UC Santa Barbara

UC Santa Barbara Electronic Theses and Dissertations

Title

Human-Wildlife Co-Existence and Conservation Education: An Example from the Potential Reintroduction of Grizzly Bears to California.

Permalink

Author

Colby, Jolie C

Publication Date

2021

Peer reviewed|Thesis/dissertation

UNIVERSITY OF CALIFORNIA

Santa Barbara

Human-Wildlife Co-Existence and Conservation Education: An Example from the

Potential Reintroduction of Grizzly Bears to California.

A dissertation submitted in partial satisfaction of the

requirements for the degree Doctor of Philosophy

in Education

by

Jolie Chrisanne Colby

Committee in charge:

Professor Mary Betsy Brenner, Chair

Professor Danielle Harlow

Professor Peter Alagona

March 2022

The dissertation of Jolie Chrisanne Colby is approved.

_____

Peter Alagona

_____

Danielle Harlow

_____

Mary Betsy Brenner, Committee Chair

December 2021

Human-Wildlife Co-Existence and Conservation Education: An Example from the
Potential Reintroduction of Grizzly Bears to California.

iii

DEDICATION

I dedicate this work, including all the time and tears that went into it, to my beloved editor-and-chief, my best friend and husband—without whom this dissertation might not be complete and would certainly be less pleasant to read.

ACKNOWLEDGEMENTS

I have endless gratitude for my two golden babies, Huxley and Helia. Please know you did not hinder, frustrate, nor become a burden to me at any time during this process. On the contrary, you were my inspiration to continue my work and never give up. You brought my joy back in the unpleasant times and reminded me to play when things got too serious. I hope I have made you both proud.

I want to thank my big sister Chelsea for her friendship and tireless support; my mom for the childcare; my dad for always letting me know how proud he is of me; and my sister Tori for continually being there for me at the drop of a hat.

I am grateful to the Ghannoums and Hopkins. I love each of you and was honored by your gracious support.

I want to acknowledge my always honest, supportive, and now happily retired advisor, Betsy. You were the perfect advisor for me, and I will never forget you.

I want to thank Peter Alagona for dreaming up and coordinating the California Grizzly Research Network and inviting me to be a part of such a dynamic group of scholars.

Finally, I want to acknowledge all scholar moms who, like me, were pregnant and had their babies whilst working towards their PhD. Thank you to those who came before me and showed me it was possible. For those who come after me, if I can do it, you can too.

VITA OF JOLIE CHRISANNE COLBY
DECEMBER 2021

EDUCATION

Bachelor of Arts in German & Philosophy, California State University, Humboldt, 2007
Master of Arts in Philosophy, California State University, San Diego, 2011
Master of Art in Education, University of California, Santa Barbara, August 2018
Doctor of Philosophy in Education, University of California, Santa Barbara, January 2022 (expected)

PROFESSIONAL EMPLOYMENT

Director of Environmental Education | Norman Bird Sanctuary | 2022 - present
Instructor of Record | Environmental Studies Department, UCSB | 2019-2021
Chief Developer of Grizzl-Ed | UCSB | 2019-2021
Lead Coordinator of Student Wildlife Ambassador Program | UCSB | 2020-2021
Teaching Assistant | Various Departments, UCSB | 2016-2021
Environmental Literacy Consultant | UCSB Children's Center| 2017-2020
Coordinator | LEAFY Program, UC Links | 2017-2018
Curriculum Design Coordinator, | Edible Campus Program, UCSB | 2016-2017
Director of Education | Batipa Field School | 2012-2015
Lecturer | Batipa Field School | 2012-2015

PUBLICATIONS

Inside, Outside, and Beyond: An Ethnographic Case Study of Garden Education at a University Preschool. *Master's Thesis.* 2018

Analogies for a no-analog world: Tackling uncertainties in species reintroductions. *Trends in Ecology & Evolution* **35:** 551-554. (Co-Author)

AWARDS

Humanities & Social Science Grant
VESR Student Grant
UCSB Block Grant
Zero Waste 2020 Grant
Coastal Fund Major Grant
The Green Initiate Fund
Crossroads Fellowship
Fulbright Fellowship

FIELDS OF STUDY
Environmental and Conservation Education; STEM aEarly Childhood; Science Learning; Endangered Species Management

ABSTRACT

Human-Wildlife Co-Existence and Conservation Education: An Example from the Potential Reintroduction of Grizzly Bears to California.

by

Jolie Chrisanne Colby

This dissertation explored the roles schools can play in the successful outcomes of large carnivore or keystone reintroduction projects. Schools are more than centers for knowledge acquisition—they connect their community and disseminate information quickly to a wide audience. This study took place in California's Eastern Sierra Nevada, a landscape where the California subspecies of grizzly bear (*Ursus arctos californicus*) was decimated a century ago, and where some interested parties would like to see brown bears reintroduced. A 7-lesson science unit was designed to be implemented in schools where grizzly reintroduction could take place. 101 students participated in the study: sixty 6th graders; thirty-two 8th graders; five 9th graders; three 10th graders and one senior in high school. The design of the unit took advantage of a Swedish carnivore management model instead of a more commonplace environmental education framework typically used in conservation education. The Next Generation Science Standards' (NGSS) innovative focus on increasing critical thinking, interdisciplinarity, as well as the Environmental Principles and Concepts' emphasis on real world environmental problem solving offered the cooperative setting for this type of pedagogy. It was theorized that the unit could assist community outreach of local conservation projects that involve controversial matters benefitting not only students but conservation goals.

This dissertation used pre and post interviews as well as surveys to examine how the Swedish carnivore management framework played out in an educational context; how teachers' (n=3) thinking about grizzly bear reintroduction changed after teaching the unit; and how students' (n=101) attitudes and knowledge changed after the educational program took place. Finally, qualitative data was collected to explore teachers' (n=6) ideas of how conservationists can work with schools to enhance the success of brown bear reintroduction in California. Findings indicated teacher thinking became more complex, rigorous, and nuanced towards grizzly reintroduction.

These findings offer conservationists and educators unique insight into how knowledge interacts with attitudes in teachers and students for a large carnivore reintroduction context. This study takes the primary steps to create a pedagogical groundwork and concrete tools that could benefit schools while also improving management strategies surrounding the potential reintroduction of grizzly bears to the state of California, as well as other reintroduction projects that involve large carnivore or keystone species.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

Chapter 1: Purpose and context of the study

This dissertation investigated education and educational theory in the context of conservation education by considering the case study of brown bear extinction and reintroduction in California. My study took place in California's Eastern Sierra Nevada, a landscape where grizzly bears were wiped out a century ago, and where some would like to see them reintroduced. It explored teachers' and students' ideas of how conservationists can work with schools to enhance the success of brown bear reintroduction in California—a place that has been without them for over 100 years, making such a reintroduction a rather tricky one. This study investigated how participants' were thinking about grizzly bear reintroduction before and after an educational program took place. It sought to understand the ideas teachers and students had, to involve schools in a conservation project such as the reintroduction of grizzly bears to California. This study's in-depth focus on teachers contributed to conservationists' understanding of schools and their perceived role in large predator or keystone reintroduction. Finally, it theorized the utilization of a carnivore management framework to enhance education design surrounding carnivore conservation education to unveil a solution to a typical model normally used called KAB, which stands for Knowledge-Attitude-Behavior (Marcinkowski & Reid, 2019). Findings offer conservationists and educators insight into the primary steps to improve the success of the potential reintroduction of grizzly bears to the state of California as well as an analogy for other large carnivore and keystone reintroductions, rewilding, and co-existence. As reintroduction science becomes a more prevalent strategy to combat the 6th mass extinction, conservation education centered around reintroduction can help

ameliorate the weaknesses of the field by contributing to what it lacks and what it needs. While this was a focused study, the lessons learned from looking at the problem of grizzly extinction and reintroduction in California concerns human wildlife co-existence and education more broadly as well.

Context of brown bear rewilding in California

The loss of apex predators is considered one of humanity's most prevalent effects on the natural world (Estes, et al., 2011). Apex predators, such as the grizzly bear, are often considered keystone species—a species whose presence helps support their entire eco-community. Keystone species have the power to transform the structure of their habitat as well as control prey populations (Lawton, 1994). The reintroduction of such species can help support major ecosystem recovery (Ripple, et al. 2014). However, the presence of keystone species could disturb human health or livelihood (Seddon & van Heezik, 2013). Although grizzly bears are technically opportunistic omnivores, they can be dangerous to humans and domesticated animals and therefore are usually considered carnivores for management purposes.

There is a recent move towards restoration that seeks to renew ecosystem function at large by restoring a keystone species (Seddon & Armstrong, 2016). There are many reasons why the idea of grizzly bear reintroduction in California presents a unique case study and opportunity for discussion surrounding successful restoration of historically extirpated carnivore species. While the grizzly may inspire awe and fear in real life, it is also a flagship species—a charismatic and engaging animal symbol for conservation efforts. It is likely that, species that are both charismatic and provide

ecosystem services are ideal for environmental education because they hold the interest of students and can elucidate many systems within their natural habitat.

The California grizzly bear evokes rich conversations surrounding carnivore reintroduction because of its important symbolism to Californians and 100-year absence from the Californian landscape. The California subspecies of brown bear was wiped out due to over-hunting and offers a sad but unique story about human wildlife conflict. Reintroduction of the brown bear to California has been a discussion in many scientific circles such as the Center for Biodiversity, which submitted a petition to the U.S. Fish and Wildlife Service to expand the existing network of recovery areas to include California (Greenwald, 2014). Various scholars of the California Grizzly Research Network (CGRN) at University of California Santa Barbara, have discussed the possibility of grizzly bear reintroduction in California since 2016 and have identified the Eastern Sierra as a suitable habitat for grizzly bear reintroduction. This study puts into stark relief the challenges to finding ways to retune public expectations to what a natural world ought to be and shifting attitudes in support of more controversial and difficult reintroductions of carnivore keystone species (George & Sandhaus, 2016).

Despite Californian's understanding of grizzly bears as their state symbol and flagship animal, general knowledge about this species is considerably low. For instance, when surveyed, only 25% of Californians knew that the California grizzly bear was extinct (Hiroyasu, Miljanich, & Anderson, 2019). The most recent study concerning student knowledge and attitudes of brown bears in eastern Europe found that the more knowledge a student gains about brown bears the more interested

students are to learn more, the more proconservation values they exhibit, and the less fear they report having (Oražem et al., 2021). For the sake of this study, the California Grizzly Bear Reintroduction Unit (henceforth referred to as CGBRU) created for this study was taught in a low-knowledge landscape, according to the work of Hiroyasu, Miljanich, and Anderson, (2019).

Conservation managers conducting carnivore management projects—such as rewilding brown bears to California—will need to navigate complex goals and hurdles that demand a profound grasp of not just the species and potential habitat, but humans as well (Decker et al., 2012). Understanding the human reactions to critical issues like grizzly reintroduction to California might only be achieved through an interdisciplinary perspective that includes both a social science-based and natural science-based knowledge systems (Decker et al., 2012; Sjölander-Lindqvist, Johansson & Sandström, 2015). In response to this need, this study administered and tested the CGBRU that fulfills Next Generation Science Standards (NGSS Lead States, 2013), which encourage interdisciplinary critical thinking and problem solving in the science classroom. It was also inspired by the Five Carnivore Coexistence Concepts (5CCCs) that helped address the human dimension of large carnivore reintroduction (Sjölander-Lindqvist, Johansson & Sandström, 2015).

The implementation of pedagogies that acknowledge the nuances and complexities of knowledge to go beyond an epistemic emphasis and include practical carnivore management concepts might inspire young scientists to combat complex environmental issues in each community better than the traditional models typically used in environmental education.

Research objective

The major aim of this study is contributing to the research literature and enhance environmental science education, which cumulatively might increase the success of grizzly reintroduction if grizzly reintroduction should come to take place in the state of California. That does not mean I personally advocated for the reintroduction of grizzly bears or that the CGBRU promoted reintroduction. Rather, I acknowledged the possibility and significance of grizzly reintroduction, its rich potential as a focal point for educational purposes, and that much ought to be done if a successful reintroduction were to take place. Reintroducing grizzly bears to a landscape that has not seen them in over 100 years has various ecological, social, political, economic, and cultural impacts. The problem of grizzly reintroduction is intrinsically interdisciplinary, as many disciplines might find specific difficulties and benefits to such a reintroduction and various disciplinary questions concerning it. Each discipline can contribute different solutions to such a problem.

As an education researcher and conservationist, I concern myself with the problems of grizzly and keystone reintroduction that would be relevant to students, teachers, and schools more generally. As such, I am curious how to enhance the dialogue between conservation managers and schools. I believe answering my research questions will be a manner of contributing to the potential project's arm of outreach and education, which might bring conservationists that much closer to managing a fruitful reintroduction project and increase the likelihood that young people and the next generation of scientists will be more practiced in solving complex environmental problem and others.

Research question one

The first question I addressed in this study started with an interest in the theoretical framework behind environmental education. How can curriculum be designed to augment the typical environmental education framework with elements from carnivore management frameworks to better inform students for carnivore reintroduction? To answer this question required an in-depth analysis of two frameworks. The first framework known as the KAB model, typical of environmental education, assumed an increase of knowledge will lead to better attitudes and in turn more responsible behaviors will be exhibited amongst learners. The second, what I refer to in this dissertation as the Five Carnivore Coexistence Concepts (henceforth referred to as the 5CCCs), a framework to increase the success of carnivore management. Understanding both frameworks is crucial in answering this question. Data from the before and after interviews contributed because they outlined what teachers thought about knowledge and its effect on attitudes as well as how the 5CCCs emerged after the CGBRU was taught. The KAB model for environmental education was designed around the assumption that knowledge can change attitudes which in turn can change behaviors. This study challenged this idea and looked to a more closely related framework based in carnivore management to see if the KAB model (especially the knowledge concept imbedded in the model) could be augmented to include more nuance to enhance education surrounding grizzly bear reintroduction and possibly other keystone species reintroduction projects or management.

Introducing the KAB Model

The underlying theoretical model of environmental education, the Knowledge-Attitude-Behavior (KAB) theory, posits that increased cognitive levels (knowledge) lead to attitudinal changes (beliefs and opinions) and attitudinal changes in turn lead to behavioral changes that increase environmentally responsible actions, known as environmentally responsible behavior (ERB) (Marcinkowski & Reid, 2019).

Figure 1. KAB model for Environmental Education

While the KAB model works well for many environmental issues, it is not apparent that the theory works equally well for all types. Human conflict with wildlife, specifically, involve unique complexities that may make the KAB framework less sufficient for educational design. How can the KAB model be improved to better address wildlife conservation efforts specifically?

Introducing the 5CCCs

The study was undertaken by introducing a novel educational unit called The California Grizzly Bear Reintroduction Unit—henceforth referred to as the CGBRU (see appendix A for an excerpt)—to several schools in an area identified as suitable for reintroduction of brown bears and using various qualitative methods for tracking

results. The CGBRU was created for the purpose of this study and was inspired by the 5CCCs: trust, representation, knowledge spheres, communication, and leadership. The CGBRU was designed with the 5CCCs in mind, but they were never explicitly stated at any point in the unit. For example, the paper that first highlighted the 5CCCs, originally referred to by the authors as an "integrated analytical model of human response to large carnivore governance" (Sjölander-Lindqvist, Johansson, & Sandström, p. 176, 2015), was read and the concepts were discussed amongst the education team during the design of the CGBRU, but they were not explicitly listed as learning outcomes or stated in the unit as a guide for teachers. It was a goal among those who designed the CGBRU to inspire science students to grapple with these concepts in the lessons but the same terminology of the 5CCCs was not explicit. The 5CCCs were also never overtly included as content for the teacher's professional development. The 5CCCs served as an underlying skeleton for educators to consider in deciding on what content might be important to include or exclude in the CGBRU. In the design phase it guided content control.

Figure 2. Five Carnivore Coexistence Concepts

This framework is far more integrative and less linear than KAB. It is built to address the areas of usual conflict in projects that involve large and possibly dangerous animals. It immerged from the carnivore management literature because addressing these five concepts has shown to make carnivore and human coexistence more successful (Sjölander-Lindqvist, Johansson & Sandström, 2015).

'Trust' refers to the relationship between citizens and those involved in conservation management. In various countries, a distrust for management is what causes a lack of support towards the animal in question. 'Communication' refers to the spheres of ongoing dialogue between citizens and managers. It points to the importance in making conservation programming transparent to locals living in areas of large carnivore presence. 'Representation' is another crucial concept that dovetails and interacts with the other four concepts. It encourages an emphasis on the importance of all those being affected by a carnivore presence having some sort of voice represented in decision making or public forums. 'Leadership' in this context refers to the importance of overcoming conflict, working with local communities, and considering the dialogue and mediation necessary when establishing rules and regulations around human-species interactions. Finally, 'knowledge spheres' refers to the utilization and recognition that there are various types of knowledge involved in carnivore conservation such as traditional, cultural, historical, informal, indigenous, scientific, etc. While the biological sciences are crucial, focusing solely on them can be troubling to a project's success (Sjölander-Lindqvist, Johansson, & Sandström, 2015).

While this integrated model was originally designed for management strategizing, the authors advocated for multidisciplinary research that studies the effects of these concepts and thus the various socio-biological values of large carnivores. The authors saw an importance in taking this model and using it in various venues to increase the success of carnivore conservation around the world (2015).

Comparing the two frameworks

Both frameworks function for different reasons. The KAB model works well for environmental education units that help students learn about certain environmental issues that directly influence their attitudes, resulting in a more environmentally responsible behavior. For instance, KAB works excellently in an environmental education unit where the learning outcome is that students turn the lights off in the room as they leave to save energy. The student can learn about the environmental problem of wasting energy and how saving energy also saves money and as a result the student is likely to shift their attitude and begin turning the lights off when they leave a room. In this example, learning about the problem and solution (knowledge), shifted the person's opinion about it (attitude), which reinforced an action that changed, namely, to shut the lights off when they leave a room (behavior). Pushing an environmental agenda can be effective to accomplish innumerable learning objectives of environmental education. However, looking for a behavioral outcome, as one might in the typical KAB model, is insufficient when the learning objective is carnivore tolerance or more generally a successful reintroduction, which ERB might not be as clear cut. The KAB model is limited because increased knowledge does not always lead to a desirable behavior that is in line with management goals (Glikman et al.,

2012; Kamil et al., 2019; Løe and Røskaft 2004; Marker et al., 2003). Furthermore, pushing an agenda (i.e., an ERB) for the support of something so complex as large carnivore reintroduction may erode trust and have the opposite result intended by conservation managers.

