PUBLIC PERCEPTIONS OF SPIDERS AND IDENTIFYING TRENDS IN COMMUNITY SCIENCE PARTICIPATION

by

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A thesis submitted to the Graduate Council of
Texas State University in partial fulfillment
of the requirements for the degree of
Master of Science
with a Major in Biology
August 2020

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DEDICATION

I would like to dedicate this thesis to my parents, Mark and Laura Marty, and my grandparent figures, Doug and Donna Semmes. Thank you for loving me and supporting me always. I could not have done this without you.

ACKNOWLEDGEMENTS

I am deeply grateful and must acknowledge my thesis advisor, Dr. Kristy Daniel for helping me make this project happen and for vehemently supporting and encouraging me to follow my dreams. She pushed me to grow and expand my abilities and capacity to handle all that comes in the professional world. This project would not have been possible without her dedication to provide me with whatever kind of support I most needed. I would also like to thank Dr. Chris Nice and Dr. Ben Schwartz, the remainder of my committee, for asking important questions and being there to help oversee my project or provide information that only bug nerds like me would need. I am also grateful for Jill Maroo and Carrie Jo Bucklin for their excellent input and assistance with my project.

I'd like to thank my undergraduate assistant, Arianna Corral for helping me to recruit my participants and for her lovely company. I also must acknowledge the amazing community of scientists I have had the pleasure of working and socializing with. All members of the Daniel Lab, especially Jenn Idema, Toni Mac Crossan, Myra McConnell, Victoria Reyes and Ryan Spencer, all helped me survive this process and helped me to become a better scientist and person. I would also like to acknowledge my family and friends, especially my parents Mark and Laura Marty and my love, Timothy Onion, for encouraging me in all that I do. I owe my sanity to my brothers and sisters, Aria, Stefan, Caden, and James as well as my best friends, especially Abby, Jenny, and Libby. Thank you all for your undying support and invested interest in my project and personal success. Without you, I would not be who I am to fulfill this achievement.

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ABSTRACT

Spiders are ecologically important invertebrates with potential to advance the fields of medicine, physiology, technology, genetics, and biological control. Despite this, spiders are highly understudied due to negative perceptions and arachnophobia, especially in the western world. Engagement through community science may be a way to bridge the gap between people and spiders, which may reduce fear and unnecessary killing of spiders and increase support for research on spiders. For this study, I aimed to better understand perceptions about spiders and to investigate how participation in a spider community science activity influences perceptions of college-age students at a southwestern university. I created an engaging spider activity and used a Spider Attitude Questionnaire to capture perceptions of spiders in four dimensions: Scientistic, Ecologistic, Negativistic, and Naturalistic. I analyzed initial perceptions and motivations, compared pre- and post-activity responses to measure any shift in perceptions, and analyzed follow-through in regard to major and recruitment method. I expected that initial perceptions would be negative with a variety of participant motivations. I also expected perceptions to shift positively after participation, and that recruitment and major would have an effect on follow-through. Participant initial perceptions were overall leaning towards negative, and the most frequent motivation to participate was because it was recommended by someone they knew. There was a significant negative shift in the Scientistic dimension from pre- to post-survey, and a significant positive shift in the Naturalistic dimension from pre- to post-survey. Recruitment method was found to have

a significant effect on follow-through, with E-mail and in person methods being not nearly as effective as recruitment by proxy (through someone they knew - such as a teacher or friend), therefore community scientists should consider this method of recruitment to improve participation and data collection from the community.

I. INTRODUCTION

Community science is a way to bridge the gap between the public and scientific efforts. The term community science has the same function as 'citizen science' but aims to improve inclusivity. In this paper, I use the term community science to describe the recruitment of typically non-specialists for assistance in data projects. Involving the public in data collection is not a relatively new innovation. However, the use of community science as a tool for data collection and connecting the public to science has been rapidly increasing in popularity by scientists (McKinley et al., 2017). Community science provides a way to acquire needed scientific data to inform important projects in management and protection of environmental resources as well as fosters engagement in policymaking (McKinley et al., 2017). This means, if done correctly and mindfully, community science can not only provide a way to acquire data, but it can also provide information in a meaningful way to those participating. Additionally, connecting the public with nature has also been accomplished through the use of nature applications based around nature, such as iNaturalist.

Negative attitudes towards invertebrates, especially spiders, due to initial unfamiliarity and already established preferences for mammals (or animals with human-like traits) has resulted in a lack of invertebrate-based research (Kellert,1993; Colleony et al., 2016). Invertebrates are the dominant life form on earth and are highly important for the ecological services they provide, as well as innovations in medicine, physiology, technology, genetics, and biological control (Mammola et al., 2017; Saez et al., 2010; Windley et al., 2012; Wyckhuys et al., 2019). Despite this, there are several issues associated with limited invertebrate conservation, including the public's general lack of

knowledge of invertebrates (Cardoso et al., 2011; Mammola et al., 2017). Spiders are invertebrates who tend to evoke negative emotions such as fear, anxiety, or other discomfort. In fact, arachnophobia is a highly common phobia in the western world despite most species of spider being harmless to humans (Kellert, 1993; Prokop et al., 2010; Saez & Herzig, 2018). A recent study showed that arachnophobes tend to immediately identify ambiguous images as spiders (Haberkamp et al., 2019). This tendency combined with a lack of skills to identify local spider species could contribute to the common occurrence of many spiders being misidentified as a harmful species.

Background Information

Open Air Laboratories (OPAL) Network supported many funded citizen science projects in biological monitoring in the UK that encouraged hands-on data collection by people of all ages (Davies et al., 2011). Goals of OPAL were to: 1) help people spend more time outside and to pay closer attention to the natural world, 2) be highly accessible to various ages and abilities, 3) help foster an environmentally minded generation, 4) increase understanding of the natural world, 5) foster partnerships among the community, voluntary, and statutory sectors, and 6) connect science and those who aspire to improve local natural habitats (Davies et al., 2011). One OPAL resource was a Household Spiders observation guide, which inspired the initial concept of *Spider Friends of Central Texas.* Another way people are being encouraged to go outside is through the iNaturalist social media website for amateurs and nature enthusiasts to share observations of the natural world. iNaturalist features algorithms that assist users in identification, but also other members have the ability to suggest identifications on other people's observations. Data

acquired through iNaturalist can potentially be used in research, as observations with two or more agreeing identifications achieve research grade status.

Problem Statement

The purpose of this study is to investigate the impact of a community science observational activity on people's perceptions of spiders. To address this purpose, I investigated the following research questions:

Research Questions

1. a. What are participants initial perceptions about spiders?
1. b. What are participants reported motivations to participate?
2. In what way does spider perception shift after completing a spider community science activity?
3. What is the rate of participation follow-through of life science majors and non-life science majors for a spider community science activity related to recruitment method?

Hypotheses

1. a. Initial participant perceptions will overall lean towards negative.
1. b. Participants will respond with a range of motivations for their participation.
2. I anticipate overall perceptions (and across all dimensions) to shift in the positive direction (improve) after participation.
3. I anticipate that participant major and recruitment method will have a significant influence on activity follow-through. Specifically, I anticipate that life science majors recruited by proxy will have the highest participation followed by

participants recruited in person, and participants recruited via email or non-life science majors having the lowest rate of follow-through.

Significance

Learning to more effectively present information about species that people fear can improve their attitudes towards those species. This is especially important for feared species that also need conservation. By analyzing current perceptions of spiders before and after an intervention such as *Spider Friends*, results of this study may help to introduce tools that provide teachers with engaging opportunities to educate about invertebrates such as spiders in a positive way. Lasting impacts could include better support of invertebrates or "scary" animals from acquisition of factual knowledge presented in a positive way, possibly earlier in childhood. I am collecting data on gender and ethnicity of my participants because that information may be used to help us identify underserved audiences and work towards improving inclusivity in nature and STEAM and community science. Additionally, a basic concern for household safety from potentially harmful species provides reason for anyone to learn more about spiders, so that they may be able to discern between a brown recluse and, likely, any other spider.

Definition of Terms

Citizen Science. Historically, this term was used to describe expertise of amateurs; today it can hold the same meaning, or it can be defined as public contribution to scientific projects in various ways, either intellectually, with their time, or other resources (Follett & Strezov, 2015 & McKinley et al., 2017).

Community science. This term holds the same functional definition as Citizen Science, but is a more inclusive version of the term, as not all members of a community are citizens (Follett & Strezov, 2015 & McKinley et al., 2017).

Perception is used to describe views or attitudes towards and ideas about something such as a spider.

Scientistic. A dimension of perceptions that measures the level of interest to learn more about spiders or how scientists study spiders, and/or spider biology (Prokop et al., 2010).

Ecologistic. A dimension of perceptions that aims to provide insight into participant's understanding of the role spiders play in nature and human-spider interactions (Prokop et al, 2010).

Negativistic. A dimension of perceptions that measures avoidance based on fear or disgust (Prokop et al., 2010).

Naturalistic. A dimension of perceptions that aims to indicate the reactions participants may have when a spider is encountered or in direct contact (Prokop et al., 2010).

iNaturalist. An application for finding and identifying organisms in nature and for sharing observations that can contribute to science. Budding nature enthusiasts or anyone who is interested in the natural world can share observations and meet other people with a similar interest in nature.

II. LITERATURE REVIEW

Conservation and Public Attitudes of Invertebrates

There are several issues associated with limited invertebrate conservation, including lack of knowledge of ecological services from both the public, stakeholders, and policymakers (Cardoso et al., 2011; Mammola et al., 2017; Saez et al., 2010; Windley et al., 2012; Wyckhuys et al., 2019). Other reasons for neglect are lack of funding, abundance of species (mostly undescribed), and largely unknown distributions (temporally and geographically) and lack of knowledge of life history and tolerance of habitat changes (Cardoso et al., 2011). However, invertebrates, such as spiders, are in general less supported by the public due to negative views (Colleony et al., 2016; Liordos et al., 2017; Kellert, 1993). Possible exceptions to this phenomenon are some butterflies whose eyespots might be the reason for increased conservation support (Manesi et al., 2015). This preference somewhat aligns with animal features favored by the public (e.g. big eyes) and the generally observed positive responses in humans towards eye-like stimuli (Colleony et al, 2016; Manesi et al., 2015).

