"That's My Kind of Animal!" Designing and Assessing an Outdoor Science Education Program with Children's Megafaunaphilia in Mind

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Abstract

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Children are naturally curious about plants and animals, and while they no longer have the same amount of direct experience with and knowledge of the natural world that previous generations did, they do have a high degree of exposure to mediated nature through television, film, and the Internet. The media, however, are often criticized for the highly stylized ways they represent the natural world. In the absence of direct, hands-on nature experiences with their own local plants and animals, children's knowledge and expectations of the natural world are being shaped by their vicarious experiences with mediated nature. The deeply nuanced relationship between modern children and mediated nature has only recently begun to appear in formal research schemes and much remains unknown about the ways that mediated nature biases children in the absence of direct experiences of the natural world.

The present, quasi-experimental, study explored three hypothesis-clusters regarding the cognitive, affective, and behavioral factors involved in children's participation in a residential, outdoor science education program. Specifically, the study assessed the outcomes of participation in a semi-structured, though brief, intervention embedded within the outdoor science program. The intervention was specifically designed to take into account children's preferences for large, charismatic animals—their *megafaunaphilia*—and their nature-experience expectations. Given these preferences and expectations, the intervention lesson featured a direct, hands-on encounter with local wildlife specimens in which the tactile element of the experience was emphasized.

Students from nine Grade 5 classrooms in a rural school district in Northern California (n= 260) were both pre- and delayed post-tested using an in-class survey instrument. As a means of addressing possible testing bias, a tenth class completed only the post-test (n=29). Pre-test results indicated that children, despite having positive affective attitudes toward nature, possessed limited knowledge of local species. A delayed post-test (average time, 19 weeks) revealed significant knowledge gains for students. Detected more than four months after participation in the residential, outdoor science education program, these knowledge gains appear to be persistent. Students in the treatment condition did not appear to receive additional cognitive benefit from participation in the intervention lesson. As hypothesized, children expressed a high level of interest in local species even prior to participation in the outdoor science program; similarly, children expressed a strong preference for learning about wildlife through direct modes. Their preferences—both for local versus exotic species and for direct versus vicarious modes of learning—were not significantly changed at the time of post-testing.

Results of this study may be insightful for educators in formal and informal science learning contexts—as well as for conservationists—for whom increasing children's knowledge of and interest in the natural world are considered to be important goals. Specifically, programmatic recommendations are made in light of these findings regarding the interplay between children's consumption of mediated nature and the outcomes of their engaging in direct, hands-on nature experiences.

Keywords: Informal science learning, environmental education, megafaunaphilia

For Mason. Without you, I never would have set off down this road that has brought me here.

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LIST OF ABBREVIATIONS

ATN	Attitudes Toward Nature
CFS	Creekside Field Station
COSEP	Creekside Outdoor Science Education Program
KAP	Knowledge-Attitudes-Preferences Framework
PLWA	Preference for Learning about Wildlife-Animal
PLWM	Preference for Learning about Wildlife-Mode
UC	University of California
WK	Wildlife Knowledge

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Chapter One

Introduction

1.1 Background Many fear that even as scientific knowledge of the natural world continues to increase, the layperson's knowledge of what could be referred to as *near-by nature* is decreasing, even for children (Atran, Medin, & Ross, 2004; Nabhan & St. Antoine, 1993). This holds for children, as well. Despite expressing strong interest in learning about nature, children have limited knowledge of local plants and animals. This knowledge-gap concerns both educators and conservationists for whom children's familiarity with nature is considered to be an essential stepping-stone toward both understanding and caring for the natural world (Balmford, Clegg, Coulson, & Taylor, 2002). A contributing factor to this knowledge-gap is children's lack of intimate and hands-on interaction with near-by nature—experiences that historically have been hallmarks of childhood (Nabhan & Trimble, 1994).

Instead of direct, hands-on experiences with flora and fauna, today's children are more likely to encounter nature in some mediated form—through television programming, in feature films, on the Internet, or in a video game (Pergams & Zaradic, 2008). These mediated forms of nature tend to place a much greater emphasis on large, exotic animals (typically the more exciting and charismatic mammals) than they do on local species and portray interactions between species as dramatic, even violent. Further, they present these interactions in ways that suggest that they are so commonplace as to be readily observed by the ordinary spectator (Quammen, 2001). Referred to as nature pornography (Barsanti, 2008), these distorted portrayals of the natural world in the media can inaccurately shape children's expectations of a nature experience and can lead to disillusionment when in "real" nature (Louv, 2005; Siebert, 1993). The task of designing near-by nature experiences through which children might have the opportunity to learn about local plants and animals can be complicated by these false expectations; the task can also be informed by them.

1.2 Study Overview The present study examines a cohort of Grade 5 students (*N* = 289) in one Northern California school district who participated in a multi-day (residential) outdoor science program known as the "Creekside Outdoor Science Education Program" (herein, COSEP).[1] Begun five years ago, the program was designed to provide "Lorry Unified School District" children with a direct nature experience with the goals of increasing children's knowledge of their local environment as well as stimulating a more holistic interest in learning about the natural world.

During the 2010-11 iteration of the COSEP, all Grade 5 public school classes in the District participated in the general residential program; half of these children also participated in a supplemental, 50-minute experimental component. This intervention session was specifically designed to build on children's expectations of a nature experience—expectations that have been shaped, not by direct, first-hand experiences with the natural world, but by passive exposure to the nature represented in the media. With children's megafaunaphilia in mind, the intervention utilized preserved specimens of large, exciting animals found in the greater Lorry area.

From its inception, the COSEP intentionally targeted children's knowledge of the local environment through participation in experiences that were sensorial. For example, during the general COSEP, children gather data on grasshopper populations using insect nets and test water quality by donning waders and collecting samples in the creek—firsts for many students. Pilot studies with a previous cohort of Grade 5 students in the same school district revealed that the sensory aspects of the COSEP remained memorable even after 7 months (Migliarese, 2010). In particular, students wished that they had had even more contact with wildlife during the

[1] All names (including program and district) and identifying references have been changed to protect confidentiality.

trips. Facilitating direct interactions with wildlife, however, is much less practical than it is to have children wading in the creek or catching grasshoppers in the meadow. But rather than dismissing children's expressed desires to have had more of these types of sensory experiences, the experimental intervention was designed to accommodate them as best as possible. In lieu of interactions with *living* (and potentially dangerous) wildlife, the present intervention addressed students' desires for direct animal experiences by providing an experimental group of students (one-half of all participating students) with hands-on interactions with a variety of once-living specimens representing local wildlife species. Through the use of preserved specimens ranging from the dramatic to the subtle, students' level of direct interaction was increased. Students in the experimental group had the opportunity to touch, pick up, and even smell the pelt of a striped skunk, the quills of a porcupine, the eggs of a Western scrub jay, and the pelt of a mountain lion (with claws fully intact), among many other specimens (see Appendix A for a sample of images of specimens used in the intervention). While the overall COSEP experience emphasized discussion of local wildlife via examination of abstract clues (for example, animal scat or tracks), the intervention session provided children with an additional opportunity to experience wildlife in a highly interactive, concrete, and tactile manner.

1.3 Research Questions and Hypothesis-Clusters The purpose of this study was to contribute to a growing body of research on the topic of modern children's relationship with the natural world. This contribution comes through the examination of children's knowledge of local wildlife, their attitudes toward engaging in a range of nature-based activities, and their preferences for learning about wildlife—both species preference and the preferred manner of learning. The research questions that frame this study include: (a) What do children know about local wildlife? Does participation in an intervention lesson (the treatment) that is embedded within a general outdoor science program result in different knowledge outcomes for children? (b) What attitudes toward nature do children hold? Do attitudes change after participation in an intervention lesson within the outdoor science program? Are children's pre-participation attitudes predictive of trip outcomes? (c) Do children prefer to learn about local or exotic species? Do they prefer to learn about wildlife in direct or vicarious ways? Does participation in the intervention lesson result in different preferences for species as well as preferred mode of learning? Do pre-participation preferences for mode of learning predict cognitive outcomes for children in either condition?

These research questions led to the generation of three hypothesis-clusters regarding the impact of cognitive, affective, and behavioral factors on the outcomes of children's participation in an intervention session embedded within the broader COSEP. First, it was hypothesized that children's knowledge of local wildlife was limited prior to the Creekside trip. Participation in an intervention lesson within the COSEP would result in different knowledge gains for treatment group members than for control group members.

Second, despite having had few direct nature-based experiences prior to participation in the COSEP, it was hypothesized that children's pre-trip affective attitudes toward nature were positive (the literature suggests children *do* want to have nature-based experiences). However, given their unfamiliarity with what to expect, children's attitudes would be relatively undifferentiated across activities; without the benefit of previous experience, all of the elements presented would be similarly appealing. After the COSEP trip—a fully immersive and hands-on nature experience—students would be able to make more realistic appraisals of their attitudes toward various elements of nature-based activities and would express more differentiated attitudes at post-testing. This increased variation would result in a shift in overall attitudes toward nature, though the shift might be small. Further, it was hypothesized that attitudes toward nature would be predictive of trip outcomes—the more positive a child's attitude toward nature at the time of pre-testing, the greater the gain in knowledge of local wildlife.

The final hypothesis-cluster addressed children's expressed preferences for learning about wildlife—both their preference for species and their preferred mode of learning. It was hypothesized that, despite the preponderance of vicarious nature experiences in children's lives that tend to focus on exotic species, the children in the sample would prefer to learn about local species and they would prefer to do so through direct modes. These preferences would be durable from pre-test to post-test. Finally, it was hypothesized that students' pre-participation preferences for mode of learning would predict cognitive outcomes for children in either condition.

1.4 Significance of the Study Though not large in scale, this study may have implications for an array of stakeholders working to address the complexities of modern children's relationship with the natural world. Specifically, educators and researchers invested in the development of children's interest in science recognize that the seeds of this interest are sown in early childhood fascination and interaction with the wonders of nature (Imura, 1999). The goal of developing children's understanding of the natural world spans both formal and informal science learning contexts. In a theoretical discussion of the roles interest and motivation play in informal science learning, Renninger (2007) noted, "[i]f there is enjoyment, then return to science and possible identification with science is anticipated. The objective is for participants to be having conversations, exploring, and having fun in and around solid science content" (p. 15). The present study builds on the premise that children's interests in engaging with animals can serve as an entry point into science learning (Gostev & Weiss, 2007; Inagaki, 1990; Thomas, 2007; Toyama, Lee, & Muto, 1997; R. Wilson, 2008). These early experiences can prepare children for success once they encounter school-based science curricula that demand that they be able to link concrete experience with abstract conceptual understanding (Duschl, Schweingruber, & Shouse, 2007). These out-of-school science learning experiences are gaining attention in academic settings, as well. With an emphasis on valuing the full spectrum of contexts in which science literacy develops, new empirical investigations of what children and adults bring to (as well as contribute to and take away from) informal learning settings are underway (Bell, Lewenstein, Shouse, & Feder, 2009). Findings from the present study, then, may be of interest to those involved in designing and implementing curricula in both formal and informal science learning environments.

Conservationists may also find this study valuable. It has long been held that pro-environmental attitudes and behaviors in adulthood can be traced back to childhood experiences exploring and playing in natural environments that were close to home—referred to as "ordinary nature" (Pyle, 2002; Wells & Lekies, 2006). As will be demonstrated in the literature review, the modern landscape of childhood now includes little time spent exploring ordinary, near-by nature. Given such pressing environmental issues as climate change and biodiversity loss (e.g., Ranney & Thanukos, 2011), the findings generated by this study are both timely and topical for conservationists whose goals include instilling in children an appreciation of the natural world that may eventually result in pro-environmental action in adulthood (Chawla, 1998, 1999; Kollmuss & Agyeman, 2002).

1.5 Organization of Subsequent Chapters In order to provide context for the research questions to be addressed in this dissertation, a review of the closely relevant literatures will be presented in Chapter 2. These literatures represent the state of four overlapping, though distinct, fields. The first literature to be reviewed is concerned with children's interest in learning about the natural world. The second literature to be reviewed is the body of work that examines the recent changes to childhood with an emphasis on changes in patterns of time spent in the out-of-doors. From there, the paper will explore the literature surrounding mediated nature, a form of symbolic nature experience that has proliferated in the past several decades as children's direct experiences with 'real' nature have declined. A final literature discussion will review the mechanisms by which children acquire knowledge of the natural world as well as existing empirical evidence that suggests that children now have a more extensive familiarity with large, charismatic animals, particularly exotic species.

In Chapter 3, the unique context of Lorry will be discussed as it relates to the sample of students that participated in the present study. Also, an overview of the Creekside Outdoor Science Education Program will be presented. The methods will be reviewed, including a description of the instrument used as both the pre- and post-test; also reviewed is the intervention session that took place during the COSEP. Chapter 3 will conclude with a discussion of the limitations and delimitations of the study.

The fourth chapter includes an analysis of the results from the data collection process. This analysis is organized around the three general dependent variables under study—children's knowledge of local wildlife, their attitudes toward nature-based activities, and their preference for species as well as preferred mode of learning about wildlife. Chapter 5 comprises a discussion of the results and situates them within a broader corpus of knowledge. The final chapter summarizes the findings from this research project and considers the implications for advancing our understanding of the nuances involved in the relationship modern children have with the natural world.

Chapter Two

Review of Closely Relevant Literatures

2.1 Children's Interests From birth, animals are virtually ubiquitous in the lives of children—from the stuffed toys in their cribs to the characters in fairy tales and fables (Melson, 2001). Research suggests that more than one-third of young children's dreams are about animals (Foulkes, 1982, 1999). Animals play a fundamental role in children's lives, and anyone who has spent time in their presence will attest to children's persistent interest in the animal kingdom. The present study builds on empirical evidence that young children are inherently curious about animals and they seek out opportunities to interact with nature (Kellert & Wilson, 1993). A review of the "interest research" literature illustrates how an understanding of children's interest can be used when designing nature experiences that will develop both knowledge of, and future interest in, the natural world.

Historically, scholastic research on interest has ebbed and flowed. It can be traced in the literature back to the early 19th century when German philosopher Herbart wrote about the relationship between interest and learning, noting that interest served as a significant mechanism for meaningful learning (Schiefele, 1992). Later, Dewey (1913), echoing Herbart, noted, "[i]t is absurd to suppose that a child gets more intellectual or mental discipline when he goes at a matter unwillingly than when he goes at it out of the fullness of his heart" (pp. 1-2). For Dewey (1910), children's playful learning was fueled by curiosity and interest. "In its first manifestations, curiosity is a vital overflow, an expression of an abundant organic energy. A physiological uneasiness leads a child to be 'into everything,'— to be reaching, poking, pounding, prying" (p. 31). Despite the widespread popularity of the work of Dewey and his contemporaries, scholastic interest-research waned for the better part of the 20th century. Rather, behaviorism took hold, a new framework that did not place much emphasis on "unobservable psychological constructs such as interest" (Schraw & Lehman, 2001, p. 25).

With a shift from a behavioral to a cognitive paradigm, one in which affective variables were taken up more seriously, interest became interesting again. In the current literature, interest is conceptualized as having both cognitive and affective components and is described as a habitual tendency, a motivational belief, or a component of one's personality (Renninger, Hoffmann, & Krapp, 1998; Hidi, 2000). Hidi and Renninger (2006) proposed a four-phase model of interest development. Situational interest, the early phase of interest development, is the curiosity that is elicited by certain aspects of the environment, including content and structural features; it is what is often referred to as the 'wow' moment or the hook. If maintained, situational interest can facilitate the development of individual interest (Krapp, Hidi, & Renninger, 1992). Individual interest is described as an individual's predisposition to attend to certain stimuli, events, and objects; it is often considered to be well-developed and persistent, leading to a willingness to reengage with a topic even in the absence of a 'wow' moment (Ainley, Hidi, & Berndorff, 2002; Hidi & Renninger, 2006). School-based science, however, has long been criticized for failing to spark and retain students' curiosity in the domain (Aikenhead, 2005; Osborne & Collins, 2000).

A large multi-national study of affective factors influencing students' interest in learning about science and technology, the ROSE Project (Relevance of Science Education), has demonstrated that secondary students do express interest in science though the topics of most interest are overlooked in curricula. Specifically, students are interested in learning about the biological sciences and the topics of highest interest are those that have personal relevance such as health/nutrition science and local environmental issues (Sjøberg & Schreiner, 2010; Uitto, Juuti, Lavonen, & Meisalo, 2006). Using questionnaire instruments consisting of four-point disagree/agree Likert-type scales, international comparative work carried out by the ROSE

Project consistently found that adolescents are interested in science that they feel is relevant—a characteristic students found to be lacking in most school science (Jenkins & Pell, 2006).

Animals can also play a role in sparking students' interest in science learning. An examination of undergraduates' interest development in a zoology class found several situational factors to be at work, including the use of live animals in the course and having "ah-ha!" moments that served as a hook (Dohn, Madsen, & Malte, 2009). It is worth noting that the live animals used by Dohn et al. in their study were what could be considered 'ordinary animals'—a toad, a guinea pig, and a once-living crab. Participants stated that the opportunity to have had hands-on experiences with the animals, despite their pre-existing familiarity with them, was a meaningful aspect of raising their interest in the lesson subject matter. In discussing their findings, the authors suggested that the students' interests were heightened due to the integration of both direct perceptual experience and engagement as a result of their interactions with the live animals.

The findings regarding the use of hands-on experiences with animals in the science classroom were bolstered by Holstermann, Grube and Bogeholz (2010). In a study of high-school biology students, the authors report that it was the quality of a hands-on experience that was essential for developing student interest. In particular, hands-on labs that involved working with animal specimens (e.g., dissections) were found to provoke students' interest in reengaging with the topic being studied.

It appears that direct, hands-on experiences with animals are becoming increasingly rare for children despite their potential for transforming interest in plants and animals into a lifelong commitment to learning about, and possibly caring for, the natural world. Opportunities for children to pursue their curiosities about the natural world—what Dewey described as the need to reach, poke, or prod—may no longer be the hallmarks of childhood.

2.2 Changing Childhoods "For much of human evolution, the natural world constituted one of the most important contexts children encountered during their critical years of maturation" (Kahn & Kellert, 2002, p. vii). As this quote suggests, our survival as a species was intricately linked to our knowledge of the plants and animals in our immediate environment (Coley, Solomon, & Shafto, 2002). It has been suggested that this intimate 'nature-knowledge' became part of our evolutionary legacy and that many of the cognitive mechanisms we use in thinking about the natural world today were laid down by these eons of direct experience with nature (Medin & Atran, 1999). Referred to as the *biophilia hypothesis* (Kellert & Wilson, 1993), this innate desire to have such intimate contact with the natural world is now shaped by culture, context, and experience, each playing a role in the development of how we think about the environment (Bang, Medin, & Atran, 2007; Waxman & Medin, 2007). As we became more agrarian and then urbanized, the degree to which we interacted with, and subsequently understood, the natural world diminished (E. O. Wilson, 2002). While direct and daily contact with nature is no longer the prerequisite for survival that it had been for much of human evolution (Medin & Atran, 1999), the echoes of our desire for intimacy with the natural world may remain.

Despite these evolutionary predispositions, we have shifted away from having intimate, daily, contact with nature. This is especially true for modern children, which some claim have become largely estranged from the natural world (Kellert, 2002). Building forts in empty lots and catching lightening bugs in jars were typical events of childhood, but time once spent exploring and playing outdoors has been transformed (Nabhan & Trimble, 1994). Modern children spend a large degree of their free time occupied by indoor activities, most of them sedentary and digital. This appears to hold for children growing up in both urban *and* rural areas (O'Brien, 2010). A host of factors have contributed to childhood's steady shift to the indoors, including the lack of accessibility to outdoor play spaces, the growth in the use of technology, and when outdoor play is available, the level of structure now being imposed on that time.

For example, recess has historically been a time for children to experience the outdoors through play and exploration. A recent study, however, revealed that nearly 15 percent of upper elementary children in the United States no longer have any recess time at all during the academic day (Parsad & Lewis, 2006). Even when playtime is permitted, air quality often forces children indoors (Breathe California, 2007). Once indoors, children now spend most of their time engaging with some type of electronic device.

A recent article in *Pediatrics* reported that more than one-third of American children aged 3 to 6 years have a television in their bedroom (Vandewater, Rideout, Wartella, Huang, Lee & Shim, 2007). And it was found that the amount of time young children spent viewing television significantly decreased the amount of time they spent engaged in creative play (Vandewater, Bickham, & Lee, 2006). Referred to as 'digital natives' (Prensky, 2001) and 'screenagers' (Rushkoff, 2006), adolescents are even more plugged in than their younger peers. On average, children 8- to 18-years old in the United States will spend upwards of seven-and-half hours *each day* in front of some type of electronic screen including televisions sets, MP3 devices, cell phones, and computers (Rideout, Foehr, & Roberts, 2010).

When children do spend time away from an electronic gadget, they aren't engaged in free-play. Rather, their time is increasingly spent in highly-structured activities. For example, over 41 million children in the United States now participate in adult-organized and highly-regulated competitive sports (Bianchi & Robinson, 1997; Hilgers, 2006). In addition, activities such as music lessons and academic enrichment classes (e.g., test preparation programs) now occupy a significant amount of children's out-of-school time that was once eligible for free-play (Juster, Ono, & Stafford, 2004). In an investigation of how Americans spend their time, a multi-decade study found that children's free playtime decreased approximately 25% between 1981 and 1997, in part due to an increase in time spent in more structured activities (Hofferth, 2009).

Each of these factors contributes to the decline in children's direct contact with near-by nature both during the school day and during out-of-school hours. This decrease results in what Pyle calls the "extinction of experience" (Pyle, 1993; 2002, p. 312) where those tactile and immersive nature experiences are being replaced with a different form of nature—the vicarious, electronic kind.

