This program of research sought to advance best-practice zoo conservation education by synthesising the status of, and key issues for, research methods quality in the field, as well as by examining the implementation and evaluation stages of a zoo conservation-education program as test case. In this final chapter, the findings from this research program are drawn together to propose a framework for zoo conservation-education evaluation. First, a summary of the key findings from each original research study is presented, followed by an overview of the key theoretical, conceptual, and empirical contributions of this thesis to zoo conservation-education evaluation. Next, a series of recommendations are suggested for future research and practice, then the limitations of these studies, problems encountered, and future directions are summarised. This chapter concludes with some thoughts about the challenges that this field faces.

6.1 Introduction

Public engagement in pro-environmental behaviours is increasingly recognised as fundamental to biodiversity conservation (Novacek, 2008). This thesis set out to advance best-practice zoo conservation education and ultimately maximise their capacity to offer meaningful contributions to this goal. The new knowledge that emerged from this program of research offers several ways to progress best-practice zoo conservation-education evaluation. An analysis of the existing literature (see Chapter 2) yielded mixed results about the efficacy of zoo conservation education in promoting and encouraging visitor conservation-related knowledge, attitudes, and behaviours. While there is evidence that zoo conservation education can be effective, inconsistencies in research outcomes have impeded a clear scholarly understanding of the conditions under which conservation education has the greatest potential to work, and subsequently inhibited zoos' capacities to refine their conservation-education practices continually, to maximise their effect on biodiversity conservation. Chapter 2 revealed that process evaluation literature pertaining to zoo conservation-education efforts is scarce, with much research focusing on the challenges and successes encountered during evaluation, rather than during the development or implementation stages of the program lifecycle. Without attending to the processes that influence development and implementation, it is difficult to obtain a holistic and accurate understanding about the factors that shape outcome evaluation findings.

Guided by these gaps, this program of research sought to progress best-practice zoo conservation education by a) identifying the quality of research methods and reporting practices of peer-reviewed zoo conservation outcome evaluations; b) applying best-practice research methods to a zoo conservation-education program outcome evaluation; and c) exploring the factors that affect conservation-education program development and implementation.

6.2 Overview of the Thesis Findings

6.2.1 Review of research methods and reporting practices in zoo and aquarium conservation-education evaluation.

In Study 1 (Chapter 3), the research methods and reporting practices of 48 studies (in 47 articles) that evaluated at least one conservation-related psychosocial outcome were reviewed and critically appraised. This identified overarching methodological problems pertaining to construct validity (e.g., overreliance on self-reported data collection measures, including surveys); external validity (e.g., few studies reported response rates and few studies had a non-Western country of origin);

internal validity (e.g., few studies had multiple time points or assessed the post-visit effects of a program); and statistical conclusion validity (e.g., few studies had mixed-method designs or reported effect sizes). In a critical appraisal of the quantitative method quality of these studies, using the EPHPPQAT (NCCMT, 2008), the majority (83.3%) of studies reviewed were of a weak methodological quality. The reporting of qualitative methods was generally good, with all eligible studies explicitly describing the methods used, and over half (60.9%) reported the method of recording data (e.g., audio or video recording, written). Key areas for development were the reporting of transcription procedures and how data verification had been performed. Generally, these findings indicated that there is great scope to enhance research seeking to evaluate the efficacy of zoo and aquarium conservation education through strengthening research methodology and reporting practices.

6.2.2 Outcome evaluation of the When Balloons Fly conservation-education program. Study 2 (Chapter 4) sought to address some of the gaps in best-practice zoo conservation-education evaluation research methodology (as identified in Study 1) in an outcome evaluation of a zoo conservation-education program. This examined the effect of Zoos Victoria's WBF conservation-education program on visitor knowledge, attitudes, and behaviours (intentions and post-visit behaviour) over six months (N = 624). Outcomes were compared between visitors who had viewed a zookeeper-led seal presentation and exhibit against those who had viewed the exhibit only, and investigated the potential priming influence of completing a survey before entering the exhibit. Visitors were found to have a greater depth of understanding about the effect of balloons on marine wildlife immediately following the visit, but post-visit recall of the key message was low. GLMs revealed that over six months, the WBF program had significantly influenced positive attitudes concerning outdoor balloon use, significantly increased the likelihood of using bubbles outside, and significantly reduced the likelihood of using balloons outside. Completion of a pre-survey significantly influenced positive attitudes and significantly reduced the intention to use balloons when outside. The results from this study indicated that the WBF program was promoting post-visit conservation behaviour, with two-thirds of the follow-up sample reporting that their changes in behaviour following the zoo visit were influenced by the zoo experience. This study overcame two key limitations in zoo conservation-education evaluation by measuring self-reported behaviour change (in addition to behavioural intention) and tracking visitors over six months. It offers a rigorous example for future

researchers and practitioners regarding how to integrate best-practice behavioural research methodology into an applied zoo conservation-education context.

6.2.3 Implementation evaluation of the When Balloons Fly conservation-education program. To gain a fuller understanding of the factors that shaped the findings from the outcome evaluation of WBF (Study 2) and increase Zoos Victoria's ability to identify and implement best program practices in the future, the findings from the outcome evaluation were triangulated with an evaluation of development and implementation processes. This comprised the third study of this research program. A total of 24 Zoos Victoria professionals completed an online survey focused on identifying challenges and successes in implementing the WBF program. Four participants completed a follow-up telephone interview as well.

The emerging themes were identified and organised according to the model of diffusion in conservation organisations, which was re-contextualised from the model of diffusion in service organisations (Greenhalgh et al., 2004). The results found that features of the organisation (e.g., structure, culture) were perceived as being most influential in implementation success, relative to features of individuals (e.g., skills, motivation) and characteristics of the conservation-education program itself (e.g., messaging).

These findings mean that attention to the organisational context is critical for promoting and evaluating the success of conservation-education programs, and must be given significant attention alongside program characteristics, staff capability to deliver them, and outcome evaluation results.

6.3 Thesis Contributions to the Current State of Knowledge

Findings from this program of research highlights the inherent and complex difficulties in conducting zoo conservation-education evaluation and offers several important advancements in our understanding of best-practice implementation and evaluation of zoo conservation education. Below, key transferrable discoveries are outlined which provide a foundation for a new three-pronged integrated approach to zoo conservation-education evaluation. The final major contribution discussed in this section is the recontextualisation of the model of diffusion in service organisations to a conservation-education context.

6.3.1 New transferrable discoveries. The following section discusses new discoveries to emerge from this thesis under three themes: (1) organisational capacity for innovation is

critical for *delivering* successful conservation education; (2) it is likely that the *way* delivery is affected by organisational capacity has an impact on conservation outcomes, *through visitor experience*; and (3) there is clear scope to improve conservation-education evaluation methods and reporting practices to supplement improved program delivery and visitor experience.

Drawing together findings from the process evaluation and the outcome evaluation, a key discovery to emerge from this research program is that organisation capacity for innovation is likely fundamental for delivering successful zoo conservation-education programs. Results from the outcome evaluation offer preliminary evidence that WBF was successful in terms of promoting greater depth of knowledge, encouraging positive attitudes, inspiring an intent to act, as well as motivating post-visit behaviour modification. When coupling these findings with results from the process evaluation, which highlight that both the major perceived challenges and successes to implementation primarily originated from *within* the organisation (and encompassed *readiness for innovation* and *antecedents for innovation),* there is compelling evidence that a key transferrable discovery in conservation-education program success rests within features of the organisation. In other words, it is possible that conservation organisations that do not exhibit features of readiness for innovation (e.g., limited staffing, competing priorities/lack of time complete tasks) or lack antecedents for innovation (e.g., do not have conservation-focussed departments, clear goals, strong leadership), would be limited in their capacity deliver successful conservation-education programs. This notion is supported by a growing body of reviews that also attribute these organisational factors (among others) to successful health (Lloyd et al., 2018), aged care (Goodman et al., 2017), and public sector-related innovations (De Vries, Bekkers, & Tummers, 2016).

This discovery is further supported by key points to emerge from the methodological review (Study 1), including the need to validate or use validated measures, measure standardised educational experiences in isolation, and address gaps in reporting of validity and reliability problems. Indeed, successful completion of these tasks will require relevant elements of innovation readiness (time, sufficient staffing) and antecedents for innovation (conservation-focussed departments, or staff/evaluators with relevant expertise). Looking to the future, there should be continued efforts to help organisations understand their level of innovation readiness, and to build organisational capacity to be ready and prepared for innovation, which might include directing resources to effective communication and tools (e.g., development or application of theoretical models). It is also likely to involve multi-

disciplinary collaboration with universities who can contribute the expertise and human resource (e.g., through post-graduate student placements) to complete the research.

The second transferrable discovery is that the *way* program delivery is affected by organisational capacity might influence conservation outcomes, *through visitor experiences*. Owing to the dominant influence of organisational factors including organisation lack of readiness for, and/or antecedents of, innovation, educational components of a program or experience could be left out or implemented poorly. This in turn would limit the potential of the program to meaningfully encourage visitor pro-environmental psycho-social outcomes, such as depth of knowledge, positive attitudes, and behaviour (intention and action) concerning a conservation issue. To illustrate, Study 3 revealed that staff continuity/staff role changes were perceived to have caused some on-site planned elements to be lost. This information could provide some context for the generally low post-visit recall of the program messaging to use bubbles instead of balloons at outdoor events (20%), which emerged from Study 2. In other words, low-post visit message recall might have stemmed from fewer on-site planned elements, which was perceived to have occurred because of staff role changes.

In parallel, the delivery of a program by an organisation with sufficient readiness for, and/or antecedents of, innovation may have greater influence in a visitor experience with well- developed and implemented educational components, and thus could be more likely to influence change. In this thesis, sufficient readiness for, and/or antecedents of, innovation were primarily represented by the use of a theoretical framework and project control groups, and in-part could explain preliminary evidence that WBF is a successful conservation-education program. Building on previous research that advocates for the combination of process and evaluation results to help explain health service intervention efficacy (Oakley, Strange, Bonell, Allen, & Stephenson, 2006), zoos that pay attention to outcome and process evaluation results together may be better equipped to identify why program are (or are not) effective and to determine how programs can be improved.

The third discovery theme points toward a clear scope to improve conservation education evaluation methods and reporting practices to supplement the improved delivery and visitor experience. As demonstrated in this thesis, addressing methodological shortcomings in this research area (identified in the methodological review) by integrating elements of best practice into an outcome evaluation offered an opportunity to more accurately measure program efficacy. A clearer picture of what does (and does not) work would provide relevant staff with the necessary information to inform changes to

educational components, and in turn, improve the visitor experience in terms of inspiring pro-environmental change. Undoubtedly, adopting best-practice research methodology would likely be limited by organisational factors, adding weight to the argument for combining process and outcome evaluation findings, as well as underlining the possible need to explore other solutions (e.g., university-industry partnership) to address this goal.

In future evaluations, attempting to resolve problems or improve program efficacy by considering both outcome evaluation and process evaluation findings, as well as adopting best practice research methodology, will be necessary to truly progress best-practice zoo conservation education, and will ultimately translate into the delivery of programs that can meaningfully contribute to the conservation of biodiversity. This is the foundation of an integrated approach to zoo conservation-education, as outlined in the following section.

6.3.2 An integrated approach to zoo conservation-education evaluation. Collectively, the aforementioned transferrable discoveries offer a conceptual advancement to zoo conservation-education evaluation that would require, as verified in this thesis, a three-pronged integrated approach to conservation-education evaluation that would encompass (1) an outcome focus, (2) a process focus, and (3) attention to the quality of the evaluation research and reporting practices. This proposed approach is displayed in Figure 6.1 and it provides a valuable opportunity to identify connections between the way programs are developed and implemented, and the key outcomes. The traditional outcome-only approach to evaluation that currently dominates this research area indicates that at present, the possible connections between these factors are generally unknown. For example, it may be that when organisational readiness for innovation is not present in development and implementation, long-term knowledge gain or behaviour change cannot be achieved, no matter how good the initiation and design, or the quality of the outcome measures. Likewise, even if the program design, development, and implementation were best practice, an outcome evaluation with weak evaluation methods would undermine detecting the nature and extent of the program's efficacy. By paying attention only to program features (as is common in the outcome-focused evaluation literature), valuable resources may be mis-invested in the program design stage, overlooking the development and implementation stages, and missing the importance of rigour in the evaluation itself. Adopting this new approach would serve as one possible step forwards in understanding the connections between the way programs are developed and implemented, and the way activities that occur during these stages can influence the program's capacity to create widespread change.

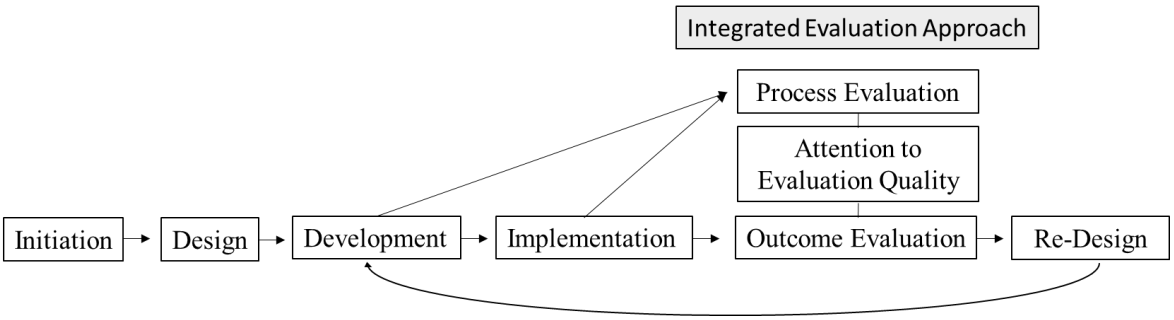


Figure 6.1. An integrated approach for zoo conservation-education evaluation.

6.3.3 Model of diffusion in conservation organisations. An integrated approach to zoo conservation-education evaluation needs a theoretically grounded and context-specific tool to evaluate development and implementation processes. Another key contribution of this research program emerged in Study 3, with the recontextualisation of the model of diffusion in service organisations (Greenhalgh et al., 2004) to produce the *model of diffusion in conservation organisations*. This demonstrated that the model of diffusion in service organisations (Greenhalgh et al., 2004) and more broadly, the DIT (Rogers, 1962, 1998, 2010), are feasible approaches and have utility in a conservation-organisation context. The application of this model offers a new way of understanding the development and implementation processes, particularly that future program implementation evaluations should encompass the examination of organisational processes (e.g., barriers and facilitators to implementation), to learn about the possible underlying factors for program success.

Capturing the nuances that shape conservation-education program implementation will allow zoos to refine their program implementation processes and in turn, maximise the potential capacity of their initiatives to engage the general public in biodiversity-protective behaviours and subsequently, contribute to biodiversity conservation.

6.4 Practical Implications and Recommendations for Future Research and Practice

In this section, the implications for zoo practitioners and researchers arising from integrating the findings across this PhD program of research are drawn together with the contributions listed above and extended with three recommendations for future zoo conservation-education evaluation research and practice.

- **Recommendation 1: Adopt a three-pronged approach to zoo conservation-education evaluation:** Drawing on the findings from Study 3, consideration of the organisational context is critically important to understanding more comprehensively the influential factors that shape the success (or failure) of zoo conservation education. A key recommendation that has emerged from this research program is to

integrate the integrated approach to zoo conservation-education evaluation that is displayed in Figure 6.1. This requires performing an assessment of outcomes *and* an appraisal of the development and implementation processes as part of the program evaluation, as well as giving attention to the quality of the evaluation research itself. An evaluation that uses good-quality evaluation research methods to provide insight about how the development and implementation processes were carried out, and to ascertain the effectiveness of the program in achieving its target outcomes, would support zoos to identify more fully the helpful and unhelpful components with regard to program success. In addition, it would equip practitioners with the knowledge to fine-tune the 'active ingredients' that inform a successful conservation-education program or experience.

- **Recommendation 2: Utilise the model of diffusion in conservation organisations for implementation evaluations:** An integrated approach to the evaluation of zoo conservation education involves an assessment of the implementation process. As demonstrated in Study 3, this could be achieved by applying the model of diffusion in conservation organisations to help organise the factors that might shape relevant tasks that occur at this stage of the program or experience lifecycle. A practical first step would be to use and/or build upon the re-contextualised definitions of each sub-section of the model of diffusion in service organisations as displayed in Table 5.1 (Chapter 5) to design questions and/or interpret data.
- **Recommendation 3: Where possible, integrate robust research methodological and reporting rigour into evaluations of zoo conservation education:** The findings from Study 1 (methods review) showed there is room to improve the quality of research methods and reporting practices of zoo conservation-education evaluation to strengthen their findings. This recommendation is for all academics and practitioners involved in zoo conservation-education evaluation to strengthen the methodological and reporting rigour of evaluations of zoo and aquarium conservation education, wherever possible. It will seldom be possible to address all of the developmental needs in a given project. Nevertheless, conducting an evaluation project that considers the problems identified in this thesis is a necessary step in progressing the quality of research in this field and ultimately, establishing a clearer understanding of the features of conservation education that are required for success. This goal could be achieved by networking with or joining working groups

that promote collaboration between experts, such as the Social Science Working Group within the Society for Conservation Biology. The Social Science Working Group was formed in 2003 and now comprises more than 700 natural scientists, social scientists, and practitioners (see https://conbio.org/groups/working-groups/social-science). The group organises symposia and workshops (including the 2018 Conservation Marketing and Engagement Congress, where the results from this thesis were presented) and facilitates collaboration. Opportunities to connect expertise will be essential for zoos to continue to progress their conservation efforts.

6.5 Limitations, Problems Encountered, and Future Directions

6.5.1 Review methodology. While there are systematic *literature review protocols* for conservation- and environmental-related research (e.g., the Collaboration for Environmental Evidence Syntheses protocol: https://www.environmentalevidence.org), a systematic *methodological appraisal protocol* for zoo conservation-education was unavailable at the time of the Study 1 data extraction. Therefore, the established (and validated) Quality Assessment Tool for Quantitative Studies (National Collaborating Centre for Methods and Tools, 2008), which was originally developed for health science research, was employed in combination with a systematic search strategy. In comparison to zoo conservation-education evaluation, which is an emerging body of work that does not have a longstanding established methodology, research methodology in health science is well established and does not possess, to the same extent, the unique contextual factors that shape research in zoo conservation education. Issues that are different for zoo-based evaluation include collecting data from participants who are volunteering to participate in research during a time of leisure and recreation; the inability to allocate zoo visitors to specific conditions; and the lack of evaluators with specific behavioural research methodology and statistical knowledge.

The results from this methods review do not take these contextual factors into consideration and therefore, they may be a harsh judgement of methodological quality in zoo conservation-education research. Future work could seek to develop a methodological appraisal tool that accounts for these contextual challenges.

6.5.2 Data collection methods. Study 3 (implementation evaluation) data collection methods comprised online surveys and follow-up interviews. The use of online surveys was not a preferred choice because survey data can lack detail and depth on the topic under investigation (Kelley, Clark, Brown, & Sitzia, 2003). However, this situation arose because

of a series of problems that were encountered when recruiting for the initial Study 3 proposal. The initial plan was to conduct telephone and face-to-face interviews with Australian zoo and aquarium practitioners working in conservation education on a national scale, to examine the barriers and facilitators to program implementation. Several attempts were made to recruit potential participants according to this initial study protocol. Australasia's peak zoo and aquarium accreditation body, ZAA, kindly agreed to help with recruitment and disseminated an email to its members over an eight-week period (August–October 2016). Of the four members (individual staff) that responded to these emails, it emerged during initial contact that they were involved in school/curriculum-focused zoo education and not conservation education for the general public (the focus of this PhD research program). Further problems were encountered when an alternative recruitment method, calling conservation organisations directly, was adopted but yielded no eligible participants.

The problems in recruiting were because few organisations listed specific contact information (email, extension number) for the people in the roles of designing and implementing conservation-education programs. Therefore, calls were typically made to a general/reception number and a message was passed on to potentially eligible staff, along with contact information. That meant it was up to potentially eligible staff to initiate contact with the researcher, which was not an effective strategy.

