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Impact of a global biodiversity education campaign on zoo and aquarium visitors

Andrew Moss[1], Eric Jensen[2], and Markus Gusset[3*]

Campaigns by zoos, aquariums, and other civil society organizations are an important tool for promoting social changes that benefit the environment. Here, we evaluate a global biodiversity education campaign's impact through a repeated-measures survey of nearly 5000 visitors to 20 zoos and aquariums located in 14 countries. By comparing visitors' pre- and post-visit responses combined across respondents, we found significant aggregate improvements in their biodiversity understanding and their knowledge of actions to help protect biodiversity. Respondents who reported seeing the education campaign's interpretive graphic panels and informative films showed a significantly higher aggregate increase in their understanding of biodiversity and actions to protect it as compared to respondents who did not see the campaign materials. These findings reaffirm the value of education at zoos and aquariums to engage 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.

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The 20 Aichi Biodiversity Targets form the basis of the 2011–2020 United Nations (UN) Strategic Plan for Biodiversity (www.cbd.int/sp/targets). Target 1 of this plan states the goal 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 positioned to contribute to achieving this target (Figure 1). Indeed, recent studies have demonstrated the potential educational impacts of these institutions (eg Wagoner and Jensen 2010, 2015; Jensen 2014). Additionally, the majority of zoo and aquarium visitors actually arrive at the site with the motivation to learn (Roe and McConney 2015). Recognizing this potential, the World Association of Zoos and Aquariums (WAZA) became an official partner of the Convention on Biological Diversity (CBD) during the UN Decade on Biodiversity, which spans from 2011 to 2020.

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). Therefore, as a first step, and prior to the analysis described here, we conducted the first global evaluation of the educational impacts of visits to zoos and aquariums. We collected data for this first evaluation between November 2012 and July 2013, surveying more than 6000 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 single 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.

Subsequently, in May 2014, WAZA launched a global biodiversity education campaign called "Biodiversity is Us" (www.biodiversityisus.org) at a large number of participating zoos and aquariums. The earlier 2012–2013 survey revealed that biodiversity literacy was significantly more improved in those visitors who were exposed to biodiversity information during their zoo or aquarium visit (Moss *et al.* 2015). The more recent multi-institutional Biodiversity is Us campaign built upon these results, and included the provision of various interpretive graphic panels, informative films of different lengths, and an interactive mobile phone application (bit.ly/2mqRg8H). 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 nature. The mobile phone application, and to some extent the films, were focused on content related to pro-conservation actions that visitors might take. A second global evaluation – the subject of this paper – 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 among zoo and aquarium visitors.