2.3 Mediated Nature While childhood may now include fewer turtles stashed in shoeboxes, forts built in empty lots, or nights spent in a tent under a star-speckled sky (Nabhan & Trimble, 1994; Pyle, 1993), children do encounter a wide range of representations of the natural world (Kellert, 2002). These symbolic forms of nature are delivered right into our homes, courtesy of the media. "Such vicarious representations of nature are surprisingly prolific despite modern society's diminishing direct contact with nature, a consequence both of revolutionary new electronic media (film, television, computers) and of the widespread occurrence of more traditional forms of written communication (books, magazines, comics)" (Kellert, 2005, p. 66). Mediated representations of nature, however, are not new.

Leland Stanford, one of California's most notorious tycoons and robber barons of the 19th century, unwittingly cast animals as subjects of the media when he commissioned Eadward Muybridge to photograph a galloping horse. The images revealed that all four feet are simultaneously off the ground, settling the long-standing question of animal locomotion (Mitman, 1999). The use of animals in photographic still images would give way to short motion films shown at nickelodeons and in traveling exhibitions, often before the feature presentation. Eventually, their popularity provided production houses with the opportunity to produce feature-length nature films in which dramatic interactions between humans and animals took center stage, often with the animals faring worse than the adventurer (Chris, 2006; Mitman, 1999).

During the early decades of the 20th century, sensationalism and fakery became the norm even as the role of motion pictures as conveyors of scientific and educational content was being touted (Mitman, 1999). For example, a 1909 thriller chronicling the African safari adventures of

President Theodore Roosevelt was filmed in its entirety on a Chicago movie lot (Mitman, 1999). Films such as *Hunting Big Game in Africa* were revered for their role in bringing scientific natural history to the masses even as they deliberately blurred the line between fact and fiction (Mitman, 1999). The legendary nature film *Simba* was released in 1928 and earned over $2 million despite having blatantly staged scenes and using stock footage of lions, elephants, and rhinoceros, as well as indigenous people (Chris, 2006). The fraudulent practices used in *Hunting Big Game* and *Simba*, as well as in most other nature films of the time, were common cinematic tools used widely, even by the Walt Disney Studios. Disney's *True-Life Adventures* gained popularity in the 1940s and 1950s with titles such as *The Living Desert* and *Jungle Cat* and were promoted as being completely authentic, unstaged, and unrehearsed with no use of fictitious situations or characters (Mitman, 1999). Disney's ground-breaking cinematic format of presenting nature would spawn labels still used today such as Disneyesque, Disneyfication, and Disneyfied; Disney's claims of authenticity would eventually be revealed to be false and the admission of guilt would turn those terms into derogations (Louson, 2010). The Disney Corporation would later apologize for their deliberate use of fakery and forgery and would attempt to justify their use by stating that the power of their films to promote an awareness of nature trumped any misleading practices that may have been used in their making (Williams, 2010).

Following in Disney's footsteps, a string of nature films made for the big screen were adapted for television and naturalists were made into small-screen stars in the 1960s-80s. Marlin Perkins on NBC's *Wild Kingdom*, Marty Stouffer of PBS's *Wild America*, and the BBC's *Look* and *Life on Earth* featuring Jeffery Boswall and David Attenborough would become mainstays of the made-for-television nature show genre (Bouse, 2000). The advent of cable television, with available stations numbering in the triple-digits rather than the three or four previously available with over-the-air broadcasting, provided a venue where nature films flourished, making stylized nature available to even wider audiences (Chris, 2006). The reach of technological nature expanded once again with the arrival of the Internet. Today, nature programming in some form is available at the viewer's discretion at any time of day or night (Siebert, 1993). As we have seen, the timeline for the proliferation and accessibility of these mediated forms of nature has coincided with a decrease in direct experiences with the natural world.

However, exchanging direct experiences of nature for more vicarious and passive ones may have unanticipated outcomes. Adams (2005) suggested that, in the absence of actual experience with a phenomenon (in this case, nature), our "reality" may be shaped by how that phenomenon has been portrayed for us in the media. Jay D. Hair (1993), former President of the National Wildlife Federation, elaborated, "[n]o amount of technology can replace the human experience necessary to instill a philosophy of stewardship toward Earth's ecosystems. More and more, children are being raised by single-parent families in densely populated urban settings. They have fewer opportunities to draw comparisons between real and televised nature. Without this experience, their challenge to protect the natural world will be even more daunting in the future" (p. 2).

The nature children consume on television differs in many ways from the nature found in the backyard. In an attempt to distinguish how experiences with *real* nature and technological nature affect us, environmental psychologists tested the hypothesis that the restorative power of *real* nature cannot be replicated by a synthetic rendering. Regression analyses of experimental data for 90 university undergraduate test subjects (mean age = 20.8) demonstrated that looking at a window with an actual view of nature was significantly more calming than was viewing a soundless HDTV real-time plasma screen of an essentially similar nature scene. While some physiological calming took place in the form of heart-rate reduction during engagement in a series of low-level stress tasks, viewing the synthesized nature was only marginally more restorative for waiting room subjects than looking at a blank wall (Kahn, et al., 2008; Kahn, Severson, & Ruckert, 2009). Also, studies of children with attention deficit disorder have shown that time spent playing in green environments (e.g., play spaces with natural greenery) support greater attentional functioning than does play in more artificial environments such as paved black-topped school yards (Taylor, Kuo, & Sullivan, 2001). Even while evidence regarding the cognitive, psychological, and physiological benefits of participation in an actual nature experience mounts, the genre of mediated nature continues to proliferate.

A recent *Economist* article reported that Discovery Communications (owners of cable television networks like Animal Planet and the Discovery Channel) declared a $372 million profit in the second quarter of 2010 alone. As the article stated, "nature sells" ("Cue the Fish: Why Natural History is Such Good Business," 2010). But a closer look at the types of programming that audiences, especially children, find so appealing reveals that the misrepresentation of nature continues even today.

Titles such as "*Invasion of the Giant Pythons*," "*Squid vs. Whale*," and "*Monster Fish of the Amazon*" evoke a kind of fast-paced drama not typically encountered by the backyard naturalist. These mediated images of nature, red in tooth and claw, artificially render the interactions between species as exceedingly dramatic and violent. These portrayals become even less realistic when we look at the types of animals that make up much of mediated nature. Overwhelmingly represented are the charismatic megafauna (Barney, Mintzes, & Yen, 2005), particularly large mammalian vertebrates. Data strongly suggest that humans are attracted to species whose young most closely resemble their own young—those animals we consider to be "cute" with large, round eyes and that exude a sense of helplessness (see Lawrence, 1989, for a disucssion of neoteny). Arguably, lower vertebrates and insects are less likely to be seen as charismatic or "cute" and, thus, are rarely given leading roles in mediated forms of nature.[2] When invertebrates are portrayed in the media, they are often highly stylized. The pervasiveness of species inequality is not restricted to the media or the general public. A recent study found that even scientific conservation research favors the cute, the furry, and the interesting (Trimble & Van Aarde, 2010). Even more neglected by academicians, the media, and the general public is the role that plants play in the natural world, amounting to what Atran and Medin (2008) referred to as a phenomenon where plants are "rarely more than stage props" (p. 260).

In an intense critique of the ways that the media distort reality, Funkhouser and Shaw (1990) stated, "[t]he media do not mirror reality. Instead, they expose audiences to synthetic realities fashioned in ways that meet the media's needs. Media images present distorted views of the world that raise false expectations" (p. 75). Mediated nature offers a tremendous amount of sensory input in the form of glossy, fast-paced interactions between species. And as voracious media consumers (Roberts & Foehr, 2004), children have been programmed to expect that the synthetic nature portrayed in the media is the reality of the nature just beyond their front-door. Conditioned to expect the dramatic and the immediate, children bring these erroneous expectations of how the natural world works with them to *real* nature experiences. Once there, they find that real nature moves at a steady, though slow, pace and the type of 'front-row' viewing of dramatic nature is the exception, not the rule (Johnson, 2009). Children's unmet expectations of nature can lead to disappointment and boredom (Louv, 2005; Weigl, 2009), a phenomenon that has also been found to exist with experiences in other informal science contexts where content is selectively represented. In examining learning outcomes of museum and zoo visits, it was found that children arrive with expectations (including to have fun and see exciting things) that, if unmet, can result in disappointment and lowered interest in returning to the setting (Falk, 2005; Falk & Balling, 1982). When some nature programs now feature such explicit violence and sex that they come with a warning about the suitability of the content for

[2] For example, animated films such as Disney-Pixar's *A Bug's Life* (Lasseter, 1998), DreamWorks SKG's *Antz* (Darnell & Johnson, 1998), and DreamWorks Animation's *Bee Movie* (Hickner & Smith, 2007) feature charismatic, though highly anthropomorphized, insects; equally inaccurate are portrayals of mutant invertebrates (typically spiders) such as Warner Bros. (US)'s *Eight Legged Freaks* (Elkayem, 2002) in horror films.

younger audiences (Slade, 1992), it is no wonder that children expect near-by nature to resemble a Hollywood production.

In a lament on the vices and virtues of mediated nature, Siebert (1993) noted, "[w]e travel into jungles and other such places as nature tourists, as though visiting the various sets of a Universal Studios theme park…fully expectant of seeing the creatures whose stories we've watched on the TV" (p. 50). Modern children are not only estranged from the natural world, but ironically, they now suffer from an expectations-reality gap produced by consuming large quantities of scripted nature (McKibben, 1989). Consumers expect a spectacular nature; what they get may not live up to those expectations (Davis, 1997; Weigl, 2009).

The media are focused on selling a particular image of nature—one that is exciting, engaging, and appealing to the masses. And while their decisions to misrepresent the natural world may never have been malevolent, the influence of those representations is far-reaching. Sobel (1996) noted, "[t]he motive for all this is honorable and just, but what's emerging is a strange kind of schizophrenia. Children are disconnected from the world outside their doors and connected with endangered animals and ecosystems from around the globe through electronic media" (p. 3). This shift away from having direct experiences with ordinary and local plants and animals is reflected in the present state of children's knowledge of near-by nature, as we will see in the next section.

2.4 Children's Nature Knowledge For better or worse, generations of armchair naturalists have been introduced to the wonders of the natural world through the various forms of natural history that have been presented by the media. For instance, the films and books of Sir David Attenborough have been particularly influential. With mediated nature as his primary method for inspiring understanding of and care for the natural world, Attenborough has brought armchair naturalists to the African savannah and the Amazonian rain forest for decades. However, he recently spoke about his concern regarding the imbalance between children's knowledge of exotic versus local species. Attenborough (as cited in Jardine, 2010) noted, "I daresay they know more about East African lions and game than they do about foxes" (para. 4). His comment was in reference to findings from a recent study of children's knowledge of plants and animals. The survey of 700 children in the United Kingdom revealed weaknesses in knowledge of even the most common flora and fauna. For instance, the study found that less than half could correctly identify an oak tree (the national tree) and deer were commonly mislabeled as antelope (Wray, 2008).

Concurrent work by the National Trust, a conservation agency in the UK, found similar results in a sample of 1,651 10- to 12-year olds. Half of the participants couldn't tell the difference between a bee and a wasp and even fewer could identify a barn owl (Sniderman, 2008). The children's knowledge of characters in popular science fiction, however, was strong; 9 out of 10 could correctly identify Yoda, a Star Wars character, and a similar number could name the Daleks as Doctor Who's archenemy.

The findings of these two recent studies confirmed those produced by Balmford, Clegg, Coulson and Taylor (2002) with similarly aged children here in the United States. Their study, published in a *Science* article titled "Why Conservationists Should Heed Pokémon," contrasted children's knowledge of nature with their knowledge of man-made 'creatures' such as those in Pokémon, the popular children's card-trading and videogame enterprise. The authors found that children were able to correctly identify nearly 80% of the Pokémon characters but their success rate dropped to less than 50% when attempting to identify common wildlife species such as rabbits or beetles. Their findings led the authors to issue the warning to conservationists: "[p]eople care about what they know" (Balmford, et al., 2002, p. 2367). If children are capable of mastering knowledge of synthetic species such as those in the Pokémon enterprise, conservationists might be wise to figure out how and why this expertise develops.

In their seminal work on American's attitudes, knowledge, and behaviors toward animals, Kellert and Westervelt (1983) studied children's knowledge of wildlife. The methods utilized in their multi-aged study ranged from true/false and multiple choice questions to pictorial identification tasks that included a battery of questions on common traits including diet, migration, etc. They found that children's basic knowledge of wildlife was limited. For example, only slightly more than half of the children surveyed could identify a bald eagle (the national symbol) and less than one-third of children could correctly say whether coral and copperhead snakes (both highly venomous) were common in their area (e.g., found in Connecticut or not). Children faired even worse on measures of their understanding of fundamental ecological processes such as predatory/prey relationship and animal behavior linked to seasonal changes. Their studies revealed that rural children had significantly more knowledge of wildlife than did their suburban and urban counterparts—findings challenged by more recent data. More recent studies reveal that the nature-knowledge gap between rural and urban children that Kellert and Westervelt found might be narrowing. In their investigation of the role of culture in the formation of individuals' epistemological orientations toward nature, Bang, Medin and Atran (2007) demonstrated a consistent weakness in nature-knowledge across both rural and urban children of European descent.[3]

Children know even less about invertebrates. Misconceptions about insects' physiological features, their life cycles, and the roles they play in ecological processes are common in children as well as adults (Barrow, 2002; Braund, 1998; Knight, 2008; Prokop & Tunnicliffe, 2008, 2010; Snaddon, Turner, & Foster, 2008; Strommen, 1995). For example, Shepardson (2002) found that children incorrectly think of insects as being exclusively terrestrial and they frequently described insects using negative associations (e.g., as biting or stinging). Further, children failed to see the integral roles that insects play in the food cycle, overlooking other organisms' dependence on insects as a primary food source and as organic materials decomposers (Shepardson, 2002). In a study utilizing children's drawings as a method for assessing their knowledge of tropical rainforest species (Snaddon, et al., 2008), it was found that, despite fairly sophisticated overall knowledge of the taxa found in rainforests, children over-represented mammals, birds, and reptiles and under-represented insects and annelids in their drawings. Reaffirming Shepardson's findings, Snaddon et al. attributed invertebrates' under-representation in the children's drawings to misconceptions about the relative contribution to biomass and biodiversity that invertebrates represent.

Though not the focus of the present study, it is worth mentioning that research on children's knowledge of plants also reveals similarly weak results. For example, a comparative study of elementary school-aged children and university undergraduates revealed that while knowledge of garden-like food and crop plants (e.g., corn or apple) was good, knowledge of wild plants was weak across both age groups with students correctly identifying less than 10% of common wild plants (e.g., maple tree or sunflower) in a slide show (Cooper, 2008). Some contend that, despite their status as the fundamental basis of the food cycle as producers, plants can become invisible to humans. In a campaign to combat our inability or unwillingness to discern the importance of plants, Wandersee and Schussler (1999) introduced the phrase "plant blindness," noting that even educators tend to "overlook, underemphasize, or neglect plants" (p. 82). This gap between people's knowledge of plants and animals is also seen in the examination of the degree to which people understand and accept evolutionary theory. Ranney and Thanukos (2010) found that, while people may be exposed to less information about plants' evolutionary relationships, it may be easier for people to accept plant evolution than human evolution. Underpinning this flora-fauna knowledge gap may be disinterest—research repeatedly shows that children are less interested in learning about plants than they are in learning about animals (Braund, 1991; Lindemann-Matthies, 2005; Tunnicliffe & Reiss, 2000).

But what do children know about ecological relationships between organisms, particularly in forests—the ecosystem where the participants in the present study largely reside?

[3] In contrast to stronger knowledge exhibited by Native American children living in the same geographic area.

A study that specifically investigated children's knowledge of forest ecosystems revealed an interesting pattern. Strommen (1995) found that while knowledge of animals' diets is fairly strong, three pervasive misconceptions in children's knowledge of forest inhabitants exist. First, large carnivores tend to be overrepresented in both number and type. Second, children do not accurately distinguish between animals found in fresh-water and marine ecosystems. Finally, children frequently included animals not found in forest ecosystems (e.g., lions, tigers, giraffes, and elephants) in their representations of North American forests. As with the rainforest study described above, Strommen (1995) concluded: "children's conceptions of forests and animals can be broadly characterized as rich in content but poor in structure" (p. 695).

In a presentation in which she addressed the factors involved in the disconnection between today's children and the natural world, Lindemann-Mathies (2008) included a playful sketch symbolizing the alienation of children from even common organisms (Figure 1). In the sketch, a teacher dejectedly looks on while her charges recoil from an ordinary snail. While the sketch may poke fun at the issue, its gravity becomes apparent when we look at the ways that different species inadvertently endear themselves to us, repulse us, or arguably worse yet, simply go unnoticed by us.

Figure 1
Lindemann-Mathies' (2008) presentation "Biodiversity Education" featured a sketch (original illustrator unknown) that captures the child-nature disconnect, a topic receiving increased attention across a broad range of research disciplines over the past decade

2.5 Animal Attraction How is it that some species, no pun intended, get the lion's share of attention from humans? It turns out that being good looking in the animal kingdom gets you noticed—and not just by potential mates. Though nascent, the 'charisma theory' of human's predilection for certain species is increasingly found in the conservation biology and psychology literatures. The theory suggests that when it comes to human attention, affection, and understanding of species, the characteristics of appearance, temperament, and expressiveness—referred to as a species' charisma—matter. A species' charisma typically rests on the physical and behavioral characteristics that endear themselves to humans (Harmon, 2009), qualities readily observed in panda bears, dolphins, and tigers; less so in hissing cockroaches, cut-throat trout, or fairy shrimp. "It is easy for most people to appreciate charismatic animals such as birds, mammals, sea turtles, butterflies, or flashy beetles. For one reason or another, it is not as easy to appreciate snakes, salamanders, lizards, and frogs" (Sasa & Bolanos, 2004, p. 191). Often, charisma is appears to be a function of size and it appears that the bigger, the better (dePlace, 2005). Despite the estimate that nearly 35% of the Earth's species (flora and fauna combined) are threatened with extinction (IUCN, 2010), conservation organizations focus on big species that exhibit an abundance of charisma over more imperiled, less exciting creatures. For example, both the World Wildlife Fund and the Natural Resources Defense Council (two of the world's largest conservation organizations) feature stylized bears in their logos as opposed to less charismatic, though more critically endangered, species such as the Catarina pupfish or the axolotl.

Interestingly, recent studies suggest that the general public isn't alone in its preference for charismatic megafauna; scientists suffer from a similar weakness (Trimble & Van Aarde, 2010). It appears that the more charismatic a species is, the more likely it is to be the subject of scientific research. These more charismatic species, who benefit from increased research, in turn become the benefactors of increased funding—a self-perpetuating cycle in the sciences (Adam & Cole, 2010). Further, an animal's attractiveness may even secure them a place in the future of our biosphere. Zoos, which house the captive-breeding programs that may become the genetic storehouses for many animals, are also susceptible to species' aesthetic allure. In a seminal examination of the relationship between animals' body size and their frequency in zoo populations (when controlling for conservation status), Ward, Mosberger, Kistler, and Fischer (1998) found that both adults and children, alike, expressed a marked preference for larger species. Of their subjects, children preferred the largest animals (all mammalian vertebrates), which the authors suggested may be the result of increased interest in social behaviors more readily observable in large species. More recently, Frynta, Liskova, Bultmann, and Burda (2010) identified a significant, positive association between the perceived beauty of parrot species and their numbers in captive breeding programs in zoos worldwide. From a conservation standpoint, a disturbing conclusion of their study also found that attractiveness frequently trumped the level of need across captive parrot species. Taken together, this research, as well as numerous studies that corroborate these findings, indicates that size and attractiveness are highly influential factors in relation to whether or not humans, particularly children, will attend to you as a species. This theory of charisma has implications not only for the exotic species found in zoological captive breeding programs, but also for the ordinary species that comprise near-by nature.

In order to capture both the theoretical and empirical research just discussed, I introduce a new word here, *megafaunaphilia*. The word embodies elements of both the biophilia hypothesis—described as our innate desire to interact with nature—as well as our tendency to be specifically attracted to large, charismatic species. Children's megafaunaphilia will serve as the organizing priniciple for the study's intervention, elaborated in the next chapter.

2.6 Conceptual Framework It has been demonstrated that lions, tigers, and bears, with their charismatic personalities, have managed to endear themselves to people in ways that plants and invertebrates have not, especially to children. Sir David Attenborough, in fact, spent much of his career introducing viewers to these creatures that seem to have the kind of star power that Hollywood, and its audiences young and old, craves. Now, though, even Attenborough is concerned that children do not know the birds, bugs or mammals right outside their doors, a worry backed by ever-expanding research literatures.

In a pioneering effort to unify the findings from multiple fields, social ecologist Stephen R. Kellert conceived of a "modes of experiencing and learning" framework, as seen in Figure 2, that captures the interplay between children and natural world (Kellert, 1996, 2002, 2005). Kellert (2002) elaborated three modes of experiencing nature: *direct experiences* are those that involve direct interaction between an individual and 'wild' nature (e.g., spontaneous exploration in a park, empty lot, or other environments where organisms live relatively independent of human intervention); similarly, *indirect experiences* also involve physical or close-proximity contact with nature though contact occurs in structured or managed contexts such as zoos or aquariums, or with domesticated animals; lastly, *vicarious or symbolic experiences* are those encounters with nature that do not have a direct, physical contact element (e.g., through mediated forms including television, film, the Internet, and print media).

