A Second at the Sign:

Signage Increases Visitors' Recall of Wildlife Information at a Kiwi Hatchery

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Abstract

Conservation of wildlife is an integral part of sustainable development of a nation and conservation education needs to remind citizens of how they can play their part. Signs are one of the commonly used low-cost tools to educate the public about different facts and actions necessary to conserve wildlife. I investigated whether a sign increased recall of specific facts about kiwi predators. I used a single-case, multiple-baseline-across-site design with an ABAB reversal design. At the intervention site The National Kiwi Hatchery, Rotorua, visitor recall increased when the sign was present, compared to when it was absent. At the control site, Hamilton Zoo, where no sign was placed, recall was similar to sign-absent conditions at the intervention site and did not change over the study period. My research provides evidence that signs can be effective low-cost behavioural interventions.

Keywords: signage, conservation, behavioural intervention, ABAB, multiple baseline

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Wildlife conservation is or should be an integral part of human lives. To think that we can ignore the call for conservation action would be ignorant of the fact that wildlife is in every way influencing our lives and those of future generations. Conservation can be woven into our daily lives if we are aware of the impact of our behaviours on the lives of the different species on this planet.

The Conservation Act (1987) in Aotearoa defines conservation as "The preservation and protection of natural and historic resources for the purpose of maintaining their intrinsic values, providing for their appreciation and recreational enjoyment by the public, and safeguarding the options of future generations" (Conservation Act, 1987). Conservation of natural resources has benefited our understanding of the past and our future in terms of evolution of our civilisations and nature (Zheng et al., 2024). Learning about extinction and destruction of natural resources directs us towards sustainable development for the future. A lot of our understanding about conservation comes from institutions and facilities that actively seek to make contributions to and promote conservation (Godinez & Fernandez, 2019; Heimlich & Ardoin, 2023). Such facilities are mainly zoos, aquariums, museums, national parks, botanical gardens, heritage sites, protected areas, and reserves, but are not limited to these.

Curators of zoos, aquariums, and botanical gardens have the same goal as those of museums; to educate the public about conservation using exhibits, with the only difference being that they use live exhibits in their facilities (Mason, 2000). In the past, they mainly strived to amuse and educate, and to engage in scientific research and species preservation (Bostock, 1993; Mason, 2000; Smith et al., 2008). Very often these objectives were

interwoven rather than discrete, creating a learning environment for educating people about the value of ecosystems and the importance of biodiversity (Godinez & Fernandez, 2019; Greenwell et al., 2023; Mason, 2000). Conservation of biodiversity contributes enormously to regulation and formation of cycles, composition of environmental processes, biological control, and primary food production, which are some of the major functions of ecosystems (Mittermeier & Konstant, 2001).

In recent decades, conservation projects like captive breeding and population management programmes have promoted education and brought awareness to visitors about preserving diversity and survival of rare and endangered species (Ballantyne et.al., 2007). Conservation of flagship species also leads to conservation of less popular species by preserving shared habitats (Ballantyne et.al., 2007; Moscardo et al., 2004). Most facilities actively seek public help in conservation efforts as the public are the main co-inhabitants in the local biodiverse regions, and little can be done by a few facility staff or activists. There is increased research in the field of conservation and organisations and governments are coming forward to fund studies as the impact of conservation is also seen in the economic development of a nation (Ballantyne & Packer, 2011), with increasing reliance on the natural world for maintenance of spiritual and psychological wellbeing, recreation, ecotourism, and scientific research (Mittermeier & Konstant, 2001). Institutions are actively creating and promoting public awareness through education about choices and behaviours of individuals and societies that are necessary to reduce if not negate the environmental problems that the world is facing. The main challenge is inducing behavioural change in individuals and groups that is environmentally friendly and eventually aligning with sustainability as behaviour is the direct or indirect cause of these major issues (Ballantyne & Packer, 2011; Nickerson, 2003).

Conservation in Aotearoa

In Aotearoa, conservation of wildlife has always been a central theme in the culture and public policies of the nation. Conservation efforts focussing on native species have helped bring back endangered species to stable population numbers. According to the Department of Conservation (2025), a major challenge of protecting native species in Aotearoa is the surging populations of introduced predators. Eradicating them seems an impossible task and controlling their population is one of the main challenges but also an important step in this process. This is where public awareness about not only the native species but also about the role of predators come into play. The Department of Conservation website (https://www.doc.govt.nz/) provides information regarding steps to control pest and threats to native species including flora and fauna. A major topic of concern is the protection of Aotearoa's endemic national icon, the kiwi, from its predators. Being the flagship species for conservation, the kiwi represents not only the uniqueness of Aotearoa's wildlife but also a natural heritage (Department of Conservation, n.d.). There are only around 70,000 kiwi left in the country and, without predator control, their numbers will decline by 2% each year (Department of Conservation, n.d.). Educating the public about these facts, especially of the threat of mammalian predators like dogs and cats, may make people aware of this important issue and bring about more public efforts in controlling such threats.

Conservation Education

As annual visitors to wildlife facilities keep increasing, these facilities offer an important opportunity to educate the public. The primary motive of visits to wildlife facilities is not always for education, but research has shown that the majority of them have a learning agenda (Roe & McConney, 2014) and many people are willing to gain information about conservation and also to teach their children something meaningful during these visits (Ballantyne & Packer,2016; Collins, 2018; Falk, 2011; Ham & Weiler, 2012; Massarani et

al., 2022). A major aim of including education in wildlife facilities is to increase knowledge and create awareness among the public about conservation steps they can take which will lead to decreased negative impacts on wildlife (Ballantyne et.al., 2007; Moscardo et al., 2004; Ogden & Heimlich, 2009). The extent of learning in such informal settings has been discussed by many (e.g., Collins, 2018; Falk, 2011; Hofstein & Rosenfeld, 1996; Packer & Ballantyne, 2004). Packer and Ballantyne (2004) suggest that in free-choice learning environments like zoos and aquariums, education and entertainment can be synergistic. The authors suggest that visitors often view learning as part of the entertainment experience, allowing such settings to offer 'learning for fun', a blend of education and entertainment. Packer (2006) further found that even visitors without educational goals may engage in meaningful learning. There is also extensive research about factors that significantly improve visitor knowledge (He & Chen, 2012) and how specific behaviours can be changed by providing more focussed educational messages on simple doable actions (Guo et al., 2017; Roe & McConney, 2014). Researchers have emphasised the need to consider the highly individualistic nature of learning, and the different factors influencing individual learning outcomes (Anderson et al., 2003; Ballantyne & Hughes, 2003; Collins, 2018; Heimlich & Ardoin, 2023; Hughes et al., 2011). Zeppel and Muloin (2025) also reiterate that on-site learning improved conservation behaviours of visitors after analysing tourist learning.

