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Jensen 1

1 **Quantifying the Long-Term Impact of Zoo and Aquarium Visits on Biodiversity-Related**
2 **Learning Outcomes**

3

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16

17 **ABSTRACT**

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

32

33 **Keywords: aquarium; biodiversity; education; impact; visit; zoo**

34

35 **INTRODUCTION**

36 Target 1 of the Aichi Biodiversity Targets within the United Nations Strategic Plan for
37 Biodiversity 2011–2020 (<https://www.cbd.int/sp/targets>) calls for action to ensure that “by
38 2020, at the latest, people are aware of the values of biodiversity and the steps they can take to
39 conserve and use it sustainably”. Committed to providing environmental education [Barongi et
40 al., 2015], the world's zoos and aquariums are well positioned to marshal the more than 700
41 million annual visits [Gusset and Dick, 2011] they receive to support achieving this target. The
42 World Association of Zoos and Aquariums (WAZA) is an official partner of the Convention on
43 Biological Diversity (CBD) during the Decade on Biodiversity to support its aims.

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

55 Following on from this on-site survey, we invited participation in a delayed post-visit
56 follow-up survey via e-mail. The aim of this online follow-up survey was to evaluate to what
57 extent participants retained their understanding of biodiversity and actions to protect it that they
58 evidently acquired over the course of their zoo or aquarium visit.

59

60 **METHODS**

61 Pre- and post-visit surveys were designed to measure two dependent variables
62 (biodiversity understanding and knowledge of actions to help protect biodiversity) and to
63 evaluate any change in individual participants over the course of their zoo or aquarium visit.
64 The survey was designed as a repeated-measures instrument (i.e., the same participants were
65 measured twice, with the same pre- and post-visit outcome measures). To measure biodiversity
66 understanding, we asked respondents to list anything that came to mind when they thought of
67 biodiversity (space for up to five responses provided). To measure knowledge of actions to help
68 protect biodiversity, we asked respondents to think of an action they could take to help save
69 animal species (space for up to two responses provided) (for detailed methods, see Moss et al.,
70 2015).

71 In short, the pre- and post-visit survey was designed to be distributed on paper by staff
72 members and self-administered by respondents. It included a pre-visit component (administered
73 at the zoo or aquarium entrance) and a post-visit component (administered at the zoo or
74 aquarium exit) for the same participants. Potential survey respondents – visitors ≥ 10 -year-old –
75 were selected using systematic sampling (every *n*th visitor) or on a continual-ask basis (once
76 one survey response was completed, the next visitor to cross an imaginary line was selected as
77 the potential next respondent). Surveys were administered from 1 November 2012 to 31 July
78 2013. Twenty-six WAZA member organizations from 19 countries around the globe
79 participated. The total number of valid surveys received across participating institutions was
80 5,661.

81 Following on from the pre-and post-visit surveys conducted at the zoo or aquarium, those
82 participants who had indicated their e-mail address ($n = 1,640$) were contacted during August
83 2015 to complete a follow-up survey. The time elapsed since completing the on-site survey was
84 a minimum of two years. This online survey (made available in eight languages) was again
85 designed to measure our two dependent variables (see above) and to evaluate any change in
86 individual participants over the time following their zoo or aquarium visit. Overall, 161
87 participants took part in the survey at all three data collection points, and we restricted our
88 analysis to these data. The follow-up survey sample included 67% women and 33% men, with a
89 mean age of 37 years (range 12 to 71).

90 The qualitative data gathered to measure the two dependent variables on the three
91 occasions were subjected to content analyses to provide quantitative data suitable for statistical
92 analyses (for detailed methods, see Moss *et al.* 2015). In short, scales for both dependent
93 variables were developed based on the range, type and content of responses. The maximum
94 score per survey response was 10 for both dependent variables. Once quantified, we used
95 repeated-measures linear mixed models with participating institutions as a (categorical) random
96 effect factor. The restricted maximum likelihood method was used to estimate variance

