

Investigating the Long-term Effects of Informal Science Learning at Zoos and Aquariums

Final Briefing Report

Photo: Zoological Society of London

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OVERVIEW

“Investigating the Long-term Effects of Informal Science Learning at Zoos and Aquariums” was a one-year project funded by Science Learning+, an international partnership between the National Science Foundation (US), the Wellcome Trust (UK), and the UK-based Economic and Social Research Council, and in collaboration with the Gordon and Betty Moore Foundation, the MacArthur Foundation, and the Noyce Foundation. The project aimed to identify the opportunities for and barriers to researching the long-term effects of informal science learning experiences at zoos and aquariums; and to construct a proposal for a five- to ten-year study as the first attempt to measure those effects. The project also aimed to establish a research relationship between the education departments at the Wildlife Conservation Society and the Zoological Society of London, as well as with researchers at Stanford University and Lancaster University. The project concluded in November 2015.

PROJECT PARTNERS



RATIONALE

Zoos and aquariums are some of the most popular sites for informal science learning. In the United States, more than 180 million people visit an accredited zoo or aquarium each year, and in the United Kingdom, 25 million people annually visit zoos and aquariums that are members of the National Association. These impressively high visitation numbers make zoos and aquariums an important focus for informal science learning research. Despite important advances in the zoo and aquarium field in recent decades, however, we still do not have a clear understanding of the ways that zoo and aquarium visitors are applying science and conservation learning beyond the walls of the zoo or aquarium--especially in the long term. Khalil and Ardoin (2011) note, for example, that most evaluation of learning at zoos and aquariums has focused on the “immediate effect on knowledge, attitude and behavioral outcomes rather than considering longer-term effects” (p. 174). Our project was guided by one central question: How might we identify and measure the long-term effects of an informal science learning experience at a zoo and aquarium?



Photo: Zoological Society of London

OUR PROCESS

We conducted a participatory process that engaged zoo and aquarium education practitioners, researchers from related disciplines, and zoo and aquarium visitors in order to identify (1) existing efforts to measure the effects (especially long-term) of informal science learning experiences at zoos and aquariums; (2) the range of potential and/or intended long-term effects of informal science learning experiences at zoos and aquariums; (3) opportunities for and barriers to measuring those effects; and (4) recommendations for further research. We collected data through four efforts:

- **Literature Review:** The purpose of the literature review was to document previous research into long-term effects of informal science learning at zoos and aquariums. We searched four databases (Academic Search Complete; ERIC; Wiley Online Library; and Taylor and Francis/Routledge Online) using combinations of 12 search terms¹, for a total of 50 searches in each of the four databases (200 searches total). Three exclusion criteria were applied to the title, abstract, and publication date of all citations turned up in the searches: (1) the study was published since 2005; (2) the article discussed a learning experience that took place at a zoo or aquarium; and (3) the study attempted to measure an outcome or impact. Citations that met all three of these criteria were flagged for full review wherein the article was read in order to determine whether the study attempted to measure long-term effects. In the end, 125 articles were subject to the full review.
- **Consultative Workshops:** We conducted three consultative workshops to ensure that our work would be as relevant as possible to the wider informal science learning community. The workshops (which varied in length from three to six hours as appropriate for the workshop objectives, audience, and conference venue) used participatory activities and discussion to gather ideas and input from practitioners, researchers, and other stakeholders in zoo and aquarium education. Workshops were held at the European Zoo and Aquarium Association (EAZA) Zoo Educators Conference in Lisbon, Portugal; the Association of Zoos and Aquariums (AZA) Midyear Meeting in Columbia, South Carolina; and the British and Irish Association of Zoos and Aquariums (BIAZA) Educators Meeting in London, UK. In total, 62 representatives from 49 institutions in 13 countries took part in the workshops.
- **Leadership Survey:** In June 2015, we surveyed leadership-level employees at zoos and aquariums in the US and Europe. Requests to complete the survey were sent out via AZA, EAZA, and BIAZA listservs. We received a total of 117 responses (70 from the US, 21 from the UK, and 26 from the rest of Europe). The survey consisted of four questions focusing on intended outcomes and effects of education programs and existing efforts to measure those effects.
- **Audience Research:** Because we believe that an important aspect of understanding the impacts of zoo and aquarium learning experiences involves developing deeper first-hand knowledge of the visitor experience, we surveyed visitors at member events at the Bronx Zoo (US) and Whipsnade Zoo (UK). We invited zoo members (rather than non-members) to participate in this survey because we believed they would be better able to reflect on their relationship to the zoos as learning institutions over a longer period of time. The surveys used closed- and open-ended questions to gather input on what visitors believe are the long-term effects of an informal science learning experience at a zoo or aquarium. In total, 85 surveys were collected (47 from WCS members and 38 from ZSL members).

