# FAMILY INTERPRETATIONS OF CONSERVATION MESSAGING IN AN AQUARIUM

by

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HONORS THESIS

Submitted to Texas State University
in partial fulfillment
of the requirements for
graduation in the Honors College
May 2020

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## ACKNOWLEDGEMENTS

I would like to start by thanking the Texas State Honors College and all of their faculty and staff such as Dean Heather Galloway, Dr. Ron Haas, and Melanie Liddle. Thank you for allowing me to undertake this research project and all of the other opportunities you have given me.

I want to thank the HSI SURE Program for allowing me to meet my mentors, Dr. Kristy Daniel and Jenn Idema. Dr. Daniel, thank you for allowing me into your lab and teaching me. Thank you for guiding me during the SURE program and helping me complete my thesis. Dr. Daniel and Jenn Idema have been wonderful mentors and role models. I have learned so much through them and I admire their hard work and dedication to the field of research. Their guidance for the past year has made me a better scientist and person.

Thank you, Bria Marty, Toni Mac Crossan, and Ryan Ament for listening to my endless rambling and supporting my endeavors. I also want to thank Ciera Cabrera, Erika Peña, Cynthia Espinoza, Ella Barwick, and many others who have whole-heartedly supported me throughout my entire college career. I would also like to thank my parents Tami Ingle and John Ingle for supporting me both financially and emotionally these past four years.

I would also like to thank Dr. Julie Westerlund, Dr. Marian Houser, and Daniel King for providing not only enjoyable classes but also believing in my goals and aspirations.

## TABLE OF CONTENTS

**Page**

## Abstract

Aquaria are places where families can develop a scientifically literate opinion through interaction with exhibits containing socioscientific messages. This study explores differences in parent and child interpretations of a socioscientific message presented at an aquarium exhibit. A staff interview and video observation identified the design elements and intended message behind the exhibit. Video observations and family interviews identified interpreted exhibit message and focal interactions. An inductive approach was used to analyze interviews and a deductive approach for exhibit design elements categorization. The goals of the aquarium are to provide accurate content that is interactive and accessible to visitors but avoid upsetting controversial topics. The intended message of water conservation was identified, and a majority of family visitor participants' interpretations were aligned, although none reported the full message. Adults spent more time interacting with digital and physical signage when compared to children who spent more time interacting with the live specimen. Exhibit design decisions and technological issues may be factors that contributed to misinterpretations. Visitors should leave the aquarium with a better understanding of water conservation and how their actions impact the environment. Future exhibit designers should take into consideration the specific needs of adults and children when designing an exhibit as doing so could help visitors leave with a better understanding of the exhibit's message.

## Introduction

The need for a more scientifically literate society is critical for creating solutions to the existing environmental issues the world currently faces. However, when the average American spends about five percent of their life in a school setting, and even less time specifically learning about science (Falk & Dierking, 2010), increasing scientific literacy becomes challenging. With an increase in urbanization, humans are becoming more removed from nature (Patrick & Tunnicliffe, 2013). As personal experiences with the natural world decrease, a virtual representation of wildlife is one of the ways humans can connect with nature. Aquaria and other informal science institutions play a key role in providing the general public with opportunities to learn about science content in user friendly settings and formats while connecting them with the natural world (Bell, Lewenstein, Shouse, & Feder, 2009).

## Literature Review

### *Informal learning in zoos/aquariums*

Zoos and aquaria are centers recognized for their contribution to the conservation of flora and fauna. Zoos and aquaria are also educational institutions, with the main attraction typically being the animals (Patrick & Tunnicliffe, 2013). Zoo visitors are drawn to the allure of live animals and species they are specifically interested in. Zoos and aquaria create a friendly environment for visitors to learn and interact with exhibits. These interactive exhibits provide visitors with an immersive learning experience that is more unique than a formal classroom (Falk & Dierking, 2010; Kopczak, Kisiel, & Rowe, 2015). Informal learning environments allow visitors to develop an emotional connection

with wildlife by physically immersing themselves in nature. Regardless of educational background and prior experiences, visitors can have fun interacting with live animals while also building upon their prior science knowledge (Cainey, Bowker, Humphrey, & Murray, 2012; Patrick & Tunnicliffe, 2013; Kopczak, Kisiel, & Rowe, 2015).

***Exhibits in aquaria***

Visitors choose to interact with exhibits they are comfortable with and can learn how environmental concerns can be personally relevant to them (Veverka, 2011; Zeidler & Nichols, 2009). Visitor interactions with exhibits can be influenced by their personal interests, exhibit design, and even their immediate environment (Davey, 2005). Aquaria commonly implement multimedia exhibits to enhance visitor engagement and knowledge development (DiPaola, Akai, & Kraus, 2007). Implementing interactive and hands-on elements allows for an extended time interacting with the exhibit and will hold visitor attention longer (Veverka, 2011). This is important because the length of visitor engagement with an exhibit increases the visitor's learning capacity (Veverka, 2011).

Prolonged interactions with exhibits can help visitors gain a better understanding of the exhibit's message. Exhibits load is the amount of time and energy a visitors uses when interacting with an exhibit (Veverka, 2011). As visitors interact with various exhibits, their emotional and mental energy begins to decrease. After prolonged interaction, visitors will become mentally exhausted and feel overloaded with information (Davey, 2005; Veverka, 2011). Preventing exhibit overload is crucial for visitor experience (Veverka, 2011).

Active exhibits allow visitors to engage in an activity using high levels of physical and mental coordination (Veverka, 2011). A highly active exhibit moves and is

physically manipulated by the visitor. These exhibits hold a higher intrinsic interest to visitors because they can directly engage with the exhibit (Veverka, 2011). However, these highly active exhibits use up more emotional and mental energy (Veverka, 2011). To prevent visitor burn out, an exhibit needs passive elements such as observing an artifact or playing a video. Passive elements hold less intrinsic interest to visitors but require extensive interpretive techniques to understand. The ideal exhibit should have a balanced mixture of active and passive elements (Veverka, 2011).

Exhibit design also plays a large role in holding visitor attention (Borun & Dritsas, 1997; Davey, 2005; Veverka, 2011). Factors such as exhibit size, placement, sensory features, structural aspects, and lighting can affect visitor behavior (Davey, 2005). Understanding the connection between visitor attributes and exhibit design variables is important when trying to capture visitor attention (Veverka, 2011; Davey, 2005). Exhibits should be designed to provoke interest and effectively communicate scientific content to enhance a visitor's learning experience (Borun & Dritsas, 1997; Veverka, 2011; Davey, 2005).

***Families visiting aquaria***

Families are one of the largest visitor groups to aquaria and they are often drawn to these institutions to experience science in a fun format (Borun & Dritsas, 1997; Zimmerman et al., 2010; Zimmerman & McClain, 2014). A parent's primary motivation for choosing to visit aquaria with their family largely stems from the desire to have safe and enjoyable educational experiences together (Idema & Patrick, 2019). Families, especially large ones, are attracted to exhibits designed to accommodate a considerable number of people while also being easily accessible for all age groups (Borun & Dritsas,

1997). Activities designed to appeal to various learning styles while expanding upon prior background knowledge are essential components for a family-friendly exhibit (Borun & Dritsas, 1997).