The general public favors conservation of mammals and other animals rated highly as either safe and/or attractive, especially animals with features more similar to humans regardless of conservation status (Colleony et al., 2016; Liordos et al., 2017). This preference is deeply manifested such that, for example, zoo adoption programs may be ineffective for species conservation because people choose to support animals based on charisma and not based on endangered status (Colleony et al., 2016). Specifically, monetary donations in support for conservation are skewed heavily towards charismatic, large mammals such as giraffes and jaguars. In a UK zoo adoption study, the jaguar

(*Panthera onca*) received 1479 “adoptions” and raised almost 100,000 US dollars. The curly-haired tarantula (*Brachypelma albopilosum*) received 94 “adoptions” and raised only 3,746 US dollars (Colleony et al., 2016). Now, endangered status is considered a desirable trait alongside activity levels and displays of intelligence, which correlates with charismatic endangered animals being the main attraction in zoos (Carr, 2016). Still, animals such as spiders and other invertebrates do not seem to align with these public preferences, even if classified as endangered (Carr, 2016; Liordos et al., 2017).

What is a Spider?

Spiders are invertebrates in the class Arachnida, which is a diverse and populous group of organisms found worldwide and evolved over 300 million years ago. All 11 orders of arachnids can be found in North America, including an estimated 3,700 species of spiders (Beccaloni, 2009; Ubick et al., 2005). Spiders are eight-legged ecologically important generalist predators that vary from mildly to highly venomous to people (Wang et al., 2018). The main purpose for venom is to paralyze or immobilize prey items to aid in feeding (Beccaloni, 2009; Binford, 2001; Ubick et al, 2005). Spider venom is a complicated mixture of many compounds designed for prey consumption but has recently shown to be useful in therapeutic treatments and antimicrobial activity for humans in medicine, for bioinsecticides in agriculture, and for its physical properties (Mammola et al., 2017; Saez et al., 2010; Saez & Herzig, 2018; Wang et al., 2018; Windley et al., 2012).

Spiders as Threats

It is clear that among the general public, perceived threat level of spiders exceeds their actual threat to humans (Hauke & Herzig, 2017; Saez & Herzig, 2018). In fact,

spiders that are potentially harmful to humans only compose about 0.5% of total spider species, 248 out of 46,778. Results from envenomation that does occur from spiders typically include mild symptoms that are localized and treatable, even from species with highly dangerous venom (Hauke & Herzig, 2017). In contrast to those with negative perceptions or phobias, some people have positive associations, with increasing popularity to keep spiders as pets in various places worldwide (Hauke & Herzig, 2017). Some of these pets can have highly potent venom. However, among these spider keepers, there is no documentation of death occurring as a result of envenomation (Hauke & Herzig, 2017).

Arachnophobia

Spiders often illicit fearful, repulsive, and overall negative responses in humans (Kellert, 1993; Prokop et al., 2010). In particular, people tend to view spiders negatively and avoid them (Kellert, 1993 & Mammola et al., 2017). The fear of being bitten is a primary reason for negative attitudes (Kellert, 1993). Spiders are often misidentified, and there is a clear tendency for spider-phobic people to immediately and incorrectly identify animals that aren't spiders (such as a beetle) as spiders (Haberkamp et al., 2019). This tendency combined with a lack of skills to identify local spider species could contribute to the common occurrence of misidentification of any real spider detected as a harmful species.

Exposure therapy is used in treating arachnophobia, though not all individuals respond to it and fear sometimes returns (Norberg et al. 2018; Wannemueller et al., 2016). However, research suggests conducting more intense exposure therapy with a step that challenges uncontrollability (such as a spider walking freely across a phobic person's

hand) offers potential benefits in providing the phobic person the tools to maintain tolerance of their fear; this is important, especially because techniques to prevent fear renewal are not always effective (Norberg et al., 2018).

Perceptions and Behavior Towards Wildlife

Spiders in particular provide a clear example of the relationship between perceptions and behavior, since most people find spiders highly unattractive and needlessly fear and/or kill them (Kellert, 1993). The way people behave can be influenced by their perceptions, and vice versa (Brewer et al., 2004), and improving toleration of spiders is attributed to reducing perceived harm probability (Norberg et al., 2018). Future changes in behavior result from current elevated perception of risk, in other words, a person's current fear can affect future decisions of how they respond to that fear and how they act on it (Brewer et al., 2004).

The way people think and behave regarding risk perception do not always align with actual risk level, such as receiving a spider bite, of which the chances of manifestation are low (Hauke & Herzig, 2017). The spider bite example demonstrates the disconnect between actual risk level and perceptions about an animal, as many animals can incite emotions not related to risk. For example, hippopotamuses are aggressive and known to cause fatalities (Valderrama-Vásquez, 2012) but are often perceived as benign and can illicit positive emotions in people. Another discrepancy between perception and risk can be seen in most people in Honduras and Costa Rica, where those interviewed associated mushrooms with danger of poison, despite a wide association with edibility (Molina-Murillo et al., 2015).

Perceptions people have about wildlife-associated diseases, such as those from spider bites, can be affected by direct or indirect contact with wildlife, or communication about such contact with wildlife (Decker et al., 2012). This means a person may have perceptions about an animal based on their own interactions or by hearing about someone else's positive or negative interactions. Additionally, what value a person places on different kinds of wildlife varies by sex and education level among other variables (Clark et al., 2017; Vaske et al., 2011).

According to Liordos et al. (2017), age, gender, and level of education are some demographic characteristics that may have an influence on attitudes towards wildlife. Females with higher education level (and specifically who are younger) are more likely to support wildlife protection than males with less education (and are specifically older) (Liordos et al., 2017; Vaske et al., 2011). Though my study only assesses major and recruitment type to answer my third research questions (about follow-through), demographic data for gender and ethnicity as well as age could be further explored to identify underserved audiences in the future.

Change in behavior is based on perceptions, for example, people with higher risk perceptions were more likely to get vaccinated against Lyme disease, and those who received the vaccination had reduced risk perceptions (Brewer et al., 2004). This is important because a reduced risk perception about spiders may reduce aggressive or avoidant behavior towards them, meaning if someone is less afraid of a spider, they are less likely to kill it or run from it.

Spider Research is Limited

Spiders and arachnids, as a collective, are highly understudied (Kellert, 1993). Along with being understudied, the knowledge base of spiders we have is biased towards only a few families, such as Araneidae (the orb weaver family). Not much is known about most spider families, and there are currently several unresolved conflicts and unclassified groups (Herzig et al., 2019). This has negatively impacted spider venom research. For example, toxin research has mainly been done on spider venoms from 28 spider families of the known 118, despite advancements in the fields of genomics and proteomics that would allow exploration of previously unstudied families (Herzig et al., 2019). A major challenge to toxinology research is misidentification of specimens as it is often difficult to consult spider taxonomists. This can negatively affect the reliability of results to other researchers (Herzig et al., 2019). Resolutions in spider taxonomy are needed and can help form the basis for improved venom research. In other words, more research about the relationships between spider families will lead to more research that can impact human health (Herzig et al., 2019). Some research that has been done has shown potential in the fields of medicine, physiology, technology, genetics, and biological control , and more research should be done for our benefit (Mammola et al., 2017; Saez et al., 2010; Windley et al., 2012; Wyckhuys et al., 2019).

Increasing Public Support

Increasing public support for unpopular animals, such as spiders, may be improved through effective communication and providing opportunities to all, especially underserved groups, to learn more about spiders in an engaging way (McGlynn, 2017). The field of entomology historically struggles with low inclusivity and a push for

increasing diversity is already underway, but so far efforts have not been adequate (McGlynn, 2017; Berenbaum, 2017). Increasing diversity can enhance impact of scientific discovery and is considered a strength in citizen science (National Academies of Sciences, Engineering, and Medicine, 2018). Outreach through modern approaches, such as the use of social media, can help improve diversity in fields such as entomology by reaching underserved groups that might not normally seek out opportunities in entomology (McGlynn, 2017). Applications that encourage observation of the natural world and provide ways to communicate, such as iNaturalist, are an increasingly popular way of connecting non-specialists and budding nature enthusiasts.

Globally today, museums and collections have begun to embrace the use of social media as an effective tool for engagement with the public about natural history, including entomology and other topics in need of greater attention. However, despite the availability of altmetric and activity analysis tools, there is no current fool-proof instrument to accurately examine the true reach that social media can achieve (Lessard et al., 2017). More research is necessary to develop more accurate methods to examine how far social media campaigns can reach, as well as how to overcome the challenges of limited staff time and support (Lessard et al., 2017).

Citizen Science and Inclusivity

It is important to understand the human dimensions behind conservation to improve efforts from a management perspective and to increase support (Decker et al., 2012). Increasing public support for unpopular animals, especially invertebrates, may be achieved through providing opportunities to learn more about them in an engaging way (Berenbaum, 2017; Lessard et al., 2017). The use of citizen science is a way bridge the

gap between the public and scientific efforts. In 1994, Alan Irwin used the term 'Citizen Science' to describe expertise of amateurs; today it can hold the same meaning, or it can be defined as public contribution to scientific projects in various ways, either intellectually, with their time, or other resources (Follett & Strezov, 2015; McKinley et al., 2017). Citizen science provides a way to acquire needed scientific data to inform management and protection of environmental resources as well as fosters engagement in policymaking, however, there is limited information on who participates in citizen science (McKinley et al., 2017; National Academies of Sciences, Engineering, and Medicine, 2018). This means, if done correctly and mindfully, citizen science can not only provide a way to acquire data, but it can also provide information in a meaningful way to those participating.

