Evaluating the impact of a global biodiversity education campaign on zoo and aquarium visitors

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Abstract

Campaigns by civil society organisations, such as zoos and aquariums, are a key means of promoting pro-environment social change internationally. Here, we evaluate a global biodiversity education campaign's impact through a repeated-measures survey of nearly 5,000 visitors to 20 zoos and aquariums from 14 countries. We found significant aggregate improvements in respondents' biodiversity understanding and knowledge of actions to help protect biodiversity by comparing pre- and post-visit responses. Those respondents who self-reported seeing the education campaign's interpretive graphic panels and informative films showed a significantly higher aggregate increase in understanding of biodiversity and actions to protect it over the course of zoo and aquarium visits. The findings reaffirm the value of enhancing educational provision within zoo and aquarium visits for engaging members of the public with biodiversity-related issues. The results also demonstrate that the aggregate impact from such experiences can be enhanced through coordinated public engagement initiatives.

Introduction

The 20 Aichi Biodiversity Targets form the basis of the United Nations Strategic Plan for Biodiversity 2011–2020 (https://www.cbd.int/sp/targets). Target 1 of this plan 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'. With more than 700 million annual visits (Gusset and Dick 2011), as well as an explicit commitment to providing environmental education (Barongi *et al.* 2015), the world's zoos and aquariums are well-placed to contribute to achieving this target (Figure 1). Indeed, recent studies have demonstrated the potential learning impacts of such institutions (e.g. Wagoner and Jensen 2010, 2015; Jensen 2014). Additionally, it has been shown that the majority of zoo and aquarium visitors actually arrive at the site with the motivation to learn (Roe and McConney 2015). Recognising this potential, the World Association of Zoos and Aquariums (WAZA) became an official partner of the Convention on Biological Diversity (CBD) during the Decade on Biodiversity.

Until relatively recently, surprisingly little was understood about the worldwide educational value of zoos and aquariums, and a robust large-scale assessment was lacking from the literature (Moss and Esson 2013). As a first step, therefore, we conducted the first global evaluation of the educational impacts of visits to zoos and aquariums. Data collection for this first global evaluation took place between November 2012 and July 2013, with more than 6,000 visitors to 30 participating institutions. The 2012/2013 survey's main findings were positive; namely, that aggregate biodiversity understanding and knowledge of actions to

help protect biodiversity both significantly increased over the course of zoo and aquarium visits (Moss *et al.* 2015). In other words, zoos and aquariums can, and do, make a positive contribution to reaching Aichi Biodiversity Target 1.

Following on from the 2012/2013 survey, in May 2014 WAZA launched a global biodiversity education campaign – Biodiversity is Us (https://www.biodiversityisus.org) – in a large number of participating zoos and aquariums. The campaign was built on our finding from the 2012/2013 survey (Moss *et al.* 2015) that respondents exposed to biodiversity information during their visit showed a significantly larger change in biodiversity literacy. This multi-institutional campaign included the provision of various interpretive graphic panels, informative films of different lengths and an interactive mobile phone application (https://www.youtube.com/user/BioDiversityIsUsWAZA). The educational goal of the graphic panels and films was to improve visitor understanding of what biodiversity is and how we, as humans, are part of it. The mobile phone application, and partly the films, were focussed on content related to pro-conservation actions visitors might take. A second global evaluation was subsequently conducted in zoos and aquariums in 2014/2015, with the aim of assessing whether the Biodiversity is Us campaign was successful in further raising levels of biodiversity literacy amongst zoo and aquarium visitors.

Methods

Same as in the 2012/2013 survey (Moss *et al.* 2015), pre- and post-visit surveys were designed to measure two dependent variables (biodiversity understanding and knowledge of actions to help protect biodiversity) and to evaluate any change in individual participants over the course of their zoo or aquarium visit. The survey was designed as a repeated-measures instrument (i.e. the same participants were measured twice, with the same pre- and post-visit outcome measures). To measure biodiversity understanding, we asked respondents to list anything that came to mind when they thought of biodiversity (space for up to five responses provided). To measure knowledge of actions to help protect biodiversity, we asked respondents to think of an action they could take to help save animal species (space for up to two responses provided). Data on relevant independent variables (Dawson and Jensen 2011) were also collected, including whether respondents saw or heard any information mentioning 'Biodiversity is Us' during their visit.