***Family behavior at exhibits***

Children typically dictate exhibit interaction and are the first to engage with an exhibit (Gleason & Schauble, 1999). Adults accompanying children often communicate what animals they are observing and the science content present. During this interaction, children examine the behavior and features of the animals they are observing and associate these traits with animals they are already familiar with (Patrick & Tunnicliffe, 2013). These interactions vary greatly, being largely dependent upon personal interest, prior knowledge, age, and/or prior experiences (Zimmerman & McClain, 2014). Children are typically more interested in sharing information about the workings of an exhibit and what they observe, while adults tend to focus on gaining information from exhibit labels and signage (Dierking & Falk, 1994; Uzick & Patrick, 2017; Zimmerman et al., 2010; Zimmerman & McClain, 2014).

Adults act as a bridge for their child's learning experience. Adults can take on roles including a decision-maker, facilitator, teacher, or helper to construct their child's understanding of scientific content and interpret the science presented at the exhibit (Uzick & Patrick, 2017; Kelly, Ocular, & Austin, 2020). The interactions between parents and children can influence how much children learn and can help create friendly dialog about conservation and science (Kopczak, Kisiel, & Rowe, 2015; Idema & Patrick, 2019). Conversations between parent and child about exhibit content play a vital role in informal learning (Kopczak, Kisiel, & Rowe, 2015). Engaging in science-related

conversations can influence a family's as well as an individual's perception of science, leading to an expansion of their scientific knowledge (Kopczak, Kisiel, & Rowe, 2015; Idema & Patrick, 2016).

## Conceptual Framework

The impact humans have on the environment has led to a variety of social issues centered on complex scientific topics called socioscientific issues (Zeidler & Nichols, 2009). Zeidler & Nichols (2009) developed the socioscientific issues framework to aid in the cultivation of student scientific literacy. The socioscientific issues framework is built upon two bases of rationale and direction for learning processes (Zeidler & Nichols, 2009). First, a student's interests are not always aligned with an educational objective which can lead to an indifference towards topics that are not personally relevant (Zeidler & Nichols, 2009). Second, learning to use ethics and evidence-based reasoning skills is important for a student's ability to make scientific decisions (Zeidler & Nichols, 2009).

The socioscientific issues framework has been implemented in studies in formal classroom settings to challenge student thinking. Personal beliefs, misconceptions, and lack of prior knowledge are impediments to a student's understanding of science. These impediments make it difficult for the student to then use evidence-based judgement for making scientific decisions (Zeidler & Nichols, 2009). Socioscientific issues have been used in classrooms to expand scientific knowledge in students by encouraging friendly discussion and debate that can challenge preconceived ideas and beliefs (Zeidler & Nichols, 2009).

People tend to feel far removed from socioscientific issues due to existing barriers, including political ideology or physical disconnection from the natural world

(Clayton, Luebke, Saunders, Matiasek, & Grajal, 2014). In informal science institutions, visitors can even feel upset or agitated when faced with messages that are emotionally provoking in nature, (e.g. climate change) or go against personal beliefs (Esson & Moss, 2013). The public may see socioscientific issues as abstract, having little relevance to their everyday lives, or are often politically charged (Clayton et al., 2014). Although controversial, socioscientific issues can be used to develop scientific literacy (Zeidler, Sadler, Simmons, & Howes, 2005; Zeidler & Nichols, 2009).

Socioscientific issues can be implemented in an informal science setting where visitors can learn about environmental issues affecting the natural world (Idema, 2019). Aquariums that implement socioscientific issues into exhibit design could provide visitors with an opportunity to develop a more scientifically literate opinion, cultivate moral reasoning, encourage friendly discussion, and improve critical thinking skills (Zeidler & Nichols, 2009). For the purpose of this study, we applied the socioscientific issues framework to examine how visitors interact with an aquarium exhibit that featured a message about water sustainability in the Texas Hill Country.

Water sustainability is essential to sustaining human communities and wildlife. Human pressures such as degradation of habitats, overexploitation, water pollution, flow modification, and invasion of exotic species have increased the extinction risk among freshwater flora and fauna (Meyers, Sale, Mulholland, & Poff, 1999; Ormerod, Dobson, Hildrew, & Townsend, 2010). Aquifers are the one of the primary water resources freshwater ecosystems depend upon. Urbanization and seasons of drought directly affect the recharge zone for aquifers (Bowles & Arsuffi, 1993) Aquifers can lose a substantial amount of water before fully recharging resulting in a loss of water for freshwater

ecosystems and human communities (Gulley, 2015; Sharp & Banner, 1997). The Texas Hill Country is dependent upon the Edwards Aquifer as the primary source of drinking water (Bowles & Arsuffi, 1993). The high demand for water conflicts with the preservation of endangered and threatened species that reside in the freshwater ecosystems creating a controversial, socioscientific issue.

Water conservation was the main topic presented at the targeted exhibit. While interacting with the exhibit, visitors could learn about the habitats and species dependent upon the Edwards Aquifer. From this information, visitors could gain a better understanding of their impact on the environment and how their actions affect wildlife.

**Purpose of the Study**

Prior research regarding families at informal science institutions has primarily focused on motivations for visiting the site, behaviors during visits, and learning outcomes (Esson & Moss 2013; Falk & Dierking, 2016; Patrick & Tunnicliffe, 2013; Phipps, 2010; Zimmerman, Reeve, & Bell, 2010). However, these studies have focused on an individual family members' perspective to represent the family and largely address adult responses rather than compare interpretations of experiences by both parents and children (Ellenbogen, 2002; Idema & Patrick, 2019).

The purpose of this qualitative study was to understand family interpretations of a socioscientific message being communicated through an aquarium exhibit. We used the following research questions to drive this study:

1. How does an aquarium present a localized socioscientific environmental issue to visitors through an exhibit?

2. What rationalizations are considered when choosing which socioscientific environmental issues to localize and feature in an exhibit's message?
3. What is the intended take home message of a localized socioscientific environmental issues exhibit?
4. How do visitor interpretations of a localized socioscientific environmental issue exhibit compare to the aquarium's intended message?
5. Upon which aspects of the exhibit do visitors most focus?

## Methodology

### *Setting*

Our study (#6594) was approved by the Texas State University IRB and took place at a small aquarium located in the Texas Hill Country. The aquarium featured exhibits containing freshwater species endemic to the area, including endangered species such as the San Marcos Salamander, the Texas Blind Salamander, and the Fountain Darter.

The targeted exhibit displayed interactive digital signage with content about the native species in each tank. The visitor could learn about feeding habits, natural habitats, and life cycles of the animals (Figure 1). Physical signage included content on the Edwards Aquifer and water-dependent habitats. Exhibit content was factual and written at a third-grade reading level to increase accessibility for a wide variety of ages and comprehension levels. Digitized elements of the exhibit allowed for an interactive experience for children.