Research question two

The second question asked how teachers and students were thinking about the topic of grizzly reintroduction and how that changed after the intervention took place. To answer this question, I looked at both the student sample and the teacher sample and how their thinking about grizzly reintroduction shifted after the intervention. This required a pre and post analysis. This question built on the inconsistent literature in wildlife conservation education, where knowledge sometimes increased positive attitudes but sometimes decreased them. By asking more broadly about thinking, I could observe more than just the connection between knowledge, attitudes, and behavior. I wanted to see how thinking could deepen in the large carnivore context of reintroduction, but this was a rare approach and yet seemed to fit the niche in a growing field of interest for conservation managers and educators. This also contributed to the literatures' lack of focus on teachers. Studying teachers as pinnacles of insight into school communities is a rare approach, perhaps because the field assumes a lot about teachers. Improving teacher knowledge is commonplace, yet sometimes teachers are extremely knowledgeable and a call to improve teacher knowledge base is not necessary or too simplistic a solution. Thinking more broadly about what teachers are thinking about and whether an intervention might influence their general thinking about a given topic might help understand how to navigate the

11

inherent complexity of environmental problem solving, and in this case the complexity of grizzly extinction and possible reintroduction.

Research question three

The final question is more of a practical one that might contribute to solving the outreach problem of grizzly reintroduction by seeking insight from teachers and students to help inform outreach design and illuminate the importance of community-based conservation. It asks teachers and students how schools in possible reintroduction zones might assist in the success of grizzly bear reintroduction. This was answerable by looking into the qualitative and open-ended responses of students as well as the qualitative interviews of teachers. This can contribute to the human side of reintroduction science of large carnivores—an area that is of growing interest in conservation and yet very little is done in conservation education to understand it.

Dissertation structure

In Chapter One, I explained the context of grizzly bear reintroduction and the problem it produced for the field of conservation education—a subfield of environmental education. The large research objective was established, and my three research questions have been stated. The value of a study of this kind has also been discussed as well as the limitations. In Chapter Two, the existing literature surrounding conservation education, human-wildlife conflict, as well as the literature that informs the design of the educational intervention is reviewed. In Chapter Three, the theoretical framework is presented to warrant my qualitative approach. Chapter Three also describes the various research instruments I used to answer my research

questions. It establishes my research context and explains how each type of data contributed to my findings. Next, my dissertation displays the qualitative and quantitative results, which provides insights from teachers and students, the meaning I took from the results. I then formulate my major arguments and answer my research questions. Finally, in the discussion section I reinforce the context of the study, reexamine my dive into the literature to explain how answering my research questions contributed to the holes in the literature and I conclude with where the future of the field might go.

Chapter 2: Review of the literature

Introduction

To answer my research questions and uncover how I might contribute to the literature, I took an extensive dive into the various research studies that preceded mine. Because of the interdisciplinary nature of environmental education (EE) and conservation education (CE), the type of research I chose to conduct, and my choice to develop an entire education unit for the sake of my dissertation research, this second Chapter will discuss assorted areas of research as the necessary preface that built the rationale for my study as well as for the curriculum design I created and used. It also illustrates how my research contributed to what the literature and field lacked.

I will first elaborate on what the Knowledge-Attitude-Behavior framework (KAB) did for EE—its drawbacks as well as successes. I will then illuminate how KAB worked and did not work for wildlife education research specifically. After I articulate what is missing from KAB, I explain the scholastic approach taken by Sjölander-Lindqvist, Johansson and Sandström, (2015), which is based on an extensive review of the carnivore management literature—I argue this approach to be an appropriate step in CE's evolution in curriculum development for schools in areas conducting large carnivore or keystone reintroduction. Finally, I provide other educational frameworks that shaped my justification for why the curriculum was designed in the manner it was. All of this is to illustrate how my study built from the prior work and why I chose to ask the research questions I did.

Background on KAB in environmental education

The underlying theoretical model for EE, and thus CE, is centered upon the KAB theory, which assumes increased cognitive levels (knowledge) lead to attitudinal changes and attitudinal changes (beliefs, opinions, etc.) in turn lead to behavioral changes known as environmentally responsible behavior (ERB) (Marcinkowski & Reid, 2019). Various reviews of the literature on EE (e.g., Rickinson, 2001; Zelezny, 1999) appeared to build upon this model, but more recently there arose many significant critiques. This first section addresses the KAB model and each of its constituent parts and offers some critiques found in the literature.

Knowledge

How has the relevant knowledge base (K) been characterized in the literature over time and do recent scholars elaborate on what is meant by 'relevant knowledge'? Throughout the literature 'relevant knowledge' base is considered a driver of attitudes and ERB, and the content of 'relevant knowledge' is one of the most easily measured variables. However, the determination of 'relevant knowledge' is an area that is lacking. In the most recent review of research on KAB, the knowledge component is uncoupled at the outset, while the topic most concerning the authors is the connection between A (attitudes) and B (behavior) (e.g., Marcinkowski & Reid, 2019). More recently, knowledge has become a component inherent or taken for granted. Perhaps this is because the assumption that knowledge comes first is almost intuitive.

David Orr (1992), a very well-cited researcher within EE and the "father" of 'ecological literacy', demanded knowledge as a foundation to literacy as it is the natural platform, which enables human beings to ask, 'what then?'. The assumption is

that without knowing something is wrong with the environment one does not begin to take the next steps to solve environmental problems. Nevertheless, there is not nearly as much elucidation or debate on what is meant by 'knowledge'. Hungerford and Volk (cited regularly throughout the literature) gave an often-cited elaboration that offers 'knowledge' a theoretical definition. A knowledge base is characterized as an entry-level variable including environmental sensitivity and knowledge of ecology (see Figure 3. in Hungerford & Volk, 1990, p. 11). If the knowledge is obtained, then in the best of all worlds that knowledge should enhance a person's decision-making ability (1990).

While 'knowledge' described by David Orr (1992) seemed both reasonable and practical, how knowledge related to attitudes and ultimately behavior was prone to greater problems. A dominating philosophy in EE is that educators who make students more knowledgeable about the environment and its associated issues can change their students' behavior (Hungerford & Volk, 1990). A similar example added the attitudinal component, saying, "[I]ncreased knowledge leads to favorable attitudes…which in turn lead to action promoting better environmental quality (Ramsey & Rickson 1977)" (Hungerford & Volk, 1990, p. 9). There is an assumption that knowledge gained in some manner, or another will allow attitudes to change and ERB to fall into place. The trend observable in the research is that authors picked a knowledge related variable and then tested how it affected attitudes or ERB. Therefore, knowledge as a primary concern is usually the testable variable of an EE study.

Some authors make knowledge tangible when they equate it with learning from books or textbooks (Mobley, Vagias & DeWard, 2010), which manifested in a few different forms. Mobley, Vagias & DeWard picked reading—a knowledge related variable—which has long been associated with "the development of an environmental identity" (2010, p. 423). They had students read three environmentally and ecologically informative books—*Walden, A Sand County Almanac*, and *Silent Spring*. Their rationale was that reading these books (K) would make readers more sensitive toward the environment and develop a concern (A) for the environment which would lead to an environmentally responsible behavior (B). In another study, mobile learning, as a free-choice educational setting was considered a knowledge related variable tested to see whether it promoted sustainable communities (Aguayo & Eames, 2017). Blogs have also been used as a knowledge related variable in the literature (Saltan & Divarci, 2017). Students who engaged in blogging with environmentally themed blogs were tested to see how that engagement augmented their attitude towards the environment.

There are not only tangible ways like books and blogs to use a knowledge related variable in EE—knowledge can take on different intangible forms as well. The attempt to transform knowledge into intangible expressions has also been considered as a knowledge related variable. For instance, Chandra (2014) proposes traditional ecological knowledge (TEK) as a *type* of knowledge used in a study as a variable for enhanced sustainability as well to move beyond the cognitive confines of traditional western science and view ecology in a more holistic manner. For instance, when students learned with a TEK lens versus a western ecology lens how did that change

17

learners' attitudes and behaviors? Within the literature there are many demonstrations of the ways researchers have understood sources of knowledge. Some test better than others and result in greater attitudinal shifts or ERB. Yet, in contrast, although vehicles of knowledge usually lead to knowing more—they do not necessarily lead to better attitudes or ERB.

The knowledge base (K) is consistently characterized within the various definitions of 'environmental literacy' as a foundational requirement. K, a primary component, is what makes a student "environmentally literate" (Cole, 2007). For example, the criteria set forth by University of Georgia's Environmental Literacy Committee (2007) first required a student to understand the basic scientific principles that govern natural systems. That included links between living things and the earth's ability to sustain life. It also included understanding cultural, political, and economic influences on environmental problems and the role of ethics.

Knowledge is also understood as the underlying foundation for environmental literacy in the Middle School Environmental Literacy Instrument that outlines the "knowledge of issues" and "ecological foundations" as the preface to any action (Cole, 2007). In 1989, UNESCO-UNEP designated environmental literacy as the most fundamental goal of EE (Cutter-Mackenzie & Smith, 2003). Therefore, institutionally speaking, science-based content-knowledge is seen as the imperative first step to making an environmentally literate human-being.

Although knowledge can be an intuitive, testable, and tangible phenomenon it is also sometimes characterized with complex language and theoretical jargon—at times I had to dig hard to understand what was prescribed by authors. 'Layered literacies',

18

for instance, was an interesting analogy for what is meant by knowledge base in EE. "Growth and sustainability of a complex society demands that citizens be armed with knowledge and understanding that cultivates culturally sensitive communication skills, increases critical thinking and empowers learners as agents of change" (Shulsky, Baker, Chvala & Willis 2017, p. 49). These scholars believed that when it comes to establishing a knowledge base, educators must consider the whole child while nurturing critical, civic, collaborative, creative, cultural, digital, environmental, financial, and geographical literacy (2017). Similarly, Shulsky et al. (2017) asked educators to question themselves constantly to address these literacies and create a critical lens that encouraged sustainable development and helped learners understand their role as citizens of the world. As such, appropriate knowledge to engage EE learners must be sifted through multiple layers of literacy (2017). This added complexity not only puts a burden on the classroom teacher, but it might also complicate and convolute the characterization of 'knowledge'. However, it is not without reason. It can connect learners and educators with the complexity and intricacies inherent in 'knowledge' and might be an important steppingstone towards understanding how and why a simplistic understanding of 'knowledge' has been problematic.

Knowledge has always been a fundamental goal of education in general, recognizing it as such is important for grappling with the sometimes simplistic but often elaborate and complex ways in which environmental educators have come to refer to knowledge as the first step to any desirable EE outcome. Bogner (1998) cited a variety of different studies to show the imbedded controversy within the importance

of knowledge and the contradictions found in research results. Many authors found that increased knowledge led to positive attitudes towards the environment which in turn leads to action, which promotes better environmental health (Hungerford & Volk, 1990) while, "Hendee (1972) simply labeled the assumption that knowledge could affect respective attitudes as the "folklore of environmental education'" (Bogner, 1998, p. 26). These polarized contradictions illuminated the heated debate of whether knowledge (K) is a foundational preface to the KAB model and never answered the question decisively.

Some environmental educators do not only see knowledge as a type of analytical skill set obtained by a student after an EE intervention but included and heightened the importance of *experiences* as a type of knowledge. Eco-literacy, for example, "requires more than just knowledge development (Kollmuss & Agyemen, 2002), but also included experiences that can lead to attitudinal development" (Aguayo & Eames, 2017, p. 9). Time spent learning about a place in that place influenced the cognitive realm significantly in a way that adjusted attitudes and behavior (Aguayo & Eames, 2017; Bogner, 1998; D'Amato & Krasny, 2011; Kinslow, Sadler, & Nguyen, 2019; Roberts & Kruse, 2019). "Place-based research has illustrated the importance of (re)-connecting people to place to support adoption of sustainable ways of living" (2017, p. 9). As Bogner (1998) puts it, "transmission of factual knowledge certainly should not be the only goal…" (p. 26). Experience derived knowledge is powerful perhaps because it not only teaches one about a place but connects one emotionally to it.

While my study conceded to the commonplace importance of knowledge testing, knowledge alone was not the primary concern in and of itself. How knowledge

interacted with attitudes was more of interest to me as that is where I noticed the biggest inconsistency in the literature—knowledge did not always lead to better attitudes. Furthermore, in the case of grizzly bear reintroduction to California, there is already a low knowledge landscape (Hiroyasu, Miljanich, & Anderson, 2019). Despite Californian's understanding of grizzly bears as their state symbol and flagship animal, general knowledge about the species is considerably low. For instance, only 25% of Californians knew that the California grizzly bear was extinct (Hiroyasu, Miljanich, & Anderson, 2019). Therefore, based on logical deduction I made a hypothesis that knowledge would be relatively low and was likely to increase. The question then was less about whether knowledge would increase and more about whether the knowledge or information acquisition enhanced the attitudes if attitudes were in fact enhanced? The literature on the debate of defining knowledge built my rationale surrounding the importance of one of the 5CCCs, knowledge spheres. I learned that in the context of CE, knowledge about a species or species reintroduction is not enough, rather giving students access to various spheres of knowledge might be a component in enhancing attitudes.

Attitudes

One of the persistent inquiries within EE research is into the relationship between attitudes (A) and behavior (B) (Marcinkowski & Reid, 2019). This section attempts to use the literature to define what is meant by attitudes in EE. It will also examine how the varieties of attitudes (A) have been measured in the research literature, and what attitudes have been empirically linked to ERB, if any.

21

The academic investigation of human attitudes is one that spans multiple disciplines. Much of the scholarly work on attitudes comes from psychological investigations (Marcinkowski & Reid, 2019). Defined more recently for the field of EE, an attitude is "a person's evaluative dispositions and judgments about an 'object' … that are derived, at least in part, from their experience or situation" (Marcinkowski & Reid, 2019, p. 461). Attitudes have been further elucidated by the literature that characterizes them as having cognitive; affective; and behavioral components (2019). Thus, 'attitude' includes the beliefs, knowledge, feelings, emotions, and predispositions that influence how one acts (2019). What further complicates attitudes, and the assessment thereof, is that beneath a feeling, emotion, belief, or predisposition are several other influencing factors including the nature, strength, reason, or situation (2019). Nevertheless, attitudes have served as a historical anchor in the field of EE both institutionally and academically (Marcinkowski & Reid, 2019).

Attitudes are the desired results of an EE treatment (often knowledge-based) because of the assumption that the attitude (A) and behavior (B) have a correlative relationship—one implied the other. However, Marcinkowski and Reid (2019), scholars who conducted the most recent meta-analysis on the A-B relationship, found an evolution of disregard and skepticism surrounding the assumptive connection. While it seemed to be a very strong correlator that many took for granted a few decades ago, the characterization of the connection between attitudes and behavior has in more recent years been shown to have significant complexities. There are added components found to either strengthen or weaken the A-B relationship.

Marcinkowski and Reid (2019) often noted the work of Kraus (1990) who found that attitudes significantly predicted future behavior. The attitude behavior correlation (or 'ABC') is higher in studies that used specific methodologies. For example, studies that used self-reported measures of behavior and had non-students as subjects had higher ABCs. Furthermore, ABCs tended to be higher when the attitude was formed by direct experience, or the attitude was held with certainty (Marcinkowski & Reid, 2019). More recently, as noted by Marcinkowski and Reid, a study by Wallace et al. (2005) found that "situational constraints, such as perceived social pressure and perceived difficulty, weaken the relationship between attitudes and behavior…which suggest a need for increased attention to the 'behavior' side of the attitude-behavior equation (p. 214)" (Marcinkowski & Reid 2019, p. 465). In short, the ABC was contingent on a few factors. Found often in the literature was the correlation of the affective domain (emotions) and attitudes with that of ERB.

It was also found that ABCs were more consistent when the subject had direct contact with nature. The empirical evidence supported that when "emotional principles are integrated, outdoor nature experience is generally considered to foster positive attitudes and to promote environmental action (e.g., Janssen, 1988)" (Bogner, 1998, p. 18). For example, in a study by Mifsud and Verret (2015) the perceptions of the Maltese public towards local marine protected areas were assessed to understand the attitudinal factors associated with local ERB. Although the public had low knowledge of the marine areas, they were emotionally concerned with them and supported their protection and treated the areas with care (ERB). These scholars believed that the ownership citizens *felt* over these marine protected areas increased the affective

23

domain and therefore the support for the protection of marine areas (2015). This also provided further evidence for Kraus (1995)—when a study had non-students as subjects and the attitude is formed by direct experience the study will result in a stronger ABC. It was observable, throughout the literature, that to increase a person's emotional connection to nature is important in creating positive attitudes (Hassan et al, 2017; Louv, 2008; Nisbet, Zelenski, & Murphy, 2011).

As seen from the recent literature review and meta-analysis of Marcinkowski and Reid (2019), the ABC results of an EE study is also a function of whether participants had direct experience. Direct experience, often in the context of EE, meant direct contact with nature or some component thereof. Participants' direct contact with nature was widely acknowledged to enhance environmentally positive attitudes and a person who was self-identified as taking environmentally responsible action (Bogner, 1998; Hungerford & Volk, 1990; Kraus 1995; Kruse & Card, 2004). Learning in natural environments (LINE) and field-based learning (FBL) have become popular EE techniques in part due to students experiencing increased positive attitudes after participating in outdoor learning programs (Kinslow, Sadler, & Nguyen, 2019). D'amato and Krasny (2011) used transformative learning theory to understand instrumental learning and personal growth in EE. They also used an outdoor adventure education setting and saw that an extended trip into pristine nature transformed attitudes and led to higher levels of ERB (2011). The direct contact between a person and a natural place is seen to increase a study's ABC. Students' direct contact with wildlife had also shown a strong ABC. In a study by Kruse and Card (2004) an animal husbandry education program at a zoo led to an increase in ERB linked to increased

positive attitude. The emphasis of the animal husbandry program was on the direct experience of the student with the animals. It also involved continuing in a tiered program where students graduated levels of animal husbandry responsibilities. As they graduated levels their knowledge, attitudes and ERB all improved (2004).

An attitude is "a person's evaluative dispositions and judgments about an 'object' … that are derived, at least in part, from their experience or situation" (Marcinkowski & Reid, 2019, p. 461). Because attitudes and behavior are intertwined, scholars have grappled with the A-B relationship for decades. Recent literature reviews and meta-analyses have unearthed what seems to be the closest one has come to understanding the ABC. Attitudes are strongly correlated to ERB when certain methodologies are considered. When the EE treatment involved a direct contact with nature, ERB was all but assured (Bogner, 1998; D'amato & Krasny, 2011; Hungerford & Volk, 1990; Kinslow, Sadler, & Nguyen, 2019; Kraus, 1995; Kruse & Card, 2004).

The ABC is contingent on a few factors. Found often in the literature is the correlation of the emotions and attitudes with that of ERB (Hassan et al., 2017; Louv, 2008; Mifsud & Verret, 2015; Nisbet, Zelenski & Murphy, 2008). ABCs are more consistent when the subject had direct contact with nature. By looking into the literature researchers can anticipate hurdles such as perceived social pressure and perceived difficulty, which will weaken the relationship between attitudes and behavior. Therefore, Marcinkowski and Reid suggest the need for increased attention to the 'behavior' side of the attitude-behavior equation (2019).