An important aim of conservation education is to ensure the public learns information about adopting environmentally sustainable behaviours (Heimlich & Ardoin, 2023). For the purpose of my study, I defined learning as the recall of information. This is a small, yet important, behaviour change that facilities can bring about in their visitors.

Interpretation and Signage

Interpretation is one of the most effective options nature-based tourism facilities rely on for inducing learning and behaviour change (Hughes, 2013; Kim et al., 2011; Roberts et

al., 2014; Zheng et al., 2024). Interpretation is a broad term used for various tools and services used to communicate information in verbal, written, or non-verbal forms to the visitor so that the visitor can effectively interpret the message being conveyed. This includes but is not limited to educational signage, prints, guided/self-guided walks, talks, and interactive activities/tools (Ham & Weiler, 2012). Interpretation mainly helps visitors learn about the consequences of their behaviour and thus minimise their impacts on wildlife (Ham, 2007; Kim et al., 2011; Moscardo et al., 2004). There have been many studies supporting the effectiveness of high-quality interpretation services in enabling learning and behaviour change of visitors (e.g., Edney et al., 2023; Lee et al., 2023; Marschall et al., 2017).

Signage is one of the most common and cost-effective interpretative tools used in a variety of settings. It is one of the most common non-personal communication channels used in nature-based recreation and tourism settings to influence visitor behaviour in terms of conservation and safety (Aley et al., 2024; Girasek, 2019; Moscardo et al., 2004). Roe et al. (2014) provided a systematic analysis of the different types of education communications used in 176 zoos from 50 countries and reported that signage was the most prevalent form of communication used by 97% of them and an average of 95% visitors read some exhibit signs. Signage is also convenient as the information on a sign will be present at the location regardless of staff presence or timing (Ballantyne & Hughes, 2003). It can be installed at remote places where regular staff cannot be deployed and in crowded or public spaces where directions, guidelines, warnings, and other information needs to be displayed (Allbrook & Quinn, 2020; Moscardo et al., 2004). From merely presenting facts and information in the past, signs have evolved in their role to educate viewers, especially in wildlife tourism. They are now designed to attract the viewer’s attention, improve learning, and promote behaviour change (Ballantyne & Hughes, 2003; Gessa & Rothman, 2021; Hughes, 2013; Marschall et al., 2017; Zhong et al., 2025).

Signage as Behavioural Intervention

Several studies have explored the different characteristics of signage in bringing about effective behaviour change. Ballantyne and Hughes (2003) provide an extensive Interpretative Signs Checklist for effectively designing, evaluating, and improving educational signs to promote environmental behaviour of visitors. Meis and Kashima (2017) reviewed evidence of effectiveness and characteristics of signage and recommended the use of clear and unambiguous messaging to improve effectiveness. Sotés et al. (2020) further reiterated the importance of having standardised safety signage systems. Based on their survey research of beach users and lifeguards, they recommended that a simple signage system that is easy to understand and familiar across different locations would avoid erroneous interpretation. However, through a field study, Newcomb and Newcomb (2020) explored wordings of signs and found that, regardless of textual formatting, littering was reduced in the presence of a sign. Rice et al. (2023) investigated the vast body of research conducted on the efficacy of message wording style on signage and found that the graphic design, quality, and typeface are equally relevant when it comes to communicating the message and bringing about behaviour change in visitors. Yang (2024) analysed the different designs and elements of information signage and found that punitive warning signs were more efficient than positive educational signs in curbing visitor depreciative behaviour of treading over vegetation, with presence of both signs significantly reducing the behaviour when compared to a no-sign condition.

Point-of-decision or point-of-choice prompts are signs displaying visual and/or verbal information placed at the point of occurrence of a certain behaviour or choice with the intent to modify it (Lee et al., 2024). Prompts are antecedent stimuli that effectively change a target behaviour (Cooper et al., 2020). Prompts have shown to effectively increase pro-environmental behaviours like promoting waste reduction, and resource and energy

conservation (Gemmecke et al., 2025). Signage has been used as an effective prompt in modifying behaviour in a variety of settings and with different populations.

Signs have successfully altered recycling and conservation behaviour of people. Signs with informational prompts placed directly above recycling receptacles were effective antecedents for increasing recycling behaviour in office environments (Austin et al., 1993) and a university cafeteria (Werner et al., 1998). Not only did they increase recycling behaviour but also increased knowledge of the appropriate recycling behaviour (Werner et al., 1998; Wu et al., 2018). Sussman and Gifford (2012) tested signs with visual prompts as a behavioural intervention to increase frequency of "lights off" behaviour in washrooms and found it to significantly increase the behaviour compared to when no signs were present.

The use of signage as an intervention to change stair-using behaviour has been an extensive topic of research for the intervention's scalability and feasibility. Stair use increased significantly with the use of signs in different settings like fitness facilities (Pillay et al., 2009), university campuses (Grimstvedt et al., 2010), workplaces (Bungum et al., 2007), and underground train stations in both high and low socioeconomic areas (Ryan et al., 2011). Bauman et al. (2016) conducted a meta-analysis of 50 studies published between 1980 and 2014 using point-of-decision signs as interventions and provided evidence of an over 50% increase in likelihood of stair use with the use of motivational signs. Puig-Ribera et al. (2019) investigated the effects of signage on stair use by pooling workplace studies and found an increase in stair descent supporting the use of signage as an intervention for behaviour change. Kahn et al. (2002) conducted a systematic review to summarise community-based interventions to increase physical activity and found that the percentage of people using stairs increased in the presence of point-of-decision signs, implying the effectiveness of signs in increasing physical activity. Updated reviews that included more studies in different settings and populations (Caputo et al., 2022; Jennings et al., 2017; Landais et al., 2020; Lee et al.,

2024; Soler et al., 2010) found strong evidence for signage interventions effectively increasing stair-use behaviour.