A goal of many citizen science programs, such as OPAL, is to bridge the gap between people and nature (Davies et al., 2011). Combined with increased inclusion in scientific efforts, citizen science could influence environmental outcomes in the future as a result of increased awareness (McKinley et al., 2017). Because spiders often evoke strong, usually negative emotions in people, a mindful approach to public education about spiders can be harnessed using this fear and/or fascination (Mammola et al., 2017).

By definition, citizen science projects allow for most anyone to be able to participate in either data collection or analysis and has shown to be important for bridging the gap between the public and science (McKinley et al., 2017). It is increasingly important for museums and other science-based organizations that also educate the public to actively engage visitors for a meaningful experience that could potentially influence policy-making decisions (Lessard et al., 2017). Additionally, advancements in science

and informed policy-making decisions are possible when connections are made between non-specialists and science (McKinley et al., 2017). Collaboration between disciplines is also critical, but fortunately, associations that facilitate the collaboration of many disciplines, such as biochemistry and public health, are supported by organizations that invest in the improvement of communication of data (McKinley et al., 2017).

The field of citizen science requires broader investment in shared resources and communication platforms, such as social media, to cut costs and allow the field to expand and develop more efficient practices. However, it is more effective to reach out to the public through social media, meetings, or newsletters rather than directly through a citizen science project (Berenbaum, 2017 & McKinley et al., 2017). A reminder, for the purposes of working towards inclusion of non-citizen residents, my team adopted the use of the term "community science" instead of "citizen science."

Conceptual Framework

This study uses a framework of four attitude dimensions originally provided by Prokop et al. (2010) which were inspired by the *Attitude Towards Animals* scale created by Kellert (1996). The four dimensions are Scientistic, Ecologistic, Negativistic, and Naturalistic. These dimensions are scaled similar to the attitude scale developed by Kellert (1996) and are designed to allow measurement of different dimensions of perceptions towards spiders. The Scientistic dimension measures the level of interest to learn more about spiders and spider biology, and the Ecologistic dimension provides insight into participant's understanding of the role spiders play in nature and human-spider interactions. The Negativistic dimension measures avoidance based on fear or disgust, and slightly different from Ecologistic, the Naturalistic dimension indicates the

reactions participants may have when a spider is encountered or in direct contact (Prokop et al., 2010). Understanding these dimensions of participant attitudes can provide insight into how uncomfortable information (such as information on spiders) can best be presented to increase support and decrease the occurrence of ineffective communication.

III. METHODOLOGY

I used a quantitative approach to capture data to answer my research questions and supplemented these data with a qualitative component to identify participant motivations for participation. For this study, I created an engaging community science activity using Microsoft PowerPoint titled *Spider Friends of Central Texas* (Appendix A) as well as an identification guide (Appendix B). Following IRB approved guidelines (Appendix C), I recruited participants to complete a pre-questionnaire and the *Spider Friends* activity packet in-person receiving a physical activity packet, through e-mail (Appendix D) receiving digital access to the packet, or by proxy, such as a teacher or friend presenting the opportunity to participate and receiving either a physical or digital packets as available for distribution. After participants completed the *Spider Friends* activity, they were directed to upload their observations to iNaturalist and complete a post-questionnaire. After I finalized data collection, I used a qualitative approach to identify initial motivations and used a quantitative approach to identify initial perceptions about spiders, shifts in perception after participation, and differences in rates of community science follow-through in regard to major (life science or non-life science) and recruitment method.

Limitations

The COVID-19 pandemic restricted my ability to complete the in-person recruitment treatment due to social distancing restrictions. Additionally, was not able to offer incentives for participation in this community science activity, potentially impacting follow-through. Lastly, findings from my study only offer interpretations of results from participation at a single large, southwestern, research university.

Data limitations.

Participants were allowed to skip questions they did not want to answer leading to some questionnaire submissions being incomplete. I removed incomplete data from my study to avoid skewing data. I also excluded pre/post-responses that showed evidence of insincerity or rushing through the activity based on limited time spent completing the questionnaire (less than one-minute) or single response provided for every prompt regardless of the nature of the question.

I noted that 52 participants completed each questionnaire more than once. In these instances, I recorded data from the submission that was most complete. If all attempts were complete, I only recorded data from the most recent submission. I ended up with 442 completed pre-questionnaires (out of 524 total submissions), 272 post-questionnaires (out of 280 total submissions), and 85 participants that recorded spider observations in iNaturalist.

Activity Packet

My activity packet (Appendix A) titled *Spider Friends of Central Texas* is 14 pages long (including front and back pages) and provides factual information about spiders in a way that intends to increase ecological understanding and connects to the Ecologistic aspect of my framework. The packet also features colorful illustrations of spiders meant to present them in a positive light in hopes of reducing Negativistic perceptions. The packet also asks participants to go look for spiders, identify them with the help of the included guide (Appendix B),and record their observations on *Spider Friends of Central Texas* iNaturalist project page as a Naturalistic component to the activity. I designed both digital and physical versions of the activity packet using mainly

pastel colors and included original spider art intended to direct participant attention to the information presented. The digital version includes clickable links to videos about finding and relocating spiders, as well as other clickable resources for participants to learn about spiders. I connected my activity packet to the Naturalistic dimension by including this observation activity and providing directions for safe relocation I also included a West African and Caribbean folklore story for a cultural component, and highlighted a spider scientist to connect to my Scientistic aspect of my framework. I used open-source icons to scaffold data responses for current weather conditions, buildings the participants observed for spiders, and included questions about mindfulness in nature and prompts to inspire reflections.

Participants and Recruitment

Participants were all university students over the age of 18 who were either life science or non-life science majors attending a large, southwestern, research university (Table 1).

Table 1.

Participant Demographic Information on Major, Ethnicity, and Gender

Variable		n
Major		
	Life Sciences	169
	Other	273
Ethnicity		
	White	199
	Hispanic	155
	Black	51
	Asian	16
	Other	21
Gender		
	Female	317
	Male	123
	Other	2

I recruited participants using one of three treatments: 1) by proxy by asking two faculty to encourage students in their biology courses to complete the activity or asking participants to recruit peers to join them, 2) via email by sending an electronic invitation to students enrolled in a campus-wide Freshmen orientation seminar, or 3) in-person through activities scheduled with residential advisors in campus dorms (Table 2).

Table 2.

Counts of Participants by Recruitment Method

Recruitment	
By Proxy	259
Email	139
In Person	44

Data Sources

I used Qualtrics to administer the pre/post-surveys of participants' demographics, motivation, and perceptions of spiders (pre- and post-surveys in Appendices E and F, respectively). To capture these data, I included questions about participant ethnicity, gender, major, how they heard about the project, their iNatualist username, an open-ended question about why they wanted to participate, and a 17-item, five-point Likert-type Spider Attitude Questionnaire (SAQ) adapted from Prokop et al. (2010) (Appendix G). The original SAQ includes 24 items that I worked with an entomologist and science education expert to consider content validity of the instrument for my project and reduced the prompts to 17 items. My resulting adapted SAQ included four items each to measure the Scientistic, Ecologistic, and Naturalistic dimensions, and five additional items to measure the Negativistic dimension. I included the additional negativistic item as the

general acceptance is that people will likely hold negative perceptions about spiders. After the initial adaptation of this instrument, I asked 11 volunteers, both specialists and non-specialists in biology education, to provide feedback on the activity design and assess the face validity of the SAQ. I used their feedback to clarify wording on items. I measured the split-half reliability of the modified SAQ by calculating the Cronbach's alpha score for both the 11 volunteers ($\alpha = 0.97$) and for my 442 study participants ($\alpha = 0.91$). I also recorded data about completion of observation submissions from iNaturalist.

Analysis

To address my first research question, I used a descriptive approach to analyze responses from all 442 participants who completed the pre-questionnaire to identify initial perceptions. I calculated percentages of means for individual scores overall and for each of the four SAQ dimensions (Scientstic, Ecologistic, Negativistic, and Naturalistic), with scores ranging from positive (1.0-2.0), leaning towards positive (2.01-3.0), leaning towards negative (3.01-4.0), and negative responses (4.01-5.0). I reverse-scored all Negativistic items and one Naturalistic item that was a negative question. I also used a qualitative approach to analyze responses to the open-ended question about motivation to participate. I used an inductive approach to first apply descriptive codes to participant motivation responses. Then, I grouped like codes into categories of motivations to report frequencies.

To address my second research question, I conducted a one-way repeated measures ANOVA using time (time 1: pre-activity to time 2: post-activity) and the individual means of the four dimensions to see if perceptions significantly shifted after completing the activity.

To address my third research question to determine significance of the effects of recruitment method and major on follow-through, I ran a 2x3 two-way ANOVA on the rate of follow-through across major type and recruitment method. My first run showed I violated Levene's test of homogeneity, this was expected due to inconsistent group sizes as a result of restricted in person recruitment from the COVID-19 pandemic. To reduce the difference in variance between the groups, I transformed the data through reciprocal transformation, by taking the base 10 log, and by taking the square root of the dependent variable and reran Levene's test on each transformation (Field, 2009). Transforming the dependent variable data through reciprocal transformation created the smallest difference in variance between the groups, therefore I used this method for my analysis. I then reran the two-way ANOVA. The ANOVA showed significance for recruitment method; therefore, I ran a Tukey's post hoc analysis to determine which recruitment method had a significant effect.