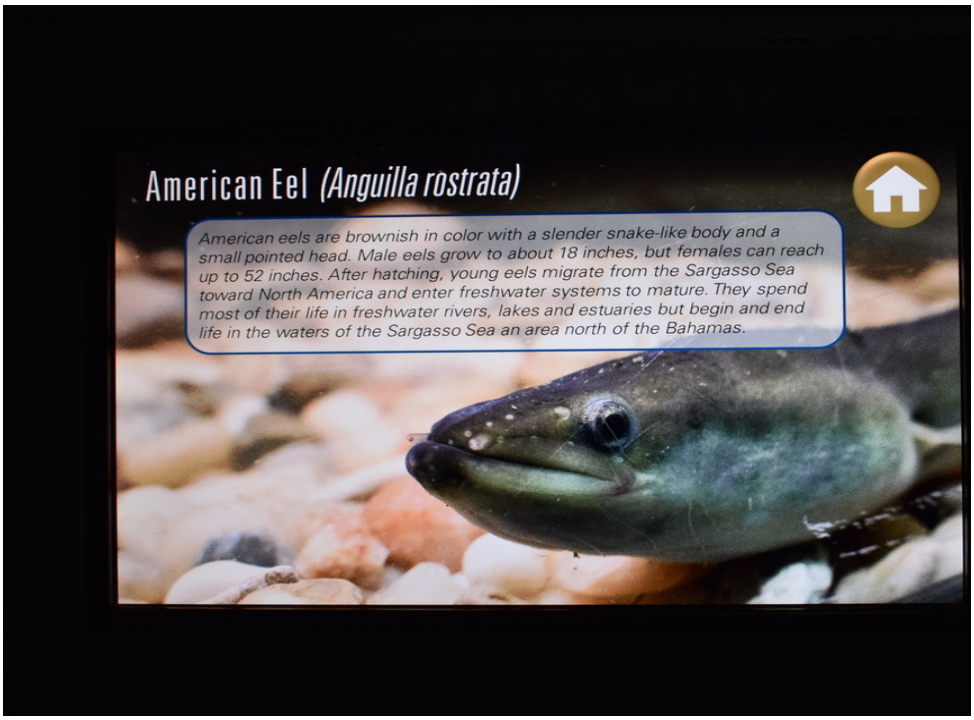


Figure 1: Shows the digitized information about the American Eel life cycle and habitat.

***Staff participant***

The staff participant was recruited based on their position as Deputy Director of the aquarium's education program (Appendix II). As Deputy Director, the staff participant was in charge of the content parameters presented in the exhibit. The staff participant was asked about exhibit design, content, target audience, and the intended take-home message (Appendix V).

***Family participants***

The recruited families were of diverse demographics and lived locally (within a 50-mile radius) to the aquarium. We recruited two members of each local participant family, one adult and one child. During recruitment, we explained our IRB approved protocol and requirements to both participants. Families who agreed to participate were required to sign informed consent, parent-guardian informed consent, and assent consent

forms before proceeding (Appendix III & IV). Recruited adults ranged from being parents, grandparents, or other close relatives. The age range for the child participants was 9-17 years old due to the Tobi Pro Glasses 2 not originally designed to fit the small faces of a child.

Once informed consent/assent was obtained, participants were fitted with Tobi Pro Glasses 2 and the glasses were calibrated to the participant's gaze. The participants were then asked to interact with the targeted exhibit as naturally as possible while wearing the Tobi Pro Glasses 2 so we could capture video observations and track participant focal interactions within the exhibit. After the participants had finished their exhibit experience, the glasses were removed, and a five-minute semi-structured interview (Appendix VI) was conducted to find out visitor interpretations of the exhibit message.

**Data Analysis**

We used an inductive approach to analyze both the staff participant and family participants' interview data. We applied In Vivo codes (Saldaña, 2016) during the first cycle of coding to capture participant claims about the socioscientific messaging. We then revisited our data and used a Pattern coding (Saldaña, 2016) process for our second cycle of analysis in order to identify emergent themes. We maintained the trustworthiness of our data through the use of inter-rater reliability where three researchers independently coded all data and reviewed outcomes reaching 100% consensus. We conducted member checking of our interpreted themes with the aquarium staff participant to make sure our interpretations were consistent with the intended messaging. We used a deductive approach to categorize exhibit design elements into either *Digital*, *Live Specimen*,

*Physical Signage*, or *Manipulative* components. Lastly, we used descriptive statistics to calculate focal point duration on identified exhibit features from video observation data of adult and children exhibit interactions.

## Findings

The mission statement for the aquarium includes a goal to have people understand the value of water because of the impact on the environment and humanity. The aquarium is free to the public and provides an educational experience on the importance of conservation. The aquarium implements these messages to communities by having activities such as guided river tours, snorkeling programs, field trips, summer school programs, free family fun day activities, and various freshwater exhibits.

### *RQ1 the presentation of a localized socioscientific environmental issue within an exhibit*

The targeted exhibit included a mix of digitized content, live example organisms, and physical signage about water conservation issues with written content presented at a 3rd-grade reading level (Figure 2). The staff participant stated that the intent behind the exhibit designs was to ensure that the exhibit is "interactive and accessible" for all visitors. Using a mixed media approach allowed for easy content updating as needed and attracted visitor attention because "digital displays attract people's eyes more so than paper information sheets."

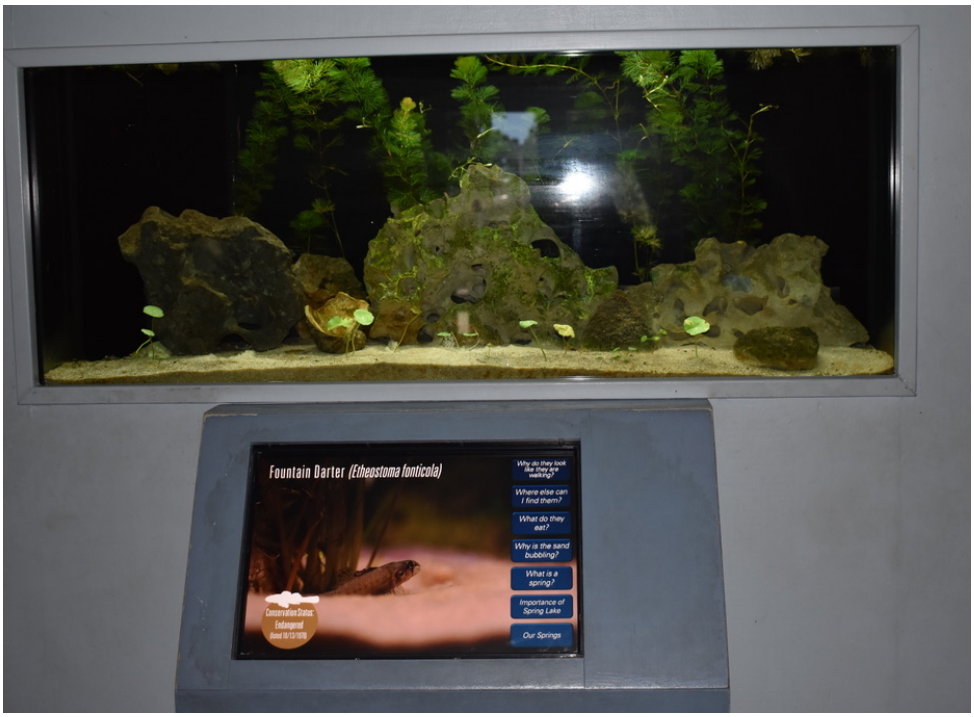


Figure 2: Shows interactive digital signage coupled with live specimen.

