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BRIEF REPORT

WILEY ZOOBIOLOGY

Quantifying long-term impact of zoo and aquarium visits on biodiversity-related learning outcomes

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Zoos and aquariums aim to achieve lasting impact on their public audiences' awareness of biodiversity, its value, and the steps they can take to conserve it. Here, we evaluate the long-term educational impact of visits to zoos and aquariums on biodiversity understanding and knowledge of actions to help protect biodiversity. A minimum of two years after completing a repeated-measures survey before and after visiting a zoo or aquarium, the same participants were invited to take part in a follow-up online survey. Despite the small number of respondents ($n = 161$), our study may still represent the best available quantitative evidence pertaining to zoo and aquarium visits' long-term educational impact. We found that improvements in respondents' biodiversity understanding from pre- to post-visit leveled off, staying unchanged in the follow-up survey. In contrast, the improved knowledge of actions to help protect biodiversity from pre- to post-visit showed further improvement from post-visit to delayed post-visit follow-up survey. These results suggest that the immediate positive effects of a zoo or aquarium visit on biodiversity-related learning outcomes may be long lasting and even help lay the groundwork for further improvements over an extended period of time following the visit.

KEYWORDS
aquarium, biodiversity, education, impact, visit, zoo

1 | INTRODUCTION

Target 1 of the Aichi Biodiversity Targets within the United Nations Strategic Plan for Biodiversity 2011–2020 (https://www.cbd.int/sp/targets) calls for action to ensure 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." Committed to providing environmental education (Barongi, Fisken, Parker, & Gusset, 2015), the world's zoos and aquariums are well positioned to marshal the more than 700 million annual visits (Gusset & Dick, 2011) they receive to support achieving this target. The World Association of Zoos and Aquariums (WAZA) is an official partner of the Convention on Biological Diversity (CBD) during the Decade on Biodiversity to support its aims.

While recent studies have shown the educational impacts zoos and aquariums can foster globally (e.g., Jensen, 2014; Moss, Jensen, & Gusset, 2015; Moss, Jensen, & Gusset, 2017a; Wagoner & Jensen, 2010, 2015), there are no published longitudinal studies that track zoos' and aquariums' learning impacts at the individual level over an extended period of time. Given the long-term nature of change that is required to establish a more environmentally sustainable world, quantifying such long-term impact is a key interest in the conservation social sciences (Bennett et al., 2017). The present study builds on a previous repeated-measures impact evaluation that assessed differences between zoo and aquarium visitors' pre- and post-visit biodiversity literacy. The study found that aggregate biodiversity understanding and knowledge of actions to help protect biodiversity both significantly increased during zoo and aquarium visits (Moss et al., 2015). In other words, zoos and aquariums were shown to be making a contribution to achieving Aichi Biodiversity Target 1.

Following on from this on-site survey, we invited participation in a delayed post-visit follow-up survey via e-mail. The aim of this online follow-up survey was to evaluate to what extent

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participants retained their understanding of biodiversity and actions to protect it that they acquired over the course of their zoo or aquarium visit.

2 | METHODS

Pre- and post-visit surveys were designed to measure our 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).

Detailed survey procedures are provided in Moss et al. (2015). In short, the pre- and post-visit survey was designed to be printed by participating institutions, distributed on paper 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). Consent from responsible adults was sought before potential respondents of minor age were approached. Surveys were administered from 1 November 2012 to 31 July 2013. Twenty-six WAZA member organizations from 19 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 5,661.

Following on from the pre- and post-visit surveys conducted at the zoo or aquarium, those participants who had provided their e-mail address ($n = 1{,}640$) were contacted during August 2015 to complete a follow-up survey. The time elapsed since completing the on-site survey was a minimum of 2 years. This online survey (made available in eight languages) was again designed to measure our two dependent variables and to evaluate any change in individual participants over the time following their zoo or aquarium visit. Overall, 161 participants took part in the survey at all three data collection points (i.e., 10% of those who had provided their e-mail address), and we restricted our analysis to these data. The follow-up survey sample included 67% women and 33% men, with a mean age of 37 years (range 12–71), which is similar to the overall study sample (Moss, Jensen, & Gusset, 2017b). Only 4% were school-aged respondents less than 18 years old (cf. Moss et al., 2015).