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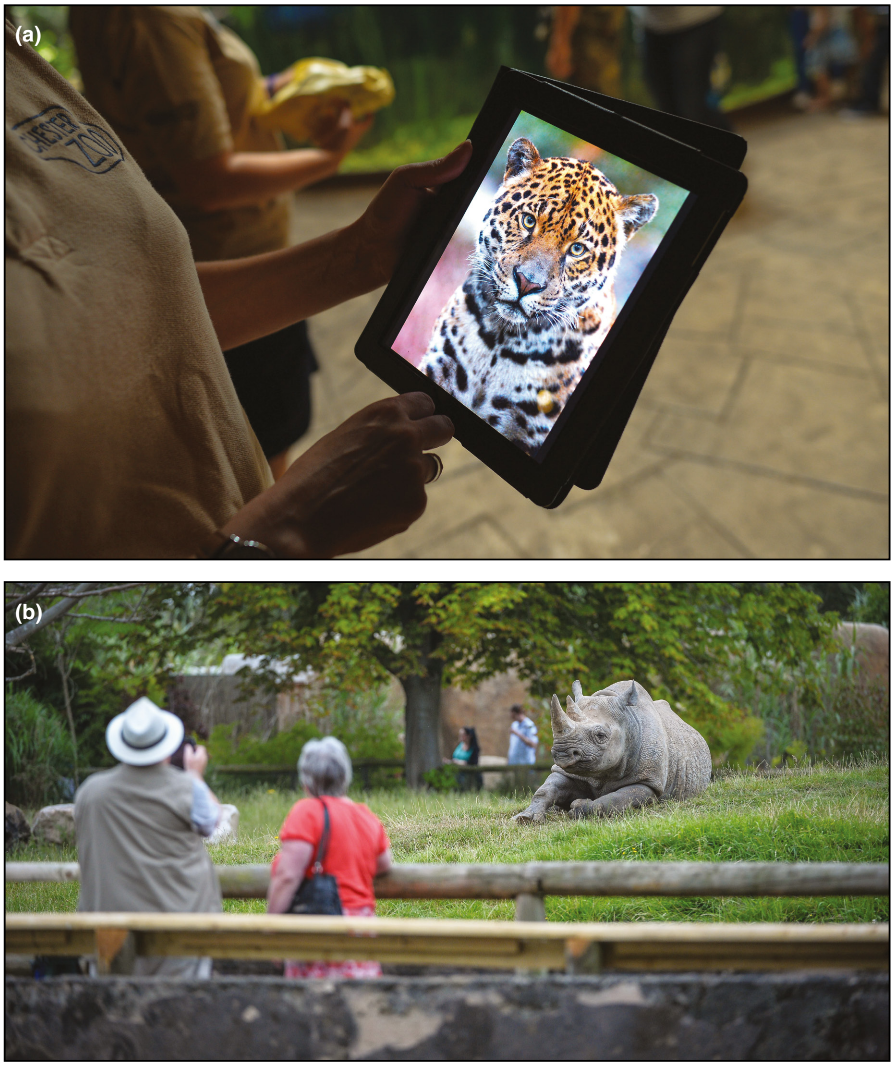

Figure 1. *Biodiversity education in a zoo setting. Visitors (a) receive biodiversity information via a tablet and (b) viewing an eastern black rhino (*Diceros bicornis michaeli*) at Chester Zoo, UK.*

Methods

The 2012–2013 survey (Moss *et al.* 2015) and the 2014–2015 survey both contained pre- and post-visit components, which were designed to measure two dependent variables (biodiversity understanding and knowledge of actions to help protect biodiversity) and to evaluate changes in individual participants over the course of their zoo or aquarium visit. The 2014–2015 survey was designed as a repeated-measures instrument (ie 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 was 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 was provided). The familiar expression "help save animal species" was used to avoid the possibly unfamiliar term, "biodiversity". 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 methodology is provided in Moss *et al.* (2015). In short, the 2014–2015 survey was distributed on paper or via a tablet computer by staff members and self-administered by respondents. It included a pre-visit component (administered at the entrance of the zoo or aquarium) and a post-visit component (administered at the exit of the zoo or aquarium) for the same participants. We selected potential survey respondents – any visitors at least 10 years old – 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 Nov 2014 to 31 Jul 2015. A total of 20 WAZA member organizations from 14 countries participated. The total number of valid surveys (ie surveys collected from the same individual pre- and post-visit) received across participating institutions was 4901; the mean number of surveys conducted at each institution (± standard deviation [SD]) was 245 ± 159, with a minimum of 60 surveys and a maximum of 597 surveys.

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 (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 scored 0. Institution-reported changes in the use of biodiversity information – excluding the Biodiversity is Us campaign materials – from the 2012–2013 survey to the 2014–2015 survey

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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 relied on 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.