***RQ2 determining which socioscientific environmental issue to focus on***

We found that the aquarium staff participant held a clear primary goal to provide accurate content about local species drawn from reputable sources (e.g., Texas Parks and Wildlife, US Fish and Wildlife Factsheets). She stated her job is to, "make sure that all information is correct… everything looks good… and that everything runs." Furthermore, the staff participant stated that a secondary goal behind messaging decisions was to avoid presented controversial topics, such as climate change, to prevent potentially upsetting visitors. All messaging decisions by the staff participant were ultimately approved by the aquarium director and followed institutional policies.

***RQ3 the aquarium's intended take-home message for visitors***

The intended take-home message from the targeted exhibit (Table 1) is the "conservation of water is important because the overuse of water and non-point pollution within a watershed can harm local endangered aquatic species." The staff participant stated she wanted visitors to understand that there are several endangered species in the local river and, "if we pump them dry then they don't have a home." The staff participant was interested in helping visitors understand where their water comes from and for them to leave the aquarium, "a little more mindful about what you're doing" (Figure 3). Additionally, she stated that there are different factors affecting water and a, "big thing is pollution," with the idea that if the river is clean upstream, "then you have a clean river downstream... Whatever happens up here will affect what happens down on the coast."

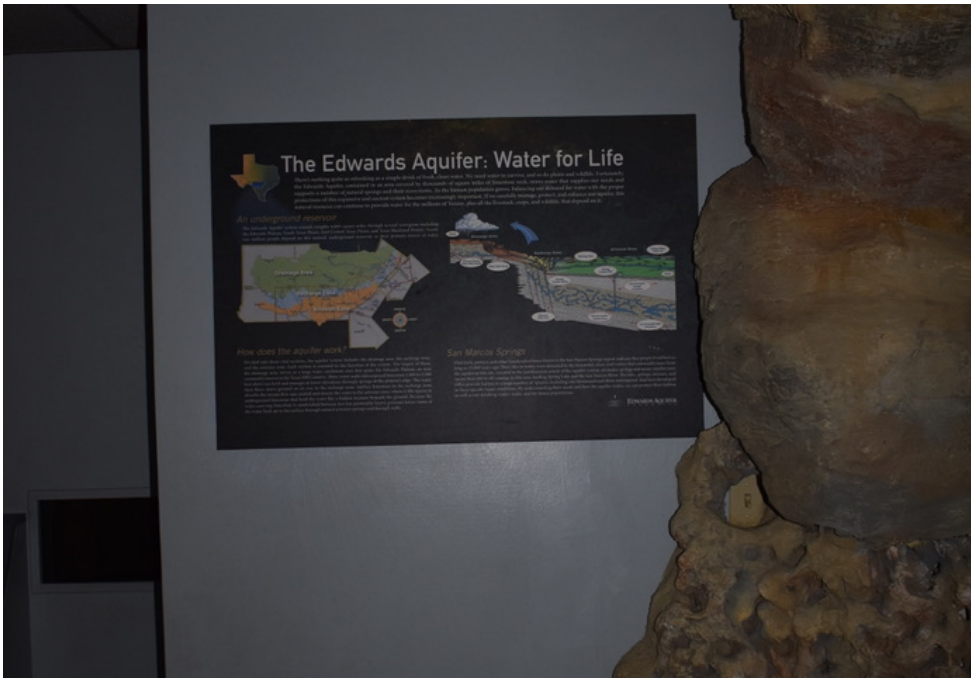


Figure 3: Shows the physical signage element of the exhibit.

***RQ4 comparing visitor interpretation and the aquarium's intended message***

When we asked family visitor participants about their interpretations of the exhibited message (Table 1), we found that many interpretations aligned with the intended message such as, “...using water wisely...”, “...save the water...”, or “...the importance of preserving the environment and nature overall” but no one reported the full message. There were visitor participants that were not able to capture the intended message at all. Some participants stated, “I didn't notice the signs. So, I didn't see them”, “You know, it’s nice just to learn something new”, or “...just to have different people's opinions so y'all learn and learn from each other”.

A majority of adult interpretations included content mentioning water and animal importance such as, “We all have to share that and... for survivability between both, you know, both human life and wildlife and... the importance of water and maintaining it” or “Take care of nature”. However, no adult discussed local conservation concerns.

Most child interpretations were more closely aligned with the intended message than the adults such as, “remember is that you need to be careful with the fishes and don't put trash in the water because it can hurt the fishes and it's going to be your fault because you're going to kill them and that's a bad thing to do” and “...I think the most important thing to remember is how a few of the animals in the exhibits were endangered and we need to focus on helping them live...”.

Table 1. Aquarium intended message compared to family interpreted exhibit message.

| **Aquarium Intended Message** |
|---|
| ***Conservation of water is important because the overuse of water and non-point pollution within the watershed can harm local endangered aquatic species.*** |
| **Visitor Interpreted Message** |
| Adult 1 Learning about the aquifer, the importance of preserving the environment and nature overall<br>Child 1 Sea animals |
| Adult 2 Salamander eye adaptations<br>Child 2 Water and to help the environment |
| Adult 3 Save the water<br>Child 3 Preserve the aquatic environment and fish |
| Adult 4 I clearly don't know everything<br>Child 4 I don't know actually |
| Adult 5 To learn about what lives in our waters<br>Child 5 The kinds of fish |
| Adult 6 We can learn from each other<br>Child 6 Don’t throw trash in the water |
| Adult 7 Take care of nature<br>Child 7 Protect endangered species |

***RQ5 elements of exhibit design visitors focus on the most***

Participants spent an average of four minutes interacting with the targeted exhibit (Table 2). Based on the biometric trends and eye-tracking video observations, adults spent more time focusing and interacting with digital and physical signage (averaging 46.83% of time interacting with signage) compared to the children, who spent more time focusing on the live specimen (averaging of 46.47% of time spent interacting with the live specimen). Physical signage was the exhibit design element least focused on by both adults and children (Figure 4).