While I went about looking and thinking about attitudes in my study, I hoped to navigate my curricular design to enhance attitudes in line with the ideas I gathered

from the literature. For instance, increasing emotional connection to the subject or bringing the student sample into a natural setting was seen to increase the ABC. This reasoning was foundational to my decision to bring this topic to students who lived in the region of possible reintroduction, as these students might have an increased emotional connection or feeling of stewardship towards the land and space in which they live and recreate, and therefore the curriculum had a better chance enhancing the opinions or attitudes concerning the topic. Making it place-based gave it a greater chance of triggering emotions and, according to the literature, strengthening the ABC. Furthermore, direct experience was a desirable component that saw excellent ABC in the literature; while it was impossible to bring students to a local grizzly bear conservation center or sight of the brown bear reintroduction (seeing as grizzly bear reintroduction is still more of a discussion and less of an act), designing the curriculum to give students direct contact with scholars or stakeholders while teaching students the various stakeholder positions, was the closet way I could simulate direct experience beyond the fieldtrip component. Finally, there was also a repeated theme that put an emphasis on including more than just students in a study to enhance attitudes. This is a part of my rationale for including teachers as well as students.

Behavior

According to Mobley, Vagias, and DeWard (2010) the majority of the ERB scholarship is pulled from social-psychological theories that provided several explanations for what encouraged ERB. For instance, there are social-situational, emotional, socio-demographic, cognitive, psychological, attitudinal, value-based, and habitual reasons that all in some manner or another contributed to an ERB outcome.

Regardless of the diverse phenomena theorized to encourage ERB, all the theories discussed imply ERB to be the final goal (Hungerford & Volk, 1990). ERB is the most highly coveted outcome of any EE. Therefore, B comes last in the KAB model because once the B in ERB is accomplished, an environmental educator's work is finished. Yet, how can researchers survey whether an ERB is accomplished? Is it promising to measure something like behavior within the confines of a study? Throughout the literature, behavior is often measured by not one or two but several variables, "none of which are likely to operate without interacting with others" (Hines, Hungerford & Tomera, 1987, p. 6). The interwoven and complex variables involved in measuring ERB was why scholars seem to struggle with creating a model and studies are still creating novel measurements for variables (Rickinson, 2001). However, three common threads are found in the literature: a self-proclaimed intent to act; self-proclaimed environmental worldview (New Environmental Paradigm); and environmental concern. Sociodemographic variables are frequently used as controls and are considered precursors to ERB (Mobley, Vagias & DeWard, 2010).

Hines, Hungerford, and Tomera (1987) conducted an analysis and synthesis of research on ERB that provided insight into the 'intent to act' variable. They suggested a new (for their time) model upon a meta-analysis of results from other studies looking into ERB. They relied heavily on knowledge as the most crucial variable in predicting ERB. "[I]ntention to act is merely an artifact of a number of other variables acting in combination (e.g., cognitive knowledge, cognitive skills, and personality factors)" (1987, p. 6). From their review, a person who expressed an intent to act is far more liable to engage in ERB than a person who does not express that intention (1987).

However, one must have the knowledge of how to act prior to forming an intention or acting— "knowledge of the problem appears to be a prerequisite to actions" (1987, p. 6). That is why 'skill' was also discussed as a form of knowledge upon which ERB hinges. However, an already established skill-based habit (such as hunting) and a need to eat food can certainly outweigh the attainment of knowledge in an EE intervention and make it harder to predict ERB. In the case of Kamil et al., (2019)—who created a program to test participants' knowledge of Komodo dragons in relation to their behavior—knowledge did not lead to ERB. They found a substantial increase of knowledge after the program's completion however more students still said they had intent and hope to hunt deer (Komodo dragons' main food source and therefore a non-desirable ERB). This illuminated the further complexities of choosing one-size-fits-all models to predict ERB.

Jensen (2002) joined the debate about ERB by expounding upon the relationship between knowledge, action, and pro-environmental behavior. Jensen would not agree with Hines et al. (1987) that knowledge leads to action. Rather, that "traditional knowledge about the environment as it is taught in schools in not in essence action oriented" (2002, p. 329). Jensen prescribed a more action-oriented pedagogy that should be "directed at solving a problem and it should be decided upon by those preparing to carry out the action" (p. 326). This makes for a much more measurable and tangible ERB. Environmental educators must focus on increasing students' "action competence" so that a change can be *seen* within the community and thus is a measurable ERB.

The measurement of behavior can also be assumed with the presence of reported

behavior and a verbal commitment (Bogner, 1998). Analyzed by way of pre and

posttest surveys, the statistical comparisons helped authors understand whether an

outdoor ecology program could increase ERB. Various statistical methods were

employed to do so (Pearson correlation coefficients and using multi-variate analysis of

variance (MANOVA)). A control group was necessary in measuring the ERB because

participants opting to participate in the program were already testing pre-sensitized

toward nature and had more willingness to act than the average population. Regardless

of the seeming success of their program, Bogner calls for the need of longitudinal

studies to effectively assess ERB (1998).

In a more recent study by Mobley, Vagias and DeWard (2010), variables of ERB

became a bit more complex than simply knowledge and skills. There were many levels

of dependent variables and independent variables. They used hierarchical, multiple

regression to examine the different level dependent variables (the consumption of

environmental literature, environmental attitudes, etc.) with that of the independent

variables (sociodemographic variables, knowledge of environmental literature,

environmental worldview (NEP), and Environmental concern). While their model

represented an intricate statistical methodology, it also showed that models for

assessing ERB have become more layered and complex over time.

Perhaps due to the complex nature of measuring ERB, many EE studies did not

consider it and measured environmental literacy outcomes in lieu of ERB (Aguayo &

Eames, 2017; Cutter-Mackenzie & Smith, 2003; Kinslow, Sadler, & Nguyen, 2019).

In some cases, researchers did not attempt to measure ERB and remained satisfied

with an analysis of attitudes as analogues for ERB. Mifsud and Verret (2015) did not discuss ERB but referred to education for sustainable development (ESD). This case offered an example of how ERB was not attempted to be measured rather the attitude towards a possible ERB (ESD) was. That seemed to be a rational strategy for a pilot project and can be enough for environmental educators to carry out an EE intervention.

There was no way to have a concrete behavioral metric for my study, however knowing how behavior interacted or did not interact with knowledge and attitudes in the literature completed my understanding of the KAB model, which was important in understanding whether it would be an appropriate framework for CE. The literature taught me that actual ERB is not usually measurable, even though it is written about as if it were. Rather, researchers more commonly predicted ERB using theoretical models that may or may not reflect empirical evidence. Hines et al. (1987) warned environmental educators that "[t]he complexity of the environmental behavior model and the operation of ever-changing situational factors illustrate the uncertainty involved in the prediction of environmental behavior." (pp. 7-8).

This literature on behavior taught me that while in some longitudinal designs it would be very informative, measuring it is quite complex and not feasible. It might have been testable in my study as participants' intended future behavior (a vote for or against grizzly reintroduction) if there was an actual vote taking pace that might decide if grizzly reintroduction would take place or not. However, I took the vote to be more of an attitude than behavior as there was no action involved and was much more of a hypothetical opinion. I agree with Jensen that behavior should take on a more

action-oriented approach (2002). Environmental educators should focus on increasing students' "action competence" so that a change can be *seen* within the community and thus is a measurable ERB (2002). However, this would not be testable in the case-study of grizzlies until grizzlies are reintroduced. While Bogner's call for more longitudinal studies (1998) is reasonable it was not within the scope of my study.

Critical analysis of KAB model

Inherent in the theoretical KAB model is a two-part assumption—increased knowledge leads to positive attitudinal changes, which in turn leads to desired behavioral outcomes (Marcinkowski & Reid, 2019). Despite the criticisms of KAB being simplistic and assumptive by nature, it remained a fundamental model for going about doing EE. The KAB model is not just overly simplistic, but metrically problematic and western science centric. It does not fully appreciate the nature of EE and its impact upon learners (Bogner, 1998; Chawla, 2007; Cole, 2007; Marcinkowsi & Reid, 2019).

Problems with knowledge (K)

Knowledge, in the field of education, was often characterized as the embodiment of culturally specific epistemologies that shape curricula (Cole, 2007). According to KAB, knowledge was the platform from whence attitudes and behavior spring forth. Yet, more recently it is understood that knowledge does not always lead to desirable EE outcomes. Furthermore, desirable EE outcomes sometimes have nothing to do with the development of knowledge. In general, the connection between knowledge, attitudes, and behavior can be problematic.

Knowledge was critiqued "for its potential to oppress marginalized populations by reproducing dominant ideologies and hierarchies of knowledge (Giroux, 1987)" (Cole, 2007, p. 39). Cole is helpful in offering advice on how environmental educators can effectively address this suggestion to decentralize knowledge. Cole believed knowledge as a lens must be broadened (2007). Environmental philosopher Andrew Brennan (1994) echoed Cole (both of whom are significantly influenced by Paulo Freire) when he argued that the traditional western transmission of knowledge is one where the teacher deposits information into the student's bank of knowledge and the teacher then expects repayment during exams thereby making students subject to the power of the teacher and that teacher's cultural context. Knowledge originates from someplace and somebody (Cole, 2017) and therefore teachers of EE must build on students' experience and knowledge of their own place (their community) and foster culturally relevant EE within the context of community sustainability projects—they must always be questioning their actions and be aware whether the teachings "resonate with local communities by grounding education in local knowledge, needs, and concerns" (p. 42).

There is an emphasis on teaching hard science—from western ecology—to increase ERB, yet indigenous groups around the world who traditionally did not have western scientific knowledge lived and continue to live far more sustainably than those of any urban group on the planet. Initiating the power of traditional ecological knowledge (TEK) was argued by Chandra (2014) to overcome the simplistic KAB model founded on "knowledge". In comparing modernity with the traditional, she explained how emphasizing TEK can help solve the problems that modernity wreaked

upon the environment. She called for a holistic approach that linked disciplines with sustainability and required hands on experiential learning.

These critiques influenced the design of both my curriculum and study. The curriculum, for instance, took a multi-disciplinary look at conservation problem solving and taught students the different approaches taken by various disciplines to solve real world environmental problems. It addressed and involved the local community and enhanced the science dialogue to include a debate on what is best for the community rather relying on whether it makes sense scientifically or not. Looking at knowledge in a human-wildlife coexistence context pushed the scientific dialogue to look at a practical application. The hands-on, experiential approach of the CGBRU was designed to push students to think critically about how this real problem would play out in the cultural context of their neighborhood. Additionally, my first research question is concerned with adjusting the typical EE framework to include concepts that challenged fact-based knowledge acquisition and replaced it with the 5CCC framework that explained knowledge to be representative of various spheres.

Problems with attitudes (A)

Throughout the review and meta-analysis literature there is a skepticism of the efficacy of quantitative measurement of attitudes, as researchers for the last few decades have shown an overwhelming preference for fixed-response questionnaire surveys (Rickinson, 2001). That is not to say qualitative assessment of student attitudes in EE had never been conducted, rather that the method of open-ended interviewing was extremely rare (Rickinson, 2001; Marcinkowski & Reid, 2019). With very few exceptions, "[t]he research questions being asked are of a closed nature

such as 'To what extent does treatment x change students' attitudes towards y?', rather than open questions such as 'What impact does initiative x have upon y students?'" (Rickinson, 2001, pp. 222-223). This restricted survey method has likely led to a restricted understanding of student attitudes. To understand attitudes regarding EE researchers ought to employ mixed methodologies that include open-ended questions (Berkes, 2003). This would help resolve the issue of closed surveys.

The most recent literature review by Marcinkowski and Reid (2019) explained the sentiment on attitudes had been long disparaged and yet 76% of the studies measured attitudes. Marcinkowski and Reid wrote of Hendee (1972) who suggested EE stop its fixation with measuring attitudes altogether (2019). Hendee thought that accessing attitudes to measure the efforts of educators presents significant problems both with "validity and feasibility" and that using these metrics for evaluating the effects of an educational program should stop (2019, p. 462). Yet, giving up on attitudes is not the answer. If EE can improve attitudes towards the environment, it may also improve ERB (Kruse & Card, 2004) and as such a different angle should be utilized before dropping the attitude variable altogether. The literature made a strong case to use interviewing to understand attitudes, which is why I structured my instruments to include them.

Problems with behavior (B)

EE researchers as well as policy makers are very aware that behaviors can both improve or intensify environmental problems (Mobley, Vagias, & DeWard, 2010). There is a lot of pressure on educators to inculcate ERB in students. Yet, predicting ERB is a complex process. There were numerous problems with the measuring of

34

behavior in the KAB model. Models have shown to be problematic albeit ever evolving—the measurement of ERB is not an exact science and therefore there is much work left for EE researchers. ERB ought to be designed and assessed on an individual basis. A model that gives more emphasis to knowledge leading to ERB (e.g., Hines et al., 1987) might work well for the cultural context for which it was created but may not be a great model for a population whose need to hunt to eat outweighs their interest in knowledge about competing predators (e.g., Kamil et al., 2019). Although, Hungerford and Volk (1990) are often cited and have impressive charts and graphs that outline and model the theoretical figures necessary for predicting ERB all while offering proscriptive EE based off an impressive review of literature, the fact remains that behavior is a complex cultural phenomenon and therefore the measurement of ERB assessment will need to consider a cultural context first to be successful.

Another issue with measuring behavior and one often voiced throughout the literature was the brevity of studies assessing behavior. No matter how successful an EE intervention may seem authors call for the need of longitudinal studies to effectively assess ERB (Bogner, 1998). In Bogner's study only the longest EE program, which lasted five days, had any effect on behavioral levels (1998). The results of one study on attitudes found "a need for subsequent long-term education, for repeated and frequent experience of interventions such as the one monitored, and for such interventions to be consistently integrated into the syllabus" (Bogner 1998, p. 26). Discussed in the review by Rickinson (2001), one study successfully changed students' ERB but said change was only seen in the students whose teachers had taken

part in a special workshop lasting three months prior to their EE intervention.

Rickinson also cited Emmons (1997) who argued that the length of time that students

spent on an outdoor ecology trip appeared to be important in the reduction of fear

associated with nature. Finding the time and money for an EE intervention to include

delayed studies or long-term interventions is an obvious solution to some of the

problems outlined in the literature. Unfortunately, this is something easy to request yet

hard to attain and thus one can easily understand its absence in the research and design

of EE programs. After reading the literature on behavior, I decided to exclude a

behavioral metric as I could not do a long-term study or take students on an outdoor

trip. For my study I rely more on attitudes and do not worry about behavior.

KAB for wildlife management

Wildlife management posed unique challenges to EE theory, specifically the KAB

model. People can benefit or be harmed from wildlife; perception of conservation

authorities can affect a person's perception of a species; and the level of education and

cultural beliefs of stakeholders can also affect behavior (Madden 2004). This section

gives an overview of how KAB has functioned in a wildlife conservation context.

What did not work?

Sometimes, an increase of knowledge does not change attitudes towards wildlife

or acceptance of their presence. Grúňová et al., (2017) discovered a disconnect

between knowledge and attitudes of Senegalese children, when attempting to use

knowledge to change their attitudes and behavior to be more positive towards the

Western derby eland (Savannah Antelope). Although knowledge about the animal

increased, attitudes towards the animal remained the same. The same was seen in Kamil et al.'s Komodo dragon education project mentioned earlier (2019). Knowledge about Komodo dragons increased amongst students after an education intervention designed to reduce resource competition for the threatened species, and yet the program failed to change students' intended behaviors (2019). Even after students of the program understood that hunting the main food source of Komodo dragons would deplete the population significantly, they reported an intention to continue the hunting (2019). There was zero connection between knowledge and ERB for these studies. Perception of predators was even more complicated due to an increased concern over human safety (Løe & Røskaft, 2004) and resource competition (Kamil et al., 2019). In the case of bear education, the behavioral metric was often discussed as a decrease of human-bear conflict (Gore, 2004). In many cases, a behavioral metric was assessed not by the presence of any tangible behavioral change after program delivery but rather an intent to change, as seen in the Andean bear education program (Espinosa & Jacobson, 2012). In the case of the Andean bear project, respondents' behavioral intent in a hypothetical bear encounter were more positive after the program's completion. However, the percentage of participants who believed the best solution to cattle predation was shooting a bear did not change (2012). This leaves one to believe that an intent to change is not always a reliable metric for actual behavioral change or ERB. Human-bear conflict is a difficult thing to reduce. In a review by Gore (2004) only one CE project out of six was successful in reducing human-bear conflict by 75% after the program's completion.

Empowerment and trust can also affect the attitudes of program participants (Hungerford & Volk, 1990). For example, Western et al., (2019) were interested in human-lion coexistence within rural areas of Kenya, Zimbabwe, and Tanzania. The long-term coexistence of lions and humans was confounded by pre-existing cultural beliefs or a general distrust of government. In many cases the unique political situation in each area caused a lack of empowerment and trust that led to an overall poor attitude (2019). There remained plenty of researched reasons to believe knowledge was the foundation of ERB, but the most successful studies were usually thinking critically about what was meant by 'knowledge', and rely on different forms of knowledge, such as emotions and experiences to make effective EE (Hassan et al., 2017; Louv, 2008; Nisbet, Zelenski, & Murphy, 2008).

What did work?

There were studies that showed high levels of ERB and positive attitudes towards specific species coinciding with low scientific knowledge (Mifsud & Verret, 2015)—in other words, sometimes people who know less about a given species are more likely to have positive attitudes towards it. However, a lack of knowledge does not mean a lack of emotions. To increase a person's emotional connection to nature was important in creating positive attitudes (Hassan et al., 2017; Louv, 2008; Nisbet, Zelenski, & Murphy, 2011). For example, Hassan et al. (2017) surveyed learners' emotions or "affective domain" to understand how their program increased the emotional connection between humans and sea turtles. They then compared emotional connection with that of any changed environmentally responsible behavior (ERB) of the learners. In the case of the sea turtle, an increased affective domain did result in

behaviors such as abstaining from eating turtle eggs (an ERB in the context of this study). In some wolf and bear tolerance studies, authors pointed to emotions and feelings as playing a more important role than knowledge (Glikman et al., 2012).

Some conservation programs increased success with some sort of compensation program or financial incentive. For instance, a long-term study concerning cheetah tolerance in Namibia began to see a shift for a more positive change after an education program. However, authors of the study noted that the concomitant economic incentives, that were offered alongside the educational program, may have been the cause for the decrease in killing cheetahs. Even though farmers still viewed cheetahs as pests, tolerance was augmented by knowledge-based education but not without economic incentives (Marker et al., 2003).

The most recent study concerning student knowledge and attitudes of brown bears found that the more knowledge a student gained about brown bears, the more interested students were to learn more, the more proconservation values they exhibited, and the less fear they reported having (Oražem et al., 2021). The authors discussed other factors such as where participants lived, whether they owned a dog, had hunters in the family, bred livestock, or frequented zoos played a part in students' tolerance of bears. Discovering these factors began to dissect the complexities of what knowledge meant in this context. However, one might argue that these factors were knowledge based, it was too simple to conclude that was *all* they were.