Detailed survey procedures are provided in Moss *et al.* (2015). In short, the survey was designed to be distributed on paper or via a tablet computer (connected to an online survey) by staff members and self-administered by respondents. It included a pre-visit component

(administered at the zoo or aquarium entrance) and a post-visit component (administered at the zoo or aquarium exit) for the same participants. Potential survey respondents – visitors ≥ 10-year-old – were selected using systematic sampling (every *n*th visitor) or on a continual-ask basis (once one survey response was completed, the next visitor to cross an imaginary line was selected as the potential next respondent). Surveys were administered from 1 November 2014 to 31 July 2015. Twenty WAZA member organisations from 14 countries around the globe participated. The total number of valid surveys (i.e. surveys collected from the same individual pre- and post-visit) received across participating institutions was 4,901 (mean of 245 [SD 159] surveys from each institution, with a minimum of 60 and a maximum of 597).

The qualitative data gathered to measure the two dependent variables were subjected to content analyses in the same way as in the 2012/2013 survey (for details, see WebPanel 1) to provide quantitative data suitable for statistical analyses. Institution-reported use of the Biodiversity is Us campaign materials specifically during the data collection period was quantified as follows: Participating institutions that reportedly used multiple campaign materials throughout the institution for an extended period of time scored 2, those that reported limited use (in content, space and time) scored 1, and those that reportedly did not use the campaign materials at all scored 0. Institution-reported changes in the use of biodiversity information other than the Biodiversity is Us campaign materials from the 2012/2013 survey to the 2014/2015 survey were quantified as follows: Participating institutions that reportedly increased the use of biodiversity information scored 1, those that reported similar use scored 0, and those that reportedly decreased the use of biodiversity information scored –1 (for content analysis reliability, see WebPanel 1).

Once quantified, we used repeated-measures linear mixed models with independent variables as fixed effect factors and participating institutions as a (categorical) random effect factor. The restricted maximum likelihood method was used to estimate variance components. All statistical tests were two-tailed, had a significance level of $p < 0.05$ and were conducted with IBM SPSS Statistics 22.

Results

Mirroring the findings from the 2012/2013 survey, we again found significant aggregate increases in both dependent variables between pre- and post-visit in the 2014/2015 survey: biodiversity understanding ($F = 7.627$, $p = 0.006$) and knowledge of actions to help protect biodiversity ($F = 19.963$, $p < 0.001$). On the 10-point scales, the score for biodiversity

understanding improved from 2.45 ± 1.08 to 2.52 ± 1.04 and the score for knowledge of actions to help protect biodiversity improved from 4.88 ± 1.98 to 5.14 ± 2.04 over the course of a zoo or aquarium visit in the 2014/2015 survey.

There was an increase from pre-visit (37.1%) to post-visit (40.4%) in respondents demonstrating at least some positive evidence of biodiversity understanding (scores 3–7) in the 2014/2015 survey (Figure 2). This means that considerably lower proportions of respondents evinced biodiversity understanding in the 2014/2015 survey when compared to the 2012/2013 survey (69.8% and 75.1% pre- and post-visit, respectively). However, the magnitude of change from pre- to post-visit is actually slightly larger in the 2014/2015 survey. That is, the proportion of respondents demonstrating at least some positive evidence of biodiversity understanding showed an 8.9% increase between pre- and post-visit (note that this proportional figure is not the same as a raw percentage point increase). During the 2012/2013 survey this proportional percentage increase was 7.6%.

There was an increase from pre-visit (46.1%) to post-visit (56.3%) in respondents who could identify a pro-biodiversity action that could be achieved at an individual level (scores of 3–4 for each of the two responses to this question) in the 2014/2015 survey (Figure 2). These figures were again lower than those in the 2012/2013 survey in absolute terms (50.5% and 58.8% pre- and post-visit, respectively). However, as with the first dependent variable, we saw a larger proportional increase between pre- and post-visit in the 2014/2015 survey (22.3%), when compared to the 2012/2013 survey (16.4%). In sum, while the respondents' *starting level* of understanding of biodiversity and actions to protect it vary considerably between the two surveys for reasons unknown to us, the scale of the aggregate *educational impact* from their visit is in fact larger in the 2014/2015 survey.

There was a significant aggregate increase in biodiversity understanding between pre- and post-visit (from 2.41 ± 1.07 to 2.50 ± 1.03) in those respondents (33.7%) who self-reported seeing the Biodiversity is Us graphic panels or films ($F = 7.315$, $p = 0.007$; Figure 3), compared to those who did not (25.0% of respondents; 6.6% were not sure and 34.9% did not answer this question). There was also a significant aggregate increase in knowledge of actions to help protect biodiversity between pre- and post-visit (from 4.79 ± 2.00 to 5.04 ± 2.07) in these respondents ($F = 11.484$, $p = 0.001$; Figure 3). Only 18.4% of respondents self-reported using any mobile phone application during their visit (< 1% of these respondents reported using the Biodiversity is Us application, which prevented us from evaluating its impact statistically).