Therefore, a new study protocol was designed, comprising a case-study approach to investigating the challenges and successes that emerged when implementing Zoos Victoria's WBF program. After unsuccessful experiences with an interview-only protocol, a triangulated data collection method (i.e., using online surveys plus follow-up interviews) was selected to gather data. It was anticipated that this triangulated approach would guarantee that enough data would be gathered to be able to draw meaningful conclusions, while maintaining the potential to obtain rich data as well.

Undoubtedly, if it had been feasible, an interview-only study would have provided opportunities to examine complex themes more comprehensively (e.g., choosing calls to action in which the benefits outweighed the potential risks). It would have fleshed out the interpretation of events from different staff/role perspectives (Sofaer, 1999) and ultimately, presented a more detailed analysis of the challenges and successes in implementing the WBF program.

Future research seeking to investigate the challenges and successes in implementing zoo conservation education at a national scale, with an interview-only protocol, might be more successful if led by a well-known or well-connected zoo or aquarium practitioner.

6.5.3 Outcome evaluation follow-up retention. In Study 2, visitors were tracked over six months to assess the post-visit effects of the WBF program. Despite efforts to follow up on non-respondents by disseminating a reminder email once a week for up to three weeks (or until the participant had completed the survey), there was a low post-visit response rate (11% across T3–T4) and this impedes the reliability of the post-visit results.

Low uptake is not uncommon in zoo research, with follow-up response rates previously ranging from 16 to 24% (e.g., Adelman et al., 2000; Dierking et al., 2004; MacDonald, 2015). Providing participants with advance notification of the upcoming survey is linked to greater survey completion rates (Edwards et al., 2016). Therefore, future research could build on the methodology adopted in this study by sending advance notification in addition to reminder emails when seeking to collect follow-up responses.

6.6 Concluding Remarks

Zoo conservation-education evaluation research is growing rapidly but at present, there are several problems with the research methods and the reporting of results, as well as barriers to best-practice evaluation, which need to be overcome if zoos are to reach their full potential as catalysts for biodiversity conservation. To achieve this goal will require the application of sound behavioural research methodology within an integration program delivery and evaluation approach that assesses program development, implementation, and outcomes together.

Drawing together the outcomes from this program of research, this thesis offers a new, integrated approach to zoo conservation-education evaluation. Best-practice zoo conservation-education evaluation requires a conceptual paradigm shift. This can be achieved by adopting an evaluation focus that encompasses the examination of the processes to implementation, as well as an evaluation of the program outcomes on the intended audience, while adopting best-practice behavioural research methods and reporting practices. A necessary next step is to move beyond the outcome-only approach that currently dominates the field and adopt rigorous evaluation methods. This new path will provide opportunities to acquire a more comprehensive understanding of the complexities of changing human environmental behaviour, to understand better the ‘active’ mechanisms of a

zoo program or experience, and to more efficiently allocate resources to educational approaches. Only when best program practice is actualised will zoos be able to advance their contributions to biodiversity conservation goals further.

In the future, a key challenge for zoo conservation-education evaluation will be to encourage and foster the integration of disciplines and to generate a standard for evaluation. Standardisation offers a mechanism for stimulating debate about what is considered 'good' evaluation, facilitating comparison and providing a language for communication between different stakeholders (Hannes, Heyvaert, Slegers, Vandenbrande, & Van Nuland, 2015). Currently, there are calls for the integration of the social sciences into conservation (Fox & Caldwell, 2006; Sievanen, Campbell, & Leslie, 2012) and an opinion that social science theories and principles are generally underutilised in conservation education (Sievanen et al., 2012). This thesis serves as an important step towards this conservation–social science 'merger', which is recognised as being fundamental to fostering global biodiversity conservation (Bennett et al., 2017; Bennett et al., 2017; Mascia et al., 2003; Moon et al., 2019; Teel et al., 2018).

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Appendices

Appendix A: Published Version of Study 1 (Chapter 3)

Conservation Biology

Review

Research methods and reporting practices in zoo and aquarium conservation-education evaluation

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Abstract: *Zoos and aquariums are increasingly incorporating conservation education into their mission statements and visitor experiences to address global biodiversity loss. To advance knowledge and practice in the field, research is being conducted to evaluate the effect of zoo conservation-education experiences on visitor psychosocial outcomes (e.g., knowledge, attitude, emotions, motivations, behavior). Following recent discussions among scholars and practitioners concerning logistical and methodological challenges that likely undermine the conclusions of such research, we identified and reviewed the methods and reporting practices in peer-reviewed articles published in English from May 1998 to June 2016 that focused on adult visitor samples (47 articles, 48 studies). We examined elements of internal, external, construct, and statistical conclusion validity. Methodological quality of quantitative methods and reporting practices was determined using the Effective Public Health Practice Project Quality Assessment Tool. Each study was coded as either strong (no weak ratings), moderate (1 weak rating), or weak (≥2 weak ratings). The quantitative methods of 83.3% of studies were weak. The remaining 16.7% had methods of moderate quality. Using an existing checklist, we also assessed the quality and rigor of qualitative methods and reporting practices and found that some aspects of these methods were reported more comprehensively than others. For example, 69.6% of articles discussed methods for identifying key themes from the data, whereas only 34.8% reported how data verification was performed. We suggest increased application of intensive longitudinal methods (e.g., daily diary) to strengthen self-reported data, experimental and repeated-measures designs, and mixed-methods approaches. Our findings and recommendations could strengthen and guide the research and evaluation agenda for the field and ultimately enhance the contribution zoos make to global biodiversity conservation.*

Keywords: Aichi biodiversity, biodiversity conservation, conservation psychology, environmental education, methodological review targets

Métodos de Investigación y Prácticas de Reporte en la Evaluación de la Educación para la Conservación en Acuarios y Zoológicos

Resumen: *Los acuarios y los zoológicos cada vez incorporan más la educación para la conservación dentro de su misión y experiencias para el visitante con el objetivo de tratar el tema de la pérdida de la biodiversidad. Para avanzar el conocimiento y la práctica en el campo se realizan investigaciones para evaluar el efecto de las experiencias de conservación – educación en los zoológicos sobre los resultados psicosociales de los visitantes (p. ej.: conocimiento, actitud, emociones, motivación, comportamiento). Después de las discusiones recientes entre académicos y practicantes con respecto a los retos logísticos y metodológicos que probablemente socavan las conclusiones de dichas investigaciones nos dedicamos a identificar y revisar los métodos y prácticas de reporte en artículos con revisión por pares publicados en inglés entre mayo de 1998 y junio de 2016, y enfocados en muestras de visitantes adultos (47 artículos, 48 estudios). Examinamos los elementos internos,*

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externos, de construcción y estructurales de la validez de las conclusiones en los artículos. Se determinó la calidad metodológica de los métodos cuantitativos y la práctica de reportes usando la Herramienta de Evaluación de Calidad de Proyectos de Práctica de la Salud Pública. Cada estudio estuvo codificado como fuerte (sin clasificaciones débiles), moderado (una clasificación débil) o débil (dos o más clasificaciones débiles). Los métodos cuantitativos del 83.3% de los estudios fueron débiles. El 16.7% restante tuvo métodos de calidad moderada. También evaluamos la calidad y el rigor de los métodos cualitativos con una lista de cotejo existente y hallamos que algunos aspectos de estos métodos estuvieron reportados de manera más comprensiva que otros. Por ejemplo, el 69.6% de los artículos discutió métodos para identificar temas clave a partir de los datos, mientras que sólo el 34.8% reportó cómo se realizó la verificación de los datos. Sugerimos un aumento en la aplicación de métodos longitudinales intensivos (p. ej.: agenda diaria) para fortalecer los datos auto-reportados; diseño de medidas experimentales y repetidas; y estrategias con métodos mixtos. Nuestros hallazgos y recomendaciones pueden fortalecer y guiar la agenda de evaluación e investigación para el campo, y por último realizar la aportación que los zoológicos realizan para la conservación mundial de la biodiversidad.

Palabras clave: conservación de la biodiversidad, educación ambiental, objetivos de biodiversidad de Aichi, psicología de la conservación, revisión metodológica

摘要: *目前, 越来越多动物园和水族馆将保护教育纳入它们的使命和游客体验活动中, 以应对全球生物多样性的丧失。为提高这一领域的知识和实践水平, 研究评估了动物园的保护教育对游客产生的社会心理学影响(如知识、态度、情感、动机和行为)。延续近期学者和保护实践者对可能削弱这类研究结论的运算学、方法学挑战的讨论, 我们选定了 1998 年 5 月至 2016 年 6 月发表的针对成年游客样本的同行评议英文文章共 47 篇 (48 个研究), 并对其所采用的研究方法及报告规范进行了综述。我们检验了内部、外部、构造和统计结论可靠性的要素。利用 "有效公共卫生实践项目质量评估工具", 我们评估了定量的方法和报告的方法学水平, 并将研究分为较高 (没有低等级评分)、中等 (一个低等级评分) 或较低 (两个以上低等级评分) 水平。83.3% 的研究的定量方法被评为较低水平, 其余 16.7% 为中等水平。利用已有的检查表, 我们还评估了定性方法和报告的水平和严谨性, 发现这些方法对某些方面的报道比其它方面更详尽。例如, 有 69.6% 的文章讨论了从数据中识别关键主题的方法, 而只有 34.8% 的文章描述了如何进行数据审核。因此, 我们建议: 更多地应用密集的纵向方法 (如每天的日记) 来加强自我报告数据的收集; 注意实验和重复测量的设计; 采用多方法混合的方式。我们的发现和建议可以指导和强化该领域的研究和评估方法, 最终加大动物园对全球生物多样性保护的贡献。* **【翻译: 胡怡思; 审校: 魏辅文】**

关键词: 保护心理学, 环境教育, 方法学综述, 生物多样性保护, 爱知生物多样性目标

Introduction

Rates of global biodiversity loss continue to accelerate (Urban 2015). With their diverse and plentiful visitorship, there is increasing recognition of the potential role of zoos and aquariums (hereafter "zoos") in the conservation of global biodiversity (Funk et al. 2017). Such conservation goals may be achieved by educating the community about conservation issues and promoting sustainable behaviors (e.g., Gusset & Dick 2010) and by contributing to conservation objectives outlined in global strategic plans (Moss et al. 2015). For example, the Aichi Target 1 of Strategic Goal A in the Convention on Biological Diversity states that "by 2020, at the latest, people are aware of the values of biodiversity and the steps they can take to conserve and use it sustainably" (Convention on Biological Diversity [CBD] 2010).

Against the backdrop of increasing biodiversity loss, over time the goal of zoos has changed markedly. Places where entertainment and specimen collections were the focus now prioritize education and conservation, as highlighted in zoo mission statements (Patrick et al. 2007) and by zoo-accreditation bodies (Moss & Esson 2013). Zoo education has evolved too, such that methods for delivering information and the nature of messaging have shifted over time. Earlier methods for delivering content typically encompassed static signage, but today methods often include interactive digital displays and animal-keeper presentations. Similarly, although earlier messaging often focused on basic animal facts (e.g., species name, habitat, social grouping), zoos now incorporate information about conservation threats and what people can do to help conserve species.

Zoo conservation education can be viewed as a type of environmental education—a process defined as one that provides the opportunity to learn about environmental issues and encourages participation in proenvironmental action (U.S. Environmental Protection Agency 2017). In the context of this review, zoo conservation education differs from other forms of zoo-based education, which are limited to interesting facts about species, in that it focuses on enhancing visitors' abilities to act on behalf of a species. In recent years, messaging has been developed using frameworks such as the connect-understand-act (CUA) principle (Zoos Victoria 2010), which draws on educational and behavioral theories, including the theory

of planned behavior (TPB) (Ajzen 1991), and community-based social marketing (Mckenzie-Mohr 2000). Based on these approaches, conservation messaging is typically delivered in the form of a campaign that asks visitors to engage in a specific, predetermined behavior linked to a conservation issue. For example, Don't Palm Us Off (https://www.zoo.org.au/get-involved/act-for-wildlife/dont-palm-us-off?gclid=EAIaIQobChMIt7yv9duJ3AIVmlRwCh0TOQnYEAAYASAAEgI5fvD_BwE) invited visitors to reconsider purchasing products that contain unsustainably sourced palm oil. To measure and enhance the capacity of these programs to influence behavioral intentions or behavior change among zoo visitors (and associated psychosocial outcomes, including knowledge, attitudes, motivations, emotions), it is critically important to evaluate their conservation effect.

The field of inquiry focused on the design and evaluation of zoo educational experiences is still in its infancy. Program outcome evaluations can determine whether and to what extent an initiative is achieving desired outcomes (i.e., in the context of zoos, increasing awareness about a conservation issue and inspiring behavioral intentions and behavioral change). Collecting information about the impact of particular educational components (e.g., keeper presentation, signage) can help pinpoint efforts that aid or hinder desired program outcomes (e.g., Patton 1987). Increasing recognition among zoo professionals that program evaluations can help align educational and organizational goals and inform future practice (Heimlich 2010) has led to efforts to assess the effects of zoo experiences on relevant conservation outcomes. An effective evaluation is tailored to the specific program and builds on existing evaluation knowledge and resources. It is inclusive, such that it involves multiple viewpoints (e.g., from multiple staff), honest, replicable, and applies methods that are as rigorous as circumstances allow (My Environmental Education Evaluation Resource Assistant [MEERA] 2017).

Of existing zoo conservation-education program evaluations, outcomes typically focus on the immediate or short-term effects of zoo experiences on knowledge, attitudes, and behavioral intentions (Khalil & Ardoin 2011). From the handful of studies on lasting impacts, it is unclear whether or when zoo education experiences contribute to sustained behavior change. For example, commitment to conservation returned to baseline 6 to 8 weeks postvisit (e.g., Adelman et al. 2000), whereas others report successful postvisit behavioral uptake (MacDonald 2015). Theoretical and conceptual frameworks, such as the TPB (Ajzen 1991) and those of conservation psychology (Saunders 2003), widely recognize that knowledge, attitudes, and behavioral intentions affect (or have the potential to affect) behavior. For example, cognitive (i.e., procedural and declarative forms of knowledge), affective (e.g., attitudes) factors, and social norms directly or indirectly influence behavioral intentions, which is a precursor to behavioral action. Although such research provides an important foundation for exploring the conservation impacts of zoo experiences, notwithstanding the unique logistical and practical challenges of zoo field work, there remains a great need for zoos to conduct or commission evaluations of their programs; for zoos to disseminate the findings of such evaluations to enhance collective wisdom; and for the quality of such evaluative processes to be strengthened.

To enhance zoo conservation-education approaches, it is important to understand the strength of research that evaluates their efficacy. Such an understanding cannot be gained without first forming a nuanced picture of the methods and reporting practices that comprise research on this topic. A range of logistical and methodological challenges likely undermines research outcomes. For example, effect sizes for conservation learning are likely minimal due to the limited time visitors focus their attention on conservation messages (Ballantyne et al. 2007). Measuring behavioral intentions on site is problematic because intentions can be short-lived (Dierking et al. 2004). Overreliance on self-reported data (Jensen 2014) and the use of retrospective items to collect information on previsit attitudes and behaviors (Wyles et al. 2013) has been discussed further as undermining the accuracy of evaluation data. Together, these limitations impede understanding of which educational strategies are most effective and hinder zoos' abilities to contribute to biodiversity conservation.

Evaluating zoo conservation activities is an important and emerging body of work that, given its complex real-world setting, has multiple unique challenges. Because this research area continues to expand, it is timely to review progress to date and to offer guidance for future evaluations. Thus, we reviewed published empirical studies investigating the effectiveness of zoo conservation education and identified the range and magnitude of methodological and reporting limitations. Specifically, we considered changes that can be made to strengthen the methods and reporting practices of research exploring evaluation of zoo conservation education. We sought to quantify study reliability and validity and report limitations of zoo conservation-education research.

Methods

Search Strategy

In June 2016 with the help of an academic librarian, we searched the ProQuest, PsycINFO, Scopus, and Web of Science databases for terms associated with 3 key concepts—zoo or aquarium visitors, conservation, and psychosocial outcomes—and for 3 corresponding groups of search terms with relevant proximity operators: "visitor*" and "zoo*" or "aquarium*"; "threaten*" or

Table 1. Examples of inclusion and exclusion eligibility criteria for articles in a review of zoo conservation education evaluation methods and reporting practices.

Inclusion criterion	*Exclusion criterion*	*Example excluded articles*
Full-text, English-language empirical, published in peer-reviewed academic journal May 1998–June 2016	conference proceedings, book chapters, grey literature (theses, dissertations, internal or commissioned reports, brief reports, research notes)	Falk et al. 2007; Balmford et al. 2007
Measured at least 1 conservation-focused psychosocial outcome	measured psychosocial outcomes not directly focused on conservation (e.g., knowledge about animal biology, facts about animal characteristics, focus not specified)	Anderson et al. 2003; Spotte & Clark 2004
General zoo visitor samples	samples not representative of general-admission zoo visitor population (e.g., children)	Randler et al. 2007; Jensen 2014
Measured typical zoo experience available to the general visitor (e.g., show, exhibit)	measured experiences available for additional fees (e.g., behind-the-scenes tours, safari park tours)	Kruse & Card 2004; Hacker & Miller 2016

"endanger*" or "conservation"; "animal*" or "wildlife" or "species" or "biodiversity," respectively.

Full-text (i.e., entire journal article available), English-language, empirical studies published in peer-reviewed journals (representing generally higher-quality evaluations) from May 1998 to June 2016 were included. At least 1 conservation-related psychosocial outcome (e.g., conservation-related knowledge, conservation-focused attitudes, conservation-related behaviors or behavioral intentions) within a population of general, adult zoo visitors on a general-admission visit had to have been assessed (Table 1). An outcome was classified as conservation related if it was likely to directly enhance a visitor's ability to act on behalf of a species (e.g., conservation-related knowledge might include knowledge about a species conservation status or the effects humans have on species' habitats). Affective measures were categorized as conservation focused (not conservation related) in recognition that affective measures may directly or indirectly influence visitor ability to act on behalf of a species. An example of an outcome we classified as not directly related to conservation is visitor learning about animal biology. We selected 1998 as the cut-off year because Broad and Weiler (1998) were among the earliest researchers to directly evaluate the conservation-education outcomes of a zoo exhibit and because their article was published at the time conservation psychology was emerging in the early 2000s (Saunders 2003).

There was a range of exclusion criteria (Table 1). Given the ethical complexity of captive wildlife-tourism experiences (i.e., wildlife conservation and public education vs. animal welfare and public entertainment trade-offs), if articles included different types of wildlife tourism experiences in captive and noncaptive settings (e.g., Moscardo 2007; Ballantyne et al. 2011*a*; Ballantyne et al. 2011*b*), we extracted data representing the conservation effects at the captive site or sites only. Because we were interested in quantifying the conservation effect of general-admission visits—the most frequent type of zoo visit with the largest reach to inspire conservation action—studies with exclusive sample demographics (e.g., children only) or those that evaluated experiences available for additional fees (e.g., behind-the-scenes tours) were not included.

The study-selection process (Fig. 1) began with citations being downloaded to EndNote. Titles and abstracts were screened in duplicate (by S.M. and J.R.) for eligibility. Full texts of remaining articles were examined as were reference lists of included studies (Fig. 1).

Analyses

Data extraction and coding were completed by S.M. and J.R. For each article in the final sample, data were extracted in duplicate under blinded conditions by both coders and included study characteristics and problems with the study's construct, external, internal, and statistical-conclusion validity. The coders also rated overall methodological quality for each study, again under blinded conditions. The features of studies included in the analysis were guided by the variables coded in 2 previous methodological reviews (Casper et al. 2007; Neall & Tuckey 2014). The coders independently coded their responses to all article features (see Results for inter-rater agreement).