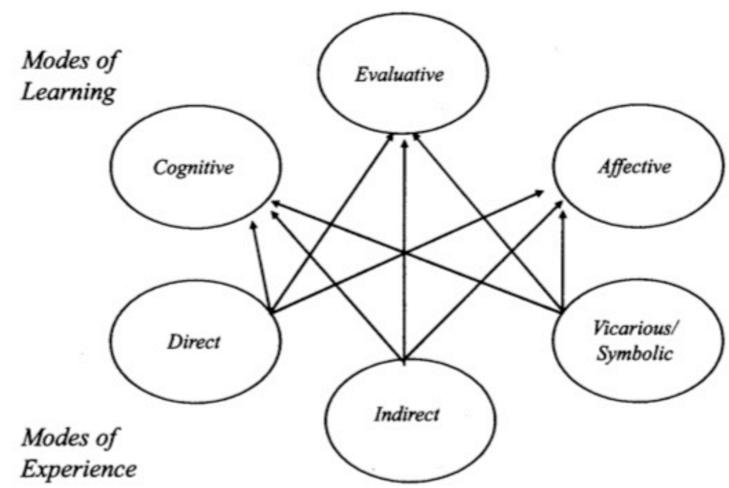


Figure 2
Kellert's Modes of Experiencing Nature and Modes of Learning in Maturation and Development framework (Kellert, 1996, 2002, 2005); reprinted with permission

Whereas Kellert's original modes framework emphasized a unidirectional relationship between experience and cognitive, affective, and evaluative outcomes, interactional theory is now widely used in environmental psychology. Unlike Kellert's framework, interactional theory states that an individual's behaviors are the products of bi-directional interactions between the individual and their environment (Cassidy, 1997). In one such seminal study, Moore (1986) examined preschool teachers' and children's use of space and spatial environments configuration building on Bronfenbrenner's (1979) conceptualization of the ecological milieu. Moore's work illustrated the functionality of interactional theory in predicting a range of cognitive, attitudinal, and behavioral outcomes through analyses of the effects of both social and physical environmental factors, as well as interactions between these factors. Outcomes-research carried out in informal learning environments such as museums, zoos, nature centers, and outdoor education settings, among others, has historically bypassed social and cultural factors as well as possible interactions therein. For example, assessing an individual's previous experiences with a given topic presents complex measurement issues that go well beyond the scope of many programmatic evaluation schemes. Exhibit or program evaluations have tended to focus instead on more straightforward demographic variables such as age, gender, and ethnic identity, excluding the influence prior experience and cultural predispositions can bring to bear on present and future learning (Falk, 2009). New empirical evidence, however, suggests the predictive power of visitors' prior experiences, for example, when modeling the cognitive, affective, and behavioral outcomes of participation in informal learning experiences.

Framed by interactional theory, Powell, Kellert and Ham (2009) investigated the interplay between a range of dimensions specifically involved in *direct* nature experiences. In an attempt to capture the complexity involved in participation in a nature-based tourism experience (a white-water rafting trip), Powell et al. modeled the interactions between what individuals bring to the experience (including their previous experiences and motivations for taking the trip), the characteristics of the trip itself (including features such as the level of immersion in nature and the intensity of the nature-based instruction) and the cognitive, affective, and behavioral outcomes of participation in the trip. In structuring the hypothesized interactive relation between variables, their interactional research framework sought to integrate a broader range of inputs than more traditional informal learning-environments research. Figure 3 illustrates their interactional NBT framework.

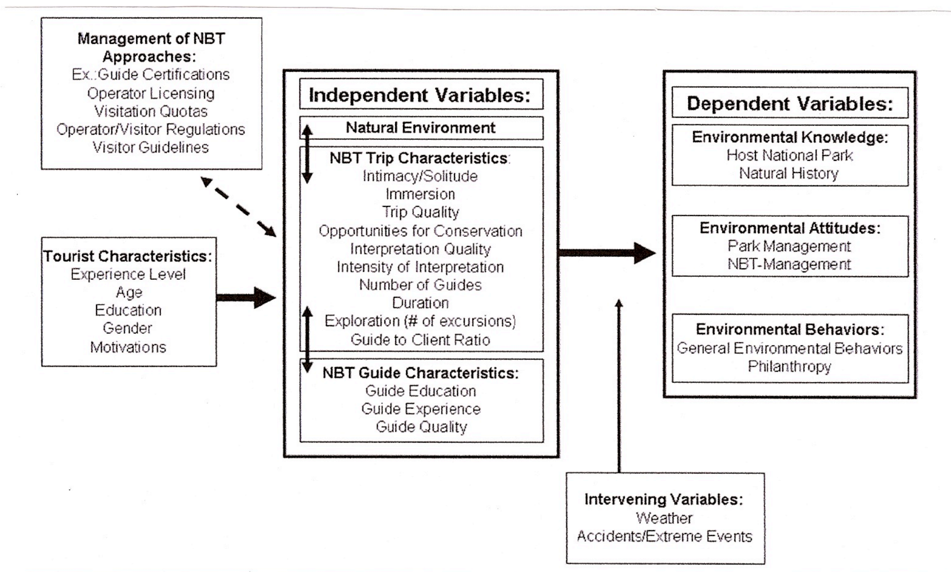


Figure 3
Interactional model of the nature-based tourism experience (Powell, et al., 2009); reprinted with permission

A series of multiple regression analyses of both tourist and tour characteristics revealed that the application of the NBT interactional theory to their investigation of cognitive and behavioral outcomes was a useful framework for studying direct, immersive, nature-based experiences. When models included factors such as participant characteristics (e.g., prior experiences, motivations for taking the trip, education level, and gender) and characteristics of the tour itself (e.g., duration, intensity of immersion [minutes per day spent actively involved in the nature-based activity of rafting], and quality of the instructor), the more dynamic interactional model enabled the prediction of significant changes in knowledge, as well as environmental behavior intentions. Of the six models Powell et al. employed, variation was accounted for at rates between 3.5 and 37% when the models included tourist and tour characteristics as predictors (Powell, et al., 2009).

The present study, which investigated outcomes similar to those researched by Powell et al., was guided by an interactional model in which children's knowledge of local wildlife (WK), attitudes toward nature (ATN), and preferences for learning about wildlife (PLWA/PLWM)—both for species and for mode of learning—were considered. This knowledge-attitude-preferences (KAP) framework (Figure 4) allowed for the exploration of these cognitive, affective, and behavioral factors that are considered integral in the development of children's interests in science as well as their appreciation and understanding of the natural world. The manner in which these variables were investigated is elaborated in the next chapter.

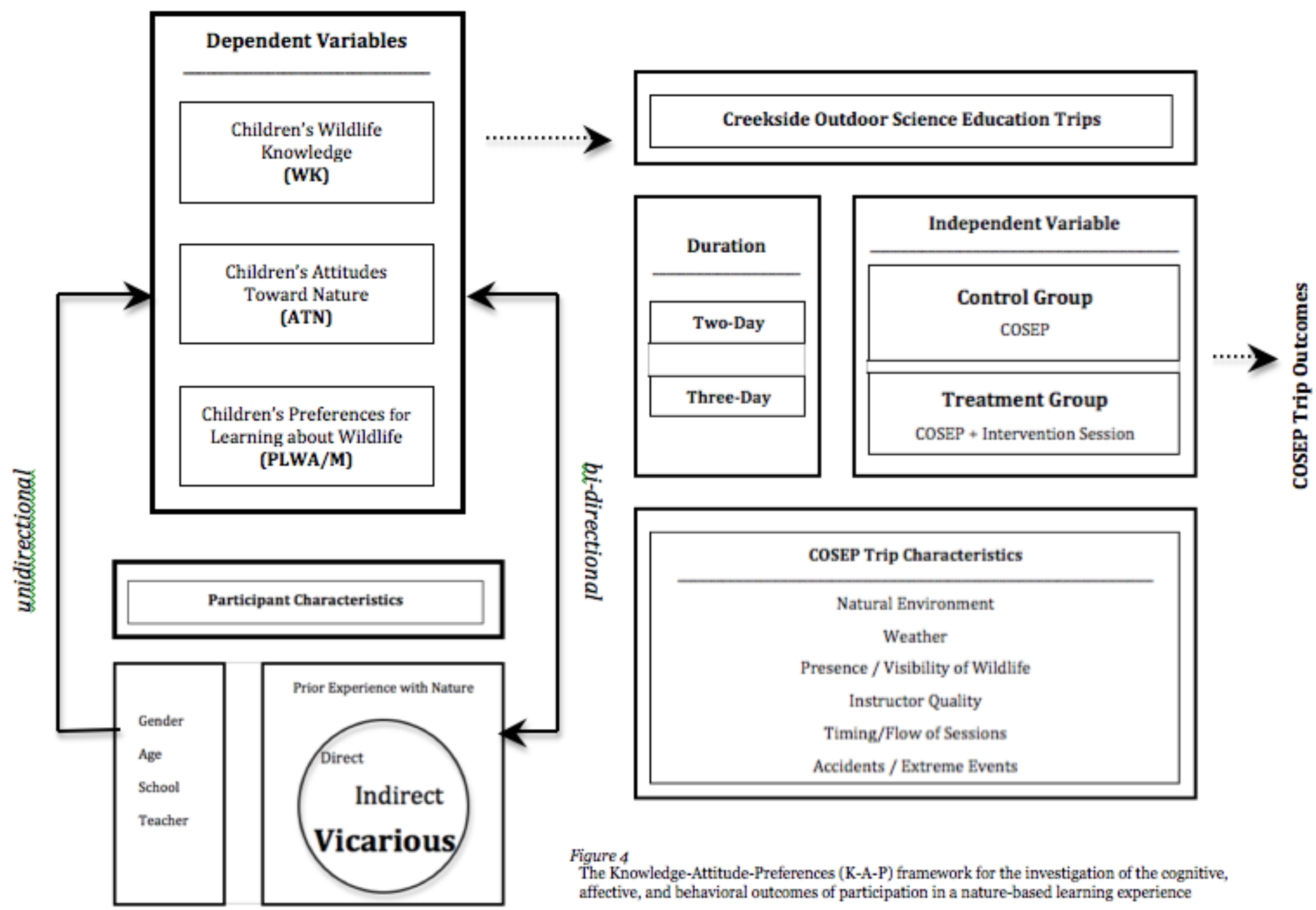


Figure 4
The Knowledge-Attitude-Preferences (K-A-P) framework for the investigation of the cognitive, affective, and behavioral outcomes of participation in a nature-based learning experience

Chapter Three

Research Design

As was illustrated in the review of the relevant literatures, there is considerable concern for the state of the relationship between modern children and the natural world given their preponderance of interaction with nature, not through direct modes but through vicarious ones, instead. Framing this concern are the cognitive, affective, and behavioral aspects of the relationship. To explore the nuances of the child-nature relationship, the present study investigated a cohort of young children as they participated in a district-wide, residential outdoor science education program. The Creekside Outdoor Science Education Program takes place annually in cooperation with (and at) a University of California Natural Reserve System Field Station. Making this program unique among many similar residential environmental education programs is the location of the Field Station where the COSEP takes place. Creekside is less than 15 miles from the center of the primary sending town, making it truly *local* for the attending children. In order to investigate a set of cognitive, affective, and behavioral hypothesis-clusters, a quasi-experimental study was designed (illustrated in Figure 5).

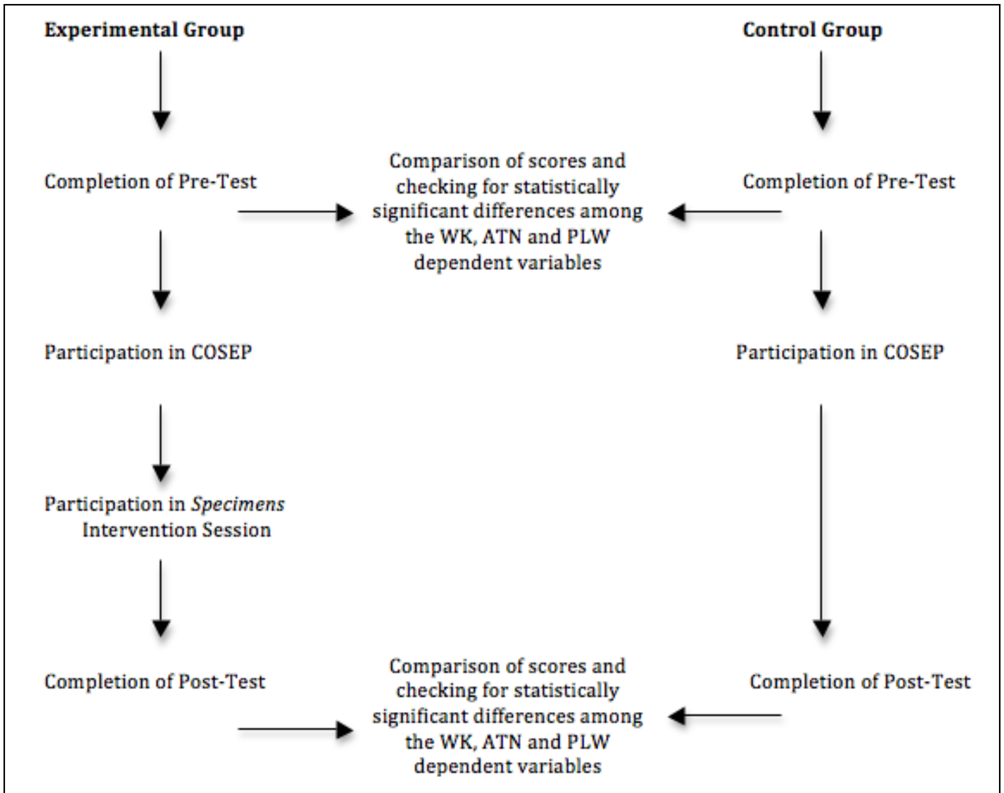


Figure 5
Diagram of the experimental design

The study utilized a pre-test/delayed post-test method with an experiment-control design. Of the 289 children that participated in the Creekside Outdoor Science Education Program, 199 (69%) participated in a two-day version and the remainder participated in an extended three-day Program.[4] Of three-day participants, 58% were in the control group; 42% of those attending for two days were in the control group. (See Table 1.)

Table 1
Participant Statistics by Duration

Duration	**Total Number of Students**	**Gender (girls) %**	**Condition (Treatment) %**
Three-Day	90	58	42
Two-Day	199	46	58

The experiment-control conditions were met through a naturally occurring semi-randomized assignment of students to the experimental and the control groups.[5] Prior to arrival at the Field Station, all classroom teachers divided their classes into two student groups; this grouping did not involve the researcher or other Field Station teaching staff. Elaborated in a summer planning session, the factors that teachers took into account when assigning students to what would become the experimental and the control groups were functions of distributing students of high-weak academic ability, to break up strong friendship groups, and to maintain gender balance as evenly as possible. Also, the COSEP is staffed by two trained outdoor educators; thus, each class was divided into two groups. The teachers were blind to the specific conditions of the experiment and were unaware of the details of the 'treatment' (in the form of the intervention lesson on local wildlife) that half of all students would receive during the COSEP.

3.1 The Setting Located high in the Sierra Nevada mountains and bounded by two large fresh-water lakes, Lorry is an incorporated town with approximately 34 square miles and with a population of nearly 16,000 (U.S.CensusBureau, 2000a). Though the town is serviced by a major rail system and is bisected by a major interstate, it is considered to be geographically isolated from the rest of the state of California. With a population density of 426.1-people/sq. mile, Lorry is classified as a rural area (U.S.CensusBureau, 2000b).

As of the 2000 U.S. Census, the racial composition of Lorry was predominantly non-Hispanic White (88%) with Latino/Hispanics representing the largest minority (15%). African Americans, Asians, and Native Americans each comprised approximately 1% of the population while Pacific Islanders represented fewer than .1%.[6] Of the 6,300 households, 37% had children under the age of 18 (<7% were female-headed households) with an average family size of approximately 3 people. Median income for a family was nearly $82,500 with males earning slightly more than females. Just over 4% of families with children were below the poverty line (U.S.CensusBureau, 2000a).

Driven by the service industry, 18% of working adults in Lorry were reported as being employed in the "arts, entertainment, recreation, accommodation/food" industry (U.S.CensusBureau, 2000a). Given its climate, and over 300 days of sunshine per year, the small community prides itself on being a four-season haven for outdoor adventure, catering to

[4] The treatment was administered on Day 2 of the COSEP for both three- and two-day Programs.
[5] A comparison of pre-test equivalence for the two conditions (control and treatment) revealed that the average *LOCALKNOWPRE* score for control group members at time of pre-test was 63.7 (SD = 11.2). With a positive difference of .9, members of the treatment group yielded a numerically higher average score of 64.6 (SD = 11.6) but this difference, $t(208) = -.055$, was not statistically significant. Given this, the assignment of students to either of the two conditions appears to be unbiased.
[6] Total percentages greater than 100% as Census reporting allows for participants to select more than one ethnic identifier.

the tourism industries year-round. According to the Lorry Chamber of Commerce Official Visitors Guide (2010),

> "...one of Lorry's greatest allures is the abundance of activities available for the outdoor enthusiast. In the summer, you can enjoy fishing, camping, rock climbing, water-skiing, sailing and windsurfing. There is also mountain biking, horseback riding, golf and tennis. Dasher Lake, rich in history and site of a state park, is your gateway to adventure. Hikers have miles and miles of trails to choose from, including the Pacific Crest Trail which will take you to mountain meadows filled with wildflowers and breathtaking scenery. There's no better way to spend a summer day than at Dasher Lake sitting on a warm pier, looking up at the rugged peaks, after getting out of the cool, clean water" (p. 7).

With an average of 194 inches of snow annually, wintertime in Lorry presents an equally broad range of possible outdoor activities—snow-shoeing, sledding, all varieties of skiing, ice-skating, snowmobiling, tubing, etc. Considering the town's geographic location and the climate, it is often described as "Mother Nature's playground" (East*WestResorts&Destinations, 2011).

3.1.1 The Creekside Field Station. Established in 1951, the Creekside Field Station is a teaching and research facility of the University of California Natural Reserve System (operated in partnership with the US Forest Service) located in the Sierra Nevada mountains. The Field Station occupies 452 acres (0.71 square mile) within the Lorry River watershed and includes various habitat forms such as montane meadows and chaparral, mixed coniferous and fir forests, and the freshwater ecosystems of Creekside (Glazer, 1986). Used as an active research station for UC undergraduate- and graduate-level teaching and research, Creekside is also host to an innovative year-long adventure/literacy program for area high school students. For the past five years, the Field Station—at less than 15 miles from the Lorry town center—has also hosted the LUSD's fifth grade classrooms for six weeks each fall for the Creekside Outdoor Science Education Program.

3.1.2 The Creekside Outdoor Science Education Program. The COSEP is a collaboration between the LUSD and UC Berkeley's *Exploring California Biodiversity Project*, a National Science Foundation GK-12 project that brings doctoral students in the natural sciences to the Field Station to teach sessions on local flora and fauna to the young students. The COSEP idea came from a pair of LUSD elementary school teachers who felt that the traditional annual Grade 5 residential outdoor environmental science field trips to the California coast, despite being meaningful and educational, precluded the opportunity to have a similar near-by nature experience while learning about local ecology. After they approached the UC Berkeley *Biodiversity Project*, which was already engaged in taking Bay Area middle and high school students on residential environmental science field trips to other UC Reserve Field Stations, the program at the Creekside Field Station for Lorry students was formally begun in 2006.

Given the various stakeholders, the Creekside Outdoor Science Education Program has a range of goals, three of which are relevant to the present study. First, the COSEP seeks to provide children with a direct, hands-on experience with near-by nature. Second, the program is designed to increase children's knowledge of local plants and animals. A third goal is to stimulate in children a more holistic interest in the natural world. These goals are addressed through a variety of activities that take place during the course of the two- or three-day program. The COSEP experience entails carrying out field research on local organisms (grasshopper population dynamics over time), tracking nocturnal mammals (using track plates), studying the effects of invasive species (pine bark beetle infestations in Sierra conifers), collecting data on water quality (including getting in the creek and collecting samples of invertebrates), and various team-building activities (the 'games' often played at outdoor education facilities such as capture the flag). See Figure 6 for an overview of the COSEP activities.

Creekside Outdoor Science Education Program Overview

Program Goals
The Creekside Outdoor Science Education Program is designed to provide children with a direct experience with local nature. The program seeks to meet Grade 5 California Science Standards through participation in an experiential field science experience that allows students to engage in collaborative science research projects led by University of California Berkeley graduate student fellows. Overarching goals of the program are to stimulate a more holistic interest in, and appreciation of, the diversity of the natural world while increasing student knowledge of local plants and animals—their *near-by* nature.

Day 1: University of California Berkeley Science Fellows' Lessons
Topics:

- Field Station Orientation
- Team Building Activities
- Hiking the Field Station
- Grasshopper Population Dynamics
- Creek Ecology
- Endangered Species / The Lorax
- Night Hiking

Day 2: Sierra Watershed Education Partnerships (SWEP) Lessons & Experimental Intervention Lesson

- Invasive Species
- Forest Ecology
- Water Quality Monitoring
- Hiking the Field Station
- Experimental: Wildlife Specimens Lesson ***or*** Control: Hiking the Field Station [a]
- Night Hiking (including Solo Sit)

Day 3: University of California Berkeley Science Fellows' Lessons

- Adaptations
- Ornithology (mist netting in several sections) [b]
- Hiking Carpenter Peak (approx. elevation of 6,930')
- Closing Circle

Figure 6
COSEP Activities Overview

[a] Terrain of control group hike was not novel
[b] By law, mist netting must be carried out by an authorized and permitted field scientist (Gustafson, Hildenbrand, & Metras, 1997); during the 2010 COSEP, the UC Berkeley licensed field scientist was not present during all sections

All students had the opportunity to engage in many of the experiences described above during their participation in the COSEP, with the experimental group participating in an additional intervention session. In designing the intervention session, a methodological decision was made about what the students in the control group would do during the time that the experimental group participated in the intervention session. During the 50-minutes when treatment group students were in the intervention session, control group members were led on a hike around the Field Station by the outdoor educators. This hike mirrored the day hike that had occurred during Day 1 of the COSEP; while hiking a nonnovel path, the outdoor educators led general discussions of local flora and fauna (e.g., unique adaptations of local species) and, when encountered, pointed out evidence of animals' presence (e.g., tracks and/or scat).