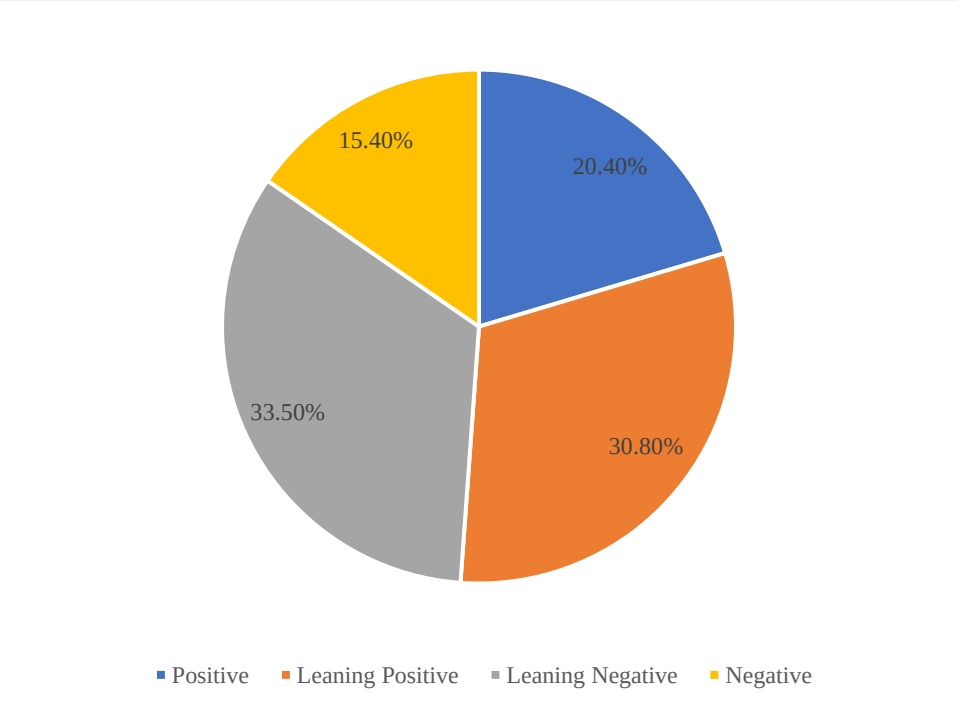
IV. RESULTS

Research Question 1

For my first research question, I asked what participant initial perceptions of spiders and motivations for participation are and expected an overall negative score. The overall participant perceptions before participating in *Spider Friends* can be seen below in Figure 1. This figure shows the percentages of positive, leaning positive, leaning negative, and negative participant initial perceptions of spiders across the four dimensions. Overall, 33.5% of participant initial perceptions were leaning towards negative, but only 15.4% had overall negative views.

Figure 1.

Overall Participant Initial Perceptions of Spiders (n=442)

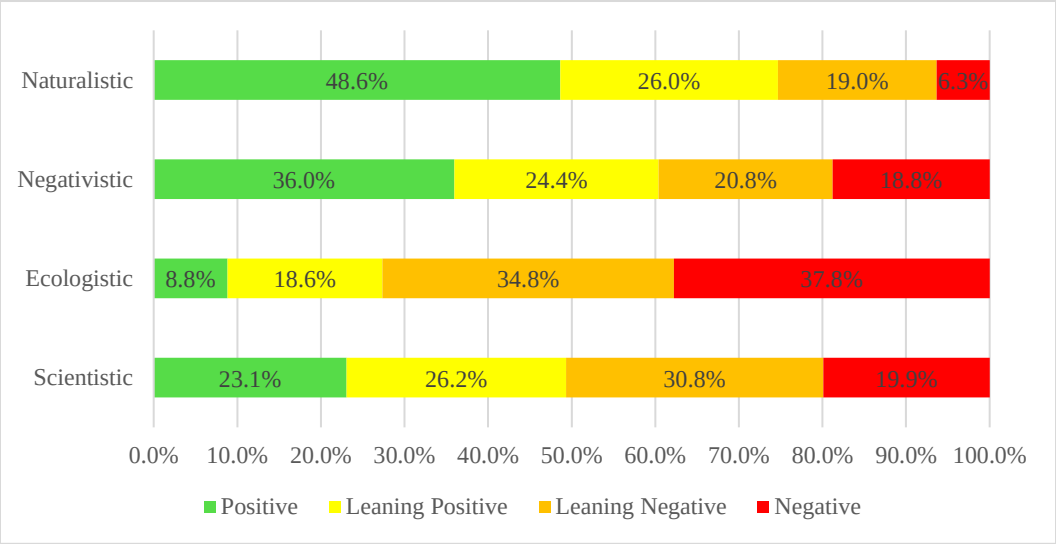


Ranges of initial perceptions according to each specific dimension can be found below in Figure 2. This figure shows the percentages of participant scores in each

dimension from positive, leaning positive, leaning negative, and negative. Of the participants, 48.6% had a positive score in the Naturalistic dimension and 37.8% had a negative score in the Ecologistic dimension. Both negative and leaning negative initial perceptions comprise over half of perceptions overall (51.2%) compared to 48.8% positive or leaning positive perceptions

Figure 2.

Ranges of Initial Perceptions of Spiders by Dimension (n=442)



I was able to categorize six motivations, with the seventh being no reason provided. Motivations can be found below in Table3. The most common reason for participating was because it was recommended to the student (56%) and the least common reported reason was to confront fears (1.8%).

Table 3.

Reported Motivation for Participation in a Spider Friends Activity

n	Percent (%)	Motivation
248	56.1	Recommended Activity
78	17.7	Interest in Activity/Topic
49	11.1	To Help Researcher/Research
36	8.1	For Fun and to Alleviate Boredom
11	2.5	Engagement with a Friend
8	1.8	Confront Fear of Organism
12	2.7	None Provided

Research Question 2

One-way ANOVA.

Results for the one-way repeated measures ANOVA with time (pre-activity to post-activity) as the independent variable can be seen in Table 4 below. I expected perceptions to shift positively across all four dimensions; however, the post-activity mean score for the Scientistic dimension significantly went down from pre- to post-activity ($F(1, 271) = 4.073$, $p = 0.045$). This finding suggests participants showed less interest in studying spider biology or learning about how scientists study spiders after participation. There was no significant difference between the pre- and post-activity mean scores for the Ecologistic dimension, in fact, the mean score from pre- to post-activity stayed the

same. This finding suggests participants did not change their view of spiders' roles in the ecosystem after participation. There was no significant difference between the pre- and post-activity mean scores for the Negativistic dimension. This finding suggests that participants did not view spiders less negatively after participation. The post-activity means for the Naturalistic dimension significantly increased ($F(1, 271) = 38.542$, $p < 0.001$). This finding suggests participants were less likely to react negatively when encountering a spider or when human-spider interactions occur.

Table 4.

One-way Repeated Measures ANOVA Comparing Pre- and Post-Activity Perception Means

Measure	Pre-activity Mean	Post-activity Mean	df	F	Sig. (p)	Effect Size
Overall	2.859	2.908	1	3.044	0.082	0.011
Scientistic	2.994	2.880	1	4.073	0.045	0.015
Ecologistic	3.596	3.596	1	0.000	1.000	0.000
Negativistic	2.714	2.779	1	2.320	0.129	0.008
Naturalistic	2.171	2.410	1	38.542	0.000	0.125

Research Question 3

Counts of participants by major and recruitment method for each level of follow-through (pre-survey, pre-survey and post-survey, both surveys and iNaturalist) can be found below in Table 5. These counts were used to conduct the two-way ANOVA.

Table 5.

Counts for Each Level of Follow-through to Determine Participation by Major and Recruitment Method

Recruitment Method	Took only pre-survey	Took pre-survey and post-survey	Took pre-survey, post-survey, and used iNaturalist	Total by Method and Major type
Life science Major				
In Person	5	1	0	6
E-mail	17	15	4	36
Other	19	83	25	127
Non-life Science Major				
In Person	30	1	7	38
E-mail	71	24	8	103
Other	28	63	41	132
Follow-through Total	170	187	85	442

Two-way ANOVA and post hoc analysis.

The results for the two-way ANOVA were significant ($F(5, 436) = 29.065$, $p = <0.001$). Results for the main effect of major on follow-through were not significant ($F(1, 436) = 0.384$, $p = 0.536$). Results for the main effect of recruitment method on follow-through were significant ($F(2, 436) = 46.598$, $p = <0.001$). Results for the interaction between recruitment method and major on follow-through were not significant ($F(2, 436) = 2.080$, $p = 0.126$).

I ran a Tukey's HSD as a post hoc analysis to determine which method of recruitment had a significant effect on follow-through compared to the other methods.

There was a significant difference between by proxy and in person recruitment methods (M_{diff} = -0.323, 95% CI [-0.415, -0.231], p = <0.001). There was also a significant difference between by proxy and e-mail recruitment methods (M_{diff} = -0.254, 95% CI [-0.313, -0.195], p = <0.001). The post hoc reveals that the by proxy recruitment method had significantly more people following through with taking the post-activity survey, or both the post-activity survey and submission of iNaturalist data.

V. DISCUSSION

This study aimed to assess public perceptions of spiders and to identify trends in community science participation. I expected initial perceptions of spiders to be negative overall and found that perceptions were indeed mostly leaning towards negative. This finding supports the notion that there people may have a potential lack of knowledge leading to the prevalence of negative views towards spiders (Kellert, 1993; Mammola et al., 2017; Prokop et al., 2010). I also expected participants to provide a variety of motivations for participation and found 7 reported categories of motivations, but these were not evenly distributed across participants. There was a majority that participated because it was a recommended activity by a proxy. Because my participants varied in ethnicity, gender, and major, it makes sense that their interests and motivations would differ. However, the skew toward having the activity be recommended as the primary motivator suggests this influence lead to more participation than expected of participants on their own volition (National Academies of Sciences, Engineering, and Medicine, 2018).

Despite the second and third most reported motivations being interest in the activity and the desire to help with research, there was an unexpected significant decrease in interest in studying spiders or spider biology (i.e., Scientistic) after participating in *Spider Friends.* This may be due to a known lack of interest in spiders among the public, and that not all community science projects stimulate wide interest (Kellert, 1993; McKinley et al., 2017). My intent was to stimulate interest in studying spiders by highlighting a current scientist studying spiders and provide details about field of spider biology to improve Scientistic perceptions. It is possible that participants satisfied their

Scientistic curiosity by completing the activity or were overwhelmed by the Scientistic-type information included in the activity packet. Asking participants to collect spider data might have been too complicated of a task for some participants. It is easier to engage volunteers in community science projects when the methods for data collection are kept simplistic (McKinley et al., 2017). Most of my participants were non-life science majors, which may have also impacted their interest in participation, as there is a known relationship between university student interest and their choice of academic major (Moore & Cruce, 2020). At the university where this project took place, Zoology is a requirement for Wildlife Biology and Aquatic Biology Majors, but not other life science degree plans such as Biology and Microbiology or for non-science majors. Zoology is the only class at the institution that discusses spider biology in great depth beyond the entomology course, which was not being offered during the semesters I collected data. Non-life science majors are required to take two science courses of their choice, but which science classes they choose is likely affected by interest, personality type, and major (Moore & Cruce, 2020) and may not include biology.