While education intervention in a low knowledge landscape can increase knowledge, attitudes, and environmentally responsible behavior (Thomas et al., 2019), it has also been shown that increase of knowledge does not always increase

environmentally responsible behavior, especially when there are pre-existing, self-sustaining values present such distrust for government agencies, the need to protect livestock, or compete for resources. This inconsistency left many questions about *what can* influence a complex environmentally responsible behavior or what is it about knowledge acquisition that can support grizzly bear reintroduction, or tolerance of brown bear presence in California?

Carnivores, education, and management

Conservation as a large body of research, advocacy, and outreach has in general recognized that social issues are entangled with conservation issues (Mascia, et al., 2003) yet only 11 out of 79 publications on CE research in the last 25 years mentioned programs that were developed with stakeholders' perspectives and values in mind (Thomas et al., 2019). If scholars, practitioners, and educators comprehended the importance of contextualizing conservation why was it not a ubiquitous conservation practice? For example, Can et al., (2014) did a global survey of experts to unearth best practices for resolving human-bear conflict. Although they did indicate that CE was an important solution to human-wildlife conflict, they made assumptions that CE was comprised of pedagogical interventions that use didactic approaches and do not discuss the importance of involving stakeholders in CE whatsoever (2014). They do recommend "new tools" for education and the need to "tailor education initiatives accordingly" (2014, p. 509) but nothing specific about diversifying the traditional perspective on pedagogy, conservation, or science. This is a theme I have also anecdotally observed in the varied conservation groups I have been a part of. Many often prescribe 'education' but do not elaborate on what that means or where to start.

Conservation managers conducting carnivore management projects (like the reintroduction of grizzly bears to California) will need to navigate complex goals and hurdles that demand a profound grasp of not just the species and potential habitat, but humans as well (Decker et al. 2012). Understanding the human reactions to critical issues like grizzly reintroduction to California might only be achieved through an interdisciplinary perspective that includes both social science and natural science knowledge systems (Decker et al., 2012; Sjölander-Lindqvist, Johansson & Sandström, 2015).

While many have done extensive research surrounding attitudes towards large carnivores, many fewer studies investigate student attitudes specifically (Dieser & Bogner, 2018; Oražem, et al., 2021; Oražem, et al, 2019; Oražem & Tomažič, 2018), while even fewer access teacher attitudes (Büssing, et al., 2019), and none look at large carnivore reintroduction. Due to the inconsistencies highlighted in the literature, to successfully navigate brown bear reintroduction in California one must look to more than a knowledge landscape. Tolerance seems to involve much more than just *learning* about a given carnivore. Tolerance can be a cultural phenomenon. Various socio-cultural practices, beliefs, relationships, histories, and values need to be considered to understand carnivore tolerance within a community (Sjölander-Lindqvist, Johansson & Sandström, 2015).

As the health of the planet and its citizens becomes a global concern, the internationality of CE has steadily grown (Thomas et al., 2019). The field of CE must look beyond a one-size-fits-all answer that is scripted and simplistic for the world's conservation efforts. Understanding the issues and idiosyncrasies of communities in

conservation zones is central to the development of CE programs (2019). As a result, researchers repeatedly emphasized the need for environmental educators and conservation biologists to work alongside community members, wherever the program takes place, to design CE programs together. CE programs "[S]hould be developed in collaboration with stakeholders in a way that is appropriate for the cultural context" (Thomas et al., 2019, p. 186). There was some research that explained how to situate CE within a culturally meaningful context and why incorporating community concerns into interdisciplinary curricula, research designs, and evaluations will see more successful CE outcomes (Thomas et al., 2019).

The CGBRU attempted to address this problem in the literature by bringing the varied voices of stakeholders into the classroom and allowing students to learn about different opinions and methodologies found in conservation projects, such as the reintroduction of grizzly bears, as well as encouraged them to approach local resources. However, the large carnivore management literature provided research that showed "measures promoting increased public involvement indicates that tensions and incompatible social and cultural frameworks may hinder negotiation and consensus." (Sjölander-Lindqvist, Johansson, & Sandström, 2015, p. 181). Involving and teaching the public the various positions (knowledge spheres) is not sufficient. Moving towards understanding each other is crucial too. Therefore, a practice of scientific dialectic is imbedded within the CGBRU to enhance communication (one of the 5CCCs).

Human-wildlife coexistence as an education goal

Socio-cultural context of conservation

Conservation biologists have long discussed the socio-cultural context of conservation—especially in the case of large carnivores (Treves et al., 2006). Wolves, large cats, bears, lions, etc. have all at some point eaten someone's cattle, injured, or killed someone's family member, or destroyed someone's agricultural livelihood. Unfortunately, this struggle goes beyond human-carnivore conflict. Critically endangered monkeys in parts of Central America are often plucked from forests to use as companion animals or killed and eaten. Reefs once swarming with schools of sharks are losing shark biodiversity due to human consumption or fear. In short, wherever there is human-wildlife conflict there is an unquestionable human component and a need to address the human behaviors to solve the conflict (Decker, Riley, & Siemer, 2012). The challenge is pervasive and a question ubiquitous amongst conservation scholars: how does a researcher manage the values, opinions, and concerns of non-elected citizens in conservation areas to make the conservation effort successful?

Sjölander-Lindqvist, Johansson, and Sandström (2015) discussed large carnivore management in rural areas of Sweden. They organized the framework referred to in this dissertation as The Five Carnivore Coexistence Concepts (the 5CCCs), which helped researchers weave rural communities' relationships with wild carnivores into the design and implementation of conservation projects. To sustain viable populations of Swedish carnivores, such as brown bear, lynx, wolf, and wolverine, Swedish conservationists needed to decrease the chances of human-carnivore conflict. To do so

these researchers reviewed extensive literature and found five themes considered especially important to the success of wildlife conservation: the roles of Trust (establishing trust between the human groups interacting on the specific conservation issues), Representation (a fair representation of stakeholder concern), Knowledge Spheres (the different emphasis on types of knowledge e.g. traditional, scientific, or personal), Communication (in order to agree on goals), and Leadership (emphasizing the democratic empowerment of non-elected citizens) (2015). This framework is an example of something easier said than done. The political and socio-cultural entanglement could be relieved by this organizational framework, yet it is an immense task involving the cooperation of many diverse collectives in programs that usually see limited fiscal support.

The 5CCCs arise in other CE studies. One's desire to see carnivore populations maintained or increased can be highly site specific (Western et al., 2019). The lion study by Western et al. mentioned earlier suggested a unique political situation in a certain area caused a lack of trust, communication, and leadership (three out of five of the framework concepts) that led to an overall low lion tolerance. The integration of CE while giving community members tangible benefits was far more likely to foster co-existence than looking at the problem outside of context-specific constraints. Their CE interventions decreased human-lion conflict in rural areas and played a role in local citizens wanting to see the lion population increase. However, the long-term coexistence of lions and humans was negatively affected by pre-existing cultural beliefs and a general distrust of government run conservation programming.

Creating a landscape of coexistence is exceedingly complex but by looking at conservation at site specific communities with a contextualized lens gives CE the greatest likelihood of success. It is the reason the CGBRU was designed to be place-based and involved the population that has the chance of dealing with a possible reintroduction of grizzlies in their future. Furthermore, schools offer excellent insight into community context. Where this framework seems most feasible is in a controlled environment of a school or classroom setting, where relevant human-wildlife conflict can be safely discussed amongst students and others in a school community. One way to do that is to take the 5CCCs into consideration in curriculum design for areas that need CE surrounding large and possibly dangerous animals—educators can look at the concepts as learning outcomes, or design units to address these concepts as themes, topics, or goals.

Place-based cultural relevance

The literature suggested that connecting conservation issues with local people produced a successful manner of doing CE. Furthermore, doing the opposite—connecting conservation issues with global citizens disconnected from a local issue—seemed to produce particularly unsuccessful results. For example, Giannetta (2018) wanted to see if conservation messaging would be more successful in engaging ERB if it was wrapped up in other related global issues such as inequality, violence, politics, labor issues, etc., as compared to conservation messaging that focused on the local conservation issue by itself. She surveyed people on two problems, elephant poaching for ivory and the palm oil crisis and its effects on orangutans. But who did she survey? Not people in places of Kenya or Indonesia where these issues are site specific

45

community concerns. Rather, she surveyed US citizens, people who are physically and directly disconnected from these issues. Her results were inconsistent as her prediction that weaving other important issues into the messaging would be more effective than talking about the conservation issue alone. There were no statistically significant findings and there were trends that both supported the prediction and contradicted it. She believed that this was because "emphasizing the connections among conservation and other issues, rather elevating the conservation issues, sometimes bury it" (p. 246). I, on the other hand, do not think it was too much information that buried the issue. Rather, by wrapping up conservation problems in a large global context to people physically removed and emotionally disconnected from the issues did not result in an overall successful form of CE. It would be interesting to see the results if the same surveys were distributed to people dealing with those conservation issues (elephant poaching and palm oil crisis) in their communities. As Chalmin-Pui and Perkins discovered from their study of a CE program at the London Zoo, "[t]he most meaningful experiences were achieved with […] the presence of perceived proximity and interconnectedness" (2017, p. 1473). This further built my rationale for creating the CGBRU for a Californian audience and more specifically for the learners in reintroduction zones.

While the original intent of my research was to work alongside teachers to build the CGBRU, this could not occur due to the restrictions inherent in the Covid-19 pandemic. However, this literature inspired the workshopping that took place after the study completed wherein myself and my research assistant analyzed the feedback and critiques of the CGBRU and altered it from teacher suggestions. Additional lessons

were added as well as various readings, all suggested by teachers. All edits and alterations were done to tailor to the opinions of local teachers and students' needs. Despite the trouble with working closely with teachers and schools during the pandemic, the CGBRU was still very much a place-based unit. It was designed with the intent of being put in schools in areas where grizzly reintroduction was most likely to occur and where the reintroduction would affect local communities. Therefore, it is more culturally and scientifically relevant to the students and teachers in the Eastern Sierra than anywhere else in the world.

The benefit of involving community members

A lot of the CE literature pointed to the traditional western understanding of pedagogy as a problem. "[B]orrowing evaluation strategies rooted in a western understanding of teaching and learning may limit opportunities for optimal community engagement and support throughout the process and holistic understanding of program outcomes" (Thomas et al. 2019, p. 185). Programs outside of the United States were more likely to incorporate stakeholders than those within the United States. Programs that emphasized human well-being and livelihood were more likely to incorporate stakeholders than those that emphasized science learning.

Conservation is sometimes regarded as a concern for elites or outsiders (Berkes, 2003). Oftentimes it is wealthy individuals who can partake in biodiversity-related volunteering while the underprivileged cannot afford to (Braschler et al., 2009). Anthropological perspectives encouraged conservation as a field to diversify, allowing more than wealthy western scientists to advocate for the planet (Brosius & Russell, 2003). Yet, the very definition of conservation is western-centric (Berkes, 2003). This

can be solved by linking conservationists with indigenous groups and local authorities (Brosius & Russel, 2003). Yet, the use of Traditional Ecological Knowledge (TEK) is often omitted from the big-picture conservation conversation. There is an unanswered but necessarily need to link conservationists and indigenous groups or rural local projects and programs. This informed the design of the curriculum as throughout the CGBRU it was encouraged for students, teachers, and schools to reach out to their local tribal council to learn about the TEK surrounding grizzly bears. For the schools in this study the local Shoshone tribe is very active in their community and talk of local TEK was stimulated by the lessons.

Berkes (2003) reminded to look for a more social definition of conservation that encompasses the cross-cultural context. "Knowledge is power, and the use of local and traditional ecological knowledge is a mechanism for co-management and empowerment" (p. 629). This notion calls upon three areas of the framework from Sjölander-Lindqvist, Johansson, and Sandström's (2015)—Representation, Knowledge Spheres, and Leadership. However, this acknowledgement of the need for Representation, Knowledge Spheres, and Leadership came with a warning. "Traditional knowledge is not a resource to be mined by outsiders, rather traditional knowledge projects can be partnerships for the cooperative process of creating and sharing knowledge" (Berkes, 2003, p. 629). To these scholars, it seemed that western science was not enough, yet researchers must also be careful not to steal traditional knowledge either. The literature suggested, rather, that a healthy balance of both cultural contextualization and collaboration was the implied best practice. "CE

programs would benefit from enhanced collaboration between parties that often have different goals and objectives" (Thomas et al., 2019, p. 185).

While the CGBRU takes place in a science classroom, it emphasizes community involvement in various ways. The heart of the CGBRU involved a lengthy lesson where students step into the shoes of various interested community members and stakeholders. Students were tasked to interview their family members as well as people from the community—many of whom are ranchers who have a stereotypically negative view of large carnivores and their reintroduction. The CGBRU implored teachers to invite guest speakers to their classroom as well as included a fieldtrip imperative to get out into the community at the unit's completion. The third research question also attempted to address this by emphasizing the importance of asking what community members think.

Interdisciplinarity as an education framework

A vast majority of the literature defends the need for more interdisciplinary approaches to CE and conservation. The five-area framework from Sjölander-Lindqvist, Johansson, and Sandström (2015)—Trust, Representation, Knowledge spheres, Communication, and Leadership—hinged on different skill sets not all capable of being met by one discipline. That was why many conservationists call for "further intra-disciplinary elaboration" and "advocate multidisciplinary research […] from social science and natural science perspectives to understand the effective impact of, and thereby the tradeoffs between societal and biological values" (2015, p. 182). As CE becomes an increasingly global practice, so must the research, designs, and evaluations become increasingly diverse and interdisciplinary. Interdisciplinarity can

offer understandings of conservation that would help progress insights into complex social-ecological interactions and provide firmer ground for a truly successful program or project (Berkes, 2003). For example, conservation educators should not only appeal to biologists and ecologists but the inherently interdisciplinary fields such as (but not limited to): Common property; Traditional ecological knowledge; Environmental ethics; Political ecology; Environmental history; Ecological economics. "Integrated complex systems do not divide along disciplinary lines; they are integrated social ecological systems" (Berkes, 2003 p. 628).

The advocacy element inherent in CE puts pressure on theories to play out in very tangible ways. Successful outcome metrics that support the advocacy of CE are seen in Thomas et al.'s (2019) review. Cognition (measuring student learning, attitudes, or emotions), Behavior (measuring students ERB), Social (measuring student self-efficacy, community resilience, etc.) and Ecology (measuring conservation accomplishments) all refer to ways in which CE should benefit learners and the environment. "There is a need to employ a variety of metrics and methods for evaluating these program outcomes, particularly […] by focusing on cognitive and behavioral components as well as social and ecological ones (Thomas et al., 2019, p. 184)".

The 5CCCs from Sjölander-Lindqvist, Johansson, and Sandström (2015) also address the advocacy component by offering a lens needed for the design and implementation of applicable, effective, and equitable CE programs. The literatures' emphasis on interdisciplinarity, children and youth, involving community members and stakeholders, as well as being place-based all informs the design of CGBRU. The

CGBRU was designed for middle school science classrooms and touched on various types of sciences as well as other disciplines altogether. It brought various local voices to the science classroom as well as informed students on the various approaches taken by different stakeholders. Furthermore, it engaged students in a 7-lesson unit centered around a topic relevant to themselves and their family.

Why teachers?

While many have done extensive research surrounding attitudes towards large carnivores, very few assessed teacher attitudes (Büssing, et al., 2019). Beyond the CE literature, it is widely accepted that teacher pedagogy and teacher attitudes directly affected how science is taught and the subsequent results of student learning (Shrigley, 1983). In the context of reintroduction science and CE, teacher attitudes and the connection to student learning or attitudes has yet to be accessed. This hole in the literature will be met by my study that examined both teacher and student attitudes in the context of carnivore management and more specifically reintroduction.

Concluding thoughts on the literature

This chapter introduced and elaborated on the widespread theoretical standard for EE and CE, which is known as the KAB model. This model assumed cognitive levels (knowledge) lead to attitudinal changes and attitudinal changes (beliefs, opinions, etc.) in turn lead to behavioral changes (ERB) (Marcinkowski & Reid, 2019). Various reviews of the literature on EE (e.g., Rickinson, 2001; Zelezny, 1999) appeared to build upon this model, but more recently there have arisen significant critiques. This chapter explained the KAB model and each of its constituent critiques. In the end, the

next generation of EE researchers need to think outside the box and take the myriad suggestions in the most recent literature reviews seriously. Designing and measuring EE programs should consider the individuals and communities involved in the project and emphasize emotional connections and experiences to supplement fact-based knowledge of nature and science. Programs should also be at least five days long and if possible, ought to bring students outside to experience a field trip or nature. Furthermore, qualitative measurements should be considered alongside quantitative testing if available. Finally, the application of traditional ecological knowledge is desirable, if possible.

Chapter 3: Methods

Introduction

My project's aim was to examine education theories of environmental pedagogy within the context of conservation education. I did this by looking at the case study of grizzly bear reintroduction to the state of California. I explored the idea of reintroduction by building a 7-lesson unit (the CGBRU) for science classrooms. The CGBRU was then taught in schools in California's Eastern Sierra Nevada where grizzlies have a potential to be reintroduced; a place that has been without a large charismatic brown bear species for over 100 years, making such a reintroduction a rather controversial and complex one. I explored teachers' and students' knowledge about and attitudes towards the possible reintroduction before and after the education intervention took place, as well as their ideas for how conservationists can work with schools to enhance the success of brown bear reintroduction in California. I also investigated the themes inherent in carnivore management (the Five Carnivore Coexistence Concepts or the 5CCCs) to expose a framework that could enhance education design surrounding carnivore conservation education—one that could solve the problems with the more commonly used framework in environmental and conservation education, known as the KAB model.

This chapter elucidates my research methodologies and rationale for why I designed the study in the manner I did. I start by discussing my reasoning for focusing on mostly qualitative data. I then explain the context of conducting my study during the global Covid-19 pandemic as well as the significance of why I chose the Eastern Sierra Nevada as the setting to my study. After that I discuss the participants. Then, I

offer detailed descriptions of the CGBRU and how it connects to the 5CCC

framework. Next, I talk about my instruments and coding schemes. Finally, I touch on

the quantitative methods and end by giving rationale to build the trustworthiness of my

study.

Design rationale based on literature

Some make a strong call for the use of qualitative methodology simply due to its

near absence from the conservation education literature (Thomas et al., 2019). In the

recent literature review conducted by Thomas et al., only 13 out of 79 conservation

education studies used qualitative methods (2019). More generally, the method of

open-ended interviewing, for example, is extremely rare in environmental education

(Marcinkowski & Reid, 2019; Rickinson, 2001). Others argue for the use of

qualitative methods in conservation education because it can help researchers gain

deeper understanding of program outcomes (Stankey & McCool 2004).