Eight of the participating institutions reported using multiple Biodiversity is Us campaign materials throughout the institution for an extended period, seven institutions reported limited use (in content, space and time), and five institutions indicated they did not use any campaign materials during the data collection period. Unlike the independent variable for exposure to campaign materials based on respondents' self-report, there was no significant change in either dependent variable between pre- and post-visit based on the institutions' reported level of use: biodiversity understanding ($F = 0.199$, $p = 0.820$) and knowledge of actions to help protect biodiversity ($F = 0.886$, $p = 0.421$). This result indicates that it is more important for the visitors to actually see the campaign materials, rather than the institutions simply reporting an increased amount of the materials being used (which may or may not be encountered by any one visitor).

Ten of the participating institutions reported increasing their use of biodiversity information other than the Biodiversity is Us campaign materials and the other ten reported no significant change (no institution reported decreasing its use of biodiversity information). There was no significant difference in either dependent variable between pre- and post-visit based on the institutions' reported level of change in the use of other biodiversity information: biodiversity understanding ($F = 1.377$, $p = 0.254$) and knowledge of actions to help protect biodiversity ($F = 4.178$, $p = 0.054$). This finding suggests that the impact of the campaign materials was not simply a consequence of the institutions reporting an overall increased provisioning of biodiversity information from the 2012/2013 survey to the 2014/2015 survey.

Discussion

Zoos and aquariums would be well advised to increase visitors' targeted exposure to biodiversity information at their institutions to reap the benefit of improved learning outcomes we have identified in our evaluation of this global biodiversity education campaign. Simply put, we saw significant increases in aggregate biodiversity understanding and knowledge of actions to help protect biodiversity in those respondents who saw Biodiversity is Us graphic panels or films displayed in the participating institutions. Moss *et al.* (2015) showed that watching a video or film, in particular, promotes biodiversity literacy in conjunction with physically visiting a zoo or aquarium. Our findings tell us that the use of campaign materials is related to improved visitor knowledge, but more so for understanding of biodiversity than actions to protect it. This aligns with the fact that the graphic panels and films focused primarily on introducing the concept of biodiversity, rather than promoting pro-

conservation actions. This directly relates to the two components of Aichi Biodiversity Target 1: biodiversity awareness and knowledge of how to conserve biodiversity and use it sustainably.

The headline indicator used by the CBD to monitor progress in the implementation of Aichi Biodiversity Target 1 is 'trends in awareness, attitudes and public engagement in support of biological diversity and ecosystem services' (https://www.cbd.int/sp/indicators). While prior studies have evaluated localised interventions at individual institutions (e.g. MacDonald 2015), we are not aware of any other study that evaluated the impact of a global biodiversity education campaign within this indicator framework. When comparing pre-visit biodiversity understanding and knowledge of actions to help protect biodiversity between the 2012/2013 survey (Moss *et al.* 2015) and the 2014/2015 survey (this study), there is no evidence for an improvement trend in the short time (less than two years) that has elapsed between the two surveys. A mid-term analysis of progress towards the 20 Aichi Biodiversity Targets (Tittensor *et al.* 2014) also concludes that efforts need to be redoubled to enable global biodiversity goals to be met by 2020.

Whilst education is almost universally seen as valuable in its own right, the obvious supplementary question that stems from our research is 'how can increased knowledge about biodiversity translate into actual benefits to the conservation of biodiversity?'. Knowing about how you can help and actually helping are two different things (Heimlich and Ardoin 2008; Moss *et al.* 2016; Sheeran and Webb 2016). The complexity and diversity of the many models of human behaviour change (cf. St John *et al*. 2010) tells us that an increase in knowledge is not necessarily a reliable predictor of a related change in behaviour (Schultz 2011; Heberlein 2012). Even the intention to behave has been shown to be a less significant predictor of actual behaviour than might have been assumed (Webb and Sheeran 2006). However, an expansive definition of 'education' could encompass skills, attitudes, values, organising community action and personal behaviour. Indeed, the challenge for zoos and aquariums is not only to maximise educational impacts on visitors – such as their positive contribution to reaching Aichi Biodiversity Target 1 (Moss *et al.* 2015; this study) – but also to understand how those impacts might be harnessed to best serve pro-environment social change internationally.

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Supplemental information

WebPanel 1. Content analysis framework

Following Moss *et al.* (2015 [*Conservation Biology* **29:** 537–544]), the qualitative data from the two dependent variables (biodiversity understanding and knowledge of actions to help protect biodiversity) were subjected to content analyses to provide quantitative data suitable for statistical analyses. Initial qualitative analyses to explore the range, type and content of responses directly informed the scoring and coding schemes developed for each of these two variables.

