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The impact of environmental education delivery methods and outreach messaging on attitudes, interests, and intended-behavior changes toward nature

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The impact of environmental education delivery methods and outreach messaging on attitudes, interests, and intended-behavior changes toward nature

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Environmental education (EE) is important for environmental awareness and stewardship. Involving youth and adults in EE ensures current and future generations will conserve natural resources. This thesis explores impacts of delivery methods on participants' environmental attitudes and behaviors toward nature through middle school classroom- and camp-based EE instruction, focus group interviews with rural minority youth, and adult responses to aquatic conservation outreach messaging. I observed no difference in environmental attitudes between online versus in-person delivery of EE lessons for middle-schoolers. Outdoor-based learning may be more impactful for EE than experiential, classroom-based learning. Focus group outcomes suggested youth EE programs should capitalize on exploratory learning that allows for independence and safety from wildlife and community violence. Arkansas anglers who reside near aquatic invasive species (AIS) are more aware of Clean, Drain, Dry (CDD) messaging despite all anglers' likeliness to perform pro-environmental behaviors. Consistent, targeted CDD messaging could help minimize AIS spread.

DEDICATION

To my dear friend, Cassie Auxt. Your unwavering passion for family, friendship, and the outdoors inspires me every day.

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CHAPTER I

INTRODUCTION

In 1969, William Stapp defined environmental education (EE) as "producing a citizenry that is knowledgeable concerning the biophysical environment and its associated problems, aware of how to help solve these problems, and motivated to work toward their solution." The EE movement formally began in the United States with The Environmental Education Act of 1970. This act was introduced in response to increasing concerns about environmental issues such as climate change, air and water pollution, and problematic pesticide use (Morrissett & Wiley, 1971). It established an Office of Environment Education to support EE through curriculum development and teacher training.

In 1975, the Belgrade Charter was proposed at the International Environmental Workshop to standardize EE internationally, promote awareness of environmental issues, and determine what solutions should be in place to resolve ecological problems (Fang et al., 2023; McCrea, 2010). Two years later, the Tbilisi Declaration created a framework for promoting EE internationally that included goals and objectives that act as implementation guiding principles (Fang et al., 2023; McCrea, 2010). These actions played vital roles in paving a path toward positive environmental changes through intentional educational approaches.

Formal education is an institutionalized, structured approach to teaching that follows standards and curriculum presented and encountered in chronological order from kindergarten to college. Nonformal education also follows curricula but not a chronological approach. It is often

employed as an extension of and supplement to formal teaching, although nonformal education can be developed for people of all ages. Informal education is defined as self-guided learning; it is not structured, and the learner has the ability to set their own goals (NAAEE, 2009).

The interdisciplinary nature of EE offers a variety of teaching strategies that can implement the use of formal, nonformal, and informal educational methods. These strategies include school (or "schoolyard") EE, place-based EE, projects curricula, and nature center-based education (Fang et al., 2023; Winther et al., 2010). When determining an EE teaching strategy, an organization needs to consider the resources, space, curriculum, and learner characteristics (Fang et al., 2023; Liefländer et al., 2014). Schoolyard EE uses school grounds as a place for exploration and learning, which helps students gain a better understanding of their local environment (UNESCO 1978; Winther et al., 2010). Place-based education uses local environments (including schoolyards, and extensions into the community) to help solve real-world environmental problems (Dewey, 1959; Winther et al., 2010). Outdoor education is a version of place-based learning that often emphasizes helping people gain a better understanding, more appreciation, and a deeper connection with their local environment (Fang et al., 2023). Project curricula, such as Project Learning Tree, Project WET, and Project WILD, are approaches to EE that provide quality instruction so educators can fulfill the goals of EE within diverse learning settings (Winther et al., 2010). Nature centers also provide a unique avenue for presenting EE programming by allowing visitors to informally engage with environmental-related subjects in a multisensory and exploratory manner (Fang et al., 2023; Winther et al., 2010; Morrissett & Wiley, 1971).

Environmental education should encompass people of all ages (NAAEE, 2009). Minor children do not have legal or political influence they can use to voice opinions on policy

(Brunelle et al., 2018; Weller, 2007), and the environment cannot wait for the next generation of stewards to reach an age where they can create change. Involving adults in EE is crucial to making meaningful changes that lead to improved environmental conditions (Bélanger, 2003).

It is equally important to involve youth in EE learning and to build a sense of connectedness with nature. People in early childhood typically show the most pro-environmental behavior, but this drastically declines as they grow into adulthood (Fang et al., 2023). Attitudes formed during adolescence are important long-term markers for future involvement in pro-environmental behaviors (Brunelle et al., 2018; Wells & Lekies, 2006). Fostering positive experiences and contact with nature from a young age may encourage youth to continue participating in pro-environmental behavior throughout their life (Chan, 2009; Chawla, 1999; Collado et al., 2015; Matsuba et al., 2012).

The purpose of this thesis is to explore how delivery and outreach methods of EE can promote positive environmental attitudes and a vested interest in the well-being of nature. Through the examination of classroom- and camp-based teaching, focus group interviews with youth, and behaviors of adults exposed to conservation messaging, I aim to provide a broadscale view of EE delivery to various audiences that can help educators and managers develop engaging and impactful EE methods for life-long learning and environmental citizenship.

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CHAPTER II

EVALUATING EFFICACY OF ONLINE AND FACE-TO-FACE ENVIRONMENTAL EDUCATION LESSONS

Introduction

One of the underpinnings of environmental education (EE) as defined by the North American Association for Environmental Education (NAAEE) is "Roots in the Real World", which posits skills are developed best when learners directly experience the environment (NAAEE, 2014). EE has traditionally been conducted in a face-to-face learning environment. Reese (2018) describes various benefits of face-to-face educational experiences, which includes reinforcing information learned in the classroom, having multiple points of contact with learned material, and increasing student focus and directed attention following an outdoor experience. Another important aspect of face-to-face lessons is the social interaction between student and teacher (Chen, 2018; Mahmud et al., 2020) and among students (Li et al., 2016). A teacher's presence often encourages social connectedness and helps to encourage engagement in activities, and praise from a teacher translates to acceptance and can stimulate motivation for engagement (Hamari & Koivisto, 2015; Mahmud et al., 2020). Peer interaction is important for a student's engagement, enjoyment, and motivation during a course (Larson et al., 2012; Li et al., 2016; Mahmud et al., 2020).

Educational camps and outdoor-based education can further promote engagement with nature and environmental awareness. Camp settings are known to have a more positive impact

on campers' attitudes toward nature than traditional classroom settings (Dettman-Easler & Pease, 1999; Shepard & Speelman, 1985), especially those camps that encourage outdoor-based learning (Amini, 2015; DeVille et al., 2021; Ewert et al., 2005).

Several barriers can prevent youth from participating in EE opportunities, such as classroom time restrictions, financial barriers, transportation costs for nonformal EE, access to nonformal EE settings (e.g. zoos, nature centers), and lack of teacher confidence due to inadequate preparation of teachers for outdoor/EE learning can prevent students from participating and gaining first-hand experience (Aivazidis et al., 2006; Anderson & Jacobson, 2018; Ernst, 2009; Ernst, 2014; NAAEE, 2014). Environmental literacy and engagement are important for society's sustainability, and affordable and accessible EE education is one way to break barriers that people of certain socioeconomic statuses (SES), genders, or race may experience. One way to provide greater access to EE is to create online content.

Online learning is a promising avenue for EE to reach more diverse and rural audiences. There are many benefits to delivering lessons online, including incorporation of various teaching materials and individualized learning (Beyth-Marom et al., 2005; Chen, 2018). Online education also provides enhanced access for audiences who need flexibility in their coursework (Beyth-Marom et al., 2005). Some published research yielded outcomes that were not in support of online instruction, but that appears to be an issue when educational information was not conveyed appropriately or was delivered in a "one-size-fits-all" approach. Diaz & Cartnal (1999) argued that teachers too often believe their traditional, in-person teaching methods will work in their online lessons. They describe teachers' mentality to classroom procedures as a "master key" and appropriate for people of all learning types, which is often ineffective. Inappropriate

pedagogical approaches can dissuade students from participating for reasons such as boredom, repetition, and unsuitable level of difficulty (Mahmud et al., 2020).

Students tend to have unrealistic expectations when participating in an online course. They think online learning will not require as much dedication as in-person instruction and underestimate the amount of work they will have (Glenn, 2018). This could be the cause of higher attrition rates for online courses compared with face-to-face courses (Fleming & Easton, 2010; Li et al., 2016). Online EE lessons could face these same consequences if not designed appropriately to accommodate different learners.

Asynchronous learning is a form of online delivery that allows interaction and communication when people cannot be online at the same time. Synchronous learning is online delivery that allows for collaboration and communication in real-time (Hrastinski, 2008). Each delivery method comes with its own set of benefits and drawbacks.

Asynchronous coursework allows students to watch lectures and ask questions on their own time (Hrastinski, 2008) and forces students to take responsibility for their own education via self-discipline (Phungsuk et al., 2017). Asynchronous learning also provides students with a better opportunity to process information and gives them a chance to think about the information they have received and allows more time to craft responses (Hrastinski, 2008; Phungsuk et al., 2017). Synchronous learning most resembles a face-to-face learning environment. It can enhance digital delivery and include social interactions that are important to youth development and learning (Olson & McCracken, 2014). Teachers can promote a collaborative environment that is hard to accomplish by asynchronous learning alone (Hyder et al., 2007; Martin et al., 2017). Interactions between teacher and students are enhanced when students receive immediate feedback from teachers and when teachers use tools such as polls and screensharing to interact

with students (Hrastinski, 2008). Interaction among peers is enhanced when teachers lead group discussions, separate students into virtual breakout rooms (Kohnke & Moorehouse, 2020), and create lessons that are focused on physical participation as opposed to passive, mental participation (Hrastinski, 2008).

Theoretical Framework

My study was guided by three underlying theories: The Value-Belief-Norm Theory by Paul Stern, the New Environmental Paradigm by Riley Dunlap and Kent Van Liere, and Experiential Learning Theory by David Kolb.

Value-Belief-Norm Theory

The Value-Belief-Norm (VBN) theory states individuals are more willing to support a cause when they believe their values are threatened and their actions can protect those values (Stern et al., 1999). A person's ecological worldviews are directly influenced through their values, and the values and environmental worldview one holds can explain the support one has for environmental policy and how engaged they are in pro-environmental behaviors (Figure 1.1; Stern et al., 1999).

Delivering EE experiences to students in this study aimed to provide a new perspective on environmental issues and their impact on Earth and human well-being in hopes of increasing positive attitudes toward nature and promoting pro-environmental behaviors (Caplow, 2021; Chawla & Cushing, 2017). It is difficult to change a person's values without "cognitive reorganization", but these values can give rise to more specific individual beliefs (Xiao et al., 2019).

The New Ecological Paradigm

The New Ecological Paradigm (NEP) is a scale that quantifies an individual's ecological worldview (Dunlap & Van Liere, 1978). The NEP is based on Schwarz's (1999) Theory of Cultural Values, which (in part) explains that human relationships with the natural world tend to follow the Dominant Social Paradigm (DSP) or the New Environmental Paradigm (NEP). Those with the DSP (also called mastery values) view the world as something to be changed and adapted, while those ascribing to the NEP (also called harmony values) view the world as something to be protected and shared (Schwarz, 1999). In other words, a person's view of the world can be anthropocentric or ecocentric. The NEP is a highly robust predictor of environmental beliefs, attitudes, and behaviors (Hornsey et al., 2016) and is based on responses to the statements on the NEP scale that determine if a person has more of an NEP or DSP view of the natural world. Higher overall scores indicate more harmonious environmental values while lower NEP scores indicate mastery and dominant social values.

The NEP is an integral part of the VBN theory. NEP serves as a mediator between the general values an individual holds and the pro-environmental actions they may take in the future (Xiao et al., 2019). One's values help explain how much or how little they support environmentalism based on their NEP score. For my study, NEP served as an indicator of how students view the natural world and as a predictor of behaviors students are likely to display in the future (assuming no further intervention).

Experiential Learning Theory

Experiential learning is defined generally as learning done through life experience (Kolb, 2015), but the definition is highly debated among researchers in the context of their experiential learning models. In 1953, David Kolb developed the Experiential Learning Theory (ELT) based

on theories outlined by foundational social science researchers such as John Dewey (Experiential Education Theory), Kurt Lewin (Action Research and Laboratory Training Theory), William James (Radical Empiricism Theory), and Jean Piaget (Constructivism Theory). Kolb (2015) combines all their theories and defines experiential learning as a holistic process of learning that explains how experience transforms to learning and reliable knowledge through concrete experience, reflective observation, abstract conceptualization, and active experimentation (Figure 2.2). David Kolb (1984) describes ELT as a four-step, continuous process:

> [Learners] must be able to involve themselves fully, openly, and without bias in new experiences. They must be able to reflect on and observe their experiences from many perspectives. They must be able to create concepts that integrate their observations into logically sound theories, and they must be able to use these theories to make decisions and solve problems. (p. 42)

ELT is a theory that focuses on education as a process, not an outcome of educational experiences. It emphasizes that ideas are not fixed but are constantly being formed and reformed based on experiences (Kolb, 1984), and they provide meaning for experiences (Mughal & Zafar, 2011). Experiences are defined as transactions between a person and their environment, with an environment being "whatever conditions interact with personal needs, desires, purposes, and capacities to create the experience which is had" (Kolb, 2015). An environment in this use can range from building a sandcastle on a barrier island to reading a book and imagining yourself in the location described in the book. If there is transaction between a person and an environment, it is considered an experience; knowledge is gained as a result of this transaction through adding this experience to existing knowledge and reflecting on how that experience fits into their worldview.

Using Kolb's ELT, a productive and engaging environment can be developed in an online format (Richmond & Cummings, 2005) as much as it can for in-person learning. ELT was used as a basis for this research to challenge the preconceived notions that youth hold toward the environment. By being introduced to new experiences, I anticipated they would be able to conceptualize new ideas and use these new ideas to make pro-environmental decisions and create meaningful ecological changes. One of the major pitfalls of ELT is that it does not take into consideration the social aspects of learning and behavior change, which is why the VBN and NEP were used in conjunction with ELT to account for personal, social, and cultural aspects that drive decision-making.

The purpose of this study was to determine if delivery method of EE lessons impacts youth attitudes and interests in nature. Online delivery of EE may be a viable avenue toward alleviating access and economic barriers by creating more accessible content. Hands-on education has been a key component of EE, so it is critical to understand if online EE lessons can also have a positive impact on youth beliefs and knowledge about the natural world. In this study, I created online and in-person EE lessons and surveyed student attitudes before and completion of the lessons to determine if there were any differences in student knowledge, attitudes or interests toward nature between delivery methods. I hypothesized that in-person learning would result in higher post-intervention NEP scores and higher knowledge scores than online learning.

Methodology

Part 1: EE Lessons at a Public Middle School

Participants

Participants in this study were sixth and seventh grader students, ages 10-13. This age group was selected because adolescents are in a formative life stage in which they are shaping their values and attitudes that will impact the rest of their future (Brunelle et al., 2018). Attitudes and interests toward science, technology, engineering, and mathematics (STEM) in middle school tend to determine interest in STEM during high school (Mangu et al., 2015), which can be influenced by exposure to STEM careers at a young age (Blotnicky et al., 2018). Socialization, which includes teachers (Cimermanová, 2018, Kohnke & Moorehouse, 2020), gender dynamics (Wieselmann et al., 2020), and peer influence (Halim et al., 2018), can also highly influence youth interest in academic topics.

In Part 1 of this study, classroom teachers were recruited through a public school-university liaison. Middle school students and research participants self-elected to enroll in a multi-week gardening and health program as part of their coursework, and the lessons for this study were integrated into that class's curriculum. Table 1.1 outlines the demographic information participants elected to provide.

Study Location

The focal school serves sixth- and seventh- grades and is located in rural northeastern Mississippi. It is a Title I school, meaning all students are eligible to receive free or reduced-priced lunch because of low household incomes. The study took place in school classrooms during operating hours with their teacher present during all lessons.

Lessons

Each EE lesson was developed to be taught in-person and online via Canvas (Instructure, Inc., 2023). I used a script for each lesson to ensure educational content was the same regardless of delivery method. Lessons were developed to meet 2020 Mississippi College- and Career-Readiness Standards for Science standards for sixth and seventh grade students to make lessons relevant for public school teachers. Student classrooms were randomly assigned to either online or in-person delivery method for my EE lessons. The study took place from March 28, 2022 to April 19, 2022. Students received EE instruction every other day according to scheduling of the gardening class (Table 2.2).

I developed online lessons using guidelines from Mississippi State University's "Best Practices in Online Teaching" course with the intent of synchronous delivery. Lesson content was video-recorded using a camera and tripod and audio-recorded using an external microphone connected to an iPad. I used Camtasia Version 20.0.13 (TechSmith Corporation, 2021) editing software to edit all video and audio for the six lessons. Lessons ranged between 10-19 minutes to stay within 30 minutes, the average attention span of middle school students (Heinsohn, 2021). The outline of lesson activities and runtime are in Table 1.3. Throughout the online lessons, the video would pause and ask a question (true/false, open ended, and multiple choice) that students could answer in the accompanying Canvas module. These quiz questions were included to ensure students were engaged and paying attention to the video; however, answers to these video questions were not analyzed further for this thesis.

I presented in-person lessons that consisted of a PowerPoint (Version 2302; Microsoft Corporation, 2021) presentation and a hands-on activity. The information conveyed with the PowerPoint followed a script developed from the online lessons to ensure the only difference in

teaching was delivery method. The same questions asked during the online video were prompted during the in-person lessons. The PowerPoint lesson lasted no longer than 15 minutes and was followed by an activity that was completed individually, in small groups, or as a class (Table 1.4). I was the sole instructor in both the in-person and online EE lessons to eliminate any variation in student responses to the survey instrument that might have resulted from changes in instructor.

Survey Instrument

The NEP for Children is a ten-question survey that quantifies environmental worldview (Table 2.5). This survey instrument is validated and reliable based on testing by Manoli et al. (2007). The NEP uses a Likert scale from "Strongly Agree" to "Strongly Disagree", with strongly agree being coded as 5 and strongly disagree being coded as 1. Questions 3, 6, 7, and 9 were reverse coded because they are "anti-environmental" questions. For these scale items, "Strongly Agree" was coded as a 1 and "Strongly Disagree" was coded as a 5.

Scale items 1, 4, and 7 result in a factor that reflects attitudes toward "Rights of Nature". Scale items 2, 5, 8, and 10 result in a factor that shows attitudes toward the "Eco-Crisis" viewpoint. Lastly, scale items 3, 6, and 9 result in a factor that reflects attitudes toward "Human Exceptionalism" (Manoli et al., 2007).

Before their EE experience (in-school online or in-school in-person), students completed the NEP survey. Participants took the NEP survey again after the final EE intervention. The post-survey also included a demographic section that captured students' grade, age, race, ethnicity, gender, and whether they participate in 4-H outside of school (a measure of additional, out-of-school education).

After completion of each lesson, participants took a knowledge quiz to determine short-term knowledge gains. The knowledge quiz consisted of ten true/false and multiple-choice questions that the students could complete with the 10-20 minutes left in class. The complete survey instrument and quizzes distributed to students can be found in Appendix A.

This study and all accompanying surveys were approved by the Mississippi State University Institutional Review Board for Human Subjects Research (IRB #22-416).

Analysis

An independent *t* test was conducted to determine if students within the two treatment groups differed in their pre-intervention NEP scores. Gains in NEP scores per student were determined to assess differences in pre- and post-intervention mean NEP survey scores.

A General Linear Mixed Models (GLMM) was conducted using post-intervention NEP score as the response variable, and delivery method, pre-intervention NEP scores, grade, race, gender, and a race and gender interaction as fixed effects; student class was included as a random effect.

To assess differences in knowledge, a GLMM was conducted to determine which factors best predicted knowledge scores. Knowledge scores were used as the response variable, delivery method and gender were fixed effects, and student class was included as a random effect. All data was analyzed using IBM SPSS Statistics Version 28 (IBM Corporation, 2021).