3.2 The Sample Within the Lorry Unified School District, there are eleven K-12 schools that serve approximately 4,100 students. Nearly 25% of students in the District have been classified as English Language Learners (nearly all ELL students in the District are native Spanish speakers) and more than 30% of students qualify for free or reduced price meals. With an average class size of 26 for Grade 5 classrooms in the District, the LUSD Grade 5 classes are below the state average of 29. All of the Grade 5 classes from across the LUSD participated in the present study, so it can be assumed that the sample under investigation in the present study was relatively representative of the demographic make-up of the District as a whole. Table 2 summarizes the descriptive statistics for the participants.

Table 2
Participant Statistics by Class/School

Class (School/Teacher)	**Total Number of Students**	**Gender** (girls) %	**Condition** (Treatment) %	**Age** (mean)	**COSEP Trip Duration** (days)
School One	90	---	---	---	---
Teacher 1	31	61	45	10.41	3
Teacher 2	28	50	43	9.95	3
Teacher 3	31	65	39	10.25	3
School Two	63	---	---	---	---
Teacher 1	31	45	52	10.36	2
Teacher 2	32	41	[a]	10.37	2
School Three	29	---	---	---	---
Teacher 1[b]	29	38	52	9.95	2
School Four	89	---	---	---	---
Teacher 1	33	49	52	10.46	2
Teacher 2	29	48	48	10.65	2
Teacher 3[c]	27	48	100	10.38	2
School Five	18	--	---	---	---
Teacher 1[c]	18	56	100	10.18	2

	Control		Treatment	
Totals	Girls	Boys	Girls	Boys
N = 289	66	78	77	68

[a] Due to inclement weather, trip was postponed to final week of COSEP; the revised agenda prevented intervention lesson from being taught
[b] Post-test only
[c] At the request of teachers, all children participated in treatment condition (class cohesion concerns)

A total of 289 students took part in the 2010 Creekside Outdoor Science Education Program; 143 (49%) of the participants were girls. Described earlier, a semi-randomized assignment of the students to one of two groups (control or treatment) resulted in 144 students being assigned to the control condition and 145 to the treatment condition. Student age at the time of participation ranged from 8 to 11 years old (median age 10 years, 3 months).[7]

3.3 Methods The present study used three primary quantitative data collection methods, summarized in Figure 7, to investigate the dependent variables of children's knowledge of local wildlife (WK), children's attitudes toward nature (ATN), and their preferences for learning about wildlife (PLWA/PLWM). These three methods were blended into a survey instrument that

[7] The age range is wide (and the mean age is fairly young) due to the fact that School Three/Teacher 1 was a combined Grade 4/5.

was administered in similar form as both a pre- and post-test.[8] Students in both the control and treatment group received the same instrument. The pre-test was administered within a two-week window prior to student participation in the COSEP with the post-test being administered, on average, 19 weeks after participation in the COSEP.[9]

Figure 7
Dependent Variables & Related Data Collection Methods

Dependent Variable Under Investigation	Data Collection Methods
Variable 1. Children's Knowledge of Local Wildlife **WK**	Animal Knowledge Task (short answer)
Variable 2. Children's Attitudes Toward Nature **ATN**	Creekside Activities Inventory (Likert-type scale)
Variable 3. Children's Preferences for Learning about Wildlife **PLWA** (animal) **& PLWM** (mode)	Wildlife Biologist Short Story (fill-in-the-blank narrative)

While the delayed timing of post-test administration was a function of convenience in the present study, it may have implications worth noting. Retention of outcomes—cognitive, affective, or behavioral—in environmental education is rarely assessed over longer periods of time. A recent exception, Stern, Powell and Ardoin (2008) assessed the impact of participation in a residential outdoor education program at the Great Smoky Mountains Institute at Tremont (an environmental education center offering programs similar to the COSEP) via a 3-month delayed post-test which they define as a mid-range evaluation. Their delayed post-testing revealed that changes to fourth- through seventh-graders' environmental awareness, knowledge, and stewardship behaviors were persistent over time, findings that begin to fill a gap in the environmental education literature. The present study, with an average time of 19 weeks from participation in the COSEP trips to time of post-testing, can contribute to the growing literature on the mid- to long-range persistence of positive environmental education outcomes.

3.4 Instrument An underlying goal of the present study was to examine the interplay between cognitive (WK), affective (ATN), and behavioral (PLWA/PLWM) aspects of children's relationship with the natural world. It was hypothesized that the use of local animals—presented in a way that more closely resembled the excitement and drama of a mediated nature experience that children expected—might produce knowledge gains as well as "hooking" children into wanting to reengage with the topic of local nature in the future. To determine the outcomes of student participation in this intervention session, it was necessary to establish baseline data on the three dependent variables. Therefore, an instrument was designed such that it could be used as both a pre- and post-test to assess children's knowledge of local wildlife, their attitudes toward nature, and expressed preferences for learning about wildlife (both species preference and learning mode preference). The instrument was designed to be visually appealing to the students and was formatted in such a way as to minimize the impression of being overly 'test-like.' (A full copy of the instrument is given in Appendix B).

8 Verb tense in the post-test version of the Creekside Activities Inventory was modified.

9 Variation in timing of pre- and post-test administration was a function of classroom teacher discretion as all testing was done during normal school hours.

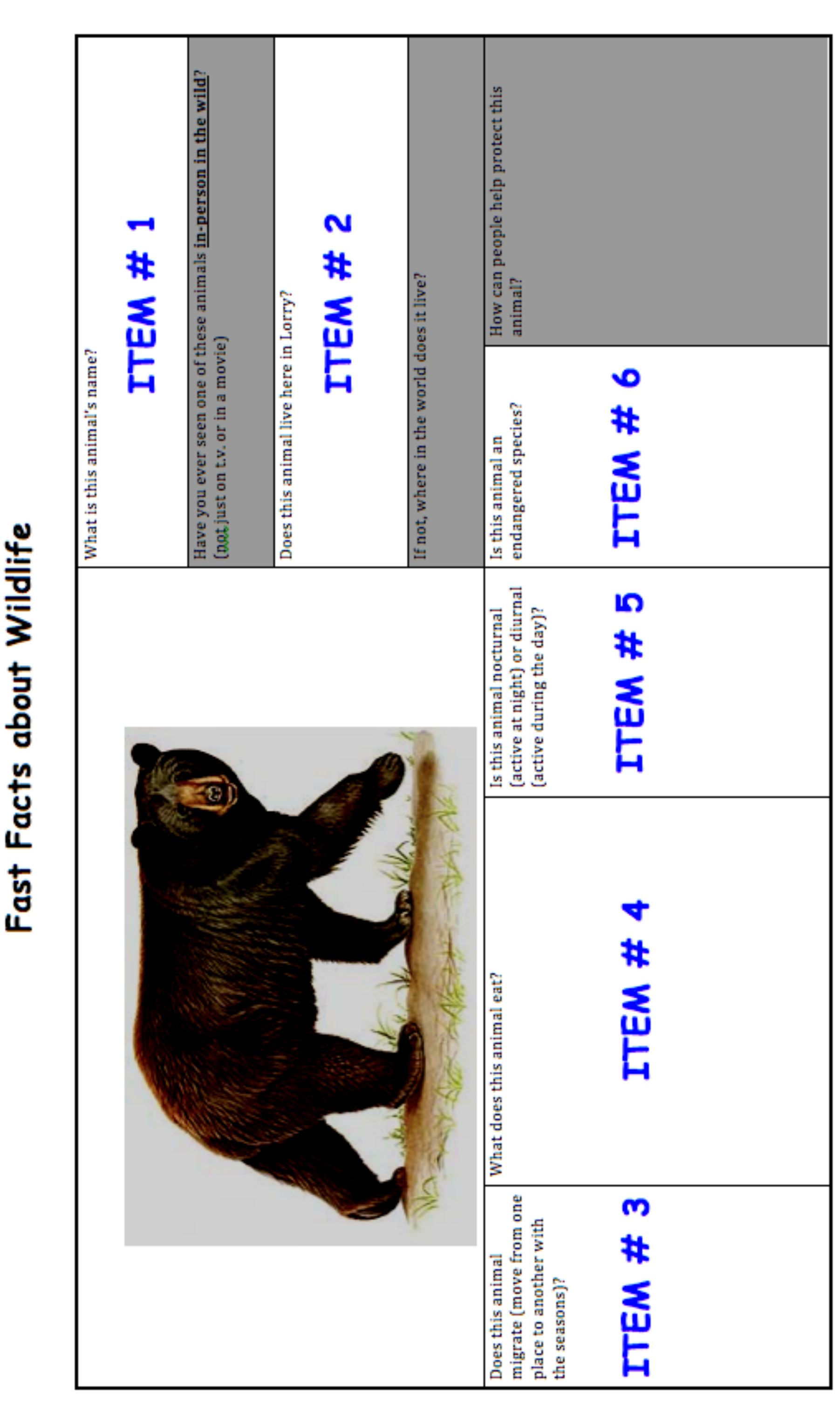
The instrument, administered by the classroom teachers during regularly scheduled class time, was designed to be embedded within a series of pre-trip activities. Some of the other activities suggested by COSEP organizers for use with students prior to the trips included completion of the well-known Draw-a-Scientist activity (see Finson, 2002, for a review of the multi-decade use of the DAST instrument) and a literature arts assignment used to assess students' perceptions of the nature of science. Though the classroom teachers did provide students with scripted information about their participation in the present study[10] (see Appendix C for teacher script), the instrument was designed as an activity packet that closely resembled other pre-trip activities, thus minimizing potential anxiety students may have felt in participating in a research study.

As it was presented to the students, the packet was comprised of three discrete elements titled "*Fast Facts about Wildlife*" (the Animal Knowledge Task), "*Creekside*!" (the Activities Inventory), and "*Wildlife Biologist"* (the Short Story). The three elements were presented in the same order for all participants in both the pre- and post-test iterations.

Animal Knowledge Task. The first element of the instrument, the Animal Knowledge Task, was designed to test students' knowledge of wildlife on a series of six dimensions[11] across 14 animals. These dimensions covered basic biological and ecological aspects of children's animal knowledge, assessing familiarity with animals' common names, their presence in Lorry, migration behaviors, diet, activity (nocturnal/diurnal), and whether the animal is an endangered species. A sample of one of the *Fast Facts* pages is reproduced below in Figure 8. The author created a content rubric for the Animal Knowledge Task and validation was established through consultation with a panel of two other animal science experts. The author and panel members were guided in developing the rubric by similar work of Strommen (1995) and Snaddon et al. (2008) who examined children's perceptions of temperate forest and rain forest habitats, respectively. An excerpt from the scoring rubric is appended (Appendix D).

[10] As addressed above, teachers and students remained blind to the experimental component of the study and were unaware that students would receive any form of treatment beyond normal participation in the general COSEP.
[11] While eight dimensions were tested, only six are included in the present study. Responses to the items "Have you ever seen one of these animals in-person in the wild (not just on TV or in a movie)?" and "How can people help protect this animal?" are not discussed here.

Figure 8
Sample page from the *Fast Fact about Wildlife* component of the instrument (item numbers refer to the six dimensions under investigation in the present study)



Informed by the literature pertaining to human preferences for species (in regard to knowledge, attention, and attitudes), a range of local species was selected for inclusion in the Animal Knowledge Task. These species range from large, vertebrate predators (mountain lions and black bears) to more humble, though no less significant, invertebrate species such as the crayfish and the Monarch butterfly. Selected animals represented the major taxa of mammals, birds, reptiles, and invertebrates. Only one animal, the Monarch butterfly, was both a local and an endangered species. All other local animals were common in the Lorry area, though some are more readily observable than others (e.g., the commonly spotted scrub jay versus the reclusive mountain lion).

Items in the Animal Knowledge Task were scored on either a three- or two-point scale.[12] The first and third items (name and diet) were scored on a three-point scale. A response to the name item was assigned a value of 2 if the response included the full common name (e.g., the animal pictured was correctly identified as a "barn owl"), a 1 was assigned if the response was partially descriptive (e.g., "owl"), and a 0 was assigned if the response was incorrect (e.g., "vulture"). Similarly, the diet item was also based on a three-point scale. A 2 was assigned if the response was wholly descriptive (e.g., the raccoon diet response included both meat and vegetation, as the animal is omnivorous); a 1 was assigned to partially descriptive responses (e.g., the raccoon "eats only berries"); and a response was scored as 0 if it was incorrect (e.g., "other raccoons"). All other items in the Animal Knowledge Task were scored on a two-point scale. For example, the activity item was scored as a 1 for a correct response (e.g., "the owl is nocturnal") and 0 for incorrect responses (e.g., "the owl is active during the daytime").

All student packets included the same set of fourteen animals (13 found in Lorry) though animals were presented in randomized order in an attempt to reduce the risk of testing fatigue on any given animal.[13] All of the *Fast Facts* pages were reproduced in full-color for the purpose of being inviting and more accurately viewed (as opposed to either black-and-white images or line drawings of the animals).

Creekside Activities Inventory. The second element of the instrument packet, *Creekside!*, was a Likert-type scale that measured students' affective attitudes toward a range of activities that students might engage in during their participation in the COSEP. The items on the Activities Inventory were presented using the prompt "When I think about doing this thing out at Creekside, I feel…". Responses were structured using a very unhappy/unhappy/not really happy or unhappy/happy/very happy type scale. Items ranged from cognitive-based experiences (e.g., learning new things about plants) to more directly kinesthetic experiences (having the chance to touch a bird). All responses to items on the Creekside Activities Inventory were converted from the 'very unhappy to very happy' scale into a numerical scale (1-5).

It became apparent in pilot work that it was difficult for students in this age group to use a 'very uninterested to very interested' Likert-type scale. Conversion of the language on the scale to 'very unhappy to very happy' made the scale more accessible to students; in turn, the conversion made independent work on the Inventory more likely for these young students. Pilot work also revealed that young students struggled with reverse wording. When using a 'strongly negative to strongly positive' scale, a comparable sample of students found items that had been reverse worded to be conceptually difficult. For example, students in the pilot study consistently reported being confused by questions asking whether they agreed or disagreed with negatively

[12] When an item was left blank or the written response was the equivalent of "I don't know," the item was scored as either 999 or 499, respectively; the method for dealing with both 999 and 499 responses in *Fast Facts* will be discussed in Section 3.6.

[13] The brown bear was the first animal in all packets as it included the directions for the *Fast Facts about Wildlife* section.

worded statements such as “I do not want to learn new things about plants.” In order to minimize the response bias of including only positively worded items in the present study, several items were included in the instrument that could be used to gauge if response bias was present. One such example, “Getting stung by a bee or yellow jacket,” represents an event that we can assume few children would enjoy and therefore we could expect responses to fall well within the very unhappy/unhappy end of the scale.

Wildlife Biologist Short Story. The final element of the instrument packet, *Wildlife Biologist*, was a short story that instructed the student to imagine that they had become a wildlife biologist. Designed to resemble MadLibs™,[14] the Short Story included free-response fill-in-the-blank type items as well as fixed-response multiple-choice items. Although the Short Story included 12 items, only responses to the two items concerned with species preference and mode of learning preference were used in the present study. As shown in Figure 9, the first of these two items was a fill-in-the-blank item about the animal students would prefer to study as a wildlife biologist. Responses to this fill-in the-blank item were scored on a three-point scale. Responses that included a local wild species were scored as 2. Other wild animals endemic to North America were scored as 1 and all animals considered to be non-endemic to North America (e.g., panda bears) were scored as 0. Worth noting were the cases in which children responded by naming a domesticated animal such as a puppy or parakeet. In these instances, which were few, the response was scored as 0 as the instructions stated that the species chosen must be a wild animal.

Wildlife Biologist

Directions: This is an activity that is kind of like MadLibs where you fill in the blanks in a story. Look at the tiny writing underneath each blank for a clue about what you should write in each blank. Two of the questions ask you to choose just one thing by circling the letter.

Fantastic! You’ve decided to become a wildlife biologist. The **wild animal** you have decided to study is the ______________________ (name of **wild** animal you want to study). You know that becoming an expert will require a lot of studying and preparation. The way that you prefer to learn about ______________________ (name of wild animal you wrote above) is by doing which of the following: (choose your **favorite** way to learn about the animal by circling just one letter):

(a) by studying your animal in the wild

(b) by reading books about your animal

(c) by watching television shows or movies about your animal

(d) by talking with other wildlife biologists that study the same kind of animal

Figure 9
Items from the Wildlife Biologist Short Story component of the instrument under investigation in the present study

The Short Story also illuminated students’ preferences regarding mode of learning about their selected animals. Understanding children’s expressed preferences for mode of learning

[14] MadLibs™ is a phrasal template word game popular with children.

about wildlife may shed light on the complex relationship between the ways children *do* learn about animals and the ways they might *prefer* to learn, if given the opportunity to do so. The four choices in the fixed-response item included one direct mode of learning about the chosen animal ("by studying your animal in the wild") and three that were variations on vicarious modes ("by reading books about your animal," "by talking with other wildlife biologists that study the same kind of animal," and "by watching television shows or movies about your animal"). This fixed-choice item was scored on a three-point scale where selection of the direct mode, studying the animal in the wild, was scored as 2; the two intermediate modes (talking with other wildlife biologists or reading books) were scored as 1; and the most vicarious mode (watch television/movies) was scored as 0.

3.5 Intervention The intervention given to students in the experimental group was designed to address several concerns raised in the literature, namely reducing children's lack of experience with near-by nature, ameliorating their contrived expectations of an experience once "in" nature, and enhancing their fundamental curiosity about plants and animals.

The intervention was designed to be both realistic and exciting, serving as a "hook" that would hold children's interest in the topic of local wildlife in both the short term (during the lesson) as well as in the long term (as evidenced by responses on the delayed post-test). To create this stimulus—described as necessary for the induction of situational interest—children's megafaunaphilia would guide both the content and format of the intervention lesson. If children were excited to learn about large, charismatic animals during their COSEP trip—the first direct, immersive nature experience for many of the participating children—then incorporating the use of once-living specimens from charismatic local fauna could bridge the expectations-reality gap. Sydney Butler (quoted in Mitman, 1999), executive director of the American Zoo and Aquarium Association, described the possible beneficial effects of certain vicarious nature experiences noting, "before you teach conservation, you have to fascinate" (p. 3). In this way, the intervention was designed to leverage children's fascination with animals through interaction with a variety of species including specimens of large and charismatic species. Specifically, the intervention was designed to capitalize on children's megafaunaphilia in the service of increasing their knowledge and enhancing attitudes toward the natural world.

The use of preserved specimens to provoke interest and to facilitate inquiry is not new, as can be seen in Figure 10, below. Natural history museums, with their deep historical traditions of exploration and discovery, have amassed extensive preserved specimen collections valuable as objects of both scientific research and public education (Suarez & Tsutsui, 2004). Sherwood, Rallis, and Stone (1989) found that the use of preserved specimens in informal science learning environments (e.g., aquariums) not only stimulates children's curiosity but can also lead to an increase in children's knowledge of natural history facts.

The specimens used in the intervention lesson in the present study were drawn from the collections of the UC Berkeley Natural History Museum and the Creekside Field Station. Specimens representing a variety of mammals, birds, and insects that ranged from the dramatic to the subtle were used. A full-sized taxidermied black bear specimen and a mountain lion pelt (with claws intact) were included as were eggs from Canada geese and pinned monarch butterflies. Ten of the species represented in the intervention were deliberately included in the pre-/post-test instrument. These included the black bear (skull, pelt, full-sized), mountain lion (skull, pelt), coyote (pelt), porcupine (full-sized, quills), barn owl (full-sized), raccoon (pelt, full skeleton), Monarch butterfly (full-sized pinned), scrub jay (full-sized), black-tail deer (skull), and the little brown bat (full-sized). Students were given the opportunity to handle each of the specimens (with the exception of pinned insects, which were viewable in a specimen preservation case), providing an experience that was both simultaneously cognitive and aesthetic and both concrete and tactile.

Figure 10
A lesson in the Exhibition Hall of the American Museum of Natural History titled "Baby Animals" brings public school children into close contact with a diverse group of wild animals (1937). Photo used with permission. American Museum of Natural History Library (Image No. 287919) http://images.library.amnh.org

Introduced to the students as the "Wildlife Safari," the intervention lesson was structured around the variety of ways that animals are uniquely adapted to their specific habitats. A brief introduction was provided at the beginning of the lesson to model the ways children could handle the specimens[15] and what they might look for when examining them for physiological adaptive features. For example, a demonstration with a taxidermied porcupine was given highlighting the use of a porcupine's quills as an adaptive defense mechanism; likewise, tooth shape in the deer and the mountain lion were contrasted in describing dietary preferences. Specimens were arranged on a series of tables and students were instructed to move around tables ('buffet-style') at 5-minute intervals; all students had the opportunity to

[15] It became apparent during the first iteration of the specimen lesson that explicit instructions for handling objects were necessary. All subsequent iterations included specific guidelines for "not playing with the objects" (e.g., swatting their neighbors with the large mountain lion paws, which had 2" claws).

view, touch and/or hold the specimens.[16] Students were allowed to ask questions of one another as well as the author throughout the lesson as the format was semi-structured and the inquiry open-ended.