Signs have been used effectively not just to increase, but also to decrease frequency of target behaviours. A systematic review by Gupta et al. (2020) gave evidence of the effectiveness of point-of-sale signage on sugar-sweetened beverages on reducing purchasing behaviour. In their experimental evaluation of signs describing potential legal and financial risks for entering a dangerous river, Girasek (2019) found that signs significantly reduced water-entering behaviour. In the art world, Fullerton et al. (2024) found that basic behavioural prompting techniques using three different messaging conditions effectively reduced the occurrences of harmful display-touching behaviour in a museum, with little difference in the outcomes of the three different messaging approaches.

Researchers investigating signage effectiveness have provided evidence of behaviour change of visitors in both captive and non-captive wildlife facilities. Different informational signs have reduced knocking behaviour of visitors in aquariums, reducing acoustic disturbances for resident fish species (Kratochvil & Schwammer, 1997). Sherwen et al. (2014) found that signage accompanied by personnel in uniform was effective in reducing visitor's negative behaviour which included making noise and interacting with zoo animals. Marschall et al. (2017) empirically tested if interpretative signage can modify tourist behaviour at a seal-watching site in Iceland. Their results showed that shouting was reduced in the presence of signage, regardless of the type of signage. However, the authors also found that signs with teleological (instructions with explanation) information were more effective than ontological (instructions without explanation) ones. Allbrook and Quinn (2020) studied the effects of regulatory signs intended to decrease visitor approaches towards colonial island-nesting birds on an unmanaged island and found that the signs dramatically increased

the distance between visitors and birds resulting in less displacement of the birds from their nests.

The Present Study

As facilities in Aotearoa rely heavily on the use of signage for conservation purposes, a study that provides evidence on the ability of signs to educate the public will be informative. The Kiwi Advocacy Project is an initiative that brings together facilities involved in conservation in Aotearoa to participate in research supporting and advocating conservation of wildlife, especially of kiwi, using signage as a low-cost intervention. As part of their accreditation, facilities housing kiwi are required to provide evidence of their advocacy efforts for their membership in Zoo and Aquarium Association Australasia (ZAA). The Chief Executive Officer of Orana Wildlife Trust, Rachel Haydon (formerly the General Manager of The National Aquarium of New Zealand, Napier), based in Christchurch, approached Dr. Rebecca Sargisson, from the University of Waikato, to collaborate on research for the Kiwi Advocacy Project. Multiple hui were undertaken to establish a collective goal and determine which facilities in New Zealand were able to participate in this study. Two facilities that agreed to participate in the project were assigned to me.

One of the sites housed kiwi and was designated as the intervention site. The other site, which did not house kiwi was designated as the control site. I investigated whether introducing a new sign at the intervention site would increase recall of information of visitors. For this purpose, a single-subject design was implemented, where at the intervention site, the sign was absent during baseline and present during intervention phases. At the control site, the sign was not used in any phase. I measured recall of information of the specific information about kiwi predators on the intervention sign by participants through a questionnaire. Data were collected from both the sites during different phases and compared across phases and sites to determine the effectiveness of the sign as an intervention to

increase recall of information. Based on previous research findings of effectiveness of signage in changing behaviour, I hypothesised that the presence of the intervention sign would increase recall of specific information about kiwi predators.

Method

Sites

I conducted the study at two sites: Hamilton Zoo and The National Kiwi Hatchery (TNKH), Rotorua. The Hamilton Zoo, which had no kiwi, was the control site and TNKH, which housed kiwi, was the intervention site. Both the sites gave written consent for collecting data from visitors through online questionnaires.

Participants

Participants for this study were visitors who completed the questionnaire at each of the participating sites. The approximate number of monthly visitors in 2024, as provided by the respective sites, was between 1000 and 2000 at TNKH and approximately 4600 at the Hamilton Zoo. The number of participants who completed the questionnaire was lower than these numbers as not all visitors chose to complete the questionnaire and data from visitors who disclosed that they were under the age of 16 were excluded. Total number of responses received was 858 from TNKH and 162 from the Hamilton Zoo. Of these, only 766 completed responses from TNKH and 126 competed responses from Hamilton Zoo were recorded for this study. The excluded responses were mainly from participants who were below the age of 16 or incomplete ones.

Design

A single-case, multiple-baseline-across-site design was used to evaluate the effect of signage on visitor behaviour. An ABAB reversal design (baseline, intervention, return to baseline, reintroduction of intervention) at the intervention site was used to demonstrate experimental control and to improve internal validity. The duration of each phase was decided after the visual analysis of data points. The intervention was introducing a new sign (Appendix A) with information about the main predators of kiwi at the intervention site. The intervention sign included images of the four main predators of kiwi and information relevant

to kiwi conservation. At the control site, data were collected for the same period but with no phase changes, to test whether visitor knowledge of kiwi predators changed across time and in the absence of the intervention.

Ethical Approval

Ethical approval was given by the Division of Arts, Law, Psychology, and Social Sciences Human Research Ethics Committee under delegated authority of The University of Waikato Human Research Ethics Committee (Approved Project no. FS2025-12).

Project Registration

This project was pre-registered with Open Science Framework (OSF; https://osf.io/). The preregistration can be found at https://doi.org/10.17605/OSF.IO/2NY8V. Two changes were made to the study once it commenced. First, to account for variability in, and low rates of, response numbers at both sites, 4-day averages were used to calculate mean scores instead of daily averages. Second, a reversal design was introduced at the intervention site as the sites gave permission to continue the study.