¹All possible combinations (50 total combinations) of one word from each of the following word sets were searched in each database, for a total of 200 searches. Set 1: zoo; aquarium. Set 2: long-term; impact; longitudinal; outcome; evaluation. Set 3: education; learning; visitor; exhibit; audience.

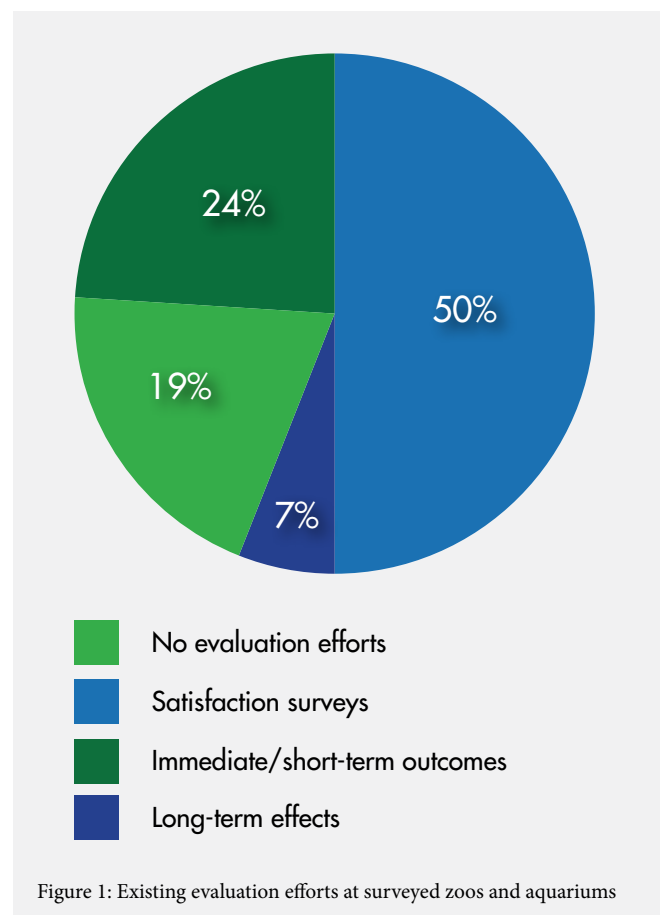
KEY FINDINGS

Finding #1: A review of the literature found just six zoo and aquarium-focused studies that collected data over periods longer than six months.

Of the 125 articles reviewed, 19 percent (n=24) collected outcomes data beyond just immediately after a program or zoo visit. Eight studies collected data over periods of up to two months. Eleven studies were executed over periods of two to six months. Just six studies looked at periods of more than six months. The longest study was an evaluation of a science center in Los Angeles (Falk and Needham, 2011). This study was conducted over roughly ten years, though the authors compared unpaired data sets over the ten-year period. While there may be studies that did not match our search terms and therefore were not reviewed, the literature review suggests a need for longitudinal studies (especially multiyear) focused on informal science learning at zoos and aquariums.

Finding #2: Existing evaluation efforts at zoos and aquariums are most frequently focused on participant satisfaction and immediate/short-term outcomes.

Data from the online survey (see Figure 1) found that nearly one-fifth (n=22) of respondents said there were no evaluation efforts—whether short- or long-term—at their institution. Half (n=58) of the respondents said that their organization’s evaluation-related efforts consisted of satisfaction surveys, while roughly a quarter (n=28) of respondents said that they focused their evaluation activities on immediate/short-term outcomes such as message or knowledge retention. A somewhat surprising finding was that 7% (n=8) of respondents described efforts to measure long-term effects. One responding institution, for example, noted a project to track teen participants as they entered university, while another respondent highlighted a three-year project focusing on early childhood education program impacts. However, most of the eight responding institutions who said that they were conducting long-term evaluation projects did not provide any further details.



Finding #3: Evidence for long-term effects of informal science learning at zoos and aquariums tends to be anecdotal in nature.

Long-term informal science learning programs are taking place at many zoos/aquariums. Participants in the consultative workshops discussed programs that ran over weeks, months, and even years. They also shared information about shorter annual programs in which audiences participate recurrently. However, evidence for long-term effects of these programs was typically anecdotal. For example, one zoo representative said, “We have had many reports of what an impact we have had on people over the years, including influencing career choices and life-long passions.” In a few cases, zoos and aquariums reported actually collecting data on a regular basis for years, but these organizations were unsure of what to do with the data, i.e. how to analyze the data for evidence of program effects.