Pilot

The online lessons were pilot-tested with students (ages 10-13) who participated in a week-long day camp in 2021. When trialed, it was anticipated camp participants would individually complete the online lessons in a university computer lab. Because of problems with

enrolling participants in the online Canvas platform, individual participation in the learning module was not possible at that time. Therefore, I delivered the online lessons synchronously as a group using a single computer and the room's projection system. The students listened quietly and had the opportunity to answer questions as they appeared on the screen throughout the lessons. They provided suggestions on what they liked and disliked about the lessons so I could improve them for delivery in the school classroom setting.

Results

The objective of "Part 1: EE Lessons at a Public Middle School" was to determine if there were differences in student environmental attitudes as a result of different EE delivery methods.

There were no significant differences in pre-intervention NEP scores between students assigned to online (n = 41) and in-person (n = 42) treatment groups, $t(81) = .39$, $p = .76$. There was also no difference between post-intervention NEP scores between online and in-person delivery methods, n = 83, $t(.97) = .07$, $p = .80$ (Table 2.6).

There was no significant change from pre-intervention NEP score to post-intervention NEP score with the online delivery method, n = 40, $t(39) = -.60$, $p = .56$, or the in-person delivery method, n = 42, $t(41) = .06$, $p = .95$. Participants who completed the in-person lessons had a (non-significant) mean gain of -0.08 in NEP scores from pre- to post-intervention surveys. In contrast, students who completed the online lessons had a (non-significant) mean gain of +0.38 points in pre- and post-intervention NEP scores (Table 2.6).

The GLMM indicated student grade was a significant predictor of post-intervention NEP score (Table 2.7); sixth graders had higher post-intervention NEP scores than seventh graders, n

= 73, $F(1, 66) = 6.65$, $p = .01$, Cohen's $d = .46$. The mean gain score for sixth graders after EE intervention was +0.77, whereas the mean gain in NEP for seventh graders was -0.31 (Table 2.8).

Participants' knowledge scores were compared between online and in-person delivery methods. Students in the online treatment group (n = 40) scored significantly higher ($M = 64.4\%$) on knowledge tests than participants in the in-person group (n = 43; $M = 54.9\%$), $t(79) = 2.60$, $p = .01$.

The GLMM analysis conducted with knowledge scores as the response variable showed participants' pre-intervention attitude score significantly influenced knowledge score, n = 72, $F(1, 65) = 23.96$, $p < .001$ (Table 2.9). Race also significantly influenced knowledge score, n = 72, $F(1, 65) = 17.17$, $p < .001$, Cohen's $d = -1.38$, with Black/African American males having lower mean post-intervention knowledge scores than White students (Table 2.9).

Study 2: EE Lessons at Camps

Participants

Part 2 of this study determined if participation in nonformal summer camps influenced attitudes and intended behaviors toward nature. This study involved middle school-aged students (ages 11-14) who were participating in multi-day youth camps in Mississippi. Students were recruited for my research because of their involvement in the camp programs.

There were three groups of camp participants: 1) those enrolled in a three-day, two-night residential nature camp; 2) those in a three-day nonresidential nature camp; 3) and those participants in one of seven 5-day nonresidential aquatic science camps. A residential camp is defined as one where campers stay overnight at the camp's facility, and a nonresidential camp is one in which students are dropped off at the beginning of the day and picked up at the end of the day.

A total of 13 campers attended the residential nature camp, but only three of them were of the target age and included in this study. The nonresidential nature camp had 11 participants and nine were eligible as targets for this study. A total of 93 campers attended the aquatic science camp; of these, and 51 participants completed the survey instrument (51% response rate). The demographics of all camp participants (n = 64) are in Table 2.12.

Because of the small sample size of the target population in the residential and nonresidential nature camps, data were combined and analyzed as “nature camp”.

Study Location

The nature camps were located in northeast Mississippi and activities took place throughout a university campus and surrounding areas. The residential camp was held from 6:00 pm, June 5-7, 2022 to 4:30 pm, June 7, 2022. The nonresidential camp was held June 13-June 15, 2022 from 8:00 AM to 5:00 PM each day. The aquatic science camps took place weekly in southern Mississippi from June to August 2022, 8:00 am-3:00 pm daily. All camps required a registration fee and daily transportation to and from the camp venue.

Lessons

All youth camps studied in this project were in-person and involved lessons on natural science topics and outdoor recreational activities. The two nature camps featured lessons on habitat management, forestry, watersheds, mammals, and water quality. Students went on short hikes and participated in educational activities such as fishing bingo, nature scavenger hunts, firearm safety, and macroinvertebrate sampling. The nature camp schedules can be found in Appendices B.1 and B.2.

The aquatic science camp featured lessons on fish biology, marine mammals, freshwater and saltwater animals, birds, barrier island ecology, reptiles, and invertebrate physiology. Educational activities included behind-the-scenes facility tours, ferry rides to a barrier island, beach walks, animal ambassador experiences, animal crafts, fish sampling, and a squid dissection. A sample of the aquatic science camp's activity schedule can be found in Appendix B.3.

Survey Instrument

Part 2 study participants took the NEP for Children ten-question survey to quantify their environmental worldview. Before starting camp, campers completed the NEP survey and a five-question, pre-intervention knowledge quiz to determine knowledge before camp. Participants took the same NEP survey and knowledge assessment again at the end of the camp week. The full survey instrument distributed to participants can be found in Appendix A.

Consent for participation in the study was obtained from parents on the first day of camp prior to their child's participation in any research activity. Assent was obtained from participants prior to the start of intervention. This research protocol, including approval of the aquatic science center employee's involvement and all survey instruments, was obtained from the Mississippi State University Institutional Review Board for Human Subjects Research (IRB#21-195).

Analysis

The camp data collected in this study violated assumptions of normality and homogeneity of variance, therefore Mann-Whitney U and Wilcoxon Signed Rank tests were used.

Two Mann-Whitney U tests were conducted to determine if pre- and post-intervention NEP scores differed between the 3-day nature camps and the 5-day aquatic science camp. Two

Wilcoxon signed rank tests were conducted to determine if there were any difference in NEP score before and after intervention at each of the camp types. Two additional Wilcoxon signed rank tests were conducted to determine differences between pre-intervention knowledge and post-intervention knowledge for both the 3- and 5-day camps.

Results

Three-day camp participants (n = 15) had significantly higher pre-intervention NEP scores, $U = .000$, $p<.001$ and post-intervention NEP scores, $U = .000$, $p<.001$, than 5-day camp participants (n = 49).

A Wilcoxon signed rank test revealed that post-intervention NEP scores were significantly higher after camp participation (n = 48, $M = 51.63$) compared to before intervention (n = 64, $M = 48.16$,), $Z = -2.91$, $p = .004$, with a small effect size, $r = .28$ when comparing all camp types.

I also examined if there were differences between pre-intervention knowledge scores and post-intervention knowledge scores for the aquatic science campers. The Wilcoxon signed rank test comparing pre- to post-intervention knowledge scores revealed that post-intervention knowledge scores were significantly higher after intervention (n = 42, $M = 41.2\%$) compared to before intervention (n = 51, $M = 32.3\%$), $Z = -3.42$, $p < .001$, with a small effect size, $r = .35$ when comparing all camp types.

Discussion

Part 1: Middle School EE Interventions

The purpose of this part of my study was to determine the impact of online versus in-person delivery methods of EE lessons on youth learning and attitudes toward nature and the

environment. No published work on this topic was found in the literature. The COVID-19 pandemic radically impacted educational approaches, and online education – including online EE—has become prevalent. Evaluating the impact of this approach on EE outcomes in timely and relevant.

I hypothesized that in-person lessons would result in higher NEP scores (or larger gains) from pre- to post-intervention than online lessons, but the results did not support my hypothesis. The EE programs did not appear to change students' environmental attitudes irrespective of delivery method. There are a few possible reasons for these outcomes. Instructional time with the students was limited to one hour for each of six days over the span of three weeks, and this may not have been enough time to make an impact on the students, regardless of EE lesson delivery method. Student values, behaviors, and attitudes are reinforced by their family and cultural backgrounds (Abdullah, 2017; Bergman, 2016; Hofferth, 2009; Hofferth & Sandberg, 2001; Ju et al., 2020), and a six-lesson program over three weeks may have been insufficient to impact deeply held positions.

Based on my personal observations and comments from students, many students did not look forward to the EE lessons. For example, some students would make comments about the knowledge quizzes. Although they knew the quizzes did not count as a class grade, they may have associated my presence with doing more work. Negative attitudes toward assignments and work may influence a student's perception toward a subject (Bergman, 2016). In this study, the extra work of knowledge tests may have negatively impacted these students' interest in learning about environmental science, which may have negatively impacted their NEP scores.

It may also be useful to note that students in the gardening program went through three different teachers over the 2021-2022 school year. Teacher turnover creates an unstable

environment, reducing time for teachers and students to form trusting relationships; this may have had an influence on students' attitudes toward the EE program and may have been reflected on attitude assessment scores. Studies have shown that the relationship students have with their teachers influences students' attitudes and achievement (Bryk & Schneider, 2002; Hamre & Pianta, 2001; Heimlich & Ardoin, 2008; Longobardi et al., 2021), and my time with the students did not allow for positive relationships to form.

The formal classroom may not be a setting conducive for environmental education learning. Studies have found that environmental attitudes greatly improve after nature-based, outdoor education experiences (Ballantyne & Packer, 2002; Genc et al., 2018). Despite having a slightly longer intervention time than most three- to five-day nature-based EE programs, the formal, indoor classroom environment in this study may not have been as impactful as outdoor-based learning.

There was no difference in pre-intervention attitudes scores between Black and White participants. Early studies reported White people tended to have more environmental concern than Black people (Hershey & Hill, 1978; Hohm 1976), but more recent literature is showing little difference in environmental concern (Caron, 1989; Mohai, 1990). Differences that have been examined show Black populations are more concerned with specific environmental problems relating to their health and wellness (i.e., water and air quality) compared to White populations (Boeve-de Pauw & Va Petegem, 2010; Lazri & Konisky, 2019). This may be a more recent finding because of evident with the history of redlining and the pollution burden placed on the communities where historically marginalized people reside (Adeola, 1994; Lazri & Konisky, 2019; Swope et al., 2022).

I expected student gender would have an influence on environmental worldview, Women have been excluded and underrepresented historically in the outdoors (Gray et al., 2017; Rogers & Rose, 2019); however, women have more pro-environmental attitudes as compared to men (Boeve-de Pauw & Va Petegem, 2010; Chan, 1996; Gardos & Dodd, 1995). My study found no differences in gender, results similar to those of Genc et al. (2018) who wanted to determine how nature-based education influences middle school students' attitudes toward nature.

I found sixth graders had more positive attitudes toward nature than seventh graders. Bergman (2016) found that younger students may have a higher affinity for nature than older students, which may be caused by the psychological development of youth around this age. Other studies have also found that positive environmental attitudes decrease as age increases (Bergman, 2016; Hines et al., 1987; Liefländer & Bogner, 2014), which may be an explanation for my observations. In the context of this study, this finding is interesting and unexpected because the sixth graders only participated for a nine-week rotation in the gardening program with which my EE lessons were affiliated; the seventh graders were in this program for the entire school year, giving them prolonged opportunity to learn about natural science in a context outside of science class. Longer interventions can lead to more sustained outcomes (Bergman, 2016, Carleton-Hug & Hug, 2010; Zelezny, 1999). Nevertheless, the longer intervention afforded to these seventh graders did not appear to lead to more sustained and positive outcomes as reflected by their environmental attitudes, as detected in this study's survey instrument.

The examination of race, gender, and grade were all included to determine if youths' background and culture had an impact on their attitudes and behaviors toward nature. Their identities and upbringing shape their values, which, according to VBN theory (Stern, 1999), shape their environmental worldviews and how likely they are to perform pro-environmental

behaviors. Due to over sampling of Black or African American individuals in this project, no conclusions can be drawn about cultural differences and values influence attitudes without inclusion of other racial or ethnic demographic groups of people in this study.

The findings of higher knowledge scores associated with online instruction did not support my hypothesis that in-person delivery would yield greater knowledge scores. Environmental education is thought to be more impactful because of the "hands-on, minds-on" approach of learning (NAAEE, 2009) whereby students can make more tactile, personal connections with the learning material and the outdoors. In-person learning in this study was more closely aligned to the underpinnings of EE than the online modules. Other studies have found no difference in knowledge scores resulting from different delivery methods (Ghanat & Laughton, 2021; Paul & Jefferson, 2019). However, these studies compared groups of students who elected to participate in online or in-person education based upon their preferences, as opposed to students in this study who were randomly assigned to a delivery method. Therefore, the results of this study may not be directly comparable to these others.

Pre-intervention attitude scores were a significant predictor of knowledge scores. Students had more positive attitudes toward nature before the start of the program, were more willing to learn more about it through my EE lessons than those with lower pre-intervention NEP scores. One might then conclude that EE programs, especially those conducted outdoors in informal and nonformal settings, may need to be part of EE programming that occurs in formal settings.

White participants scored higher on post-program knowledge assessments than Black/African American participants. Other studies have found similar results (Larson et al., 2009; Larson et al., 2010; Larson et al., 2011; Whittaker et al., 2005). Norman et al. (2001)

argues that differences in knowledge is not a racial gap, but due to a sociocultural position a group holds within society ranging from dominant to marginalized. It is also important to consider that the sample sizes between Black and White participants were different (n = 58 and n = 14, respectively) which may have impacted the accuracy of the statistical test.

It is not uncommon for EE programming to assume that increasing environmental knowledge will lead to an increase in positive environmental attitudes and subsequently, an increase in pro-environmental behaviors (Casaló & Escario, 2017; Fabrigar et al., 2006; Liu et al., 2020). I did not find any relationship between knowledge gains and increases in environmental attitudes. There are many studies that determined knowledge alone may not be enough to impact attitudes and behaviors (Bamberg & Möser 2007; Hungerford & Volk 1990; Kollmuss & Agyeman 2002; Otto & Pensini, 2017), which may be the case for this study. Lessons that inspire more direct and specific action are more likely to influence youth attitudes toward nature and result in more pro-environmental behaviors (Heimlich and Ardoin 2008). Further investigation to assess long-term knowledge retention would be necessary to determine if higher environmental knowledge is a determinant of future environmentally responsive behaviors.

Part 2: Nature Camps

Participants in Part 2 of this study attended an environmental science camp, and post-camp surveys showed significant improvement in environmental attitudes for participates of all the study camps. Studies have shown that long-term interventions of three or more days are more likely to make lasting impacts than short-term interventions (Bergman, 2016, Carleton-Hug & Hug, 2010; Zelezny, 1999). They increase the likelihood of sustained program outcomes (Bergman, 2016; Carleton-Hug & Hug, 2010; Stern et al., 2008; Yildirim et al., 2018, Zelezny,

1999) and can foster positive attitudes toward wildlife (Bexell & Jarrett, 2013; Dettmann-Easler & Pease, 1999).

The improvement between pre-intervention and post-intervention knowledge scores by the aquatic science center campers in this study seem to agree with current literature and imply that the five-day intervention had a significant impact on participants' knowledge gains. Two studies by Collins et al. (2020a; 2020b) found students who participated in a five-day camp had demonstrated increases in knowledge, which was attributed to participation in the program.

As was seen in the formal EE interventions in my study, pre-intervention NEP scores were significant predictors of post-intervention knowledge scores. Students' environmental attitudes coming into the camp programs could be impacting their knowledge gains during the camps (Hewson & Hewson, 1983; Yenilmez et al, 2007).

Comparison Between Formal & Nonformal Education Methods

Participants in all delivery method (online, in-person classroom, and in-person camp) had positive environmental worldviews, described as a "harmonious" worldview on the NEP scale. This may be because all participants appeared to have a common interest in environmental sciences based on their self-selection in either the classroom-based gardening program or outdoor-based summer camps.

Although the formal and nonformal EE programs in my research project cannot be compared statistically, some differences appear present. Students in educational camp settings displayed greater changes in environmental attitudes than those in the formal school settings (mean NEP gains = +1.24 and +.16, respectively). This finding supports ELT theory; the camps may have been more impactful on youth attitudes because the learning experiences were more hands-on, exploratory, and outdoor-based compared to the lessons in the formal school setting

(Bogner, 2002; Collado et al., 2020; Kolb, 2015; NAAEE, 2009). Having multisensory, outdoor-based experiences that allow for reflection and application of the experience may support of youth learning processes.

Youth had to pay to participate in the camps whereas the public middle school students did not pay for their EE experience. People from higher SES may have more opportunity to participate in EE opportunities (Carlone et al., 2015; Rigolon, 2017; Stern et al., 2022), so the camp participants in this study may have had more prior opportunities that led to more positive environmental attitudes. Public school youth in this study were of low SES and may have had fewer EE opportunities in their past. Youth from low SES have been shown to have more positive gains in attitude as a result of EE than those from higher SES because the fewer opportunities they do get are more impactful (Bedimo-Rung et al., 2005; Stern et al., 2022). Findings in this study related to the rural public school students did not support this literature. It would have been interesting to see if the attitudes and knowledge of the public school participants would have changed significantly if they were to enroll in an out-of-school, camp-style experience.

Conclusion

Although there were no major differences in outcomes related to delivery methods, online EE may be a promising avenue for delivering conservation education lessons to populations who experience barriers to access, such as economic or time constraints, or to those who prefer online learning. Based on the findings of this study, it is possible for students to learn EE in diverse settings, but not all may lead to strong changes in environmental attitudes or promote pro-environmental behaviors. Enabling students to gain new experiences through hands-on investigation or camp-like offerings may be a better way to change attitudes, but this is not

always possible for students of lower SES and rural demographics. It is most important that educators are taking steps to provide experience for youth of all backgrounds that will promote a harmonious relationship with the Earth and the natural resources it provides.

Limitations and Recommendations for Future Studies

This study was not without limitations. First and foremost, the interpretation of this study could be more definitive with control groups and larger sample sizes, including additional education sites. This project was schedule to be conducted May 2020-September 2022; however, it coincided with the height of the COVID-19 pandemic. Access to schools and nonformal EE was highly restricted. Inclusion of a control group within the venues to which I had access would have limited the already small number of participants in the study.

Second, it is important to note that all studies that use self-reported data may not be completely accurate. Survey respondents tend to overestimate their attitudes and intentions (Geller, 1981), so the findings in this study should be interpreted cautiously and not be applied to other groups of youth.

It would be useful for further research if cohorts of students could be followed over time to see how environmental attitudes, knowledge, and intended behaviors change throughout time. The information in this study could be used as a baseline for further studies, which could provide valuable information about attitudes of students over these formative years. Additionally, including more diverse youth in this study, such as youth who are not already involved in environmental studies (like the gardening program), those from different socioeconomic backgrounds (public versus private school), and representatives from additional races and ethnicities, would give this study a more holistic view of how delivery influences learner attitudes.

Based on the findings of this study and findings represented in the literature, outdoor-based learning seems to be more impactful at increasing environmental attitudes and behaviors than classroom-based learning. This study could be replicated using outdoor delivery opposed to classroom delivery for in-person delivery methods to determine if environmental attitudes increase from pre- to post-intervention.

Tables

Table 2.1 Demographic Information of Middle School Participants in the Study.

	Black or African American	White	Some Other Race	No Race*	Total
Male	26	10	2	8	46
Female	31	4	0	1	36
No Gender**	2	0	0	3	5
Total	59	14	2	12	87

*Participant elected not to include their race in the demographic survey

**Participant elected not to include their gender in the demographic survey

Table 2.2 Schedule for 2022 Online and In-Person EE Lessons at the Middle School Study Site

Date	Delivery	Lesson
Monday, March 28	In-person	Birds
Tuesday, March 29	Online	Birds
Wednesday, March 30	No lesson*	
Thursday, March 31	Online	Invasive Species
Friday, April 1	In-person	Mammals
Monday, April 4	Online	Mammals
Tuesday, April 5	In-person	Water Cycles
Wednesday, April 6	Online	Water Cycles
Thursday, April 7	In-person	Food Webs
Friday, April 8	Online	Food Webs
Monday, April 11	In-person	Watersheds
Tuesday, April 12	Online	Watersheds
Wednesday, April 13	No lesson**	
Thursday, April 14	No lesson**	
Friday, April 15	No lesson***	
Monday, April 18	No lesson***	
Tuesday, April 19	In-person	Invasive Species

*Inclement weather

**previously scheduled guest speaker

*** Easter break

Table 2.3 Lesson Topic, Time Commitment, and Activity for Online Lessons Delivered at a Rural Middle School in Mississippi

Topic	Time (mm:ss)	Activity
Bird Adaptations	18:46	Class dichotomous key in video
Food Web	15:34	Class food web puzzle in video
Invasive Species	15:13	Class discussion of invasive species
Mammals	09:44	-Pictures/videos of skulls integrated through video -Students were provided a link to manipulate skulls on their individual computers
Water Cycle	11:42	Activity demonstrated in video
Watershed	13:23	Activity demonstrated in video

Table 2.4 Lesson Topic, Time Commitment, and Activity for In-Person Lessons Delivered at a Rural Middle School in Mississippi

Topic	Time	Activity
Bird Adaptation	15-minute PowerPoint	Small group dichotomous key
Watershed	15-minute PowerPoint	Class watershed demonstration
Water Cycle	15-minute PowerPoint	Individual infiltration activity
Invasive Species	15-minute PowerPoint	Group discussion
Food Web	15-minute PowerPoint	Class food web assembly
Mammals	30-minute PowerPoint	Use of skull replicas integrated into lesson

Table 2.5 NEP for Children Survey Instrument

For this activity, you are to put an X in the box that best shows how <u>you feel</u> about each of the statements. Remember, there are no right or wrong answers. The first row is an example.