Procedure

Baseline data collection began at both sites at the same time on the 04th of July 2025. During the baseline phases of the study, a QR code link to the questionnaire (Appendix B) was displayed on a poster (Appendix C) on stands at two locations at the control site, inviting visitors to participate in the questionnaire through the online platform Qualtrics (https://www.qualtrics.com/). One poster was placed near the indoor cafe or zoo exit and the other was placed along the path to the outdoor cafe cum playground area inside the zoo premises. The poster was also distributed as a flyer at the control site entrance. At the intervention site, the QR code link to the questionnaire (Appendix D) was included in the post-visit email from the site and promoted by staff using a flyer (Appendix E) to visitors on their way back in the shuttle van from the site to the main reception at the end of their visit.

For a phase to document a pattern and to meet evidence standards without reservation, Kratochwill et al. (2010) recommended a minimum of five data points in each phase and more if the data are not stable, in other words, if there is high variability, outliers, or trending data. After stable and sufficient data were obtained during the baseline phase at both the sites, the TNKH site representative was notified, and a request was sent to have the intervention sign ready for installation. However, the representative introduced the intervention before confirming the date to install and the intervention was first introduced at TNKH on the 16th of August 2025. Consequently, the last datapoint in the baseline for TNKH was lower than all previous datapoints for the site, but we started collecting data for the intervention as it was expected to increase the number of questions answered correctly. The intervention sign about the predators of kiwi (Appendix A) was put up in the entry area of TNKH and an additional question was included in the questionnaire for TNKH about viewing the sign (Appendix F). All other questions, QR code links, and locations were the same at both sites as in the baseline phase.

After stable data were obtained for the intervention phase and as per the intervention site's request, the return-to-baseline phase was introduced at the intervention site on the 31st of October 2025. For the return-to-baseline phase, the intervention sign at TNKH was covered with a poster featuring non-predator-related content. All contents of both the questionnaire, QR code links, and locations were the same as the initial baseline phase at both the sites. Following stable data, the intervention was reintroduced on the 20th of November 2025. For the reintroduction of intervention phase, the intervention sign was unhidden, and the additional question about viewing the sign was again included in the questionnaire at TNKH. All other conditions were similar to those of the intervention phase. The Hamilton Zoo continued as a control site and used the same questionnaire throughout the study without

the intervention. After stable data were obtained during the last intervention phase, data collection ended on the 14th of December 2025.

Recruitment was self-driven by the participants by scanning the QR code link. The QR code was advertised as collaborative research between the respective sites and The University of Waikato. When the QR code was scanned and the link of the questionnaire clicked, the participant was directed to an online Qualtrics page (Appendices B, D, and F) detailing the study information and providing a consent checkbox before the first page of the questionnaire appeared. Participants were also asked if they were over 16 years of age on the initial information page of the questionnaire. If they selected "No", they did not proceed to the questionnaire. Participants could withdraw at any time before clicking the final submit button by closing the browser window. After this, withdrawal of data was not possible because all data were anonymised.

The questionnaire included three multiple-choice questions related to the main predators of kiwi. Each correct answer received a score of 1, and each incorrect answer received a score of 0. An individual participant's total score ranged from 0 to 6. Participants were asked the following questions to assess knowledge about the main kiwi predators:

1. What are the four main predators of kiwi? (Answer: Stoats, Dogs, Cats, Ferrets; max = 4 points)
2. What predator is the biggest threat to kiwi chicks? (Answer: Stoats; 1 point)
3. What predator is the biggest threat to adult kiwi? (Answer: Dogs; 1 point)

The dependent variable was the mean of all participants' total scores at that site across 4 consecutive days.

Formula

Score (per site per data point) = Sum of all participants' total scores across 4 consecutive days at the site ÷ Number of participants in those 4 consecutive days at that site.

The number of responses varied at both sites with some days having no responses.

Incentives

An option was presented to participants to provide their email address if they wished to receive a copy of the research outcomes and/or participate in future research. A debrief email (Appendix G) was sent to participants who completed the questionnaire and provided their email addresses. Email addresses were stored separately from questionnaire responses and were not linked to any data.

Participants were also presented an option to provide their email address if they wished to participate in a draw to win a prize at each of the facilities. Participants who opted to take part in the draw from the two sites went into draws to win prizes provided by the facilities (small kiwi prize by The National Kiwi Hatchery, Rotorua, and a family pass by Hamilton Zoo). As per the sites' requests, I chose winners randomly from the list of email addresses provided by participants who opted to be included in the draw (from their respective facilities) and these two facilities were provided with email addresses of the winners. Only designated facility staff received the email addresses of winners for prize distribution purposes. Data will be stored indefinitely. No personal information identifying participants was collected within this research.

Data Analysis

I used Microsoft Excel (Version 2508; https://excel.cloud.microsoft) to record data and to produce all figures. As the design met evidence standards without reservations, as outlined by the What Works Clearinghouse (WWC) (Kratochwill et al., 2010), I conducted behaviour analytic visual analysis to demonstrate evidence for a relationship between the intervention and the recall of information about kiwi predators by documenting level, trend, and variability of data points. I examined graphed results and assessed the changes in behaviour within and between different phases by documenting immediacy of the effect,

proportion of overlap, and consistency of data points. I calculated effect size using percentage of non-overlapping data (PND). PND is the percentage of intervention phase data points that exceed the highest data point in the baseline phase (when behaviour increase is expected), with higher PND showing larger effect (Johnston et al., 2019). PND scores over 90% reflect a very effective intervention, between 70-90% is effective, 50-70% questionable, and scores below 50 ineffective (Scruggs & Mastropieri, 1998).