Finding #4: The most frequently cited intended educational outcomes of programs at zoos and aquariums were conservation awareness, connecting to wildlife, and experiencing science.

Responses to an outcomes-focused question in the online survey were coded, with five themes emerging from the data. The most frequently mentioned intended outcomes of zoo and aquarium education efforts were:

Conservation awareness (55%) included ideas such as wildlife issues, general sustainability issues, and awareness of zoo and aquarium efforts in conservation.

Connecting to wildlife (48%) included developing an appreciation for animals, fostering empathy, and developing compassion.

Experiencing science (41%) included learning scientific knowledge and facts, fostering interest in science, and understanding real-world application of science.

Inspiring action (34%) included pro-environmental behaviors and actions one could take on behalf of wildlife conservation.

Fostering learning (14%) included promoting lifelong learning at zoos, aquariums, and other informal science institutions.



Photo: Wildlife Conservation Society

Of particular note was the fact that the question did not focus on informal science learning specifically, but on educational opportunities at zoos and aquariums in general. The finding that 41% of respondents cited science-related outcomes suggests that zoos and aquariums are placing a high priority on their role as informal science learning institutions alongside their conservation education emphasis.

Finding #5: While learning science facts and concepts was reported most frequently, zoo members also said their visits motivated them to learn more about science and the world around them.

When asked how zoo and aquarium visits had helped them learn about science, zoo members surveyed as part of this project were most likely to cite science facts or concepts (particularly related to animals and their habitats). However, the zoo members also discussed how they were motivated to continue learning and making scientific observations after their visit.

Finding #6: Zoo and aquarium professionals recognize the need for and value in identifying and measuring long-term effects.

Data from the consultative workshops and the online survey both suggested strong interest in and support for this line of research. Respondents noted that research of this type had the potential to improve programs by (1) identifying effective interventions; (2) providing sound justification for the mission of zoos and aquariums; (3) supporting appeals for funding; (4) guiding strategic and long-term planning; and (5) demonstrating the collective impact of zoos and aquariums on learning.

Finding #7: Most zoos and aquariums lack the capacity and expertise to conduct long-term evaluation and research projects.

Both the consultative workshops and online survey suggested that, in the zoo and aquarium field, there is a need for more knowledge, skills, and confidence to conduct long-term effects research. Further, respondents noted that many institutions are simply not ready to investigate long-term effects, in particular, of informal science learning at their sites. One respondent noted, “We decided that we needed to start with the basics by understanding more about visitor expectations and motivation, and evaluate efficacy of learning styles and methods. Our more immediate questions are around measuring learning outputs and outcomes against specific objectives.” Participants at the consultative workshops suggested that future long-term research efforts should include a capacity building element to improve the zoo and aquarium community’s ability to engage in this type of work.

Finding #8: Evidencing the long-term effect of a single visit to a zoo or aquarium may be impossible.

As one of our survey respondents noted, “We need to realize that our impacts come most typically from multiple visits and not a single time.” Additionally, it is methodologically challenging to pinpoint the effects of science learning at zoos and aquariums amongst the myriad other sources of science learning in a person’s life. Therefore, the greatest potential for this research in the future may lie in investigating (1) the effects of repeated visits or programs, and/or (2) what role zoos and aquariums play in lifelong science learning.



Why “effects” and not “impacts”?

In this report, we use the more open, methodologically neutral and exploratory term *effect* rather than the more convergent, objective-oriented term *impact* to denote the longer-term learning outcomes associated with a zoo or aquarium experience. Our decision is based on a kind of methodological pragmatism, particularly in complex environments such as zoos and aquariums.

Our project was part of an imperative to “sense make” in the landscape of learning at zoos and aquariums. Weick (1995) discusses sense making in terms of “active agents” (in this case, us as researchers) structuring the unknown. In this “unknown” research environment, we have taken an open, exploratory stance with an emphasis on knowledge building. In turn, this requires that we use discourse in alignment with this sense-making endeavour.

The notion of impact within the research and evaluation community has been conventionally associated with attempting to identify clear, causal links between controlled or planned treatments or interventions and specified (in advance) objectives or outcomes. In essence, it is as near to an experimental paradigm as is possible.

However, this does not characterize the research environment of this project. In this project, the focus has been on (1) existing practices undertaken and experienced by visitors rather than planned “treatments”; (2) oftentimes unstructured, rather than controlled, experiences; and (3) unknown outcomes rather than specified objectives.

Therefore, the notion of effect in this context refers to the contribution made by the experience of visiting a zoo or aquarium to changes in science practices, attitudes or understanding.