The qualitative data gathered to measure the two dependent variables on the three occasions were subjected to content analyses to provide quantitative data suitable for statistical analyses. Details on content analysis—and its reliability (Krippendorff, 2004)—are provided in the supplementary appendix. Once quantified, we used repeated-measures linear mixed models with 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 $p \le 0.05$, and were conducted with IBM SPPS Statistics 22.

3 | RESULTS AND DISCUSSION

A comparison of pre-visit, post-visit, and delayed post-visit follow-up survey results for the two dependent variables shows significant increases from pre- to post-visit in the 161 participants who took part in the survey at all three data collection points (Figure 1): biodiversity understanding ($F = 3.026$, $p = 0.050$) and knowledge of actions to help protect biodiversity ($F = 11.271$, $p < 0.001$). The restricted sample in the present study thus mirrors the educational impact findings between pre- and post-visit survey for the overall study sample (Moss et al., 2015).

While the level of biodiversity understanding remained steady (Figure 1), the level of knowledge of actions to help protect biodiversity significantly increased from post-visit to delayed post-visit follow-up survey ($F = 11.057$, $p < 0.001$). This pattern is indicative of a possible "sleeper effect" (e.g., Kumkale & Albarracín, 2004). One way this might have worked is that the experience during the zoo or aquarium visit primed respondents to pay greater attention to information about pro-conservation actions available through other communication channels when they returned to their normal lives. While there is likely never a sole source for knowledge about an issue like biodiversity, the zoo or aquarium visit may have helped lay the foundation for future growth in practical knowledge of pro-conservation actions.

We now turn to our study's primary limitations. As is common with longitudinal research, attrition in participation was substantial. However, the fact that our analysis focuses on tracking learning outcomes for the same individuals over the entire study period mitigates concerns about sampling bias due to attrition in participation (e.g., Jensen & Lister, 2016). This is because all data in the present study are drawn from individuals who participated in the survey at all three data collection points: pre-visit, post-visit, and delayed post-visit follow-up survey. Nevertheless, pre- and post-visit scores were higher in our restricted sample (Figure 1) compared to the overall study sample (Moss et al., 2015). This leaves the possibility that people who were more attuned to biodiversity-related issues, and therefore, more likely to continue increasing their knowledge over time, were more likely to complete the follow-up survey. That said, it would be almost impossible to achieve an unbiased sample in this regard.