The literature was also extremely helpful in seeing the importance of mixed

methods in assessing outcomes. There is reason to "consider utilizing mixed methods

and qualitative approaches" (Berkes, 2003, p. 184). Most of the studies found use

quantitative measurements, but to understand attitudes researchers ought to employ

mixed methodologies that include open-ended interviewing (Berkes, 2003). Mixed-

methods approaches will also be helpful in reaching inquiry and analysis objectives

(Mertens & Wilson, 2018). After a look at the literature, I was convinced that for this

study both qualitative (e.g., open-ended interviews, open-ended survey questions, and

teacher journals) as well as quantitative research methods (e.g., before-and-after

54

surveys and before-and-after quizzes) were used to answer the following research

questions:

1. How can a curriculum be designed to augment the KAB model with elements of the Five Carnivore Concepts from Sjölander-Lindqvist, Johansson and Sandström, (2015)?
2. How did thinking bout grizzly reintroduction change in both teachers and students?
3. How do students and teachers think schools in possible reintroduction zones assist in the success of grizzly bear reintroduction?

Context

Covid-19 pandemic

The data was collected during a very confusing and precarious time in the

beginning of the global Covid-19 pandemic. The research design had to drastically

shift to address and navigate the restrictions and unpredictability that came along with

mandatory quarantines. Teachers had to adapt to teaching the CGBRU remotely and it

was not originally designed to be taught remotely. This not only slowed data

collection down, but it also caused frustration, hardship, or disinterest among half of

the teachers, who eventually quit the study. The teachers that had a hard time starting

the unit (because their teaching venue was too unclear), struggled with adapting the

unit to be taught remotely despite my best attempt to assist them remotely. The

teachers who remained were instructed by school administration to return to the

classroom halfway through teaching the unit and had to then readjust to being back in

the classroom. The CGBRU was allowed to be altered as needed to adjust to the

requirements of the Covid-19 pandemic (e.g., teaching it virtually or adjusting to their

special classroom needs). Because of the pandemic it was impossible to conduct on-

site ethnographic research as all data collection had to take place remotely. However,

in-depth qualitative interviews, a professional development for teachers, and countless email exchanges with teachers, administers, and parents did take place that helped establish rapport.

Beyond the struggles teachers and students experienced, it was perplexing to shift the research design to take place remotely as well. The original goal was to conduct in-depth ethnographic research with the intention to spend extensive time with the teachers and be present in the classroom whilst the unit was being taught. The pandemic demanded a remote context and thus a major shift from ethnographic design to a mixed method design was necessary. In the end, this shift from a strictly qualitative to a mixed-method approach was still appropriate as it was something the literature called for and can still contribute to and meet the current needs of the field.

Eastern Sierra region

The area this research took place is significant, as it was not randomly selected, and had cultural, historical, and ecological significance. Grizzlies are flexible animals that can thrive in diverse habitats. Prior to the Gold Rush, they lived throughout all non-desert California. The last credible sighting of a California grizzly occurred outside Sequoia National Park in 1924. Today, human development has eliminated potential future grizzly habitat from much of the state, including the coastlines and most valley ecosystems. Potential habitats include large areas of contiguous public land throughout California, but the national parks and wilderness areas of the Sierra Nevada provide the largest protected area for grizzly introduction. Furthermore, this area has the most potential due to its proximity to suitable public lands, its socioeconomic diversity, and because of its long history of managing wildlife in

56

recreational and urban areas. It was chosen for the geographical context of this study because if grizzly bears were to be introduced it would be this area that that reintroduction project would take place. Therefore, the participants of the study had insight into how this reintroduction might impact the communities of this region, specifically.

Participants

Teachers

Teachers were recruited remotely. I emailed the superintendents of various school districts in the region and those superintendents then sent out emails to all their teachers describing the study. Within a few weeks I heard from potential teacher participants. Six science teachers volunteered to teach the intervention in their science classroom (science disciplines varied from 6th grade earth science to high school AP environmental science), but only three teachers completed the CGBRU. All the three teachers that stuck with the study were from different schools in the Eastern Sierra region, but their participation remained confidential. As far as I know, none of the teachers knew the other teachers participating in the study and thus never spoke to one another during the study and therefore could not influence one another.

Teachers were given the CGBRU as well as a remote professional development that included insight into the development of the CGBRU as well as details on teaching each lesson, including tips about how to adapt each lesson in a remote setting. The CGBRU focused on grizzly bear reintroduction and was made available to Eastern Sierra based science teachers for free. Teachers were compensated for their time with $100 each.

The research focused on an in-depth qualitative investigation of the three teachers that completed the study. The three teachers were uniquely different but all of them were engaged actively with the natural environment and had a lot of knowledge about local flora and fauna. One of the teachers (referred to as Teacher Alaska) taught life science and earth science for 9th and 10th grade. She grew up in rural Alaska. She was a former wilderness guide and exhibited the most knowledge about grizzlies at the start of the CGBRU. The second teacher (Teacher Hunter) was a physical science teacher for the 8th grade, a leader in his community (a hunter, a boy scout leader, and outdoorsman), and held a specific emphasis on conservation in his pedagogical philosophy as well as a lot of grizzly bear experience and knowledge. The third teacher (Teacher Skier) taught earth science for 6th grade. He was an outdoor recreationalist but had far less wilderness experience and grizzly bear knowledge than the other two teachers. Nevertheless, he was very interested in the topic of conservation management regarding local black bears and had a passion for skiing and mountain biking.

The other three teachers that volunteered for the study but did not complete it seemed far less interested in the topic and appeared less knowledgeable about nature and grizzlies in general. One of them taught 6th grade math and every now and then was asked to teach science. Another taught high school biology and anatomy. The other taught mainly physics and chemistry and sometimes AP environmental science. These teachers were not given pseudonyms as their qualitative interviews were only used for their suggestions about how schools might be involved in grizzly reintroduction and what typical questions might be asked.

101 students participated in the study: sixty 6th graders; thirty-two 8th graders; five 9th graders; three 10th graders and one senior in high school. Participation meant being present in the classroom for all or most of the lessons included in the CGBRU. Students were asked to take a survey prior to the lessons and a survey after the lessons. According to the teachers, most students were non-Hispanic, while less than 30% were Hispanic. The student population was ~15-25% Native American, American Indian, or Alaska Native. Most of the Native American Indian students were Paiute Shoshone. However, some report as part or all Athabaskan, Apache, Hopi, Navajo, and Cheyenne.

Curriculum

Overview and context

The CGBRU was designed for Californian students to learn about the interdisciplinarity of conservation management in a science classroom. It provided some of the fundamental ecosystem interactions the keystone species offers. It also taught the historical account of grizzly bear and human interaction in California. It used the topic of California grizzly bear extinction and reintroduction to encourage science students to think critically about the human dimension of environmental change as well as offered some tools to navigate environmental problem solving through debating scientifically. After teaching students, the historical human-bear relationship in California, as well as the ecological impacts of both a landscape without bears and a landscape with the bears, the CGBRU presented the current question of grizzly bear reintroduction and engaged students to think about it from

several stakeholders' perspectives such as Bear Scientist, Environmental Historian, Archeologist, Rancher, and more. It addressed knowledge and attitudes as it asked students to vote on the topic of grizzly reintroduction at the beginning and then again at the unit's completion. It asked students to debate with one another from various perspectives, which tested students' ability to articulate the many voices involved in conservation science and management. It included options for students to conduct field interviews, do object-based learning with artifacts from the teacher trunks from Wolf and Bear Discovery Center in Yellowstone or local natural history museums, and required a field trip in the end.

The CGBRU was created over the course of two years, in collaboration with an education subgroup of the California Grizzly Research Network (CGRN), a network of interdisciplinary scholars that focus on the various topics inherent in brown bear reintroduction to California with most interest and funding from University of California Santa Barbara. The CGBRU was designed for science classrooms and satisfied Next Generation Science Standards or NGSS (NGSS Lead States, 2013), Common Core Standards (National Governors Association Center for Best Practices, 2010) as well as some of the Environmental Concepts and Principles (California Education and Environment Initiative, 2004) for middle school. It came with more complicated supplementary science articles for easy adaptation to an older high school population.

The pandemic made some of the supplemental options impossible. Most teachers opted to invite guest speakers over zoom instead of coming into the classroom in person. The students brought in black bear artefacts they had at home instead of

accessing artefacts on their own at natural history museums or by ordering them

through the Wolf and Bear Discovery center. Finally, because field trips were not

feasible during the pandemic some teachers had their students interview assorted

members of the community and present their findings in class.

Lessons and standards

The CGBRU links to the Next Generation Science Standards (NGSS), the

Environmental Principles and Concepts, as well as Common Core standards for

middle school science. The following are the unit's learning outcomes:

1. Students will learn about a keystone predator and their state mascot.
2. Students will be able to grasp the perspectives of different disciplines and areas of knowledge, to get a complete idea of the environmental problem.
3. Students will use critical thinking to make an informed decision about the outcome of the project.
4. Students will bring together many types of evidence and resources to gain scientific, historical, economic, cultural knowledge, etc. about the specific topic and form an opinion based on those sources.
5. Students will get experience engaging in dialectic with their peers and presenting information in their class.

The first lesson gave students background information and a better understanding

about grizzlies and their cultural and ecological importance, role, and history. The

second lesson provided hands-on experiences for students to help them understand

grizzly bear extinction in California, sift through assumptions, and prompt critical

thinking about the artefacts. Lesson three introduced the different roles involved in

grizzly conservation to the students and familiarized them with different kinds of

environmental careers as well as community stakeholder roles. Students located a

person from their life and community and interviewed them to get multiple

perspectives on grizzly reintroduction. Teachers engaged with students and had a

classroom conversation surrounding the roles. They interacted with community members and local experts through guest speaker presentations, library visits, etc. (if feasible). Students completed an interview assignment. In lesson four, students gained the background knowledge needed to make a critical decision about their role's stance on the issue of reintroduction. Students played the role of the class "expert" in that given field. Students had to make an informed initial decision about their stance on the issue, using the evidence and lens they were given. In lesson five, students gained an understanding of issues surrounding real world conversations about wildlife reintroduction, students exercised their public speaking skills, and practiced thinking critically about policy, economics, history, cultural phenomena, etc., regarding conservation science. In lesson six, students practiced articulating opinions. They gained a deeper understanding of their assigned role's field of study or interest. Students could define why each role was for or against reintroduction. In the final lesson, students and teachers gained experiential knowledge from local experts at local environmental institutions during field trips. Students reflected together and individually.

These lessons encouraged various skill develevment and called upon dimensions of NGSS's Scientific and Engineering Practices (SEP's), disciplinary core ideas, and cross-cutting concepts by asking students to ask questions and define problems (SEP-1), plan and carry out investigations (SEP-3), analyze, and interpret data (SEP-4), construct explanations and design solutions (SEP-6), engage in argument from evidence (SEP-7) evaluate, and communicate information (SEP-8). They also helped students begin to understand ecosystem dynamics, functioning and resilience (LS2-C),

the interdependent relationships in ecosystems (LS2-A), as well as biodiversity and humans (LS4-D). It fulfilled all the Environmental Principles and Concepts (EP&C's I, II, II, IV, and V) that are designed to highlight the deep relationship between humans and the natural world. They also fulfilled various of Common Core's science and technical concepts for middle school[1].

How the CGBRU addressed the 5CCCs

The unit was also inspired by what I refer to in this dissertation as the Five Carnivore Coexistence Concepts (5CCCs), which helped address the human dimension of large carnivore management. They are referred to by Sjölander-Lindqvist, Johansson and Sandström as the five recurrent concepts or an integrated analytical perspective because they emerged several times in the carnivore conservation literature and it "enables identification of existing interdependence and interrelationships between different parts of a system" (2015, p. 179). I chose to use a more descriptive term for a pedagogical setting. This framework was originally designed for strategizing carnivore management in Sweden. However, the authors advocated for multidisciplinary research that studies the effects of these concepts and thus the various socio-biological values of large carnivores. The authors saw an importance in taking this model and using it in various venues to increase the success of carnivore conservation around the world. I had a brief email exchange with the lead author, and she agreed that there was value in using the integrated analytical perspective in an educational capacity.

---

[1] Visit https://www.calgrizzly.com/educationamaterials for the full unit and more details on standard fulfillment.

I utilized these concepts as a framework in the design of the CGBRU because I saw its potential to inform education around carnivore reintroduction, specifically. The CGBRU was designed with the 5CCCs in mind, but they were never explicitly stated at any point in the unit. It was a goal among those who designed the CGBRU to inspire students to grapple with these practical carnivore management concepts in the lessons but the same terminology of the 5CCCs was not explicit. The 5CCCs were also never overtly included as content for the teacher's professional development. The 5CCCs served as an underlying skeleton for educators to consider in deciding on what content might be important to include or exclude in the CGBRU. I hypothesized that it might serve as a bedrock pedagogy that goes beyond an epistemic emphasis to better contribute to the overall success of large carnivore management while also benefitting school communities. The 5CCCs are trust, communication, representation, leadership, and knowledge spheres. Keep in mind, these are integrated concepts and therefore they interacted and overlapped in many ways.

'Trust' refers to the relationship between citizens and those involved in conservation management. The fundamental essence of the CGBRU was to increase trust between people in reintroduction zones with those doing the reintroducing of large carnivores—for this study drawing connections between the students and teachers with the scientists, scholars, and stakeholders who were discussing the reintroduction of grizzly bears to their area for the sake of increasing trust in wildlife managers and therefore the project itself. In various countries, a distrust for management is what caused a lack of support towards the animal in question, thus

involving students and teachers prior to such a controversial reintroduction might increase trust.

'Communication' refers to the spheres of ongoing dialogue between citizens and managers. It points to the importance in making conservation programming transparent to locals living in areas of large carnivore presence or possible presence (via reintroduction). The CGBRU is a way for scientists and managers to communicate the important information surrounding the project. It offered direct insight from members of the CGRN and allowed students to access resources from foundational members such as papers, transcribed interviews, current research, and more. For instance, I interviewed various members of the CGRN about their specific interest in grizzly reintroduction. In CGBRU's lesson 3, 4 and 5 students can access these interviews to gain insight into the various ways certain scientific and other scholastic disciplines look at the problem of grizzly extinction in California as well as grizzly reintroduction. The unit encouraged teachers and students to engage actively in communicating with scientists and scholars who study grizzly bears or local large carnivores as guest speakers to continue the open communication as the project develops. It also encouraged teachers to invite speakers from local fish and wildlife and local tribes into the classroom, as well as organize field trips to visit local conservation projects, sites, or institutions.

'Representation' is another concept that dovetails and interacts with the other four concepts. It encouraged an emphasis on the importance of all those being affected by a carnivore presence to have their voice represented in decision making or public forums. At various times throughout the unit, students are encouraged to interview

local stakeholders and family members about their concerns or reasons for support giving community members a venue to voice concerns and learn more about the possible reintroduction. Teachers are encouraged to go further and invite local stakeholders to speak in their classroom. This could create a forum for discussion and therefore representation of various local voices.

'Leadership' in this context refers to the importance of overcoming conflict, working with local communities, and considering the dialogue and mediation necessary when establishing rules and regulations around human-species interactions. The teachers can become leaders that foster insight into the classroom that students then take outwardly to become beacons of knowledge surrounding the project in their family and community. The unit presented teachers with the option to implore students to design their own outreach program for visiting tourists. In many ways, the unit can encourage a student-based approach that urges leadership and projects in a community.

Finally, 'Knowledge spheres' referred to the utilization and recognition that there are various types of knowledge involved in carnivore conservation such as traditional, cultural, historical, informal, indigenous, scientific, etc. While the biological sciences are crucial, focusing solely on that alone can be troubling to a project's success (Sjölander-Lindqvist, Johansson, & Sandström, 2015). The CGBRU embraced the various knowledge spheres as valid approaches to understanding the complexities of grizzly extinction and reintroduction. It offers historical, practical, scientific, indigenous, local, global perspectives and encourages students to synthesize the

various knowledge spheres to build their own rationale surrounding grizzly reintroduction. This is a novel manner of engaging with science materials.

Instruments

Interviews

Both pre and post interviews were conducted over Zoom and the audio was recorded using a simple recording program found on all Apple phones. The interviews were transcribed by a research assistant. The interview questions focused on establishing a teacher's initial response to grizzly bear reintroduction; their general attitude towards it, and their behavior around engaging with wildness or nature. The follow-up interviews focused on noting changes to teachers' knowledge and attitudes regarding grizzly bear reintroduction, including their thoughts about the role of schools in locally controversial conservation projects, such as grizzly bear reintroduction (see Appendix B).

Teacher Journals

The teachers were asked to record their candid thoughts and experiences in digital journals after each lesson from the unit was completed. These entries took note of critiques, frustrations, and alterations made to the unit by the teachers as the unit progressed. These journals clarified the details of why the participant teachers had varying success at increasing tolerance and knowledge surrounding grizzly bear reintroduction as well as what needed to be altered to improve the CGBRU.

Surveys

Pre-surveys were sent to the students using the online Qualtrics program. The purpose of the pre-survey was to establish a baseline of knowledge, values, attitudes,

and behavior surrounding nature, wildlife, carnivores, and brown bears more specifically. It then established a baseline around students' tolerance of brown bear reintroduction to the area they lived, before the intervention took place. Follow up surveys focused on noting shifts in tolerance and knowledge after the intervention took place. It also asked students to think about how their classroom and school could assist in the success of local conservation programs (see Appendix C).

Although there were 101 students who underwent the intervention and 101 students who filled out a pre-survey, unfortunately the post-survey was only filled out by 21 students due to interruptions caused by the Covid-19 pandemic. Of those 21 students, only 10 students used the same name on both surveys and could be identified and selected from the others to see how their responses changed. That is why these results only represented a small number of students and while it offers important insight is not amenable to statistical analysis due to the sample size. The statistical program SPSS was used to compile frequencies from the two surveys.

Quizzes

One of the teachers created before-and-after quizzes that tested students' knowledge and opinion surrounding grizzly bear reintroduction before-and-after the intervention took place. Sixty-two students completed the before-and-after quizzes. These quizzes were very helpful in getting a larger number of consistent student responses and were used to understand how attitudes changed after the intervention took place (see Appendix D).

Analysis

Qualitative

Pre and post interviews were first analyzed using open coding. They were read "line-by-line to identify and formulate all ideas, themes, or issues...no matter how varied and disparate" (Emerson, Fretz, & Shaw, 1995, p. 143). Themes that occurred in all three teachers' interviews were then assigned codes, a coding scheme was designed and all data from transcribed interviews were coded. Finally, an additional but more restricted layer of coding took place that specifically looked for the way the 5CCCs occurred naturally in the interview dialogue (the codes are Trust, Representation, Knowledge spheres, Communication, and Leadership, see Table 3 for examples). Finally, I looked at the open-ended survey questions for details about why students voted yes or no to grizzly reintroduction to inform qualitative findings concerning attitude formation. With all qualitative research, causality is difficult to investigate, and the data is not statistically representative. However, the benefit to qualitative research is the researcher's ability to look deeply into the attitudes and genuine opinion of the participants, which this study did effectively.