Construct validity refers to the extent to which a test measures what it was intended to measure (Cronbach & Meehl 1955). Variables related to construct validity were data-collection methods and measurement instruments (e.g., questionnaire, interview, observation, multimedia), which were exhaustively coded. Internal validity is the extent to which causal inferences can be concluded from the data (Cozby 2007), in our case, whether changes observed in visitors resulted from the experience itself or

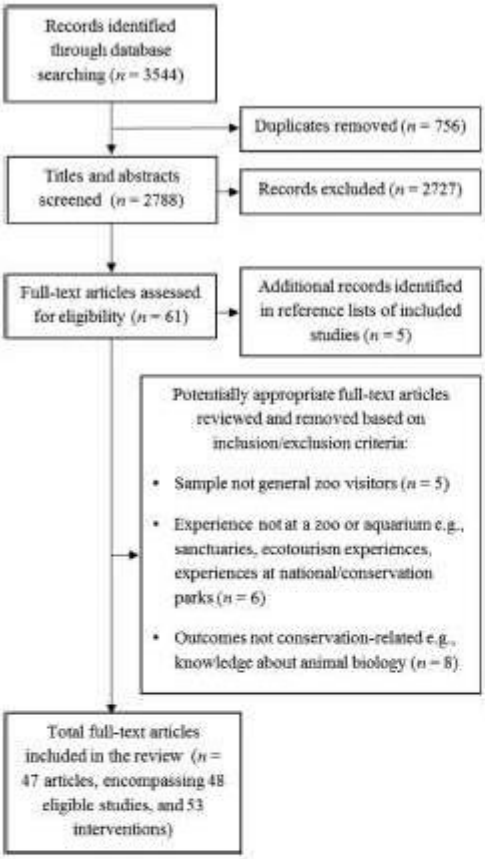


Figure 1. Flow diagram detailing the article-selection process for an examination of zoo conservation-education evaluation research.

other factors. Elements of internal validity included time horizon (exclusively coded, number of times specified) and level of control (exclusively coded as randomized controlled trial, controlled comparison, cohort analytic, interrupted time series, cohort, one group cross-sectional survey). External validity describes the extent to which findings apply to other populations and settings (Cozby 2007), in our case, whether another zoo is likely to produce similar results. Variables related to external validity were setting (exclusively coded as zoo-only, aquarium-only, or multiple sites or not specified); sample country of origin (exhaustively coded); and response rate (coded as reported or not reported). Statistical conclusion validity defines the level of accuracy with which conclusions about the relationship between 2 variables can be inferred (Cook & Campbell 1979). Indicators of statistical conclusion validity we coded for were data-analysis techniques (exhaustively coded); reporting of effect sizes (coded as reported or not reported); data triangulation (coded as reported or not reported); and testing of measures (coded as reported or not reported).

Quality of Qualitative Methods

There is growing recognition that mixed-methods designs are better able to answer research questions than monomethod designs (Johnson & Onwuegbuzie 2004). Qualitative methods allow researchers to examine issues in greater depth, which can reveal complexities about problems that may be missed in quantitative analyses. However, data quality is largely influenced by the skills of the researcher, and analysis can be time consuming, such that rigor in qualitative research is often more difficult to maintain and assess (Anderson 2010). For our exploration of qualitative methods, we adopted relevant items from an existing set of criteria used to provide guidance for authors and reviewers to prepare and review qualitative research papers (Anderson 2010). For each study, we determined whether qualitative methods were explicitly stated; methods for recording data were described (e.g., audio or visual recording, written); procedures for transcribing data were described (where applicable, e.g., interviews); examples of methods were included (e.g., interview guides); methods for analyzing data were described (e.g., thematic analysis, content analysis); methods for verifying data were described (e.g., inter-rater reliability); and qualitative data were examined through quantitative analysis (i.e., frequency of responses used in statistical models as opposed to exploring depth or nature of detail in response).

Quality of Quantitative Methods

We used the Effective Public Health Practice Project Quality Assessment Tool (EPHPPQAT) (NCCMT 2008) to rate overall methodological quality of quantitative items. Based on the evaluation of 6 aspects of design and methodology, each study was coded as either strong (no weak ratings), moderate (1 weak rating), or weak (≥2 weak ratings). The coding guide for this resource is available from http://www.ephpp.ca/PDF/Quality%20Assessment%20Tool_2010_2.pdf (accessed June 2016). Each quality-scoring component and paired coding description (as per the *Tool* dictionary), with application examples, is in Supporting Information. In the absence of a tool that specifically evaluates the study methods of conservation-education interventions, we selected EPHPPQAT. This tool underwent validity appraisal (yielding accepted standards for content validity, construct validity, and inter-rater reliability) (Thomas et al. 2004) and testing processes that involved

experts appraising study quality (NCCMT 2008). The tool has been applied in the fields of psychology and environmental behavior change (e.g., Fraser & Lock 2011; Randal et al. 2015). It examines selection bias (sample representativeness of the target population, response rate); study design (type of design, use and method of randomization); confounders (identification and control of potential differences between groups prior to the intervention); blinding (assessor awareness of participant intervention status, participant awareness of the research question); data-collection methods (validity and reliability of data collection tools); and withdrawals and dropouts (reporting of withdrawals and dropouts in terms of numbers or reasons, percentage of participants completing the study).

Results

Forty-seven journal articles (Supporting Information) measuring the conservation effect of zoos were reviewed. They encompassed 48 studies and 53 interventions. Studies were published in journals across several disciplines, including tourism and visitor studies (e.g., *Journal of Sustainable Tourism* [$n = 3$], *Tourism Management* [$n = 2$], *Tourism Review International* [$n = 1$], *Visitor Studies* [$n = 5$]), museum studies (e.g., *Curator: The Museum Journal* [$n = 6$]), education (e.g., *Science Education* [$n = 1$], *Environmental Education Research* [$n = 3$]), and conservation (e.g., *Biodiversity Conservation* [$n = 1$], *Conservation Biology* [$n = 1$]). Almost one-quarter (20.8%, $n = 10$) of the studies were published in *Zoo Biology*. There was high inter-rater point-by-point agreement (range 88.9–100%) across all study features coded. For methodological-quality scoring (with EPHPPQAT), coding was initially completed independently and resulted in a mean inter-rater reliability score of 0.62. All discrepancies were discussed until 100% agreement was reached, which we used as the final coding in our analyses.

Study Characteristics

The most frequently evaluated intervention or experience was an entire site or overall visit (24.5%, $n = 13$), followed by a presentation or keeper talk (17.0%, $n = 9$). Seven studies (13.2%) did not specify or describe the type of intervention material that was being evaluated (Table 2). Five of the 9 studies (55.6%) that evaluated a presentation or keeper talk further reported that the experience was standardized (e.g., used scripts). Conservation-related behavioral outcomes were assessed by just under half of the eligible studies (47.9%, $n = 23$), whereas conservation-related cognitive measures and conservation-focused affective measures were assessed by 79.2% ($n = 38$) and 72.9% ($n = 35$) of articles, respectively (see Supporting Information).

Table 2. Frequency and type of zoo conservation-education intervention evaluated in a review of zoo conservation-education evaluation methods and reporting practices.

Intervention type	*Frequency (%)**
Overall visit (specified)	13 (24.5)
Intervention type not specified	2 (3.8)
Specific exhibit or section of the site (interpretative material type not specified)	7 (13.2)
Specific exhibit or section of site (interpretative material type specified),	
signage (including banners, graphics, maps, posters, petition cards)	8 (15.1)
presentation or keeper talk	9 (17.0)
multimedia (e.g., video presentation or kiosk, touch tables or touch screens)	6 (11.3)
bus tour	1 (1.9)
animal interaction	1 (1.9)
biological facts cart (e.g., cart with items made from elephant)	1 (1.9)
exhibit aesthetics (e.g., naturalistic or unnaturalistic, immersive)	2 (3.8)
Seafood Watch program pocket guide	1 (1.9)
Walkway or path area	1 (1.9)
Use of docents to disseminate conservation messages	1 (1.9)

**Type of interventions was exhaustively coded such that frequency represents the proportion of interventions ($n = 53$) that used each type of approach.*

Table 3. Frequency of data-collection methods used in reviewed zoo conservation-education studies.

Method	*Frequency (%)**
Survey or questionnaire (including personal meaning mapping)	37 (77.1)
Interview	14 (29.2)
Observation (e.g., recorded typology of verbal responses)	7 (14.6)
Multimedia (e.g., playing a game)	1 (2.1)

**Data-collection methods were exhaustively coded such that frequency represents the proportion of studies ($n = 48$) that reported each method.*

Methodological Validity

Just over three-quarters (77.1%, $n = 37$) of the included studies used surveys or questionnaires to collect data; 29.2% ($n = 14$) collected data with interviews (Table 3). In most studies data were collected at only 1 point in time (54.2%, $n = 26$) (e.g., when a visitor exited the zoo). The most commonly used levels of control were single-group cross-sectional surveys (39.6%, $n = 19$) (e.g., surveying one group of visitors at the end of their visit)

Table 4. Frequency of research design characteristics present in reviewed zoo conservation-education evaluation studies.

Characteristic	*Frequency (%)*[a]
Time horizon	
1 time	26 (54.2)
2 times	13 (27.1)
3 times	8 (16.7)
4 times	1 (2.1)
Level of control	
randomized control trial (≥2 conditions, 1 time, random allocation)	1 (2.1)
controlled comparison (≥2 conditions, 1 time, nonrandom allocation)	18 (37.5)
cohort analytic (2 conditions, 2 times, same sample)	2 (4.2)
interrupted time series (≥1 condition, ≥2 times, different samples)	2 (4.2)
cohort (1 condition, 2 times)	6 (12.5)
1 group cross-sectional survey (1 condition, 1 time)	19 (39.6)

[a] *Research design characteristics were exhaustively coded such that frequency represents the proportion of studies (n = 48) that reported each method.*

Table 5. Frequency of data-analysis techniques used in reviewed studies of zoo conservation-education evaluation research.

Technique[a]	*Frequency (%)*[b]
Simple inferential statistics	
correlations	5 (10.4)
chi square (or equivalent e.g., Fisher's exact test)	21 (43.8)
t tests (or equivalent, e.g., Mann–Whitney *U*)	18 (37.5)
One DV with single relation	
ordinary least squares regression	1 (2.1)
general linear model	1 (2.1)
multiple linear regression	5 (10.4)
logistic regression	4 (8.3)
discriminant regression or discriminant function analysis	2 (4.2)
ANOVA or ANCOVA (including linear mixed models)	24 (50.0)
Multiple DVs with a single relation	
MANOVA	2 (4.2)
Multiple relations with both IVs and DVs	
structural equation modeling	3 (6.3)
Structure of data	
confirmatory factor analysis	2 (4.2)
exploratory factor analysis	1 (2.1)
cluster analyses	1 (2.1)
principal component analysis	1 (2.1)
Qualitative analyses (i.e., thematic analysis, content analysis)	23 (47.9)

[a] *Abbreviations: DV, dependent variable; IV, independent variable; ANOVA, analysis of variance; ANCOVA, analysis of covariance; MANOVA, multivariate analysis of variance.*
[b] *Some studies reported multiple analysis techniques such that frequency represents the proportion of studies that reported each analysis type (n = 48).*

and controlled comparisons (37.5%, $n = 18$) (e.g., outcomes for exhibit visitors compared with show visitors, where visitors were not randomly assigned to conditions) (Table 4).

The majority of the 48 studies were from zoo-only settings (62.5%, $n = 30$); aquarium-only settings accounted for 16.7% ($n = 8$) of the sample. Seven (14.6%) studies contained samples from a zoo and an aquarium, and 6.3% ($n = 3$) did not specify the setting. Most samples originated from countries with a majority English-speaking population (i.e., Australia, Canada, New Zealand, North America, United Kingdom) (Supporting Information). Twenty-seven (56.3%) studies reported participant response rates.

Simple inferential statistics (e.g., correlation, chi square, *t* test) were reported by most studies (91.7%, $n = 44$). Analysis of variance (ANOVA) and analysis of covariance (ANCOVA) models were the most commonly used techniques to examine 1 dependent variable with a single relation (50.0%, $n = 24$). Few studies used techniques to examine multiple dependent variables with a single relation (e.g., multivariate analysis of variance [MANOVA]; 4.2% $n = 2$) or multiple relations with both independent and dependent variables (e.g., structural equation modeling, 6.3%, $n = 3$). The structure of the data (i.e., relationships among subsets of the data) was investigated in 5 studies, and 17 studies included a quantitative technique to explore data (Table 5). Less than half (43.8%, $n = 21$) of the studies reported effect sizes. Ten (20.8%) reported that measures were tested prior to data collection. Twelve (25.0%) studies validated data by utilizing 2 or more sources (e.g., surveys and in-depth interviews).

Quality of Qualitative and Quantitative Methods

There were 23 studies that included qualitative data. All of them explicitly described the methods used, and over half (60.9%; $n = 14$) reported the method of recording data (e.g., audio or video recording, written). Where transcription was applicable (e.g., audio recording or interviews), 3 of the 14 eligible articles (21.4%) detailed the transcription procedure. Eight studies (34.8%) reported how data verification was performed, and 16 (69.6%) discussed methods for identifying or extrapolating themes and concepts from the data. Fifteen studies (65.2%) treated qualitative data with a quantitative analysis (i.e., frequency of responses was used to interpret data or was used in statistical models, as opposed to exploring depth or nature of detail in response).

We awarded 8 (16.7%) studies a moderate methodological quality (i.e., scored 1 weak rating across all criteria) and the remaining 40 (83.3%) a weak methodological quality (i.e., scored ≥2weak ratings). Based on

Table 6. Methodological quality component subscores and overall global score for reviewed zoo conservation-education evaluation studies.

Methodological quality component	Selection bias frequency (%)	Study design frequency (%)	Confounders[a] frequency (%)	Blinding frequency (%)	Data collection methods frequency (%)	Withdrawals and drop outs[b] frequency (%)	Overall Global Score frequency (%)
Weak	20 (41.7)	21 (43.8)	20 (41.7)	43 (89.6)	21 (43.8)	11 (22.9)	40 (83.3)
Moderate	17 (35.4)	14 (29.2)	—	5 (10.4)	12 (25.0)	3 (6.3)	8 (16.7)
Strong	11 (22.9)	13 (27.1)	12 (25.0)	—	15 (31.3)	2 (4.2)	0 (0)

[a]*As per the EPHPP guidelines, we coded 16 (33.3%) studies as "can't tell" because we were unable to ascertain whether confounder variables were controlled for in the study design or in the analyses.*
[b]*As per the EPHPP guidelines, we coded 32 (66.7%) studies as "not applicable" because the study was a 1-time interview or survey or there were no follow-up data reported.*

our scoring, no studies were awarded an overall strong methodological quality (i.e., no weak ratings across all criteria). The individual methodological design features we rated as most rigorous included selection bias (28 studies, 58.3%, rated as moderate or strong) and study design and data collection methods (27 studies, 56.3%, rated as moderate or strong for both these features). We typically rated confounders, blinding, and withdrawal and dropouts as weak (Table 6).

Discussion

Study Characteristics

The most common type of intervention evaluated was an entire site or overall visit (24.5%). This approach presents a major challenge to determining the effect of such experiences because little information is gleaned about the specific influential aspects of the visit. By more frequently isolating variables of interest (i.e., specific interpretative medium, such as a presentation), the effect of an intervention—and in particular the active ingredients of the intervention—can be more accurately understood. Despite changes in visitor behavioral intention and action being a key motivation for many interventions, less than one-half the studies (47.9%) included a conservation-related behavioral outcome measure. Assessing visitor engagement in conservation behaviors following an experience could increase accuracy of quantification of the lasting effect of zoos on public conservation behavior. Around one-half of keeper talks (just under one-fifth of all interventions) were standardized (i.e., used scripts). Evaluating a nonstandardized intervention makes it difficult to pinpoint components of the intervention that contributed to outcomes of interest. Ensuring that elements of a program are delivered consistently with the aid of materials (e.g., scripts) and staff training or briefing (about program messaging and key touch points) where feasible, could help overcome this challenge.

Below we summarize key methodological concerns, highlight some particularly exemplary work that addresses existing barriers, and provide recommendations for future research in Table 7.

Construct Validity

Consistent with earlier statements about overreliance of self-reporting measures in zoo research (e.g., Jensen 2014), we identified that the conservation effect of zoos is most frequently assessed with surveys or questionnaires (77.1%) or interviews (29.2%). Such methods have limitations, including social desirability bias (respondent tendency to provide answers deemed more desirable by others) and consistency motif (respondent attempt to remain consistent in thoughts and feelings [Grimm 2010]). Although overreliance of self-reporting measures is likely in response to the unique barriers of objectively measuring visitor outcomes, future research could be strengthened by supplementing self-reported data with intensive longitudinal methods (collection methods that require participants to provide systematic self-reporting at random occasions, such as a diary) to facilitate more in-depth analysis of psychological processes (Fraley & Hudson 2014). We recommend that future researchers use validated measurement tools where possible and that the reliability of measurement tools be more frequently examined (e.g., item analysis) and reliability estimates be reported.

External Validity

Studies more often comprised zoo-only samples (62.5%) as opposed to aquarium-only samples (16.7%); some studies included both sample types (14.6%). Although zoos and aquariums are commonly considered one entity, demographic differences between zoo and aquarium visitors are evident (e.g., aquariums may attract more tourists and first-time visitors than zoos; aquarium visitors may be more likely to display motivations toward learning than zoo visitors [Mann et al. 2014]). Differences in

Table 7. Summary of methodological or reporting barriers to zoo conservation-education evaluations and recommendations for future practice.

Barrier	*Validity threat*	*Recommendation*	*Exemplary work that overcomes barrier*
Overreliance on self-report measures	construct	apply intensive longitudinal measures (e.g., daily diary)	not applicable[a]
No examination of metric reliability	construct	examine and report reliability estimates of measures	Clayton et al. (2014); Moss et al. (2015)
Overuse of zoo-only samples	external	incorporate aquarium-only and mixed (i.e., aquarium and zoo) samples	Skibins & Powell (2013); Skibins, Powell, & Hallo (2013)
Overuse of Western country of origin samples	external	incorporate samples from non-Western populations	Moss et al. 2015
Lack of reporting response rate	external	report response rates	Smith and Broad (2008); Clayton et al. 2011
Overuse of controlled comparisons	internal	use randomized controlled trials, time-series designs, or cohort analytic designs	Lindemann-Matthies & Kamer (2006)
Underuse of complex data-analysis techniques	statistical conclusion	apply statistical analyses that allow researchers to explore complex models of causal effects	Skibins and Powell (2013); Skibins et al. (2013)
Underuse of qualitative measures	statistical conclusion	incorporate qualitative measures	Pearson et al. 2014
Analysis of overall visit or entire site	statistical conclusion	measure intervention or interpretative medium of interest (e.g., a presentation) in isolation	Perdue et al. 2012
Lack of standardized interventions	statistical conclusion	employ scripts for presentations	Perdue et al. (2012); Mann-Lang et al. (2016)
Lack of reporting effect size estimates	statistical conclusion	calculate and report effect-size estimates	Wagner et al. (2009); Clayton et al. (2014)
Reliance on one source of data	statistical conclusion	use multiple data collection methods	Briseño-Garzón et al. (2007); Falk et al. (2008)
Lack of piloting measures	statistical conclusion	pilot measures	Lindemann-Matthies and Kamer (2005); Lukas & Ross (2005)

[a] *See Bolger et al. (2003) for an overview of diary methods.*

learning motivations are of particular importance when considering the perceived role of learning and discovery elements of a wildlife tourism experience (captive and noncaptive) among visitors because they are considered integral to their enjoyment of and engagement with the experience (Packer & Ballantyne 2004). Developing a more comprehensive understanding of the similarities and differences between typical zoo and aquarium audiences could shape the type of initiatives delivered across sites (in terms of content and delivery method).

Although it is likely that the exclusion criterion of non-English publications contributed to the limited studies with a non-Western country of origin, our results suggest that peer-reviewed research exploring the conservation effect of zoos is concentrated in Western countries. Given the widespread nature of biodiversity loss and range of cultural factors that underpin environmental attitudes and behaviors (e.g., beliefs [Schultz & Zelezny 1999]), understanding how these factors influence the conservation effect of zoo education programs among non-Western samples is important and warrants further research. A final issue concerning external validity is the portion of studies (43.8%) that failed to report a response rate. Response rates are critical when evaluating the value of research findings because higher response rates increase confidence that the sample is representative of the broader population (e.g., Rogelberg & Stanton 2007). Further, reporting response rates can help identify potential sources of bias (i.e., research with a large nonresponse rate may potentially represent only those more motivated to reply or those with a more extreme perspective). As such, it is critically important that future research report this information so as to indicate the extent to which results are generalizable to the broader zoo-visiting population.