	Strongly agree	Agree	Not sure	Disagree	Strongly disagree
EXAMPLE: Chocolate ice cream is one of my favorite flavors		**X**			
1. Plants and animals have as much right as people to live					
2. There are too many (or almost too many) people on earth					
3. People are smart enough to keep from destroying the earth					
4. People must still obey the laws of nature					
5. When people mess with nature it has bad results					
6. Nature is strong enough to handle the bad effects of people and pollution					
7. People are supposed to rule over the rest of nature					
8. People are treating nature badly					
9. People will someday know enough about how nature works to be able to control it					
10. If things don't change, we will have a big disaster in the environment soon.					

Table 2.6 Descriptive Statistics for Data Collected from Public Middle School Students Participating in a Study on EE Delivery Methods

	Environmental Attitude*			
Delivery Method	Pre-EE *M*	Post-EE *M*	PostNEP SD	Change
Online (n = 38)	33.95	34.39	4.57	+0.38
In-person (n = 37)	33.22	33.30	4.40	-0.08
Overall (n = 75)	33.64	33.87		0.16

*Environmental attitudes were measured with the New Ecological Paradigm Scale for Children (Manoli et al., 2007)

Table 2.7 Results of GLMM with Environmental Attitude Score* as Response Variable for Data Collected from Rural Mississippi Middle School Students

Source	***F***	**df**	**Sig.**
Delivery	.07	1	.80
Gender	.27	1	.61
Race	2.44	1	.12
Grade	6.65	1	.01**
Gender*Race	.36	1	.55
PreNEP	29.86	1	<.001**

*Environmental attitudes were measured with the New Ecological Paradigm Scale (Manoli et al., 2007)
**significant p-value ($p<.05$)

Table 2.8 Results of post-intervention NEP score by grade Collected from Middle School Students in Rural Mississippi

	Environmental Attitudes*				
Participants	Pre-EE Attitudes		Post-EE Attitude		Change
	M	SD	M	SD	
6th Grade (n = 35)	34.28	6.42	35.05	4.77	+0.77
7th Grade (n = 40)	32.18	4.44	32.87	3.76	-0.31

*Environmental attitudes were measured with the New Ecological Paradigm Scale (Manoli et al., 2007

Table 2.9 Average Knowledge Scores by Race for All Delivery Methods Based on Data Collected from Middle School Students in Rural Mississippi

Race	**Knowledge Scores (out of 10)**		
	n	*M*	*SD*
Black/African American	58	5.58	1.52
White	14	7.62	1.28

Table 2.10 Demographic Information of All Camp Participants For All Delivery Methods Throughout Mississippi

	Race			
Camp Type	White	Black or African American	Some Other Race	Total by Camp
Residential Nature Camp (n = 3)				
Male	1	0	-	1
Female	2	0	-	2
Day Nature Camp (n = 9)				
Male	4	0	-	4
Female	4	1	1	6
Aquatic Science Camp (n = 51)				
Male	-	-	-	28
Female	-	-	-	21
Unknown	-	-	-	-
Total	11	1	1	62

Table 2.11 Descriptive Statistics from Data Collected from All Camp Participants in a Study on EE Delivery Methods

	NEP Score		
Camp Type	Pre *M*	Post *M*	Change
Aquatic Science Camp (n = 34)	35.67	36.50	+0.83
Nature Camp (n = 12)	35.22	36.59	+1.37

Figures

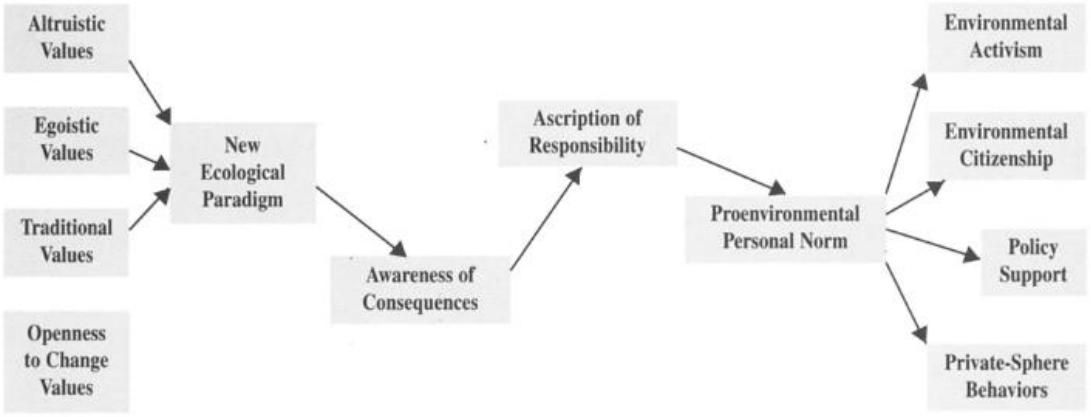

Figure 2.1 Stern et al. (1999) schematic model of variables in the Value-Belief-Norm Theory

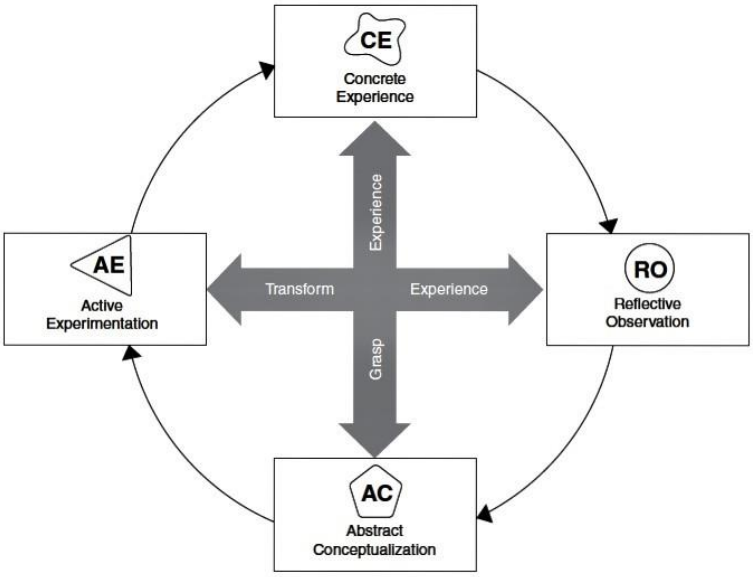

Figure 2.2 Kolb's Experiential Learning Cycle

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CHAPTER III

YOUTH PERCEPTIONS AND ENGAGEMENT WITH NATURE: A FOCUS GROUP ASSESSMENT

Introduction

Environmental education (EE) is important for creating environmentally literate citizens who will become stewards of the environment. It is especially important for future generations to ensure children are introduced to the outdoors from an early age and to teach them about the importance of environmental conservation. As children approach adulthood, they are less likely to perform pro-environmental behaviors (Fang et al., 2023). Targeting younger audiences may help instill environmental stewardship from a young age which could follow them throughout their lives.

To provide engaging EE experiences to children, it is essential stakeholders and educators work together to develop meaningful lessons and programs. Stakeholders are defined as people or organizations with a vested interest in the outcomes of EE programming, including state conservation organizations and agencies, political leaders, industry, media/press, academic institutions, community members, and informal education organizations (Tristão & Tristão, 2016). Stakeholders also include parents, teachers, and most importantly, the students. Understanding what interests and motivates youth is important for recruiting and engaging their participation in EE opportunities. Obtaining student input on what activities they find interesting and where they stand in their relationship with nature and the outdoors is a missing piece of the

puzzle in creating impactful lessons. The unique characteristics and challenges that the target audience faces must be considered before developing programs.

Barriers to Environmental Education: Educators

Most of the prior work involving youth barriers to EE programming opportunities sought adult opinions and experiences. In response to these perceived barriers, stakeholders often suggest incorporating EE into formal education as a way of overcoming barriers. This recommendation has been suggested since the beginning phases of the EE movement in 1977 when the Tbilisi Declaration was established. The Tbilisi Conference was the first intergovernmental conference that discussed the role of education in addressing environmental issues, as well as suggesting strategies for implementing EE on a national and international level (UNESCO, 1978). At the conference, leaders agreed EE has positive outcomes and should be incorporated into formal educational curriculum (Anderson & Jacobson, 2018; Center for Research and Education, 1972).

The Next Generation Science Standards (NGSS) are a set of formal, K-12 educational standards developed in 2013 with the goal of creating consistent science learning standards across the United States. Some NGSS subject areas address EE topics such as human impact on global climate change and conservation of natural resources. Despite the development of these standards, each state has the power to control whether they introduce NGSS into their curriculum, and only 20 out of 50 states have fully adopted the NGSS standards (Next Generation Science Standards, n.d.). Twenty-four of the remaining states have developed their own standards based on recommendations of the NGSS (which may not include EE), and the remaining six states have created their own science standards outside of the NGSS framework. Ideally, EE would be directly incorporated into every state's curriculum, but there are many

barriers that prevent formal education systems from incorporating and adopting suggestions outlined by the Tbilisi Declaration.

Two of the most prevalent educator barriers to EE are time and funding. Many teachers report they do not have enough time in a class period or a school year to incorporate EE into their curriculum. Teachers feel pressured to focus on the existing curriculum (Anderson & Jacobson, 2018; Ernst, 2014) that will prepare students for standardized testing that states have invested money into developing and administering. Even if teachers did have the necessary time, there is often insufficient funding to buy the necessary resources for EE lessons (Anderson & Jacobson, 2018; Center for Research and Education, 1972; Ernst, 2007, 2009, 2014; Larson et al., 2010; NAAEE, 2014; Tan & Pedretti, 2010).

Teachers have expressed limitations in their knowledge, as well as a lack of confidence, leadership, and safety measures when asked about incorporating EE in the classroom. The limitations in knowledge and confidence result from inadequate subject matter training and limited professional development opportunities (Anderson & Jacobson, 2018; Ernst, 2009; NAAEE, 2014). Teachers also believe their schools lack safe outdoor access and supervisory support for the outdoor instruction that is often associated with EE (Ernst, 2014). Other barriers to incorporating EE in schools include lack of leadership to jumpstart and sustain programs, teacher incentives, and educator interest (Anderson & Jacobson, 2018; Center for Research and Education, 1972; Kezar & Elrod, 2012; Tan & Pedretti, 2010).

It is challenging to incorporate EE lessons into classroom instruction, but even more challenging to integrate nonformal education opportunities into a formal education schedule. These nonformal education opportunities can include trips to science centers and museums, nature hikes, or field-based investigations. Like EE in formal education settings, nonformal EE

opportunities require time and funding that may be unavailable to adult stakeholders (Reese, 2018; Soga et al., 2018). There can be inadequate access to outdoor spaces, low numbers of EE facilities such as nature centers, and limited opportunities for group transportation to these facilities (Ernst, 2009, 2014; NAAEE, 2014). Unsafe walking access to green spaces (Ernst, 2014, Tan & Pedretti, 2010) may encourage parents to enroll their children in more structured extracurricular activities (e.g., sports) to provide safer outdoor options (Hofferth, 2009; Skar & Krogh, 2009). There may also be a lack of partnership among community members and nonformal EE facilities due to ineffective communication and public information (Center for Research and Education, 1972; Parker & Green, 2016).

Barriers to Environmental Education: Youth

Although stakeholder-based data provide insight into opportunities for youth engagement in EE opportunities, it may not be an accurate interpretation of what motivates and engages youth. For EE to be successful, youth perspectives must be understood when creating educational opportunities, particularly those which occur outside the classroom (i.e., nonformal education). One objective of this study aims to understand how diverse and rural youth engage with nonformal EE programs. With this information, reported barriers can be addressed, thereby expanding access to nonformal learning opportunities.

While extensive literature regarding youth perspectives of EE is lacking, there are a few studies related to youth in outdoor recreation. One youth-perceived barrier that aligns with those reported by adult stakeholders is safety. Studies have found youth do not feel safe outside when it is dark, in places where gang violence occurs, or when they are alone. They are apprehensive to participate in activities outdoors when they are on unfamiliar terrain, in proximity to wildlife, and when they lack wilderness survival skills (Flett et al., 2010; Mackenzie et al., 2017).

In Mackenzie et al. (2017), other barriers that prevent participation in out-of-school activities (such as these associated with EE) included lack of money, transportation, or parental support, poorly organized information regarding opportunities, homework demands, and distractions caused by technology.

Electronic entertainment, such as gaming and social media use, can contribute to decreased contact and connections with nature, factors that are important for developing positive environmental attitudes and behaviors (Fang et al., 2023; Kesebir & Kesebir, 2017). The reported time youth spend outdoors is decreasing while time inside interacting with technology is increasing. When outside, children have expressed getting distracted by their phones when they are actively playing outside. One student said, "Even when someone messages me on my phone or Facebook, and it vibrates in my pocket, … I just drop the ball and just be on my phone and never come back." (Mackenzie et al., 2017). Hofferth (2009) reported that youth in 2003 were spending over 13 hours each week consuming media (e.g., watching television). As of 2018 there has been a drastic 384% increase in media consumption (Center for Disease Control, 2018). According to the CDC (2018), weekly consumption of entertainment media (e.g., social media, television, video games) is 42 hours for 8-10 year-olds, 63 hours for 11-14 year-olds, and 52.5 hours for 15-18 year-old youth.

Youth have been surveyed about perceived motivators to participate in EE. Reported motivators include having a choice of activity (rather than assigned activities), touching animals, experiencing nature, getting out of school, and having a knowledgeable and enthusiastic guide (Ballantyne & Packer, 2002). Others suggested skill-building and topics that impact on students' daily lives as factors that motivate youth to participate in EE activities (Hall et al., 2004; Subramaniam & Moncloa, 2010; Ural & Dadli, 2020). Activities thought to dissuade youth EE

engagement include boring presentations, worksheets and assignments, inclement weather, long bus rides, extended periods of walking, getting dirty, and being near bugs (Ballantyne & Packer, 2002).

Although the perceptions of adults regarding youth motivators may be insightful for designing and conducting EE programs, it may not be an accurate reflection of actual motivators. This project sought to gain understanding of these motivators by engaging directly with young people in focus group discussions regarding EE.

Race and Gender Barriers to EE

"Equity and Inclusion" are major underpinnings of the NAAEE meaning EE should be inclusive, respectful, and equitable for all people. Most of the barriers discussed thus far have been identified from researching involving majority White populations. Black individuals and women are thought to face additional barriers to those discussed previously.

Race

There has been substantial amount of research on barriers to the outdoors for minority populations which may be related to EE. Although it has been documented that Black populations have lower levels of environmental knowledge (Larson et al., 2009; Larson et al., 2010; Larson et al., 2011; Whittaker et al., 2005), it does not equate with lack of concern for the environment (Lewis & James, 1995). Environmental education is generally perceived as being designed for the White majority (Agyeman, 2003; McLean, 2013; Nxumalo & Ross, 2019). Without acknowledging that differing consequences of environmental destruction on White versus minority communities (McLean, 2013), this false narrative suppresses Black

representation and fails to acknowledge systematic inequalities and unequal consequences of environmental hazards toward underrepresented communities (Krieger et al., 2020).

Discrimination can be a major barrier to EE for Black learners (Baker, 2000; Gobster, 2002; Virden & Walker, 1999; West, 1989). West (1989) stated Black individuals often feel unwelcomed in public outdoor spaces due to explicit prejudice, discrimination, and hostility they may experience. Other times, the discrimination in outdoor spaces is more implicit. It can often be due to subconscious stereotypes or lack of understanding about a certain race or ethnic group (Baker, 2000). For example, barriers may result unintentionally when it is assumed all people will enjoy the same types of outdoor activities. Byrne and Wolch (2009) found Black communities tend to enjoy organized outdoor activities, Latinos prioritize a family-friendly atmosphere, and Asians prefer park visits with family and organized groups; in contrast, White people prefer solitude or exercise in the outdoors.

The EE field may unintentionally discriminate against minority groups through lack of representation in educational media, curriculum, and role models and mentors in academics and professional careers. Lack of representation while designing EE programs and outdoor spaces causes exclusion and engagement barriers for Black individuals (Baker, 2000; Lewis and James, 1995). For example, Lewis and James (1995) concluded workshops meant to address lack of diversity in curriculum were ineffective because Black individuals were inappropriately recognized and were not integral in setting the agenda and planning the workshop.

When diverse viewpoints are excluded from EE programs, curriculum development, and outdoor space design, a disservice is done to non-White communities, and the goals of EE cannot be met. My project aimed to contribute the viewpoints of underrepresented youth to create a more inclusive EE field that acknowledges and promotes diversity.

Gender

Women may face a unique set of barriers to Science, Technology, Engineering, and Mathematics (STEM) fields. Men have historically dominated STEM fields; however, women now comprise 48% of all STEM professionals in the workforce (Martinez & Christnacht, 2021). Nevertheless, McCullough (2020) found that women were underrepresented in the top U.S. STEM universities, with only one-third of higher education leadership roles being held by women. The unique perspectives of women are needed to advance STEM (Kenney et al., 2012) at all levels, especially in higher education (McCullough, 2020). Identifying gender-based barriers may help create an inclusive environment that can improve STEM opportunities, including those related to environmental conservation.

The obstacles and prejudice women face in STEM may not be obvious because they can be more covert and implicit. Gender stereotyping, sexual harassment, and male counterparts questioning women's technical skills are just some of the ways that women experience sexism in STEM fields (Gray, 2016). Women are more likely to work in jobs that are subordinate to men, such as in administration assistant positions, thus contributing to stereotypes of women as caregivers (Punnett, 2016). Women are also likely to experience gender identity threat (feeling devalued or stigmatized) when they are in the minority gender numerically. Gender identity threat impacts women who work in STEM fields more than in any other sector (van Veelen et al., 2019).

Systematic and societal expectations not only shape how women are expected to perform in STEM fields, but also the views that women have for themselves. Women often lack self-confidence, are modest about their accomplishments, and are deprived of the recognition they have earned (Gray, 2016; Gray et al., 2017). These attitudes trickle down through generations

and can cause young girls to have unwarranted beliefs about their knowledge and abilities in STEM fields (Pajares, 2005; Wieselmann et al., 2020). In a study by Wieselmann et al. (2020), young girls believed boys were smarter and more capable in STEM fields because they perceived boys in their class as having more ideas and being faster in completing classwork.

It is important to acknowledge gender biases, support women from an early age, and to represent women appropriately to encourage female engagement in EE and sustain girls in STEM fields, including those related to environmental conservation.

Objective

There are gender, racial, economic, cultural, and infrastructural barriers to accessing science and environmental education opportunities, and most of the barriers outlined in the literature are the opinions of parents, teachers, and other adult stakeholders. The objective of this study was to determine attitudes, interests, and nature engagement of diverse, rural, and adolescents. This information can inform development of EE programs and curriculum that incorporate youth opinions and beliefs and result in effective and engaging lessons which include Black or African American youth.

Methodology

Participants

The target audience recruited for this study was youth ages 10-14 who lived in rural areas in Mississippi. Participants were recruited by contacting 4-H club leaders from counties around the state, as well as administrators from school districts from northeastern MS. Each focus group contained a minimum of five and a maximum of 15 participants. Although participants could achieve a greater sense of comfort during focus groups when separated into groups containing

students of the same race, gender, and similar age (Krueger and Casey, 2009), this was not possible due to convenience sampling of established groups.