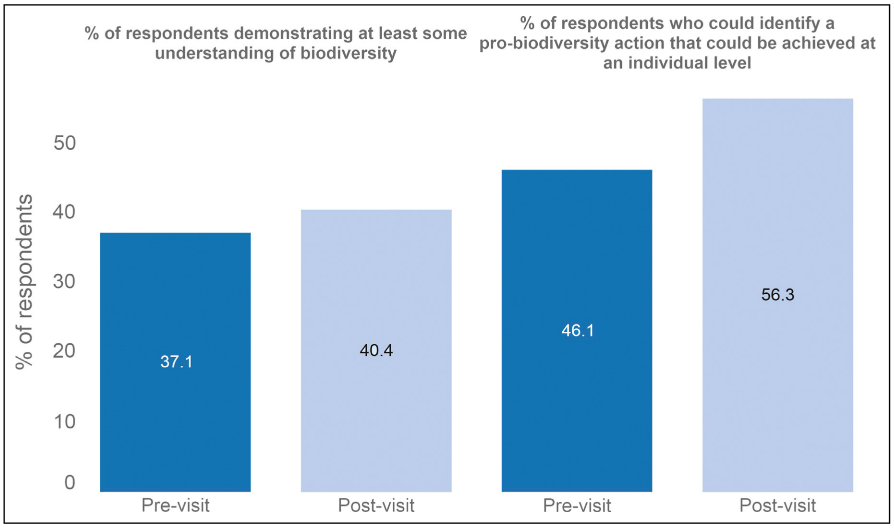

***Figure 2.** Overall comparison before and after a visit to a zoo or aquarium for the two dependent variables – biodiversity understanding (n = 2743) and knowledge of actions to help protect biodiversity (n = 2585) – in the 2014–2015 survey.*

Results

Mirroring the findings from the 2012–2013 survey and combined across respondents, we observed 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 (WebPanel 1), 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.

In the 2014–2015 survey, proportionally more respondents demonstrated at least some positive evidence of biodiversity understanding (scores of 3–7 for the response to this question; WebPanel 1) at the end (40.4%) as compared with the beginning (37.1%) of their visit (Figure 2). Both proportions were considerably lower than those in the 2012–2013 survey (69.8% and 75.1% pre- and post-visit, respectively). However, the magnitude of change from pre- to post-visit was slightly larger in the 2014–2015 survey. That is, the proportion of respondents demonstrating at least some positive evidence of biodiversity understanding increased by 8.9% between pre- and post-visit. During the 2012–2013 survey, this proportional percentage increase was 7.6%.

Likewise, proportionally more respondents identified 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; WebPanel 1) at the end (56.3%) as compared with the beginning (46.1%) of their visit in the 2014–2015 survey (Figure 2). These values 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 percentage increase between pre- and post-visits in the 2014–2015 survey (22.3%) as compared to the 2012–2013 survey (16.4%). To summarize, the respondents' pre-visit understanding of biodiversity and actions to protect it varies considerably between the two surveys for reasons unknown to us, with the aggregate educational impact from their visit being larger in the survey with the lower starting level (ie the 2014–2015 survey).

There was a significant aggregate increase between pre- and post-visit biodiversity understanding (from 2.41 ± 1.07 to 2.50 ± 1.03) in those respondents (33.7%) who reported seeing the Biodiversity is Us graphic panels or films ($F = 7.315$, $P = 0.007$; Figure 3), as compared to those who did not see these materials (25.0% of respondents; 6.6% were not sure and 34.9% did not answer this question). There was also a significant aggregate increase between pre- and post-visit knowledge of actions to help protect biodiversity (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 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 for an extended period, seven institutions reported limited use (in terms of content, space, and time), and five institutions indicated that they did not use any campaign materials during the data collection period. Based on the reported changes in institutions' use of these materials, observed differences in respondents' aggregate pre- and post-visit biodiversity understanding ($F = 0.199$,

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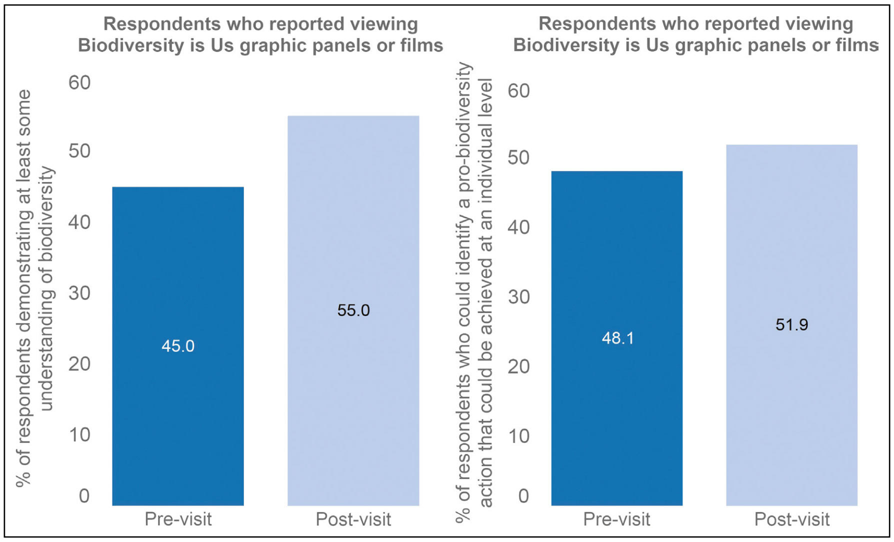