Internal Validity

In the sample of studies we reviewed, there was only one randomized controlled trial. This result likely reflects the inherent challenges in conducting randomized controlled trials at a zoo (e.g., high cost, difficulty in allocating paying visitors to a condition). This is problematic given the effect of visitor sociodemographic variables (e.g., age, gender, pet ownership, vegetarian status, prior visit [Driscoll 1992; Signal & Taylor 2007; Ross & Gillespie 2009]) on their preexisting knowledge, attitudes, and interaction with the interpretive elements. Where feasible, adopting random allocation of visitors or participants to conditions will allow zoos to more accurately assess the level of impact particular intervention elements have on changes in visitor conservation-related psychosocial outcomes and to refine future conservation education initiatives based on this knowledge. One solution to facilitate random allocation might be to invite visitors upon zoo entry to be allocated randomly to a particular experience or condition in return for a small incentive (e.g., discount voucher for zoo shop or café purchases).

In cases wherein randomized controlled trials are impractical, cohort analytic designs, controlled comparisons, and time-series designs can serve as appropriate alternatives (in conjunction with analyses to explore differences in participant demographic) to facilitate scholarly knowledge about the effects of community interventions (Biglan et al. 2000). The most frequent research design type (37.5% of studies) we found was the comparison of 2 visitor groups who experienced different educational content (e.g., an exhibit experience compared with an animal presentation experience) at 1 point in time (coded: controlled comparison). Including time-series designs more frequently offers additional contributions to the field, given that 54.2% of studies we examined had only 1 data-collection time point. For instance, time series designs could offer much needed insights regarding the extent to which zoo conservation-education strategies translate into behavior change and for how long or to what extent such behavioral change persists. Consistent with Khalil and Ardoin (2011), who have expressed concern about the lack of research investigating longer-term effects of zoos, we conclude that the direction of research in this field should focus on evaluating the sustained effects of zoo conservation-education interventions.

Statistical Conclusion Validity

Zoo conservation-education evaluation is an emerging field of enquiry in which there are few commonly agreed on or clearly defined measures. Thus, it is unsurprising that we identified, as a key problem with statistical-conclusion validity, a lack of studies that adopted data-analysis techniques with multiple relations or that examined the structure of data. These techniques (e.g., path analysis or structural-equation modeling) offer researchers the opportunity to explore complex models of causal effects (e.g., Hair et al. 2011; Kline 2011) and could be applied more frequently in future zoo conservation-education evaluation research. This is particularly relevant given previous work emphasizing concerns that zoos are focusing on the immediate effects of their experiences on knowledge, attitude, and behavioral outcomes instead of exploring how these components interact with each other over time (e.g., Khalil & Ardoin 2011).

In light of our finding that qualitative measures were utilized in only 50.0% of studies, future zoo research could also benefit from more frequently including measures of this type. Qualitative measures may unveil topical areas not initially considered and inform understanding of why (or why not) people engage in particular conservation behaviors. For example, including qualitative behavior measures in postexperience visitor surveys in time-series designs may yield explanations for why zoo visitors do or do not maintain the uptake of a behavior.

Effect-size estimates are important for empirical research because they indicate the practical significance of a result. In comparison with statistical significance (where statistical probabilities are used to reject or accept a null hypothesis), practical significance helps quantify how important or large study results are, regardless of sample size (e.g., Hojat & Xu 2004). This is particularly relevant to applied research, which focuses on the practical application of science to real-world problems (e.g., biodiversity conservation). Yet only 43.8% of the studies in our review reported effect sizes. Increasing the frequency of reporting the magnitude of differences will advance zoo conservation-education experiences because they can be used to calculate sample size for future or follow-up analyses or to make comparisons between effects across studies (Lakens 2013).

We also considered data triangulation and testing of measures. Only 25.0% of the studies validated data by utilizing 2 or more sources. Designing and conducting mixed-methods research in zoos can yield broader insight about the conservation effect of an intervention. How zoos triangulate research will largely depend on research aims, but combining different techniques (e.g., focus groups vs individual interviews) and techniques that suit a research setting (e.g., diaries vs. e-workshops for remote or indirect projects) are examples of how zoos could cross-verify research outcomes. There were a limited number (20.8%) of studies that reported testing measures prior to data collection. Pilot studies allow for pretesting of research instruments and can highlight problems with procedures and thereby facilitate a more robust study design (e.g., van Teijlingen & Hundley 2002).

Quality of Qualitative Methods

Generally, methods for recording data and methods for extrapolating data were appropriately reported. However, a minority of studies reported data-verification methods. Because qualitative research is highly influenced by experiences of each individual researcher, informing readers about how data were identified and validated will strengthen the reproducibility and stability of the data (Anderson 2010). There was also a tendency within some studies to treat qualitative data with quantitative methods. This is problematic because such methods can contribute to a loss of the richness of the data. Although choosing which analytic approach to apply largely depends on the research question, analyzing text without coding or counting allows a more raw interpretation of the data (Bernard 1996). For example, when considering knowledge, a qualitative approach could more accurately identify patterns or sequences in narrative accounts that explain why (or why not) conservation messaging translated into action, as well as more precisely discover visitor knowledge gaps concerning a conservation issue. Such information would be useful when developing messaging strategies for future campaigns (e.g., use of postvisit action resources such as take-home information sheets) (Ballantyne & Packer 2011).

Quality of Quantitative Methods

Overall, the studies included in this review were generally of weak methodological quality as determined by the EPHPPQAT (83.3%). The categories of section bias, study design, data collection method, and withdrawal and drop out held more robust methodological integrity. For example, individuals selected to participate in the studies had a moderate likelihood of being representative of the target population, and there was a moderate use of stronger study designs across samples. Based on our results we recommend future research control for demographic differences between groups, blind study participants to the research question (along with increased reporting of this information), and use more reliable and valid measurement instruments (together with reporting reliability and validity information).

Strengths and Limitations

To our knowledge, we are the first to review the methodological and reporting practices in evaluations of zoo conservation education. A key strength of our review was the rigorous systematic search protocol developed with input from researchers and an academic librarian to maximize the potential to capture all relevant literature. In addition, data collection, extraction, and quality rating were undertaken in duplicate by 2 independent researchers under blinded conditions. Nonetheless, there are limitations to our review. Although we endeavored to capture all relevant literature by using a systematic search strategy, eligible articles may have been missed. When rating methodological quality, poor or unclear reporting means that for many studies instances of blinding were recorded as unclear, which automatically eliminated the article from potentially receiving a strong global score. Further, when considering publication bias, it is possible that outcomes from our sample of peer-reviewed articles underrepresented the degree to which methodological limitations truly undermine the conclusions of research in this area. Over two-thirds of the literature we found had a Western country of origin, indicating a strong possibility of bias by cultural influences. We selected peer-reviewed journal articles because they represent research of relatively high quality. Examining grey literature may offer additional insight about the extent of methodological challenges. Finally, our assessment of qualitative measures was preliminary. Future reviews could exclusively and more extensively focus upon investigating the methodological quality of qualitative methods.

Our review offers a summary of the key methodological and reporting barriers facing zoo conservation-education evaluation research published before June 2016 and outlines recommendations to strengthen future research outcomes. Research in this growing area of enquiry can move forward by adopting multiple data-collection and analysis techniques and relying less on zoo-only and Western-only samples. More often measuring standardized educational experiences in isolation and addressing gaps in reporting of validity and reliability problems (e.g., testing measures, response rates, effect sizes) will further guide the progression of scholarly knowledge in this field. Research published since this review provide exemplars in overcoming some of the aforementioned challenges, including the use of mixed methods (i.e., questionnaires and interviews with qualitative and quantitative measures [e.g., Bueddefeld & Van Winkle 2017]), non-Western populations (Mann et al. 2018), and control and treatment groups (Chalmin-Pui & Perkins 2017). If zoos are to fulfill the conservation and education outcomes increasingly featured within their mission statements, it is imperative that they design and implement conservation education programs and that these programs be evaluated rigorously and the results disseminated widely.

Representative bodies (e.g., Zoo and Aquarium Association, World Association of Zoos and Aquariums) are well positioned to play a key role by uniting to develop a research and evaluation agenda for the field; providing training and support for zoo staff to more accurately evaluate conservation education programs; publishing zoo-specific guidelines for conducting evaluations to facilitate improvements in evaluation quality; establishing a research and evaluation repository and dissemination system for the global zoo community; and facilitating collaborations between industry and academia to bridge

knowledge gaps concerning rigorous scientific research methods. Through these processes, the potential for zoos to contribute to global conservation objectives, such as the Aichi biodiversity targets, can be realized.

Supporting Information

A list of articles included in this review (Appendix S1), a table of quality-scoring components and paired coding description (as per the *Tool* dictionary), with application examples (Appendix S2), a table of example conservation-related behavioral outcomes, conservation-related cognitive measures, and conservation-focused affective measures that we assessed (Appendix S3), and a table of the studies' sample origins by country (Appendix S4) are available online. The authors are solely responsible for the content and functionality of these materials. Queries (other than absence of the material) should be directed to the corresponding author.

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Appendix B: Author Contributions to Study 1 (Chapter 3)

Mellish, S., Ryan, J. C., Pearson, E. L., & Tuckey, M. R. (2019). Research methods and reporting practices in zoo and aquarium conservation-education evaluation. *Conservation Biology*, *33*(1), 40–52. doi:10.1111/cobi.13177

Sarah Mellish conducted the data search and data analysis, and wrote the majority of the content for this paper with feedback from Associate Professor Michelle Tuckey, Dr Elissa Pearson, and Dr Jillian Ryan. Associate Professor Michelle Tuckey worked closely with Sarah to determine the key outcome variables of interest. Dr Jillian Ryan worked closely with Sarah on data screening and data analysis, and reviewed and edited the content during the drafting stages.



Sarah Mellish



Dr Jillian C. Ryan



Dr Elissa L. Pearson



Associate Professor Michelle R. Tuckey

Appendix C: Effective Public Health Practice Project Quality Assessment Tool Quality-scoring and Paired-coding Description with Application Examples (Study 1, Chapter 3)

Quality-scoring component	Application examples
Selection Bias	
(Q1) Are the individuals selected to participate in the study likely to be representative of the target population?	Are individuals general public zoo visitors?
Q2) What percentage of selected individuals agreed to participate?	What percentage of zoo visitors agreed to participate (e.g., participation/response rate)?
Study Design	
(Q1) Indicate the study design (randomised controlled trial, controlled comparison, cohort analytic, case-control, cohort, interrupted time series, other specify).	Randomised Controlled Trial: An experimental design where investigators randomly allocate eligible zoo visitors to an intervention or control group. Controlled Comparison: A study design with two conditions (post only), without random allocation between conditions; e.g.,, when comparing an exhibit+show visitor group with an exhibit-only visitor group. (Note: This category was revised from the Tool's original "controlled clinical trial" category to more appropriately reflect the characteristics of studies in the zoo literature. Specifically, the health classification approach specifies that the allocation method for controlled clinical trials should be determined in advance by the researchers, which is not a feature of evaluations within the review sample). Cohort Analytic: A study design with two conditions (pre and post), without random allocation. E.g., two zoo visitor groups are surveyed before and after two different experiences (e.g., pre and post comparisons with an exhibit+show group v. an exhibit-only group). Cohort: The same zoo visitor group is pretested, given an intervention (i.e., educational content/campaign), and tested immediately after the intervention. The intervention group, by mean of the pretest, act as their own control group. E.g. surveying visitors before and after a show experience. Interrupted time series: A study with multiple observations over time. For example surveying zoo visitors across multiple visits.

(Q2) Was the study described as randomised?	Scored yes if the authors used words such as random allocation, randomly assigned, and random assignment. Scored no if no mention of randomisation is mad
If yes, was the method of randomisation described?	Scored yes if the authors described any method used to generate a random allocation sequence; scored no, if the authors did not describe the allocation method or described methods of allocation such as alternation, dates of birth, or day of the week.
If yes, was the method appropriate?	Scored yes if the randomisation sequence allowe each zoo visitor to have the same chance of receiving each intervention (i.e., educational content/campaign), and the investigators could nc predict which intervention was next. Scored no if the randomisation sequence was open to the individuals responsible for recruiting and allocating participant, or providing the intervention, since those individuals could influence the allocation process, knowingly or unknowingly.
Confounders	
(Q1) Were there important differences between groups prior to the intervention? (If yes, indicate the percentage of relevant confounders tha were controlled, either in the design e.g stratification, matching, or in the analysis.)	A confounder is a variable that is associated with the intervention or exposure and causally related to the outcome of interest. Even in a robust study design, groups may not be balanced with respect to important variables prior to the intervention. The authors should indicate whether confounders were controlled in the design (by stratification or matching) or in the analysis. If the allocation to intervention and control groups is randomised, th authors must report that the zoo visitor groups were balanced at baseline with respect to confounders (in either the text or a table).
Blinding	
(Q1) Was (were) the outcome assessor(s) aware of the intervention o exposure status of participants?	Experimenters should be described as blinded to which zoo visitors were in the control and intervention groups. The purpose of blinding the outcome assessors is to protect against detection bias.
(Q2) Were the study participants aware of the research question?	Zoo visitors should not be aware of (i.e., should b blinded to) the research question. The purpose of blinding the zoo visitors is to protect against reporting bias.
Data Collection Methods	

(Q1) Were data collection tools shown to be valid?	If ‘face’ validity or ‘content’ validity has been demonstrated, this was deemed acceptable.
(Q2) Were data collection tools shown to be reliable?	Reliability and validity can be reported in the study or in a separate study. E.g., some standard assessment tools have known reliability and validity.
Withdrawal and Dropouts	
(Q1) Were withdrawals and dropouts reported in terms of numbers and/or reasons per group?	Score yes if the authors describe both the number and reasons for withdrawals and dropouts. Score no if either the numbers or reasons for withdrawals and dropouts are not reported.
(Q2) Indicate the percentage of participants completing the study. (If the percentage differs by groups, recor the lowest).	The percentage of zoo visitors completing the study refers to the % of visitors remaining in the study at the final data collection period in all groups (i.e., control and intervention groups).

Appendix D: Frequency of Outcome Measures, With Example Outcome Variable Labels (Study 1, Chapter 3)

Outcome measures	Examples	Frequency (%)
Conservation-related knowledge outcome	Conceptual understanding of conservation; deepening and expanding of personal knowledge an understanding of environmental sustainability issues learning about environmentally friendly practices an facts about endangerment of species.	38 (79.2)
Conservation-focused affective outcome	Interest and concern in conservation (e.g., concern for the survival of the polar bear); opinion about wildlife conservation; conservation mindedness; environmental identity; conservation caring; visitor motivation to become involved in conservation; connectedness to nature; feelings about individual's role in marine conservation.	35 (72.9)
Conservation-related behavioural outcome	Behavioural actions that may help to conserve or protect a species (e.g., signing a petition, talking about a conservation issue, donating/making a charitable contribution; keeping cats inside at night) behavioural intentions (e.g., willingness to perform an act such as signing a pledge and intentions to avoid products containing unsustainably sourced palm oil); information seeking (i.e., visitors observe to determine the degree to which they actively sougl information encompassing conservation messages through sign reading or asking questions).	23 (47.9)

Appendix E: Published Version of Study 2 (Chapter 4)



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Sarah Mellish, Elissa L. Pearson, Emily M. McLeod, Michelle R. Tuckey & Jillian C. Ryan

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What goes up must come down: an evaluation of a zoo conservation-education program for balloon litter on visitor understanding, attitudes, and behaviour

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ABSTRACT

Balloons used outdoors can fly away, posing ingestion and entanglement hazards to wildlife. "When Balloons Fly" (WBF) conservation-education program seeks to educate zoo visitors about these threats and encourage the use of wildlife-friendly bubbles at outdoor events. We examined the effect of WBF on visitor knowledge, attitudes, and behaviours (intentions and actions) over 6 months ($N = 624$). We compared outcomes among visitors who viewed a presentation and exhibit, to viewing the exhibit-only, and investigated the priming influence of completing a survey before entering the exhibit (pre-survey). Visitors had greater depth of understanding about the impact of balloons immediately following the visit, but post-visit message recall was low. General Linear Models revealed that over 6 months WBF significantly ($p < .05$) influenced positive attitudes concerning balloon use, increased likelihood to use bubbles, and reduced likelihood to use balloons. Completion of a pre-survey significantly influenced positive attitudes and reduced likelihood to use balloons. WBF is promoting conservation behaviour, with two-thirds of the follow-up sample reporting that behaviours they changed while hosting or attending an outdoor event since their visit were influenced by the zoo experience. Future work can investigate materials that might mimic a priming effect (e.g., worksheets).

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Global biodiversity is declining (Butchart et al., 2010), with experts estimating losses 100–1,000 times higher than what could be considered a natural extinction rate (Barnosky et al., 2011; Pimm et al., 2014). As one of the fastest-growing global economic sectors and contributor to 10% of the world's gross domestic product (World Travel and Tourism Council, 2018), it is critical for the travel and tourism industry to establish a leading involvement in worldwide biodiversity

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conservation (United Nations World Tourism Organization, 2017). Conservation education represents an important avenue for the tourism industry to make meaningful contributions to sustainable development, for example, to address Sustainable Development Goal 15 of the 2030 Sustainable Development Agenda: "*protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss*" (United Nations General Assembly, 2015). This article presents an evaluation of one such conservation-education initiative.

Nature-based tourism and wildlife tourism

Nature-based and wildlife tourism (viewing or interacting with nature and wildlife) are powerful tourism industry sub-sectors that can drive environmental stewardship (Higginbottom & Tribe, 2004). There is mounting evidence that such experiences can meaningfully influence people's affective reactions toward nature and wildlife, including increased empathy, sense of connectedness, and concern/care (Curtin, 2009; Curtin & Kragh, 2014; Luebke, 2018; Young, Khalil, & Wharton, 2018). Indeed, care is labelled a "fundamental starting point" for protecting the natural environment (Clayton & Myers, 2015, p. 7). Well-run modern zoos, that is, those "*conscious of the welfare of the animals in [their] care, dedicated to the conservation of animals in the wild, and committed to developing good citizens through education and empowerment of [their] visitors*" (Gray, 2017, p. 10), hereafter "zoos," have a unique capacity to inspire care, as they offer close encounters with animals, thus creating opportunities for people to connect with nature and non-human species and inspire conservation behaviour (Clayton, Fraser, & Burgess, 2011; Clayton, Fraser, & Saunders, 2009).

Although it is difficult to generalise the conservation involvement of tourism operators as diverse as zoos, conservation-education is becoming a prominent goal among zoo mission statements (Patrick, Matthews, Ayers, & Tunnicliffe, 2007). The structure of conservation-education programs or experiences vary, but typically they focus on a specific environmental issue, and promote a specific pro-environmental behaviour through multiple interpretive mediums, such as static signage displays, videos, and keeper/animal presentations. Examples include Zoos Victoria's "*Don't Palm Us Off*" which addresses the impact of unsustainable production of palm oil on orangutan habitat (see: https://www.zoo.org.au/get-involved/act-for-wildlife/dont-palm-us-off) and the Monterey Bay Aquarium Seafood Watch® program that seeks to support visitors to choose sustainably sourced seafood (see: http://www.montereybayaquarium.org/conservation-and-science/our-programs/seafood-watch). To develop a comprehensive understanding of the conservation impact of such programs, and to refine zoo-based conservation-education strategies moving forward, program outcome evaluations are necessary. Unfortunately, such evaluations are infrequently published in peer-reviewed journals, and of published work, outcomes are inconsistent, which could be attributed to the developmental needs present in evaluation methodology and reporting practices of related research (Mellish, Ryan, Pearson, & Tuckey, 2019).