Since this was a convenience sample, it was understood during recruitment that all participants had a pre-existing interest in science-related fields influenced by teacher and student willingness to participate during the COVID-19 pandemic. Students in Focus Groups 1, 2, and 3 were 4-H club participants, and Focus Groups 4-11 were those who elected to participate in a gardening class as part of their middle school coursework. These study participants had self-selected to seek out additional learning opportunities, and they might not be representative of their peers.

There were 11 focus groups with 82 total participants: 34 Black or African American males, 32 Black or African American females, 10 White males, and 3 White females (Table 3.1). Not all group interviews were separated homogenously as intended due to supervision and time constraints. Participants who did not identify as White or Black/African American were excluded from the analysis due to their small sample size (n = 3).

Data Collection

Discussions with Focus Groups 1 and 2 were conducted in a college classroom in July 2021 prior to the groups' participation in a campus field trip. I served as moderator, and an undergraduate assistant and the youth group leader were present with the study participants during the interview. Focus Group 3 was interviewed at a 4-H center in northwestern Mississippi during August 2021. The focus group participants, a group leader, and I were present. Focus Groups 4-11 were held in a formal classroom setting, and the teacher and I were present during the interview. I served as the only moderator for all focus groups to reduce potential variability in responses and the analysis.

Focus groups interviews lasted between 22-35 minutes, depending on size of group and cooperation of the participants. All discussions were recorded on two devices; an iPad and a WS853 Digital Voice Recorder, to account for sensitivity to background noise and to have backup copies in case of dead batteries, electronic malfunction, or lost files when transferring between devices and software.

Interview Questions

Interview questions were developed using the focus group framework for planning a quality questioning route outlined by Krueger and Casey (2009). Questions were divided into five categories: opening, introductory, transition, key, and ending. The longer it takes for someone to talk during a focus group interview, the less likely they are to speak during the discussion (Krueger and Casey, 2009); therefore, easy and factual *Opening Questions* were asked at the beginning of the student focus group meeting so all participants felt comfortable in contributing. *Introductory Questions* are those that introduce participants to the main topic discussed in the focus group. They are typically open-ended to gauge participant attitudes toward the topic. *Transition questions* moved the conversation from general to more specific and set the stage for the key questions. *Key questions* are the most important questions, and they highlight primary topics to be examined during analysis. Time was allotted for detailed responses to these more probing questions. *Ending Questions* wrapped up the focus group time and allowed participants to ask any questions or say anything they may not have gotten the chance to say. Questions were formatted using words that the participants would use when talking about the issue. They were also short, clear, and generally open-ended.

Following the focus group meetings, all audio-recordings were transcribed verbatim into electronic format. I took notes during the focus group on interactions or non-verbal cues that may

not be easily discerned over a transcript, such as tone of voice, body language, or group dynamics. These nonverbal cues were noted the transcription. I followed Braun and Clarke's (2006) methodology for thematic analysis of focus group discussions. An inductive, or "bottom up" analysis, was applied to prevent data collection from being influenced or screened by pre-existing frame or the researcher's theoretical interests (Braun and Clarke, 2006).

Parental permission was obtained, and youth assent was collected for each participant, represented in the data analysis. This research was approved by the Mississippi State University Institutional Review Board (IRB) for Human Subjects Research (IRB#21-064).

Analysis

Analysis was conducted following the six phases outlined by Braun and Clarke (2006). Phase 1 required me to familiarize myself with the data. Audio recordings from the focus groups were downloaded directly from the iPad and voice recorder and transcribed in MAXQDA, a social science transcription software for mixed method analysis.

After an initial review of the data, MAXQDA was used to code the data into themes that emerged from the students' answers. Data was coded into themes and further delineated into subthemes when necessary. I reviewed and refined how the data had been organized into these themes and subthemes. Lastly, each theme was given a succinct, representative title that identified or represented the story told by each theme.

The focus group data were individually analyzed by me and verified through independent analysis by an experienced colleague familiar with MAXQDA and focus group research. We then compared themes that emerged and converged our ideas to reach one consensus on the overarching themes.

Results

Four themes emerged from the focus groups conducted in this study: Exploration, Independence, Social Connectedness, and Well-Being.

Exploration

Study participants often raised topics that alluded to wanting the freedom to explore outdoors and express their creativity. When asked if they learned about the environment outside of school (Table 3.2), 17.3% of participants who answered stated they learn by going into the woods and learning about nature on their own. Approximately 36% stated they learn about the environment from visiting zoos, aquariums, and museums with family; and 1.7% said they learn from going on field trips with their classmates.

When exploring outside, youth said that they like to play, walk or run, and participate in outdoor recreation (Figure 3.1). Activities mentioned include jumping on a trampoline, riding bikes, playing with animals, hunting, fishing, climbing trees, exploring the woods, and enjoying nature.

Youth were asked to recall the types of activities they enjoyed in science class throughout their life. Most of the activities they described were hands-on, exploratory activities, including building activities, egg drop experiments, chemistry experiments, making hand-made ice cream, making s'mores to demonstrate heat, and other activities that allow them to observe, touch, and feel. Students also expressed interest in camps that allow for exploration and hands-on activities, such as robotics camp, cooking camp, and outdoor shooting sports camp.

Independence

Study participants expressed interest in experiences that would allow them choice and freedom. When participants were asked, “What activities do you like to do when you go outside?” (Figure 3.1), 9.1% indicated they like to walk or run and 3.4% said they like to drive a car or 4-wheeler (i.e., an all-terrain vehicle). Similarly, when asked what they are not allowed to do outside but would like to do (Table 3.3), approximately 17% said they would like to drive, and 13.9% said they would like to walk or run (e.g., “Walk late at night”, “Walk to another place down the road”, and “Go places around town”.) Some participants even expressed interest in walking to the park or running on trails, but the availability and infrastructure to access these spaces independently (e.g. public transportation from neighborhoods to parks) does not exist where they live. More students in the focus groups would like the freedom to walk around than the number that are currently allowed to do so. Youth want to have the freedom to choose the type of camp they go to and the activities they do at camp. One student said,

> Participant 3: Yes, I would go to a camp. I wanna go to a camp like it's on Babysitter's Club. Like, that's what I wanna do.
>
> Moderator: What kinds of stuff do they do at the camp?
>
> Participant 3: Like, they um, go um, they have a theatre program and all that, yeah. A math program, that.
>
> Moderator: So they do all types of different stuff…
>
> Participant 3: Yeah.” (personal communication, 2022)

Social Connectedness

The theme Social Connectedness can be further broken into various subthemes: Athletics, Hanging Out, and Adult Dynamics.

Adolescents in this study sought social interaction with their peers through organized athletics. When asked, “What do you want to be when you grow up?”, 21% of respondents stated they wanted to play a professional sport, including basketball, baseball, football, and soccer (Figure 3.2). Participants (34.1%) also said they like to play when they go outside (Figure 3.1), with 34.1% of respondents stating they would like to play a sport. When asked if they would like to go to a camp, many students said they want to go to a sports camp, including basketball, football, baseball, soccer, softball, and cheer.

Youth often look for social connections with their peers and siblings in the form of “hanging out” (Brunelle et al., 2018), which is a theme reflected throughout these focus groups. Participants wanted to play outside with their friends, siblings, or pets. They also stated that they wish that they had more freedom to hang out with their friends and go places around town with them. Hanging out with friends may also be a reason youth choose to participate in organized sports. One participant stated that he likes to play football, but he specifically like to play football with his friends.

The use of technology and social media may reflect a desire by youth to seek social connectedness with their peers by connecting virtually and “hanging out” with people their age. When asked what they like to do outside, participants stated they like to “be outside with [their] phone”, “walk around, listen to music and be on [their] phone”, and “hammock outside while on [their] phone”. Interestingly, one student stated that he would not want to go to a camp “’Cause when I'm at a camp that means I stay there. And if I stay there that means I don't got my game or phone.” Unfortunately, sometimes interactions with peers can have a negative impact on what youth want to do. One student said, “I've never been to a camp, but I don't want to go to a camp... And I don't- I don't want to deal with people who will prank you and stuff.”

When focus group participants were asked what they want to be when they grow up (Figure 3.2), 25% of participants wanted to work in healthcare and 21% wanted to work in science-related fields. When asked if they personally know any scientists, 16.7% of participants said they knew a family member in the medical field, they had family that worked as a professor or teacher, or their friend's parent works as a scientist (Figure 3.3). For example, one student said, "My sister is a traveling nurse." and another student said, "My dad is a physics and astronomy teacher." When asked where they learn about science outside of school, 3.4% of participants who answered said they learn from their parents. One participant said, "I'm asking my mom too, 'cause she was very smart in math also."

Teachers are also extremely influential in a student's life. When focus group participants were asked if they personally knew any scientists (Figure 3.3), 45% named their science teacher, and 21% of participants stated they would ask their science teacher if they needed answers to their questions.

The social interactions youth have with adults can also prevent them from participating in outdoor activities. One student stated that they did not feel safe outside because of their uncle, while a few others stated that they do not like to go outside because of people hiding in the woods that could kidnap them. One participant said, "It's just too much stuff that can happen outside… like bad stuff… you could get hurt. Somebody could come up and get you."

Well-Being

An adolescent's well-being includes their physical and mental well-being which is often determined by their environment and the community to which they belong (Scales & Roehlkepartain, 2018; Stanton-Salazar, 2011). It is difficult to completely separate social connectedness from well-being, since youth development is largely influenced by the

relationships they have with the people in their lives (Bornstein & Putnick, 2018; French & Cheung, 2018; Scales & Roehlkepartain, 2018)

Of the participants who said they did not feel safe outdoors (68.4%), 21% said they did not feel safe outside because of community violence, mainly that associated with firearms (Figure 3.4). Many students repeated the sentiment of a student who said she did not feel safe outside "because all the killing and shooting and all that going on."

Youth also felt unsafe outdoors because of animals (12.6%), weather conditions (3.2%), and the time of the day (4.2%). My study participants indicated they were afraid that mosquitos and snakes would bite them, and that coyotes and bears would attack them. Some students were unfamiliar and uncomfortable with local wildlife, as suggested by one who said, "What if there's some animal coming at you? There's a lot of animals outside and what if you encounter them? You die!". Inclement weather, such as extreme heat and cold, storms, lightning, and strong winds, as well as darkness, were other reasons youth perceived they were in danger when outdoors.

Personal health and the environment were linked in student responses. Two students from separate focus groups said they did not feel safe outside because of the coronavirus. Another student mentioned that he wears a mask to protect the environment. One student responded with the word "hygiene" when asked what he thought of when he heard the word "environment". In contrast, other youth thought going outside was good for their health. One student said, "If you stay inside for too long your head starts hurting." Another girl said, "We need to be more outside. We need to be more energetic". She was met with a lot of criticism from her classmates who thought the best way to get energy was to sleep and that going outside would not increase their energy like sleep would.

Youth also described wanting to go outside more frequently by walking to nearby parks, trail running, playing with their friends, siblings, and pets, and exploring the natural environmental around them. Unfortunately, this was not always possible due to access and development, which was described by one participant who said he would like to "Go explore… but like now they're building houses through it... I hate when that happens. They just take your area." They also described wanting to participate in outdoor camps and visiting the wildlife refuge on a field trip.

Discussion

Adolescence is a critical time in a person's life, which is highly influenced by their social, physical, mental, financial, and cultural experiences in childhood (Brunelle et al., 2018). Outdoor exploration can promote science and stewardship interest, a sense of self, and greater connections to nature (Lackey et al., 2022). Youth who had opportunities to participate in unorganized, self-directed exploration (going for a walk or hanging out in a park) felt more connected to nature than those who participated in organized recreation (Beery et al., 2020; Earnst & Theimer, 2011; Grimwood et al., 2018; Lackey et al., 2022), which may subsequently lead to higher levels of pro-environmental behaviors and improved mental and physical health (Brunelle et al., 2018; Collado et al., 2015; Wells & Leikies, 2006; Whitburn et al., 2019). The earlier the environment-based intervention, the more likely adolescents will be involved in environmental stewardship as an adult (Chan, 2009; Chawla, 1999; Horwitz, 1996; Matsuba et al., 2012), which further supports the premise that EE experiences for adolescents are important for future attitudes toward nature (Brunelle et al., 2018). The participants in this study expressed a desire to do more outside and to have increased access to green spaces (e.g., parks), so there

appears to be missed opportunities for these youth to develop a sense of connectedness to nature and the benefits that would consequently follow.

Adolescents seek to form their own identity and separate or individuate from their parents (Bornstein & Putnick, 2018; Koepke & Denissen, 2012). Independence is extremely important for developing a sense of connectedness to nature. Restricted access due to adult concerns or lack of infrastructure to outdoors spaces or participation in EE activities can hinder youth development and potential for connectedness to nature (Brunelle et al., 2018; Maas et al., 2006).

It is important for youth to feel empowered and to solve problems independently (Collins & Steinberg, 2008). For example, the science activities most memorable to youth in this study were hands-on, engaging activities where students got to build and do experiments. Environmental education is a "hands-on, minds-on" approach to learning, so continued use of hands-on teaching strategies, especially when conducted in or with nature, is an important part of student engagement (NAAEE, 2009) and building a sense of self.

Although independence from adults is a hallmark trait of adolescence, socializing with peers and peer influence peak around middle school (French & Cheung, 2018; Steinberg & Monahan, 2007). Youth in the focus groups in my study described their desire to walk around town and go places with their friends, and they only wanted to go to camps if their friends were there. They may also use sports to socialize with their peers (Howie et al., 2020) and social media and technology to stay virtually connected to friends. This confirms that "hanging out" with their friends influences their activities and interests. The theme "hanging out" seems informal, but it has been described as a legitimate way that adolescents spend their time (Hays-Grudo & Morris, 2020). Lieberg (1995) describes youth's desire for a "place of retreat" to either disconnect from the adult world or connect with their peers (Brunelle et al., 2018). One way to

achieve this is mentioned by Childress (2000) who described the need for "walkability" to promote adolescents' interactions with outdoor spaces, as well as the need to have flexible space for youth to interact with each other. For example, having benches scattered along a sidewalk is not very "teen-friendly", as opposed to flexible and mobile seating is more conducive for socializing in public spaces (Brunelle et al., 2018; Owens, 2000). Using suggestions like these can provide youth with opportunities to connect with their peers in nature.

Children spend most time of their time with family members and teachers, so the adults in their immediate environment (referred to as their "microsystem") have the biggest influence on their lives (Bronfenbrenner, 1974; Soga et al., 2018). Bornstein & Putnick (2018) noted "parents are the primary agents who set the agenda for what adolescents learn and who administer the rewards and punishments that strengthen desired characteristics and weaken undesired ones in adolescents." My study strongly supports Bornstein & Putnick's findings in that I observed youth indicating interest in careers similar to those of their parents. Focus group youth also reported going to their parents and teachers for information about nature, further supporting the important roles these adults play in developing environmental literacy interests, and connections.

More than half of the participants in this study stated they do not feel safe outdoors. They were afraid that animals would hurt them if they go outside, a result that Mackenzie et al. (2017) and Flett et al. (2010) also found in their youth focus groups. These statements demonstrate the importance of youth participation in EE, which if designed appropriately, could help youth understand their local wildlife, leading to more awareness of their natural surroundings, less unnecessary fear, and increase pro-environmental behaviors (Amahmid, et al., 2019; Bexell et al., 2013; Musila, et al., 2018; Naylor & Parsons, 2018). Studies have found that knowledge

about nature, awareness of animals, and the importance of a conservation practice is not necessarily a good predictor of whether a student will perform pro-environmental behaviors (Amahmid, et al., 2018; Ahmad et al., 2015). This may occur if EE curriculum and programs are focused on content knowledge without understanding the values, interests, attitudes, and motivations of the program's target audience.

Participants in the study did not feel safe outside because of fear of community violence, such as gun violence and kidnappings. Other studies have also found that youth do not engage in outdoor activities due to neighborhood safety concerns (Carver et al., 2008) and "gang violence" (Mackenzie et al., 2017). Youth may also feel unsafe because of what they experience or their parents' perception of safety in the neighborhood. Carver et al. (2008) explains that parental anxiety could cause parents to decrease their child's time spent outside due to road and community member danger. Parents may be restricting their children's activities outside to protect their safety and well-being.

Some youth throughout the focus groups reported not feeling safe because of the COVID-19 pandemic. The recurring theme of health leads me to believe that students directly related their well-being to the environment (i.e., the community being the natural world they live in and the community within) where they reside. Although only a few students mentioned the pandemic, it obviously made an impact on them and their views of the world around them. This finding is consistent with findings from Larcher et al. (2020) and Commodari & La Rosa (2020) who found that youth are aware and understand implications the virus has on themselves, their community, and vulnerable populations of people.

It was interesting to see students provide a new perspective on what the word "environment" meant that did not align with an ecocentric world view. This leads to an important

point about framing conservation messages. Since youth have varying definitions of "environment", we must consider the differences in culture, race, gender, and socioeconomics when recruiting youth and developing EE activities and opportunities (Codrow et al., 2022). This is echoed by Byrne and Wolch's (2009) whose outdoor recreation study found that park visitors have varying opinions on landscaping, park features, signage, and presence of dogs based on their language and cultural background.

The socioeconomic situation in which youth are raised can influence youth participation in extracurricular opportunities, career aspirations, and experiences in the outdoors. Mississippi has the lowest median household income of all the states, with an annual average income of $47,446 for a single household earner and $57,148 for a two-earner household. (U.S. Department of Justice, 2022). Having socioeconomic shortcomings can cause stressors which result in adverse childhood experiences. When not paired with prevention, this can lead to negative physiological, developmental, and health outcomes, such as changes in brain structure, poor emotion regulation and executive function, and mental health issues (Hays-Grudo & Morris, 2020). All of these can influence the way a child learns and the opportunities they have. Approximately one-third of youth in this study said that they did not learn about the environment outside of school. Another third of the students said they go to zoos, aquariums, and museums to learn about science and nature. There are no zoos, aquariums, or other educational facilities in northeastern Mississippi, so those students would have had to leave town to participate in these opportunities, requiring involvement of a family member, friend, or another trusted adult. Those with limited financial or homelife resources would have fewer available opportunities like this.

Rahm and Ash (2008) found out-of-school EE to be important for promoting positive experiences in the outdoors and helping underrepresented youth feel accepted and capable of

working in outdoor-based science fields. Some families are more supportive and have more resources available for these out-of-school opportunities than other, which further contributes to the perception that family and upbringing play a big role in cultivating interest in particular subjects. Without opportunities and access for learning, students may not have the opportunity to develop an interest in environmental stewardship or natural science careers.

Conclusion

Humans play a significant impact on the health of the planet; therefore, fostering a generation of young environmental stewards to engage, appreciate, and conserve natural resources is an essential step toward sustaining the planet's future. Promoting appreciation toward the outdoors can be achieved through education initiatives from nature centers, summer camps, and outreach events. Identifying youths' attitudes, interests, and current behaviors toward nature are needed to develop engaging and impactful educational opportunities that create positive EE experiences.

Youth in this study wanted to spend time outdoors. They did not feel safe due to community violence, wild animals, and the COVID-19 pandemic, although participants indicated interest in attending camps and exploring outdoors. They did not learn about the environment outside of school, rather they did more self-exploration and learned from their families and teachers. They liked to do hands-on activities and experiments to express their independence and creativity, and they preferred activities in which they could socialize with their friends.

To best engage youth in outdoor learning and recreational activities and to foster a positive outdoor experience, it is essential they are provided with accessible and affordable opportunities that feature activities that interest and represent their demographic characteristics. They should be provided opportunities that promote their independence, creativity, socialization,

and ensure a sense of safety and belonging. When youth can appreciate what the outdoors can provide and how humans benefit from a healthy environment, we have greater opportunity to reduce negative anthropogenic changes and conserve natural resources.

Limitations and Recommendations for Future Research

One limitation to this study is the lack of minority representation by myself and my graduate committee. Since most of the participants in the study identified as Black or African American, there may have been some unconscious bias or linguistic misinterpretations in the focus group data due to cultural differences between the participants and the research team members who analyzed the focus group data. To echo the opinions of Evangelista et al. (2020), studies about diversity should be conducted by a diverse group of researchers, and future studies on these topics should include people of different genders and races.