Table 2: Shows the percentage of time participants spent on exhibit elements. Average time participant spent 4 minutes at target exhibit.

| Participant | % Time on Digital Signage | % Time on Live Specimen | % Time on Physical Signage | % Not Focused |
|---|---|---|---|---|
| Adult 1 | 68.40% | 29.90% | 0% | 1.70% |
| Child 1 | 16.20% | 77.10% | 0% | 6.70% |
| Adult 2 | 52.20% | 40.00% | 0% | 7.80% |
| Child 2 | 43.50% | 56.50% | 0% | 0.00% |
| Adult 3 | 39.60% | 33.60% | 20.20% | 6.60% |
| Child 3 | 40.20% | 59.20% | 0% | 0.60% |
| Adult 4 | 47.90% | 34.70% | 6.50% | 10.90% |
| Child 4 | 38.90% | 34.70% | 8.70% | 17.70% |
| Adult 5 | 43.60% | 42.30% | 0% | 14.10% |
| Child 5 | 47.00% | 38.40% | 1.30% | 13.30% |
| Adult 6 | 25.20% | 12.40% | 4.10% | 58.30% |
| Child 6 | 30.90% | 35.90% | 0% | 33.20% |
| Adult 7 | 17.00% | 47.90% | 4.30% | 30.80% |
| Child 7 | 17.40% | 41.70% | 1.30% | 39.60% |
| Avg. Adult | 46.83% | 34.34% | 5.17% | 13.66% |
| Avg. Child | 30.56% | 46.47% | 1.74% | 21.23% |

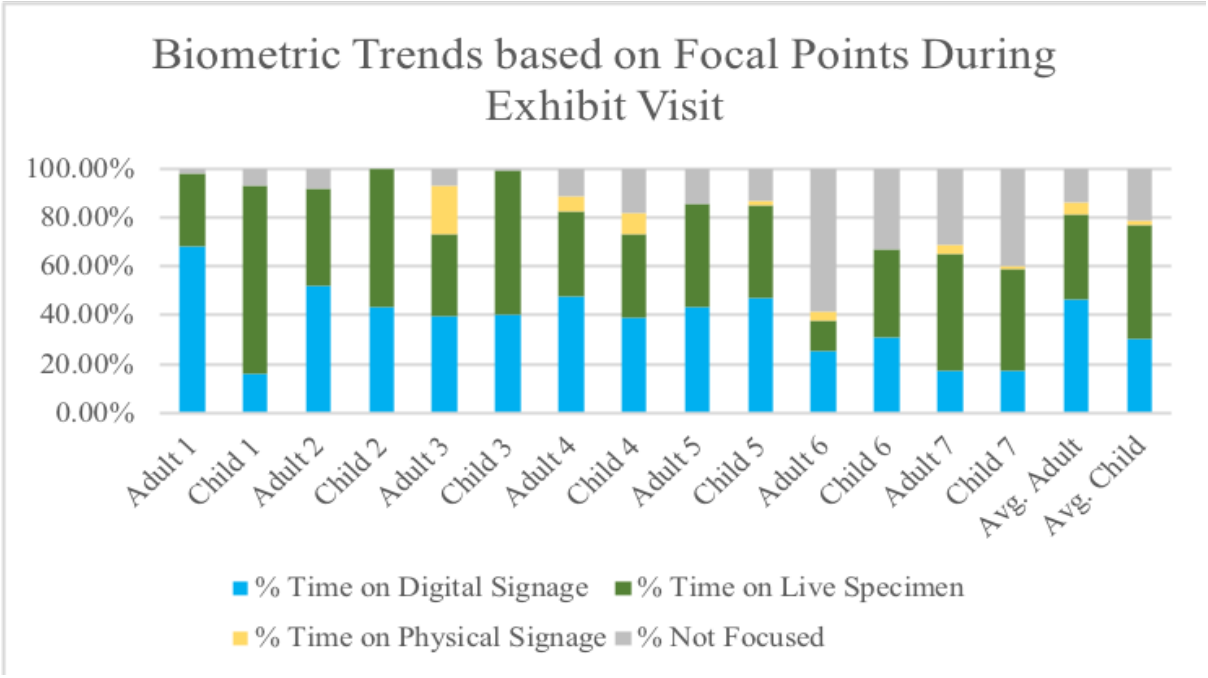


Figure 4: Biometric trends based on focal points during target exhibit visit (reported in % of total time by individual participant and overall averages).

## Discussion

This project explored a socioscientific issue communicated in an aquarium setting. Visitor interpretations of the targeted exhibit mostly aligned with the aquarium's interpreted message, with children typically having a closer interpretation of the message when compared to adults. Video observation via Tobi Pro Glasses 2 showed adults typically spent more time focusing on digital signage, while children spent more time focusing on the live species.

The staff participant chose to include factual, data-driven content within the identified target exhibit on local species of concern for conservation rather than present discussion points that could foster conservation dialogue between visitors. This type of design choice is a frequent occurrence with socioscientific issues since environmental messages can be upsetting (Esson & Moss, 2013). The staff participant's decision to omit discussion points for the socioscientific issue created a family-friendly environment for visitors since most families go to aquaria for entertainment and to have an additional learning experience (Bell, Lewenstein, Shouse, & Feder, 2009; Idema & Patrick, 2019). A majority of socioscientific messaging is controversial in content and it is difficult to fully address these issues through fact-based messaging approaches. Excluding topics, such as climate change, which could upset visitors, the staff participant presented family-friendly content in a relatively uncontroversial, easily accessible, and educational format. Visitors, regardless of educational background, could learn about the wildlife living in the area due to an easy to navigate 3rd-grade reading level. This created an inclusive environment for families with younger children and non-native English speakers that visit the aquarium.

The targeted exhibit lacked design elements such as hands-on, manipulative components. According to Veverka (2011), manipulative elements hold visitor attention longer, increases engagement opportunities, and have the most intrinsic interest. This design decision could be a reason why visitors spent a limited time interacting with the targeted exhibit.

The main message the aquarium wanted their visitors to leave with was the importance of water sustainability and the need to conserve water to protect endangered species. While most of the visitor interpretations aligned with the aquarium's intended message, none of the participants fully captured the intended goals of the aquarium staff participant. The children's interpretations included content about the animals they observed during their interaction with the exhibit while the adult's interpretations highlighted the importance of nature (Table 1). Child participants were more interested in the live specimen and spent more time interacting with the endangered species even though they could not physically touch them (Table 2, Figure 4). These observations could be due to children having a natural fascination and empathy for live plants and animals (Patrick & Tunnicliffe, 2013; Bates, 2018). At aquaria, children are provided the opportunity to build an empathetic bond with the animals they observe which can create a unique and memorable experience (Bates, 2018). The children in this study echoed this idea through an expressed desire to "…preserve the aquatic environment and fish," and "…to protect the endangered species."

Adult participants spent a larger portion of time interacting with the digital and physical signage compared to the children (Table 2, Figure 4). Adults typically take on the role of an educator to aid in their child's education and stimulate their learning by

initiating a conversation about exhibit content (Patrick & Tunnicliffe, 2013; Kopczak, Kisiel, & Rowe, 2015; Uzick & Patrick, 2017; Idema & Patrick, 2019; Kelly, Ocular, & Austin, 2020). Parents tend to utilize various inquiry skills including observation, questioning, analysis, and interpretation (Patrick & Tunnicliffe, 2013). Additionally, adults may be sufficient at guiding their children's understanding but struggle in aiding in the analysis of evidence and observation (Patrick & Tunnicliffe, 2013). While we did not analyze conversations between parents and children at the exhibit, based on the interactions observed, the varying interpretations may be due to a disparity in content analysis among adults and children. Alternate methods utilized by adults versus children to analyze evidence and observation could have also contributed to the variation in their interpretations (Patrick & Tunnicliffe, 2013). This may suggest that prior experience, knowledge, and personal interest greatly influences a visitor's perception (Zimmerman & McClain, 2014). Science learning requires the integration of old and new knowledge to aid in the development of perceptions, beliefs, and understating of scientific ideas (Zimmerman & McClain, 2014). Visitors can engage in science learning by making cognitive connections by associating new information to their prior knowledge and experiences (Patrick & Tunnicliffe, 2013; Zimmerman & McClain, 2014).