Table 1

Pre-Interview Codes

Themes	Codes	Example Quotation(s)
The power of schools to influence their community	Power of Schools	"I teach the majority of students, so basically anyone under 30 that has gone through our school system probably sat in my classroom, and just being by nature the largest, it happens to be where things kind of come to the forefront and discussion sort of happens." (Teacher Hunter, Pre-Interview, p. 2)

		"[S]cience doesn't just take place […] in my classroom, it takes place everywhere. So, when they learn something, I tell them, go out now and talk about it, discuss it with your family, talk about it with other people, talk about it with your friends. So, in that respect, if you're talking about Wildlife Conservation and whatnot, there's like a bridge from scientists to teachers in the classrooms to students to their family, which now you're making that connection with the community." (Teacher Skier, Pre-interview, p. 3) "I realized that this school was the heart of the community a lot of community events took place here" (Teacher Alaska, Pre-interview, p. 1)
Pedagogy ideas that are good for their students	Pedagogy	"[Y]ou're gonna have radio collar tracking, right, and so we [as a class] could monitor the bears and map them […] pay attention to incident reports because at some point you're going to have livestock and bear interaction […] we'd have to bring in and talk to the wildlife managers" (Teacher Hunter, Pre-interview, p. 7) "I would like to talk to specialists about it, or those that are heading up the program of reintroduction, and maybe get their thoughts on it could be in an outreach capacity, it could be in some sort of data collecting capacity. I don't know. Either way, however, their involvement, I think would be pretty cool." (Teacher Skier, Pre-interview, p. 6)
Positive opinions towards carnivores, grizzlies, or black bears.	Predator Positive	"I think there's a huge amount of research that shows that apex predators can change the underlying dynamics of an ecosystem. Both by feeding on their prey and by influencing where their prey live and graze." (Teacher Alaska, Pre-interview, p. 1) "I have absolutely no problem with predators. I'm part of the Predator Conservation Alliance" (Teacher Hunter, Pre-interview, p. 4)

Concerns about carnivores or negative towards reintroduction	Bear worry	"They are also dangerous." (Teacher Alaska, Pre-interview, p. 7) "There are a lot of tourists that come up here and that would be my biggest concern" (Teacher Skier, Pre-interview, p. 4)

Table 2

Post-Interview Codes

Themes	Codes	Example Quotation(s)
The power of schools to influence their community	Power of Schools	"I think a huge part of it being successful is having a public education so that people know how to protect the bears and themselves. And school can be a big part of that." (Teacher Alaska, post-interview, p. 8)
Pedagogy ideas that are good for their students	Pedagogy	"We'd go on field trip to see the bears. You would eventually have to have bear biologists here, who are actually paying attention to the area where they talking about putting bears, and you would have entire monitoring systems installed […] I would drag biologists in, we would go follow the bears, would learn about bears, would learn about bear procedures…" (Teacher Hunter, post-interview, p. 9)
Positive opinions towards carnivores, grizzlies, or black bears.	Predator Positive	"I think that they are incredible animals that need to be respected and given space, and I think they have a really important role in the ecosystem." (Teacher Alaska, post-interview, p. 1)
Positive towards CGBRU	Positive towards unit	"I think it was really fun for the students. It wasn't a topic that any of them had said they had explored before. And so, it was fun for them to talk about something new. I enjoyed teaching it at the end of our ecology unit because then students could connect it to the ecology unit." (Teacher Alaska, Post-interview, p. 3)
Concerns about carnivores, comments on	Bear worry	"[W]e get millions of tourists up here […] and they are clueless. They're absolutely clueless on what to do. Like, they don't know how to camp. They don't

human-wildlife conflict, or negative towards reintroduction.		know how to, it's ridiculous. So, if you throw something like a grizzly bear in the mix, like, yikes!" (Teacher Skier, Post-interview, p. 5)
Lack of bear science in community	Lack of bear science	"I couldn't even come up with a bear biologist here, I asked and we just don't have one." (Teacher Hunter, Post-interview, p. 5)
Unit Suggestions for bettering the lessons	Teacher suggestions	"I would love to see a component of public information where were talking to people who don't necessarily see that, you know, like city, a city population, you know like we have our tourists […] like, you know, what are their reactions? What do they think?" (Teacher Skier, Post-interview, p. 7)
Teacher talks about how they learned so much from the unit.	Teacher knowledge gained	"I'd say it's gone basically from like a zero percent to a lot more. I really had no prior knowledge at all whatsoever and we've learned quite a bit." (Teacher Skier, Post-Interview, p. 1)
Students' attitudes changed over course of unit Teacher attitude changed over course of unit	Attitude changed to positive	"Yes, I think it did [change student attitudes]." (Teacher Skier, Post-interview, p. 3)
Changed to a lack of support for reintroduction	Attitude changed to negative	"And by the end of it, I think many of them were more against or cautious about grizzly bear reintroduction." (Teacher Alaska, Post-interview, p. 4).

Table 3

Five Carnivore Coexistence Concept Codes

Concept	Code	Example Quotation(s)
Trust	T	"California Fish and Game was really receptive over the last year, we have our first bear tax issued to a native tribe, ever in the history of California for our local tribe, and they readjusted the fishing regulations for the entire state for our area to promote conservation of species […]" (Teacher Hunter, Post-interview, p. 5)

Representation	R	"It was nice to have an issue that was controversial enough that it generated a lot of discussion and different viewpoints to bring into the classroom." (Teacher Alaska, Post-interview, p. 3)
Knowledge Spheres	K	"I'd like to see a bear safety component […] food storage, what to do if you encounter a bear, how to properly set up camp in the mountains." (Teacher Hunter, Post-interview, p. 10)
Communication	C	"[T]hen we'd have to take what they're doing, I think, and then amplify it, like multiply it even more to reach a way larger audience […]" (Teacher Skier, Post-interview, p. 5)
Leadership	L	"I think that these kids should and their families should be given some sort of say, or at least have their voices listened to." (Teacher Hunter, Post-interview, p. 5)

Quantitative

There were two types of quantitative data analyzed for this study, however no extensive statistical tests were needed to inform my research questions outside of looking at frequencies in descriptive statistics using the SPSS program. The first type of data was the before-and-after surveys that were given to all students. The second was the before-and-after quizzes administered in Teacher Skier's 6th grade classrooms. The after-survey data was compared to the before-survey data to uncover significant changes in presence of concepts integral to the CGBRU. Change in knowledge about the species was assessed by looking at the change in frequencies. The efficacy of before-and-after surveys to assess changes in attitudes were limited (low response rate of post-surveys) due to pandemic interruptions. However, because the before-and-after quizzes and case-study of before-and-after surveys saw a similar percent increase

(~15-28%) in positive attitudes, the validity of these results is supported.

Trustworthiness

This study did present some potential bias that needs to be discussed. I came into this study as an experienced environmental educator. Therefore, I am both the researcher and the author of the CGBRU—I designed the lessons with the help of my undergraduate assistants and was the one not only guiding the teachers through the unit but was the one conducting the data collection with the help of one research assistant. Naturally, I would want what I designed to be of high quality and be reflected well in the results. However, I strategized my research design to counter many of the inherent subjectivities and meet certain "dimensions of quality" set forth by Moschkovich and Brenner's Standards for Naturalistic Research: Trustworthiness (2000).

The data were not a result of only preliminary impressions but recurrent observations—by me and my research assistant. I also used "persistent observation" (Moschkovich & Brenner, 2000), to remain continuously engaged in data collection without a hiatus of any kind. I worked with one undergraduate volunteer and a postdoc advisor, in so doing I used "multiple researchers" (Moschkovich & Brenner, 2000). I also did not conduct most of the interviews, having only conducted one. Rather, I utilized the skills of my research assistant to conduct the interviews so that participants felt they could say whatever it was without fear of offending me—for instance, in the case they hated the curriculum or hated grizzly bears. Triangulating by comparing interviews and surveys with that of teachers' journals also pointed to any contradictions or bias in my analysis. Finally, I was very clear that I was both the

researcher and the author of the curriculum to participants so that my role as the

researcher was clearly defined (Moschkovich & Brenner, 2000). I believe these

strategies suggest a dimension of quality in the credibility, dependability, and

confirmability that overall points to the trustworthiness of the data and analysis.

Chapter IV: Results

This Chapter elucidates the most important aspect of this dissertation—the findings. Chapters one, two and three all work towards this chapter. In this chapter I explain what my findings are and how I interpreted them. This unveils the meat of my research and the point of this dissertation project. First, I will share my results from the qualitative data, which include the teachers' pre- and post-interviews as well as the students' open-ended qualitative survey answers to answer RQ2. To start this section off, I sift through my data from each teacher and give an in-depth analysis of each with a special focus on their knowledge and attitudes and how these shifted throughout the course of the study. This first section will make use of the text from the transcribed interviews to provide evidence for my analysis. After explaining my analysis of each teacher, I discuss the recurrent themes that were consistent amongst all three teachers. I then display my analysis of the students' open-ended survey questions. Once I complete my qualitative analysis, I move on to share my quantitative findings from students' pre- and post-surveys as well as a pre- and post-quiz given to the students by one of the teachers.

Interview results

Based on evidence from the pre-interviews, the science teachers (to varying degrees) possessed *a priori* understanding of how a reintroduction of grizzly bears might impact them, their community, and the ecosystem. Nevertheless, as found in the post-interviews, knowledge about California grizzlies increased amongst all teachers after teaching the CGBRU. However, positive attitudes towards reintroduction decreased. However, it is too simplistic to talk about knowledge and attitudes alone. The way teachers were thinking about this topic became more complex and nuanced after the unit was taught and

interviews explain this complexification efficiently. This section provides qualitative accounts from each teacher to see in what ways the teachers offered unique and in-depth insight into the case-study of grizzly bear reintroduction to answer RQ2 and RQ3, and to contribute to the literature of conservation education that involves large carnivore reintroduction and schools—an area understudied but of growing interest. There were some themes consistently repeated and restated by all three teachers at various phases.

The major unanimous themes observed from all teachers are discussed. The qualitative post-interviews were coded with The Five Carnivore Coexistence Concepts (5CCCs) to see if these themes contributed to CGBRU to answer RQ1. Then, teachers' suggestions for how schools can be involved and help conservation efforts were also coded with the 5CCCs to answer RQ3. Next, all six teachers' questions and concerns about grizzly reintroduction were open-coded and were categorized into naturally occurring themes (future; place; fear; food; education; and cost) to answer RQ3. Finally, one of the open-ended survey questions from the students' pre-survey is analyzed as qualitative data, which finds a concern for grizzly bear well-being to be the most focused on explanation for why students who were against reintroduction voted no on the topic of reintroducing grizzly bears to California.

Teacher Alaska

This teacher came into the study with the most direct experience and knowledge about grizzlies. She grew up in Alaska and was a backcountry wilderness ranger for the forest service where she encountered grizzly bears many times (Teacher Alaska, Pre-interview, p. 6). She had also been a part of various wildlife and conservation research projects throughout her life. Despite her science and research background, her knowledge

did increase slightly after the intervention. For example, she was not aware that plants make up a high percentage of the grizzly bear diet and admitted she had an incomplete understanding of their significant role in the ecosystem (Teacher Alaska, Post-interview, p. 1). Teacher Alaska misunderstood grizzlies as strict meat eaters. While her knowledge may have changed, I think it is also important to note that the way she thought about grizzly bears changed due to this subtle realization.

Despite, her life-long interest in wildlife and her science knowledge, Teacher Alaska's attitudes during the pre-interview were negative towards grizzly reintroduction unless, she said, a significant education campaign occurred first. Teacher Alaska is a well-informed citizen with more knowledge than the average person; it was because of this knowledge that she would *not* support grizzly reintroduction. She recognized the critical importance of grizzly bears, "I think there's a huge amount of research that shows that apex predators can change underlying dynamics of an ecosystem. Both by feeding on their prey and by influencing where their prey live and graze" (Teacher Alaska, Pre-Interview, p. 6). But she had a realistic respect and admiration for grizzlies' potential to be dangerous:

> I think they [grizzlies] are beautiful. They're not good for hunting, they don't taste very good. Black bears are lot better […] It's amazing to see the amount of strength and power they can have […] but yea, they are also dangerous. And even growing up learning to read their aggression and behavior, they can also surprise people and really hurt people. So […] you have to respect them and give them space (Teacher Alaska, Pre-interview, p. 7).

When elaborating on what it was like to grow up amongst grizzlies she said, "[I]t's always really sad when somebody is killed by a bear. And it's scary when people are mauled by bears." (Teacher Alaska, Pre-interview, p. 7).

Teacher Alaska understood the benefits and drawbacks to grizzly reintroduction and had no illusions about the negative or positive effects their potential reintroduction might bring. However, she concluded her pre-interview by admitting that she had no intention of supporting the reintroduction of grizzly bears to California unless conservation managers implement a massive educational campaign:

> If it was purely introducing grizzlies without an education effort involved, I would vote no. It would go really poorly. If there had been a really thoughtful campaign about introducing grizzlies in a way that allowed the public to respect them and keep their distance and stay safe from them, ensure the grizzlies had a year-round food source in which they weren't attracted to human communities or pets or domestic farm animals, etc., like if it was thoughtfully done and we could minimize their human interaction, then I would vote yes (Teacher Alaska, Pre-interview, p. 9).

This attitude towards grizzly reintroduction is not changed by the intervention at all. Nevertheless, she found the CGBRU to be very helpful and "fun for the students" in that "it was nice to have an issue that was controversial enough that it generated a lot of discussion and different viewpoints to bring into the classroom" (Teacher Alaska, Post-interview, p. 3).

After asking the students to conduct interviews of people in the community on their opinion of grizzly reintroduction, Teacher Alaska was shocked by how many ranchers in the area "had concerns about grizzly bears" even though she did not think grizzly bears would want to come down that far or be much of a problem for ranchers (Teacher Alaska, Post-interview, p.6). On the other hand, she thought it was "interesting talking to people who never hike [...] thought that abstractly it would be a good idea" (Teacher Alaska, Post interview, p. 6). She was pointing to a carnivore attitude phenomenon that she herself exhibited throughout both interviews—sometimes the more knowledge one has

the less likely they are to have a supportive attitude and the less one knows (in the case of the person who never hikes) the more supportive.

Teacher Alaska emphasized the importance of keeping conservation education focused on critical thinking instead of pushing students to trust the opinion that grizzlies be reintroduced. She reiterated a few times how the goals of teaching science are not to shape the opinion of her students but help them critically navigate a topic and understand it. For instance, she discussed this in the last minutes of her post-interview:

> I wouldn't want the curriculum to ever be coercive in terms of trying to influence students to come to one conclusion or the other in terms of supporting their reintroduction or not. I think it's much more important to present students with scientific papers that evaluate their reintroduction programs and present all sides of it and be able to interview people with a variety of opinions and learn how to form their own opinion that's not just based on a general feeling, that is actually backed by research and interviewing a variety of stakeholders and having a position that is informed. (Teacher Alaska, Post-interview, p. 8).

Teacher Alaska's thinking about the topic of grizzly bears in California shifted after the intervention. It became more complex and nuanced. This shift in complexity is even more obvious and explicit in Teacher Hunter.

Teacher Hunter

Teacher Hunter was given the pseudonym because he was a hunter and very knowledgeable about how the Department of Fish and Game operates as well as active in local tribal fish trapping. He would never wish to hunt or hurt bears. In fact, he adored large carnivores and was delighted by the prospect of teaching this topic in his science classroom, "I thought it was a really unique opportunity for my kids to participate in critical thinking, and something for them to really pay attention to because it's such an interesting idea […] I really personally find it a super interesting idea." (Teacher Hunter,

Pre-interview, p. 3). Teacher Hunter is interesting because he supported grizzly

reintroduction at the beginning of the study prior to the intervention but questioned it in

the post interview, which provided another example of how sometimes the more one

engaged with the topic of grizzly reintroduction the less likely they were to support it.

Teacher Hunters' thinking about the topic of grizzly reintroduction was confused, which

seems like a natural link for him in processing the complexity of the topic.

Teacher Hunter was a passionate senior teacher who seemed to adore his career and

was inspired by his students. He made compelling arguments for involving schools in the

possible reintroduction because of the number of people he taught, and the ease at which

he navigated bureaucracy:

> I teach the majority of students, so basically anyone under 30 that has gone through
> our school system probably sat in my classroom […] this morning I was already
> talking to a couple board members about your study, and it's just really easy for me to
> shoot a text message to the board or the superintendent and be like "hey, I'm doing
> this, can we get everybody's attention?!" and we just have a conversation ahead of
> time, instead of it needing to go through all the bureaucracy. (Hunter, Pre-interview,
> p. 2)

Teacher Hunter, as a member of the Predator Conservation Alliance (a non-profit that

helps monitor predator species' conservation status), actively talked about conservation

issues with his students. He supported grizzly reintroduction at first because he was in

awe of their power, "It's kind of neat to be out there and know that there's something that

could make *you* not be there. It's sort of fun to know that you're not the biggest thing in

the ocean, sort of. They don't bug me." (Hunter, Pre-interview, p. 5). Even as a hunter he

wished "people would stop hunting large carnivores," because they offer intrinsic value

and are undeniably "cute" (Hunter, Pre-interview, p. 6). He had great ideas for how

conservationists could involve local science classrooms if grizzly bears were to be

introduced:

> You're gonna have radio collar tracking, right, and so we could monitor the bears and map them […] and pay attention to incident reports because at some points you're going to have livestock and bear interaction. We'd bring in and talk to wildlife managers […] educational programs for how to deal with going into the back country for kids, and you're going to have to re-educate literally the entire state of California about their back country practice and their lack of bear management technique, whenever they're camping. (Hunter, Pre-interview, pp. 7-8).

He continued in the post interview to list the number of ways he would get his students

involved in grizzly bear reintroduction. His rationale to reintroduce the bears was not just

for ecological reasons but to enhance science pedagogy:

> Oh, we'd go on field trips to see the bears, we would […] have to have bear biologists here, who are actually paying attention to the area where they're talking about putting bears, and you would have entire monitoring systems installed […] so we would go follow the bears, would learn about the bears, would learn about bear procedures. (Hunter, Post interview, p. 9)

Teacher Hunter's post-interview revealed more insight into how the intervention was

successful and how knowledge, he thought, interacted with attitudes. He noted how the

CGBRU, "could change people's attitude about the bear by educating them about it."

(Hunter, Post-interview, p. 2). He also pointed out the many conversations that arose

about hunting the bears after reintroduction, "Half of my little boys want to know when

they were going to reintroduce bears to the valley, so that they can hunt them, so I was

like well you don't get to do that, you know?" (Hunter, Post-interview, p. 7).