The author taught the intervention lessons for all of the participating classes. This format maximized content consistency across iterations. Further, as a COSEP staff member, the author was present at many of the day's activities and served in a variety of roles including chaperone, co-teacher/leader, third-party observer, etc. This omnipresence allowed for a rapport to be established between the author and the students before their participation in the intervention lesson; likewise, it may have helped to minimize any distinction students may have made between other adult COSEP staff members and "the researcher."[17]

While experimental group students participated in the intervention lesson, control group students were taken on another hike of the Field Station. Evidence of wildlife, either in the form of direct observation of the animals themselves, or as indirect evidence (e.g., tracks, scat), was discussed with the students while they hiked. While the specific content of these lessons was dependent on the local conditions, this hike resembled all other hikes taken as a whole class (e.g., terrain covered was not novel).

3.6 Analyses All of the analyses were conducted using the STATA/Version 11 statistical software package. The dependent variables under investigation—children's knowledge of local wildlife (WK), their attitudes toward nature (ATN), and their preferences for learning about wildlife (PLWA/PLWM)—will serve as an organizing scheme for the description of the statistical analyses performed. Both descriptive and inferential statistical tests will represent evidence used to accept or reject the hypotheses for each of these variables.

Children's knowledge of local wildlife. The first dependent variable under investigation was children's knowledge of local wildlife (WK). Data were collected using the Animal Knowledge Task, a series of questions about local wildlife that were presented for a set of 14 different animals. The topics included animal names; presence in Lorry; diet; migration; day/night activity; and status (threatened, endangered, extinct, etc.). Animals within the set ranged from large predators (e.g., the mountain lion) to freshwater macro-invertebrates (e.g., crayfish).

The analyses most germane to the research questions of the present study focused on two subsets of these 14 animals. [18] The first subset included the thirteen local animals included in the pre- and post-tests; a second subset included only the 10 local animals that had been represented as specimens in the intervention lesson.

The coding rubric for all items in the Animal Knowledge Task included the codes 499 for responses similar to "I don't know" and 999 for any items left blank. It became clear that all responses coded 499 and 999 would need to be addressed prior to performing final analyses. A decision was made to convert all 499 responses (e.g., "I don't know" or "I'm not sure") to 0, where a 499 became the equivalent of an incorrect response. When an item was left blank it was scored as a 999, or the equivalent of missing data. A judgment of the reasons for the missing data, true random versus selective loss, was made. In order to include all cases where students had completed the Task at both the time of pre- and post-testing but had left items blank, a test

[16] Not all students elected to touch and/or hold the specimens; reasons varied from fear, disgust, and sadness to ethical aversion.

[17] Although students were made aware of the author's role as a UC Berkeley student/researcher at the time of pre-test administration, they remained blind to the conditions of the experiment.

[18] Of the 14 animals included in the Animal Knowledge Task, the lemur was the only exotic (non-local) species. Found in pilot work to be an animal well-known to young children, the lemur was not a part of the present study's analyses but was included in the Task as a way of contrasting student knowledge of local versus an exotic species (this contrast will be described elsewhere).

of significance was conducted to determine if any patterns existed for the 999 responses. As none was found it was decided that, when a student left no more than 1 item blank for any given animal, those responses coded as 999 would be converted to 0. Supported by the literature on the preferred method for handling missing data (Acock, 2005; Allison, 2002), all cases with more than one response per animal that had been coded as 999 were subjected to listwise deletion.

It was hypothesized that children's knowledge of local wildlife would be limited at the time of pre-test. This knowledge would be higher at post-test for the students that participated in the supplementary intervention session that was explicitly designed to facilitate an up-close and tactile experience with local animals.

Analysis of data regarding this first variable examined any pre- to post-test changes in student performance on the Animal Knowledge Task (ΔWK). Further, between group change was analyzed [$\Delta WK_{GROUP} = (\Delta WK^{control} - \Delta WK^{experimental})$]. Local animal knowledge, *LOCALKNOW*, was assessed as a function of student scores on the combined 78 questions in the Task (6 items/animal for all 13 local animals).

In keeping the terminology used in the present study consistent with the existing literature on children's knowledge of plants and animals, a methodological decision was made in regard to the categorization of children's knowledge of local wildlife (*LOCALKNOWPRE* and *LOCALKNOWPOST*). A minimum possible value was 0 and a maximum possible value was 104. In the Results section of this paper, all knowledge scores have been discussed as continuous values. To facilitate interpretation and discussion of students' knowledge scores, however, the scores were parsed into three "levels of knowledge" categories: scores that fell between 0 and 34 were categorized as being weak or limited and were labeled novice knowledge; those scores between 35 and 69 were labeled as intermediate knowledge; and the term expert knowledge was applied to scores between 70 and 104.

Children's attitudes toward nature. Data on the second dependent variable, children's attitudes toward nature (ATN), were collected using a Likert-type scale organized in the form of an inventory of possible activities that the children might have engaged in during their participation in the Creekside program. A variable, *CREEKNATURE*, was created for these data.

In the Results section, all attitudes will be discussed as numerical values. However, in order to facilitate the discussion of children's attitudes toward nature as positive, negative, or neutral in later chapters, the 5-point Likert-type scale was converted to categories. With a minimum possible score of 27 and a maximum of 135, values on the *CREEKNATUREPRE* and *CREEKNATUREPOST* indices were parsed into three categories. Values from 27 to 63 were classified as a negative attitude; values from 64 to 99 were neutral; and values in the range of 100 to 135 were considered to be a positive attitude.

During the scoring phase, it became apparent that missing values on the Creekside Activities Inventory would need to be addressed prior to final analyses. Unlike the treatment of 999 values in the *Wildlife Biologist* segment of the instrument, a more sophisticated treatment of missing values in the Likert-type scale that comprised the Creekside Activities Inventory was possible. Given the sample size for the study, which fluctuated as a function of the number of students that completed the pre- and post-test packets to varying degrees, listwise deletion of cases was not recommended. When considering the affordances of various methods for handling missing values, Newman (2003) suggests the multiple imputation (MI) statistical method (when listwise deletion, the preferred method, is not feasible) given the power of statistical software packages widely used today. He noted: "MI is a procedure by which missing data are imputed several times (e.g., using regression imputation) to produce several different complete-data estimates for the parameters. The parameter estimates from each imputation are then combined to give an overall estimate of the complete-data parameters as well as reasonable estimates of the standard errors" (p. 334). Using the STATA/Version 11's capacity for conducting multiple imputation for missing data, it was determined that only cases with fewer than or five missing responses (999) would be included in the analyses. Those cases with more than five missing responses were dropped. After applying this 'more than five missing response rule,' 208 cases were subjected to the three-step STATA/Version 11 technique for multiple imputation (StataCorp, 2009). The analyses described below were using data from these 208 cases.

Analysis of the data regarding the attitudinal variable was conducted to examine for any changes in student performance on the Likert-type scale that inventoried activities that children may have participated in during their Creekside experience (ΔATN). Between group change was represented as $\Delta ATN_{GROUP} = (\Delta ATN^{control} - \Delta ATN^{experimental})$.

Supported by the literature that claims that children are excited about being outdoors and that they hold positive attitudes toward many aspects of nature (insects and bats typically excepted, Prokop & Tunnicliffe, 2008), the first hypothesis of the affective cluster was that the children in the sample would have positive attitudes toward nature. The literature also suggests that, while positive, children's attitudes are based on passive, vicarious nature experiences rather than direct ones and may, therefore, be under-informed. In the present study, it was hypothesized that students' pre-test responses to items on the Activities Inventory would be positive but would show little variation. Children were generally excited to go on the Creekside field trips; therefore, scores would be clustered at the high end of the 5-point scale. After participation in the COSEP (either condition), students would be able to more thoughtfully appraise their attitudes toward the range of nature-based activities queried in the inventory. It was predicted that post-testing would reveal that, while attitudes would remain positive, a greater degree of variation in students' responses would be observed. The final hypothesis in the affective cluster was that attitudes toward nature would be predictive of cognitive trip outcomes. It was predicted that the more positive a child's attitude toward nature at the time of pre-testing, the greater the gain in knowledge of local wildlife.

Children's preferences for learning about wildlife. Data regarding children's expressed preferences for further learning about wildlife (PLWA/PLWM) were gathered using a fill-in-the-blank narrative that required children to provide information about the type of animal that they would most like to study as a young wildlife biologist. After responses to the preference items were coded, the treatment of missing data in the *Wildlife Biologist* was addressed. It was determined that all cases with missing data for either of the preference items would be subjected to listwise deletion.

Based on pilot study findings (Migliarese, 2010), it was hypothesized that children would prefer to learn about local species and that their preferred mode of learning would be through direct study; these preferences were further predicted to be durable from pre- to post-test for students in either condition. Finally, it was hypothesized that students' pre-trip preference of learning mode would predict cognitive gains. Pre- to post-test changes in expressed preferences (both species and mode) were represented as ΔPLWA/ΔPLWM.

3.7 Limitations and Delimitations The generalizability of the present study, naturally, has limitations. The sample, though reasonably diverse in socioeconomic make-up and cultural composition, is drawn from a geographically isolated, rural community. Results, therefore, may not be generalizable to the larger population of similarly aged children in other locations even within the state of California. While the use of such a unique sample may represent a threat to the external validity of this study, it can also be seen as opportune—studies of the impoverished interactions between children and nature tend to focus on urban children, the more obvious subjects in this particular field of research. The present study was an opportunity to examine rural students who presumably have more frequent interactions with the out-of-doors due to geographic circumstance. Therefore, while generalizabilty to the larger population of similarly aged children in other locations may not be possible, the insights generated by studying this particular sample of rural children may help researchers and practitioners broaden the scope of future outreach efforts regarding the child-nature relationship to include children who already live in the kind of nature others travel great distances to visit.

Also, the findings may be susceptible to issues surrounding statistical conclusions validity due to fluctuations in sample size across the three pre-/post-test measures. As was indicated previously, the number of observations included in specific analyses varied as a result of the ways in which missing values were handled, particularly when indices were created. Similarly, one class that participated in the 2010 COSEP did not complete a pre-test (n=29). While this reduced the overall number of observations that could be used in comparative pre/post analyses, it also enabled the study to have a naturally occurring condition where we could control for the introduction of testing bias that is also considered to be a possible threat to internal validity. Students in the group not taking the pre-test came to the COSEP (and for 52% of that class, the intervention) unaware of the items that would be queried in the post-test.

The internal validity of the study may have been compromised at several levels. Given the practical limitations that prohibited true random assignment of participants to either the control or treatment group, the design of this study was such that it is quasi-experimental in nature. Thus, the limitations naturally include the data's susceptibility to uncontrollable conditions. For example, during the course of the multi-day COSEP, members of the control group may have been incidentally exposed to information that had been specifically designed to serve as an element of the treatment.

There is also the risk of the influence of confounded experiences on the validity of the data. Classroom teachers administered the post-test during a 21-week window following students' participation in the COSEP. During this period of time, students may naturally have been exposed to information that could interfere with various measures. For example, in the time between completion of the pre-test and the post-test, a student may have participated in an after-school program that taught about local plants and animals. Thus, the influence of confounded experiences may have produced an alternative explanation for the differences both within and across individuals over time.

Similar to the threat of confounded experiences on the internal validity of this study, so too is the influence of history. Though often assigned to large-scale phenomena that would make attribution of causality impossible, it is not beyond the realm of possibility that an event with deep local significance to the community from which the sample in the present study was drawn could have interfered with post-test data. For example, if a mountain lion had been found wandering in a neighborhood within the greater Lorry community, the ensuing media coverage could have injected noise into the data regarding the cognitive dependent variable, children's knowledge of local wildlife, and possibly biased data on the affective dimension, as well. Change to the dependent variables of knowledge and attitudes as a result of participation in the intervention session, the independent variable, could (or could not) have been flooded by the influence of this (fictitious) event. To address this specific threat to validity, all current events for the greater Lorry area were closely monitored between the time pre- and post-tests were administered. Other than coverage of an incident involving the rescue of an orphaned bear cub,[19] no other major nature-related events were reported in the local media.

From the outset, there were two fundamental delimitations of the proposed study. First, this study was designed such that it would neither compare nor contrast two geographically different samples of students. As alluded to above, a comparison group of students from an

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[19] This particular incident (Renda, 2010), while nature-related and possibly influential, is not an uncommon occurrence in the Lorry area.

urban area was not employed because this study was *not designed* to compare urban and rural children's knowledge of local wildlife. Rather, it is designed to investigate whether children's knowledge, etc., can be changed through participation in a program such as the one offered at Creekside—with or without value added due to participation in an intervention session. Given the paucity of research investigating the nature experiences of rural children, as opposed to their more frequently studied urban and suburban counterparts, the findings generated by this particular sample of rural children are worthy of close examination and are potentially insightful without needing a comparison group.

The second fundamental delimitation was the decision not to collect data that might determine a causal link between an individual participant's specific experiences with the natural world (beyond participation in the COSEP and the treatment) and their knowledge of wildlife. Though quantitative and qualitative pilot data drawn from similarly aged children and their families in the same community suggest the existence of correlations between children's prior nature experiences and their wildlife knowledge, determining causality is not the goal of the present study. The value of doing so is understandable, however, and suggestions for future work that would move our understanding of the problem beyond correlations and towards causality will be discussed in the final section of this paper.

Chapter Four

Results

The major purpose of this study was to contribute to a relatively new, though broad, body of research that investigates the relationship between modern children and the natural world. The present study was organized around three overarching cognitive, affective, and behavioral variables—children's knowledge of local wildlife (WK), their attitudes toward nature (ATN), and their preferences for learning about wildlife (PLWA/PLWM). The analyses presented in this chapter include descriptive as well as inferential statistics for each of these variables, which serve as the organizing schema. All of the analyses were conducted using the STATA/Version 11 statistical software package. Unless otherwise specified, standard linear multiple regression analyses and two-tailed t-tests were conducted.

4.1 Children's Knowledge of Local Wildlife The first hypothesis within the cognitive hypothesis-cluster was that children's knowledge of local wildlife (WK), though limited at time of pre-testing, would be higher after participation in the COSEP; it was predicted that even greater knowledge gains would result from participation in the intervention (treatment) condition. To test this hypothesis-cluster, a series of indices was created from students' responses to items from the *Fast Facts about Wildlife* segment of the instrument. Figure 11 describes each of the WK indices. Descriptive and inferential statistics regarding the local wildlife knowledge hypothesis-cluster will now be presented.

Figure 11
Description of All Wildlife Knowledge (WK) Indices

WK Indices	Description & Highest Possible Value
LOCALKNOWPRE/POST	Includes all dimensions (6)[a] for the local animals (13) combined: bear, turtle, mountain lion, coyote, crayfish, porcupine, owl, raccoon, butterfly, rattlesnake, scrub jay, deer, and bat. Highest possible value was 104.
LOCALKNOW___animal___PRE/POST	Includes all dimensions (6) for each animal individually. Highest possible value was 8.
VERTMAMMALPRE/POST	Includes all dimensions (6) for the mammalian vertebrates combined: bear, mountain lion, coyote, porcupine, raccoon, deer, and bat. Highest possible value was 8.
VERTBIRDPRE/POST	Includes all dimensions (6) for the avian vertebrates combined: owl and scrub jay. Highest possible value was 8.
VERTREPTILEPRE/POST	Includes all dimensions (6) for the reptilian vertebrates combined: turtle and snake. Highest possible value was 8.
INVERTPRE/POST	Includes all dimensions (6) for the invertebrates combined: crayfish and butterfly. Highest possible value was 8.
SPECIMENKNOWPRE/POST	Includes all animals (10) that were represented in the intervention lesson (treatment) combined: bear, mountain lion, coyote, porcupine, owl, raccoon, butterfly, scrub jay, deer, bat. Highest possible value was 80.

[a] Recall that the 6 dimensions include: name, location, migration, diet, activity, and status

4.1.1 Descriptive statistics (WK). To test the hypothesis that students' local wildlife knowledge scores would increase from time of pre-test to post-test, several descriptive analyses were conducted. The first wildlife knowledge index, *LOCALKNOWPRE,* was created for all students that completed the *Fast Facts about Wildlife* portion of the pre-test[20] (*n* = 210). Prior to their participation in the Creekside Outdoor Science Education Program, the average local knowledge score for all students was 64.2 (*SD* = 11.4). All 10 classes that participated in the COSEP completed the post-test (*n* = 228). After their participation in the multi-day field trips, the average local knowledge score for all students, *LOCALKNOWPOST*, was 68.4 (*SD* = 11.3). Table 3 summarizes these numerical scores.

Table 3
Summary Statistics for LOCALKNOWPRE and LOCALKNOWPOST

Index	Mean Score	Std. Deviation	Students' Minimum Score (lowest possible score=0)	Students' Maximum Score (highest possible score=104)
LOCALKNOWPRE	64.17	11.42	27	88
LOCALKNOWPOST	68.38	11.27	29	88

At the time of pre-test, children possessed variable knowledge across the 13 local animals included in the *Fast Facts*. Indices for each of the 13 local animals were generated for this analysis; a maximum possible value for each individual animal was 8. Numerically, students were most knowledgeable about the raccoon (*M* = 5.9, *SD* = 1.5), the mountain lion (*M* = 5.7, *SD* = 1.6), and the black bear (*M* = 5.6, *SD* = 1.1) and the least about the crayfish (*M* = 4.5, *SD* = 1.7), the butterfly (*M* = 4.3, *SD* = 1.6), and the turtle (*M* = 4.0, *SD* = 1.2). At the time of post-test, variability in children's knowledge across the 13 local animals included in the *Fast Facts about Wildlife* had numerically increased (mean range increased from 1.88 to 2.17). Overall, the three animals best known to children at the time of pre-test remained, numerically, the best known after participation in the Program. These were the raccoon (*M* = 6.3, *SD* = 1.1), the mountain lion (*M* = 6.0, *SD* = 1.6), and the black bear (*M* = 5.96, *SD* = 1.3). The crayfish (*M* = 4.8, *SD* = 1.7), the butterfly (*M* = 4.6, *SD* = 1.5), and the turtle (*M* = 4.1, *SD* = 1.2) were, once again, the least known animals to children, numerically. Tables 4 and 5, below, summarize numerical pre- and post-test knowledge scores for the 13 local animals, listed from highest mean score to lowest.

[20] Recall that students in one class did not take the pre-test.

Table 4
Summary Statistics for LOCALKNOWPRE Scores by Animal

Rank	Animal	Mean Score	Std. Deviation	Students' Minimum Score (lowest possible score=0)	Students' Maximum Score (highest possible score=8)
1	raccoon	5.9	1.51	0	8
2	mountain lion	5.7	1.6	0	8
3	bear	5.6	1.14	3	8
4	porcupine	5.3	1.70	0	8
5	rattlesnake	5.1	1.57	0	8
6	scrub jay	4.9	1.40	0	8
7	coyote	4.8	1.48	0	8
8	deer	4.7	1.5	0	8
9	owl	4.7	1.58	0	8
10	bat	4.7	1.59	0	7
11	crayfish	4.6	1.67	0	7
12	butterfly	4.3	1.61	0	8
13	turtle	4.0	1.23	0	7

Table 5
Summary Statistics for LOCALKNOWPOST Scores by Animal

Rank	Animal	Mean Score	Std. Deviation	Students' Minimum Score (lowest possible score=0)	Students' Maximum Score (highest possible score=8)
1	raccoon	6.3	1.14	0	8
2	mountain lion	6.0	1.59	0	8
3	bear	5.96	1.31	1	8
4	porcupine	5.5	1.57	0	8
5	coyote	5.4	1.36	0	8
6	rattlesnake	5.4	1.36	0	8
7	owl	5.1	1.37	0	8
8	deer	5.1	1.31	1	8
9	scrub jay	5.0	1.21	1	8
10	bat	4.9	1.64	0	8
11	crayfish	4.8	1.66	0	8
12	butterfly	4.6	1.48	0	8
13	turtle	4.1	1.23	0	7

An analysis of changes to students' knowledge of local wildlife from pre- to post-test was also conducted. Table 6, below, summarizes the correlation of pre- to post-test scores for local wildlife knowledge by *animal*.

Table 6
Correlation of Students' Pre- to Post-Test Scores by Animal

Animal	***r***	***df* (n-2)**
crayfish	.61	194
butterfly	.49	199
bat	.49	201
deer	.47	199
lion	.45	202
bear	.44	213
owl	.43	202
jay	.42	195
porcupine	.41	199
rattlesnake	.41	195
coyote	.33	203
raccoon	.33	196
turtle	.29	212

The 13 local animals included in the *Fast Facts* were also clustered by membership in major taxonomic groups. Doing so produced indices for four groups: *VERTMAMMAL*, *VERTBIRD*, *VERTREPTILE*, and *INVERT*. The number of animals in each taxonomic group varied; in order to make comparison across groups possible, composite scores were generated by tabulating all of the mean scores for each animal and dividing this value by the number of animals in that group. Children's knowledge at the taxonomic level showed almost uniform numerical improvement from pre- to post-test. Tables 7 and 8 summarize local wildlife knowledge scores by taxonomic group at time of pre- and post-test; numerical ranking from highest to lowest mean score for taxonomic groups remained the same from pre- to post-test.

Table 7
Summary Statistics for LOCALKNOWPRE Scores by Taxonomic Group

Rank	**Taxonomic Group**	**Mean Score**	**Std. Deviation**	**Students' Minimum Score** (lowest possible score=0)	**Students' Maximum Score** (highest possible score=8)
1	Vertebrate mammals	5.2	.94	2	7.3
2	Vertebrate birds	4.8	1.2	1.5	7.5
3	Vertebrate reptiles	4.6	1.07	1	7
4	Invertebrates	4.4	1.27	1.5	7

Table 8
Summary Statistics for LOCALKNOWPOST Scores by Taxonomic Group

Rank	**Taxonomic Group**	**Mean Score**	**Std. Deviation**	**Students' Minimum Score** (lowest possible score=0)	**Students' Maximum Score** (highest possible score=8)
1	Vertebrate mammals	5.6	.98	2	7.1
2	Vertebrate birds	5.1	1.00	2	7.5
3	Vertebrate reptiles	4.7	.98	1	6.5
4	Invertebrates	4.7	1.3	1.5	7.5

A final permutation of the local wildlife knowledge scores resulted in the creation of the *SPECIMENKNOWPRE* and *SPECIMENKNOWPOST* indices. These indices captured students' numerical knowledge scores for the 10 local animals featured in the *Fast Facts* that were also explicitly included in the intervention (specimen) lesson that all treatment group students participated in during the COSEP. Both pre- and post-test values are summarized in Table 9, below.