This project provided evidence that even though visitors have a shared experience, interpretations may differ among individuals. Interpretation disconnections may in part be due to technical issues with the digital displays available as limited touch sensitivity prevented some participants from accessing content about the species on display. Additionally, the physical signage was frequently out of eyeline for most child

visitors. Physical signage could be difficult to read as the exhibit is dimly lit and signage was located above children's eye level (Figure 3).

To truly provide a valuable learning experience where visitors actively invest time in exhibit content, aquaria need not be afraid of challenging visitor thinking and engaging visitors in dialogue (Esson & Moss, 2013; Kopczak, Kisiel, & Rowe, 2015). Families visiting this aquarium should leave with a better understanding of how water sustainability affects their lives and the wildlife around them. As a primary water resource, the sustainability of the Edwards Aquifer is crucial for the communities of the Texas Hill Country. Visitors to the aquarium could gain knowledge on how their actions affect this resource by engaging with a more interactive exhibit that encourages them think about their actions and acknowledge the consequences of them.

Future directions for this investigation are to explore messaging trends across more aquaria with exhibits displaying other socioscientific issues. Still, this current study provides evidence that adults and children attend to a different element of aquarium exhibit features concurrently. Exhibit designers should take into consideration individual needs when deciding upon messaging strategies.

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# Appendix I. IRB Approval Letter

TEXAS STATE UNIVERSITY
SAN MARCOS
*The rising* STAR *of Texas*

In future correspondence please refer to 6594

June 28, 2019

Jennifer Idema
Texas State University
601 University Dr.
San Marcos, TX 78666

Dear Jennifer:

Your application titled, "Exploring the impacts of socio-scientific environmental issues through aquarium exhibits" was reviewed by the Texas State University IRB and approved. It was determined there are: (1) research procedures consistent with a sound research design and they did not expose the subjects to unnecessary risk. (2) benefits to subjects are considered along with the importance of the topic and that outcomes are reasonable; (3) selection of subjects are equitable; and (4) the purposes of the research and the research setting are amenable to subjects' welfare and produced desired outcomes; indications of coercion or prejudice are absent, and participation is clearly voluntary.

**1.** In addition, the IRB found you will orient participants as follows: (1) informed consent is required; (2) Provision is made for collecting, using and storing data in a manner that protects the safety and privacy of the subjects and the confidentiality of the data; (3) Appropriate safeguards are included to protect the rights and welfare of the subjects. (4) Compensation will not be provided for participation.

**This project was approved at the Full Board Review Level until May 31, 2020**

2. **Research should not be conducted at any site not approved by Texas State IRB.** Please note that the institution is not responsible for any actions regarding this protocol before approval. If you expand the project at a later date to use other instruments, please re-apply. Copies of your request for human subjects review, your application, and this approval, are maintained in the Office of Research Integrity and Compliance.

Report any changes to this approved protocol to this office. Notify the IRB of any unanticipated events, serious adverse events, and breach of confidentiality within 3 days.

Sincerely,

Monica Gonzales
IRB Regulatory Manager
Office of Research Integrity and Compliance
Texas State University

CC: Dr. Kristy Daniel
Jennifer Idema
Victoria Reyes

OFFICE OF THE ASSOCIATE VICE PRESIDENT FOR RESEARCH
601 University Drive | JCK #489 | San Marcos, Texas 78666-4616
*Phone:* 512.245.2314 | *fax:* 512.245.3847 | WWW.TXSTATE.EDU

# Appendix II. Staff Participant Informed Consent

## INFORMED CONSENT

**Study Title:** *Exploring the impacts of socioscientific environmental issues through aquarium exhibits*

**Principal Investigator:** *Jenn Idema*
**Email:** *jli17@txstate.edu*
**Phone:** *512-245-7208*

**Co-Investigators/Faculty Advisor:** *Dr. Kristy Daniel*
**Email:** *kristydaniel@txstate.edu*
**Phone:** *512-245-2178*

This consent form will give you the information about (1) why this research study is being done, (2) why you are being invited to participate, (3) what you will do if you participate, and (4) what are the risks, inconveniences or discomforts that you might have participating. Please feel free to ask questions at any time. If you decide to participate, you will be asked to sign this form, and it will be a record of your agreement to participate. You will be given a copy of this form to keep.

**PURPOSE AND BACKGROUND**
You are invited to participate in research to study how aquariums present environmental issues through exhibits and how visitors interpret those issues based on the design of the exhibit. The information gathered from this study will be used to understand how the presentation of an environmental issue influences visitors' thoughts and perceptions of the environmental issue. You are being asked to participate because you have been identified as a major contributor to the design of your institution's exhibits.

**PROCEDURES**
Participation in this study will take about 45 minutes. If you agree to participate you will be asked to answer some questions about the exhibits in your aquarium and the decisions that go into exhibit messaging. Your answers to the interview will be recorded. We will transcribe the recording with any identifying information replaced with an alphanumeric identifier to maintain confidentiality. Your aquarium will be de-identified and given a pseudonym. Once the transcription is complete and verified by the research team for accuracy, the original audio recordings will be erased and only the transcribed copies will be stored for research purposes.

After the interview, your aquarium could be selected as a site for a more in-depth analysis. This would involve allowing two members of the research team access to the aquarium to document existing exhibits, and give permission to recruit and observe a limited number of visitors as they interact with a specified exhibit.

**RISKS/DISCOMFORTS**
This study consists of 45-minute interview and presents minimal risks to you, the participant.

**BENEFITS/ALTERNATIVES**
At the end of project, study results will be made available to any participants upon request. The information that you provide could help zoos and aquariums, informal science educators, researchers, and exhibit designers improve how environmental issues and conservation messages are presented in exhibits.

**EXTENT OF CONFIDENTIALITY**
No personally identifiable data will be collected as part of the study. You will be assigned a random numeric

identifier to keep track of all of your measurements and records. The members of the research team and the Texas State University Office of Research Compliance (ORC) may access the data. The ORC monitors research studies to protect the rights and welfare of research participants.

Your name will not be used in any written reports or publications which result from this research. Data will be kept for three years (per federal regulations) after the study is completed and then destroyed.

**PAYMENT/COMPENSATION**
There is no compensation for participation in this study.

**PARTICIPATION IS VOLUNTARY**
You do not have to be in this study if you do not want to. You may also refuse to answer any questions you do not want to answer. If you volunteer to be in this study, you may withdraw from it at any time without consequences of any kind or loss of benefits to which you are otherwise entitled.

**QUESTIONS**
If you have any questions or concerns about your participation in this study, you may contact the Principal Investigator, Jenn Idema: 512-245-7208 or jli17@txstate.edu.

This project was approved by the Texas State IRB on June 28, 2019. Pertinent questions or concerns about the research, research participants' rights, and/or research-related injuries to participants should be directed to the IRB Chair, Dr. Denise Gobert 512-245-8351 – (dgobert@txstate.edu) or to Monica Gonzales, IRB Regulatory Manager 512-245-2334 - (meg201@txstate.edu).