To continue the discussion of race and diversity, I regret the unfortunate but unavoidable use of binary race as a metric for comparison's sake (Armstrong & Greene, 2022). The sample size for this group was not large enough and there was not enough demographic information to appropriately assign race to youth in this study. I understand that race is a very complex and non-dichotomous matter, and I recognize that the youth in this study come from rich and diverse cultures, heritages, and backgrounds that cannot be appropriately reflected in a few short pages.

Second, future studies should include different genders and races so they will be able to draw conclusions about the data collected. Unfortunately, this study was conducted during the height of the COVID-19 pandemic, so it was difficult to conduct research with youth while protecting the health of safety of all participants and researchers during a time of uncertainty

Tables

Table 3.1 Demographic Information (gender and race) of Middle School Focus Group Participants

	Black or African American		White		
Focus Group Number	Male	Female	Male	Female	Total
1	0	5	0	1	**6**
2	11	0	0	0	**11**
3	4	5	0	0	**9**
4	2	1	1	0	**4**
5	4	3	0	0	**7**
6	4	5	0	0	**10**
7	1	5	1	1	**8**
8	4	0	1	1	**6**
9	2	5	5	0	**12**
10	2	3	2	0	**9**
Total	**34**	**32**	**10**	**3**	**78**

Table 3.2 Middle School Student Responses to the Focus Group Question, "Do you learn about the environment outside of school?"

Response	**Theme**	**% Responses (n = 58)**
No	No/Not sure	36.2%
Yes	Zoo, Aquarium Museum	36.2%
	Self-Exploration	17.3%
	Family Members	3.4%
	TV/Online	3.4%
	Field Trips	1.7%
	4-H	1.7%

Table 3.3 Middle School Student Response to the Focus Group Question, “What activities would you like to do outside?”

Theme	**% Responses (n = 36)**
Nothing	25.0%
Outdoor recreation	22.2%
Play	19.4%
Drive	16.7%
Walk/Run	13.9%
Social	2.8%

Figures

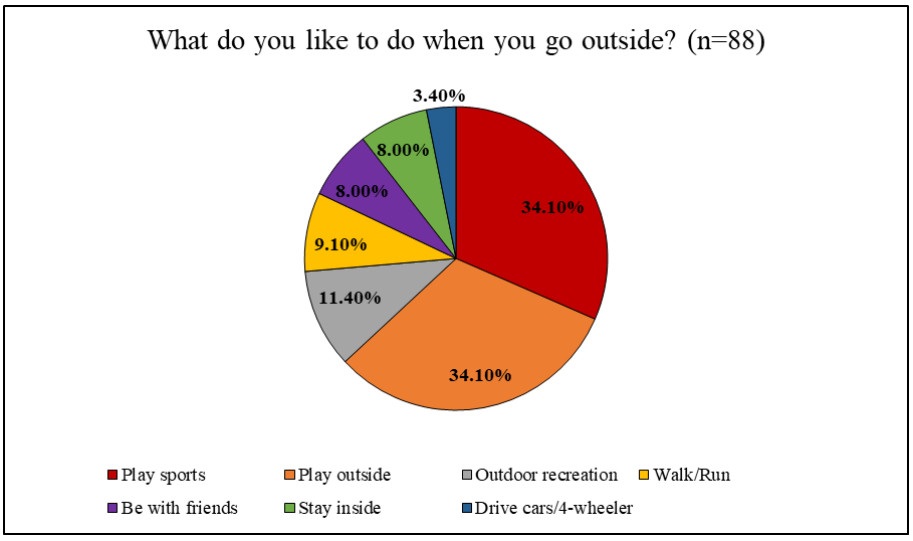

Figure 3.1 Middle School Student Responses to the Focus Group Question, "What do you like to do when you go outside?"

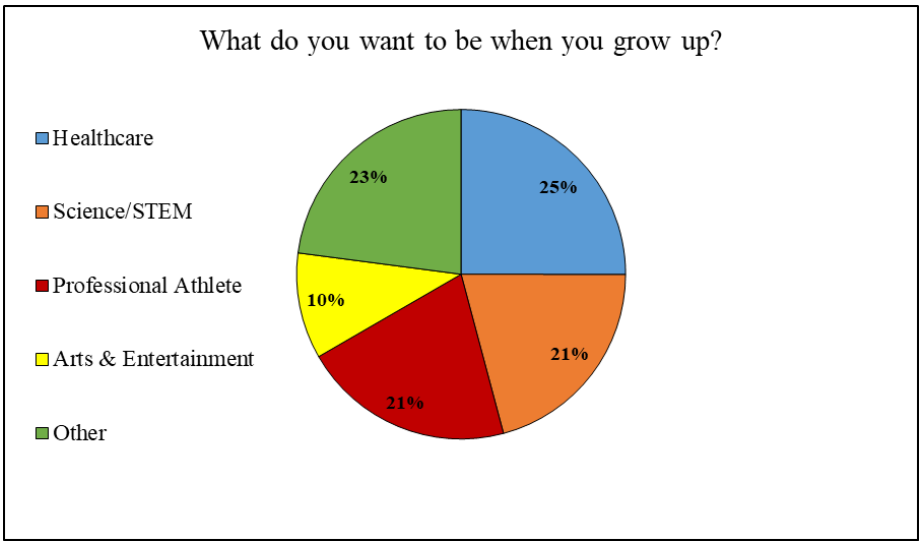

Figure 3.2 Middle School Student Responses to the Focus Group Question, "What do you want to be when you grow up?"

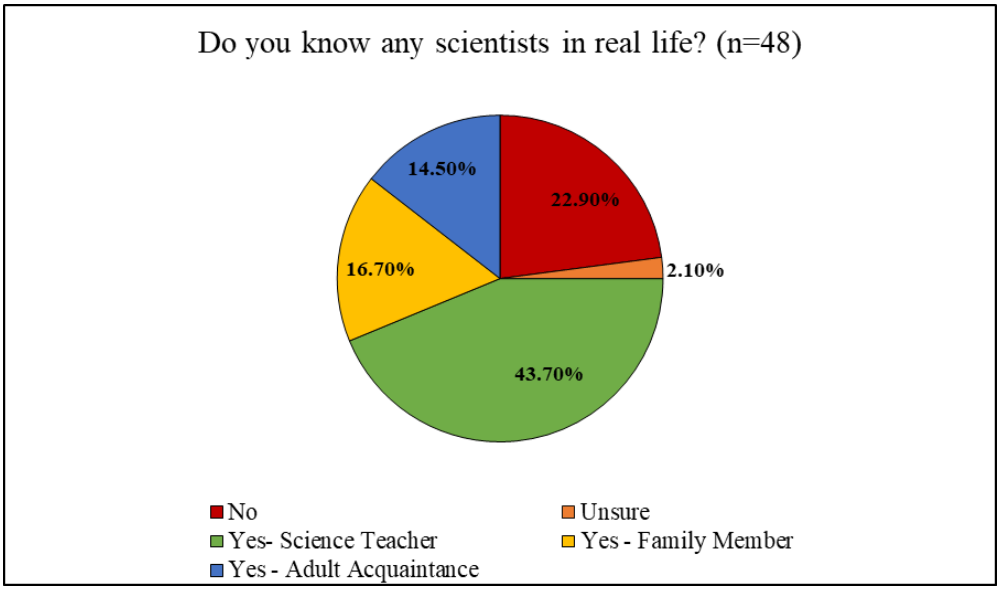

Figure 3.3 Middle School Student Responses to the Focus Group Question, "Do you know any scientists in real life?"

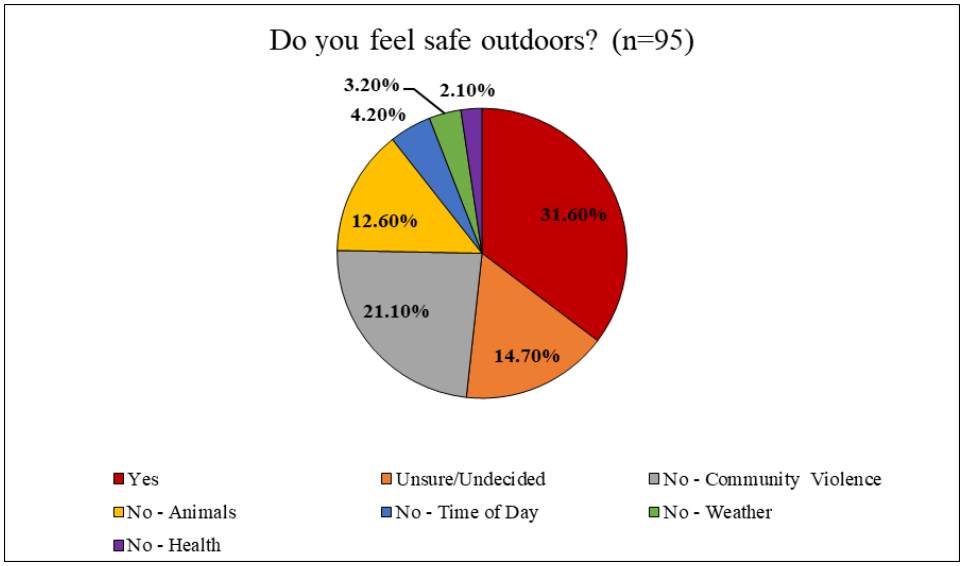

Figure 3.4 Middle School Student Responses to the Focus Group Question, "Do you feel safe outdoors?"

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CHAPTER IV

THE INFLUENCE OF EXPOSURE TO AQUATIC INVASIVE SPECIES ON ATTITUDES AND INTENDED-BEHAVIORS OF ARKANSAS ANGLERS

Introduction

Aquatic Invasive Species

Aquatic Invasive Species (AIS) are nonnative species found in bodies of water that pose economic, ecological, and human health threats to environments they are found in outside of their native range (IISD – International Institute for Sustainable Development, 2021). They are often introduced inadvertently by attaching to motors or getting trapped in the hulls or live wells of commercial and recreational vessels. Some invasives are intentionally taken out of their native range for biological control or ornamental use (McNeely, 2001). For example, the Northern Snakehead (*Channa argus*) was intentionally introduced to the United States through the pet trade and live food fish markets (Herborg et al., 2007; United States Geological Survey, 2022). Escapements from aquaculture facilities into waterways has also been a major cause of AIS proliferation (Chick & Pegg, 2001; Kolar et al., 2005).

AIS are difficult to eradicate due to their high dispersal and reproduction rates in favorable conditions (Leuven et al., 2009; O'Reilly-Nugent et al., 2016), making them challenging to trace and control (Crowl et al., 2008). AIS cause many ecological and economic issues, which is why it is important to prevent the spread of invasive species when they are sighted. For example, Asian carp have been prevalent in the United States since the 1970's and

threaten ecological systems, human health, and economic industries (Kolar et al., 2005). They outcompete native fishes for resources and diminish zooplankton abundance, cause negative and potentially dangerous experiences for boaters, and impact the economic efficacy of fishing and boating industries (Li et al., 2020). As potential carriers of AIS in their vessels, anglers and boaters who use any public waterway need to: 1) be made aware of the threats AIS pose, 2) be able to identify AIS species of concern, and 3) know what actions they can take to help stop the further spread of AIS.

Contributions of Anglers and Boaters

Recreational anglers and boaters make a large contribution to the United States economy in terms of trip expenditures and excise taxes paid on equipment and fuel. For example, recreational anglers in the US contributed $49 billion in retail sales, $23 billion in salaries and wage, $9 billion in federal, state, and local tax revenue, which resulted in the creation or maintenance of over 500,000 jobs in 2021 (American Sportfishing Association, 2022). An estimated 52.4 million Americans went fishing recreationally in 2021. Of these, 62% were freshwater anglers, 13% saltwater, 10% fished both freshwater and saltwater environments, and the remaining anglers went fly fishing in a combination of fresh and saltwater environments (American Sportfishing Association, 2022).

In Arkansas, outdoor recreation greatly contributes to the economy as well with more than 700,000 people participating in recreational fishing, 9,000 angling-related jobs produced, $338 million in salaries earned, and approximately $159 generated in federal, state, and local tax revenues (American Sportfishing Association, 2022). The presence of invasive species directly threatens the economic value achieved by anglers and boaters. For example, public and private boat ramps, marinas, and even lakes could close because of AIS, potentially decimating local

rural economies that rely on tourism for jobs and tax generation. For example, in September 2022 the Arkansas Game and Fish Commission (AGFC) needed to shut down the boat ramp to Mercer Bayou in Miller County because AIS were found, and it remains closed as the writing of this article as AGFC attempts to mitigate impacts to its conservation efforts (Zellers, 2022). Closure of boat ramps and waterbodies could continue to be a pattern if corrective pro-environmental behaviors outlined by the Clean, Drain, Dry (CDD) campaign are not taken seriously by boaters and anglers, resulting in loss of revenue to local economies. Additionally, the money that AGFC typically spends on management activities (e.g., stocking fish, habitat restoration/renovation, and facility upkeep) might be needed to control and eradicate invasive species, which may further hinder the angler and boater experiences.

Clean, Drain, Dry Initiative

One national approach to prevent the spread of AIS is a public awareness campaign called the Clean, Drain, Dry campaign. This is a form of "nonformal education" that launched in 2002, which is considered an educational technique that relies on incidental exposure (NAAEE, 2021). The CDD slogan encourages boaters and anglers to 1) ***Clean*** visible aquatic plants and animals, 2) ***Drain*** boat compartments and 3) ***Dry*** everything for 5 days or dry before entering the next body of water. It also encourages anglers to properly dispose of their unwanted bait (USFWS, 2022).

The national CDD campaign has several goals to effectively communicate their message with the public. First, Wildlife Forever works with federal, state, and local partners, such as the United States Fish and Wildlife Service (FWS) and the Minnesota Department of Natural Resources (MNDNR), to spread CDD messaging and create educational resources the public can use (Wildlife Forever, 2021). For example, organizations around the US worked together to

create “Clean. Drain. Dry: Protect the West”, a mobile device application the public can download that outlines AIS laws in each state so anglers know the local laws during interjurisdictional travel. The computer application also includes an interactive map to help users locate boat wash stations in their area.

Second, CDD uses outreach to educate the public on CDD recommendations through outdoor media marketing. This entails placing CDD messaging in areas anglers and boaters frequent to reinforce the message, such as fuel stations and bait shops. Clean, Drain, Dry also attempts to educate through billboards, digital and social media, television and radio announcements, and print advertisement. An important part of CDD marketing is the use of consistent, targeted messaging, which is more effective than one-time exposure to outreach materials (Lee et al., 2015; Oh, 2018; Wildlife Forever, 2021). In 2021, the CDD message had 117 million combined impressions on the public through implemented outreach strategies (Wildlife Forever, 2021).

The AGFC launched a general, statewide campaign for CDD in 2015. As of 2022, the campaign messaging in Arkansas includes posting signs at boat ramps, fuel stations, and bait shops, public meetings between local authorities and anglers, and social media engagement, such as the Facebook group “Friends of Bull Shoals Lake”.

Species of Interest

There have been two AIS recently introduced into Arkansas waterbodies that are of primary concern for AGFC: Giant Salvinia (*Salvinia molesta*) and Zebra Mussel (*Dreissena polymorpha*). Both species can threaten the health and biodiversity of native species and can hinder recreational experiences. These species were detected early enough where control and

eradication are possible, but their populations are rapidly growing and expanding, posing a serious threat to the health of Arkansas freshwater ecosystems.

Zebra Mussels

Zebra mussels were first introduced in North America to the Great Lakes when commercial cargo ships transported their free-floating larvae from their native range in the Black, Caspian, and Azov seas (Benson et al., 2022). They have rapidly expanded throughout the United States as shown in Figure 4.1. As sessile adults, zebra mussels can attach to hard substrates in the water, such as vegetation, stems, or rocks, and can get caught on boats or trailers when transported to another location. If boats are not drained properly and in the right location, the larval zebra mussels can be transported elsewhere (Benson et al., 2022). The AGFC has also confirmed the presence of zebra mussels in commercial pet and aquarium stores. They were found in moss balls sold from overseas where zebra mussels are native and have been accidentally introduced into natural waterways through commercial sales (Zellers, 2021). Additionally, when people improperly dispose of their aquarium pets, they may infect a body of water that does not yet have zebra mussels.

Zebra mussels contribute to changes in water quality, such as elevated toxin levels, increased cyanobacteria, decreased turbidity and phytoplankton diversity, and decreased oxygen levels, each of which can influence food web interactions and human health (Benson et al., 2022). They also have adverse effects on native species by outcompeting native aquatic species for aquatic nutrients (Benson et al., 2022).

Zebra mussels can accumulate on the bottoms of boats, encrust commercial fishing gear, and impact navigation. They clog intake valves and pipes associated with reservoirs designed for drinking water or hydroelectric generation, as well as structures associated with wastewater

treatment. Each of these events cost utility companies money and resources to remove zebra mussels from water and surfaces (Benson et al., 2022; Darwall et al., 2018; Fantle-Lepczyk et al., 2022).

The first confirmed sighting of Zebra Mussels in Arkansas was in 2015. They are restricted to the Arkansas River and Bull Shoals Lake, but given patterns of observation elsewhere (Bossenbroek et al., 2007; Robertson et al., 2020) the species is likely to expand if proper public education, knowledge, and management are not implemented.

Giant Salvinia

Giant Salvinia is an aquatic fern native to Brazil. It arrived in the United States as an ornamental plant for gardens and aquariums. It was first observed in South Carolina in 1995 (USGS, 2018) and has spread considerably as shown in Figure 4.2. It forms dense mats on the water's surface and can easily get caught on the bottoms of boats, trailers, or be introduced into live wells. Even tiny fragments of Giant Salvinia can spread the plant from an infested body of water to a non-infested body of water (Thayer, 2018). Giant Salvinia has a negative impact on the environment, recreation, the economy, and human health. Giant Salvinia poses threats to human health because it slows the flow of water and creates an environment suitable for increased disease spreading mosquito populations. People have reportedly mistaken the thick mats of Giant Salvinia for solid ground and have incurred injuries from the fall. It also impedes boat movements by getting caught in boat propellers (Thayer et al., 2018). Giant Salvinia poses ecological threats leading to disruption in food web cycles, taking from the already limited conservation funds in repairing the damage caused by the species. It outcompetes native plant species, which negatively impacts food sources and habitats for native aquatic species (Texas Parks and Wildlife, 2022; Thayer et al., 2018). It also shades out sunlight and lowers oxygen

levels, decreasing pH and dissolved oxygen levels and reducing abundance and diversity of macroinvertebrates and ecosystem productivity (Thayer et al., 2018).

Giant Salvinia is an ongoing threat in the southwestern part of Arkansas and is prevalent in lakes such as Mercer Bayou and Lake Erling (Figure 4.3). Nevertheless, procedures put in place combined with severe winter weather temperatures have successfully eradicated Giant Salvinia from the U.S. Army Corp of Engineer's lake named Lake Columbia in southwestern Arkansas. Early detection, intensive monitoring by staff, and reports from anglers played an essential part in eradication from these lakes. Despite constant efforts to detect, control, and eradicate Giant Salvinia, new sightings are being reported in previously unaffected lakes in Southwest Arkansas.

Purpose/Objective

Invasive species are rapidly spreading through Arkansas and the rest of the United States resulting in negative ecological, economic, and human health impacts. The purpose of this study was to determine if Arkansas resident anglers who were likely to reside near Zebra Mussels or Giant Salvinia have more awareness of CDD messaging, are more likely to preform pro-environmental behaviors, and are more willing to shift resources to support practices that minimize the spread of invasive species. I hypothesize that anglers who are likely to reside in regions with high numbers of these two AIS of interest will report greater awareness, support, and pro-environmental behaviors than anglers in regions without the AIS of interest.