Table 9
Summary Statistics for SPECIMENKNOWPRE and SPECIMENKNOWPOST

Index	Mean Score	Std. Deviation	Students' Minimum Score (lowest possible score=0)	Students' Maximum Score (highest possible score=80)
SPECIMENKNOWPRE	50.5	9.01	17	69
SPECIMENKNOWPOST	54.1	8.96	19	71

4.1.2 Inferential statistics (WK). As predicted, descriptive statistics show that knowledge of local wildlife numerically increased from time of pre-test to time of post-test for students in the both control and treatment groups. Results from a paired two-tail t-test, as seen in Table 10, revealed that this was a highly significant finding at the $p<.0001$ level.

Table 10
Paired Two-Tailed t-Tests of Students' Pre- to Post-Test Knowledge of Local Wildlife Scores

Index	Δ	*t*	*p*	*df*
LOCALKNOW	4.17	6.6	.0000	190

To determine if gains in knowledge from pre- to post-test for individual animals, taxonomic groups, and the group of animals specific to the specimen lesson were significant, paired two-tailed *t*-tests were conducted. Several gains were highly significant at the $p<.001$ level. See Table 11 for a summary of those results.

Table 11
Paired Two-Tailed t-Tests of Pre- to Post-Test Scores by Animal, Taxonomic Group, and Group of Specimen Lesson Animals (sorted by Δ, highest to lowest)

Index	**Δ**	***t***	***p***	***df***
coyote	.59	5.1	.0000	204
raccoon	.43	3.8	.0002	197
lion	.42	3.7	.0003	203
owl	.42	3.8	.0002	203
butterfly	.41	3.7	.0003	200
rattlesnake	.34	2.9	.0042	196
deer	.31	3.0	.0029	200
bear	.3	3.4	.0009	214
porcupine	.28	2.2	.0265	200
scrub jay	.2	1.9	.0577	196
bat	.18	1.6	.1119	202
crayfish	.14	1.3	.1952	195
turtle	.01	.14	.8925	213
vertebrate mammals	.37	6.3	.0000	190
invertebrates	.32	4.0	.0001	190
vertebrate birds	.31	3.9	.0002	192
vertebrate reptiles	.16	2.1	.0373	195
specimen lesson animals	3.7	6.9	.0000	190

The second component of the wildlife knowledge hypothesis-cluster was regarding participation in the intervention lesson. The hypothesis was that students in the intervention lesson would experience different wildlife knowledge gains than did students in the control group. For all students, we see that the net increase in local wildlife knowledge of 4.2 points (d = .37) from pre- to post-test was significant (p<.001). Of the 191 students included in this analysis,[21] 69% showed improvement from pre- to post-test. A regression was conducted (see Table 12, below) showing that students in the treatment group did not have statistically significantly different gains. Even though students in the treatment group may have performed slightly numerically worse, their overall increase pre- to post-test was still positive and statistically significant (t = 3.4, df = 100, p <.001).

Table 12
Effect of Membership in Treatment Condition on Post-test Knowledge of Local Wildlife (Controlling for Pre-test Knowledge)

Index	**ß**	***t***	***p***	***R²***
LOCALKNOW	-1.7	-1.44	.151	.50

A series of regressions was conducted to test whether membership in the treatment condition resulted in greater increases in children's local wildlife knowledge. Carried out for the individual local animals, taxonomic groups, and the group of animals specific to the intervention lesson, the regressions controlled for pre-test scores with a dummy variable for inclusion in the treatment. Table 13 summarizes these three sets of values.

[21] This n was the result of including in the analysis only students with a combined ≤ 28 missing values in pre-/post-test where 999 was recoded as 0.

Table 13
Effect of Membership in Treatment Condition on Post-Test Knowledge of Local Wildlife (Controlling for Pre-test Knowledge) by Animal, Taxonomic Group, and Group of Specimen Lesson Animals

Index	**ß**	***t***	***p***	***R²***
bear	.12	.75	.456	.19
owl	.07	.39	.699	.18
coyote	.03	.18	.859	.11
scrub jay	-.05	-.31	.758	.172
deer	-.05	-.27	.785	.23
rattlesnake	-.06	-.32	.747	.17
lion	-.07	-.35	.726	.25
turtle	-.08	-.47	.638	.085
bat	-.12	-.60	.551	.24
crayfish	-.12	.19	.522	.37
raccoon	-.21	-1.33	.185	.113
butterfly	-.23	-1.28	.203	.245
porcupine	-.51	-2.56	.011	.19
vertebrate birds	.01	.07	.946	.230
vertebrate reptiles	-.06	-.46	.646	.214
invertebrates	-.15	-1.09	.279	.387
vertebrate mammals	-.18	-1.63	.104	.44
specimen lesson animals	-1.32	-1.34	.180	.45

Considering the delay from the time of participation in the COSEP—an average of 19 weeks—the delay in post-testing was used as a final analytical lens when examining changes in children's knowledge of wildlife. A regression testing whether the delay from time of trip to time of post-test predicted students' post-test scores after controlling for pre-test scores found a nonsignificant (p = .104) result (ß = -.75, t = -1.63, $F(2, 188)$ = 94.53).

4.2 Children's Attitudes Toward Nature The second variable under investigation, children's attitudes toward nature-based activities (ATN), was addressed by several hypotheses. The first hypothesis in the affective hypothesis-cluster was that students' pre-test responses to a battery of Likert-type scale items would be positive, overall, but would show less variation across the affect scale than would responses on the post-test. Variation in students' responses was predicted to increase at the time of post-test.

The *CREEKNATUREPRE* and *CREEKNATUREPOST* indices were created using twenty-seven nature-based items drawn from the broader constructed-response Activities Inventory. *CREEKNATUREPRE/POST* items were those specifically related to having direct or indirect interactions with nature and included encounters with animals, plants, and non-living elements of the natural world such as water, mud, stars, etc. The lowest possible score on the two indices, which would represent the most negative attitude, was 27. The highest possible score, representing the most positive attitude, was 135.

4.2.1 Descriptive statistics (ATN). Utilizing the *CREEKNATUREPRE* index (minimum score = 27, maximum score = 135), mean scores for all students that completed the pre-test Activities Inventory (n = 207) were calculated. Numerically, the lowest *CREEKNATUREPRE* score was 80 and the highest was 134 with a mean score of 112.3 (SD = 13.1). For all students completing the post-test Activities Inventory (n = 240), results revealed a numerical low score of 52 and a high score of 135 (M = 111.9, SD = 14).

4.2.2 Inferential statistics (ATN). Sixty-percent of all participants (n=173) completed the Creekside Activities Inventory at *both* the time of pre- and post-test. For these students, the mean score on the inventory at pre-test was 112.2 (SD = 12); at post-test, the mean score was 110.6 (SD = 14.7). In analyzing the changes in students' attitudes toward nature (ΔATN), a paired t-test determined that the 1.6 decrease from pre- to post-test, $t(172)$=1.90, was marginally significant (p = .06). On average, children's attitudes toward nature became slightly more negative after participation in the COSEP. Though not statistically significant (p = .23), students in the treatment condition of the experiment had smaller decreases than did their control group counterparts.

The second hypothesis of the affective hypothesis-cluster was in regard to the amount of variance in students' responses to the attitudes toward nature (ATN) items. Variance at pre-test, it was hypothesized, would be low but the variance across items would increase at post-test. To test this hypothesis, a variance ratio test was conducted. At the p<.05 significance level, the test revealed that there was greater variability in students' post-test responses, confirmed by an increase in the standard deviation from 12.04 at pre-test to 13.99 at post-test (f = 1.35, df = 239, 206).

The final hypothesis related to attitudes toward nature stated that a participant's pre-test attitude score (*CREEKNATUREPRE*) would predict the overall change to local wildlife knowledge (ΔWK). A regression was conducted predicting children's post-test local knowledge controlling for pre-test local knowledge to test whether students who had a high pre-trip attitude toward nature (ATN) score would have larger wildlife knowledge gains. Statistically, it could not be said with confidence (p = .213) that students' affective attitudes toward nature prior to their participation in the COSEP —whether negative, neutral, or positive—predicted any change in their local wildlife knowledge score (ß = .06, t = 1.25, R^2 = .56, $F(2, 168)$ = 107.82).

4.3 Children's Expressed Preferences for Learning about Wildlife The third construct being investigated was children's preferences for learning about wildlife—both at the species level and that of mode of learning (PLWA/PLWM). The hypothesis-cluster was that children (a) prefer to learn about local species and (b) that given the opportunity to do so, they would prefer to study those animals in more direct, as opposed to vicarious, modes. These preferences were predicted to be durable and would change little from pre- to post-test. Finally, it was hypothesized that students' pre-trip preferences for mode of learning would predict cognitive outcomes for children in either condition.

4.3.1 Preferred species when learning about wildlife (PLWA). Within the PLW construct, the first preference to be investigated was for species. With a three-point measure, this free-choice item (Item 1 in the W*ildlife Biologist* segment of the instrument) asked children to select a species that that they would like to study as a junior wildlife biologist. Responses to *WBANIMALPRE* were coded as 2 when students responded with animals local to Lorry, as 1 for animals not found in Lorry but extant in North America, and as 0 for exotic animals. Pre-test responses (n = 172) indicated that 69% of students preferred to study an animal local to the Lorry area. At a much lower level of 17%, students selected a species found elsewhere in North America; lower still, numerically, was the preference for an exotic species at 14%. With a highest possible value of 2 (most local), the mean average score on the *WBANIMALPRE* item was 1.55 (SD = .8).

Post-testing results revealed that students maintained similar preferences for species. Student responses indicated a 70% preference for local species, 15% of students preferred North American/non-local species, and 16% preferred exotic species. Overall, students' post-test responses (M = 1.54, SD = .8) for *WBANIMALPOST* nonsignificantly decreased by .006, (t = -.89, df = 158).

An ordered logistic regression testing for a relationship between students' preference for species and inclusion in the treatment group showed that membership in this condition resulted in a nonsignificant .6 increase in the likelihood that their post-test preference would be lower than their pre-test preference in which "lower" indicates a more exotic preference.

4.3.2 Preferred mode of learning about wildlife (PLWM). The second preference in the PWL construct was regarding children's preferred mode of learning about wildlife. A fixed-response multiple-choice item on the W*ildlife Biologist*, *WBSTYLEPRE*, asked children to select a response indicating the mode that that they would like to use when studying their preferred species as a junior wildlife biologist. The item was scored as 2 for the most direct mode of learning, as a 1 for intermediate modes, and as a 0 for the least direct mode, and therefore the most vicarious mode. One hundred and seventy-five students completed this item on the pre-test *Wildlife Biologist*. Responses indicated that 60% of students expressed a preference for direct modes of learning (by studying the animal in the wild). The intermediate modes (by reading about or talking with other biologists about the animal) returned a 28.6% preference and the lowest response was for the least direct mode (watching television shows or movies about the animal) at 11%. The mean score for students at the time of pre-test on the *WBSTYLE* item was 1.5 (SD = .7).

As hypothesized, students' preferences for mode of learning about wildlife remained similar on the post-test. The average post-test preference for mode was 1.6 (SD = .6) for the 238 student responses to Item 2 on the post-test *Wildlife Biologist*. Two-thirds of students (66%) expressed a preference for the most direct mode of study; 27% preferred an intermediate mode of learning; and, at the lowest response rate, 7% of students preferred to study their chosen animals in the most vicarious, and therefore least direct, mode. Overall, the change in students' response rate on *WBSTYLEPRE* (pre-test) to *WBSTYLEPOST* (post-test) showed a gain from a mean value of 1.47 to 1.6. A two-tailed t-test revealed that this .13 increase indicates a shift in students' preference toward more direct modes of learning (t = 1.8, df = 154); this shift was of marginal significance (p = .07). Participation in the treatment condition did appear to have a significant ($p<.05$) effect on students' preferred mode of learning about wildlife; with an odds ratio of 2.3, students that participated in the hands-on intervention lesson were more likely to prefer direct modes of learning at the time of post-testing.

The final hypothesis in the behavioral hypothesis-cluster stated that a pre-trip preference for mode of learning (*WBSTYLEPRE*) had predictive power. A regression was conducted predicting children's post-test local knowledge controlling for pre-test local knowledge to test whether students' preference for mode of learning at pre-test would predict wildlife knowledge gains. Statistically, it could not be said with confidence (p = .207) that students' preference for mode—whether direct, intermediate, or vicarious—at time of pre-test prior to their participation in the COSEP predicted any change in their local wildlife knowledge score (ß = 1.11, t = 1.27, R^2 =.51, $F(2, 153)$ = 80.30).

4.4 Conclusion In summary, this chapter presented the results from a quasi-experimental study that explored the cognitive, affective, and behavioral aspects of modern children's relationship with the natural world and their participation in a residential, outdoor science education program. In the next chapter, these quantitative findings, illuminated by qualitative data, will be interpreted.

Chapter Five

Discussion

To situate the discussion of the findings of the present study, consider the following Creekside vignette:

> *Even though vacation is coming to a close, it still feels like summer outside. You have just celebrated your tenth birthday and now that the new school year has begun—your last year in elementary school—you are focused on the big Creekside field trip that is just a week or two away. You've been looking forward to the trip—your friends in last year's fifth-grade class came back with stories of bears, bugs, and burrito night. Oh yeah! And you'll finally get to learn all the words to that song. How does it go? "It starts with an 's' and it ends with a 't'!" Yep, you're excited to learn the scat song. But at the same time, you are feeling (secretly) a little nervous about the trip. It is the first time you have slept away from home without your parents, your brothers and sisters, and your papa…not to mention your best friend, your dog Max. And didn't someone say that the wolverine came right through camp during the night last year? ("Do wolverines eat people?", you wonder.) But speaking about those animals out there at Creekside. You'd better get the chance to see something besides those dumb garden-wreckers, the deer, and a plain old raccoon who is in your trash can every other night. You want some excitement on your trip—maybe seeing a shooting star or going swimming in the creek if it's too hot outside (which you really hope it's not because you don't like that hot weather, being from Lorry and all). Maybe it will even be just like that show "Untamed and Uncut" on the Animal Planet! Oooh. Maybe you'll get to see a monkey out there in the woods. (Monkeys live in Lorry, right?) Oh, the possibility of having a real outdoor adventure is too much! Your bags are packed (extra socks in case your shoes get wet—Yuck!—and a secretly stashed flashlight just in case the outhouse is near where that wolverine was spotted) and it's time to go. Fifteen minutes into the ride, you and your best friends can't help but shout out to the carpool mom who is driving a mammoth-sized SUV, "are we there yet???"*

With a purpose of making a contribution to the growing body of research on children's connection to the natural world, the present study was framed by several questions. What do children know about local wildlife? What attitudes toward nature do children hold? Do children prefer to learn about local or exotic species? If given the opportunity to do so, would children prefer to learn about wildlife through direct versus vicarious modes? Nested within these top-level questions, it was also asked if participation in an outdoor science education program or an intervention lesson embedded within the program would result in different outcomes for children.

Overall, the present study did generate evidence that addresses these questions. We now have a better idea of Lorry children's knowledge of, and their feelings toward, nature. As the vignette that opened this chapter suggests, they recognize and can name many of the animals that live in and around their neighborhoods, especially the ones that they come into close contact with on a regular basis. Although this knowledge was not consistent across species, it was considerable even at time of pre-test. We also see that the children's attitudes toward nature were very positive—even for the kinds of experiences that the literature describes as missing from their childhoods. Likewise, if given the chance to do so, these children would prefer to learn about nature through direct interactions, much more so than by passively watching nature programming on television.

Subtle variations across the broad outcome categories of cognition, affect, and behavior emerged. Discussion of these subtleties will be organized by the questions that framed the study; when suggestive, links across the three constructs of children's knowledge of local wildlife, their affective attitudes toward nature, and their preferences for learning about wildlife will also be presented.

What do children know about local wildlife? The literature has generally painted a bleak picture of the relationship between modern children and the natural world, especially their knowledge of local plants and animals (e.g., Atran, et al., 2004; Balmford, et al., 2002; Bang, et al., 2007; Braund, 1998; Louv, 2005; Nabhan & St. Antoine, 1993; Snaddon, et al., 2008; Strommen, 1995). Rather than spending hours digging around in the garden or exploring empty lots on the outskirts of the neighborhood—experiences that breed familiarity and understanding of how nature works—children are now stationed on the sofa where they are bombarded with the glossy, fast-paced version of nature that the media are pedaling. Many fear that the heyday for children's knowledge of even the most common local organisms has come and gone.

In contrast to such literature, the present study found that the children of Lorry possessed considerable knowledge of local wildlife even prior to their participation in the Creekside Outdoor Science Education Program. In fact, their knowledge was essentially on the cusp of being considered high or strong. To facilitate the interpretation of the quantitative data, a three-tiered novice-expert knowledge scale was used. This scale also helped to situate the local wildlife knowledge of children in the sample within the broad literature on children's knowledge of the natural world. The *LOCALKNOW* index had a lowest possible score of 0 and a highest possible score of 104. At the lowest tier of knowledge, scores ranging from zero to 34 are considered novice. Scores from 35 to 69 are considered intermediate while scores from 70 to 104 are considered expert. At pre-test, the mean score for children's knowledge of local wildlife was 64.2. This indicates that the Lorry Grade 5 students do possess considerable knowledge of the animals that make up their near-by nature. This knowledge was higher at post-test with a mean score of 68.4. These pre- to post-test wildlife knowledge gains were significant.[22]

In unpacking children's specific local wildlife knowledge, we see that, while all of the local species were either readily observable or were part of a shared awareness,[23] some species were better known to children than others. For example, of the local species included in the instrument, the three animals that were best known overall to children at the time of pre-test were the raccoon, the mountain lion, and the bear (these animals remained in the top three spots at post-test, as well). Why might these three particular animals be so well known to children? One possibility, simply put, is trash, at least for the raccoon and the bear. Bears are exciting to see but, like other areas where black bear territories overlap with human settlements, bear sightings in Lorry are common. Most people have had, themselves, or know a neighbor or colleague that has had, a first-hand encounter with a black bear. The bears frequently pry garage doors up at the corners or ravage even metal dumpsters in pursuit of a tasty morsel of food. Though much less destructive in their search for food, raccoons are just as common. "Trash" and "garbage" were frequently cited in students' responses to the diet question for both the bear and

[22] Recall that the design of the study did not include a control group of students not attending the COSEP; thus, no causal claims are being made.
[23] This shared awareness will be described when the mountain lion's status as well-known is discussed.

raccoon. The frequency of these answers suggests that children assume trash is supposed to be part of what these creatures eat, rather than a circumstantial, and unfortunate, habit.

Unlike the bear and raccoon, the mountain lion's place among the most well known local animals probably doesn't stem from having had a first-person encounter. Rather, children are made aware of the mountain lion's presence in the Lorry area (despite its elusive demeanor) in school, primarily for the purposes of self-defense. In the United States and Canada, the majority of fatal cougar attacks[24] have been on children under the age of 12 (Baron, 2004; Beier, 1991, 1992). It is believed that small children are seen as potential prey by the big cats and an attack on a child involves less physical risk than attacking a larger, stronger adult. Children in Lorry are taught from an early age how to protect themselves from a cat attack, including defensive strategies if attacked as well as ways of avoiding an attack in the first place. Since the large cats are reclusive, actual sightings are not common. Given the frequency in which the species is spoken about, however, it can be assumed that children tend to be very aware of its presence in the area.

Another interpretation of the consistency in children's knowledge of the raccoon, the mountain lion, and the bear is the charisma factor. The literature supports the claim that big, social, animals that we can relate to tend to be best understood by us. This certainly could explain the children's familiarity with raccoons. Responses to the diet item such as "He's a garbage lobster and eats anything" and "Plants, rodents (really anything if you count their searching in our garbage cans" capture children's familiarity with this species described by one student as the "mischivos little guy." The charisma theory could also explain why the animals' rank by student knowledge also roughly correlated to body size. It appears that the smaller in body size the tested species were, the less known they were to the Lorry children.

For these smaller, and quite possibly less universally appealing, animals at the other end of the knowledge spectrum, Lorry children knew the least, numerically, about the crayfish, the butterfly, and the turtle. In contrast to two of the best-known species, none of these animals can kill you (though crayfish can give a surprisingly nasty bite). Described as the silent majority ("Invertebrate Facts: The Silent Majority," 2010), invertebrates tend to be less well known to most people, children included (Strommen, 1995). But the turtle is a vertebrate. And we know that some children develop disproportionate amounts of knowledge on certain reptilian relatives of the red-eared slider (Lorry's common pond turtle). Dinosaur expertise develops, clearly, without any sort of interaction with a living animal, yet for some children, encounters with preserved specimens, models, and mediated representations of dinosaurs are enough to catapult them to expert levels of knowledge (Crowley & Jacobs, 2002). Though also a reptile, the slider pond turtle of Lorry doesn't appear to have the same effect on children. It was the least known to children at both the time of pre-test and post-test. Knowledge of the turtle barely increased at all from time of pre-test to time of post-test. An exception to the "size matters" theory was the Monarch butterfly. Although knowledge scores for the butterfly placed in the lower quartile of the 13 local species at time of both pre- and post-test, gains were significant ($p<.001$). One possibility is that butterflies and moths figure prominently in elementary science curricula. While the Monarch butterfly is an endangered species (making harming them illegal), butterflies are commonly found in science classroom discussions of insect life cycles. Many children suggested in the pre- and post-tests that you should not touch a butterfly's wings as this would either kill or irreparably maim them in some way. This degree of familiarity may be the product of being chastised for their less-than gentle handling when they catch butterflies. This familiarity, however, did not translate into knowledge about other aspects of the Monarch's life;

[24] Both fatal and non-fatal cougar attacks have greatly increased in the past several decades in North America (e.g., of the 73 confirmed attacks in the U.S. and Canada between 1991 and 2003, there were 10 fatalities); children are several times more likely than adults to be victims (Chester, 2004).

in particular, children rarely were able to correctly identify if Monarch's migrate (they do, and over great distances) or that nectar is primary food source.