**DOCUMENTATION OF CONSENT**
I have read this form and decided that I will participate in the project described above. Its general purposes, the particulars of involvement and possible risks have been explained to my satisfaction. I understand I can withdraw at any time.

Your participation in this research project may be recorded using audio recording devices. Recordings will assist with accurately documenting your responses. You have the right to refuse the audio recording. Please select one of the following options:

I consent to audio recording:

Yes _____ No _____

| | | |
|---|---|---|
| **Printed Name** of Study Participant | **Signature** of Study Participant | Date |

| | |
|---|---|
| Signature of Person Obtaining Consent | Date |

# Appendix III. Parent/Guardian Informed Consent

## PARENT/GUARDIAN INFORMED CONSENT

**Study Title:** Exploring the impacts of socioscientific environmental issues through aquarium exhibits

**Principal Investigator:** Jenn Idema
**Email:** jli17@txstate.edu
**Phone:** (512) 245-7208

**Co-Investigator/Faculty Advisor:** Dr. Kristy Daniel
**Email:** kld119@txstate.edu.
**Phone:** (512) 245-2178

This consent form will give you the information about (1) why this research study is being done, (2) why you are being invited to participate, (3) what you will do if you participate, and (4) what are the risks, inconveniences or discomforts that you might have participating. I encourage you to ask questions at any time. If you decide to participate and allow your child to participate, you will be asked to sign this form, and it will be a record of your agreement to participate. You will be given a copy of this form to keep.

**PURPOSE AND BACKGROUND**

You are invited to participate in research to study how people understand and learn about environment issues and conservation through aquarium exhibits. The information gathered will be used to help zoos and aquariums design exhibits that help visitors connect with conservation and environmental issues. You are being asked to participate because you and your family are visiting the aquarium today. As part of this project, I would like you and your child to each wear a pair of eye tracking glasses that would use video recording to see what you and your child look at and talk about during his/her experience at an aquarium exhibit.

**PROCEDURES**

The study session will take about 30 minutes. If you agree and allow your child to participate, you will each be asked to do the following:

1. Take an eye tracking calibration (or "test run") (5 to 10 minutes) to make sure that we can obtain accurate measurements. **If you and/or your child does not pass this test run, we cannot include you or your child in the study.**
2. Wear the eye-tracking glasses as you walk through an exhibit together as a family (10 minutes). An eye tracking device in the glasses will track the direction of your and your child's eye gaze as each of your views and engages with the aquarium exhibit. It will also record what your conversation during the exhibit experience.
3. Answer questions about your impressions of the exhibit during a group interview with you and your child (after the eye-tracking portion of the study) (10 minutes).

Your and your child's exhibit experience will be video recorded through the eye-tracking device's camera. The Tobii eye tracker won't collect images of the eyes; it only tracks the gaze data, i.e., where pupils were focused in the exhibit. You and your child's responses will be audio recorded during a short post exhibit group interview.

**RISKS/DISCOMFORTS**
This study consists of wearing a pair of eye-tracking glasses that will record your and your child's aquarium exhibit experiences and presents minimal risks and discomfort.

Part of the data for this study is collected using a *Tobii Pro Glasses 2* eye tracking device. Participants should only wear these glasses in the assigned area of the aquarium, as directed by a member of the research team. These eye tracking glasses may record images of people around the visitor wearing the glasses. However, these if any of these images are captured, the research team will blur faces to maximize confidentiality and not use any video data including such image captures for dissemination purposes. All of the cameras on the Tobii device have been tested and approved by certified labs according to the European standard for optical radiation hazards of different lamps and lamp systems, IEC/EN 62471. Devices that meet this standard are not considered harmful to the human eye.

However, some people are susceptible to epileptic seizures or loss of consciousness when exposed to certain flashing lights or light patterns in everyday life such as the lights used in the Tobii—a condition known as *photosensitive epilepsy*. A person with photosensitive epilepsy is likely to have problems viewing computer and TV screens, some arcade games, flickering fluorescent bulbs, or light sources of an eye tracker. This may happen even if the person has no medical history of epilepsy or has never had any epileptic seizures.

A common precursor to photosensitive epilepsy is *aura* – a perceptual disturbance manifested as seeing strange light, experiencing an unpleasant smell, or confusing thoughts. If you or your child experiences aura— if he or she is seeing strange light, smelling unpleasant smells, having confusing thoughts or feeling odd in any other way during the study— notify myself or a research team member immediately and we will help remove the glasses.

Our research team has a checklist for detecting signs of a seizure and a plan for taking immediate precautions and making immediate response. We will call 911, notify the appropriate aquarium staff and refer you and your child to Emergency Medical Staff for immediate medical attention, should an adverse event occur. **If your child is affected by the photosensitive epilepsy, we ask that you notify the investigator immediately and withdraw from the study.**

When activated, the Tobii Eye Tracker emits pulsed infrared (IR) light. If your doctors have warned you about exposing your or your child's medical device to IR light, or if you have any potential concerns about interactions, you and your child cannot participate in this study.

You or your child may feel uncomfortable wearing the eye-tracking glasses as it records what you and your child sees, but the tiny camera within the device is placed in a manner that should not cause any distractions.

**PARTICIPATION IS VOLUNTARY**
You do not have to be in this study if you do not want to. You may also refuse to answer any questions you do not want to answer. If you volunteer to be in this study, you may withdraw from it at any time without consequences of any kind or loss of benefits to which you are otherwise entitled.

**BENEFITS**
There will be no direct benefit for you from participating in this study. However, the information gained from this research may help zoos and aquariums design better exhibits for informing people about conservation.

**EXTENT OF CONFIDENTIALITY**
Video data gathered from the Tobii eye-tracking glasses will be stored on a password protected computer that will be securely stored in a locked cabinet locked in the research team lab facilities. Numerical eye tracking data will be saved with an alphanumeric identifier before collection to maintain confidentiality when downloading and analyzing the focal durations and counts. No individual eye tracking data will be shared beyond the research team with only aggregated summaries being included in any dissemination to maintain confidentiality of all participants. Video stills showing example fixation points will only be used as sample evidence if no identifying details are included in the image (e.g., no faces, no names of locations). Selection of sample stills will only be used when required to show which elements of an exhibit are being referenced and no aquarium names or people are required (or should) be in the image still frame in any way.

Interview recordings will be transcribed with any identifying information replaced with an alphanumeric identifier to maintain confidentiality. Once the transcription is complete and verified by the research team for accuracy, the original audio recordings will be erased and only the transcribed copies will be stored for research purposes.

Reasonable efforts will be made to keep the personal information in your research record private and confidential. Any identifiable information obtained in connection with this study will remain confidential and will be disclosed only with your permission or as required by law. The members of the research team and Texas State University Office of Research and integrity (ORC) may access the data. The ORC monitors research studies to protect the rights and welfare of research participants.

No names will be used in any written reports or publications which result from this research. Data will be kept for three years (per federal regulations) after the study is complete and then destroyed (kept for no more than 10 years after collection).