Evaluation of conservation-education in zoos

Empirical outcome evaluations of zoo conservation-education programs can serve as important tools for understanding their effectiveness in creating change, and for tailoring the content of future initiatives (Shadish, Cook, & Leviton, 1991). Indeed, there is a growing research area that seeks to assess whether such programs are achieving their desired conservation goals (see review: Thomas, Teel, Bruyere, & Laurence, 2018). A large portion of this research applies theoretical frameworks of behaviour to quantify conservation impact, including the Theory of Planned Behaviour ([TPB]; Ajzen, 1991). TPB suggests that intention to perform behaviours is a key precursor to behavioural action, and that perceived behavioural control, attitudes toward the target

behaviour, subjective norms, and past behaviour, together, may predict intentions. Perhaps due in part to this TPB influence, there appears to be an overreliance on exploring self-report behavioural *intentions* within zoo-based conservation-education studies (Khalil & Ardoin, 2011; Mellish et al., 2019). Less so does literature investigate indicators of the effect of zoo conservation-education on visitor behaviour – in particular, self-reported or observed post-visit conservation behaviour (defined as actions relating to environmental sustainability; Ballantyne & Packer, 2005; Smith, Broad, & Weiler, 2008).

Within the published literature that has assessed self-reported uptake of conservation action, findings vary, which makes it difficult to draw reliable conclusions. For example, 6 months following a bird presentation, 23 out of 30 visitors who intended to increase their commitment to complete a prompted action did so, however, a large portion of these visitors further reported that influences other than the presentation shaped their commitment (e.g., media messaging, greater provision of recycling bins; Smith et al., 2008). In other studies, short-term changes in visitors' ($N = 100$) level of intended conservation action did not persist 2–3 months following a "Conservation Station" zoo experience (Dierking et al., 2004), and responses concerning uptake of conservation-related lifestyle changes 6–8 weeks following an aquarium visit most often included themes about increased respect for land and animals ($n = 37$) and being more informed/aware of an issue ($n = 26$), but did not detail specific daily behaviours (Adelman, Falk, & James, 2000). In contrast, follow-up interviews 6 weeks after viewing a presentation with messaging to keep cats inside at night indicated that 70% of visitors who pledged to perform the action had self-reported implementing the behaviour (MacDonald, 2015). Further, Mann, Ballantyne, and Packer (2018) reported that 49% of respondents gave an example of a conservation action (saved energy, eco-friendly purchasing) that they had performed that was attributed to uShaka Sea World's "Penguin Promises" program after 1-year post-visit.

There are likely several reasons for variations in the pattern of results across zoo-based conservation-education evaluation studies. Results may be attributed to the design and implementation of the program. Programs often contain different types of interpretive materials in different combinations and intensity, presenting challenges to identifying exactly what works and how. Another factor is the variety of target behaviours, which differ according to how demanding or effortful they are. The perceived difficulty of the targeted behaviour can influence uptake; simple behaviours requiring little effort (e.g., recycling) are more likely to be performed than complex behaviours that require more time or effort (e.g., volunteering; Smith, Curtis, & Van Dijk, 2010). Another example can be taken from Smith et al. (2008) who reported that participants who expressed the intent to remove road kill upon exiting the zoo but have since had the opportunity to do so and did not, explaining that this was because they felt too squeamish.

Other determining factors concern evaluation methodology and the inherent practical challenges that accompany zoo evaluation work. A review of zoo evaluation methods indicated that the most frequent intervention assessed within this body of work is an entire site or overall visit (Mellish et al., 2019). Assessing overall visit as opposed to isolated assessments of a specific interpretation element or an exhibit experience makes it difficult to determine what aspect of the experience may have contributed to study findings. Moreover, when often each program or experience is related to a specific conservation issue with a particular aim, there are typically tailored outcomes (e.g., to promote a shift in attitudes concerning a certain environmental issue), which often require the development of new measures to accurately assess program success (e.g., a custom-designed attitude scale for the specific environmental issue). Another inherent challenge is the difficulty in directly capturing post-visit conservation behaviours; subsequently, related research often draws upon indirect proxy measures including self-reported behaviour change, which, while largely unavoidable, can compromise methodological validity (i.e., social desirability bias; Arnold & Feldman, 1981).

A final consideration is the limited application of repeated measures designs (Mellish et al., 2019). There are multiple practical challenges here, including limited funding for more

comprehensive long-term evaluations within non-for-profit organisations, and the logistical burdens associated with surveying zoo visitors, that is, zoo visitors often participate in research voluntarily, and during recreational time, which poses challenges when recruiting for multiple survey completions across time points. Moreover, when seeking to establish a baseline measure against which the post-experience data can be compared, it is unknown to what extent completing the survey before being exposed to the exhibit or experience (hereafter refer to as the "pre-survey") might prime visits to engage or interact with the conservation-education material (e.g., signage, presentation). Priming theory asserts that exposure to a stimulus can unintentionally function as a filter or interpretive frame and influence how a person responds to subsequent stimuli (Bargh & Chartrand, 2000); as such, it is possible that a pre-survey could influence how visitors interpret and/or respond to intervention components.

Together, the inherent difficulties of comparing effects across interventions, the paucity of research evaluating post-visit conservation influences, and the presence of field-specific methodological gaps and practical challenges, signpost a critical need for more evaluations pertaining to the conservation impact of zoo experiences after visitors leave the zoo grounds. To address these gaps and to help move forward scientific understanding in the field, we evaluated the conservation effect of Zoos Victoria's "When Balloons Fly" (WBF) program. Guided by the TPB framework, we examined the impact on visitor understanding, attitudes, and behaviour (behavioural intentions and post-visit conservation behaviour) concerning balloon litter and the use of balloons outdoors, over a 6-month period. This study was guided by the following research questions:

1. How and to what extent does WBF influence visitor psychosocial outcomes over 6 months?
2. How and to what extent does the completion of a pre-survey impact visitor psychosocial outcomes immediately and 6 months posit-visit?

Connect-understand-act and when balloons fly

Balloons and their attachments pose "*considerable entanglement risk*" to marine wildlife (Wilcox, Mallos, Leonard, Rodriguez, & Hardesty, 2016, p. 111). Perhaps attributed to the visual similarity to typical prey items (e.g., jellyfish), balloon litter is commonly ingested too, with potential to block sections of the gastro-intestinal tract, affecting the victim's ability to breathe and threatening death by starvation (Acampora, Schuyler, Townsend, & Hardesty, 2014). Indeed, balloon litter and their attachments are one of the most common identifiable items found in the stomachs of flesh-footed shearwater chicks (*Puffinus carneipes*), a species whose population decline has been associated with high levels of plastic ingestion (Lavers, Bond, & Hutton, 2014). In response to these hazards, in February 2017, The Zoological Parks and Gardens Board (Zoos Victoria) launched their WBF conservation-education program which sought to (a) reduce the use of balloons outdoors and (b) promote the use of wildlife-friendly bubbles (hereafter "bubbles") as alternatives to balloons outdoors (McLeod, Sanders, & Wilson, 2018).

Zoos Victoria is the governing body of three zoos in the Australian state of Victoria: Healesville Sanctuary, Werribee Open Range Zoo, and Melbourne Zoo. Zoos Victoria utilise their Connect-Understand-Act (C-U-A) behaviour-change model to guide the development of programs (Zoos Victoria, 2010). Drawing upon Community-Based Social Marketing (CBSM; McKenzie-Mohr, 2000), theory of planned behaviour (Ajzen, 1991), and best-practice storytelling and engagement techniques to step visitors through a program "story," C-U-A highlights three key steps to promoting behaviour change within the zoo context: (1) *Connect* visitors and the broader public with species through emotionally engaging experiences; (2) facilitate *Understanding* of conservation issues through innovative and educational displays; and (3) encourage people to *Act* through education about specific, well-known behaviours, thus reducing threats to species and habitats (Lowry & Grey, 2009).

CBSM highlights the importance of choosing behaviours that have the largest "weight" in terms of impact, probably, and penetration among the target audience (McKenzie-Mohr, 2000). As such, Zoos Victoria conducted belief elicitation interviews (e.g., Johnson & Weller, 2002) with zoo visitors to inform the proposed program messaging. This analysis revealed that the most commonly identified benefits of the proposed behaviours was the avoidance of unnecessary plastic waste, benefits to the environment, and bubbles are a fun and interactive activity for children. The most commonly identified barriers to the behaviours were the perception that bubbles don't last as long as balloons, that they can be messier to use and require cleaning up, and that they are less impressive for party decorations; however, 30% of respondents reported that there was nothing to dislike about committing to wildlife-friendly bubbles over balloons (Zoos Victoria, unpublished data). Based on these results, the program messaging to use wildlife-friendly bubbles instead of balloons at outdoor events was developed to engage with children to highlight the fun and value of using bubbles outdoors (where the created mess would not matter) while also educating visitors about the impact balloons and their attachments have on our wildlife and the environment. Information about Zoos Victoria's approach to developing conservation-education programs and experiences can be found in Zoos Victoria Conservation Science Plan (see: https://www.zoo.org.au/sites/default/files/conservation-science-plan-zoos-victoria.pdf).

Melbourne Zoo is well-positioned to deliver a conservation-education program about marine debris (i.e., balloon litter) given its dedicated "Wild Sea" precinct, which describes an area of the zoo with multiple exhibits that showcase some of Victoria's iconic marine wildlife, including: Australian fur seals (*Arctocephalus pusillus doriferus*); Little penguins (*Eudyptula minor*); Australian pelicans (*Pelecanus conspicillatus*); Port Jackson sharks (*Heterodontus portusjacksoni*); and Fiddler rays (*Trygonorrhina*). At the time of data collection, there were multiple interpretive mediums installed in the Wild Sea precinct including static signage displays with information about balloon litter hazards (Figure 1), and a short (approximately 4 minutes) animation projected on a 20-m indoor screen, depicting the journey of a balloon that floated away from an outdoor party, entered the ocean, and entangled marine wildlife (Figure 2; a video of the projection can be viewed at: https://www.youtube.com/watch?v=9i41eW5TzxY).



Figure 1. A static signage display at the penguin tide pool located in Wild Sea that reads: "*Penguins can't fly but balloons can! When released outside, balloons can float on air currents and travel hundreds of kilometers. What goes up must come down and unfortunately for wildlife, balloons come down in all the wrong places. When balloons fly, seabirds die, but you can change that!*" Melbourne Zoo, Australia.



Figure 2. The 4-minute animation projected on a 20-m screen depicting the journey of a balloon that floated away from an outdoor event and entered the marine environment. Melbourne Zoo, Australia.

The program also included a 15-minute zookeeper-led presentation at the seal enclosure. The presentation told the story of a seal that encountered a balloon floating in the ocean. To begin, the keeper guided the seal to demonstrate typical behaviours performed in the wild including aquaplaning and diving. In this time and unknown to the audience, a balloon-like prop was thrown into the water by the keeper. The keeper then "spotted" the balloon, and instructed the seal to retrieve it from the water. The seal presented the balloon to the keeper who held it up for audience viewing. The keeper identified the object as a balloon and explained to the audience the entanglement and ingestion threats that balloons pose to marine wildlife. The seal was then guided to place the balloon in a bin. To conclude, the keeper suggested bubbles as an alternative to balloons at outdoor events. To end, the seal leaped back into the water (with visitors invited to simultaneously shout "*bubbles not balloons*"). Consistent with research indicating sensory impressions can enhance the impact of an experience, and subsequently the uptake of environmental behaviours (Ballantyne, Packer, & Sutherland, 2011), a bubble machine was turned on as visitors exited the presentation arena. As the presentation area filled with bubbles, visitors were encouraged to make a pledge to use bubbles at their next outdoor event upon exiting Wild Sea, either by signing a pledge book (Figure 3) or by writing their name on a magnetised bubble and placing it on a pledge board (Figure 4). Asking visitors to make a public and durable commitment to use bubbles instead of balloons outdoors may increase the likelihood of post-visit behaviour change (McKenzie-Mohr, 2000).

Methods

This research was approved by the University of South Australia Human Research Ethics Committee (Application ID: 0000036359) and was conducted in compliance with the Zoos Victoria Code of Conduct for Scientific Research Practice.

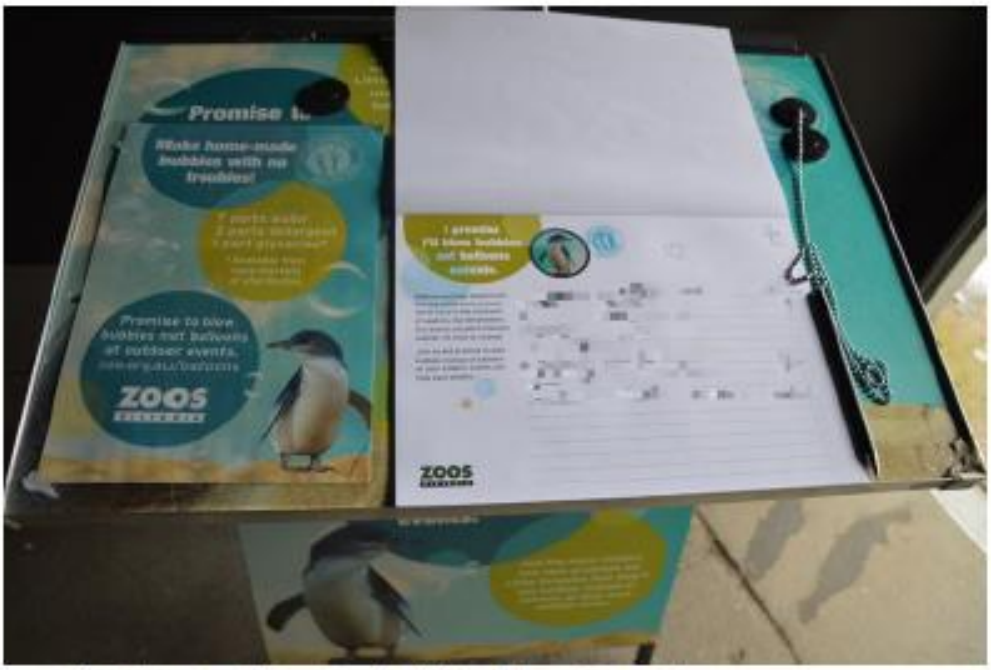


Figure 3. When Balloons Fly pledge book located in Wild Sea, Melbourne Zoo, Australia.



Figure 4. Bubble pledge board for visitors to place magnetised bubbles. At the time of this research, whiteboard markers were provided for visitors to write their name on the bubbles, which were wiped clear each day for reuse. Melbourne Zoo, Australia.

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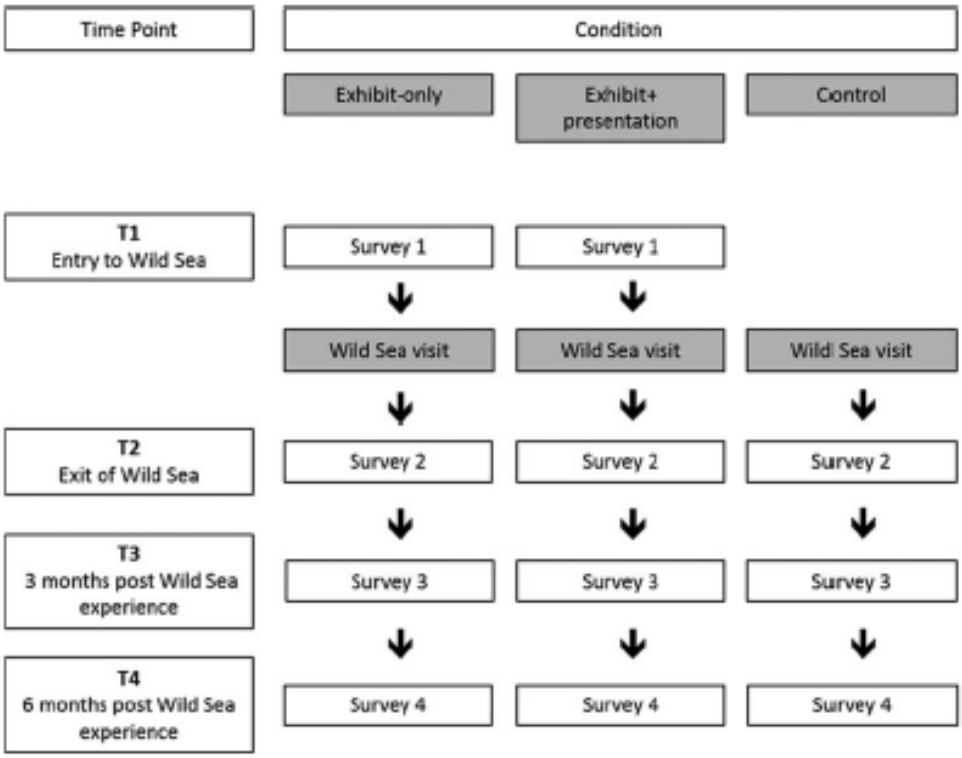


Figure 5. Study design with time points and visitor group conditions.

Study design

The Wild Sea precinct is structured such that the presentation area is located in the centre of the exhibit; visitors cannot reach the presentation area without first walking through a portion of the exhibit (thus viewing a portion of related program material). Given this layout, exhibit-only and exhibit + presentation experiences (and not a third presentation-only experience) were the two possible experiences available for visitors. Accordingly, comparisons were made between two groups: (1) exhibit-only (visitors who walked through Wild Sea, *did not* view the seal presentation, and completed a pre-survey); and (2) exhibit + presentation (visitors who walked through Wild Sea, *did* view the seal presentation, and completed a pre-survey). To account for how the completion of a pre-survey may influence visitor interaction/engagement with the exhibit, and thus influence visitor outcomes, we also collected data from an exhibit post-only group (visitors who walked through Wild Sea, *did not* view the seal presentation, and *did not* complete a pre-survey; hereafter referred to as "control"). Visitors could be surveyed before entering Wild Sea (T1), immediately exiting Wild Sea (T2), 3 months post-visit (T3), and 6 months post-visit (T4); Figure 5 depicts the study design.

Procedure

Potential participants were approached on a "next-to-pass" basis, wherein on completion of approaching a visitor for recruitment, the next person to pass the survey point was approached to participate. Visitors were eligible if aged 18 years and over, and were proficient in English. Participants in the exhibit-only and exhibit + presentation groups were given a paper survey

pack as they entered Wild Sea, which included a take-home information sheet, a consent form to sign and return to the researchers on-site, a pre-experience survey (printed on green paper), and a post-experience survey (printed on blue paper). The control group was approached immediately upon exiting Wild Sea with the survey pack (minus the pre-survey). Data collectors were aware of the project objectives. Visitors were not told the specific purpose of the research, only that it was a study about knowledge and attitudes toward wildlife. Once given the pack, exhibit-only and exhibit + presentation visitor groups were instructed to complete the pre-survey at T1, and to complete the post-survey when they saw the second researcher, who was positioned at the exhibit exit waiting to accept completed surveys (T2). On the last page of the post-survey, participants were invited to provide contact information to be sent a short (5 minutea) online follow-up survey via SurveyMonkey at T3 and T4. Participants who completed assessments all four time points were eligible for a prize draw (3 × $100 Visa Prepaid gift cards); this incentive was specified in the post-survey and information sheet. At T1 and T2, data were collected over an equal number (8) of week and weekend days, and during non-school holiday periods, to reduce potential differences in visitor socio-demographic characteristics. Surveys were collected between 10:00 AM and 4:00 PM. Exhibit-only data collection ceased during exhibit + presentation data collection times (11:00 AM–11:25 AM daily). The keeper presentation was delivered once daily thus our capacity to recruit to the presentation condition was limited, yielding uneven condition sample sizes. During T3 and T4 data collection, respondents were emailed once a week for 3 weeks (one initial email to participate and then two reminder emails if they had not yet participated).

Piloting of measures

A pilot survey with $N = 82$ zoo visitors was conducted prior to the program launch. Connelly (2008) recommends that the pilot sample be 10% of the total project sample size. We initially sought to recruit 250 participants per group (i.e., intended total sample size 750) and therefore 75–80 was our target pilot sample. This pilot yielded an unacceptable ($\alpha = .58$) internal consistency parameter for our attitude scale specific to the issue of outdoor balloon use. Following modifications, a second pilot study (attitude scale only; $N = 80$) was conducted with a paid SurveyMonkey sample and yielded acceptable internal consistency ($\alpha = .72$). Each item of this revised scale is detailed in the "Materials" section.