Ultimately, Teacher Hunter stated he would vote for the reintroduction of grizzly

bears in the pre-interview, but he then changed his mind against introduction after the

intervention. Before the intervention when asked what his vote would be if he had to vote

today, he said, "I would vote yes just for fun. I want to see what happens" (Hunter, Pre-Interview, p. 8). When asked if there was anything that would change his mind he responded, "No, absolutely not […] I lived around the dang things forever, I couldn't care less." (Hunter, Pre-Interview, p. 8). He admits he would change his behavior a bit, specifically around protecting his child, but that he does not mind them (grizzlies).

Despite, his positive attitude towards reintroduction prior to the intervention, in the post-interview his vote changed to a strong no. However, I think it is too simplistic to say he had a negative attitude, rather his thinking around the topic became more complex and nuanced as his understanding deepened. His main concern was for the tourists from out of the area. "These people are not ready for a large predator experience in any way shape or form" (Hunter, Post-interview, p. 9). Regardless of his change of support for the reintroduction, he stressed the importance of school involvement in a reintroduction effort:

> [I]f the grizzly are gonna be reintroduced this is where they're gonna end up and I think that these kids should and their families should be given some sort of say, or at least to have their voices listened to (Hunter, Post-interview, p. 5).

Teacher Hunter made recommendations to increase the safety components in the lessons and in the end was against the reintroduction for the safety of those Californians who he thought were not ready for this type of wild animal encounter. He remains staunch that if they were to be reintroduced, students must be involved, "because anytime that children are passionate about things, it's very hard for adults to ignore that." (Hunter, Post-interview, p. 10).

Teacher Skier

This teacher admitted to the greatest knowledge increase of the three teachers. "I really had no prior knowledge at all whatsoever […] I am embarrassed to admit I didn't even know that that was a grizzly bear on our flag. And I've lived in California my whole life." (Skier Teacher, Post-Interview, p. 1). Regardless of his knowledge surrounding the topic, in the pre-interview he maintained that he would support reintroduction of grizzly bears in California, yet he believed it will be the human conflict that will make it unsuccessful:

> I would love to see grizzly bears, you know, in their rightful place in the food chain. But humans will just ruin everything. You know, there's going to be that one guy who wants to be known for hunting the first grizzly bear back to California, you know, there's going to be that one person who wants to get their Instagram picture […] that's the worst part of all of this, is that there's animals out there, and there's environments and ecosystems that are paying the price for having really really stupid humans making decisions in those areas. (Skier Teacher, post-interview, p. 5).

Teacher Skier talked a lot about the power of schools to disseminate information within communities. He explained how the science he does with his students is quickly absorbed by the community.

> That science doesn't just take place, you know in my classroom, it takes place everywhere. So, when they learn something, I tell then, go out now and talk about it, discuss with your family, talk about it with other people, talk about it with your friends […] there's like a bridge from scientists to teachers in the classroom, to students, to their family, which now you're making that connection with the community. And I think that's huge (Teacher Skier, Pre-interview, p. 3).

Teacher Skier listed various reasons why he might be in support of grizzly reintroduction. First, he recognized their importance as keystones in an ecosystem, "[..] they [grizzlies] are very, very important, as far as that balance, keeping a balance in the ecosystem" (Teacher Skier, Pre-interview, p. 3). He also listed the way grizzly

84

reintroduction would be a great learning opportunity for the students, "I think it would be a really unique experience for our students to be involved in something like this." (Teacher Skier, Pre-interview, p. 5). He listed details of how his students and their school might get involved by talking to specialists and collecting data with biologists (Teacher Skier, Pre-interview, p. 6). However, Teacher Skier appeared to waver on the idea of grizzly reintroduction because, while he felt strongly that they ought to be reintroduced and that the reintroduction would benefit the ecosystem and add richness to learning for students in local schools, he admitted he could not support it because he thought the high influx of year-round tourists to the area would ruin it.

Teacher Skier's support for grizzly reintroduction hinged on a massive education and outreach program and his thinking about the topic became more complex after the unit took place. He said he would support grizzly reintroduction if conservationists could "somehow magically implant education about these animals into every single Californian and then into every single [..] out of state tourist, international tourist, [etc]." (Teacher Skier, Pre-Interview, p. 8). He explained how bringing the knowledge and conversation about grizzly bears to local schools is the best way to conduct an education campaign at this level.

> […] take the teacher who's working with the scientists, or educating the students, they can take that home with them and talk about it with their family and their families take it to work and so on. And that whole community eventually, you know, it has all the information and everything that they would need" (Teacher Skier, Pre-Interview, p. 8).

Teacher Skier was, at one point, a tourist himself. He came to enjoy the beautiful snowy slopes as an outsider from an urban area—his concern for tourists was grounded in personal experience. He suggested the CGBRU be further developed to include a

component where students engaged in outreach to local tourists. He believed,

conservationists could utilize students by engaging student volunteers to dream up ways

to educate tourists and then go out and educate them. Teacher Skier made an analogy of

the black bear a few times in both interviews. He thought that because the community

had a culture that already embraced and felt pride surrounding the local black bears, that

the grizzlies would eventually become a source of cultural pride for locals and tourists.

> [A]s far as the community goes, with our large black bear population, that we do a
> fairly good job of not only coexisting with them but protecting them and making sure
> that our tourists are educated on that, so I think it would be pretty similar. Where we
> would embrace the grizzlies like we do with our black bear population and learn from
> them and learn the benefits that they give to our community. (Teacher Skier, post-
> interview, p. 6)

Despite his many positive perspectives and ideas in support for grizzly reintroduction,

he was hesitant to indicate support. I saw a pattern of contradiction in Teacher Skier

because while he believed knowledge was crucial to changing people's attitudes and

actions, he resorted back to the belief that, nothing could alter human behavior. "We

can't get people to leave animals alone in their natural habitat." (Teacher Skier, Pre-

interview, p. 8)

Reoccurring themes from teacher interviews

After reading the transcriptions I realized that while it was easy to show how

knowledge or attitudes shifted it was more encompassing to point to how thinking about

the topic became more nuanced, rigorous, and complex after the unit took place. There

were a handful of themes, ideas, or attitudes that all three teachers held that exhibit how

thinking became more complex after the unit. Table 4 helps illustrate those themes so to

easily see a consistent input from teachers, which can help managers build programs with

stakeholder input in mind. These results contributed to answering RQ2 and RQ3. All teachers thought that reintroducing grizzly bears to California would hinge on a powerful and well executed education campaign and must involve schools not just as venues for learning but engaging community members. Teachers put a special emphasis on knowledge; however, all mentioned the importance of culture too. In the scenario that grizzlies be reintroduced, all teachers voiced worry for the wellbeing of people coming from out of the area. They all seemed to think locals would be just fine. Finally, all teachers found value in the CGBRU but offered suggestions to better it.

Table 4

Unanimous Themes Amongst the Three Teachers

Theme	Quotation from Interview
Reintroducing large predators to a community must involve schools to engage community and families of students.	"I think a lot of times they can help educate their family members about an issue" (Teacher Alaska, Pre-interview, p. 8) "[T]hroughout the year we have regularly scheduled programming, where people are on campus and were doing things together as a community" (Teacher Hunter, pre-interview, p. 2) "[T]he students […] take ownership of that, they're proud of being able to have these discussions with their parents and then I tell them too […] the next step after having that discussion at your house is, are your parents taking that to work?" (Teacher Skier, pre-interview, p. 3)
A successful reintroduction must be preceded by a massive education campaign.	"If it was purely introducing grizzlies without any education effort involved, I would vote no. It would go really poorly. If there had been a really thoughtful campaign about introducing grizzlies in a way that allowed the public to respect them and keep their distance and stay safe from them […] then I would vote yes." (Teacher Alaska, Pre-interview, p. 9) "You're going to have to re-educate literally the entire state of California about their back country practices" (Teacher Hunter, Pre-interview, p. 8) "If you could magically implant education about these animals into every single Californian and then into every single other […] out of state tourist, international tourist, everybody […] (Teacher Skier, Pre-interview, p. 8)

While knowledge through education is mostly focused on, culture is also brought up.	"I don't know what that [encountering a bear] would look like in the absence of that awareness or that culture of knowing how to exist with them" (Teacher Alaska, Pre-interview, p. 7) "[I]t's not part of the culture of the place. So it would be wonderful to build the culture, it would be neat to see it, but it's a big one." (Teacher Hunter, Post-interview, p. 10) "[W]e live in a very small town that's surrounded 360 degrees by nature. So we we've been kind of, you know, raised and and guided by the community to know how to go out and in nature and be respectful and to give animals their space and not intrude on their territory. So I would say that really hasn't changed." (Teacher Skier, Post-interview, p. 2)
Worry about tourists/other Californians' (not locals) ability to navigate a large predator in local wilderness areas.	"I think there can be a lot of conflict between people and bears, and especially in California, where I think there's less awareness and like home grown education or training on how to appropriately safeguard them from your food and interact with them when you see them in the wild." (Teacher Alaska, post-interview, p. 2) "No, I still don't think it's a good idea [...] the population [...] in California is frankly not tough enough to deal with it." (Teacher Hunter, Post-interview, p. 9) "I don't mean to sound condescending, but especially when you throw in the tourist factor, because of a lot of tourists are just not prepared. They're no educated, and they're not prepared to have those types of interactions with wildlife." (Teacher Skier, pre-interview, p. 5)
The curriculum has value.	"I think it was really fun for the students. It wasn't a topic that any of them had said that they had explored before. And so it was fun for them to talk about something new. I enjoyed teaching it at the end of our ecology unit because then students could connect it to the ecology unit." (Teacher Alaska, Post-interview, p. 3) "The idea worked, It's a very interesting idea. It gets peoples' attention" (Teacher Hunter, Post-interview, p. 6) "I thought it was well thought out, well planned. The timing and pacing, everything like that was pretty spot on. [...] they [the students] were interested right from the start. And then they maintained a high level of interest throughout. I was really impressed with them and the unit that it was able to maintain that level of interest." (Teacher Skier, Post-interview, p. 3)
Helpful critiques for the improvement and	"[O]ne thing I felt was missing was just more scientific background information that succinctly presented grizzly bears and their role in ecosystems [...] I ended up pulling a scientific paper that had looked

reception of the CGBRU.	at their reintroduction across the U.S. and the world and presented different case studies in terms of what works and what didn't." (Teacher Alaska, Post-interview, p. 5).
	"I'd like to see a bear safety component." (Teacher Hunter, Post-interview, p. 10)
	"I would have liked to have seen like a community outreach where we maybe got to survey the general public, that would have been interesting to see what their opinions were." (Teacher Skier, Post-interview, p. 4)

The answer to RQ2 regarding teachers and how thinking changed after the CGBRU was taught, is that thinking became more complex, nuanced, and rigorous. This showed that the unit helped complexify the topic, a needed process to help grapple with the problem of grizzly extinction and rewilding. It just happens that this answer is also an ethos inherent in Environmental Principle and Concepts' number five that hopes teachers can understand the complicated spectrum of what is considered in making decisions about the environment and how those factors influence decisions as well as the process of making decisions about the environment, and how the assessment of social, economic, political, and environmental factors has changed over time. The teachers, like this principle and concept, recognized how environmental problem solving is complex and decisions involve various factors.

The 5CCCs and research question one

My first research question asked how curriculum might be designed to augment the typical environmental education framework with elements from a carnivore management framework to better inform students for carnivore reintroduction. Another layer of coding was applied to the qualitative post-interviews to see if any of the 5CCCs immerged after teaching the lessons. This helped grapple with RQ1 because it showed what the teachers

did to address these concepts and what concepts are most emphasized without directly talking about the concepts with the teachers. 'Knowledge Sphere' emerged from the interviews most frequently. This shows that knowledge is talked about the most and likely emphasized the most. 'Representation' emerged second, then 'Communication', 'Leadership' and finally 'Trust'. Table 5 describes examples of how the concepts immerged and what I considered to satisfy coding a theme with one of the 5CCCs. I only coded post-interviews to see how teachers unknowingly discussed these concepts after the intervention took place. This table is meant to give examples of what satisfied a concept and therefore was coded, while Table 6 was made to display how often that code arose.

Table 5

Example of the Five Carnivore Coexistence Concepts with Transcription Quote

Code	Example from Transcription
T, trust	"I would try to stay away from anybody from the Nature Conservancy […] because the kids […] are going to look at that stuff and immediately shut off as soon as they see anything that says the word 'conservation' on it. The more stuck in the mud, kind of right-wing kid as soon as he sees that word 'conservation' they freak out." (Teacher Hunter, Post-interview, p. 7)
R, representation	"These are the kids who will be affected if the grizzly bears reintroduce to California." (Teacher Hunter, Post-interview, p. 4)
K, knowledge sphere	"I always try in class to kind of give my students exposure to different professions and the pathways that it takes to get to those professions" (Teacher Skier, Post-interview, pp. 3-4)
C, communication	"I think that these kids should, and their families should be given some sort of say, or at least to have their voices listened to." (Teacher Hunter, Post-interview, p. 5)

L, leadership	" [I]f the reintroduction were actually happening, we would do our best to connect our junior and senior students who are taking biology or environmental science classes directly with that research" (Teacher Alaska, Post-interview, p. 7)

Table 6

Frequency of the Five Carnivore Coexistence Concepts

Code Teacher	T	R	K	C	L
Hunter	4	3	6	3	2
Skier	0	4	7	4	2
Alaska	0	6	7	1	2
Total	**4**	**13**	**20**	**8**	**6**

Note. The following are the abbreviations used in this table: T, trust; R, representation; K, knowledge spheres; C, communication; L, leadership

According to the coding scheme, 'Knowledge Spheres' had the highest frequency of occurrence. This suggests two things. The first, and most obvious, the teachers felt knowledge acquisition played an important role in learning. Second, the CGBRU emphasized the various spheres of knowledge involved in the complex idea of grizzly reintroduction to California. One of the lessons of the CGBRU brings various interdisciplinary perspectives for students to use critical thinking and interdisciplinary thinking to navigate the question of brown bear reintroduction to California. The presence of 'Knowledge Spheres' did not just emphasize the cognitive learning but pushed for a more reflexive approach that focused on paying attention to different types of knowledge that underlies various beliefs, which each teacher mentioned at various times. An example of how the CGBRU does this is when it asks students to step into the shoes of a stakeholder and argue from their perspective. It also asked teachers to push students to talk to family members or local people in the community. Teacher Alaska sought her own version of this by asking students to conduct formal interviews of locals.

91

This helped students learn about the diverse opinions within family units and among community members. "Awareness of participants' perspectives, values, and social and cultural surroundings will help with implementing legitimate governance approaches and assist with facilitating dialogue occurring within the measures." (Sjölander-Lindqvist, Johansson & Sandström, 2015, p. 181).

Second to 'Knowledge Spheres' was 'Representation'. Representation dovetailed with 'Knowledge Spheres' in that the fair representation concept encouraged hearing from various voices, which is only accessed by appreciating the diverse spheres of knowledge. Representation meant getting a "more comprehensive input during decision-making processes and will lead to better decisions and better, more informed representation" (p. 180). Teacher Hunter brings up representation in his post interview many times. For example, "[S]o if the grizzly are gonna be reintroduced this is where theyre gonna end up. And I think that these kids should and their families should be given some sort of say, or at least to have their voices listened to." (Teacher Hunter, Post-interview, p. 5).

The 'Communication' concept came third. Communication can be both a practical and intellectual phenomenon as the success of environmental policy making hinges on understanding one another and coordinating well enough to move towards a single goal (Sjölander-Lindqvist, Johansson & Sandström, 2015). Teacher Alaska mentioned pedagogical mechanisms that enhance communication. For example, having students and researchers come together to present the research that is happening during a poster night for the school and community (Teacher Alaska, Post-interview, p. 7).

The concepts that occurred the least, were 'leadership' and finally 'trust'. These two

concepts interact explicitly. It is reasonable that Trust, as a code, occurred the least

because Trust was the concept emphasized the least in the CGBRU. Also, trust is not as

much a problem in a Californian culture where respect and trust for fish and wildlife

officers is commonplace. Furthermore, Teacher Hunter invited local conservationists to

speak in his classroom regularly. However, building trust and leadership in conservation

management requires regular visits from members of the conservation team at the time of

reintroduction.

Teachers, students, and research question three

The six pre-interviews provided a comprehensive list of the teacher's answer to "If

grizzlies were to be introduced how do you think your school should be involved?". I

only used the pre-interviews because I was interested in learning the teachers' opinion

unaffected by the intervention. I thought it was appropriate to use all six teachers,

including half of whom dropped out prior to teaching, because they all had valid ideas

and concerns as stakeholders and leaders in their community. This clearly answered RQ3,

concerning how schools believe schools can be involved in a controversial rewilding

project such as the reintroduction of grizzlies. I took the answer a step further and coded

the teachers' idea with the 5CCCs and the table below corelates the ideas for school

involvement to the 5CCCs that are inherent in the idea. The ideas that involved all five

concepts are listed first in the table below are numbers: 1, 2, 3, and 4. This signified the

areas where carnivore management and pedagogical goals significantly overlap. This can

be a tool for conservation managers that wish to organize, narrow down, and prioritize

the feedback from the teachers and can also be used for other community members' input

as well. Coding it with the 5CCCs can help managers prioritize action plans and reintroduction mapping. Table 7 is different from the other tables as the process of creating it acts as a useful mechanism. It is a practical tool that gives conservation managers a way to see which ideas would benefit schools while also benefitting conservation plans. For instance, the coding in this table revealed the following teacher ideas to be the most conducive to not only school success but conservation management success: bring in wildlife managers to provide updates; Give students, teachers, and parents a venue to learn and talk about their concerns; Students can help collect data; Teachers can work with scientists to design a unit that covers all the topics of grizzly introduction. It is likely that teachers will be happy to provide ample suggestions, therefore, conservation managers will need a tool to objectively narrow down the list to ideas that benefit schools and conservation planning. This table elucidates that process. The suggestions that satisfied only one of the 5CCCs were not included in the final table.

Table 7

Teacher Ideas for School Involvement Coded with Five Carnivore Coexistence Concepts

	Code					
	Trust	Representation	Knowledge	Communication	Leadership	#
Idea						
Students can help collect data	●	●	●	●	●	5
Give students, teachers, parents a venue to learn and talk about their concerns	●	●	●	●	●	5
Teachers can work with scientists to design a unit that covers all the topics of grizzly introduction	●	●	●	●	●	5
Bring in wildlife managers to give updates	●	●	●	●	●	5
Students can help bring knowledge to their parents on the issue		●	●	●	●	3
Conduct backcountry safety programs for the students		●	●		●	2
High schoolers could shadow scientists	●		●			2
Give kids access and training on GPS and radio tracking of collared bears		●	●			2
Talk to students about incident reports about bears eating livestock or hurting people			●	●		2

Questions from teachers about possible reintroduction of grizzlies

In the pre-interviews, all six teachers were asked what they would want to know before they voted on a grizzly bear reintroduction in their local area. These questions can help conversationists navigate reintroduction planning and contributed to RQ3. From left to right the themes are in descending order (i.e., concerns are mostly centered around the future and the concern that comes up the least is cost). This table displays a likely indication of typical inquiries a community might develop when they learn a large keystone is to be reintroduced to their area and can provide conservation managers foresight into the types of answers to prepare when communicating with schools.