Methodology

Analysis Groupings

To test my hypotheses, I identified two lakes in Arkansas that have been impacted by Zebra Mussels and Giant Salvinia: Bull Shoals Lake and Erling Lake, respectively. Anglers who lived in the adjacent counties of those lakes and were surveyed by Hunt and Westlake (2018) were considered the two treatment groups in my analysis. Next, in collaboration with the AGFC Fisheries Division, I identified anglers who lived in non-adjacent counties to impacted lakes but were in the same region of the state to serve as control groups for my analysis. For ease of interpretation, I labeled treatment anglers (n = 136) living in Baxter and Marion counties adjacent to Bull Shoals Lake as Region 1; anglers (n = 29) living in the nearby non-adjacent counties (Benton, Carroll, Madison, and Washington) served as the control group in my "Zebra Mussels Analysis" and are referred to as Region 2. Anglers (n = 48) living west of Arkansas Hwy 167 and south of Arkadelphia, AR were considered treatment anglers for my "Giant Salvinia Analysis" and were labeled Region 3. Anglers (n = 68) living east of Arkansas Hwy 167 and South of Pine Bluff, AR were considered control anglers for this analysis and were labeled Region 4.

Analysis Variables

I choose 12 questions from the 2017 Arkansas Statewide Angler Survey (Hunt and Westlake, 2017) to use for group comparisons in my "Zebra Mussel Analysis" and "Giant Salvinia Analysis", respectively. First, anglers were asked about their familiarity with "AGFC's Clean, Drain, and Dry message" on a 5-point scale with response format: 1 = "not at all familiar", 2 = "slightly familiar", 3 = "moderately familiar", 4 = "very familiar", and 5 = "extremely familiar". Second, anglers were then asked their likelihood of performing eight pro-

environmental behaviors related to minimizing the spread of AIS on a 5-point Likert-type scale with response format: 1 = “very unlikely”, 2 = “unlikely”, 3 = “neutral”, 4 = “likely”, and 5 = “very likely”. Behaviors included 1) “Open all compartments and livewell and allow the boat and trailer to sit and dry for a week or more before entering another body of water”, 2) “Clean your boat with high-pressure water after each use”, 3) “Report a new sighting of an invasive plant or animal to a state natural resource office”, 4) “Remove aquatic plants from your trailer after each use”, 5) “Retain a receipt for all commercially purchased live bait while fishing”, 6) “Dispose of unused bait in the trash”, 7) “Volunteer time to assist in habitat enhancement projects”, and 8) “Donate money to support habitat enhancement projects”. Anglers were then asked three questions about the acceptability of shifting more managerial resources from common practices such as stocking fish to control and eradicate invasive species on a 5-point Likert scale with response format: 1 = “strongly disagree”, 2 = “disagree”, 3 = “neutral”, 4 = “agree”, and 5 = “strongly agree”. Statements included 1) “Shifting more resources from sport fish stocking to activities that plant native aquatic vegetation in Arkansas would be acceptable to me”, 2) “ Shifting more resources from sport fish stocking to activities that control noxious aquatic vegetation in Arkansas waters would be acceptable to me”, 3) “Shifting more resources from sport fish stocking to activities that eradicate invasive species such as zebra mussels and Asian carp would be acceptable to me”. I believed these 12 questions help discern if anglers’ reported behaviors align with the CDD initiative recommendations.

Statistical Analysis

For both the “Zebra Mussel Analysis” and “Giant Salvinia Analysis”, I ran a Wilcoxon Rank Sum Test in SAS Version 9.4. (SAS Institute 2012) to compare Region 1 and Region 2, and Region 3 and Region 4, respectively on their responses to the 12 questions from the

statewide survey to determine if any significant differences existed between the respective groups. The Wilcoxon-Rank Sum Test is appropriate for comparing two independent groups with ordinal response data (Siegel & Castellan, 1988).

Results

Zebra Mussel Analysis

When anglers were asked to "Please indicate how familiar you are with the following: AGFC's 'Clean, Drain and Dry' message.' participants that reside in Region 2 near Beaver Lake were significantly more familiar with the CDD message than participants in Region 1 near Bull Shoals reservoir ($X^2 = 10.61$, df = 1, $p < .01$) (Table 4.1). When asked how likely they are to perform pro-environmental behaviors, anglers in Region 1 were more likely than anglers in Region 2 to "Dispose of unused bait in the trash" ($X^2 = 4.57$, df = 1, $p = .033$) (Table 4.2). There were no statistically significant differences in likelihood to perform pro-environmental behaviors in the remaining six behavioral items: opening compartments and drying their boat after each use, washing boats with high pressure water, reporting new sightings of AIS, removing aquatic plants from their boats and trailers, volunteering time, and donating money for habitat restoration projects (Table 4.2). When asked to "Indicate the extent you agree with the following statements about shifting more resources toward management approaches other than sport fish stocking", no statistically significant differences were found between angler support in Region 1 and Region 2 for shifting funds (Table 4.3).

Giant Salvinia Analysis

Participants that reside in Region 3 near Erling Lake were significantly more familiar with the CDD message than participants in Region 4 near Bayou Bartholomew ($X^2 = 4.22$, df =

1, p = .04) (Table 4.4). In terms of pro-environmental behaviors, anglers in Region 4 were significantly more willing to donate money to support habitat restoration than anglers in Region 3 (X^2 = 4.50, df = 1, p < .03) (Table 4.5). There were no significant differences between Regions 3 and 4 for the remaining six behavioral items: opening compartments and drying their boat after each use, washing their boat with high pressure water, reporting new sightings of AIS, removing aquatic plants from their boats and trailers, disposing of unused bait in the trash, and volunteering time toward habitat restoration projects. Additionally, when asked to "Indicate the extent you agree with the following statements about shifting more resources toward management approaches other than sport fish stocking.", anglers residing in Region 3 were significantly more likely to support shifting resources to control noxious aquatic vegetation than respondents in Region 4 (X^2 = 4.12, df = 1, p = .04). The analysis of the remaining questions regarding anglers' support for shifting resources to plant native species, and to eradicate AIS yielded insignificant statistical differences between Regions 3 and 4 (Table 4.6).

Discussion

The objective of this research was to determine if anglers who reside near invasive species would have more awareness of CDD and are more likely to exhibit pro-environmental behaviors toward minimizing the spread of invasive species.

Zebra Mussel Analysis

It was hypothesized that anglers in Region 1 would be more aware of CDD messaging and exhibit more prosocial behaviors due to recent exposure to Zebra Mussels than anglers in Region 2. Based on results of the analysis, anglers in Region 1 were significantly more aware of CDD messaging than those in Region 2, which supported my hypothesis. This may be due to the

presence of zebra mussels in Bull Shoal reservoir; although, the chances of zebra mussels being detected by the public in the wild are low due to their sessile nature.

Despite not being as familiar with CDD messaging, anglers in Region 1 expressed that they were likely to open their compartments, let their boat sit for a week after use, and remove aquatic plants from their trailer. Anglers in Region 2 may be slightly familiar with CDD recommendations because of state-wide messaging, but without knowing the full extent of the campaign efforts, it is difficult to conclude the reasoning. Regardless, it is important for anglers and boaters who recreate near Beaver Lake to have targeted messaging and be aware of the CDD recommendations so invasive species are not accidentally introduced into a lake with no reported sightings of AIS.

The only significant result that was yielded from the "Zebra Mussel Analysis" was that anglers in Region 1 are more likely to dispose of their unused bait in the trash. Unfortunately, there is no interpretation that can be drawn from this, as there is no survey information that indicates the type of bait anglers use. The survey instrument also did not specify throwing away live bait in the trash, which often leads to the spread of invasive species when not disposed of properly (Kilian et al., 2012).

Anglers are likely to participate in opening compartments, reporting new sightings of invasives, and removing aquatic plants from their trailer after each use, but they are not likely to clean their boats with high-pressure water. This could be for a few reasons. First, boaters and anglers might not want to wash their boats after going from one body of water to another because they do not feel like it and it takes a lot of effort. Second, boaters and anglers do not have access to a boat wash station to clean their boats. As of 2023, there are no public access boat wash stations in Arkansas, and these boaters may not have these resources at their own houses. Even if

they did, they run the chance of transporting invasive species across state lines and infecting a new body of water during travel. The AGFC is currently working with the Minnesota Department of Natural Resources (MN DNR) to introduce public access boat wash stations, which include high pressure washing hoses and vacuums to remove AIS from boats, motors, live wells, and other compartments.

Cimino & Streker (2018) distributed a survey in 2012 to gauge Oregon boaters' interest in boat wash stations. Boaters reported interest in using these stations, resulting in installation of boat wash stations throughout the state. A second survey was distributed after installation of the boat wash stations and officials found that boaters were not using the boat wash stations like they said they would. Even if Arkansas installed boat was stations, the relationship between availability and pro-environmental behavior is inconsistent and will not guarantee anglers and boaters will take advantage of using the wash stations.

Although anglers are not likely to donate their own time or money for habitat enhancement projects, they are supportive of AGFC reallocating funds from sport fish stocking to minimizing the spread of invasives. Martín-López et al. (2007) found that people with higher levels of environmental knowledge (e.g., environmental professionals and nature users) are more willing to donate than those with lower knowledge levels. This study found that anglers are not very willing to donate their own money for environmental causes, but it would take a deeper investigation of the social and economic circumstances of respondents to shed light on their motives to donate money or not. More investigation into respondent demographics, participation patterns, and attitudes may also shed some light on respondent's general disinterest in volunteerism, since volunteering heavily depends on socialization, career, and learning (Bruyere & Rappe, 2007; Clary et al., 1996; Ryan et al., 2001).

Giant Salvinia Analysis

It was hypothesized that in the Giant Salvinia area comparison that anglers in Region 3 would have more awareness and more pro-environmental behaviors than anglers in Region 4 due to their proximity to the recently introduced AIS Giant Salvinia. The results of the "Giant Salvinia Analysis" showed that anglers in Region 3 were significantly more familiar with CDD messaging than anglers in Region 4 (Table 4.3), which supports my hypothesis.

It is important to mention that invasive fish species, such as Bighead Carp, Yellow Bass, Silver Carp, etc. have been found around Arkansas for decades. Other vegetative species, such as Alligatorweed, Parrot Feather, Eurasian Watermilfoil, Water Lettuce, Brazilian Waterweed, Hydrilla, and Water Hyacinth have also been in Arkansas waters since the 1970's. Anglers in Region 4 could be experiencing a "habituation effect" (Kalnicky et al., 2014; Kalnicky et al., 2018), so negative feelings toward AIS may decrease the longer they are exposed.

Despite anglers in Region 4 being significantly less familiar with CDD messaging, anglers in both Regions 3 and 4 stated they are likely to open compartments, let their boats dry, and report invasive species sightings. Anglers stated they are unlikely to wash their boats with high-pressure water, which may be the same reason as stated in the Zebra Mussel Area results. The only significant result for "Giant Salvinia Analysis" (Table 4.5) showed that anglers in Region 4 are more likely to donate money to support habitat enhancement projects than those in Region 3. Anglers in Region 3 also are significantly more likely to support reallocating funds to control noxious aquatic species, and they are overall more likely to support shifting of funds for planting native species and eradicating invasives than those in Region 4. Region 3 angler's higher levels of support and pro-environmental behaviors could have to do with the presence of newly introduced Giant Salvinia or Region 4's habituation effect toward invasive species.

Anglers in Region 3 could also have more resources to help support habitat restoration projects, but this is inconclusive without further investigation of anglers' social and economic information.

AIS Campaign and Message Framing

AGFC has only done broadcast messaging across Arkansas. Since the introduction of Giant Salvinia and Zebra Mussels, it is important for AGFC to target their messaging to control and eradicate these species before they spread into unaffected lakes and rivers. One approach to effectively distribute the message of CDD to the public could be by framing the message to appeal to the general public. A study by Wallen and Kyle (2018) compared efficacy of four messaging frames to determine which message was more effective at changing intended behaviors among boaters and anglers in Texas. The four campaign condition methods were: standard, regulation, descriptive, and injunctive. Standard appealed to large scale audiences, regulation appealed to fines and law, descriptive appeals to local scale statements, and injunctive is framing the expectation of participating in CDD pro-environmental behaviors. Results found that framing in a regulation condition yielded greater intended behaviors from anglers than any other type of messaging frame. Displaying message that allude to AIS policies and laws in place encourage anglers and boaters to exhibit behaviors that prevent the spread of AIS (Cimino & Strecker, 2018; Nanayakkara et al., 2018).

Conclusion

The purpose of this study was to determine if people who are located near invasive species have more awareness of CDD, are more likely to preform pro-environmental behaviors, and are more willing to shift resources to support practices that plant native populations and

eliminate invasive species. Anglers in Region 1 had more awareness than those in Region 2, and anglers in Region 3 had more awareness than those in Region 4, showing that anglers who live in regions with the AIS of interests are more familiar with CDD messaging than those who do not reside near these AIS.

Besides CDD messaging, there was no difference between anglers in the four regions in terms of pro-environmental behavior and how each regions supports shifting resources. These survey results may be able to provide baseline data for future comparison of attitudes, behaviors, and support of CDD after AGFC implements more targeted and consistent messaging approaches to minimize the spread of AIS.

Limitations and Recommendations for Future Research

There were a few limitations to this study. AGFC helped determine where anglers from around the state frequently recreate, which informed which survey participants were included in the analysis. Although there were many people who completed the survey around the state, many of them did not reside near the species of interest. A bigger sample size would give us more reliable results and a better understanding of angler attitudes.

I recommended implementing a targeted campaign not only at lakes that have recent and secluded infestations of the AIS of interest at Bull Shoals Lake and Erling Lake, but also at Beaver Lake in order to protect the native ecosystem. Using a targeted campaign that utilizes regulation condition messaging would increase the chances that boaters and anglers are more compliant with CDD recommended behaviors.

The true number of AIS around the state is unknown, so having meetings and outreach events with anglers and boaters throughout the state to help identify the species may be a valuable investment in identifying and intervening with bodies of water with AIS present. Also

introducing high pressure washing and vacuuming stations by boat ramps throughout the state, especially where vegetative AIS are present, would be a valuable investment for minimizing the spread of AIS from affected bodies of water to unaffected bodies of water.

Wildlife Forever's "2021 National Invasive species Report: Clean. Drain. Dry." emphasizes how many resources they have implemented to create communication with the public through "impressions", which is a metric to keep track of how many times a message has appeared to the public. Although CDD has reached over 2.3 billion impressions since its inception, evaluation of those impressions is missing. Moving forward and after targeted messaging is put into place, it would be beneficial for AGFC to distribute another survey to Arkansas anglers in about five years to evaluate how messaging frames, boat wash stations, and consistent, targeted messaging has impacted the attitudes and intended behaviors of anglers. Since there is not any targeted messaging around Arkansas, the results of this study can be viewed as a baseline to refer to as more management and outreach practices are put in place to see if their current efforts are worthwhile or if changes need to be made moving forward.

Tables

Table 4.1 Survey responses to, “Please indicate how familiar you are with the following:”

Statement	Response	Region 1 Treatment (n = 29)	Region 2 Control (n = 136)	X^2	*p* value
AGFC’s Clean, Drain, and Dry message”?	Not at all familiar	13.79	35.29	10.61	0.001*
	Slightly familiar	10.34	15.44		
	Moderately familiar	20.69	24.26		
	Very familiar	31.03	16.18		
	Extremely familiar	24.14	8.82		

*significant *p*-value ($p < .05$)

Table 4.2 Survey responses to, “Please indicate how likely you are to perform the following behaviors:”

Statement	Response	Region 1 Treatment (n = 29)	Region 2 Control (n = 136)	X^2	*p* value
Open all compartments in live wells and allow the boat and trailer to sit for a week or more before entering another body of water	Very Unlikely	0.00	7.35	0.001	0.99
	Unlikely	13.79	6.62		
	Neutral	27.59	26.47		
	Likely	37.93	38.24		
	Very Likely	20.69	21.32		
Clean your boat with high-pressure water after each use	Very Unlikely	3.45	16.18	0.24	0.62
	Unlikely	34.48	26.47		
	Neutral	34.48	22.79		
	Likely	13.79	24.26		
	Very Likely	13.79	10.29		
Report a new sighting of an invasive plant or animal to a state natural resource office	Very Unlikely	3.45	7.35	0.13	0.72
	Unlikely	20.69	16.18		
	Neutral	34.48	22.79		
	Likely	24.14	42.65		
	Very Likely	17.24	11.03		
Remove aquatic plants from your trailer after each use	Very Unlikely	3.45	9.56	0.82	0.36
	Unlikely	3.45	2.21		
	Neutral	20.69	20.59		
	Likely	37.93	41.18		
	Very Likely	34.48	26.47		
Dispose of unused bait in the trash	Very Unlikely	0.00	14.71	4.57	0.03*
	Unlikely	17.24	16.91		
	Neutral	13.79	19.85		
	Likely	41.38	30.15		
	Very Likely	27.59	18.38		
Volunteer time to assist in habitat enhancement projects	Very Unlikely	17.24	12.50	0.07	0.80
	Unlikely	27.59	26.47		
	Neutral	34.38	44.85		
	Likely	17.24	15.44		
	Very Likely	3.45	0.74		
Donate money to support habitat enhancement projects	Very Unlikely	17.24	12.50	0.01	0.92
	Unlikely	31.03	26.47		
	Neutral	24.14	44.85		
	Likely	24.14	15.44		
	Very Likely	3.45	0.74		

*significant *p*-value ($p < .05$)

Table 4.3 Survey responses to, “Please indicate the extent you agree with the following statements about shifting more resources toward management approaches other than sport fish stocking:”

Statement	Response	Region 1 (n = 29) (Treatment)	Region 2 (n = 136) (Control)	X^2	*p* value
Shifting more resources from sport fish stocking to activities that plant native aquatic vegetation in Arkansas would be acceptable to me	Strongly disagree Disagree Neutral Agree Strongly Agree	3.45 13.79 58.62 17.24 6.90	2.94 17.65 35.29 37.50 6.62	1.30	0.26
Shifting more resources from sport fish stocking to activities that control noxious aquatic vegetation in Arkansas waters would be acceptable to me	Strongly disagree Disagree Neutral Agree Strongly Agree	0.00 3.45 44.83 44.83 6.90	1.47 9.56 31.62 51.47 5.88	0.01	0.94
Shifting more resources from sport fish stocking to activities that eradicate invasive species such as zebra mussels and Asian carp would be acceptable to me	Strongly disagree Disagree Neutral Agree Strongly Agree	0.00 3.45 24.14 48.28 24.14	1.47 4.41 25.00 50.00 19.12	0.38	0.54

Table 4.4 Survey responses to, “Please indicate how familiar you are with the following:”

Statement	Response	Region 3 Treatment (n = 48))	Region 4 Control (n = 68)	X^2	*p* value
AGFC’s Clean, Drain, and Dry message”?	Not at all familiar Slightly familiar Moderately familiar Very familiar Extremely familiar	27.94 20.59 26.47 19.12 5.88	50.00 12.50 18.75 18.75 0.00	4.22	0.03*

*significant *p*-value ($p < .05$)

Table 4.5 Survey responses to, “Please indicate how likely you are to perform the following behaviors:”

Statement	Response	Region 3 Treatment (n = 48))	Region 4 Control (n = 68)	X^2	*p* value
Open all compartments in live wells and allow the boat and trailer to sit for a week or more before entering another body of water	Very Unlikely	11.76	8.33	0.09	0.77
	Unlikely	16.18	27.08		
	Neutral	25.00	20.83		
	Likely	36.76	31.25		
	Very Likely	10.29	12.50		
Clean your boat with high-pressure water after each use	Very Unlikely	17.65	12.50	1.52	0.22
	Unlikely	38.24	33.33		
	Neutral	22.06	22.92		
	Likely	19.12	27.08		
	Very Likely	2.94	4.17		
Report a new sighting of an invasive plant or animal to a state natural resource office	Very Unlikely	11.76	12.50	0.02	0.90
	Unlikely	23.53	25.00		
	Neutral	27.94	16.67		
	Likely	25.00	39.58		
	Very Likely	11.76	6.25		
Remove aquatic plants from your trailer after each use	Very Unlikely	7.35	8.33	0.07	0.79
	Unlikely	7.35	10.42		
	Neutral	19.12	6.25		
	Likely	33.82	43.75		
	Very Likely	32.35	31.25		
Dispose of unused bait in the trash	Very Unlikely	19.12	8.33	1.90	0.17
	Unlikely	16.18	18.75		
	Neutral	26.47	22.92		
	Likely	25.00	33.33		
	Very Likely	13.24	16.67		
Volunteer time to assist in habitat enhancement projects	Very Unlikely	25.00	25.00	0.20	0.66
	Unlikely	27.94	25.00		
	Neutral	36.76	33.33		
	Likely	8.82	16.67		
	Very Likely	1.47	0.00		
Donate money to support habitat enhancement projects	Very Unlikely	25.00	16.67	4.50	0.03*
	Unlikely	22.06	18.75		
	Neutral	39.71	29.17		
	Likely	11.76	35.42		
	Very Likely	1.47	0.00		