Does the charisma theory hold when animals were clustered according to taxonomic group? As with individual animals, the mammalian vertebrates were best known to children. Invertebrates, however, were least known even though they comprise the majority of biomass on the planet; this ranking held for both pre- and post-testing. Interestingly, even though the invertebrates were the least known taxonomic group to children at both testing times, the gain in knowledge was highly significant. Perhaps time spent learning creek ecology by wading in the actual creek helps increase children's knowledge of the smaller (and some argue, less charismatic) species.

Though not central to the hypotheses of the present study, analyses revealed[25] that, of the six dimensions tested for all species, animals' names were particularly salient for children. It appears, however, that the names of certain animals flummoxed children. For some qualitative (and, in this case, comedic) relief when scoring the pre- and post-tests, scorers only had to reflect on the numerous ways children named the porcupine. Though most were able to approximate its name, the porcupine rarely had its name spelled correctly.[26] Some of the more humorous exceptions included the "quill king," the "needl pounter," and the "pinkle." The porcupine was called the "borkee pin," the "pork pie," the "spine pig," the "porquispine"… the misspellings got more enjoyable with each one. Also not elaborated in the primary hypotheses, but worth mentioning is children's weak knowledge of what animals eat. At pre-test, there was a full two-point difference between name and diet knowledge. Interestingly, this gap had widened at post-test. This held even for the most common animals in Lorry. Carnivores, according to some children, consumed berries and twigs. Herbivores were thought to eat meat. For example, many incorrect responses for the deer's diet were given, including one suggestion of cannibalism, "They eat other deers." A common error was the narrow response that crayfish eat only hot dogs. While crawdads are typically baited with human food (especially hot dogs and deli meat), they are omnivores and children failed to list any natural foodstuffs alongside bait-like items humans introduce. People, according to many children, are also thought to be natural dietary items. The large predatory animals in the instrument provoked "people" and "humans" as responses frequently. More than any other animal tested, the butterfly's diet was a mystery to children. Many assumed it was an herbivore and ate flowers or leaves.

Did participation in a supplemental intervention lesson embedded within the general program result in different knowledge outcomes for children? Children's knowledge of local wildlife coming into the Creekside Outdoor Science Education Program was stronger than the literature had suggested it would be (Balmford, et al., 2002; Kellert & Westervelt, 1983; Lindemann-Matthies, 2005; O'Brien, 2010; Snaddon, et al., 2008), although there were large gaps in what was known. At the time of post-test, students exhibited significant knowledge gains across the board. This was true for students in both the control and treatment conditions. Contrary to the hypothesis, however, students in the treatment group—those who participated in the hands-on intervention lesson that had included specimens of ten of the 13 local animals included in the *Fast Facts*—showed no greater improvement in knowledge scores than did their control group counterparts. Students did not demonstrate statistically significant gains on any one of the animals; likewise, none of the taxonomic groups showed statistically significant improvement for treatment group children. For the 10 animals that were included in the specimen lesson, all children showed a statistically significant improvement from pre-test to post-test. Being a member of the treatment group, however, did not equate to a larger gain in

[25] See Appendix E for data on children's knowledge of local wildlife at the dimension level.
[26] Spelling did not count against children in the scoring barring any responses that were illegible or uninterpretable.

knowledge, even for the 10 animals students had the opportunity to directly interact with during the lesson. Possible interpretations of this nonfinding will be taken up in the final chapter.

All of the findings regarding changes in children's knowledge of local wildlife must be viewed through the analytical lens that accounts for the delay in post-testing from the time of participation in the COSEP. The delay ranged from 17 to 21 weeks with an average of 19 weeks from the Creekside trips to administration of post-tests back in the classrooms. Analysis revealed that the delay was not significant in predicting students' knowledge gains; this may indicate that the gains were persistent over time. When considering the lack of environmental education research that has examined the retention of cognitive, affective, and behavioral outcomes over longer periods of time, these findings are interesting. It appears that the gains, prompted by participation in the COSEP alone, a condition not directly tested in the present study, or in the supplementary intervention lesson, were still detectable even after four months.

What attitudes toward nature do children hold? As was hypothesized, the children in the sample had very positive attitudes about nature-based experiences prior to attending the Creekside Outdoor Science Education Program. The children were clearly excited by the *idea* of experiencing nature, as the literature suggested they would be (Bonnett & Williams, 1998; Kruse & Card, 2004; Stern, et al., 2008). But if we look to the literature, we could assume that modern children spend little time in the out-of-doors exploring and interacting with the natural world. According to numerous studies, modern children are nature-deprived. It is unclear, then, what motivated the Lorry children's positive attitudes toward nature. It is possible that the positive attitudes of the children in this sample were based on their familiarity with the natural world from prior experiences; it is also possible that their excitement stemmed from the concept of what a nature-based experience *might* be in the absence of having had those or similar experiences in the past.

A clue that sheds light on the uncertainty regarding the underpinnings of children's positive attitudes toward nature is the change in variation of responses from the time of pre-test to the time of post-test. It was hypothesized that students' pre-test attitude responses would be relatively undifferentiated. In the absence of having had a wide range of their own prior experiences with nature, students would have little functional knowledge of what a direct nature experience would be like. Forming a realistic attitude toward an imagined event would be challenging for children, and their expectations clouded by the representations of nature they had previously encountered. A considerable number of these previous experiences would be with mediated representations of nature. These representations are typically erroneous, leading to illusory expectations. These illusions may have inhibited children's reports of their attitudes toward nature. It all looks so thrilling and fantastic on television and the big screen. What isn't there to be excited about when asked how one feels about having a nature experience of their own?

If this is true—that children exhibit a blanket-like enthusiasm for nature-based activities prior to participation in an intensive outdoor education field trip—we should expect that the post-test results would be more differentiated across the 5-point scale. The findings show just that. Students' overall reported attitudes toward nature remained fairly constant after the COSEP with a mean score just slightly lower than they had been prior to the field trips. Each of the pre- and post-test means was highly positive. What changed was the variability in responses across the negative-to-positive scale. This change in variation was significant ($p<.05$). Perhaps the time spent at the Creekside Field Station, engaged in a combination of exploration, instruction, and play, afforded the students a more realistic sense of how they feel about being in nature.

Were children's pre-participation attitudes predictive of trip outcomes? Grounded in the motivation and interest literatures that suggest that cognitive outcomes can be enhanced when the learner experiences some form of excitement or enthusiasm for the subject, it was hypothesized that children with the most positive attitudes prior to the trips would exhibit the highest cognitive gains. Simply stated, it was hypothesized that the children who were most excited to be a part of the Creekside experience would take away the most from having done so. Interestingly, while excitement and knowledge levels remained high after the trips, there was no empirical evidence to suggest that one was predictive of the other. One possibility is that the children were almost uniformly excited about the trips. With a very high positive attitude both before and after the trips, a ceiling effect may have inhibited the predictive power of the affective stance. It is also possible that the instrument was too blunt to detect such a nuanced interplay between affective and cognitive factors or that the interplay was lost in the noise that the regression models couldn't account for. An alternative hypothesis is that the Creekside trips did not match well with the expectations of students. Students' expectations, which were very positive prior to participation, may have been unrealized during the trips; these inaccurate expectations then may have limited students' cognitive gains.

Do children prefer to learn about local or exotic species? What mode of learning do they prefer? The literature demonstrated that children are interested in interacting with and learning about animals (Ballantyne, Packer, Hughes, & Dierking, 2007; Kruse & Card, 2004; Sherwood Jr., et al., 1989). Likewise, we know that when presented with the opportunity to do so, children would prefer to learn about plants and animals in hands-on and interactive ways with the organisms themselves, not merely representations of them. It appears that the Lorry fifth graders are no different. At pre-test, they even expressed a preference for learning about *local* species despite their exposure to mostly exotic species in the media. Exotic species, for these children, were the least frequently mentioned. Children even selected predators for up-close observation and study. One response was for the fox "even though they can be really ferisous."

As was suspected, a majority of children wanted to learn about their chosen species through direct observation—by studying the animal in the wild. And while media are pervasive in children's lives today, the findings regarding the Lorry children suggest that they would least prefer to learn about wildlife in a vicarious—and mediated—way.

The difference between children's pre-test and post-test preferences, while trending toward being even more direct, was not statistically significant so no assumptions can be made about whether having had a direct experience with nature would provoke an even greater preference for doing so in the future. What did occur with statistical significance ($p<.05$) was the rate of increase for the students in the treatment group. Participation in the intervention lesson resulted in a 2.3 times greater likelihood that preference for mode would increase (shift toward more direct modes). It is possible that a highly tactile and interactive experience with an assortment of animal artifacts produced a shift toward preference for a similar experience in the future. In this last finding, future research is suggested. While membership in the intervention lesson did not significantly increase knowledge of local wildlife (no more so than did participation in the more general COSEP itself), the children in the treatment lesson came away from the experience with a stronger preference for learning in direct ways. In a future study, it would be worthwhile to offer the specimen lesson to a control group of students that did not participate in the broader field program, possibly in a classroom context, to examine for its cognitive as well as behavior-changing power.

Were children's pre-participation preferences for mode of learning predictive of trip outcomes? The final element of the investigation was consonant with the affective hypothesis that what one brings to an experience shapes, and may even constrain, what one takes away from it. In the context of the COSEP, it was hypothesized that children who had a stronger preference for more direct modes of learning coming into the trips would gain more given the nature of the trips as being wholly-immersive. As with the predicted power of positive attitudes for cognitive outcomes, no statistical evidence was found to support the hypothesis that preferred mode would predict knowledge gains.

While the vignette that began this chapter is an amalgam of the sentiments expressed by many children that have had the opportunity to attend the Creekside Outdoor Science Education Program over the years, it is based on numerous conversations the author has had with Lorry teachers, parents, older siblings, and even the students, themselves, several years after their own Creekside experience. Closing the discussion of the empirical findings of this study, another vignette provides the reader with a look at what students may experience once the trips have come to a close.

> *Summer vacation is fading into memory. You're ten years old but you feel just a little more grown up these days. You spent two nights in a strange place out in the middle of the woods without any of the comforts of home. (You still feel like Creekside was "out there in nature" even though it was less than 15 miles from your own front door.) You didn't see a wolverine or a mountain lion, but that's o.k. (It means you didn't get eaten by one, either.) You did get to gently press your hand against the tiny chest of a mountain chickadee. You had no idea that the heart of a bird could beat so fast and so hard! Or that its little beak was so strong. At the dinner table that first night back at home you couldn't talk fast enough to tell you parents, your brothers and sisters, and your papa about the fish house where you go underground and spy on the trout in the creek, the racket that all the animals make when you're sitting quietly in the meadow in the middle of the night (it was really only 8p.m., but when you're ten years old and it's dark and the trees cast shadows that dance in the moonlight, it may as well have been midnight), and the enormous grasshopper you caught with you own bare hands. You even got to hold the skull of a black bear up to your friend Tony's face, roaring all the while. (He was really scared for a minute even if he says he wasn't.) When you can talk no more (and everyone around the table is getting restless sitting there listening to you go on and on…and on about Creekside), you crawl into bed. Just before you drift off to sleep, you share one last story. This one is for your best friend, your dog Max. You tell him that the coyote you caught a glimpse of in the woods out at Creekside looked just like him. Except the coyote howled a lot louder. And it ran much faster. And, now that you think about it, it had much bigger teeth, too. And, while you missed him and home, maybe hanging out in nature right there in Lorry was as cool as watching "Shark Week" on TV … maybe.*

Chapter Six

Conclusions and (More) Future Directions

From the outset of this research project, it was understood that the relationship between children and the natural world involves a complex interplay of cognitive, affective, and behavioral factors. This interplay shapes each experience children have with nature, whether the encounter is direct and hands-on or more vicarious and passive—and it defines the outcomes of those experiences. Researchers must not only untangle the intricacies of what children bring with them to nature-based experiences; they must model the outcomes of participation in an outdoor experience in light of them. In the case of the present study, the outdoor experience was specifically designed to alter children's knowledge of, their attitudes toward, and their preferences for, various aspects of the natural world. While this study produced less than an abundance of statistically significant evidence, it did show, most notably, that students' knowledge of local wildlife had significantly improved after participation in the Creekside Outdoor Science Education Program. This improvement was detectable even after four months—a finding that adds to the nascent empirical literature examining the persistence of participants' cognitive outcomes in environmental education programming.

This study also generated suggestive questions for future research in the effort to unravel the complex child-nature relationship. These questions clustered around three main themes—context novelty, the duration of the outdoor experience, and the varying degree to which different species appeal to children. Leading to the concluding remarks of the present thesis, a discussion of each of these themes—and implications for future research—will now be elaborated.

Context novelty. A fundamental issue that repeatedly presented itself as the data analysis progressed was one of *context*. It was possible that the very novelty of the Creekside Field Station as the context for the study may have constrained the cognitive, affective, and behavioral outcomes for participating children.

Well-established in the informal learning environments literature, the concept of the novelty factor (Falk, Martin, & Balling, 1978) may have impacted the outcomes of participation for the COSEP students. Explicated by Orion and Hofstein (1994), "place-novelty" in relation to field trips consists of cognitive, geographic, and psychological factors. These factors include the "thinking and learning" tasks students will be asked to engage in during the field trip, the students' familiarity with the place/setting where the field trip takes place, and students' prior experiences with similar out-of-class excursions.

Each of the three place-novelty factors described by Orion and Hofstein may have been acting on the trip outcomes for participating COSEP students. First, while the COSEP students did engage in a range of pre-trip activities designed to prepare them for the experience (e.g., reviewing a trip packing list, discussion of details about the Field Station and the general itinerary of the trips, and covering relevant vocabulary words such as habitat, migration, meadow, scat, and endangered), little work was done that would replicate students' participation in actual field-based scientific studies such as the collection of living insect specimens or testing water quality. The use of field-based science tools (e.g., insect nets, vials, pH strips, etc.) was not modeled for students prior to arrival at the Field Station. Training in the use of these tools took place only moments before engaging in their use at the Field Station.

Second, students' familiarity, or lack thereof, with the place/setting may have had an effect on the outcomes of participation in either condition of the COSEP. In numerous studies that examine the possible effect of novelty on participation outcomes in informal learning environments (see Meiers, 2010, for a concise review), the settings themselves are often unfamiliar to the subjects. This literature typically focuses on environments such as museums, science centers, and zoos/aquaria. Unlike an experience *in* the natural environment, these settings require logistical effort—travel to the institution, related costs, and for children, adult supervision/provision—and are thus unique, or novel, for attendees. Even when the specific literature on other outdoor nature-based programs is considered, it is clear that even natural settings can be highly unfamiliar to the participants (Rickinson, et al., 2004). Unlike other nature-based trips where the setting is a destination other than one's own near-by environment, the Creekside Field Station is located just over 10 miles from the Lorry town center. Given Lorry's rurality, the landscape of the Field Station is not qualitatively different than that found even in the most developed parts of town; the flora, fauna, and geological features of the Field Station are familiar to children, at least at the level of daily exposure, if not awareness.

Though the children may be familiar with the setting, the nature of the experience may be novel for them. The literature states that modern children spend significantly less time playing in the out-of-doors than did previous generations (including even their own parents; Louv, 2005). It may be possible that, when presented with the chance to spend a large block of time outdoors in nature, children may perceive this not as a learning experience but rather as an opportunity for adventurous play (Orion & Hofstein, 1994). Sebba (1991), as a result of her investigation of the childhood roots of pro-environmental attitudes and behaviors in adulthood, reasoned that nature-based experiences are qualitatively different for children than they are for adults. Rather than experiencing nature as the backdrop for an event, children experience nature as the event *itself* in these early life encounters with the natural world. For the COSEP children, the sheer act of being outdoors from sun-up to well past sundown—extraordinary for most—may have swamped the other cognitive, affective, or behavioral inputs/outcomes we had expected to find as a result of participating in the field-based trips. What children gained as a result of their time spent at the Field Station may have eluded the measures employed in the present study; more than learning particular facts about local wildlife, the COSEP children may have gained a more holistic, though nebulous, appreciation for the natural world.

It has been long-debated which of the three-pronged goals of environmental education should be given priority—knowledge of, appreciation for, and/or action in the service of, the natural world (NAAEE, 2010; Simmons, 1991; UNESCO, 1978). Though it may be no less important to developing our understanding of the many ways children might benefit from participation in outdoor, nature-based education programs, the measurement of subtle changes in children's appreciation for nature is a much more complicated endeavor than capturing cognitive gains. The present study may have only scratched the surface of children's appreciation for nature by examining the changes in children's expressed attitudes toward certain elements of a nature-based learning experience. Given that "appreciation of the natural world" was one of the overarching goals of the COSEP creators, it would follow that a possible next step in the evaluation of the program would be to conduct more qualitative studies of the experience, constructing more sensitive measures of the affective outcomes of participation. Paired with the quantitative data generated by the present study, this qualitative insight may provide a more thorough picture of a child's experience of the Creekside Program, pointing toward ways it could be improved.

Duration. Another issue raised in the analyses and subsequent discussion was that of the impact the *duration* might have had on student outcomes. Seven of the 10 participating classes spent two days at the Field Station while three classes engaged in an extended, three-day program. Despite the difference of approximately 24 hours spent at the Field Station, the results did not indicate significant differences between the two- and three-day versions of the Creekside Program. This finding, though surprising for COSEP organizers, might be instructive for both program designers and researchers, alike. From a practical standpoint, this lack of significance may indicate that even a small amount of time spent outdoors in near-by nature is beneficial in relation to developing children's knowledge of the local flora and fauna. There is also the possibility that just the opposite is happening. Given children's paucity of unstructured outdoor free time—which often includes elements of play, exploration, and discovery—it may be possible that two- and three-day excursions out into the natural world are not enough to overcome what has been described as the nature-deficit that modern children now undergo (Louv, 2005). It would be worthwhile to examine the differential outcomes of participation in a longer version of the COSEP, perhaps a variation that lasted a full school-week. This extended duration might allow organizers to attend to all three of the factors described in the place-novelty construct. Particularly, COSEP organizers could address the issues surrounding children's unfamiliarity with the setting, the tools, and the procedures to be used, as well as working through and moving beyond children's perception of the experience as adventure play time as opposed to one where learning is a primary goal.

From an evaluation standpoint, researchers may find that the differences in what children take away from a program such as the Creekside residential program may be finer-grained than the instrument used in the present study could detect. A reasonable next step in elaborating these results would be to triangulate the findings with more qualitative data.

Charisma. The findings of the present study also prompt questions about the animals, themselves, that children both knew about and preferred. If the "charisma theory" mentioned earlier in this paper (Adam & Cole, 2010; dePlace, 2005) holds, then a closer look at the characteristics of the animals that were more well-known to children, both prior to and after participation in the COSEP, would be warranted. Is it possible that children's knowledge of, their attitudes toward, and preferences for, certain animals correspond to the animals' charisma— as indicated by the nascent charisma theory? For example, when we look at the three most-well-known animals in the present study, we see that they are large vertebrate mammals. Children possessed the most factual knowledge, numerically, of the raccoon, the mountain lion, and the black bear; conversely, children knew the least about the crayfish, the butterfly, and the turtle. After participation in the COSEP, large, land mammals retained their top spots in terms of knowledge and the aquatic reptile and invertebrates came in last.

While the phrase "charismatic megafauna" has found its way into the research literature, and certain species have been frequently showcased in discussions of charisma (e.g., bears, tigers, sharks, etc.), little systematic work has been done to create some type of charisma/species scale. Such a map would allow for the testing of the theory that charisma garners not only greater attention from both scientists and the public in general but that it also results in greater knowledge of those species. Doing so could provide a critical piece of the child-nature puzzle that could guide future programmatic decisions for both small- and larger-scale environmental/outdoor science education programs in which the goals include both knowledge and appreciation gains. A deeper understanding of children's affinities for particular animals, their megafaunaphilia, would also be advantageous for those that develop different forms of mediated nature—outlets that range from print media to film and to the Internet. As Butler suggested, the work of conservation education must begin with fascination (Mitman, 1999). For the Lorry children, mediated forms of nature do not appear to be able to generate the same interest in the children as do direct encounters, particularly when their megafaunaphilia is aroused. Maybe, then, the field of conservation education should turn its attention toward leveraging children's interest in the more charismatic species that have been so cleverly portrayed in the media into a broader interest in other less appealing species that are just as important as are other members of integrated ecosystems.

Final thoughts. The relationship between children and the natural world is continuously changing. Many claim that this relationship has undergone radical revision in the past generation and it is now in peril; direct, hands-on encounters with local flora and fauna have been replaced with passive exposure to the highly stylized representations of nature being put forward by media outlets ranging from television and film to the Internet. These vicarious nature experiences artificially shape children's expectations of nature when they are given the opportunity to experience the out-of-doors. Taking the possible implications of this disparity between direct and vicarious nature experiences into account, the present study set out to examine the cognitive, affective, and behavioral outcomes of participation in a pre-existing program that provided Grade 5 students with the opportunity to engage in a residential, outdoor science education field trip. In particular, this study tested the power of an intervention session that had been specifically designed to take children's megafaunaphilia into account (in the form of an interactive lesson with preserved local wildlife specimens) to increase children's knowledge of, attitudes toward, and preference for, local species.