Materials

Visitor sociodemographic characteristics

Drawing upon previous literature and contextual factors (e.g., location), we collected demographic information that may influence pro-wildlife attitudes and conservation behaviours (Driscoll, 1995; Lukas & Ross, 2005; Ross & Gillespie, 2009; Signal & Taylor, 2007). Items included: gender (male; female; interdeterminate/intersex/unspecified; prefer not to say); age (open-ended); vegetarian status (yes/no); pet ownership (yes/no); Zoo Victoria member (yes/no); mean social norm score concerning balloon use outdoors (agreement rated on a scale from 1- strongly disagree, 7- strongly agree regarding the statement "my friends and family consider using balloons outdoors not harmful to marine wildlife"); prior zoo visit in past 12 months (yes/no); level of education (high school; certificate/diploma/TAFE; undergraduate degree [i.e., bachelor]; post-graduate degree [i.e., honours, masters, PhD, graduate certificate]); prior outdoor balloon use (yes/no), and visit motivation including: learning and discovery; social interaction; passive enjoyment; self-fulfilment; and restoration (each coded as reported/not reported; Packer & Ballantyne, 2002; descriptions of each motivation are detailed in Table 2). Since WBF was

exclusive to the state of Victoria at the time of the research, visitors were asked to indicate if they were an international visitor (yes/no) or an interstate visitor (yes/no).

Understanding about impacts of using balloons outdoors

At T1 and T2, visitors were asked to describe any impacts that they were aware of concerning outdoor balloon use (open-ended).

Post-visit message recall

To assess post-visit recall of the primary conservation message (to use bubbles not balloons at outdoor events), at T3 and T4, visitors were asked to report any conservation behaviours they had learned about during their Wild Sea visit (open-ended).

Identification of bubbles as an alternative to balloons for outdoor events

At T1 and T2, visitors were asked to describe alternatives to balloons that could be used at outdoor events (open-ended); this item was coded as either reporting or not reporting bubbles as an alternative to balloons.

Attitudes toward the use of balloons outdoors

Attitudes toward the use of balloons outdoors was measured at all-time points (1- strongly disagree, 7- strongly agree). A 7-point scale (as opposed to a 5-point scale) was employed for all scale items since more categories can yield greater test–retest reliability and internal consistency (Preston & Colman, 2000; Lozano, García-Cueto, & Muñiz, 2008; Weng, 2004), and are rated more favourably in terms of respondent preference (Preston & Colman, 2000). The final attitude scale comprised six items: (1) Balloons are marine-wildlife friendly outdoor decorations; (2) I do not see anything wrong with using balloons outdoors; (3) I am concerned that balloons can be harmful to marine wildlife when used outdoors; (4) Bubbles provide a marine-wildlife friendly alternative to balloons for outdoor events; (5) I prefer that outdoor events I attend do not use balloons; (6) I care about marine wildlife and the impact of plastic pollution on marine wildlife. Item 1 and 2 were reverse-coded prior to data analysis. Possible total scores ranged from 6 to 42, with a higher score indicating a more positive attitude toward not using balloons outdoors.

Behaviour intentions

Likelihood to use balloons and likelihood to use bubbles at future outdoor events

Behaviour intentions were measures at all four time points. Visitors rated (a) how likely they were to use balloons at future outdoor events and (b) how likely they were to use bubbles at future outdoor events (1- extremely unlikely, 7- extremely likely).

Post-visit conservation behaviour

Post-visit conservation actions were measured at T3 and T4 and related to: discussions about the impact of using balloons at outdoor events; purchases of wildlife-friendly bubbles; and new behaviours that were engaged in while hosting or attending an outdoor event. Specifically, visitors were asked:

1. Since your visit to Wild Sea, have you discussed with anyone the impact of using balloons outdoors on marine environments (yes/no)?
   a. If yes, what was the discussion about (open-ended)?
2. Since your visit to Wild Sea, have you purchased wildlife-friendly bubbles (yes/no)?
3. Since your visit to Wild Sea, have you hosted or attended an outdoor celebration (yes/no)?
   a. If yes, did your zoo visit impact your behaviour at this event in any way (yes/no)?
   b. If yes, how? (open-ended)

At T4, visitors were asked to report behaviours *since the completion of the T3* survey, for example, "since completion of this survey three months ago, have you discussed with anyone the impact of using balloons on marine environments?").

Participants

All participants who participated in T1 also participated at T2, resulting in a total $N = 624$ visitors across T1 and T2. Of these, 67 respondents also participated at T3 and 42 at T4 (Table 1). The initial follow-up response rate of 11% at T3 is lower than previous research that has assessed post-visit impacts of zoo conservation programs with matched samples (16–24%; Adelman et al., 2000; Dierking et al., 2004; MacDonald, 2015). There was a relatively even proportion of males to females (female: 50–69%) and participants' mean age was 31 ($SD = 12.4$). Around two-thirds (57–64%) of the sample were prior balloon users; see Table 2 for participant demographic information.

Analysis of quantitative data

Statistical analyses were performed with IBM SPSS Statistics (v25). To identify and control for possible demographic between-group differences, One-Way Analysis of Variance (ANOVA) and Chi-Square Test of Independence (or Fisher's Exact Test of Independence) were performed. Analyses revealed significant between-group differences on eight demographic variables ($p < .05$; Table 2). We used the univariate general linear model (GLM) procedure to analyse the quantitative repeated-measures variables assessed across all time points including: (1) attitudes toward the use of balloons outdoors (2) likelihood to use balloons at future outdoor events; and (3) likelihood to use bubbles at future outdoor events. The univariate GLM procedure provides regression analysis and analysis of variance for one dependent variable on one or more predictor variables. This procedure is the most appropriate method for our repeated-measures items because it allows for the accommodation of analysing non-normal data, prevents listwise deletion due to missing data or dropouts (i.e., retains the people who have data for only some time points as opposed to deleting the entire case), and accounts for unbalanced sample sizes (Cnaan, Laird, & Slasor, 1997; Gelman & Hill, 2007; Krueger & Tian, 2004; Pinheiro & Bates, 2000).

To identify and account for only significant predictor variables and thus optimise model fit, a purposive selection method was applied during data analysis (Bursac, Gauss, Williams, & Hosmer, 2008). Prior to generating the final model, we first ran the models with all eight significant demographic variables and then excluded those that did not significantly contribute to the model and/or influence other variables. The final models included time point, completion of pre-survey (yes), viewed a presentation (yes), and all significant covariates relative to each outcome variable,

Table 1. Total sample numbers for each visitor group, by time point.

	T1	T2	T3	T4
Exhibit-only	249	249	29	23
Exhibit + presentation	125	125	23	10
Control		250	15	9
Total Sample *n*	374	624	67	42

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Table 2. Visitor demographic characteristics, by visitor group.

	Exhibit-only valid (%)	Exhibit + presentation valid (%)	Control valid (%)	Significant?*
Total *n*	249	125	250	
Gender (Female)	50	69	50	Yes
Mean Age in Years (SD)	31 (11.9)	32 (12.8)	30 (12.5)	No
Vegetarian Status (Yes)	8	7	7	No
Pet Ownership (Yes)	60	67	67	No
Zoos Victoria Member (Yes)	17	33	14	Yes
Prior Visit in Past 12 months (Yes)	31	40	22	Yes
International Visitor (Yes)	24	15	22	No
Interstate Visitor (Yes)	22	23	27	No
Highest Level of Education				
High School	22	2	25	No
Certificate/Diploma/TAFE	23	21	21	
Undergraduate Degree (e.g., Bachelor)	38	34	40	
Post-graduate Degree (e.g., Honours, Masters, PhD, Graduate Certificate)	17	22	14	
Prior Balloon Use (Yes)	63	64	57	No
Mean Social Norm Score (SD)	4	3	4	No
Motivation for Visit				
Learning and Discovery (Yes) *(to expand understanding, desire to discover new things)*	32	46	4	Yes
Social Interaction (Yes) *(to spend time with friends/family)*	53	65	61	Yes
Passive Enjoyment (Yes) *(to enjoy oneself, be pleasantly occupied)*	47	40	54	Yes
Self-Fulfilment (Yes) *(to make things more meaningful, feel a sense of achievement)*	13	11	21	Yes
Restoration (Yes) *(to relax, have a change from routine)*	19	23	34	Yes

Due to missing data, *n* varies between 243 and 250 for the exhibit-only and control groups, and between 123 and 125 for the exhibit + presenation group.
*Significant at $p < .05$ level.

as fixed effects. Due to insufficient cases for between-group comparisons, gender was recoded as reporting or not reporting female for these analyses. The maximum likelihood method was used to estimate variance components. We used an alpha level of .05 for all statistical tests.

Analysis of qualitative data

We employed thematic analysis (Braun & Clarke, 2006) to identify and organise patterns in our qualitative data, and adopted a complete coding method to account for visitor responses that contained multiple themes (and therefore, the valid item *n* may exceed the total sample *n*). We included 100% of cases in our inter-rater reliability (Cohen's Kappa [κ]) assessments. Cases were independently coded by two coders. Kappa is reported for each outcome variable individually in the "Results" section. In this research, κ ranges from 0.62 to 1.0. Based on guidelines by Landis and Koch (1977), Kappa values of 0.0–0.20 = "slight agreement," 0.21–0.40 = "fair agreement," 0.41–0.60 = "moderate agreement," 0.61–0.80 = "substantial agreement," and 0.81–1.0 = "almost perfect" or "perfect" agreement.

Results

Due to the low follow-up response rate on open-ended knowledge and behaviour items at T3 and T4, below we report the *total* most frequently reported themes (i.e., across both follow-up time points [T3–T4] and all three visitor groups; total valid *n* = 109). A table of response themes

and proportions itemised by visitor group and time-point for each relevant outcome variable is provided in the Supplementary Material. We report a range % instead of the mean % to represent the percentage range across the three condition groups (exhibit-only, exhibit + presentation, control).

Understanding about impacts of using balloons outdoors

Analyses of the open-ended question about impacts of using balloons outdoors at the T1 pre-survey revealed three main themes: balloons becoming general litter (26–27%); balloons becoming marine litter (27–32%); balloons posing a general/non-specified hazard to wildlife (20–21%). At T2, of visitors who reported additional understandings, exhibit-only and exhibit + presentation groups reported impacts that most commonly included: balloons posing a general/non-specified hazard to wildlife (21–30%); and balloons posing an entanglement hazard to wildlife (13–22%). The exhibit + presentation group were nearly twice more likely to report the specific entanglement threat than exhibit-only visitors (22% vs. 13%). Only 3% of control group responses contained this theme ($\kappa = 0.68$). See Table 3 for response themes and proportions.

Post-visit message recall

When asked in an open-ended question to describe any conservation behaviours they had learned about during their Wild Sea visit, participant responses most frequently contained a do not litter/reduce/recycle theme (20 of 74 total valid responses; 27%). Using bubbles/using bubbles instead of balloons was the second most frequently reported theme (identified 19 times out of 74 valid responses; 26%; $\kappa = 0.62$). See Supplementary Material for a table displaying response themes and proportions by condition and time point.

Identification of bubbles as an alternative to balloons for outdoor events

Figure 6 displays the percentage of each visitor group that reported bubbles as an alternative to using balloons at outdoor events at T1 and T2. The identification of bubbles as an alternative to balloons for outdoor events increased from T1 to T2 for the exhibit-only and exhibit + presentation groups. Further, visitors groups who completed a pre-survey were almost twice as likely to have reported bubbles as an alternative at T2 than visitors in the control condition who did not complete a pre-survey. Notably, the difference in the identification of bubbles at T1 between the exhibit-only and exhibit + presentation groups (21%) became smaller at T2 (4%; $\kappa = 1.0$).

Attitudes concerning the use of balloons outdoors

In this study, our attitude scale yielded an internal consistency estimate of $\alpha = .76$. As depicted in Figure 7, mean attitude scores were already high at T1 for visitor groups (34–35 on a 42-point scale), and these scores increased to 38–39 by T4; exhibit + presentation visitors consistently reported higher attitude means than both the exhibit-only and control groups. A univariate GLM revealed that WBF significantly impacted visitor attitudes toward not using balloons outdoors, $F[11, 9.63] = 9.63$, $p = .000$, adjusted $R^2 = 0.65$. Time point was a significant predictor of more positive attitudes ($p = .000$). Attitudes were significantly more positive among visitors who: completed a pre-survey ($p = .000$); viewed a presentation ($p = .001$); reported a learning and discovery motivation ($p = .000$); and reported self-fulfilment motivation ($p = .039$), than those who did not. There were no significant differences concerning zoo membership ($p = .061$). There was a significant interaction effect between time-point and viewing the presentation on attitudes ($p = .000$), indicating that for people who viewed a presentation, as time progressed, attitudes become

Table 3. Response themes and proportions for visitor understanding about impacts of using balloons outdoors at T1 and T2, by visitor group.

		T1		T2		
Response theme	Example response	Exhibit-only % (*n*)	Exhibit + presentation % (*n*)	Exhibit-only % (*n*)	Exhibit + presentation % (*n*)	Control % (*n*)
		Valid item *n* = 252	Valid item *n* = 168	Valid item *n* = 262	Valid item *n* = 142	Valid item *n* = 316
Balloons become general litter	"pollution," "waste that negatively impacts the environment"	27 (68)	26 (44)	6 (15)	6 (8)	23 (72)
Balloons become marine litter	"ends up in the water," "blows away into water"	27 (67)	32 (53)	9 (24)	8 (11)	22 (68)
Balloons pose a hazard to marine life: general/non-specified	"animals could be affected," "danger to wildlife"	20 (51)	21 (35)	21 (55)	30 (42)	13 (40)
Balloons pose a choking/ingestion hazard to animals	"balloon string is a choking hazard," "animals swallow them"	4 (11)	5 (8)	6 (16)	45 (7)	21 (66)
Balloons pose entanglement hazard to animals	"seals become entangled," "string can trap and entangle penguins"	7 (17)	5 (9)	13 (33)	22 (31)	3 (9)
Balloons are non-biodegradable	"don't break down," "doesn't decompose"	4 (10)	3 (5)	1 (3)	–	5 (16)
Don't know/None	"not sure," "don't know," "none"	7 (17)	7 (11)	3 (7)	6 (8)	13 (40)
Nothing additional (for T2 pre-post groups only)	"nothing additional," "no more than I already knew"			41 (108)	25 (35)	
Other	"get caught on electricity line," "choking hazard for humans," "visually unattractive," "invade air space," "scare animals," "helium is a finite resource"	4 (11)	2 (3)	0.4 (1)	–	2 (5)

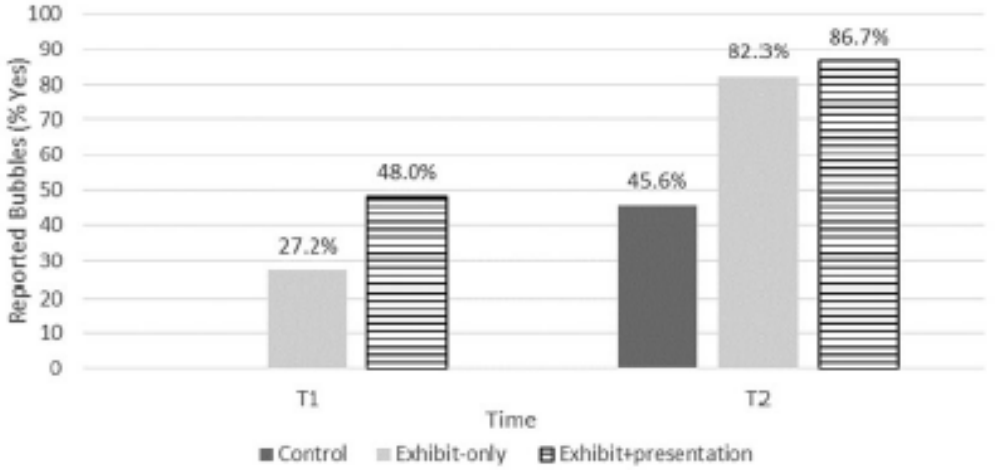


Figure 6. Clustered column chart displaying the percentage of each visitor group that reported bubbles as an alternative to using balloons at outdoor events at T1 and T2.

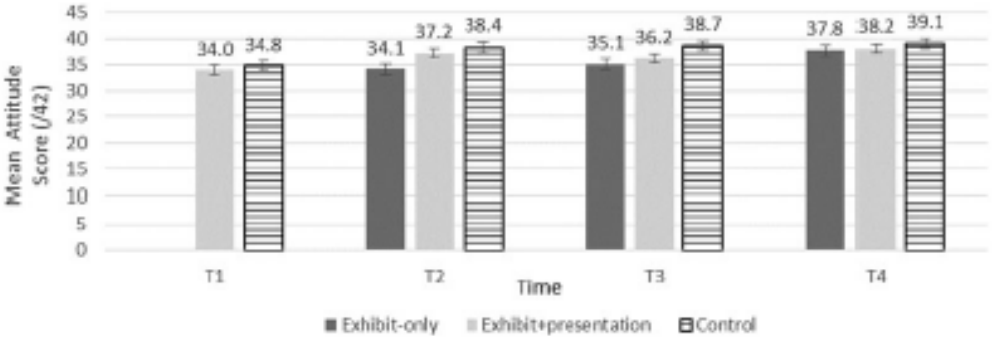


Figure 7. Clustered column chart with standard error bars displaying mean scores for attitudes concerning the use of balloons outdoors, across time.

more positive. The full univariate GLM outputs for each outcome variable can be found in the Supplementary Material.

Likelihood to use balloons and likelihood to use bubbles at future outdoor events

As displayed in Figure 8a, mean likelihood to use balloons scores were already low at T1 for all visitor groups (2.4–2.5 out of 7), and this decreased further across time (1.5–1.7 at T4). Analyses revealed WBF significantly impacted visitor likelihood to use balloons $F[10, 16.8] = 7.81$, $p = .000$, adjusted $R^2 = 0.59$. Mean likelihood scores overall reduced significantly across time ($p = .000$); compared to mean scores at T1, significant differences were observed at T2 ($p = .000$) and T4 ($p = .000$). Likelihood to use balloons scores were significantly lower among visitors who: completed a pre-survey ($p = .000$); reported a learning and discovery motivation ($p = .000$); and reported a social interaction motivation ($p = .022$). Scores did not differ significantly on viewing a presentation ($p = .476$), and there was no significant interaction between time and viewing a presentation on likelihood to use balloons scores ($p = .232$).

Figure 8b shows moderately high mean likelihood to use bubble scores at T1 (4.8–5.4/7), and these scores increase over time. Analyses indicate WBF significantly impacted mean likelihood to

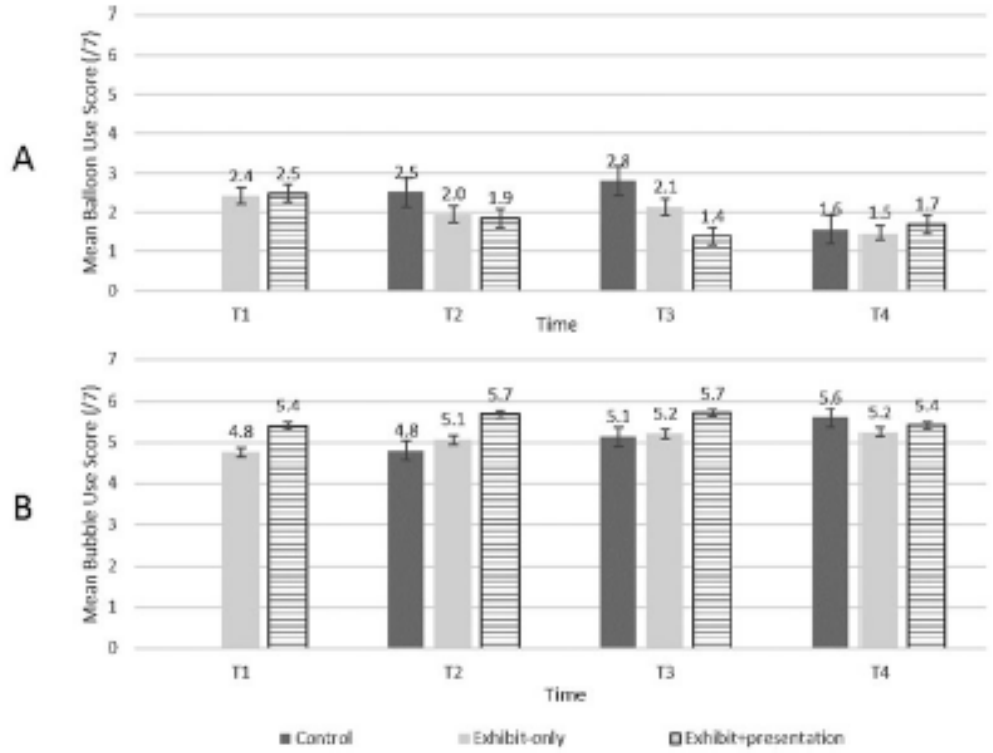


Figure 8. Clustered column charts with standard error bars displaying mean scores for each visitor group on (A) likelihood to use balloons at future outdoor events and (B) likelihood to use bubbles at future outdoor events, across time.

use bubbles scores, $F[10, 20.42] = 5.10$, $p = .000$, adjusted $R^2 = 0.47$. Likelihood to use bubbles scores were significantly higher among visitors who reported being a zoo member ($p = .000$) and reported being female ($p = .001$). Scores did not differ significantly on viewing a presentation ($p = .177$), completing a pre-urvey ($p = .157$), reporting a learning and discovery motivation ($p = .080$) or time ($p = .145$), and there was no significant interaction between time and viewing a presentation on likelihood to use bubbles scores ($p = .874$).