Although I expected a significant shift in Negativistic perceptions, there was only a slight increase in perception that was not a significant finding. This slight increase may be attributed to my attempt to calm anxieties by exposing participants to aesthetically pleasing illustrations of jumping spiders. However, persistent arachnophobia and a resistance to learn more about spiders might explain the lack of significant improvement of Negativistic perceptions (Kellert, 1993; Prokop et al., 2010). Additionally, the least reported motivation provided, even less so than no reason given, was participant desire to overcome fears (Kellert, 1993; Prokop et al., 2010).

Exposure therapy has been used to treat arachnophobia with varying intensities of exposure (Norberg et al., 2018; Wannemueller et al., 2016). Exposure that is uncontrolled by the spider-fearful person, such as allowing a spider crawling across the fearful person's hand as treatment, has shown potential for improving maintenance and toleration of fear (Norberg et al., 2018). However, participants were instructed not to handle spiders in the directions I included in *Spider Friends*. The only exception to this recommendation being cases where harmless spiders were found and could be safely relocated. Rather than using exposure therapy, participants confronted their perceptions of spiders through observations at a distance as they tried to identify and document spiders found.

Participants who may have had initial negative risk perceptions may have experienced a reduced risk perception if a peer or teacher was willing to recommend participation in *Spider Friends* (Brewer et al., 2004; Decker et al., 2012) Though various recruitment techniques exist in citizen science, experts in the field should consider recruitment by proxy as a potentially effective method (McKinley et al., 2017; National Academies of Sciences, Engineering, and Medicine, 2018). My results suggest community or citizen scientists should focus less on reaching out electronically and consider emphasis on the use of an authority figure or social approach for outreach as a means to encourage participation and collect more and higher quality data.

It is possible that some participants were not convinced (or interested) in the ecological importance of spiders, perhaps non-life science majors or life science majors that focus less on ecology in their academic setting (Moore & Cruce, 2020). There is historical evidence that references to pop culture might be used to promote engagement

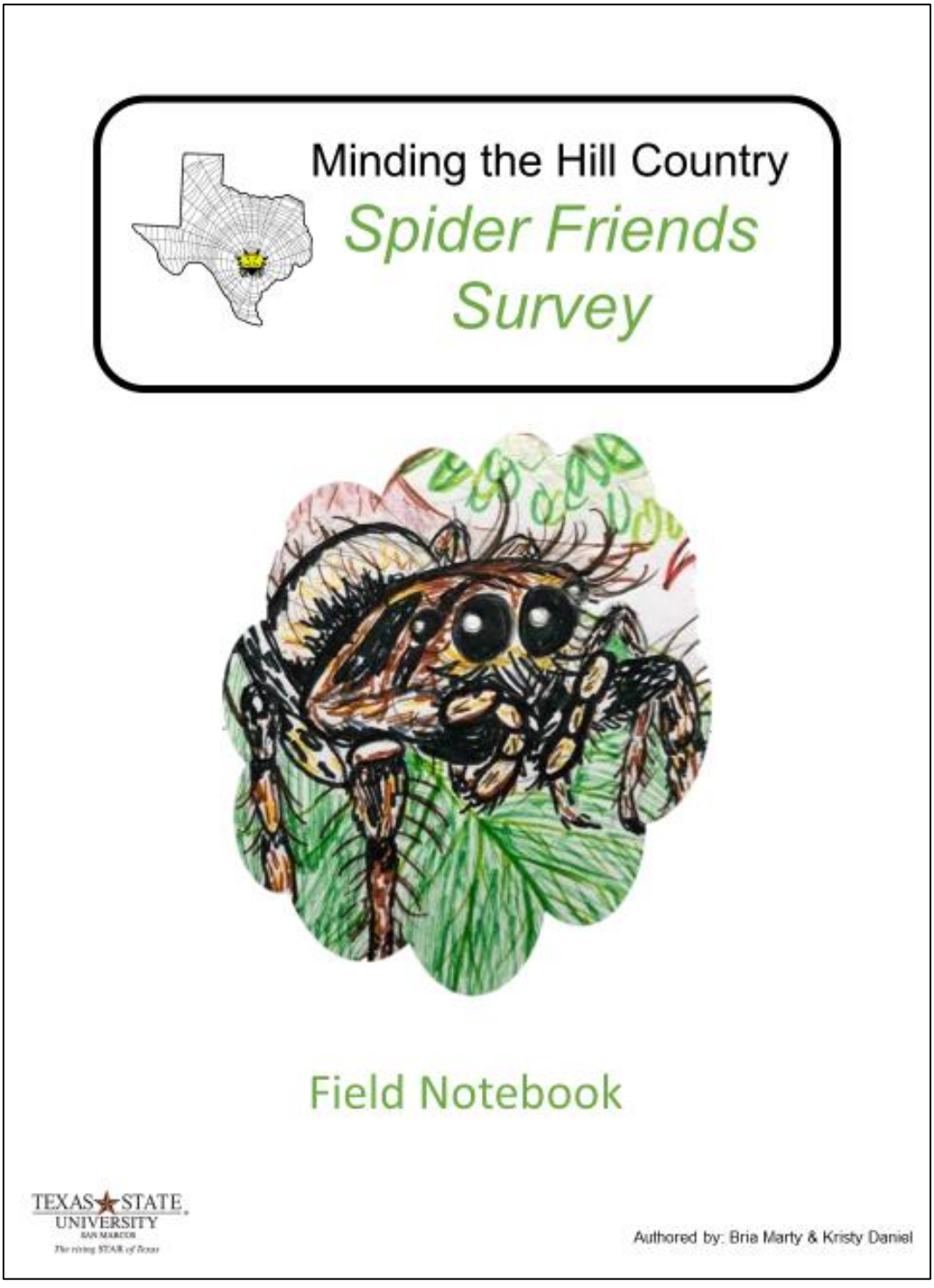
in education (Duff, 2003). However, pop culture references are not always understood by students of all backgrounds because of unfamiliarity and access to media that would expose some students to pop culture (Duff, 2003). I also only included one indigenous story, which could be addressed in future improvements by fostering a stronger local and cultural connection to spiders and/or nature, or other topics in science. This may improve engagement and produce higher quality results both scientifically and in participant knowledge (National Academies of Sciences, Engineering, and Medicine, 2018). Community and citizen scientists should consider a deeper integration of a diverse or regional cultural influences in their approach to improve engagement from participants of all backgrounds in future projects (National Academies of Sciences, Engineering, and Medicine, 2018).

This project provides a positive direction for future attempts to improve science education in non-specialists and for the advancement of science through public involvement. Community scientists can consider my findings to continue working towards improving participation and scientific outcomes through understanding perceptions, improving inclusivity, and communicating effectively (Berenbaum, 2017; Follett & Strezov, 2015; Lessard et al., 2017; Mammola et al., 2017; McGlynn, 2017; McKinley et al., 2017; National Academies of Sciences, Engineering, and Medicine, 2018). Further implementation of citizen and community science as a means to collect data can and increase support of understudied yet important animals such as spiders in the future (McKinley et al., 2017; National Academies of Sciences, Engineering, and Medicine, 2018). If exposure to activities such as *Spider Friends* facilitates positive results when a spider is encountered, less spiders might be killed, and fewer challenges

will stand between conservation of and research on many ecologically important animals in nature.

APPENDIX SECTION

Appendix A: Spider Friends of Central Texas Activity Online Packet



Minding the Hill Country is about inspiring people to spend more time exploring the natural world around them. We want to encourage and support people of all ages, abilities and backgrounds to enjoy and study wildlife in their local area and to observe and record information about the local environment. Minding the Hill Country's research and education program is delivered through a network of organizations, providing resources, training and events. To find out more, you are welcome to contact the project PI: Kristy Daniel: kristydaniel@txstate.edu

A day in the life of a spider

I eat loads of insects and help prevent the spreading of diseases carried by fleas, ticks, and mosquitos. I help maintain ecological balance in the places I live. Some of us can be found all around the globe, in plain sight, treetops, underground, and even underwater! Really, you can find us just about anywhere except for polar regions, the highest mountains, and deep oceans.

Highlighting Spider Science

There are scientists like **Dr. Aimée K. Thomas**, from Loyola University New Orleans, who work with students to explore the biology, ecology, and natural history of spiders in New Orleans, Belize, Guatemala, Ecuador and the Galapagos Islands. Dr. Thomas serves on the Board of Directors for the Louisiana Master Naturalist of Greater New Orleans, an organization that encourages members of the community to be good stewards of the environment by learning the natural history of the Greater New Orleans region and volunteering time to teach others about the complexities of the natural history of the region. She has been passionate about studying spiders for more than 25 years because there is a lack of information about their niche in our environment, even though they provide important ecological services.

According to West African and Caribbean folklore:

A long time ago there were no stories in our world. Then, Anansi, a trickster that took the form of a spider, went to visit Nyan, the sky god, to buy his stories to share with the world. However the god said the stories can only had if Anansi brought back a python, leopard, fairy, hornet. Off Anansi when to find the other animals. First, he traveled to where the python lived and debated out loud if the python really longer than a palm branch. Python overheard and agreed to tied to the branch to solve the debate. When he was completely tied, Anansi took him and searched for the other animals. Anansi dug a deep hole the Leopard fell into. Anansi offered to help him out with his webs. Once the leopard was out of the hole he was bound in Anansi's webs. Next, Anansi pretended it was raining by using a gourd to pour water his head and hornet nest. He helped the hornets seek cover in the empty gourd and sealed the opening. To catch the fairy, he a doll covered with sticky gum. When the fairy touches the doll, her hands stuck. Anansi brought his captives to Nyan the sky god where he was granted the stories. Nyan "Kawku Anansi, from today and going on forever, I present my stories to you with my blessing! Form now on we shall call them spider stories!