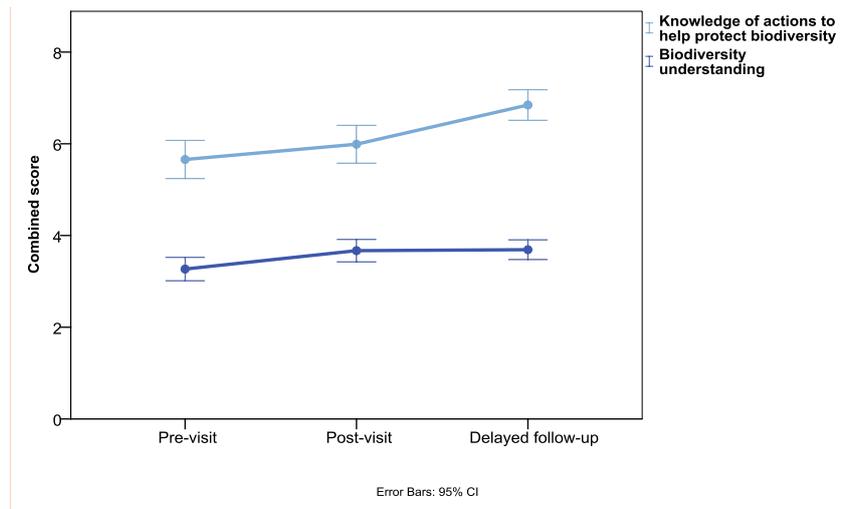
97 components. All statistical tests were two-tailed, had a significance level of $P \leq 0.5$, and were
98 conducted with IBM SPSS Statistics 22.

99

100 RESULTS AND DISCUSSION

101 A comparison of pre-visit, post-visit and delayed post-visit follow-up survey results for
102 the two dependent variables shows significant increases from pre- to post-visit in the 161
103 participants who took part in the survey at all three data collection points (Fig. 1): biodiversity
104 understanding ($F = 3.026, P = 0.050$) and knowledge of actions to help protect biodiversity ($F =$
105 $11.271, P < 0.001$). The restricted sample in the present study thus mirrors the educational
106 impact findings for the overall study population [Moss et al., 2015].

107



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108

109 Fig. 1. Comparison of pre-visit, post-visit and delayed post-visit follow-up survey results for the
110 two dependent variables – biodiversity understanding and knowledge of actions to help protect
111 biodiversity (combined scores on 10-point scales; values in boxes indicate mean scores).

112

113 While the level of biodiversity understanding remained steady, the level of knowledge of
114 actions to help protect biodiversity increased significantly from post-visit to delayed post-visit
115 follow-up survey (Fig. 1). This pattern is indicative of a possible “sleeper effect” (e.g., Kumkale
116 and Albarracín, 2004). One way this might have worked is that the experience during the zoo or
117 aquarium visit primed respondents to pay greater attention to information about pro-
118 conservation actions available through other communication channels when they returned to
119 their normal lives. That is, the zoo or aquarium visit may have laid the foundation for future
120 growth in practical knowledge of pro-conservation actions.

121 We now turn to our study’s primary limitations. As is common with longitudinal
122 research, attrition in participation was substantial. However, the fact that our analysis focuses on
123 tracking learning outcomes for the same individuals over the entire study period mitigates
124 concerns about sampling bias due to attrition in study participation (e.g., Jensen and Lister,
125 2016). This is because all data in the present study are drawn from individuals who participated
126 in the survey at all three data collection points: pre-visit, post-visit and delayed post-visit
127 follow-up survey.

128 Another concern in longitudinal research is the possibility that confounding variables
129 might explain the patterns that are uncovered in a follow-up survey (e.g., Dawson and Jensen,
130 2011). This means that the present study is only able to demonstrate that the data from the
131 delayed post-visit follow-up survey are consistent with a pattern of long-term impact; the
132 attribution of the outcome patterns we have identified is not definitive. For example,
133 respondents may have visited more zoos and aquariums since completing the on-site survey; we
134 previously showed that in the overall study population, repeat visitors have better biodiversity-
135 related knowledge [Moss et al., 2016].

136 Nevertheless, the persistence, and even improvement, of the aggregate learning outcomes
137 2+ years after the zoo or aquarium visit is a surprising and promising finding. These results
138 suggest that the immediate positive effects of a zoo or aquarium visit may be long-lasting and
139 even lay the groundwork for further improvements over an extended period of time following

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140 the visit. [In addition to the educational impact realized over the course of a zoo or aquarium](#)
141 [visit \[Moss et al., 2015\], such a long-term impact may further support achieving Aichi](#)
142 [Biodiversity Target 1.](#)

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150

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177 **Figure Legend**

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