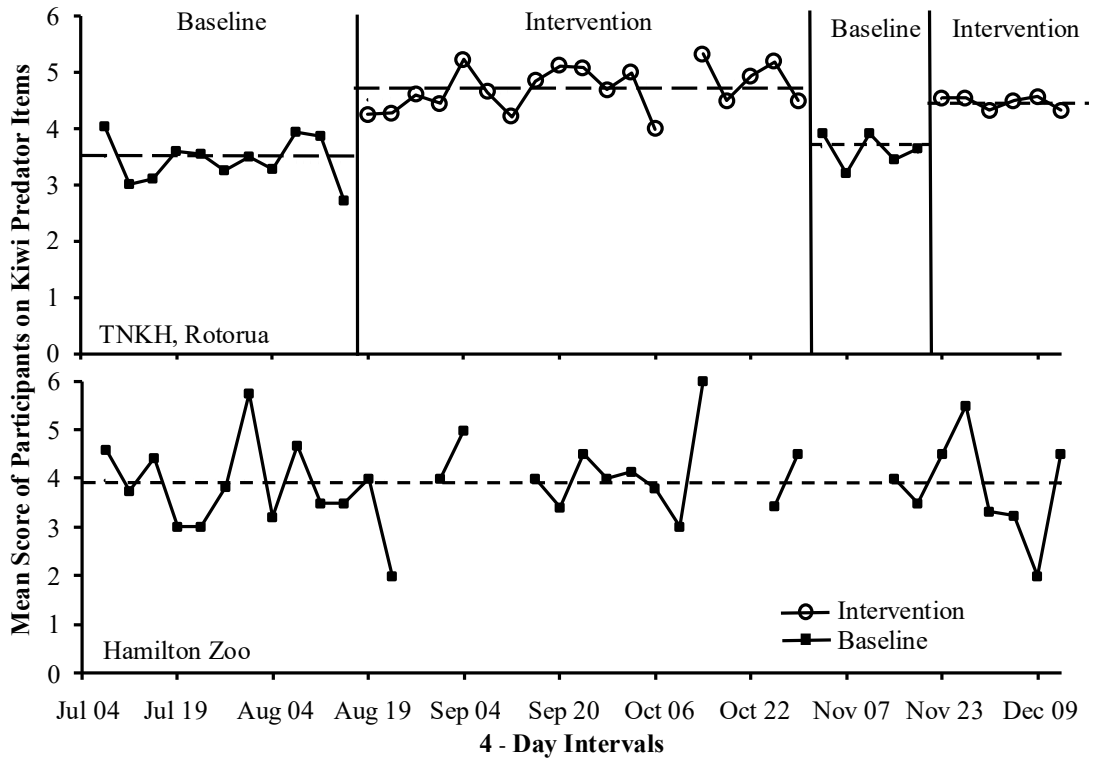
Results

Level, Trend, and Variability

Figure 1 shows the data collected at both sites during the different phases of the study. Throughout the entire study, data from the Hamilton Zoo displayed a variable but stable pattern. The mean score was 3.93 and ranged from 2 to 6.

Figure 1

Mean Recall Score in 4-Day Intervals at Both Sites



Note. The vertical lines indicate each phase change. The horizontal dotted lines indicate trend and the horizontal dashed lines indicate mean or levels in each phase.

During the initial baseline phase at TNKH stable data were obtained. The mean score during this phase was 3.44 and ranged from 2.71 to 4.04 with a stable trend. During the first phase of intervention at TNKH, data were slightly variable but at a higher level compared to baseline phase. The mean score during this phase was 4.71 and ranged from 4 to 5.33 with a

slightly increasing trend. In the return-to-baseline phase, data were slightly variable but at a lower level than in intervention phase and at a similar level to the initial baseline phase. The mean score during this phase was 3.63 and ranged from 3.21 to 3.91 with a stable trend. During the final intervention phase, a high and stable level of data was obtained. The mean score during this phase was 4.47 and ranged from 4.33 to 4.57 again with a stable trend.

Immediacy of Effect

In Figure 1, there is a clear, immediate effect of the intervention in both the initial and return-to-intervention phases.

Proportion of Overlap

PND for the first intervention phase was 94.44% and for the second intervention phase was 100%, implying very little overlap between intervention and baseline phases.

Consistency of Data Patterns

At the intervention site, during both baseline phases there was consistency in the data points and the values were lower than the intervention phases. During both intervention phases, the data points were consistently above the scores of those in baseline phases.

The baseline data at the intervention site were mostly within the same range of values as the control site. Throughout the study, the mean score of participants on the kiwi predator items raised only during the two intervention phases. In other words, the mean scores were higher in phases in which the sign was present and lower in all other phases in which the sign was absent.

Discussion

I used a questionnaire to evaluate the effect of signage on visitor recall of information about kiwi predators. I hypothesised that in the presence of the intervention sign, visitors' recall of specific information would increase. My findings supported my hypothesis.

Figure 1 gives clear evidence of an increase in recall of information when comparing the baseline data with the intervention data. Data from the control site show no change in mean score across the experiment, showing that in the absence of a sign, visitors' recall did not improve. The mean of the control site data was also lower than the intervention phase data implying an effective increase in recall of information in the presence of the intervention sign. The high PND scores support the effectiveness of the intervention. Strong causal inference from the ABAB design in this study suggests that recall of information was increased in the presence of sign.

My results support previous research findings of the effectiveness of signs as interventions for behaviour change, especially the findings of Werner et al. (1998) who demonstrated increased knowledge when using signs to convey information and messages. Like their study, I measured participant recall using questionnaires to provide evidence of actual behaviour change. My findings add to the growing research that signage is a simple yet effective behavioural intervention to increase target behaviours in public places like campuses (Nettle et al., 2012; Platter & Pokorny, 2017), wildlife facilities (Kratochvil & Schwammer, 1997; Marschall et al., 2017) and for bringing about effective behavioural change for the benefit of the greater good (Hamilton & Rane, 2022; Werner et al., 2002).

Many environmental problems are rooted in human behaviour and relevant changes in these behaviours can help to reduce environmental impacts. Not all people can make drastic changes in the environment, but each person can make a meaningful change in their daily lives by adopting comparatively better behaviours for the environment (Osbaldiston &

Schott, 2012). Behaviour-specific knowledge and skills that can be provided at conservation facilities are factors that motivate the change in behaviour of individuals (Kim et al., 2018; Stern, 2000; Zhang et al., 2020). There is a significant positive correlation between an individual's increase in knowledge of environmental issues and their behaviour towards positive environmental actions (Abdullah et al., 2019; Situmorang et al., 2020). Providing information can make visitors more aware of inappropriate behaviours and their consequences, reminding them of their responsibilities and alternative behaviours they can adopt (Luo et al., 2020). A lack of knowledge about environmental issues, potential solutions, and ways to modify behaviour could potentially lead individuals to contribute negatively to conservation as they may think that their efforts do not matter (Kim & Stepchenkova, 2019).