Story adapted from:
https://www.wilderutopia.com/traditions/myth/ashanti-of-ghana-how-spider-obtained-the-sky-gods-stories/

The Survey

There are almost 900 species of spiders that live in Texas. Some are common and found in lots of places while others are rare. This survey aims to find out more about the distribution of where spiders live in Central Texas.

Some spiders are sensitive to many environmental factors and that may influence where they live. Scientists can use results about where spiders live as an indicator of environmental health.

This is what you get to do!

- Choose your location and record site characteristics (on page 4).
- Begin looking for spiders inside your home.
- Take pictures of spiders you see.
- Upload pictures to the project iNaturalist site.
  - Spider Friends of Central Texas
- Search for more! Look for spiders outside of your home!
- Return all your results and survey responses (See back of packet).

Join iNaturalist iNaturalist.org

How to set up an iNaturalist account:

- Visit the iNaturalist website at https://www.inaturalist.org/ or download the iNaturalist app onto your smartphone.
- Create an account using an existing email and choose any username (many TXST students use their NetID).
  If you already have an account, feel free to use that one!
- We suggest you turn on Geolocation services

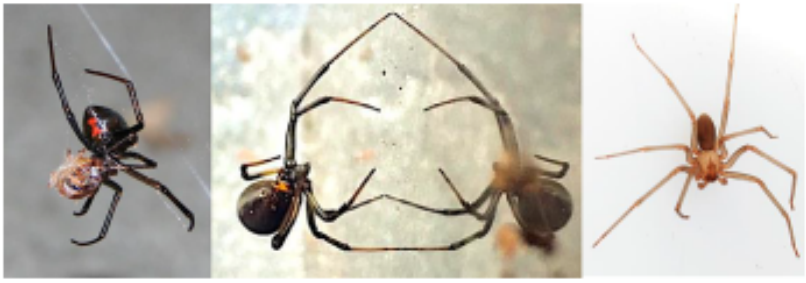
How to access *Spider Friends of Central Texas* on iNaturalist:

Website: Within the webpage, search for *Spider Friends of Central Texas* in the search bar located at the top left corner. Click 'Join project"

App: Click the tab in the lower right corner labeled More. In the search bar, type *Spider Friends of Central Texas* and click 'Join'

Safe fieldwork

In the event that you are bitten by a spider during your observations, you should wash the affected area with soap and water, apply an icepack or cold washcloth, elevate the site to prevent swelling, and optionally apply an antihistamine cream to the site. If you choose to go to the doctor, capture/kill the specimen and bring it with you to your appointment for species verification.



Potentially Dangerous Spiders to Avoid

Activity: Observing Spiders

Use the Spider Identification Guide included!

Choose your location and record site characteristics.

Observer Name:_____Date: _____

Survey Start Time:_____Survey End Time: _____

Current Weather Conditions (circle all that apply):

Describe the building you are observing:

☐ Apartment, Town House, or Dormitory

Name of Dorm/Complex: _____

☐ Modular Home or Trailer 

☐ Tent 

☐ Shed or Outbuilding 

☐ Business Building, School, or Hotel/Motel 

☐ House 

Location Zip Code: _____

Number and Type of Indoor Pets:

____ 

____ 

____ Other ____

Activity: Observing Spiders

Use the Spider Identification Guide included!

Search around inside your living space for spiders!

Inside – Suggestions:

Click to watch video

- Top and bottom corners of each room
- Under chairs/stools, bookshelves, and other similar objects
- Around cabinets
- Corners of windowsills, doorframes – or anywhere you find them!



Search around outside your living space for spiders!

Outside – Suggestions:

Click to watch video

- Around doorframes and exterior of windows
- On the walls



Activity: Observing Spiders

Use the Spider Identification Guide included!

I FOUND ONE! What do I do now?

1. Take as as many clear photos as possible!

Tip: *It helps to zoom instead of bringing the camera closer to a small object – Using your regular photo app, then uploading to iNaturalist is recommended. You also can also take a video and take still images by pausing the video when the spider is in focus and taking a screenshot!*

2. Upload to iNaturalist.org

1. Open iNaturalist webpage and click '+ Add Observations' or click the camera icon labeled 'Observe' in the smartphone app

2. Select 4 photos at a time on the app

   Tip*: you can add more than 4 by clicking 'Next' then clicking the square with '+' sign to the left of the photos o add more*

3. Click 'Search Species bar' if using the webpage or click 'What did you see?' in the app to view identification suggestions – **Don't be intimidated! There is no pressure here! It can be as broad as necessary! Do your best!**

4. In the Notes/Description section, mention where you found the spider (for example: 'found on the windowsill inside my dorm,' or, 'found on the doorframe outside of my dorm')

5. Lastly **don't forget to add your observation to the project** *Spider Friends of Central Texas*. This can be done by clicking Projects and selecting our project before clicking Share or Submit.

Activity: Your Thoughts About Spiders

Do you think spiders are important? Yes | No | Not Sure

Do you like outdoor activities? Yes | No | Not Sure

How did you hear about this survey? In-Person Activity | Website/ E-mail | Other: _____

What is your iNaturalist username? _____

**If you do not have an iNaturalist Account, you check out an iPad to use for free at the Meadows Center. Or you can email photos you find directly to TXSciencePEERS@gmail.com*

Read each statement and then select the response that best indicates how you feel:

	Strongly agree	Somewhat agree	Neither agree nor disagree	Somewhat disagree	Strongly disagree
It is fun looking for things in nature.					
I like to learn about nature.					
I enjoy spending time outside in nature.					
I think about nature when I am outside.					
I do things without paying attention.					
I rush through activities when outside.					
Nature has value even when not used by humans.					
I understand how my actions impact nature.					
I do not think I am a part of nature.					
I pick up trash I find outside.					
I try not to disturb animals outside.					
It is not my job to take care of nature.					

Activity: Your Thoughts About Spiders

How do you think you will react next time you see a spider?

_____
_____
_____
_____

Pretend you are a spider and look around outside, where would you like to live? Why?

_____
_____
_____
_____

How do you think the world would change if there were no more spiders?

_____
_____
_____
_____

How do you think people should treat spiders?

_____
_____
_____
_____

Safe Relocation

Click to watch video

Moving a Spider to Safety

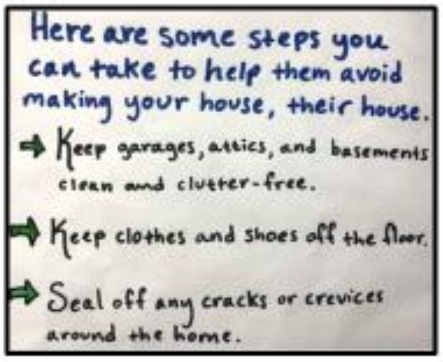
Caution! Do not attempt to handle a spider if it cannot be identified as harmless

1.Place a cup or glass over the spider on a flat surface to trap it (mind its legs)

2.Get a piece of paper or thin cardboard and slide it between the cup and the surface and under the spider (again, mind the legs!)

3.Keep the paper/cardboard securely against the cup with your hand and try to flip the cup right side up to trap the spider at the bottom (you can keep the paper/cardboard as a "lid" in case the spider jumps or climbs out)

4.Take your rescued spider friend outside and release it away from your home in a patch of grass or on a plant



Activity: Your Thoughts About Spiders

Read each statement and then select the response that best indicates how you feel:

	Strongly agree	Somewhat agree	Neither agree nor disagree	Somewhat disagree	Strongly disagree
I want to know more about spiders					
I want to know how scientists study spiders					
We should learn more about spiders in school					
I want participate in activities investigating spiders					
We should protect spiders					
Spiders are interesting animals					
People should use fewer chemicals in order to allow spiders to live close to them					
I want to watch a spider construct its web					
I will run away if I find a spider in my room					
Spiders scare me more than other animals					
I get nervous if someone tells me there is a spider near me					
I do not like pictures of spiders					
Thinking about touching spiders scares me					
Catching spiders is exciting					
I am fine with spiders living in my home					
I would rather avoid places with spiders					
I would like to touch a spider					

Extra Notes & Drawings

You can use this space to take notes or draw pictures of what you found!

Fun Extra Resources…

Find more Information about Spiders!
Meet Lucas the Spider:
https://www.youtube.com/watch?v=ZoYVZmKSYFg

Watch the Sicariid Spider that couldn't hide:
https://www.youtube.com/watch?v=rLw-9dpHtcU

General Spider Information: https://www.spidersworlds.com/spider-information/ or https://www.spidersworlds.com/es/informacion-sobre-aranas/

Texas AgriLife Extension-Spiders:
https://lubbock.tamu.edu/files/2015/04/Spiders_E408.pdf

The Great Spider Debate:
https://www.uky.edu/Ag/Entomology/ythfacts/resourc/tcherpln/spiderdebate.pdf

Community Organizations and Programs Available:
Centro Cultural Hispano de San Marcos: http://www.sanmarcoscentro.org/programs.html
EARDC Aquatic Science Adventure Camp: https://www.eardc.txstate.edu/camp.html
Indigenous Cultures Institute: https://www.indigenouscultures.org/
San Marcos Youth Services Bureau: http://ysb.org/ysb/
Spider Joe: http://spiderjoe.com/

Send in your responses!

Now that you have gathered your results it is important that you return them to us so that they can be shared with the scientific community.

Return your results through the project Qualtrics site (https://tinyurl.com/SpiderFriends)

OR

Return this activity packet through Campus Mail to:

Bria Marty
Texas State University
295 Supple Science Building

Thank you for taking part in the Spider Friends of Central Texas survey!