**PAYMENT/COMPENSATION**
There will be no payment to you or your child as a result of your child taking part in this study.

**QUESTIONS**
If you have any questions or concerns about your participation in this study, you may contact the Principal Investigator, Jenn Idema: (512) 245-7208 or at jli17@txstate.edu or Faculty Advisor: Kristy Daniel at kld119@txstate.edu.

This project was approved by the Texas State IRB on June 28, 2019. Pertinent questions or concerns about the research, research participants' rights, and/or research-related injuries to participants should be directed to the IRB Chair, Dr. Denise Gobert 512-716-2652 – (lasser@txstate.edu) or to Monica Gonzales, IRB Regulatory Manager 512-245-2314 - (meg201@txstate.edu).

**DOCUMENTATION OF CONSENT**

I have read this form and decided that I and my child will participate in the project described above. Its general purposes, the particulars of involvement and possible risks have been explained to my satisfaction. I will discuss this research study with my child and explain the procedures that will take place. I understand I can withdraw myself and my child at any time.

Your and your child's participation in this research project will be recorded using video & audio recording devices. Recordings will assist with accurately documenting your responses. You have the right to refuse the video & audio recording. Please select one of the following options:

I consent to including my child as part of this study:

Yes _____ No _____

I consent to audio recording of me and my child:

Yes _____ No _____

I consent to video recording through the eye-tracking glasses:

Yes _____ No _____

_____

Printed Name of Child

_____ _____ _____

**Printed Name** of Parent/Guardian **Signature** of Parent/Guardian Date

_____ _____

Signature of Person Obtaining Consent Date

**Return the last page to the researcher**
**Keep the consent for your records**

# Appendix IV. Child Assent

**ASSENT CONSENT**

**Study Title: Exploring the Impacts of Socioscientific Environmental Issues through Aquarium Exhibits**
**Principal Investigator: Jenn Idema** **Co-Investigator/Faculty Advisor: Dr. Kristy Daniel**

My name is Jenn Idema and I am a student at Texas State University trying to learn about how people learn about science at aquariums. I am asking you to be a part of my project because you are visiting this aquarium today. This letter tells you a little bit about what will be going on so you can decide if you want to be in the study or not.

This project will take place here at the aquarium while you are with your parent. If you would like to participate, I will ask you to wear a special pair of glasses that has a tiny camera. This camera will record what you say and are looking at while you and your family go to one display at the aquarium. After you are done at the display, I will ask you some questions about what you saw and did. You may think the glasses are neat, but if you decide you want to take off the glasses for any reason, just let me know and I will be happy to help you. You also don't have to answer any question you don't want to.

By participating in this project, you will help me learn how we can make aquarium displays better for other people.

Please talk with your parents about this project before you decide if you want to take part. I have also asked your parents if was okay for me to talk to you. Even if your parents say you can help me, you can still say that you don't want to. It is okay to say, "no," if you don't want to be included. No one will be mad at you. If you change your mind later and want to stop, you can.

You can ask me any questions you have, you can also talk to my teacher Kristy Daniel, or your mom or dad.

---

*If you want to be in this project, please sign. If you don't want to, please do not sign.*

| | |
|---|---|
| PRINT your name | Date |
| SIGN your name | Date |
| Signature of Person Obtaining Consent | Date |

## Appendix V. Interview Protocol for Aquarium Staff

1. Please describe your position at this aquarium.

2. How long have you been in your current position at this aquarium?

3. Give an example of some of your primary responsibilities in terms of exhibit design and interpretation?

4. What were your motivations for pursuing/accepting your current position?

5. What is the job title of your immediate supervisor?

6. Describe your professional relationship with this supervisor in terms of their influence on decisions you make regarding exhibit design and interpretation?

7. Which exhibits in the aquarium, if any, do you feel best addresses climate change or a resulting impact of climate change on aquatic resources (i.e. rising sea temperatures, ocean acidification, coral bleaching, melting polar icecaps)?
   If an exhibit is identified:
   a. Describe what is encompassed by this exhibit. (Including details on the topic issue)
   b. Who created this exhibit?
   c. Who ultimately decided what information should be included in the exhibit?
   d. Where did the information included in this exhibit/signage come from?
   e. What resources were used when developing this exhibit? In support of this exhibit?
   f. Who is the intended target audience for this exhibit?
   g. What is the intended take-home message visitors should understand after interacting with this exhibit?
   h. Why do you think this message is important to share with aquarium visitors?

If an exhibit is not identified:
   Why do you think that this issue has not been included as part of aquarium messaging?

8. What do you feel are some important local conservation issues?

9. Which aquarium exhibit do you think best represents a local conservation issue?
   If an exhibit is identified:
   a. Describe what is encompassed by this exhibit. (Including details on the topic issue)
   b. Who created this exhibit?
   c. Who ultimately decided what information should be included in the exhibit?

d. Where did the information included in this exhibit/signage come from?
e. What resources were used when developing this exhibit? In support of this exhibit?
f. Who is the intended target audience for this exhibit?
g. What is the intended take-home message visitors should understand after interacting with this exhibit?
h. Why do you think this message is important to share with aquarium visitors?

10. How do you prioritize what messages are included in exhibits?

11. Describe any directives (formal or informal) that have been issued in terms of what messaging content you present to the public through aquarium exhibits.
    If regulations are identified:
    a. Who issues these directives?
    b. If applicable, describe an example of how you resolved a messaging issue that conflicted with a directive.

12. What are the typical demographics of visitors to the aquarium?

13. Approximately how many people visit your aquarium annually? Daily?

14. Does the aquarium have discounted admission or free days for local people?
    If a discount/fee day is offered:
        a. When and how often are this discounted/free days offered?
        b. How are these discounted/free days advertised?
        c. What are the demographics of visitors that typically attend these discounted/free days?

15. From where does the aquarium receive most of its funding?
    a. Are funders involved in content design?

16. In what ways does/has the aquarium interact(ed) with the local community?

## Appendix VI. Interview Protocol for Family Group Participants

Questions to both participants (Adult and Child simultaneously)

Why did you choose to visit the aquarium today?
How often have you visited this aquarium?

Questions directed to child to answer:

Tell me about what you just saw.
(If applicable) Tell me about what you just did.
What do you think the activity you just did/signs you just saw were about?
What do you think was the most important thing for you to remember about ___?

Questions directed to adult to answer:

Tell me about what you just saw.
(If applicable) Tell me about what you did.
What do you think the activity you just did/signs you just saw were about?
What do you think was the most important thing for you to remember?

Questions to both participants (Adult and Child simultaneously)

Describe which parts/features of the exhibit stick out in your mind?
How did the information in the exhibit make you feel?
Have you heard about this issue (state the issue) before visiting this exhibit today?
If so, tell me about what you have heard before. Where did you hear this?
If not, what did you learn about (insert issue) today?
Do you think (insert issue) is important? Why or why not?
Do you think this issue has (an impact on (adult) / impacts your life (child)? Why or why not?
What are some conservation issues you see in your own community?
Have you ever talked about conservation as a family before today?
If so, give me an example of an issue you have discussed.
Have you ever taken part in an activity intending to help the environment?
If so, describe what you did and why you chose to take part in that activity.