Post-visit conservation behaviour

At T3, 50 participants (of 67; 75%) reported having discussed a topic related to the impact of using balloons outdoors on marine environments; 26 participants (of 46; 57%) reported having done so at T4 (see Table 5 for response proportions by visitor group). Of those who provided further detail about what they talked about in an open-ended question, the most common response themes included discussions about general/non-specified hazards of balloons (e.g., "how harmful they can be"; 52%, 32 of 62 follow-up responses), discussions about balloon use ("avoiding balloons," "using balloons responsibly," "using balloons irresponsibly"; 27%, 17 of 62); and discussions about balloon alternatives (26%; 16 of 62). Few participant responses detailed discussing the specific ingestion or entanglement hazards that balloons pose to marine wildlife (8%; 5 of 62). Please refer to Supplementary Material for a table of response themes and proportions itemised by time point and visitor group ($\kappa = 0.67$).

Purchase of bubbles was reported by 24 participants (of 67; 36%) at T3, and by 8 visitors (of 31; 26%) at T4 (Table 4).

Table 4. Response frequencies and percentages for quantitative behavioural outcome measures at T3 and T4, itemised by time point and visitor group.

Post-visit behaviour change measure	T3			T4		
	Exhibit-only $n = 29$ % (n)	Exhibit + presentation $n = 23$ % (n)	Control $n = 15$ % (n)	Exhibit-only $n = 23$ % (n)	Exhibit + presentation $n = 10$ % (n)	Control $n = 9$ % (n)
Discussed impact of using balloons outdoors on marine environments (Yes)	79 (23)	83 (19)	53 (8)	64 (14)[h]	80 (8)	44 (4)
Purchased bubbles since visit (Yes)	41 (12)	35 (8)	27 (4)	23 (5)[h]	33 (3)[i]	–
Hosted or attended an outdoor celebration since zoo visit (Yes)	44 (12)[a]	52 (12)	57 (8)[c]	50 (10)[j]	56 (5)[l]	33 (3)
Changed behaviour while hosting/ attending an outdoor event (Yes)	50 (5)[b]	73 (8)[d]	86 (6)[f]	67 (4)[j]	75 (3)[a]	67 (2)[m]
Changed behaviour while hosting/ attending an outdoor event was influenced by visit to Wild Sea (Yes)	86 (12)[c]	69 (11)[e]	75 (3)[g]	83 (10)[k]	50 (2)[g]	44 (4)

Due to missing data: the valid n for groups at T3 ranges from 11 to 27; and the valid n for groups at T4 ranges from 3 to 22.

Attending or hosting an outdoor event was reported by 32 participants (of 64; 50%) at T3, and by 18 (of 38; 47%) participants at T4 (Table 5). Of these, 19 participants (of 28; 68%) at T3 and 9 participants (of 13; 69%) at T4 further reported that their visit to Wild Sea influenced their behaviour at the outdoor event. Of those who additionally described in an open-ended response how their behaviour was influenced, the total most frequently reported themes included: did not use/purchase balloons (10 of 25; 40%) and encouraged others not to use balloons/use alternatives (8 of 25; 32%). Four of 25 (16%) responses specifically identified using bubbles as a way their visit influenced their behaviour. See Supplementary Material for a table of response themes and proportions itemised by time point and visitor group; $\kappa = 0.67$.

Discussion

This outcome evaluation found preliminary evidence that WBF is promoting greater depth of knowledge concerning impacts of balloon use outdoors, is encouraging more positive attitudes post-visit, and more favourable social norms toward not using balloons immediately following the exhibit experience. The program is inspiring intent to act, with visitors overall reporting increased likelihood to use bubbles, and reduced likelihood to use balloons. In terms of post-visit conservation behaviour, Melbourne Zoo visitors reported talking about the issue of outdoor balloon use, as well as modifying their behaviours at outdoor events, with 66–69% of the follow up sample specifying that the behaviours they changed at an outdoor event after their visit were influence by their Wild Sea experience. A final major finding from this evaluation is the likely influence of a pre-survey on visitor psychosocial outcomes. For example, visitors who completed a pre-survey reported significantly more favourable subjective norm scores, more positive attitudes, and significantly lower likelihood to use balloons, than visitors who did not complete a pre-survey. These results may indicate that the completion of a pre-survey influenced visitors to look for or more fully engage in the WBF program material.

Understanding about impacts of using balloons outdoors

WBF is facilitating greater depth of knowledge about the threats of balloon use outdoors in the short-term, with responses at T2 containing more detailed aspects of hazards than at T1 (e.g., balloons harm wildlife vs. balloons pose entanglement hazards to wildlife). This is an important first step for WBF, given knowledge is a necessary (albeit not sufficient) precondition for pro-environmental behaviour (Kaiser & Fuhrer, 2003; McKenzie-Mohr, Lee, Kotler, & Schultz, 2011). Visitors who did not complete a pre-survey did not demonstrate the same depth of understanding at T2 than those who did, indicating that the pre-survey likely influenced how visitors interacted with educational material and/or absorbed information. Is it possible that that exposure to the pre-survey encouraged participants to seek out or be more likely to focus on WBF materials (Bargh & Chartrand, 2000).

Post-visit message recall

Three to six months following their visit, only 25% of visitors recalled the primary conservation message to use bubbles not balloons at outdoor events. Since familiar concepts are easier to recall because of their long-term associative links (Deese, 1960), it is possible that the novelty of bubble use at outdoor events impacted participants' abilities to recall this behaviour. Another explanation for this outcome could be communication 'noise' created by the multiple conservation-education programs that encompass different educational components and are delivered concurrently.

Identification of bubbles as an alternative to using balloons outdoors

Results indicate that WBF is educating people about bubbles as a wildlife-friendly alternative to balloons short-term. Consistent with group differences on understanding of impacts of using balloons outdoors (above), both exhibit-only and exhibit + presentation groups were twice more likely than the control group to report bubbles as an alternative. In contrast to previous research that has generally demonstrated enhanced conservation impacts for presentations when compared with traditional exhibit experiences (Mellish, Pearson, Sanders, & Litchfield, 2016; Miller et al., 2013), in this study there was no marked difference between exhibit-only and exhibit + -presentation groups on identification of bubbles as an alternative at T2. This outcome, again, may be attributed to a pre-survey priming effect, or alternatively may reflect the persuasiveness of the exhibit as a whole, including the indoor animation experienced by all visitors.

Attitudes concerning use of balloons outdoors

Consistent with previous research measuring post-visit attitudes following a zoo visit (e.g., Miller et al., 2013), increases in mean attitude scores concerning balloon use outdoors persisted over time (T2–T4). This is an important result for WBF as is represents a possible success in changing in how people think or feel about outdoor balloon use, which is a difficult task because the behaviour is typically symbolic of celebration and festivity (when used at birthday parties and weddings) and spiritual output (when released at funerals), and less so has a negative connotation to harming wildlife. Given knowledge about an environmental problem can influence pro-environmental concern (Gifford & Nilsson, 2014), one possible explanation for this rise in mean attitude scores might be the aforesaid increased understanding about the impact of balloons on marine wildlife, which may have inspired concern for animals affected by balloon debris.

Likelihood to use balloons and likelihood to use bubbles at future outdoor events

Greater knowledge is associated with intention to act through increasing positive attitudes (e.g., in the context of zoo-based orang-utan conservation education; Pearson, Dorrian, & Litchfield, 2013). This information coupled with the aforesaid increases in depth of understanding, more positive attitudes, and more favourable subjective norm scores, makes the overall rise in likelihood to use bubbles and decrease in likelihood to use balloons among visitor groups unsurprising. It is interesting to note that the rise in likelihood to use bubbles is inconsistent with the low number of follow-up participants who actually reported using bubbles at outdoor events post-visit. There are several factors to consider when interpreting this outcome (discussed further in the post-visit conservation action section below), including for example, the possible limited opportunity to use bubbles for those who may not have planned a party or memorial.

Post-visit conservation behaviour

Many visitors reported to have discussed the topics of balloons becoming marine litter and posing hazards to marine wildlife, as well the matters of avoiding balloons, using balloons responsibly, and using alternatives to balloons, with their friends and family after their visit. This finding lends some support to existing work indicating zoo experiences can influence interest in and commitment to talking to others about the target conservation issue (Dierking et al., 2004), which may also perpetuate social norms around balloon use or spread the impact of the campaign to a wider audience than the zoo visitors themselves.

Our results suggest that WBF created some post-visit behaviour change at outdoor events, with 68% (T3)–69% (T4) of the follow-up sample reporting that their visit to Wild Sea impacted their behaviour at an outdoor event in some way. However, when asked how their behaviour was influenced, few responses containing the theme of using alternatives to balloons specifically mentioned bubbles. This is consistent with the limited number of follow-up participants who specifically reported purchasing bubbles post-visit. In addition to the explanation that the novelty of bubble use at outdoor events could have contributed to this outcome, as well as possible limited opportunities to use bubbles, contextual factors or personal preference may also explain the low uptake of bubble use. Costs associated with purchasing bubble equipment, limited knowledge or resources to make homemade equipment/bubble mix, and/or the variety of other wildlife-friendly alternatives available (e.g., paper streamers, biodegradable confetti), offer some further explanations for this result. Regardless, not using balloons and the uptake of using wildlife-friendly alternatives (bubbles or otherwise) represents an overall reduced potential for balloon litter to enter the marine environment, and thus is a positive end.

Strengths and limitations

This research addressed several methodological problems identified in reviews of related research (Khalil & Ardoin, 2011; Mellish et al., 2019). The use of a pilot study revealed reliability issues with our custom-designed attitude scale for balloon use outdoors, which enabled us to modify and re-pilot the scale prior to conducting the full-scale research. Further, by adopting a repeated-measures design over 6 months, we were able to assess if changes at T2 persisted over time, and if behaviour modification occurred post-visit, thus allowing for a more comprehensive assessment of the impacts of WBF. Finally, by controlling for the completion of a pre-survey, we were able to factor in to our analyses the influence that completing a pre-survey likely has on visitor interaction with and/or interpretation of the program material. Consistent with limitations of other post-visit evaluations (Smith et al., 2008), a key limitation to this research is the low follow-up response rate, which subsequently restricts our capacity to more thoroughly assess lasting impacts. Further, it is possible that follow-up outcomes over-represent the broader visitor

population, as those who provided contact information and completed the follow-up surveys may be more environmentally oriented than those who did not. Social desirability bias (i.e., participants providing socially favourable survey responses; King & Bruner, 2000) should additionally be considered when interpreting our results. According to this type of response bias, it is possible that respondents over-stated rather than under-stated their post-visit behaviours. Moreover, while our research was informed by TPB, we acknowledge that it does not measure all sub-constructs that make up the theory.

Conclusions and directions for future research

Findings build upon existing work that indicates zoo-based conservation-education programs have potential to inspire visitors to modify their behaviour after the zoo visit (MacDonald, 2015; Mann et al., 2018; Miller et al., 2013). Research outcomes have further yielded direct on-the-ground implications for the WBF program, including modifications to the keeper-led seal presentation. In response to T2 findings which indicate a generally low proportion of visitors who reported a specific entanglement threat of balloon litter (13–22% across exhibit-only and exhibit + presentation groups), Zoos Victoria introduced into their presentation more discussion around the risk of entanglement with balloon string and the subsequent impact on marine wildlife. This work also offers important methodological contributions for future zoo program evaluations that utilise repeated-measures designs. A key learning from this research is that inviting visitors to complete a survey prior to the intervention under evaluation likely influences how visitors interpret and engage with educational material and/or experiences. This is a useful discovery for: (a) refining evaluation methodology, as it highlights the need to control for or consider pre-survey influences (or test for priming influences at the pilot study stage; Weiler, Moyle, Wolf, de Bie, & Torland, 2017) when exploring if evaluation outcomes are attributable to program material, and; (b) implementing and empirically testing conservation-education resources that mimic the potential educational effect of a pre-survey. One possible suggestion is worksheets containing questions related to exhibit interpretation, available to visitors at the entry of an exhibit (or available to download prior to visit). For the portion of visitors who visit zoos with a learning and discovery motivation (31–46% across groups in this study), a worksheet may additionally increase visitor enjoyment (i.e., learning for fun; Packer, 2006).

Future work could seek to empirically explore why balloons represent celebration and festivity (when used at birthday parties and weddings) and spiritual output (when released at funerals). A scholarly understand of the underlying benefits and human values of balloon use could help to create interventions that might more comprehensively discourage the behaviour. Finally, given that participants' post-visit message recall was low, a future direction for the program might include offering visitors a post-visit reinforcement (Hughes, Packer, & Ballantyne, 2011), as a way to extend the potential impact of the program.

Notes on contributors

Sarah Mellish is a PhD candidate in the University of South Australia's Conservation Psychology and Applied Animal Behaviour Research Group. Sarah's current work focuses on the evaluation of environmental behaviour-change programs.

Elissa L. Pearson is a Lecturer in Psychology at the University of South Australia. Elissa's work focuses upon the relationships between people and the natural world. Her research and practice consider the ways in which nature supports human health and wellbeing, as well as applying conservation psychology knowledge and research methods to inform and evaluate environmental education programs.

Emily M. McLeod is the Senior Social Science Research Manager at Zoos Victoria. Emily's work focuses on how zoo-based conservation organisations can better connect people with wildlife and foster sustainable behaviours. Her

Appendix F: Author Contributions to Study 1 (Chapter 3)

Mellish, S., Pearson, E. L., McLeod, E. M., Tuckey, M. R., & Ryan, J. C. (2019). What goes up must come down: An evaluation of a zoo conservation-education program for balloon litter on visitor cognition, affect, and behaviour. *Journal of Sustainable Tourism.* doi:10.1080/09669582.2019.1625908

Sarah Mellish was the lead data collector, with help from Dr Jillian Ryan and Ms Emily McLeod. Sarah performed the majority of the data analysis, with guidance and feedback from Dr Jillian Ryan and Associate Professor Michelle Tuckey. Sarah wrote the majority of the paper, with feedback from Dr Elissa Pearson, Associate Professor Michelle Tuckey, Dr Jillian Ryan, and Ms Emily McLeod. Ms Emily McLeod provided feedback and edited sections of the paper concerning descriptive information about the When Balloons Fly program and Zoos Victoria's Connect-Understand-Act framework.



Sarah Mellish



Dr Elissa L. Pearson



Ms Emily M. McLeod



Associate Professor Michelle R. Tuckey



Dr Jillian C. Ryan

Appendix G: Take-home Information Sheet Used at the Wild Sea Precinct (Study 2, Chapter 4)

University of South Australia

Research Project: Community awareness and attitudes regarding wildlife conservation

Dear potential participant

My name is Sarah and I am a PhD candidate within the School of Psychology, Social Work and Social Policy at the University of South Australia. In collaboration with Zoos Victoria, I am conducting research to investigate community awareness and attitudes regarding wildlife conservation. I am writing to ask you to fill in a two five-minute questionnaires about this topic (one before and one after your zoo experience). You will be asked about your knowledge and attitudes towards aspects of animal conservation. Your participation is voluntary and you are welcome to withdraw from the study while undertaking the survey, without affecting your position now or in the future. However, once you submit your survey, we are unable to remove your response and it will be impossible to identify your individual data. You must be 18 years of age or older to participate in this research.

We do not foresee any risks of participating. No identifying information about yourself is required for the purpose of this research. The researcher will take every care to remove responses from any identifying material as early as possible. Likewise, responses will remain confidential by the researcher and will not be identified in the reporting of the research. No information which could lead to identification of any individual will be released, unless required by law. However, the researcher cannot guarantee the confidentiality or anonymity of material transferred by email or the Internet. The information collected as part of the current study will be retained for five years and stored in a secure place in the School of Psychology, Magill Campus, at the University of South Australia. This data may also be used for future related research projects.

This project has been approved by the University of South Australia's Human Research Ethics Committee (project: 0000036359). If you have any ethical concerns about the project or questions about your rights as a participant please contact the Executive Officer of this Committee, Tel: +61 8 8302 XXXX, Email: vicki.XXX@unisa.edu.au. For any further questions about the study, please feel welcome to contact me via email: Sarah.Mellish@mymail.unisa.edu.au. A summary of the research findings and outcomes can be sent to you at the conclusion of the research (by July 2018) if you would like to receive this. For this to occur, please ensure you provide the researcher with an email or postal address at the conclusion of the research. The overall research findings will be published by the researchers and may be used by Zoos Victoria.

Thank you for your participation in this study.

Sarah Mellish

[PLEASE FEEL WELCOME TO TAKE HOME WITH YOU THIS PARTICIPANT INFORMATION SHEET]

Appendix H: Consent Form (Study 2, Chapter 4)

UniSA Research and Innovation Services

Human Research Ethics Committee
CONSENT FORM
Retention of taped materials, photographs or original works

This project has been approved by the University of South Australia's Human Research Ethics Committee. If you have any ethical concerns about the project or questions about your rights as a participant please contact the Executive Officer of this Committee, Tel: +61 8 8302 XXXXX; Email: humanethics@unisa.edu.au

SECTION 1: CONTACT AND PROJECT DETAILS	
Researcher's Full Name:	Ms Sarah Mellish
Contact Details:	Sarah.XXXXX@mymail.unisa.edu.au (T: 0404 XXXXX)
Supervisor's Full Name:	Associate Professor Michelle Tuckey; Dr Elissa Pearson
Contact Details:	Michelle.XXXXX@unisa.edu.au(*T: +61 8 830 XXXXX*); Elissa.XXXXX@unisa.edu.au(*T: +61 8 830 XXXXX*);
Protocol Number:	0000035677
Project Title:	Investigating barriers and facilitators experienced by Zoo educators when evaluating conservation-education programs.

SECTION 2: CERTIFICATION

Participant Certification

In signing this form, I confirm that:

- I have read the Participant Information Sheet, and the nature and the purpose of the research project has been explained to me. I understand and agree to take part.
- I understand that I can withdraw from the study at any stage and that this will not affect my status now or in the future.
- I confirm that I am over 18 years of age.
- I understand that I will be audiotaped during the study
- I understand that while I may not directly benefit from taking part in the project, upon completion of the interview, I will be entered into a draw to win one of two $100 Visa Prepaid gift cards.
- I understand that while information gained during the study may be published, I will not be identified and my personal results will remain confidential, unless required by law.
- I understand that the audio tape(s) and transcripts will be stored for five years in the School of Psychology, Social Work and Psychology data storage facility (C1-03, Magill campus) upon completion of data analysis.

Participant Signature	*Printed Name*	*Date*

Researcher's Certification

I have explained the study to subject and consider that he/she understands what is involved.

Researcher's Signature	*Printed Name*	*Date*

Appendix I: The Pre-experience Survey Items for Visitors to the Wild Sea Precinct (Study 2, Chapter 4)

Have you ever used balloons outdoors?