Appendix B: Spider Identification Guide

SPIDER IDENTIFICATION GUIDE

Orb-weavers | Family Araneidae

Also known as orb web spiders, we have an impressive amount of variation in our family! Almost anything about our bodies, habitats, and spidery lives can be different from species to species. However, our webs often look like what humans think of as classic spider webs!

iNaturalist : https://www.inaturalist.org/taxa/47535-Araneidae

Wolf Spiders | Family Lycosidae

We don't spin webs, but we do have silk and we usually build a burrow or stay on the move. You can mostly find us on the ground running quickly, and sometimes we have an egg sac with us, or our babies on our backs. We can get big, but don't be intimidated: we're good spiders!

iNaturalist : https://www.inaturalist.org/taxa/47416-Lycosidae

Jumping Spiders | Family Salticidae

We are the biggest and most diverse family of spiders! We don't make webs, but we dispense silk and can use it as a lifeline to get away from danger quickly! We can be found jumping around almost anywhere, with large eyes and excellent eyesight to helps us ambush our prey.

iNaturalist : https://www.inaturalist.org/taxa/48139-Salticidae

Crab Spiders | Family Thomisdae

Just like our name, we resemble crabs. Some of us even scuttle sideways like crabs, too! We are web-less and can be brown or bright-colored for camouflage, and you can often find us hunting for pests in flowers. We can snag moths, bees, flies, basically anything we are big enough to catch!

iNaturalist : https://www.inaturalist.org/taxa/47866-Thomisidae

Tarantulas | Family Theraphosidae

We are the largest spiders you can find, but we won't try to hurt you! We also don't spin traditional webs, but we do dig burrows and line them with silk. Females can live up to 35 years!

iNaturalist : https://www.inaturalist.org/taxa/47424-Theraphosidae

Trap-door Spiders | Family Ctenizidae

We often look like smaller, shinier tarantulas, with short and thick legs. We're named for our special method of capturing prey. We dig burrows and make a "trap door" of silk, then ambush prey when they get close!

iNaturalist : https://www.inaturalist.org/taxa/57327-Ctenizidae

SPIDER IDENTIFICATION GUIDE

Cellar Spiders | Family Pholcidae

You can often find our disorganized webs in all kinds of shaded places, like your basement, porch, or shed. We are slim and shy, and often wait upside down for prey to get caught in our webs. We're messy and don't clean up our webs, so they accumulate, or gather up, until something knocks them down!

iNaturalist : https://www.inaturalist.org/taxa/47823-Pholcidae

Nursery Web/Fishing Spiders | Family Pisauridae

Fishing spiders have a special talent: we can walk on still water surfaces and stay below the surface for as long as 30 minutes to catch small prey! Nursery web spiders and Fishing spiders can get big and can sometimes be confused with wolf spiders.

iNaturalist : https://www.inaturalist.org/taxa/55788-Pisauridae

Spitting Spiders | Family Scytotidae

The way we ambush prey might be considered rude to humans… Instead of using webs, we spit a sticky substance onto our prey to keep them still while we bite and inject venom. Look for our characteristic spots! We can protect rooms like your bathroom from other insect pests.

iNaturalist : https://www.inaturalist.org/taxa/47431-Scytodidae

Lynx Spiders | Family Oxyopidae

Our webs are minimal and messy with no obvious shape, but they work just fine. We are quick hunters with great eyesight and have very spiky legs! You can often find us searching – or enjoying – our prey while on a plant. On a side note, our egg sacs kind of look like muffins. (Don't eat).

iNaturalist : https://www.inaturalist.org/taxa/83843-Oxyopidae

Six-eyed/Recluse Spiders | Family Siicaridae

We are important in our natural habitats but can get inside occasionally. **Be careful to not to ever touch us.** Our venom is extra potent, and we could bite from self defense. In Texas, the Brown recluse is the most famous sicariid. Look for the **fiddle/violin shape** behind our eyes!

iNaturalist : https://www.inaturalist.org/taxa/48140-Sicariidae

Cobweb Spiders | Family Theridiidae

We have many members that are important in our natural habitats, and occasionally get inside. **Be careful to not to ever touch Widow spiders** because our venom is extra potent, and we could bite from self defense. Look for the **hourglass/hourglass-like shape** on our underside!

iNaturalist : https://www.inaturalist.org/taxa/47371-Theridiidae

APPENDIX C: IRB Approval Letter

TEXAS STATE UNIVERSITY
SAN MARCOS
The rising STAR of Texas

In future correspondence please refer to 6548

June 6, 2019

Bria Marty
Texas State University
601 University Drive.
San Marcos, TX 78666

Dear Bria:

Your IRB application titled "Assessing Public Perceptions of Spiders and Identifying Trends in Citizen Science Participation" was reviewed and approved by the Texas State University IRB. It has been determined that risks to subjects are: (1) minimized and reasonable; and that (2) research procedures are consistent with a sound research design and do not expose the subjects to unnecessary risk. Reviewers determined that: (1) benefits to subjects are considered along with the importance of the topic and that outcomes are reasonable; (2) selection of subjects is equitable; and (3) the purposes of the research and the research setting is amenable to subjects' welfare and producing desired outcomes; that indications of coercion or prejudice are absent, and that participation is clearly voluntary.

1. In addition, the IRB found that you need to 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 to participants.

This project is therefore approved at the Exempt Review Level
Category 1 Education Research

2. 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. All **unanticipated events and adverse events are to be reported to the IRB** within 3 days.

Sincerely,

Monica Gonzales

Monica Gonzales
IRB Regulatory Manager
Office of Research Integrity and Compliance

CC: Dr. Kristy Daniel

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Appendix D: Recruitment E-mail

This email message is an approved request for participation in research that has been approved by the Texas State Institutional Review Board (IRB).

Dear [university] Undergraduate,
I am a graduate student conducting a research study to investigate the impact of a citizen science activity on people's perceptions of spiders. You are being asked to be a part of this survey and take part in a self-directed *Spider Friends of Central Texas* observational activity because you are an undergraduate student at [university]. If you wish to participate, all identifying information will be kept confidential. This initial survey time should not take longer than 15 minutes. The self-directed activity can take as much or as little time as you would like to spend (15min+). Afterward, we ask that you complete a follow-up survey that will take no longer than 15 minutes. The total time spent for full participation will take about 45 minutes or **as much time as you care** to spend observing spiders. Your choice to participate can help improve our understanding of people's perceptions about spiders and how an engaging, educational activity can influence those perceptions. To participate in this research please go to this Qualtrics link: [link]

If you have any questions about this research please contact me:
Bria Marty, 512.245.2178, bnm50@txstate.edu
This project [IRB Exempt Review Level Category 1 #6548] was approved by the Texas State IRB on June 6, 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 - (dgobert@txstate.edu) or to Monica Gonzales, IRB Regulatory Manager 512-245-2334 - (meg201@txstate.edu).

My best,

Bria Marty

Appendix E: Pre-Activity Qualtrics Questionnaire

Q1 – To indicate your consent to participate, please mark the appropriate box below:

- o I consent to participate in this study and am at least 18 years of age
- o I do not consent to participate in this study
- o I am under the age of 18

Q2 – [Under the condition that I consent to participate in this study and am at least 18 years of age is selected] What is your Name? (Use your [school ID] if you are a student at [university]. (open ended)

Q3 – How did you hear about this survey?

- o In-Person Activity (I have a physical activity packet)
- o Website/Email (I need the online link to get access to a digital packet)
- o Other: Assigned by Teacher/Invited by Friend (I need the online link to get access to a digital packet)

Q4 – What is your ethnicity?

- o Hispanic/Latino
- o Black/African-American
- o Asian
- o Native American
- o Native Hawaiian or other Pacific Islander
- o White/Caucasian
- o Other
- o Prefer not to answer

Q5 – What is your gender? (Select the option that you most identify with)

- Male
- Female
- Other
- Prefer not to answer

Q6 – What is your major? (open ended)

Q7 – What are your reasons for being willing to take part in this spider observation activity? (open ended)

Q8 – Environmental Mindfulness Instrument – for Minding the Hill Country project (data collected not included in analysis for this study)

Q9 – SAQ measure of Scientistic attitude (four items)

Q10 – SAQ measure of Ecologistic attitude (four items)

Q11 – SAQ measure of Negativistic attitude (five items)

Q12 – SAQ measure of Naturalistic attitude (four items)

Q13 – [If answer to Q3 included 'I need the online link to get access to a digital packet']

Thank you for completing this survey! You can download the Spider Friends Survey at:

Click here to access your digital packet! [hyperlink to packet]

Appendix F: Post-Activity Qualtrics Questionnaire

*Force response

Q1 – *What is your Name? (Use your [school ID] if you are a student at [university].

(open ended)

Q2 – *How did you hear about this survey?

- In-Person Activity (I have a physical activity packet)
- Website/Email (I need the online link to get access to a digital packet)
- Other: Assigned by Teacher/Invited by Friend (I need the online link to get access to a digital packet)

Q3 – What is your iNaturalist username? (open ended)

Q4 – Current weather conditions (during activity – check all that apply):

- Sunny
- Partially Sunny
- Cloudly/overcast
- Rainy
- Storming
- Nighttime

Q5 – *Describe the building you are observing:

- Apartment, Town House, or Dormitory
- Modular Home or Trailer
- Tent
- Shed or Outbuilding
- Business Building, School, or Hotel/Motel

- House

Q6 – Location Zip Code (open ended)

Q7 – Number and Type of Indoor Pets – response table with type of pet (dog, cat, bird, other) on the y-axis and number of pets on the x-axis (0, 1, 2, 3, 4 (or more))

Q8 – About how much time did you spend conducing your spider observation?

- 1-15 minutes
- 16-20 minutes
- 31-59 minutes
- 1-3 hours
- Over 3 hours
- No time spent

Q9 – Do you think spiders are important?

- Yes
- No
- Not Sure

Q10 – Do you like outdoor activities?