*significant *p*-value ($p < .05$)

Table 4.6 Survey responses to, “Please indicate the extent you agree with the following statements about shifting more resources toward management approaches other than sport fish stocking:”

Statement	Response	Region 3 Treatment (n = 48)	Region 4 Control (n = 68)	X^2	*p* value
Shifting more resources from sport fish stocking to activities that plant native aquatic vegetation in Arkansas would be acceptable to me	Strongly disagree Disagree Neutral Agree Strongly Agree	7.35 19.12 48.53 22.06 2.94	8.33 10.42 37.50 29.17 14.58	1.94	0.16
Shifting more resources from sport fish stocking to activities that control noxious aquatic vegetation in Arkansas waters would be acceptable to me	Strongly disagree Disagree Neutral Agree Strongly Agree	0.00 8.82 35.29 42.65 13.24	2.08 6.25 39.58 41.67 10.42	4.17	0.04*
Shifting more resources from sport fish stocking to activities that eradicate invasive species such as zebra mussels and Asian carp would be acceptable to me	Strongly disagree Disagree Neutral Agree Strongly Agree	4.41 8.82 41.18 30.88 14.71	2.08 10.42 29.17 33.33 25.00	0.19	0.66

*significant *p*-value ($p < .05$)

Figures

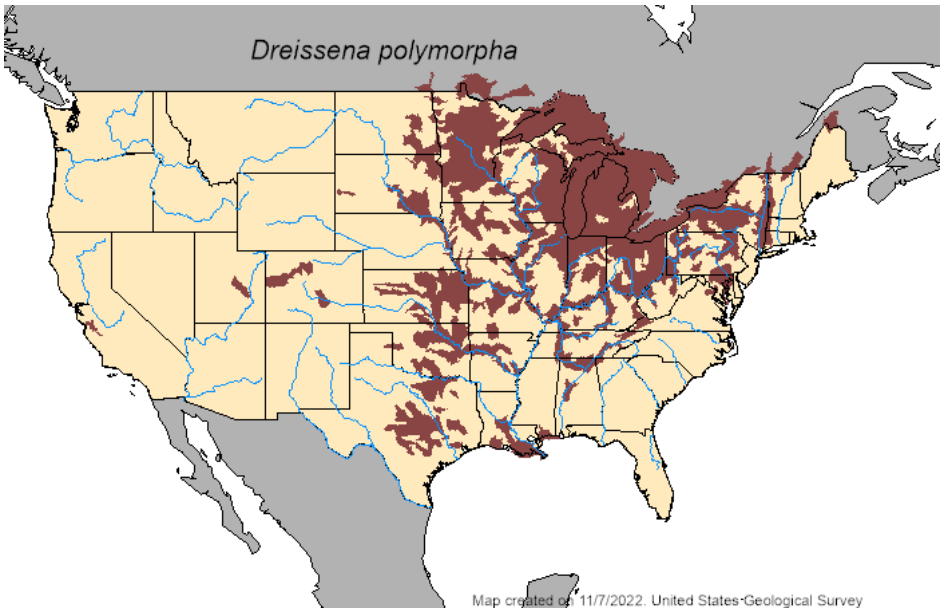

Figure 4.1 Distribution of Zebra Mussels in the United States, USGS

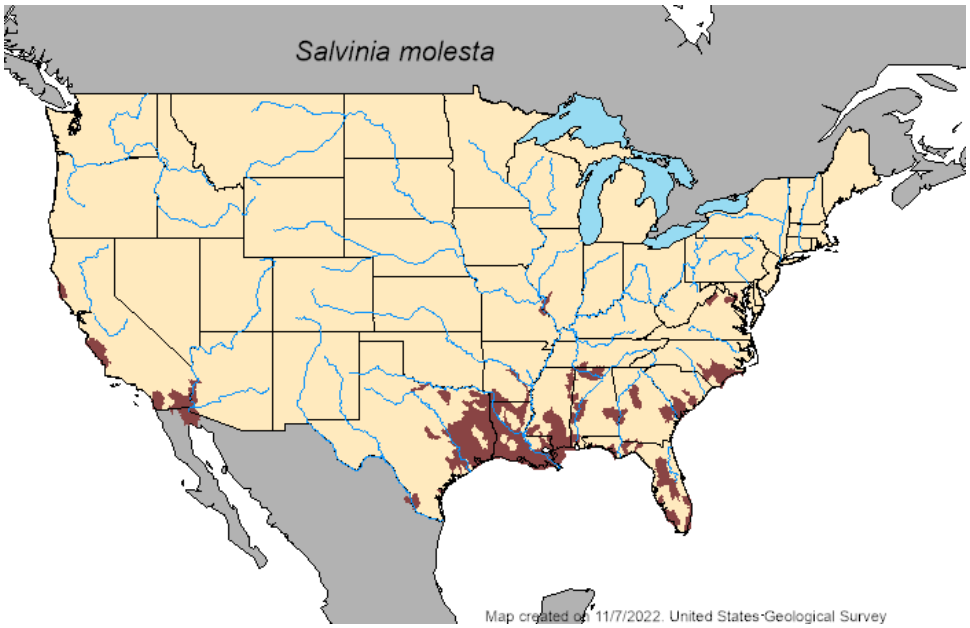

Figure 4.2 Distribution of Giant Salvinia in the United States, USGS

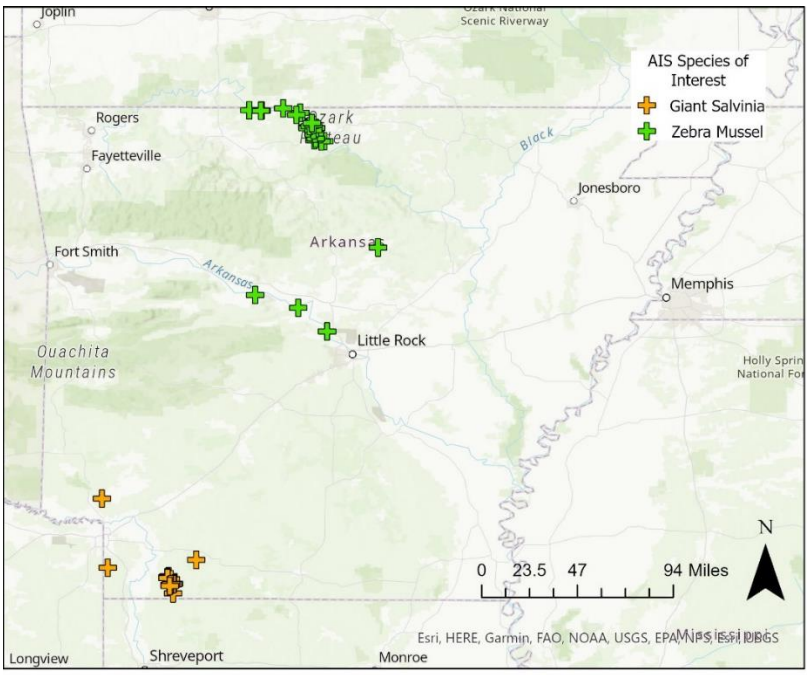

Figure 4.3 Map of AIS of interest in Arkansas

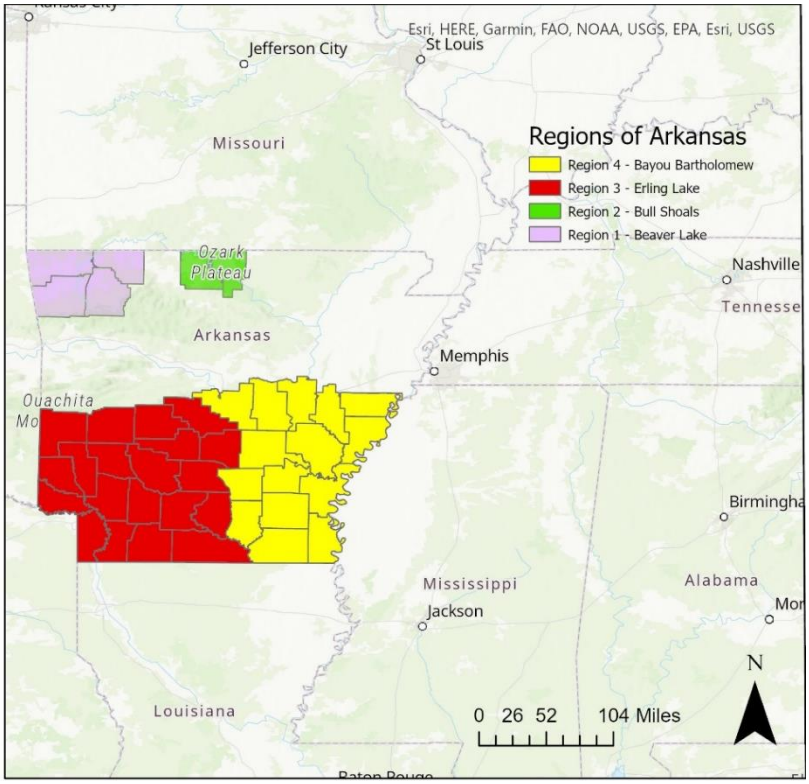

Figure 4.4 Regions in Arkansas delineated by AGFC for analysis

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APPENDIX A

SURVEY INSTRUMENTS

Middle School and Nature Camp Survey Instrument

Dear Participant:

You have been given this survey because you participated in a youth program, and we would like to learn about you and your experiences.

Your answers are important, and they will be kept private. If you don't want to fill out the survey, you don't have to. If there is a question you don't want to answer, you can leave it blank.

Thank you for your help!

Pre-Assessment

For this activity, you are to put an X in the box that best shows how you feel about each of the statements. Remember, there are no right or wrong answers. The first row is an example.

	Strongly agree	Agree	Not sure	Disagree	Strongly disagree
EXAMPLE: Chocolate ice cream is one of my favorite flavors		**X**			
11. Plants and animals have as much right as people to live					
12. There are too many (or almost too many) people on earth					
13. People are smart enough to keep from destroying the earth					
14. People must still obey the laws of nature					
15. When people mess with nature it has bad results					
16. Nature is strong enough to handle the bad effects of people and pollution					
17. People are supposed to rule over the rest of nature					
18. People are treating nature badly					
19. People will someday know enough about how nature works to be able to control it					
20. If things don't change, we will have a big disaster in the environment soon.					
21. I have talked with my family about how to help with environmental problems.					
22. I would be willing to separate my family's trash for recycling					
23. To save energy, I turn off the lights at home when they are not in use.					
24. I would like to see animals and birds near my home.					

25. I get angry about the damage pollution causes the earth.					
26. I do not worry about environmental problems.					
27. It makes me sad to see houses being built where animals used to live.					
28. I think learning about science is interesting.					
29. Understanding science is important to me.					
30. I am sure I can do science work even if it is really hard.					
31. An important reason I do the science work is because I want to get better at doing science.					
32. The main reason I do science experiments is because my teacher says so.					
33. I expect to do well when we do work in science.					
34. My mom and dad encourage me to participate in science activities.					

Post-Assessment

For this activity, you are to put an X in the box that best shows how you feel about each of the statements. Remember, there are no right or wrong answers. The first row is an example.

	Strongly agree	Agree	Not sure	Disagree	Strongly disagree
EXAMPLE: Chocolate ice cream is one of my favorite flavors		**X**			
1. Plants and animals have as much right as people to live					
2. There are too many (or almost too many) people on earth					
3. People are smart enough to keep from destroying the earth					
4. People must still obey the laws of nature					
5. When people mess with nature it has bad results					
6. Nature is strong enough to handle the bad effects of people and pollution					
7. People are supposed to rule over the rest of nature					
8. People are treating nature badly					
9. People will someday know enough about how nature works to be able to control it					
10. If things don't change, we will have a big disaster in the environment soon.					
11. I have talked with my family about how to help with environmental problems.					
12. I would be willing to separate my family's trash for recycling					
13. To save energy, I turn off the lights at home when they are not in use.					
14. I would like to see animals and birds near my home.					
15. I get angry about the damage pollution causes the earth.					
16. I do not worry about environmental problems.					
17. It makes me sad to see houses being built where animals used to live.					
18. I think learning about science is interesting.					
19. Understanding science is important to me.					
20. I am sure I can do science work even if it is really hard.					
21. An important reason I do the science work is because I want to get better at doing science.					
22. The main reason I do science experiments is because my teacher says so.					
23. I expect to do well when we do work in science.					
24. My mom and dad encourage me to participate in science activities.					

What was your favorite part about this lesson?

What was your least favorite part of this lesson?

Would you change anything about this lesson?

Other comments/suggestions:

Demographic Information

Please check the box(es) that applies to you. If there is a space, please write/type your answer.

1. **How old are you? _____**

2. **What grade are you in? If it is summer break, which grade will you be starting in the fall?**

   _____

3. **Which of the following describes your gender?**
   - ☐ Female
   - ☐ Male
   - ☐ Not specified: _____
   - ☐ I don't want to say

4. **What school do you go to? _____**

5. **What type of school is your school?**
   - ☐ Public
   - ☐ Private
   - ☐ Homeschool

6. **Are you involved in 4-H?**
   - ☐ Yes
   - ☐ No

7. **Which of the following describes your race and ethnicity? Select all that apply:**
   - ☐ American Indian or Alaskan Native
   - ☐ Asian
   - ☐ Black or African American
   - ☐ Native Hawaiian/Pacific Islander
   - ☐ White
   - ☐ More than one race
   - ☐ I don't know
   - ☐ I don't want to say

8. **Which of the following describes your ethnicity?**
   - ☐ Hispanic or Latino
   - ☐ Non-Hispanic or non-Latino
   - ☐ I don't know
   - ☐ I don't want to say

Middle School Classroom-based EE Knowledge Assessments

Knowledge Assessment – Bird Adaptations

Please answer the following questions to the best of your ability.

1. **What is an adaptation?**
   - ☐ A skin condition that effects birds
   - ☐ A characteristic that allows an animal to survive in their environment
   - ☐ A group of animals with a common ancestor
   - ☐ A device that connects a phone to a charger

2. **What type of beak is on a bird that eats seeds & must crack through hard shells?**
   - ☐ Long, straight beak
   - ☐ Short, thin beak
   - ☐ Thick, cone-shaped beak
   - ☐ Flat-billed

3. **Which type of feet would you find on a bird that spends a lot of time in water or near marshes/swamps?**
   - ☐ Zygodactyl toes
   - ☐ Talons
   - ☐ Anisodactyl
   - ☐ Webbed feet

4. **Scientists group (or classify) living things based on _____.**
   - ☐ their habitat
   - ☐ their size
   - ☐ their shared characteristics
   - ☐ their color

5. **Why do scientists use a dichotomous key?**
   - ☐ to identify an organism based on its ancestry
   - ☐ to identify an organism based on internal (inside) traits or characteristics
   - ☐ to identify organisms based on external (outside) traits or characteristics
   - ☐ Identify organisms based their songs or other sounds

6. **Which of the following are adaptations that allows birds to survive in their environment? Select all that apply.**
   - ☐ Dense bones
   - ☐ Webbed feet
   - ☐ Wings
   - ☐ Specialized beaks

7. **Which type of beak would a bird have if it ate food found along at the bottom of a lake?**
   - ☐ Long straight beak
   - ☐ Thick, curved beak
   - ☐ Short, triangular beak
   - ☐ Flat, strainer-like beak

8. **What step do you start with when using a dichotomous key?**
   - ☐ 1
   - ☐ 2
   - ☐ 3
   - ☐ 4

9. **True or False. When organisms are classified, scientists starts very specific and become more general.**
   - ☐ True
   - ☐ False

10. **Which type of feet would you find on a bird that feeds and moves up and down tree trunks?**
    - ☐ Webbed feet
    - ☐ Zygodactyl toes (2 forward, 2 back)
    - ☐ Anisodactyl toes (3 forward, 1 back)
    - ☐ Sharp, curved talons

Knowledge Assessment – Water Cycle

Please answer the following questions to the best of your ability.

1. **Which is not a stage in the water cycle?**
   - ☐ Stagnation
   - ☐ Condensation
   - ☐ Precipitation
   - ☐ Evaporation

2. **What is the definition of transpiration?**
   - ☐ The process of water from lakes and ponds turning into water vapor
   - ☐ The process of water from plants turning into water vapor
   - ☐ The process of gas turning into a liquid
   - ☐ The process of water being released from the clouds to the surface of the Earth

3. **In the water cycle, what stage occurs after precipitation?**
   - ☐ Infiltration
   - ☐ Surface Runoff
   - ☐ Groundwater Collection
   - ☐ All of the above

4. **What is the ideal soil type for quality filtration?**
   - ☐ Coarse soil
   - ☐ Fine Soil
   - ☐ Both coarse and fine soil
   - ☐ Silt

5. **What is the name for the reservoir that collects water underground?**
   - ☐ Basin
   - ☐ Sinkhole
   - ☐ Aquifer
   - ☐ Aquatic

6. **What part of the water cycle did the water filtration system we made represent?**
   - ☐ Surface runoff
   - ☐ Infiltration
   - ☐ Condensation
   - ☐ Precipitation

7. **What is one reason conserving water is important?**
   - ☐ Humans need drinking water
   - ☐ Plants and animals need water
   - ☐ There is a small amount of freshwater for all living organisms to share
   - ☐ All of the above

8. **True or False. Condensation is when water transforms from a gaseous state to a liquid state.**
   - ☐ True
   - ☐ False

9. **Which of the following is a form of precipitation?**
   - ☐ Rain
   - ☐ Snow
   - ☐ Hail
   - ☐ All of the above

10. **What is the correct order of the water cycle?**
    - ☐ Precipitation → Accumulation → Evaporation → Condensation
    - ☐ Accumulation → Condensation → Evaporation → Precipitation
    - ☐ Evaporation → Precipitation → Condensation → Accumulation
    - ☐ Condensation → Accumulation → Precipitation → Evaporation

Knowledge Assessment – Watershed

Please answer the following questions to the best of your ability.

1. **What watershed is Mississippi located in?**
   - ☐ Lower Mississippi Watershed
   - ☐ Upper Mississippi Watershed
   - ☐ South Atlantic Gulf Watershed
   - ☐ Both A & B
   - ☐ Both A & C

2. **What percentage of freshwater is accessible that all living organisms must share?**
   - ☐ <1%
   - ☐ 1%
   - ☐ 2.5%
   - ☐ 31%

3. **Where is the majority of freshwater found on Earth?**
   - ☐ Oceans
   - ☐ Rivers
   - ☐ Glaciers
   - ☐ Streams & Ponds

4. **True or False. Watersheds eventually lead to the ocean.**
   - ☐ True
   - ☐ False

5. **What is a watershed?**
   - ☐ An increase in elevation on the land
   - ☐ An area of land where water drains to a central point
   - ☐ The forms and features of land and ocean surfaces
   - ☐ A depression in the land for holding water

6. **What is point source pollution?**
   - ☐ A type of pollution in which the source of contamination is traced to a single location
   - ☐ Any person or thing from which something comes from
   - ☐ Introduction of contaminants into the natural environment that cause adverse change
   - ☐ A type of pollution in which the source of contamination cannot be traced to a single location

7. **What is non-point source pollution?**

   ☐ A type of pollution in which the source of contamination can be traced to a single location

   ☐ Pollution that drains away from the ocean

   ☐ Introduction of contaminants into the natural environment that cause adverse change

   ☐ A type of pollution in which the source of contamination cannot be traced to a single location

8. **Why is pollution a problem? Select all that apply.**

   ☐ It contaminates our drinking water

   ☐ Saltwater is not effected by pollution, only freshwater

   ☐ It can kill animals that live in the water

   ☐ It blocks storm drains and can cause flooding

9. **True or False. Hurricanes and other strong weather events cannot change the shape of a watershed.**

   ☐ True

   ☐ False

10. **True or False. An example of point source pollution is waste draining from a factory pipe directly into the ocean.**

    ☐ True

    ☐ False

Knowledge Assessment - Mammals

Please answer the following questions to the best of your ability.