Boding well for the overall Creekside Outdoor Science Education Program, children's knowledge of local wildlife significantly increased from pre- to post-test regardless of whether they had participated in a two- or three-day trip or in the control or treatment group. Further, for children in the treatment group, preference for mode of learning about wildlife shifted away from more vicarious modes toward those modes that are more direct (and that more closely resemble the work of field biologists).

Contrary to expectation, however, was the impact of participation in the intervention. Only one of the three dependent variables underwent significantly different changes across the conditions. As was suggested above, these findings may have been clouded by the place-novelty of the Field Station, the duration of the trips, the inherent interest that children show toward certain species and not others, or the effects of length of time between students' participation in the COSEP and their taking the post-test. What is clear, however, is that each of these possibilities can point us toward other avenues of future research as we continue to unravel the complexities of the child-nature relationship.

Gelman and Stern titled their 2006 article in *The American Statistician* "The Difference Between 'Significant' and 'Not Significant' is Not Itself Statistically Significant" (p. 328). Though it may have been somewhat tongue-in-cheek, their title is a useful reminder that even non-findings are of value to researchers and practitioners, alike. The value comes not in the answers provided but in the new questions generated. With so much at stake—both for near-by nature and the biosphere, in general—we must continue to let those questions point us forward in our work.

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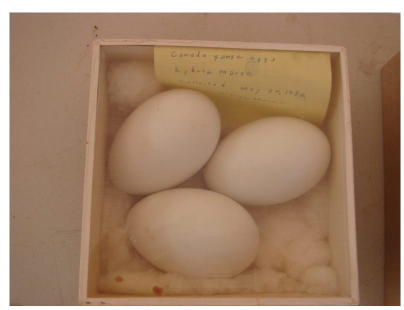
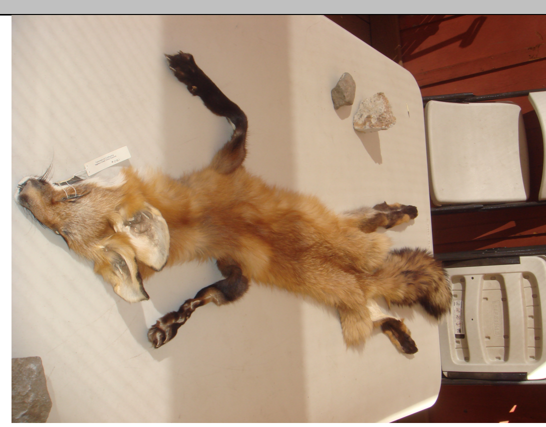
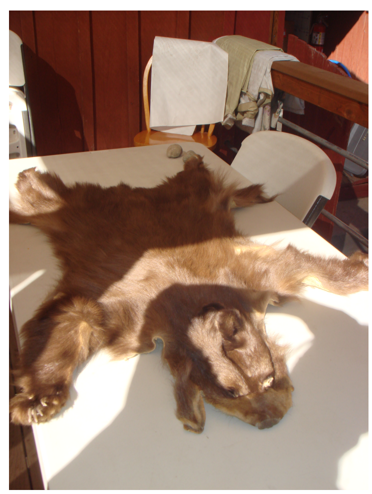
Appendix A: Specimen Lesson Images

	
Mountain Lion	**Mountain Lion**
	
Mountain Lion	**Mountain Lion**
	
Squirrel	**Canada Goose**

Appendix A (continued)

	
Porcupine	**Snowshoe Rabbit**
	
Owl	**Raccoon**
	
Bobcat	**Red Fox**

Appendix A (continued)

	
Coyote	**Coyote**
	
Black Bear	**Black Bear (cub)**

Appendix A (continued)

Black Bear

Little Brown Bat

Monarch Butterfly

Specimen Lesson

Appendix B: Pre- and Post-Test Instrument

Fast Facts about Wildlife

Directions: On the next few pages, you will see pictures of different animals. Each page will have a set of questions about the animal in the picture. Please answer each question as best as you can. If you are not sure about an answer, take a guess and write it in the box.

<table>
<tr><td colspan="4" rowspan="3"></td><td>What is this animal's name?</td></tr>
<tr><td>Have you ever seen one of these animals <u>in-person in the wild</u>? (not just on t.v. or in a movie)</td></tr>
<tr><td>Does this animal live here in Lorry?

If not, where in the world does it live?</td></tr>
<tr><td>Does this animal migrate (move from one place to another with the seasons)?</td><td>What does this animal eat?</td><td>Is this animal nocturnal (active at night) or diurnal (active during the day)?</td><td>Is this animal an endangered species?</td><td>How can people help protect this animal?</td></tr>
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Appendix B (continued)

Creekside!

Directions: On these two pages you'll see a long list of things that we might be doing during our trip to the Creekside Field Station. Doing some of these things may make you feel very happy and doing some of them may make you feel very unhappy – or somewhere in between. Please say how you would feel about doing each of these things by putting an "**X**" in the appropriate box next to each of the things we might do. The example will show you how to mark your choice. Don't spend too much time on each item. There are lots of things, so move through the list thoughtfully but quickly.

When I Think about Doing This Thing Out at Creekside, I Feel…	 Very Unhappy	 Unhappy	 Not Really Happy Or Unhappy	 Happy	 Very Happy
	1	2	3	4	5
SAMPLE: Sleeping in a sleeping bag				**X**	
Spend the night in a cabin with my friends					
Learn new things about plants					
See a carnivore up close (*hint: a carnivore is a 'meat-eater')					
Learn how to use binoculars					
Catch and release grasshoppers					
Take a twilight hike in the meadow					
Keep a nature journal					
Have time to play **outside**					
Cook dinner in the kitchen with my friends					
Doing research with a scientist from UC Berkeley					
Listen to the sounds of different animals					
Explore the creek					
Have quiet time by myself outside in nature					
Look for signs of animals (tracks, scat, feathers)					
Have the chance to touch a bird					
See a shooting star					
Get to know others in my class better					
Play games					
Learn new things about animals that live near my house					

continue on next page…

Appendix B (continued)

When I Think about Doing This Thing Out at Creekside, I Feel…	Very Unhappy 1	Unhappy 2	Not Really Happy Or Unhappy 3	Happy 4	Very Happy 5
Do a science experiment					
Clean up after dinner					
Have time to play **inside**					
Learn new things about animals					
Take a day-time hike in the meadow					
Getting muddy and dirty					
Being in a class where we learn about wildlife					
Learn what makes a stream 'healthy'					
Getting stung by a bee or yellow-jacket					
Learn new things about animals that live far-away from my house					
Have the chance to touch the fur of a bear					
Get to see a trout up close					
Be outside in the early morning when it is very cold out					
Get my shoes wet					
Get to know new people					
Eat foods I have never had before					
Being in a group without my best friends					
Being outside when it is very hot out					
Learning some new 'campfire songs'					
Being outside after it is dark out					
Learning about the watershed					
Being away from home overnight					
Have quiet time by myself in the cabin					
Seeing macroinvertebrates up close (*hint: an example of a macroinvertebrate is a critter in the stream)					

Appendix B (continued)

Wildlife Biologist

Directions: This is an activity that is kind of like MadLibs where you fill in the blanks in a story. Look at the tiny writing underneath each blank for a clue about what you should write in each blank. Two of the questions ask you to choose just one thing by circling the letter.

Fantastic! You've decided to become a wildlife biologist. The **wild animal** you have decided to study is

the ______________________________. You know that becoming an expert will require a lot of studying and
(name of **wild** animal you want to study)

preparation. The way that you prefer to learn about ____________________________ is by doing which of
(name of wild animal you wrote above)

the following: (choose your **favorite** way to learn about the animal by circling just one letter):

(a) by studying your animal in the wild

(b) by reading books about your animal

(c) by watching television shows or movies about your animal

(d) by talking with other wildlife biologists that study the same kind of animal

What is a question about your animal that you would like to know the answer to: ____________________

____?

How would you go about finding an answer to your question about your animal? ____________________

____.

When someone asks you why you have chosen to study this particular wild animal, you tell them that

you have chosen to study this animal because ____

____.

They want to know more! You tell them that your animal lives in ______________________________

and they eat ____. They also want a short description of how

your wild animal looks and how it behaves. The four things you would say about how your wild animal

looks and behaves are:

1) ____

2) ____

3) ____

4) ____

Finally, they want to know if your wild animal is an endangered species. You tell them: (choose one)

(a) "Yes, it is an endangered species."

(b) "No, it is not an endangered species."

Appendix C: Teacher Script to Accompany Pre-Test

Creekside Field Station Trips ~ Fall 2010
Pre-Test for All LUSD 5th Graders
Part of Nicole Migliarese's (UCB Graduate Student) Dissertation

Dear LUSD Grade 5 Classroom Teacher**,**

I hope your summer vacation was restful and warm and you are now off to a great start to the new school year. I had the good fortune of meeting most of you last year over the course of the field trips to Creekside in the fall and spring as well as in your classrooms during the school year.

As most of you will remember, I am working on my dissertation, which is part of the larger *Exploring California Biodiversity* project (together with the scientist fellows that work with your students at Creekside). Last year's data collection included field observations of all Grade 5 classes while out at Creekside in the fall, surveys with many of the Grade 5 families in the district, and focus group interviews with students in several of the classrooms. This year, I will be in the final phase of data collection with the current 5th graders. This will entail assessing the children's knowledge of wildlife, ecosystems, and science both **BEFORE** and **AFTER** their Creekside trips through the use of a pre- and post-test. It is imperative that the assessment be given at both times so that I can have comparative data for each child and will be able to see how their personal Creekside experience impacted their knowledge.

con't

Appendix C (continued)

In this package for you, you will find:

-35 student packets (the 'pre-test' to be given before your class goes out to Creekside)

-35 manila folders

-a teacher copy of the student packet (incl. a SAMPLE page for your reference for the *Fast Facts about Wildlife* portion of the packet), and

-an overhead for use when explaining the *Fast Facts about Wildlife* portion of the packet, if necessary

As you look over the pre-test packets, you will see that many of the activities resemble pre-trip activities you have done with your kids in previous years. None of the items in any section should look or feel too 'test-like', though the items have been very carefully designed to gather specific data about children's ideas about local plants and animals.

The packet is designed to take one class period for most students. The organization of the first section, *Fast Facts about Wildlife*, is randomized for statistical reasons, so each child will have their 'animals' in a different order after the first page. The next three sections – *Creekside!, Wildlife Biologist*, and *Draw-a-Scientist* – are in the same order in all packets; thus, if some children take longer, the drawing will be something they could work on during recess or quiet time.

con't

Appendix C (continued)

For the entire packet, it is required that children work independently. I have included 35 manila folders for the students to use as “privacy cubbies” on their desks. Likewise, I ask that you not provide any ‘answers’ to children. If they have any questions, please try to answer the question as best you can without revealing any answer-like information. If they do not know an answer, encourage them to take an educated guess, reminding them that this doesn’t count toward their classroom grades and they will not be receiving a score in any of their classes, so guesses are ok if they do not know an answer. Remind them that I am interested in what they know **and** think, including their guesses.

Before you begin, please have the students complete the front page (name, teacher’s name, etc.) and read over the Introduction page with them. Remind them that they will need to work at a steady pace as there is a lot to cover and only one class period to complete the packet. [If many children do not finish in one class period, it is at your discretion to allow more time.] Encourage them to work thoughtfully but quickly.

When you are ready to begin, please briefly review the first portion of the packet, *Fast Facts about Wildlife*, with the class. (I have included an overhead of a sample page for your use, if you feel it is necessary. I ask that you not fill in any answers on the overhead, or, if you do, please take the overhead down before students begin working on their own packets.) Encourage them to be as specific as possible in all of their work. For example, in the Fast Facts portion, the name of the sample is not just ‘fish’ but rather a more specific name ‘clown fish’ should be given, if they can. Another example…rather than just butterfly,

con’t

Appendix C (continued)

the best answer would be monarch butterfly. **<u>They should be as specific in their answers as possible</u>,** otherwise scoring a change in knowledge from before Creekside to after Creekside will be nearly impossible.

I realize that not every class will have 35 students. Please bring your completed packets **and** any extras with you when your class visits Creekside.

If you have any questions, please feel free to contact me at anytime. I can be reached via e-mail at project_email@berkeley.edu or cell phone at 123-456-7890. Please keep in mind that there is no cell service at Creekside Field Station so e-mail will be the only way to reach me after 12th September.

I so greatly appreciate your time and your cooperation in helping me collect this 'data' with your students. Their thoughts – and your time – are what makes my doctoral work possible. I am looking forward to seeing what your students are thinking about our local plants and animals. Most of all, I am looking forward to meeting all of the new 5th graders and chatting with you when your class arrives at the Field Station. See you soon!

In sincerity,

Nicole Migliarese (aka Miss Mig!)

Appendix D: *Fast Facts about Wildlife* Scoring Rubric Excerpt

Fast Facts about Wildlife

What is this animal's name?

2 = North American porcupine, porcupine
1 = porker, porky, rodent, mammal, vertebrate
0 = name of other animal
499 = I don't know/remember, not sure, ?
999 = blank

Have you ever seen one of these animals in-person in the wild? (not just on t.v. or in a movie)

Does this animal live here in Lorry?

1 = yes, I think so, I think, "maybe yes", I'm pretty sure, probably
0 = no, maybe, kind of, some, sometimes, sort of, possibly, it could, might, I don't think so
499 = I don't know/remember, not sure, ?
999 = blank

If not, where in the world does it live?

***Often, the YES or NO response to the question above is written in here. When this occurs, it is scored above.

Does this animal migrate (move from one place to another with the seasons)?

1 = no, I don't think so, it stays here
0 = yes, maybe, kind of, who knows, it could
499 = I don't know/remember, not sure, ?
999 = blank

What does this animal eat?

2 = herbivore, vegetation/vegetarian, plants, COMBO of lettuce, weeds, seeds, grass, berries, leaves, twigs, bark, fruit, nuts, salt, things that grow close to the ground, CROPS, PINECONES, FLOWERS, VEGGIES
1 = just ONE vegetation item (e.g., writing TWIGS only)
0 = any form of meat: small animals (e.g., birds, mice, squirrels, fish, etc.), bugs, insects, human food/trash/garbage, anything it can find, everything, ALL STUFFS, maybe, yes, no
499 = I don't know/remember, not sure, ?
999 = blank

Is this animal nocturnal (active at night) or diurnal (active during the day)?

1 = nocturnal, night, diurnal, day, both nocturnal & diurnal, both night & day, both
0 = other (e.g., hibernates), maybe, yes, no, kind of
499 = I don't know/remember, not sure, ?
999 = blank

Score underlines in question text accordingly.

Is this animal an endangered species?

1 = no, I don't think so, not really
0 = yes, maybe, unknown, who knows
499 = I don't know/remember, not sure, ?
999 = blank

How can people help protect this animal?

Appendix E: Students' Knowledge of Local Wildlife at the Dimension Level for all *Fast Facts about Wildlife* Animals – Pre-Test

(Percentage of Students Answering at Each Point Value)

Variable	Wholly Correct (2)	Partially Correct (1)	Incorrect (0)	"I Don't Know" (499)
Name*	21.95	78.05	-	-
Location**		89.39	10.61	-
Migration**		72.84	26.34	0.82
Diet*	36.59	63.01	0.41	-
Activity**		81.22	17.14	1.63
Status**		60.00	39.18	0.82

Fast Facts about Wildlife **– Black Bear**
* = valid scores were 2, 1, 0, 499
** = valid scores were 1, 0, 499

Variable	Wholly Correct (2)	Partially Correct (1)	Incorrect (0)	"I Don't Know" (499)
Name**	4.90	93.88	0.41	0.82
Location*		22.73	75.21	2.07
Migration*		63.90	31.54	4.56
Diet**	10.61	67.76	17.14	4.49
Activity*		60.74	38.02	1.24
Status*		64.61	32.10	3.29

Fast Facts about Wildlife **– Red-Eared Slider Turtle**
* = valid scores were 2, 1, 0, 499
** = valid scores were 1, 0, 499

Variable	Wholly Correct (2)	Partially Correct (1)	Incorrect (0)	"I Don't Know" (499)
Name**	73.71	20.26	4.74	1.29
Location*		62.77	35.50	1.73
Migration*		69.03	25.22	5.75
Diet**	73.13	18.94	3.52	4.41
Activity*		45.13	53.10	1.77
Status*		61.95	35.40	2.65

Fast Facts about Wildlife **– Mountain Lion**
* = valid scores were 2, 1, 0, 499
** = valid scores were 1, 0, 499

Appendix E (continued)

Variable	Wholly Correct (2)	Partially Correct (1)	Incorrect (0)	"I Don't Know" (499)
Name**	33.77	64.91	0.88	0.44
Location*		59.21	39.04	1.75
Migration*		70.93	26.43	2.64
Diet**	8.30	84.72	2.18	4.80
Activity*		47.14	50.22	2.64
Status*		68.58	26.99	4.42

Fast Facts about Wildlife **– Coyote**
* = valid scores were 2, 1, 0, 499
** = valid scores were 1, 0, 499

Variable	Wholly Correct (2)	Partially Correct (1)	Incorrect (0)	"I Don't Know" (499)
Name**	64.41	14.86	19.37	1.35
Location*		75.57	22.62	1.81
Migration*		72.27	24.55	3.18
Diet**	4.52	76.92	9.50	9.05
Activity*		5.00	91.82	3.18
Status*		81.82	15.45	2.73

Fast Facts about Wildlife **– Crayfish**
* = valid scores were 2, 1, 0, 499
** = valid scores were 1, 0, 499

Variable	Wholly Correct (2)	Partially Correct (1)	Incorrect (0)	"I Don't Know" (499)
Name**	94.9	1.34	3.13	1.34
Location*		60.63	35.75	3.62
Migration*		63.35	29.86	6.79
Diet**	28.38	28.38	28.83	14.41
Activity*		79.19	18.10	2.71
Status*		64.71	33.03	2.26

Fast Facts about Wildlife **– Porcupine**
* = valid scores were 2, 1, 0, 499
** = valid scores were 1, 0, 499

Appendix E (continued)

Variable	Wholly Correct (2)	Partially Correct (1)	Incorrect (0)	"I Don't Know" (499)
Name**	22.67	76.00	0.89	0.44
Location*		55.36	38.84	5.80
Migration*		51.35	44.14	4.50
Diet**	36.00	47.56	7.11	9.33
Activity*		74.22	25.33	0.44
Status*		62.05	31.25	6.70

***Fast Facts about Wildlife* – Barn Owl**
* = valid scores were 2, 1, 0, 499
** = valid scores were 1, 0, 499

Variable	Wholly Correct (2)	Partially Correct (1)	Incorrect (0)	"I Don't Know" (499)
Name**	96.00	0.44	2.67	0.89
Location*		95.56	4.44	-
Migration*		69.51	26.91	3.59
Diet**	10.67	80.89	3.56	4.89
Activity*		68.16	30.94	0.90
Status*		78.03	18.39	3.59

***Fast Facts about Wildlife* – Raccoon**
* = valid scores were 2, 1, 0, 499
** = valid scores were 1, 0, 499

Variable	Wholly Correct (2)	Partially Correct (1)	Incorrect (0)	"I Don't Know" (499)
Name**	30.04	69.06	0.90	-
Location*		95.52	4.48	-
Migration*		75.00	23.64	1.36
Diet**	25.68	4.05	59.46	10.81
Activity*		72.27	27.27	0.45
Status*		11.82	85.45	2.73

***Fast Facts about Wildlife* – Monarch Butterfly**
* = valid scores were 2, 1, 0, 499
** = valid scores were 1, 0, 499

Appendix E (continued)

Variable	Wholly Correct (2)	Partially Correct (1)	Incorrect (0)	"I Don't Know" (499)
Name**	76.21	21.59	1.32	0.88
Location*		20.81	76.02	3.17
Migration*		71.75	22.42	5.83
Diet**	52.89	36.44	6.67	4.00
Activity*		32.59	64.29	3.13
Status*		78.48	17.94	3.59

***Fast Facts about Wildlife* – Rattlesnake**
* = valid scores were 2, 1, 0, 499
** = valid scores were 1, 0, 499

Variable	Wholly Correct (2)	Partially Correct (1)	Incorrect (0)	"I Don't Know" (499)
Name**	34.93	58.95	2.18	3.93
Location*		77.39	18.70	3.91
Migration*		25.11	75.25	2.64
Diet**	14.04	77.63	3.51	4.82
Activity*		73.89	23.45	2.65
Status*		83.19	11.50	5.31

***Fast Facts about Wildlife* – Scrub Jay**
* = valid scores were 2, 1, 0, 499
** = valid scores were 1, 0, 499

Variable	Wholly Correct (2)	Partially Correct (1)	Incorrect (0)	"I Don't Know" (499)
Name**	3.03	95.24	0.87	0.87
Location*		87.72	10.96	1.32
Migration*		52.65	44.69	2.65
Diet**	39.74	41.05	14.41	4.80
Activity*		51.09	47.16	1.75
Status*		71.49	25.00	3.51

***Fast Facts about Wildlife* – Black-Tailed (Mule) Deer**
* = valid scores were 2, 1, 0, 499
** = valid scores were 1, 0, 499

Appendix E (continued)

Variable	Wholly Correct (2)	Partially Correct (1)	Incorrect (0)	"I Don't Know" (499)
Name**	1.28	94.44	2.56	1.71
Location*		65.80	32.90	1.30
Migration*		59.84	34.91	5.60
Diet**	38.46	16.24	38.46	6.84
Activity*		75.54	24.46	-
Status*		75.86	20.69	3.45

Fast Facts about Wildlife **– Little Brown Bat**
* = valid scores were 2, 1, 0, 499
** = valid scores were 1, 0, 499