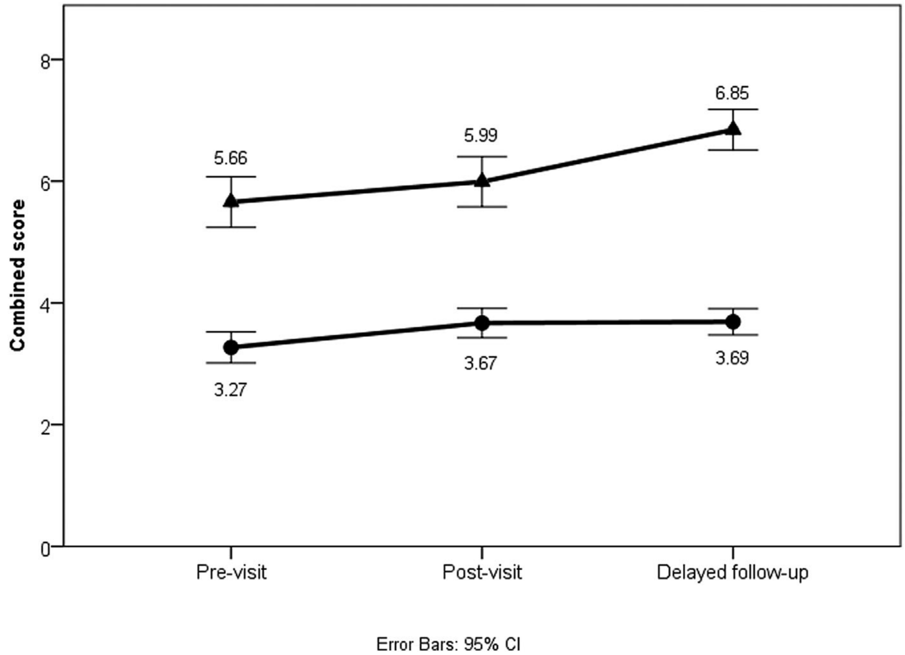

FIGURE 1 Comparison of pre-visit, post-visit, and delayed post-visit follow-up survey results for the two dependent variables—biodiversity understanding (●) and knowledge of actions to help protect biodiversity (▲) (combined scores on 10-point scales)

Another concern in longitudinal research is the possibility that confounding variables might explain the patterns that are uncovered in a follow-up survey (e.g., Dawson & Jensen, 2011). This means that the present study is only able to demonstrate that the data from the delayed post-visit follow-up survey are consistent with a pattern of long-term impact; the attribution of the learning outcomes we have identified is not definitive. Such confounding variables include information about pro-conservation actions obtained through other communication channels, including respondents having visited other zoos and aquariums since completing the on-site survey (Moss et al., 2017b).

4 | CONCLUSIONS

The persistence, and even improvement, of the aggregate biodiversity-related learning outcomes 2+ years after the zoo or aquarium visit is a surprising and promising finding. These results suggest that the immediate positive effects of a zoo or aquarium visit may be long lasting and even help lay the groundwork for further improvements over an extended period of time following the visit. In addition to the educational impact realized over the course of a zoo or aquarium visit (Moss et al., 2015, 2017a), such a long-term impact may further support achieving Aichi Biodiversity Target 1.

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SUPPLEMENTARY APPENDIX

Content Analysis Framework

Consistently applying the same framework for all three data collection points (pre-visit, post-visit, and delayed post-visit follow-up survey), 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 the two variables.

Biodiversity Understanding

The preliminary qualitative analysis of data for the variable biodiversity understanding strongly suggested that there were continuous degrees of biodiversity understanding or accuracy. From this, a 5-point unidirectional scale was developed. Each pre- and post-visit 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/2010/biodiversity). 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 behaviors 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 in the pre-visit, post-visit, and delayed post-visit follow-up survey 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 behavior was mentioned (yes = 1 point and no = 0 points). If an action or behavior 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 behavior identified not relevant to conservation; +1, no specific action or behavior mentioned (vague platitudes about need for change [e.g., “save ecosystems”]); +2, specific identification of pro-biodiversity action or behavior 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 behavior 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 behavior that the respondent clearly states is a personal action or behavior (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 in the pre-visit, post-visit, and delayed post-visit follow-up survey were coded by the same researcher.

Content Analysis Reliability

A second trained coder performed inter-coder reliability analyses for both dependent variables in the pre- and post-visit survey and the delayed post-visit follow-up survey. A small, randomly selected sample of data was coded separately (and blind to the previous coding) by the same second coder (n = 294 in the pre- and post-visit survey and n = 38 in the post-visit follow-up survey). A Cohen's kappa statistic was calculated for these matching data, in the pre- and post-visit survey (kappa = 0.82, $P < 0.001$, for biodiversity understanding and kappa = 0.84, $P < 0.001$, for knowledge of actions to help protect biodiversity) and the post-visit follow-up survey (kappa = 0.75, $P < 0.001$, for biodiversity understanding and kappa = 0.85, $P < 0.001$, for knowledge of actions to help protect biodiversity). This indicated substantial or nearly perfect agreement between the two researchers [Landis and Koch, 1977 (Biometrics 33:159–174)] for both variables.

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