There are daunting methodological problems in identifying robust causal links between an intervention, a program or an experience of any kind, and the resultant learning. Attribution (i.e. identifying the extent to which a particular experience has created a specific outcome) is particularly problematic in informal learning environments such as zoos and aquariums. Using effect rather than impact does not resolve the problem of attribution, but it does guard against the chimera of certainty and acknowledges the difficulty of establishing unequivocal lines of determination.

FUTURE DIRECTIONS

In August 2015, the research team gathered to review the activities and findings of this project. The purpose of this meeting was to identify the most promising avenues for further research into the long-term effects of informal science learning at zoos and aquariums. Part of this work was to visually describe through a theory of change (Figure 2) how science learning takes place at zoos and aquariums. At the center are the learning experiences that take place at zoos and aquariums, including early childhood programs, interpretive signage, school programs, animal encounters, and internships, amongst others. These experiences then interact with other forms of science learning (e.g. formal learning, family learning, media). Together, these experiences can lead to a variety of learning outcomes, here represented by the National Research Council’s (2009) informal science learning standards. The placement of the zoo and aquarium learning experiences at the center of the graphic are not meant to imply that zoo and aquarium learning is more important or has greater effects than other informal science learning experiences—only that they are the focus of our research.



Figure 2: Informal Science Learning at Zoos and Aquariums Theory of Change

The theory of change demonstrates that informal science learning experiences at zoos and aquariums do not take place in isolation. Zoo and aquarium learning experiences are in fact one part of an individual’s lifelong science learning journey. Therefore, our project findings have shifted our focus away from a likely futile attempt to isolate the long-term impacts or effects of zoo and aquarium learning only. Instead, our research agenda will attempt to describe how zoo and aquarium learning experiences interact with, influence, and are influenced by a range of other science learning experiences that may take place in one’s life.

Based on this shift in focus as well as the other findings of this project, we generated the following recommendations for future research:

- Consider the contribution of zoos and aquariums to an individual's lifelong science learning journey, rather than attempt to establish attributional links between interventions and long-term effects. Versions of this inductive approach include contribution analysis (Mayne, 2001), in which possible explanations are tested for their contribution to a present 'condition' in circumstances in which experimental methods are inappropriate. This approach would not preclude making comparisons between different dimensions of a zoo or aquarium visit, but keeps open the attributional relationship.
- Investigate to what extent and in what ways informal science learning experiences at zoos and aquariums motivate visitors to pursue science learning in other settings.
- Investigate to what extent and in what ways informal science learning experiences at zoos and aquariums motivate visitors to apply that learning in their everyday lives.
- Examine in greater detail the existing long-term data sets or evaluation efforts currently underway at zoos and aquariums. Determine the utility of existing data and explore ways to strengthen or improve existing data collection and analysis efforts.
- Given the dearth of long-term research studies focusing on zoo and aquarium learning experiences, execute a five- to ten-year longitudinal investigation.
- Reorient our language to focus on long-term effects rather than impacts of informal science learning experiences.
- Due to a lack of existing capacity within the zoo and aquarium field, design long-term studies with central coordination in order to ensure quality and rigor. Ideally, future long-term studies will also include professional development and capacity building to enable additional zoos and aquariums to contribute to this research agenda in the future.

CONCLUSION

At the beginning of this one-year project, we set out to better understand the need for longitudinal studies focusing on informal science learning at zoos and aquariums, and possible approaches for this line of research. Through a literature review, consultative workshops, and surveys, we found that 1) few previous efforts have attempted to measure long-term effects of science learning at zoos and aquariums; 2) zoo and aquarium professionals identify a need for research of this kind; and 3) an approach that considers informal science learning within an individual's lifelong science learning landscape may yield the most relevant and useful research findings. At the end of this project, we designed a study that will attempt to examine the contribution of zoo and aquarium experiences to lifelong science learning. When completed, we hope this next phase of our research will fill an important gap in our understanding of zoo and aquarium learning, and the wider informal science learning field.

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REFERENCES

Falk, J. H., & Needham, M. D. (2011). Measuring the impact of a science center on its community. *Journal of Research in Science Teaching*, 48(1), 1–12.

Khalil, K., and Ardoin, N.M. (2011). Programmatic evaluation in Association of Zoos and Aquariums-accredited zoos and aquariums: A literature review. *Applied Environmental Education and Communication*, 10(3), 168-177.

Mayne, J. (2001). Addressing attribution through contribution analysis: Using performance measures sensibly. *Canadian Journal of Program Evaluation*, 16(1), 1-24.

National Research Council. (2009). *Learning Science in Informal Environments: People, Places and Pursuits*. Washington: The National Academies Press.

Weick, K. E. (1995). *Sensemaking in Organizations*. Thousand Oaks, CA: SAGE Publications.

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