Biodiversity understanding

The preliminary qualitative analysis of data for this variable suggested that there were continuous degrees of biodiversity understanding or accuracy. From this, a 5-point unidirectional scale was developed. Each response was scored according to the following scale: 1, inaccurate (descriptions contained no accurate elements [e.g. 'open air', 'everything in general'] or were too vague to indicate accurate knowledge [e.g. 'many things']); 2, ambivalent (some accurate descriptions and some of inaccurate descriptions); 3, some positive evidence (mention of something biological [e.g. 'species'], but no other accurate elements or detail); 4, positive evidence (some evidence of accurate descriptions, but only mention of animals or plants, not both [minimal inaccurate elements], or vague but accurate description [e.g. 'lots of life', 'many species', 'variety of species']); 5, strong positive evidence (no inaccurate elements, specific mention of both animals and plants [e.g. 'diversity of flora and fauna of the region', 'wide variety of plants and animals in a given environment or ecosystem', 'all the animals and plants on our planet', 'wildlife and plant life in balance']).

In addition, we developed a series of binary coding variables (yes or no), all of which were based on the Convention on Biological Diversity (CBD)'s 'Value of Biodiversity and Ecosystem Services' (https://www.cbd.int/2011-2020/learn). Individual survey responses were again scored for each of the following queries on a yes or no basis: Interconnections between species and the environment mentioned? Genetic value of biodiversity mentioned? Expressed importance of biodiversity for humans? Expressed need for biodiversity conservation? Mention of environmentally responsible behaviours relating to biodiversity?

A master combined score was calculated as the sum of the biodiversity accuracy scale (1–5 points) and all the five binary variables (yes = 1 point and no = 0 points). The maximum

combined score per survey response was therefore 10. All data were coded by the same researcher.

Knowledge of actions to help protect biodiversity

Initial qualitative analysis of data for this variable suggested that the actions reported fell along a continuum ranging from very general to very specific personal actions. Responses were coded under an initial binary variable (yes or no) to determine whether an action or behaviour was mentioned (yes = 1 point and no = 0 points). If an action or behaviour was mentioned (1 point), then further points were added along a continuous scale as follows (up to a maximum of 5 points per action): 0, action or behaviour identified not relevant to conservation; +1, no specific action or behaviour mentioned (vague platitudes about need for change [e.g. 'save ecosystems']); +2, specific identification of pro-biodiversity action or behaviour at a general level (not feasible to address as an individual [e.g. 'stop hunting', 'stop Chinese medicine', 'scientific research in environmental studies and conservation', 'don't cut our forests', 'give animals space and protect their environment']); +3, very specific identification of pro-biodiversity action or behaviour that can be done at an individual level (e.g. 'hanging bird houses, feeding birds in winter time', 'drive less to reduce effects of climate change'); +4, very specific identification of pro-biodiversity action or behaviour that the respondent clearly states is a personal action or behaviour (e.g. 'I recycle my mobile phone for gorillas').

We left spaces for respondents to identify up to two different actions. Where two actions were reported, each action was coded separately using the scale defined above. The two separate scores were then summed to yield a combined score (maximum total of 10). All data were coded by the same researcher.

Content analysis reliability

A second trained coder performed inter-coder reliability analyses for both variables. A small, randomly selected sample of data (n = 504) was coded separately (and blind to the previous coding) by the second coder. A Cohen's kappa statistic was calculated for these matching data (kappa = 0.61, $p < 0.001$, for biodiversity understanding and kappa = 0.66, $p < 0.001$, for knowledge of actions to help protect biodiversity). This indicated substantial agreement between the two researchers (Landis and Koch 1977 [*Biometrics* **33:** 159–174]) for both variables.

Similarly, use of the Biodiversity is Us campaign materials and changes in the use of biodiversity information other than the Biodiversity is Us campaign materials were separately coded by two trained coders. There was nearly perfect agreement between the two researchers (kappa = 0.92, $p < 0.001$, for use of Biodiversity is Us campaign materials and kappa = 0.90, $p < 0.001$, for changes in the use of other biodiversity information).

Figure Captions

Figure 1. Visitors exposed to biodiversity information at Chester Zoo.

Figure 2. Overall comparison before and after a visit to a zoo or aquarium of the two dependent variables – biodiversity understanding (n = 2,743) and knowledge of actions to help protect biodiversity (n = 2,585) – in the 2014/2015 survey.

Figure 3. Comparison before and after a visit to a zoo or aquarium of the two dependent variables – biodiversity understanding (n = 1,329) and knowledge of actions to help protect biodiversity (n = 1,210) – for respondents self-reported seeing the Biodiversity is Us graphic panels or films in the 2014/2015 survey.