☐ Yes

☐ No

Please identify any potential impacts of using balloons outdoors:

_____

_____

Please identify any alternatives to using balloons outdoors:

_____

_____

Please *circle* your level of agreement with the following statements. Remember we are interested in your opinions; there are no right or wrong answers.

	strongly disagree	disagree	somewhat disagree	neither agree no disagree	somewhat agree	agree	strongly agree
Balloons are marine-wildlife friendly outdoo decorations.	1	2	3	4	5	6	7
I do not see anything wrong with using balloons outdoors.	1	2	3	4	5	6	7
I am concerned that balloons can be harmful to marine wildlife when used outdoors.	1	2	3	4	5	6	7
My friends and family consider using balloons outdoors not harmful to marine wildlife.	1	2	3	4	5	6	7

Bubbles provide a marine-wildlife friendly alternative to balloons for outdoor events.	1	2	3	4	5	6	7
I prefer that outdoor events I attend do not us balloons.	1	2	3	4	5	6	7
I care about marine wildlife and the impact of plastic pollution on marine wildlife.	1	2	3	4	5	6	7

How likely are you to use balloons outdoors in the future?

1	2	3	4	5	6	7
Extremely unlikely	Moderately unlikely	Slightly unlikely	Neither unlikely nc likely	Slightly likely	Moderately likely	Extremely likely

How likely are you to use wildlife-friendly bubbles outdoors in the future?

1	2	3	4	5	6	7
Extremely unlikely	Moderately unlikely	Slightly unlikely	Neither unlikely nc likely	Slightly likely	Moderately likely	Extremely likely

Will/does your visit to this exhibit include a presentation today?

- ☐ Yes
- ☐ No

Gender:

- ☐ Male
- ☐ Female
- ☐ Interdeterminate/Intersex/Unspecified
- ☐ Prefer not to say

Age: _____ (please leave blank if you prefer not to say)

Do you identify as vegetarian?

- ☐ Yes
- ☐ No

Do you own a pet?

- ☐ Yes
- ☐ No

Are you a member of Zoos Victoria?

- ☐ Yes
- ☐ No

Prior to today, have you visited any of the Zoos Victoria sites in the past 12 months (i.e., Melbourne Zoo, Healesville Sanctuary, Werribee Open Range Zoo)?

- ☐ Yes
- ☐ No

Are you an international visitor?

- ☐ Yes [If yes, skip to F10]
- ☐ No

Are you an interstate visitor?

- ☐ Yes
- ☐ No

Please select your highest level of education:

- ☐ High School
- ☐ Certificate/diploma/TAFE
- ☐ Undergraduate degree (i.e., bachelor)
- ☐ Post-graduate degree (i.e., honours, masters, PhD, graduate certificate)
- ☐ Other, please specify _____

What was your motivation for visiting the zoo today? *(please <u>select all</u> that apply):*

☐ Learning and discovering *(i.e., to expand knowledge, desire to discover new things)*

☐ Social interaction *(i.e., to spend time with friends/family)*

☐ Passive enjoyment *(i.e., to enjoy oneself, be pleasantly occupied)*

☐ Self-fulfilment *(i.e., to make things more meaningful, feel a sense of achievement)*

☐ Restoration *(i.e., to relax, have a change from routine)*

☐ Other *(please specify):* _____

Appendix J: The Post-experience Survey Distributed to Visitors at the Wild Sea Precinct (Study 2, Chapter 4)

Since completing these questions at the beginning of your exhibit/presentation experience today:

Please identify any additional potential impacts of using balloons outdoors:

_____

_____

Please identify any additional alternatives to using balloons outdoors:

_____

_____

Please *circle* your level of agreement with the following statements. Remember we are interested in your opinions; there are no right or wrong answers.

	strongly disagree	disagree	somewhat disagree	neither agree nor disagree	somewhat agree	agree	strongly agree
Balloons are marine-wildlife friendly outdoor decorations.	1	2	3	4	5	6	7
I do not see anything wrong with using balloons outdoors.	1	2	3	4	5	6	7
I am concerned that balloons can be harmful to marine wildlife when used outdoors.	1	2	3	4	5	6	7
Bubbles provide a marine-wildlife friendly alternative to balloons for outdoor events.	1	2	3	4	5	6	7
I prefer that outdoor events I attend do not use balloons.	1	2	3	4	5	6	7

I care about marine wildlife and the impact of plastic pollution on marine wildlife.	1	2	3	4	5	6	7

Following your experience, how likely are you to use balloons outdoors in the future?

1	2	3	4	5	6	7
Extremely unlikely	Moderately unlikely	Slightly unlikely	Neither unlikely nor likely	Slightly likely	Moderately likely	Extremely likely

Following your experience, how likely are you to use wildlife-friendly bubbles outdoors in the future?

1	2	3	4	5	6	7
Extremely unlikely	Moderately unlikely	Slightly unlikely	Neither unlikely nor likely	Slightly likely	Moderately likely	Extremely likely

Appendix K: Follow-up Survey Items that Were Distributed to Visitors at T3 and T4 via SurveyMonkey

(Study 2, Chapter 4)

Please describe any conservation behaviours you learned about during your visit to Wild Sea (open-ended).

Please *circle* your level of agreement with the following statements. Remember we are interested in your opinions; there are no right or wrong answers.

	strongly disagree	disagree	somewhat disagree	neither agree nor disagree	somewhat agree	agree	strongly agree
Balloons are marine wildlife friendly outdoor decorations	1	2	3	4	5	6	7
I do not see anythin wrong with using balloons outdoors.	1	2	3	4	5	6	7
I am concerned that balloons can be harmful to marine wildlife when used outdoors.	1	2	3	4	5	6	7
Bubbles provide a marine-wildlife friendly alternative balloons for outdoo events.	1	2	3	4	5	6	7
I prefer that outdoo events I attend do n use balloons.	1	2	3	4	5	6	7
I care about marine wildlife and the impact of plastic pollution on marine wildlife.	1	2	3	4	5	6	7

How likely are you to use balloons outdoors in the future?

1	2	3	4	5	6	7
Extremely unlikely	Moderately unlikely	Slightly unlikely	Neither unlikely nor likely	Slightly likely	Moderately likely	Extremely likely

How likely are you to use wildlife-friendly bubbles outdoors in the future?

1	2	3	4	5	6	7
Extremely unlikely	Moderately unlikely	Slightly unlikely	Neither unlikely nor likely	Slightly likely	Moderately likely	Extremely likely

Since your visit to Wild Sea, have you discussed with anyone the impact of using balloons outdoors on marine environments (yes/no)?

a. If yes, what was the discussion about (open-ended)?

Since your visit to Wild Sea, have you purchased wildlife-friendly bubbles (yes/no)?

Since your visit to Wild Sea, have you hosted or attended an outdoor celebration since your zoo visit (yes/no)?

a. If yes, did your zoo visit impact your behaviour at this event in any way (yes/no)?
b. If yes, how? (open-ended)

(Note: At T4, visitors were asked "*since the completion of this survey three months* ago…?")

Appendix L: Response Themes and Proportions Itemised, by Visitor Group and Time Point for Open-ended Knowledge and Behaviour Items at T3 and T4 (Study 2, Chapter 4)

Table Appendix L.1: *Response Themes and Proportions for Discussions Related to the Effect on Marine Environments of Using Balloons Outdoors*

		T3			T4			Total
		Exhibit-onl (Valid item = 16) % (n)	Exhibit+ presentation (Valid item *n* 17) % (n)	Control (Valid iter *n* = 4) (n)	Exhibit-only (Valid iter *n* = 14) % (n)	Exhibit+ presentatio (Valid item = 7) % (n)	Contro (Valid item *n* 4) % (n)	(Valid iten *n* = 62)
Discussion about balloons becoming marine litter	"*how they get into our oceans* "*how the balloons eventuall land somewhere and that is usually in the ocean*"	31.3 (5)	11.8 (2)	-	-	-		11.3 (7)
Discussion about general/non-specified hazards of balloons	*"harm balloons cause", "ho harmful they can be"*	62.5 (10)	52.9 (9)	75.0 (3)	50.0 (7)	14.3 (1)	50.0 (2	51.6 (32)
Discussion about ingestion and/or entanglement hazards	*"balloons choke sea life", "se life get stuck and choke on th harmful materials"*	12.5 (2)	11.8 (2)	-	7.1 (1)	-	-	8.1 (5)
Discussion about balloon use	*"avoiding balloons" ,"using balloons responsibly" "continual use of free balloor at public events"*	25.0 (4)	23.5 (4)	-	42.9 (6)	42.9 (3)	-	27.4 (17)
Discussion about balloon alternatives	*"consider other options", "bubbles are fun", "bubbles are cost effective"*	25.0 (4)	23.5 (4)	75.0 (3)	28.6 (4)	-	25.0 (1	25.8 (16)

Discussion topic: Othe	*"likelihood of older people changing from balloons to bubbles" ,"how to share message with others", "how balloons degrade/balloon material"*	18.8 (3)	29.4 (5)	-	14.3 (2)	57.1 (4)	25.0 (1	24.2 (15)
Discussion topic: Not specified	*"what I learned at the zoo", "passed on the info I learnt a the zoo", "awareness of the issue"*	6.3 (1)	11.8 (2)	-	-	-	-	4.8 (3)

Table Appendix L.2: *Response Themes and Proportions for How Behaviour Was Affected While Attending or Hosting an Outdoor Event*

		T3			T4			Total
		Exhibit-only (Valid iter *n* = 6) % (n)	Exhibit+ presentati n (Valid iter *n* = 4) % (n)	Control (Valid iter *n* = 4) % (n)	Exhibit-onl (Valid iten *n* = 6) % (n)	Exhibit+ presentati n (Valid iter *n* = 3) % (n)	Control (Valid iter *n* = 2) % (n)	Total vali item *n* = 25 % (n)
Encourages others to use bubbles/use alternatives/no use balloons	*"encouraged others to think about using alternatives"*	-	25.0 (1)	75.0 (3)	33.3 (2)	33.3 (1)	50.0 (1)	32.0 (8)
Didn't use/purchase balloons	*"I didn't use balloons in my birthda party", "have not purchased balloons"*	83.3 (5)	50.0 (2)	-	16.7 (1)	33.3 (1)	50.0 (1)	40.0 (10)
Used an alternative to balloons: Non-specified/other	*"I chose an alternative for a work event", "used piñatas instead of balloons"*	-	50.0 (2)	25.0 (1)	16.7 (1)	-	-	16.0 (4)
Used bubbles	*"organised bubbles for the kids", "took bubbles for the kids to play with"*	-	25.0 (1)		16.7 (1)	66.7 (2)	-	16.0 (4)
Other	*"refused offer of free promotional balloons", "ensured that all the kid at a party had their balloons secure to their wrist"*	16.7 (1)	-	25.0 (1)	16.7 (1)	-	-	12.0 (3)

Table Appendix L.3: *Response Themes and Proportions for Recall of Conservation Behaviours Learned About During the Wild Sea Visit*

		T3			T4			
		Exhibit-only Valid ite *n* = 22 % (n)	Exhibit+ presentat n Valid ite *n* = 17 % (n)	Control Valid item =13 % (n)	Exhibit-only Valid item = 15 % (n)	Exhibit+ presentatic Valid item = 3 % (n)	Control Valid item = 4 % (n)	Total Valid item *n* = 7 % (n)
Do not use balloons/dc not use balloons outdoors	*"avoid using balloons outside", "not to use balloons"*	4.5 (1)	17.6 (3)	30.8 (4)	6.7 (1)	33.3 (1)	25.0 (1)	14.9 (11)
Use balloons less/Use balloons responsibly	*"to use balloons responsibly", "less use o balloons"*	9.1 (2)	-	7.7 (1)	-	-	-	4.1 (3)
Use bubbles/use bubbles instead of balloons	*"use bubbles not balloons "bubbles as an alternativ to balloons"*	36.4 (8)	35.3 (6)	23.1 (3)	-	-	50.0 (2)	25.7 (19)
Balloons pose a dange to wildlife: General/non-specified	*"become hazardous to marine wildlife", "new awareness about the dangers of balloons in relation to wildlife"*	13.6 (3)	29.4 (5)	7.7 (1)	13.3 (2)	33.3 (1)	25.0 (1)	17.6 (13)
Balloons pose a dange to wildlife: Choking/ingestion/ent nglement	*"sea animals can choke an die from balloons and thei string", "balloons choke sea life*	9.1 (2)	-	-	-	33.3 (1)	25.0 (1)	5.4 (4)

Plastic is bad for the environment/plastic harms wildlife	*"plastic waste can be harmful to wildlife", "my visit reinforced the awareness of the negative impacts plastics have on se life"*	18.2 (4)	17.6 (3)	7.7 (1)	6.7 (1)	-	-	12.2 (9)
Do not litter/Reduce/Recycle	*" recycle plastic rings fror cans", "not littering", reduce any plastic waste that may impact wildlife"*	18.2 (4)	35.3 (6)	15.4 (2)	46.7 (7)	-	25.0 (1)	27.0 (20)
Do not recall/None	*"can't remember anything specific", "sorry, none"*	9.1 (2)	-	-	26.7 (4)	33.3 (1)	-	9.5 (7)
Other	*"the impact of fishing line "more observant on how segregate household waste", "support marine conservation organisations*	9.1 (2)	5.9 (1)	7.7 (1)	60.0 (9)	-	-	17.6 (13)

Appendix M: Univariate GLM Outputs for Each Outcome Variable (Study 2, Chapter 4)

Parameter	*β*	SE*	F	*p*	*df*	Partial Eta Squared
Attitudes towards balloon use outdoors						
Corrected model			9.63	.000	11	.073
Time			7.27	.000	3	.016
Time point 1	0[a]	-				-
Time point 2	-.14	.48		.766		.000
Time point 3	.01	.49		.984		.000
Time point 4	-.65	.49		.189		.001
Completed pre-survey			18.90		1	.014
No	0[a]	-		-		-
Yes	1.90	.44		.000		.014
Viewed a presentation			5.30		1	.004
No	0[a]	-		-		-
Yes	-1.88	.58		.001		.008
Zoos Victoria member			3.52		1	.003
No	0[a]	-		-		-
Yes	-.67	.36		.061		.003
Learning and discovery motivation			24.07		1	.018
Not reported	0[a]	-		-		-
Reported	-1.44	.29		.000		.018
Self-fulfilment motivation			4.25		1	.003
Not reported	0[a]	-		-		-

Reported	.842	.409		.039		.003
Time*Viewed a presentation			8.81	.000	3	.003
Likelihood of using balloons outdoors						
Corrected model			7.81	.000	10	.068
Time			10.49	.000		.028
Time point 1	0[a]	-		-		-
Time point 2	-.46	.13		.000		.012
Time point 3	-.25	.25		.312		.001
Time point 4	-1.04	.29		.000		.012
Completed pre-survey			20.71		1	.019
No	0[a]	-		-		-
Yes	-.57	.13		.000		.019
Viewed a presentation			.24		1	.000
No	0[a]	-		-		-
Yes	-.12	.16		.476		.000
Learning and discovery motivation			20.27	.000	1	.018
Not reported	0[a]	-		-		-
Reported	-.42	.09		.000		.018
Social interaction motivation			5.27	.022	1	.005
No	0[a]	-		-		-
Yes	-.21	.09		.022		.005
Time*Viewed a presentation			1.43	.232	3	.004

Likelihood of using bubbles outdoors						
Corrected model			5.10	.000	13	.058
Time			1.80	.145	3	.003
Time point 1	0[a]	-		-		-
Time point 2	.28	.16		.084		.003
Time point 3	.58	.31		.058		.003
Time point 4	.48	.36		.181		.002
Completed pre-survey			2.13		1	.002
No	0[a]	-		-		-
Yes	.23	.16		.157		.002
Viewed a presentation			1.61		1	.001
No	0[a]	-		-		-
Yes	-.46	.20		.177		.005
Learning and discovery motivation			3.08		1	.003
Not reported	0[a]	-		-		-
Reported	-.20	.12		.080		.003
Zoos Victoria member			13.72		1	.013
No	0[a]	-		-		-
Yes	-.51	.14		.000		.013
Gender			12.09		3	.011
Non-Female	0[a]	-		-		-
Female	-.393	.113		.001		.011
Time*Viewed a presentation			.25	.874	3	.001

Appendix N: Participant Information Sheet

(Study 3, Chapter 5)

University of South Australia

Research Project: Experiences of designing and evaluating conservation-education programs

Dear potential participant

Zoos, aquariums, and other wildlife tourism sites can play a vital role in promoting greater understanding of environmental issues and inspiring conservation action among community members. We are interested in understanding your experiences in designing and evaluating conservation-education programs. The end goal of our research is to develop a resource kit to support the evaluation process.

Participation in this study is voluntary and you are welcome to withdraw from the study at any stage, without affecting your position now or in the future. Participation will involve a telephone or face-to-face interview about your experiences of developing and evaluating the outcomes of conservation-education programs, taking approximately 15-20 minutes to complete.

With your permission, the interview will audio-recorded. No identifying information is required during the interview, and the researcher will take every care to remove all potentially-identifying details (e.g., about the organisation or education program) as the interviews are transcribed. Interview transcripts will be made available upon request. To thank you for your time, participants who complete the interview will go in a draw to win one of two $100 Visa Prepaid gift cards.

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All information will be kept confidential by the researcher, and individual participants will not be identified when the research findings are reported. No information which could lead to identification of any individual will be released, unless required by law. Information collected as part of the study will be retained for five years and stored in a secure place in the School of Psychology, Magill Campus, at the University of South Australia.

This project has been approved by the University of South Australia's Human Research Ethics Committee (project: 0000035677). If you have any ethical concerns about the project or questions about your rights as a participant please contact the Executive Officer of this Committee, Tel: +61 8 8302 XXXXX, Email: vicki.XXXXX@unisa.edu.au.

For any further questions about the study, please feel welcome to contact me via email: XXXXX@unisa.edu.au or telephone 0404 XXXXXXXX. If you would like to receive a summary of the research findings and outcomes when the research has been finished, please provide a contact email or postal address.

Kind regards

Sarah Mellish
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Appendix O: Participant Consent Form (Study 3, Chapter 5)

UniSA Research and Innovation Services

Human Research Ethics Committee
CONSENT FORM
Retention of taped materials, photographs or original works

This project has been approved by the University of South Australia's Human Research Ethics Committee. If you have any ethical concerns about the project or questions about your rights as a participant please contact the Executive Officer of this Committee, Tel: +61 8 8302 XXXXX; Email: humanethics@unisa.edu.au

SECTION 1: CONTACT AND PROJECT DETAILS	
Researcher's Full Name:	Ms Sarah Mellish
Contact Details:	Sarah.XXXXX@mymail.unisa.edu.au (T: 0404 XXXXX)
Supervisor's Full Name:	Associate Professor Michelle Tuckey; Dr Elissa Pearson
Contact Details:	Michelle.XXXXX@unisa.edu.au(*T: +61 8 830 XXXXX*); Elissa.XXXXX@unisa.edu.au(*T: +61 8 830 XXXXX*);
Protocol Number:	0000035677
Project Title:	Investigating barriers and facilitators experienced by Zoo educators when evaluating conservation-education programs.

SECTION 2: CERTIFICATION

Participant Certification

In signing this form, I confirm that:

- I have read the Participant Information Sheet, and the nature and the purpose of the research project has been explained to me. I understand and agree to take part.
- I understand that I can withdraw from the study at any stage and that this will not affect my status now or in the future.
- I confirm that I am over 18 years of age.
- I understand that I will be audiotaped during the study
- I understand that while I may not directly benefit from taking part in the project, upon completion of the interview, I will be entered into a draw to win one of two $100 Visa Prepaid gift cards.
- I understand that while information gained during the study may be published, I will not be identified and my personal results will remain confidential, unless required by law.
- I understand that the audio tape(s) and transcripts will be stored for five years in the School of Psychology, Social Work and Psychology data storage facility (C1-03, Magill campus) upon completion of data analysis.

Participant Signature	*Printed Name*	*Date*

Researcher's Certification

I have explained the study to subject and consider that he/she understands what is involved.

Researcher's Signature	*Printed Name*	*Date*