Interventions that provide information are usually aimed at increasing an individual's knowledge and awareness of the impact of their behaviours on the environment and to increase knowledge of alternative behaviours as new knowledge is assumed to change their attitude and in turn the relevant compliant behaviour (Cornelisse & Duane, 2013; Khan & Thomas, 2023; Steg & Vlek, 2009). Increased knowledge as measured by participant recall of information is an important initial behaviour change that would support actionable steps the general population could take in conservation efforts.

Strengths

For a behavioural intervention to be effective, it must be systematically planned, implemented and evaluated (Steg & Vlek, 2009). A causal relationship between an independent variable and a dependent variable can be experimentally evaluated using single-subject designs, which address the internal validity by systematic replication and the structure of the study's design (Kratochwill et al., 2010). According to What Works Clearinghouse (WWC) (Kratochwill et al., 2010), ABAB and multiple-baseline designs with sufficient phases meet the evidence standards without reservation; if there are four phases per case and

at least five data points per phase. The robust design of my study that meets these standards give confidence in the results and gives very strong evidence of the use of signage as an effective behavioural intervention. The consistency of level, trend, and variability within each phase along with the immediacy of the effect, proportion of overlap, consistency of data points across the different phases all provides a strong basis for a causal relationship. Assessing and measuring the intended behavioural outcome is a crucial requirement to ensure that the intervention had been effective (Lange & Dewitte, 2019).

The dependent variable at the intervention site was compared with data from a control site that was completely independent of the intervention site, and located in a different city in New Zealand, providing further evidence of the stability of the baseline data in the absence of an intervention, and confidence in the baseline knowledge of visitors to wildlife facilities in New Zealand about kiwi and their predators. At both sites, data were collected over an extended period in all phases demonstrating the stability of the effect. This included normal working days and school holidays in the initial baseline and intervention phases. As the study was conducted in an applied setting with a heterogeneous sample, it gives high ecological validity. Signs are used in a variety of settings and populations, and so my results support the use of signs to increase recall of information of individuals, which was the initial behaviour change we intended to induce in visitors.

Limitations

Conducting studies in applied settings results in less experimental control. Factors like the presence of staff at the intervention site could have affected the time and attention the sign was given by visitors, as staff presence has been previously found to positively affect behaviour change (Marschall et al., 2017; Sherwen et al., 2014; Tay et al., 2023). TNKH conducts a guided tour for all visitors with different staff at different times. So, we cannot be sure that staff at TNKH did not verbally emphasize the information in the sign. The location

of the sign, especially at the beginning of the itinerary, can positively influence the recall of information and the attention of visitors (Bourdeau & Chebat, 2003), which could have been a reason for the higher recall of information in my study, as the intervention sign was placed in the entrance area of TNKH. These limitations at TNKH could have been addressed by introducing the intervention sign at the Hamilton Zoo, but this was not a possibility as Hamilton Zoo did not house kiwi and gave approval to be a control site with only data collection. An additional approach may have been to relocate the sign to a different location at TNKH, where staff presence was minimal to eliminate potential bias and to test the effect of the location. This would mean more phases with replication which was beyond the scope of this study.

The low response numbers at the Hamilton Zoo means that data collected from there are based on a much lower sample size, which likely contributed to the variability in those data. A better approach may have been to ask visitors to complete the questionnaire on an iPad as they were leaving the zoo, however, we unfortunately did not have the resources to support this approach.

Future Directions

It is important to study long-term effects of interventions. Arndt et al. (1992) suggested that more studies are needed to evaluate the long-term recall of information as most measurements of recall through questionnaires are immediately collected from visitors on-site. In my study, participants at the intervention site were given QR code flyers when they returned from the site and sent post-visit emails which were completed at a later time. Responses could have been received from half an hour after viewing the sign up to a few days later. Measuring individual recall delay could provide data on length of recall of information. A follow-up questionnaire at a later date could be useful to measure long-term recall. Most researchers also recommend collection of long-term measures of recall a few

months after the intervention to evaluate if recall persists (Ballantyne et al., 2007; Ienna et al., 2022; Jensen et al., 2017; Luo et al., 2020). Smith et al. (2008) also suggested that follow-up interventions could be effective in reinforcing the messages or information initially conveyed by the sign.

Another possible direction could be to assess if recall of information especially the measures suggested on the sign were enacted upon by the participants. In other words, to test if there was actual behaviour change of visitors with increased recall. Lemmen et al. (2020) observed actual behaviour change of visitors to a zoo and found rule-compliant behaviour increased in the presence of signs when visitors were observed in a designated free-ranging area of monkeys, after the visitors were exposed to the signs. Such a direct observation would not be possible with the present sign as some of the measures that the participants could take are keeping dogs on a leash and cats indoors during nighttime, which was not included specifically on the present sign but could be used in future studies. A later self-reported questionnaire could possibly be an option to assess if the signs were effective in bringing about these actions. However, there is also chances of biases in such self-reported assessments. A thorough evaluation and planning to measure behaviours resulting from signs could be another extension of this study.

Conclusion

When considering behaviour change, it is necessary to consider the feasibility of these behaviour changes. Small-scale or low-cost interventions can greatly influence individuals' behaviour and should not be overlooked. As found by Newcomb and Newcomb (2020), behaviour change of visitors using signage, regardless of textual formatting, supports the fact that low-cost interventions like signs are effective and no less significant than technical or complex interventions. Research into environmentally responsible behaviour change has always focussed on field studies and the present study adds to the evidence that public awareness and knowledge can be increased with signs, and in turn will increase environmental behaviours.

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Appendices

Appendix A

Intervention Signage at TNKH

Kiwi Threats

The Usual Suspects.

They may look cute, but these four introduced mammalian species are the main threats to kiwi.

Understanding these predators helps us protect New Zealand's national bird and other native species.