Figure 3. *Comparison before and after a visit to a zoo or aquarium for the two dependent variables – biodiversity understanding (n = 1329) and knowledge of actions to help protect biodiversity (n = 1210) – for respondents who reported seeing the Biodiversity is Us graphic panels or films in the 2014–2015 survey.*

$P = 0.820$) and knowledge of actions to help protect biodiversity ($F = 0.886$, $P = 0.421$) were not significant. This result indicates that it is more informative to know whether visitors actually see the campaign materials (see above) than to know whether institutions simply report using more of these materials (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 remaining ten reported no substantial change (no institution reported decreasing its use of biodiversity information). Based on the reported changes in institutions' use of biodiversity information unrelated to that of the Biodiversity is Us campaign, observed differences in respondents' aggregate pre- and post-visit biodiversity understanding ($F = 1.377$, $P = 0.254$) and knowledge of actions to help protect biodiversity ($F = 4.178$, $P = 0.054$) were not significant. This result 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 benefits of improved learning outcomes, as we have shown in our evaluation of the Biodiversity is Us campaign. 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. The use of campaign materials appears to be related to improved visitor knowledge but more notably for understanding the concept of biodiversity than for being aware of actions to conserve biodiversity. Given that the graphic panels and films focused primarily on introducing the former concept, rather than promoting the latter actions, this difference in improvement makes sense. Further, the observed improvements align directly with 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 implementing Aichi Biodiversity Target 1 is "trends in awareness, attitudes and public engagement in support of biological diversity and ecosystem services" (www.cbd.int/sp/indicators). While prior studies have evaluated localized interventions at individual institutions (eg MacDonald 2015), we are not aware of any other study that has evaluated the impact of a biodiversity education campaign on a global scale 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 2 years) that has elapsed between the two surveys. A mid-term analysis of progress toward 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.

While 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 conserve biodiversity?" Knowing about how to help and actually helping are two different concepts (Heimlich and Ardoin 2008; Sheeran and Webb 2016; Moss *et al.* 2017). The complexity and diversity of the many models of human behavioral change (St John *et al.* 2010) indicate that an increase in knowledge is not necessarily a reliable predictor of a related change in behavior (Schultz 2011; Heberlein 2012). Even the intention to behave is a less significant predictor of actual behavior than might have

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been assumed (Webb and Sheeran 2006). However, an expansive definition of "education" could encompass skills, attitudes, values, organizing community action, and personal behavior. Indeed, the challenge for zoos and aquariums is not only to maximize 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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Supporting Information

Additional, web-only material may be found in the online version of this article at http://onlinelibrary.wiley.com/doi/10.1002/fee.1493/suppinfo

A Moss *et al*. – Supplemental Information

WebPanel 1. Content analysis framework

Following Moss *et al.* (2015), 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 five-point unidirectional scale was developed. Each response was scored according to the following scale: 1, inaccurate (descriptions contained no accurate elements [eg "open air", "everything in general"] or were too vague to indicate accurate knowledge [eg "many things"]); 2, ambivalent (some accurate descriptions and some of inaccurate descriptions); 3, some positive evidence (mention of something biological [eg "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 [eg "lots of life", "many species", "variety of species"]); 5, strong positive evidence (no inaccurate elements, specific mention of both animals and plants [eg "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's (CBD's) "Value of Biodiversity and Ecosystem Services" (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 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 [eg "save ecosystems"]); +2, specific identification of pro-biodiversity action or behavior at a general level (not feasible to address as an individual [eg "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 (eg "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 (eg "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) 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 (Landis and Koch 1977) (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).

WebReferences

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