1. **Which is NOT a way you can tell if an animal is a predator/prey?**
   - ☐ Eye position
   - ☐ Teeth
   - ☐ Length of nasal passage
   - ☐ Thickness of fur

2. **What types of canine teeth do carnivores have?**
   - ☐ Short and flat
   - ☐ Long and sharp
   - ☐ They don't have canine teeth
   - ☐ Long and flat

3. **Which is a characteristic of herbivores, specifically white-tailed deer?**
   - ☐ Long canines
   - ☐ Flat teeth with cusps
   - ☐ Short nasal passage
   - ☐ Forward facing eyes

4. **True or False. The pre-molars & molars of carnivores are sharp.**
   - ☐ True
   - ☐ False

5. **Which of the following animals is a carnivore?**
   - ☐ White-tailed Deer
   - ☐ Cow
   - ☐ Virginia Opossum
   - ☐ Bobcat

6. **Which of the following are characteristics of omnivores? Select all that apply.**
   - ☐ Long canine teeth
   - ☐ Sharp pre-molars
   - ☐ No incisors
   - ☐ Flat molars

7. **Which of the following animals is an omnivore?**
   - ☐ Opossum
   - ☐ Coyote
   - ☐ White-tailed Deer
   - ☐ Red Fox

8. **True or False. Prey have forward-facing eyes.**
   - ☐ True
   - ☐ False

9. **Why is diversity important? Select all that apply.**
   - ☐ Protection from disease outbreak
   - ☐ Offer unique experiences for human recreation and tourism
   - ☐ Increase ecosystem productivity
   - ☐ All predators need a varied diet

10. **How do adaptations help animals?**
    - ☐ It helps them escape predators
    - ☐ It helps them hunt for prey
    - ☐ It helps them survive in their environment
    - ☐ All of the above

Knowledge Assessment – Invasive Species

Please answer the following questions to the best of your ability.

1. **What is a native species?**
   - ☐ A species that is naturally occurring and self-sustaining in a particular environment
   - ☐ A species that is not established in a particular environment
   - ☐ A species whose introduction causes ecological harm
   - ☐ None of these

2. **What is an invasive species?**
   - ☐ A species that is naturally occurring and self-sustaining in a particular environment
   - ☐ A species that is not established in a particular environment
   - ☐ A species not naturally occurring in a certain environment whose introduction causes ecological harm
   - ☐ None of these

3. **What is one way that invasive species may be introduced?**
   - ☐ It travelled there on it's own
   - ☐ It was in a package from a different country
   - ☐ Weather events carried it there
   - ☐ All of the above

4. **What is one reason that invasive species are so hard to manage?**
   - ☐ It is hard to take invasive species back to their original habitat
   - ☐ New species introduced to eradicate the invasive species may result in a new invasive species
   - ☐ Chemical control can cause harm to native species
   - ☐ All of the above

5. **What is one reason native species compete with invasive species?**
   - ☐ North American species are well-adapted compared to European and Asian species
   - ☐ Humans depend on invasive species
   - ☐ Both species need humans to survive
   - ☐ Invasive species have few (if any) predators to control population growth

6. **Invasive species threaten native species because (select all that apply):**
   - ☐ Invasives compete with natives for resources
   - ☐ Invasives are bigger
   - ☐ Invasives can be used for medicine
   - ☐ Invasives take up a lot of space

7. **Which of the following is a characteristic of an invasive species?**
   - ☐ Short-lived
   - ☐ Long generation time – takes a long time to reach sexual maturity
   - ☐ Tolerant to a range of environmental conditions
   - ☐ They do not cause ecological harm

8. **Why are invasive species a problem?**
   - ☐ They disrupt ecosystem functions
   - ☐ They don't have predators
   - ☐ They reduce abundance and diversity of native species
   - ☐ All of the above

9. **True or False. You cannot control invasive species by introducing another organism.**
   - ☐ True
   - ☐ False

10. **True or False. All non-native species cause ecological harm.**
    - ☐ True
    - ☐ False

Knowledge Assessment – Food Web

Please answer the following questions to the best of your ability.

1. **True or False. Food webs and food chains are the same.**
   - ☐ True
   - ☐ False

2. **What is a trophic level?**
   - ☐ A carnivore at the topmost level in the food chain
   - ☐ Links in a food web starting from producer to apex consumer
   - ☐ A carnivore that only feeds upon herbivores
   - ☐ Position an organism occupies in a food chain/food web

3. **Which is not a trophic level?**
   - ☐ Secondary producer
   - ☐ Producer
   - ☐ Tertiary consumer
   - ☐ Secondary consumer

4. **What is the correct order of trophic levels?**
   - ☐ Producer → secondary consumer → primary consumer → tertiary consumer
   - ☐ Producer → primary consumer → secondary consumer → tertiary consumer
   - ☐ Primary consumer → producer →secondary consumer → tertiary consumer
   - ☐ Tertiary consumer → secondary consumer → primary consumer → producer

5. **What does the arrow in a food web or food chain represent?**
   - ☐ Which organism an animal eats
   - ☐ The flow of energy
   - ☐ The direction of the sun
   - ☐ None of the above

6. **What is another name for a producer?**
   - ☐ Primary producer
   - ☐ Heterotroph
   - ☐ Herbivore
   - ☐ Autotroph

7. **Which of the following trophic levels can omnivores be found in? Select all that apply.**
   - ☐ Producers
   - ☐ Primary consumers
   - ☐ Secondary consumers
   - ☐ Tertiary consumers

8. **What is the ultimate energy source that starts any food web/food chain?**
   - ☐ Producers
   - ☐ Autotrophs
   - ☐ The sun
   - ☐ Primary consumers

9. **True or False. Producers never benefit from consumers.**
   - ☐ True
   - ☐ False

10. **What happens if one part of the food chain/food web is removed?**
    - ☐ Every organism is impacted by the change
    - ☐ One or more of the animals in the food chain will go extinct
    - ☐ Primary consumers become secondary consumers
    - ☐ Producers will no longer be able to reproduce

Aquatic Science Camp Survey Instrument

Summer Camp Pre-Assessment Name _____

1. In the box below, draw a reptile with as much detail as you can. Label your drawing.

2. What is the definition of an adaptation?

3. Fill-in-the-blank: _____ _____ separate the Sound from the Gulf.

4. Circle the letter that corresponds to the flipper of a dolphin on the image below?

5. I can help conserve animals or their habitats by:
   a. _____
   b. _____

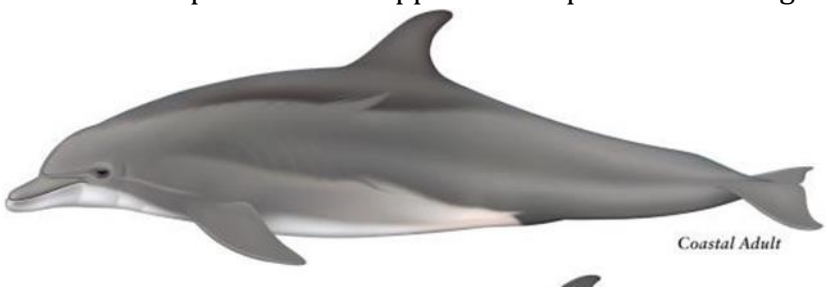
For this activity, you are to put an X in the box that best shows how you feel about each of the statements. Remember, there are no right or wrong answers. The first row is an example.

	Strongly agree	Agree	Not sure	Disagree	Strongly disagree
EXAMPLE: Chocolate ice cream is one of my favorite flavors		X			
1. Plants and animals have as much right as people to live					
2. There are too many (or almost too many) people on earth					
3. People are smart enough to keep from destroying the earth					
4. People must still obey the laws of nature					
5. When people mess with nature it has bad results					
6. Nature is strong enough to handle the bad effects of people and pollution					
7. People are supposed to rule over the rest of nature					
8. People are treating nature badly					
9. People will someday know enough about how nature works to be able to control it					
10. If things don't change, we will have a big disaster in the environment soon.					
11. I have talked with my family about how to help with environmental problems.					
12. I would be willing to separate my family's trash for recycling					
13. To save energy, I turn off the lights at home when they are not in use.					
14. I would like to see animals and birds near my home.					
15. I get angry about the damage pollution causes the earth.					
16. I do not worry about environmental problems.					
17. It makes me sad to see houses being built where animals used to live.					
18. I think learning about science is interesting.					
19. Understanding science is important to me.					
20. I am sure I can do science work even if it is really hard.					
21. An important reason I do the science work is because I want to get better at doing science.					
22. The main reason I do science experiments is because my teacher says so.					
23. I expect to do well when we do work in science.					
24. My mom and dad encourage me to participate in science activities.					

Summer Camp Post-Assessment Name _____

6. In the box below, draw a reptile with as much detail as you can. Label your drawing.

7. What is the definition of an adaptation?
8. Fill-in-the-blank: _____ _____ separate the Sound from the Gulf.
9. Circle the letter that corresponds to the flipper of a dolphin on the image below?



10. I can help conserve animals or their habitats by:
    a. _____
    b. _____
11. How do you feel after your visit to Aquatic Science Center? Circle one!

12. How much did you learn from you visit to Aquatic Science Center? Circle one below!

A lot A little I don't know None The lesson confused me

For this activity, you are to put an X in the box that best shows how you feel about each of the statements. Remember, there are no right or wrong answers. The first row is an example.

	Strongly agree	Agree	Not sure	Disagree	Strongly disagree
EXAMPLE: Chocolate ice cream is one of my favorite flavors		**X**			
1. Plants and animals have as much right as people to live					
2. There are too many (or almost too many) people on earth					
3. People are smart enough to keep from destroying the earth					
4. People must still obey the laws of nature					
5. When people mess with nature it has bad results					
6. Nature is strong enough to handle the bad effects of people and pollution					
7. People are supposed to rule over the rest of nature					
8. People are treating nature badly					
9. People will someday know enough about how nature works to be able to control it					
10. If things don't change, we will have a big disaster in the environment soon.					
11. I have talked with my family about how to help with environmental problems.					
12. I would be willing to separate my family's trash for recycling					
13. To save energy, I turn off the lights at home when they are not in use.					
14. I would like to see animals and birds near my home.					
15. I get angry about the damage pollution causes the earth.					
16. I do not worry about environmental problems.					
17. It makes me sad to see houses being built where animals used to live.					
18. I think learning about science is interesting.					
19. Understanding science is important to me.					
20. I am sure I can do science work even if it is really hard.					
21. An important reason I do the science work is because I want to get better at doing science.					
22. The main reason I do science experiments is because my teacher says so.					
23. I expect to do well when we do work in science.					
24. My mom and dad encourage me to participate in science activities.					

APPENDIX B

SCHEDULES

Nature Camp Schedules

Table B.1 3-Day Nonresidential Nature Camp Schedule of Activities 2022

Monday June 13

Time	Activity
7:45-8:15	Check-in
8:15-8:30	Survey
8:30-11:00	Canoeing
11:15-12:00	Team building game (balloon tower; start lunch)
12:00-12:45	Lunch
1:00-2:00	Owl Pellet Dissection
2:00-2:45	Wildlife habitat
3:00-5:00	Over the Hedge-habitat loss; T/F
5:00-5:30	Parent pickup

Tuesday June 14

Time	Activity
7:45-8:15	Check-in
8:30-9:00	Weather Bingo
9:00-9:30	Travel to Eastdell Lake
9:30-11:30	Forestry/Dendrology/Forest Ecology
11:30-12:15	Nature hike/scavenger hunt
12:30-1:00	Picnic lunch
1:00-1:30	Travel to NWR
1:30-2:45	Visitors Center Boardwalk
2:45-3:15	Travel to university
3:15-3:30	Snack/bio break
3:30-4:00	Trail camera photo ID PPT
4:00-4:15	Travel to Southcliff
4:15-5:00	Set out trail cameras
5:00-5:30	Parent pickup

Table B.1 (continued)

Wednesday June 15

Time	Activity
7:45-8:15	Check-in
8:30-9:00	Pick up trail cameras
9:00-10:30	Macroinverts.
10:30-10:45	sampling Snack
10:45-11:15	Watershed lesson
11:15-11:45	Review pics from trail cameras
11:45-12:30	Lunch
12:30-1:45	Mammals - pelts, skulls, tracks/plaster tracks
2:00-3:30	Water
3:30-4:00	Qual.
4:00-5:00	Survey
5:00-5:30	Ice cream sundae social/games
	Parent pickup

Table B.2 3-Day Residential Nature Camp Schedule of Activities 2022

Sunday June 5

Time	Activity
3:00-3:45	Check in
4:00-4:30	Parent meeting
4:30-5:00	Ice breaker/intros
5:00-5:45	Dinner
6:00-8:30	Fishing
9:00-9:45	Night sounds/animals
10:00-11:00	Dorm time
11:00	Lights out

Table B.2 (continued)

Monday June 6

Time	Activity
7:30-8:00	Breakfast
8:00-8:30	Travel to Orshore
8:30-11:30	Firearm safety
11:30-12:00	Travel to campus
12:00-12:45	Lunch
1:00-2:15	Bird ID scavenger hunt
2:15-2:30	Snack
2:30-3:30	"Birds and Worms"
4:00-5:00	Plaster tracks, pelts, skins and skulls
5:15-6:00	Dinner
6:00-7:15	Volleyball
7:30-9:30	Wildlife film
10:00-11:00	Dorm time
11:00	Lights out

Tuesday June 7

Time	Activity
7:30-8:15	Breakfast
8:30-10:00	Electrofishing/seining
10:15-11:15	Macroinvertebrates
11:30-12:00	Change clothes
12:15-1:00	Lunch
1:15-2:00	Waterfowl
2:15-3:00	Habitat and deer
3:00-3:15	Snack
3:15-3:45	Travel to Longview
4:00-5:00	Habitat management/prescribed burn
5:00-5:30	Travel to campus
5:30-6:15	Dinner
6:30-7:15	Hunting dog/Retriever Demonstration
7:15-8:15	Trail Cameras
8:30- 9:45	Trail cameras photo
10:00-11:00	Dorm time
11:00	Lights out

Table B.2 (continued)

Wednesday June 8	
Time	**Activity**
7:15-8:00	Breakfast
8:15-9:00	Check trail cameras
9:00-9:30	Travel to Eastdell
9:30-11:30	Forestry/Dendrology/Forest Ecology
11:30-12:00	Travel to campus
12:00-12:45	Lunch
1:00-2:30	Entomology
3:00-4:30	Water quality
4:30-5:15	Pack up
5:30-7:00	Family Dinner/awards
7:00-800	Dorm Checkout

Aquatic Science Camp Schedule

Guppies	Monday - Finding Fish			Tuesday - Discovering Dolphins			
Time	Activity	Description	Location	Time	Activity	Description	Location
08:00	Drop-off			08:00	Drop-off		
08:15				08:15			
08:30	Introduction to Camp and Expectations of Campers	Introductions, rules, week outline, icebreaker games	Classroom	08:30	Introduction to Animals	Introduction to Freshwater Fish	River
08:45				08:45			
09:00				09:00	Mammal Team Talk	Enrichment	Lower Dolphin
09:15				09:15	Animals Cont.	Saltwater Fish	Building 40
09:30				09:30			
09:45	Snack 1			09:45	Snack 1		
10:00	Behind the Scenes	BTS Tour	BTS	10:00	Marine Mammals	Lesson, dolphin anatomy, echolocation game	Classroom
10:15				10:15			
10:30				10:30			
10:45				10:45			
11:00				11:00			
11:15				11:15			
11:30	Lunch		Classroom	11:30	Lunch		Classroom
11:45				11:45			
12:00				12:00			
12:15	Fish Biology	Lesson, floating fake fish craft	Classroom	12:15	Otterly Amazing	Lesson, carrying capacity game	Classroom
12:30				12:30			
12:45				12:45			
13:00				13:00			
13:15	Facilities Talk	Campers meet FO	LSS Yard	13:15			
13:30	Snack 2			13:30	Snack 2		
13:45	AMB Animal	Anna and Elsa	MAC	13:45	AMB Animal	Pele	Classroom
14:00				14:00			
14:15	Finish Crafts		Classroom	14:15	Dolphin	Game	Outside
14:30				14:30			
14:45	Prep for Pick-up		Classroom	14:45	Prep for Pick-up		Classroom
15:00	Pick-up		15TH ST	15:00	Pick-up		15TH ST

Figure B.1 5-Day Aquatic Science Camp Schedule of Activities, 2022

Figure B.1 (continued)

Wednesday - Analyzing Aves				Thursday - Recognizing Reptiles			
Time	Activity	Description	Location	Time	Activity	Description	Location
08:00	Drop-off	Pick up food for the day		08:00	Drop-off	Pick up 1st snack	
08:15				08:15			
08:30	Board Ferry	Transport		08:30	Prep Campers	Be sure all campers are appropriate	Classroom to CTA
08:45				08:45			
09:00				09:00	Beach Day	Sampling	Beach
09:15	Ferry Ride	Campers will all sit together on 2nd floor of ferry	Island Excursion	09:15			
09:30				09:30			
09:45				09:45			
10:00				10:00			
10:15	Tour of South Side of Island	After stepping off ferry group explores South Ship	Pavilion & Southern Island	10:15			
10:30				10:30			
10:45				10:45	Pick-up	Park	to Classroom
11:00				11:00	Camper Clean-up	Change clothes	Classroom Bathrooms
11:15	Lunch		N. Pavilion	11:15			
11:30				11:30	Lunch		Classroom
11:45				11:45			
12:00	Tour of Fort	Learn about the vibrant history of Fort	Fort	12:00			
12:15				12:15	Reptile Time	Lesson, make your own reptile, Freddi's Adventure	Classroom and outside
12:30				12:30			
12:45	Free Play on North Side of Island	Explore Sound	Northern Island	12:45			
13:00				13:00			
13:15				13:15			
13:30	Snack 2		N. Pavilion	13:30	Snack 2		Outside
13:45	Collect Belongings and Board Ferry	Board at least 15 minutes early		13:45	AMB Animal	Bobbie	Classroom
14:00				14:00			
14:15				14:15	Slithery Snakes	Snake Craft	Classroom
14:30	Ferry Ride	Campers will all sit together ferry	Ship Island Excursion	14:30			
14:45				14:45	Prep for Pick-up		Classroom
15:00				15:00	Pick-up		15TH ST
15:15							
15:30	Arrive Back at Port	Pick-up					
16:00	Pick-up	Late Pick-up Day	15TH ST				

Figure B.1 (continued)

Friday - Invertebrate PI			
Time	Activity	Description	Location
08:00	Drop-off		
08:15			
08:30	AMB Animal	Invert Touch	3rd Floor
08:45	Aquatics Team Talk	Feeding	3rd Floor
09:00	Squid Dissection	Each Camper will disect their own squid!	Classroom
09:15			
09:30			
09:45	Snack		Outside
10:00	Goodbye Party	Jellyfish craft, games, certificates, thank you cards, fun!	Classroom
10:15			
10:30			
10:45			
11:00			
11:15			
11:30			
11:45	Prep for Pick-up		Classroom
12:00	Pick-up		15TH ST

APPENDIX C

FOCUS GROUP QUESTIONS

Focus Group Questions

1. **Opening Questions –** *an easy, factual question that participants can easily answer*.
    a. Name
    b. Pronouns
    c. What do you want to be when you grow up?

2. **Introductory Questions**
    a. What comes to mind when you hear the word environment?

3. **Transition Questions**
    a. Are you interested in learning about science? → For example, animal science, environmental science, engineering/robotics
    b. Do you personally know any scientists in your community? On TV/the internet?
    c. Where do you get information about the environment?
    d. Do you do anything at home/in school to protect the environment?

4. **Key Questions**
    a. Is the outdoors a place where you…
        i. get to do things you like?
            1. What do you like to do outside?
            2. What do you wish you could do outside?
        ii. Feel you belong?
        iii. Feel safe?
    b. Do you learn about the environment from places outside of school? (For example, museums, 4-H, Scouts). Why or why not?
        i. If you don't, would you like to?
    c. If you had the chance to go to youth outdoor camp, would you go?
        i. A science museum?
        ii. Do you think your parents would let you go?
    d. What types of activities have you do in school where you learned about the environment?
        i. What did you like/dislike about it?

5. **Ending Questions** – *Wrap up the conversation & the purpose of the study*
    a. Is there anything you wanted to say that you didn't get to say?
    b. Is there anything you wanted to talk about that we didn't get to talk about?