Stoats

Stoats are the main reason why 95% of kiwi chicks hatched in the wild die before reaching breeding age. The stoat is very mobile and incredibly smart, which makes them very difficult to trap. Their high metabolism and heart rate keep them constantly hunting.

Dogs

Dogs are the biggest threat to adult kiwi. Even a gentle nudge from an inquisitive dog has the potential to crush the kiwi's delicate ribcage. Help protect kiwi and don't let your dog roam.

Cats

Cats stalk quietly and can kill kiwi of all ages. Even well-fed domestic cats may still hunt wildlife. Please keep cats indoors, especially at night.

Ferrets

Ferrets belong to the same family as stoats, but they are much larger and can confidently take on adult kiwi. Ferrets are nocturnal which means they hunt at the same time kiwi are out looking for food. They are strong, fast and opportunistic.

The National Kiwi Hatchery Aotearoa

ZAA Wildlife Conservation Fund

The University of Waikato — School of Psychology

Appendix B

Questionnaire at Control Site Throughout the Study - Hosted on Qualtrics (https://www.qualtrics.com/)

THE UNIVERSITY OF WAIKATO
Te Whare Wānanga o Waikato

Default Question Block

Information Sheet/Implicit Consent
Kiwi Advocacy Project

You are invited to participate in this study on aspects of Kiwi conservation efforts in New Zealand.

All submissions that include an email address will be entered into the draw, if the participant chooses to opt in.

This research project is being supervised by Dr Rebecca Sargisson of the University of Waikato and carried out by Masters graduate student Annie George under her supervision. The findings may be published in peer-reviewed journals and Masters Theses.

Participant's role

You will be asked to complete a short questionnaire about your visit to Hamilton Zoo today. The questionnaire is estimated to take less than 5 minutes. Confidentiality and participants' rights All data are anonymised, meaning no personal information can be linked to your data. You can withdraw from the study anytime for any reason by closing your browser window and not completing the questionnaire. Once you have submitted your responses, you will not be able to withdraw your data. If you choose to provide your email for the prize draw or research updates, it will be stored separately from your

responses. Your contact information will not be used for any other purpose. There is a small risk to privacy, but appropriate steps will be taken to protect your information. Please contact the researcher if you have any concerns.

Storage of data

Data will be stored for a minimum of 5 years after completion of this research project. The data will be stored securely by Dr Rebecca Sargisson and the research investigators of this project will have access to it. Anonymised data may be shared in public repositories if required for paper publication.

Funding

This project has no external funding.

For further information or if you have any questions related to the research project, please email the researcher:

Annie George (ag503@students.waikato.ac.nz)

University of Waikato Masters Supervisor

Dr Rebecca Sargisson (rebecca.sargisson@waikato.ac.nz)

Co-Researcher - Hamilton Zoo

Ken Millwood (ken.millwood@hcc.govt.nz)

Ethics approval

This research project has been approved by the Human Research Ethics Committee of the Division of Arts, Law, Psychology and Social Sciences (ALPSS) at the University of Waikato. Any questions about the ethical conduct of this research may be sent to the Secretary of the Committee, email ALPSS- ethics@waikato.ac.nz , postal address: Division of Arts, Law, Psychology and Social Sciences, University of Waikato, Te Whare Wananga o Waikato, Private Bag 3105, Hamilton 3240.

Consent

By proceeding with the online survey, you are agreeing that: (1) you have read and understood this information (2) questions about your participation in this study have been answered satisfactorily (3) you are aware of the potential risks (4) you are taking part in this research study voluntarily (5) anonymised data may be shared in public research repositories.

Do you consent to participate in this survey?

Yes
No

Is your age 16 or above?

Yes
No

Block 1

How many species of Kiwi are there in New Zealand?

What are the four main predators of kiwi?

Hedgehog
Dog
Possum
Cat
Stoat
Rat
Ferret
Pig
Weka

What predator is the biggest threat to kiwi chicks?

Cat
Rat
Weka
Possum
Ferret
Dog
Stoat
Hedgehog
Pig

What predator is the biggest threat to adult kiwi?

Pig
Stoat
Rat
Dog
Weka
Possum
Hedgehog
Cat

Ferret

Demographic Details

What is your age in years?

What is your gender?

Male
Female
Non-binary
Other
Prefer not to say

Do you live in NZ?

No
Yes

If you would like to enter into the draw to win the Prize, please tick the box.

Yes

If you are interested in receiving a copy of the research outcomes and/or wish to participate in future research regarding New Zealand conservation, please tick the box.

Yes

Please enter your email address below if you answered **Yes** to either of the last two questions:

Appendix C

QR Code Poster/Flyer at Hamilton Zoo

Appendix D

Baseline Phase Questionnaire at Intervention Site - Hosted on Qualtrics

(https://www.qualtrics.com/)

THE UNIVERSITY OF WAIKATO
Te Whare Wānanga o Waikato

Default Question Block

Information Sheet/Implicit Consent
Kiwi Advocacy Project

You are invited to participate in this study on aspects of Kiwi conservation efforts in New Zealand.

All submissions that include an email address will be entered into the draw, if the participant chooses to opt in.

This research project is being supervised by Dr Rebecca Sargisson of the University of Waikato and carried out by Masters graduate student Annie George under her supervision. The findings may be published in peer-reviewed journals and Masters Theses.

Participant's role
You will be asked to complete a short questionnaire about your visit to The National Kiwi Hatchery, Rotorua today. The questionnaire is estimated to take less than 5 minutes. Confidentiality and participants' rights All data are anonymised, meaning no personal information can be linked to your data. You can withdraw from the study anytime for any reason by closing your browser window and not completing the questionnaire. Once you have submitted your responses, you will not be able to withdraw your data. If you choose to provide your email for the prize draw or research updates, it will be

stored separately from your responses. Your contact information will not be used for any other purpose. There is a small risk to privacy, but appropriate steps will be taken to protect your information. Please contact the researcher if you have any concerns.

Storage of data

Data will be stored for a minimum of 5 years after completion of this research project. The data will be stored securely by Dr Rebecca Sargisson and the research investigators of this project will have access to it. Anonymised data may be shared in public repositories if required for paper publication.