- Yes
- No
- Not Sure

Q11 – [If answer ‘Apartment, Town House, or Dormitory is selected for Q5] Name of Dorm/Complex (open ended)

Q12 - Environmental Mindfulness Instrument* – for Minding the Hill Country project (data collected not included in analysis for this study)

Q13 – SAQ measure of Scientistic attitude (four items)

Q14 – SAQ measure of Ecologistic attitude (four items)

Q15 – SAQ measure of Negativistic attitude (five items)

Q16 – SAQ measure of Naturalistic attitude (four items)

Appendix G: Spider Attitude Questionnaire (SAQ)

Scientistic Attitude Items

Read each statement and then select the response that best indicates how you feel:

	Strongly disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Strongly agree
I want to know more about spiders	○	○	○	○	○
I want to know how scientists study spiders	○	○	○	○	○
We should learn more about spiders in school	○	○	○	○	○
I want to participate in activities investigating spiders	○	○	○	○	○

Ecologistic Attitude Items

Read each statement and then select the response that best indicates how you feel:

	Strongly agree	Somewhat agree	Neither agree nor disagree	Somewhat disagree	Strongly disagree
We should protect spiders	○	○	○	○	○
Spiders are interesting animals	○	○	○	○	○
People should use fewer chemicals in order to allow spiders to live close to them	○	○	○	○	○
I would like to watch a spider construct its web	○	○	○	○	○

Negativistic Attitude Items

Read each statement and then select the response that best indicates how you feel:

	Strongly agree	Somewhat agree	Neither agree nor disagree	Somewhat disagree	Strongly disagree
I will run away if I find a spider in my room	○	○	○	○	○
Spiders scare me more than other animals	○	○	○	○	○
I get nervous if someone tells me there is a spider near me	○	○	○	○	○
I do not like pictures of spiders	○	○	○	○	○
Thinking about touching spiders scares me	○	○	○	○	○

Naturalistic Attitude Items

Read each statement and then select the response that best indicates how you feel:

	Strongly agree	Somewhat agree	Neither agree nor disagree	Somewhat disagree	Strongly disagree
Catching spiders is exciting	○	○	○	○	○
I am fine with spiders living in my home	○	○	○	○	○
I would rather avoid places with spiders	○	○	○	○	○
I would like to touch a spider	○	○	○	○	○

REFERENCES

Beccaloni, J. (2009). *Arachnids* (1st ed). University of California Press.

Berenbaum, M.R. (2017). Communicating about science communication: A brief entomological history. *Annals of the Entomological Society of America, 110*(5), 435-438.

Binford, G.J. (2001). Differences in venom composition between orb-weaving and wandering Hawaiiam *Tetragnatha* (Araneae). *Biological Journal of the Linnean Society, 74,* 581-595.

Brewer, N.T., Weinstein, N.D., Cuite, C.L., & Herrington Jr., J.E. (2004). Risk Perceptions and Their Relation to Risk Behavior. *Annals of Behavioral Medicine*, *27*(2), 125-130.

Cardoso, P., Erwin, T.L., Borges, P.A.V., & New, T.R. (2011). The seven impediments in invertebrate conservation and how to overcome them. *Biological Conservation, 144*(11), 2647-2655.

Carr, N. (2016). Ideal animals and animal traits for zoos: General public perspectives. *Tourism Management, 57,* 37-44.

Colleony, A., Clayton, S., Couvet, D., Saint Jalme, M., & Pre´vot, A.C. (2016). Human preference for species conservation: Animal charisma trumps endangered status. *Biological Conservation, 206,* 263–269.

Clark, K.E., Cupp, K., Phelps, C.L., Peterson, M.N., Stevenson, K.T., & Serenari, C. (2017). Household dynamics of wildlife value orientations. *Human Dimensions of Wildlife, 22*(5), 483-491.

Davies, L., Bell, J.N., Bone, J., Head, M., Hill, L., Howard, C., Hobbs, S.J., Jones, D.T., Power, S.A., Rose, N., Ryder, C., Seed, L., Stevens, G., Toumi, R., Voulvoulis, N., & White, P.C. (2011). Open Air Laboratories (OPAL): A community-driven research programme. *Environmental Pollution, 159*(8-9), 2203-2210.

Decker, D.J., Siemer, W.F., Evensen, D.T.N., Stedman, R.C., McComas, K.A., Wild, M.A., Castle, K.T., & Leong, K.M. (2012). Public perceptions of wildlife-associated disease: risk communication matters. *Human-Wildlife Interactions, 6*(1), 112-122.

Duff, P.A. (2003). Intertextuality and hybrid discourses: The infusion of pop culture in educational discourse. *Lingistics and Education, 14,* 231-276.

Field, A. (2009). *Discovering Statistics Using SPSS* (3rd ed.) Sage Publications.

Follett, R. & Strezov, V. (2015). An analysis of citizen science-based research: Usage and publication patterns. *PLoS ONE, 10*(11), e0143687.

Hauke, T.J., & Herzig, V. (2017). Dangerous arachnids—Fake news or reality? *Toxicon, 138*, 173-183.

Herzig, V., King, G.F., & Undheim, E.A.B. (2019). Can we resolve the taxonomic bias in spider venom research? *Toxincon: X1,* 100005.

Kellert, S.R. (1993) Values and perceptions of invertebrates. *Conservation Biology, 7*(4), 845- 855.

Kellert, S. R. (1996). *The Value of Life: Biological Diversity and Human Society*. Island Press.

Lessard, B.D., Whiffin, A. L., & Wild, A. L. (2017). A Guide to Public Engagement for Entomological Collections and Natural History Museums in the Age of Social Media. *Annals of the Entomological Society of America, 110*(5), 467-479.

Liordos, V., Kontsiotis, V.J., Anastasiadou, M., & Karavasias, E. (2017). Effects of attitudes and demography on public support for endangered species conservation. *Science of the Total Environment, 595,* 25-34.

Mammola, S., Michalik, P., Hebets, E.A., & Isaia, M. (2017). Record breaking achievements by spiders and the scientists who study them. *PeerJ, 5*, e3972.

Manesi, Z., Van Lange, P.A.M., & Pollet, T.V. (2015). Butterfly eyepots: Their potential influence on aesthetic preferences and conservation attitudes. *PLoS One, 10*(11), e0141433.

McKinley, D.C., Miller-Rushing, A.J., Bonney, R., Brown, H., Cook-Patton, S.C., Evans, D.M., French, R.A., Parrish, J.K., Philips, T.B., Ran, S.F., Shanley, L.A., Shirk, J.L., Stepenuck, K.F., Weltzin, J.F., Wiggins, A., Boyle, O.D., Briggs, R.D., Chaplin III, S.F., Hewitt, D.A., Preuss, P.W., & Soukup, M.A. (2017). Citizen science can improve conservation science, natural resource management, and environmental protection. *Biological Conservation 208*, 15-28.

Molina-Murillo, S., Rojas, C., Somerville, S., Doss, R.G, Lemus, B. (2015). What do you think of fungi? Perceptions by "educated" groups in Honduras and Costa Rica. *Brenesia* (83-84), 30-36.

Moore, J.L., & Cruce, T.M. (2020). The impact of an interest-major fit signal on college major certainty. *Research in Higher Education, 61,* 383-407.

The National Academies of Sciences, Engineering, and Medicine. (2018). *Learning Through Citizen Science: Enhancing Opportunities by Design*. Washington, DC: The National Academies Press, doi: https://doi.org/10.17226/25183.

Norberg, M.M, Newins, A.R., Jiang, Y., Xu, J., Forcadell, E., Alberich, C., & Deacon, B.J. (2018). The scarier the better: Maximizing exposure therapy outcomes for spider fear. *Behavioral and Cognitive Psychotherapy, 46*(6), 754-760.

Prokop, P., Tolarovicová, A., Camerik, A.M., & Peterková, V. (2010). High school students' attitudes towards spiders: A cross-cultural comparison. *International Journal of Science Education, 32*(12), 1665-1688.

Saez, N.J., & Herzig, V. (2018). Versatile spider venom peptides and their medical and agricultural applications. *Toxicon, 158*, 109-126.

Saez, N.J., Senff, S., Jensen, J.E., Yan Er, S., Herzig, V. Rash, L.D., & King, G.F. (2010). Spider- Venom peptides as therapeutics. *Toxins, 2*, 2851-2871.

Ubick, D., Paquin, P., Cushing, P. E., & Roth, V. (Eds.) (2005). *Spiders of North America: An identification manual* (2nd ed). Keene, NH: American Arachnological Society.

Valderrama-Vásquez, C.A. (2012). Wild Hippos in Colombia. *WebConserva, 15*, No 80-68 of 301.

Vaske, J.J., Jacobs, M.H., & Sijtsma, M.T.J. (2011). Wildlife value orientations and demographics in The Netherlands. *European Journal of Wildlife Research, 57*(6), 1179-1187.

Wang, B., Dunlop, J.A., Selden, P.A., Garwood, R.J., Shear, W.A., Müller, P., & Lei, X. (2018). Cretaceous arachnid *Chimerarachne yingi gen. et sp. nov.* illuminates spider origins. *Nat. Ecol. Evol.*, *2*(4), 614-622.

Windley, M.J., Herzig, V., Dziemborowicz, S.A., Hardy, M.C., King, G.F., & Nicholson, G.M. (2012). Spider-Venom peptides as bioinsecticides. *Toxins, 4*(3), 191-227.

Wannemueller, A., Appelbaum, D., Küppers, M., Matten, A., Teismann, T., Adolph, D., Margraf, J. (2016). Large group exposure treatment: A feasibility study in highly spider fearful individuals. *Frontiers in Psychology, 7*, 1183.

Wyckhuys, K.A.G., Pozsgai, G., Lovei, G.L., Vasseur, L., Wratten, S.D., Gurr, G.M., Reynolds, O.L., & Goettel, M. (2019). Global disparity in public awareness of the biological control potential of invertebrates. *Science of the Total Environment, 660*, 799-806.