Funding

This project has no external funding.
For further information or if you have any questions related to the research project, please email the researcher:
Annie George (ag503@students.waikato.ac.nz)

University of Waikato Masters Supervisor

Dr Rebecca Sargisson (rebecca.sargisson@waikato.ac.nz)

Co-Researcher - The National Kiwi Hatchery

Emma Bean (emma.bean@nationalkiwihatchery.org.nz)

Ethics approval

This research project has been approved by the Human Research Ethics Committee of the Division of Arts, Law, Psychology and Social Sciences (ALPSS) at the University of Waikato. Any questions about the ethical conduct of this research may be sent to the Secretary of the Committee, email ALPSS- ethics@waikato.ac.nz , postal address: Division of Arts, Law, Psychology and Social Sciences, University of Waikato, Te Whare Wananga o Waikato, Private Bag 3105, Hamilton 3240.

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Do you consent to participate in this survey?

Yes
No

Is your age 16 or above?

Yes
No

Block 1

How many species of Kiwi are there in New Zealand?

What are the four main predators of kiwi?

Weka
Rat
Possum
Ferret
Dog
Stoat
Pig
Cat
Hedgehog

What predator is the biggest threat to kiwi chicks?

Pig
Cat
Rat
Possum
Hedgehog
Dog
Weka
Ferret
Stoat

What predator is the biggest threat to adult kiwi?

Stoat
Ferret
Weka
Dog
Possum
Pig
Rat
Cat

Hedgehog

Demographic Details

What is your age in years?

What is your gender?

Male
Female
Non-binary
Other
Prefer not to say

Do you live in NZ?

No
Yes

If you would like to enter into the draw to win the Prize, please tick the box.

Yes

If you are interested in receiving a copy of the research outcomes and/or wish to participate in future research regarding New Zealand conservation, please tick the box.

Yes

Please enter your email address below if you answered **Yes** to either of the last two questions:

Appendix E

QR Code Flyer shared with Visitors in TNKH Shuttle Van

The National Kiwi Hatchery Aotearoa

Help Us Help Kiwi!

& be in to Win a Kiwi Prize!

Complete a short survey to help us support research on kiwi conservation education and go in the draw to win a special kiwi-themed prize!
Scan the QR code to take part:

THE UNIVERSITY OF WAIKATO
Te Whare Wānanga o Waikato
SCHOOL OF PSYCHOLOGY
TE KURA WHATU OHO MAURI

Zoo and Aquarium Association Australasia

Appendix F

Intervention Phase Questionnaire at Intervention Site - Hosted on Qualtrics

(https://www.qualtrics.com/)

Default Question Block

Information Sheet/Implicit Consent
Kiwi Advocacy Project

You are invited to participate in this study on aspects of Kiwi conservation efforts in New Zealand.

All submissions that include an email address will be entered into the draw, if the participant chooses to opt in.

This research project is being supervised by Dr Rebecca Sargisson of the University of Waikato and carried out by Masters graduate student Annie George under her supervision. The findings may be published in peer-reviewed journals and Masters Theses.

Participant's role

You will be asked to complete a short questionnaire about your visit to The National Kiwi Hatchery, Rotorua today. The questionnaire is estimated to take less than 5 minutes. Confidentiality and participants' rights All data are anonymised, meaning no personal information can be linked to your data. You can withdraw from the study anytime for any reason by closing your browser window and not completing the questionnaire. Once you have submitted your responses, you will not be able to withdraw your data. If you choose to provide your email for the prize draw or research updates, it will be

stored separately from your responses. Your contact information will not be used for any other purpose. There is a small risk to privacy, but appropriate steps will be taken to protect your information. Please contact the researcher if you have any concerns.

Storage of data

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University of Waikato Masters Supervisor

Dr Rebecca Sargisson (rebecca.sargisson@waikato.ac.nz)

Co-Researcher - The National Kiwi Hatchery

Emma Bean (emma.bean@nationalkiwihatchery.org.nz)

Ethics approval

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By proceeding with the online survey, you are agreeing that: (1) you have read and understood this information (2) questions about your participation in this study have been answered satisfactorily (3) you are aware of the potential risks (4) you are taking part in this research study voluntarily (5) anonymised data may be shared in public research repositories.

Do you consent to participate in this survey?

Yes
No

Is your age 16 or above?

Yes
No

Block 1

How many species of Kiwi are there in New Zealand?

What are the four main predators of kiwi?

Possum
Stoat
Hedgehog
Cat
Ferret
Pig
Dog
Rat
Weka

What predator is the biggest threat to kiwi chicks?

Dog
Ferret
Cat
Weka
Hedgehog
Stoat
Possum
Rat
Pig

What predator is the biggest threat to adult kiwi?

Ferret
Cat
Stoat
Weka
Rat
Dog
Pig
Hedgehog

Possum

During your visit to the Hatchery, did you read the sign about the different predators of kiwi?

Yes
No

Demographic Details

What is your age in years?

What is your gender?

Male
Female
Non-binary
Other
Prefer not to say

Do you live in NZ?

No
Yes

If you would like to enter into the draw to win the Prize, please tick the box.

Yes

If you are interested in receiving a copy of the research outcomes and/or wish to participate in future research regarding New Zealand conservation, please tick the box.

Yes

Please enter your email address below if you answered **Yes** to either of the last two questions:

Appendix G

Debrief Emails Sent to Participants of Respective Sites

Kia ora,

Thank you for participating in this research study about Kiwi conservation.

Remember, every completed response will go into a prize draw. So please keep an eye on your email as **The National Kiwi Hatchery, Rotorua** will be in touch with the winner pending the results once the survey is completed.

If you have any questions about the research outcomes, please contact: ag503@students.waikato.ac.nz

Ngā mihi,

Annie George

Kia ora,

Thank you for participating in this research study about Kiwi conservation.

Remember, every completed response will go into a prize draw. So please keep an eye on your email as **Hamilton Zoo** will be in touch with the winner pending the results once the survey is completed.

If you have any questions about the research outcomes, please contact: ag503@students.waikato.ac.nz

Ngā mihi,

Annie George