Table 8

Teachers' Questions about Reintroduction Categorized by Theme

Future	Place	Fear	Food	Education	Cost
What is the long-term plan?	Where will they be?	What should we expect in an encounter?	Do they have enough to eat?	Are there plans or initiatives to educate tourists?	How much does it cost?
How might they alter the ecosystem?	Will they be tracked and monitored?	Are they territorial?	What is their anticipated food source (throughout all seasons)?	What can we learn from other case studies in areas where grizzlies were introduced?	How will it affect insurance for ranchers?
What could go wrong and what could go right?	What is their range, and might they roam into areas where people are?	Should hikers, backpackers and bikers be worried?	How will their presence conflict with hobby fisherman?		

How quickly is the grizzly population going to increase?	Will they be restricted to a territory?	What behavior can we anticipate when encountering them?	
What do they envision when the grizzlies are established?	Would they stick to higher elevations?		
What will the population size be?			

Note. Repeated questions are not included to reduce redundancy.

Teacher's attitudes towards a topic can significantly affect their students (Ulug, et al., 2011). While the increase of knowledge amongst students can be correlated with support for grizzly reintroduction, the qualitative interviews of teachers offer a deeper look that revealed the opposite. All three teachers were against grizzly reintroduction after the intervention. Teacher Alaska's knowledge increased, and she warned more gravely against grizzly reintroduction. Because of this increase of knowledge and decrease of support, Teacher Alaska illuminated a limitation in using the KAB model for a framework for pedagogy surrounding carnivore reintroduction. Teacher Hunter who was at first a passionate supporter for grizzly bear reintroduction changed his mind after conducting the unit. He communicated an unchanging support for reintroduction and yet altered after the intervention due to his concerns about his students hunting reintroduced bears as well as the wellbeing of tourists. Teacher Skier revealed the same concern for tourists and his stance towards grizzly reintroduction, like Teacher Alaska, seems to get more negative with the more knowledge he gained.

97

After asking the students to conduct interviews of people in the community on their opinion of grizzly reintroduction, Teacher Alaska was shocked by how many ranchers in the area "had concerns about grizzly bears" even though she thought grizzly bears would not be much of a problem for ranchers (Teacher Alaska, post-interview, p.6). On the other hand, she thought it was "interesting talking to people who never hike, didn't have much of an opinion or thought that abstractly it would be a good idea." (Teacher Alaska, post interview, p. 6) This illustrates an important difference in support among people who *know* how harmful and disruptive grizzlies might be versus the blind support by people who know very little about the species. This insight sheds light on a different way knowledge interacts—less of certain types of knowledge can mean more support. These examples show the kind of knowledge included in the KAB model to be limited for the design of education programs for carnivore reintroduction. Knowledge about grizzlies does not imply positive attitudes are increased. Grizzly reintroduction is more complicated than knowledge acquisition and the qualitative data from the Teachers does an excellent job of illuminating why that is.

Open-ended survey answers from students

In the pre-surveys (n=101) students were asked for the reason they believed grizzly reintroduction should or should not happen—they were allowed to answer openly. As shown in Table 9 below, this "why or why not" open-ended question from the students' pre-survey is worth mentioning as it illuminated an overwhelmingly negative attitude towards humans as the reason they were against reintroduction, as opposed to the bears themselves. Many of the students' concerns were not centered around fear *of* bears but fear *for* the bears. This is an interesting finding that helped answer RQ3, because

educators and managers should include more lessons in outreach programming that inform students about how reintroduced animals are protected by laws. I think this sheds light on the case study of grizzly bears specifically. Animals go extinct for a variety of reasons, yet grizzlies in California went extinct because of humans over-hunting them. However, what is not understood by the students is that bears reintroduced would be protected by law. Clearly, students in reintroduction zones will need more information surrounding reintroduced species protection.

Table 9

Open-ended Survey Responses: "No" to Reintroduction for the Well-being of Bears

"They [bears] are awesome. and people r dumb."

"I think no because people are gonna kill them again."

"No Because they will be killed again."

"I don't think they should because they will be killed and go extinct all over again."

"Because if they come back they would die much faster because the world is worst."

"No because then it would probably just go extinct again and it's better for it to live somewhere it actually gets protected and not killed"

"Because the world is trash and it is most likely that people kill them again."

"No, I feel like that's not fair to the grizzlies because we could drive them to extinction again. And we don't deserve them anymore."

"Maybe because they could get hunted down again and go extinct again."

"People might just kill them again and probably will suffer a lot."

"No because they were extinct by humans so I think that might happen again so I wouldn't take my chances."

"No because if they come back humans will get them extinct."

Quantitative results

The quantitative results helped to answer how knowledge interacted with attitudes towards grizzly reintroduction in students (RQ2) and how students thought schools in

possible reintroduction zones might assist in the success of grizzly bear reintroduction (RQ3). The pre-survey established what was known about students' knowledge, attitudes, and fear to gain insight into the sample of students in areas of proposed reintroduction. This informed RQ3 but also RQ2 as it was necessary to establish the base knowledge and attitude to see how knowledge and attitudes interacted and changed. Next, before and after findings were analyzed in both surveys and quizzes to note shifts in attitudes and knowledge, which contributed to RQ2.

Pre-survey findings

Surveys given prior to the intervention offered insight about the 101 students that received the intervention. Descriptive statistic frequencies shed light on students' knowledge, attitudes, and intended behavior towards wildlife, more generally, and grizzly reintroduction specifically. The pre-survey findings illuminated what was learned about the student sample prior to the intervention.

As shown in Table 10 below, most students felt positively towards wildlife believing that wildlife deserved protection and should not be fully controlled by humans. This meant that more students were on the side of letting wild things be and thrive without human intervention. There are more students at least somewhat concerned about wildlife issues than not. At the same time, they reported having received little educational exposure to wildlife conservation at school. Most students thought their school was not at all involved in local conservation surrounding wildlife. This was surprising considering the wildness of the area and the incredible interest the teachers had in conservation and local wildlife. Students were either wrong about this or student involvement was very low. Despite most students not formally studying environmental education, most students

had experienced nature closely for a week or longer. This told me that schools were not the way students were getting exposure to wildlife or nature, rather it was from their families or at home.

Table 10

Important Date from Student Pre-survey (n=101)

Survey Question	Result
Should animals receive the same kind of protection or justice that people do? (always, sometimes, never)	Almost 97% of students believed animals should sometimes or always receive the same kind of protection or justice that people do.
What level of control do you believe people should have over wildlife populations? (All wildlife should be in zoos, wildlife should be moderately controlled, wildlife populations should only be controlled in some cases, wildlife should never be controlled).	While most students (66%) believed wildlife should only be controlled in some cases, 15% believe that wildlife should never be controlled.
If you were to encounter a large carnivore such as a mountain lion on your school campus, do you feel prepared? (Yes, no).	Half of the students felt prepared to run into a carnivore while the other half do not feel prepared.
To the best of your knowledge, is your school involved in local wildlife conservation efforts? (Yes, no).	Nearly 80% of students think their school is not at all involved in local conservation surrounding wildlife.
If grizzly bears lived in your area, would you act differently when you were outdoors?	40% would act differently outdoors if they knew grizzlies were around.
Have you taken environmental education class, course, or workshop previously?	Most students had never taken an environmental education course (63%).
Have you ever been to an outdoor summer camp or gone on a trip where you lived close to nature for a week or longer?	Despite most students not formally studying environmental education, 75% of students had experienced nature closely for a week or longer.
On the following scale please indicate your level of concern for local wildlife issues (local endangered species, local wildlife conservation projects, etc.) (0=not at all concerned 10 = it is my biggest concern).	There are more students on the side of concerned about wildlife issues (61%) than not (39%).

Students were asked attitude, knowledge, and fear questions to help understand their and their family's stance towards carnivores living in their area, prior to the intervention.

The following table displays the findings surrounding students' carnivore attitudes from frequencies in descriptive statistics using SPSS.

Table 11

Student Pre-survey Attitudes, Knowledge, Fear (n=101)

Phenomena	Survey Question	Result
Attitude	If grizzly bears lived in your area, would you be interested in hunting them (yes, no)?	Only 6% of students report the desire to hunt grizzly bears, if they were living in their area.
	How would you rate your family's opinion of large carnivores living near your home (0=negative opinion, 5=neutral opinion, 10=positive opinion)?	~25% had a negative attitude and ~33% had a positive attitude while 40% were neutral towards carnivores living near their home.
Knowledge	Which of these four images is a grizzly bear?	88% of students knew enough about grizzly bears to identify one from a group of four other bears.
	Which of the following animals are extinct in California, pick all that apply, (California condor, California spotted sea turtle, Black bear, California grizzly bear)?	64% knew that the Californian grizzly bear was extirpated.
Fear	On the following scale indicate how fearful you are of nature (0= not at all afraid; 10= terrified).	Most students (71%) fell on the "not at all afraid of nature" side of the spectrum.
	A mountain lion is spotted around your school, what is your reaction, pick all that apply, (Fearful- "The animal may attack me or someone I love!"; Curious- "I want to try and see the lion for myself."; Indifferent- "I don't know why people like or dislike mountain lions."; Positive- "I am so happy these amazing animals live in this region."	15.8% of students reported a fearful reaction to seeing a mountain lion around their school campus, while 60% report curiosity. Fear of mountain lions was strongly outweighed by curiosity.

How would you feel if a grizzly bear was seen in an area near your school campus, pick all that apply, (Fearful- "The animal may attack me or someone I love!"; Curious- "I want to try and see the lion for myself."; Indifferent- "I don't know why people like or dislike grizzly bears."; Positive- "I am so happy these amazing animals live in this region."	Compared to mountain lions there is a slight increase in fear of seeing grizzly bears around campus (~19%).

Before-and-after findings and research question two

Comparing the frequencies from pre-surveys with that of post-surveys, which were filled out after the CGBRU was taught, revealed that thinking also changed amongst students. Attitudes and knowledge changed and more generally thinking about this topic became much deeper and nuanced. Table 12 below shows how knowledge and attitudes shifted. After the intervention, support for grizzly reintroduction increased 29% while knowledge increased 46%.

Table 12

Attitudes and Knowledge—Small Survey (n=10)

Question	Before Intervention	After Intervention
Do you think grizzly bears should be reintroduced to California?	Yes (50%)	Yes (79%)
Which of these four images is a grizzly bear?	Grizzly Bear (64%)	Grizzly Bear (100%)

Before and after quizzes were given to students by Teacher Skier. Prior to the intervention, students were asked the question, "Do you think Grizzly Bears should be

103

brought back to California (Opinion question. No wrong answer)?" 34 of the students

(54%) said yes, 25 (40%) said "maybe but need more information" and 3 (4%) said no.

After the intervention, students were asked again to "Vote as yourself. This is your

opinion! Would you vote Yes or No to reintroduce grizzly Bears in California?" This

time students were not given the chance to answer ambiguously, they could only select

either 'yes' or 'no'. In the post-quiz, 43 (69%) of the students said yes and 13 (20%) said

no. The shift of support for grizzlies in Teacher Skier's classroom after the intervention

grew 15%. The questions are not identical as the wording is different (the first question

allows students to answer 'maybe') and this may have affected the answers, however it is

still a worthwhile comparison to note the shift in those students reporting a strong 'yes'

as shown in Table 13.

Table 13

Changes in Attitudes Towards Reintroduction—Quizzes (n=62)

Do you think grizzly bears should be brought back to California?	Before Intervention	After Intervention
Yes	54%	69%

Note. Teacher Skier did not ask any knowledge questions on his quizzes after the CGBRU took place.

Chapter 5: Discussion

Conservation managers have sought to return keystone species to wild areas with hopes to restore ecosystem health (Lawton, 1994; Seddon & Armstrong, 2016;). The current 6th mass extinction made this a growing strategy of interest in the field of conservation. The grizzly bear, a keystone species, might offer ecosystem restoration and is a significant cultural symbol to Californians. As such, various conservationists and some institutions have discussed their possible reintroduction to California and various types of research has been conducted and is ongoing to understand if such a reintroduction should occur and how it might occur. The case-study of the California grizzly can offer analogies and insight into other keystone reintroductions and is insightful as it exposes the various complexities and controversies involved in keystone and large carnivore reintroduction.

For instance, the presence of keystone species could disturb human health and livelihood (Seddon & van Heezik, 2013). Grizzlies might present substantial human-wildlife conflict in their possible reintroduction zone—the Eastern Sierra of California. Like others, George and Sandhaus (2016) explained the importance of involving the public, doing education and outreach, and retuning public attitudes to do successful reintroduction. While many point to education, few explain how to do it well or what it looks like in the context of large predator reintroduction. Likewise, those that have researched learning in a wildlife context have found inconsistencies in how knowledge interacts with conservation goals—sometimes knowledge acquisition supports management success, yet other times it hinders it.

The answers to the research questions in this study advanced the actions and inquiries of conservation education because they provided a pedagogical groundwork centered around practical outcomes that assist the plausibility of grizzly bear reintroduction in California. These answers are a part of ensuring the schools in reintroduction zones, and the next generation who might inherit these bears, can benefit from such a provocative rewilding. These answers have the potential to assist conservation managers in reintroduction planning, in the case such a rewilding can occur. In the end, grizzly bear reintroduction to California might never occur. However, if it does occur, it will hinge on studies like mine and other groundwork studies that lay foundations for it to have gained feasibility and therefore momentum.

This study depended on the creation of a 7-lesson education unit and required that unit to be taught by local science classrooms in the potential grizzly reintroduction zone. The goal was to see how the typical KAB framework could be augmented to address human-wildlife conflict by using a carnivore management framework referred to in this study as the Five Carnivore Coexistence Concepts (or the 5CCCs); how thinking surrounding grizzlies and their reintroduction changed in teachers and students after the intervention took place; and what teachers and students thought about the involvement of schools and how they might assist symbiotic goals (goals that help a conservation project succeed but also benefit the school). The science teachers interested in the topic who volunteered for the study were not only tasked with teaching the CGBRU (California Grizzly Bear Reintroduction Unit) but became research participants as well.

While all the teachers experienced an increase in knowledge surrounding grizzlies and reintroduction, none were swayed to support reintroduction of grizzlies to their local

area. In the case of Teacher Hunter, positive attitudes towards reintroduction changed to negative because of feelings of fear for others, among other considerations. Alternatively, knowledge increased for students as well as support for reintroduction after the intervention. Yet, it is likely that the other aspects of the CGBRU contributed to this shift, such as: the involvement in an exciting new topic that was relevant to the community; the chance to think critically about something controversial; to debate a topic in science class; to hear from guest speakers; and to play stakeholder roles. To attribute the marginal shift in support for reintroduction by students to knowledge acquisition alone, is too simplistic an analysis considering how severely the teachers of these students warned against reintroduction. Rather, it is more plausible to attribute the increase in support for grizzly reintroduction to the novel themes this unit brought to the classroom or the 5CCC framework behind the unit itself. Teachers' thinking about the topic became deeper and grew more nuanced and complex after the intervention. The unit helped complexify the topic and teachers exhibited a development of the Environmental Principles and Concepts, especially principle five, which admits that decisions affecting resources and natural systems are complex and involve many factors.

Findings and research questions

My exploration included three areas of inquiry: first, a theoretical investigation concerning pedagogical framework best suited for large carnivore reintroduction projects. Second, a look into how education intervention might alter student and teacher thinking about carnivore reintroduction; and finally, a look into how teachers and students thought schools could assist the potential reintroduction of brown bears to California.

Research question one

How can a curriculum be designed to augment the KAB model with elements of the Five Carnivore Concepts from Sjölander-Lindqvist, Johansson and Sandström, (2015)? The first question observed the educational design typical in environmental education for carnivore reintroduction specifically, so that learners become more informed about carnivores and long-term conservation goals can be met by managers at the same time. This question interacted with RQ3 (concerning how schools think they might be involved in conservation management) with a more specific focus on educational frameworks appropriate for reintroduction projects. The answer to this question also contributed to a pervasive question in interdisciplinary conservation circles that ask an important question—how might conservationists and educators work together to do successful and symbiotic programming?

The CGBRU was designed with the 5CCCs in mind, but they were never explicitly stated at any point in the unit. For example, the Sjölander-Lindqvist, Johansson and Sandström, (2015) paper was read, and the concepts were discussed amongst the education team during the design of the CGBRU, but they were not explicitly described as learning outcomes or stated in the unit as a guide for teachers. It was a goal among my team who helped design the CGBRU to inspire students to grapple with these concepts in the lessons but the same terminology of the 5CCCs was not explicit. The 5CCCs were also never overtly included as content for the teacher's professional development. They served as an underlying skeleton for educators to consider in deciding what content might be important to include or exclude in the CGBRU. In the design phase it guided content control but was never a tool given to students or teachers.

The findings show that the 5CCCs are naturally emerging, meaning teachers discussed them generally as themes after the intervention took place. It might be helpful to plainly insert these concepts as a framework for pedagogy to help guide teachers in keystone reintroduction zones to augment learning and conservation outcomes. These concepts originally emerged from the carnivore management literature because they also naturally emerged during carnivore management practices. Sjölander-Lindqvist, Johansson and Sandström, (2015) located them as repeated themes in the literature and then advocated for their explicit use to navigate the human-dimensions of carnivore-human coexistence. I believe my findings give rationale for other conservation educators to utilize the same or similar pedagogical design surrounding carnivore reintroduction projects. In fact, I believe the use of the 5CCCs ought to be more explicit and can even be designed into a lesson for older students in high school or beyond.

Research question two

How might thinking about grizzly reintroduction change in both teachers and students after the unit is taught? Teachers' thinking about the topic became deeper and grew more nuanced and complex after the intervention. The unit helped complexify the topic and teachers exhibited a development of the Environmental Principles and Concepts, especially principle five, which declares decisions affecting resources and natural systems are complex and involve many factors. While the increase of knowledge amongst students can be correlated with support for grizzly reintroduction, the qualitative interviews of teachers offered a deeper look that revealed the opposite. My results were not unlike the other inconsistencies found in the conservation education literature. Teacher's attitudes towards a topic can significantly affect their students (Ulug, et al.,

109

2011) and yet student attitudes became more supportive while teachers did the opposite. All three teachers were against grizzly reintroduction after the intervention or mentioned a possible support with major caveats such as massive education campaigns. Teacher Alaska's knowledge increased, and she warned more gravely against grizzly reintroduction. However, it is far-fetched to conclude Teacher Alaska became more negative because of knowledge increase, rather her thinking became more complex and nuanced as she processed the idea. Teacher Hunter who is at first a passionate supporter for grizzly bear reintroduction changed his mind after conducting the unit. He communicated an unchanging support for reintroduction and yet changed after the intervention due to his concerns about his students hunting reintroduced bears as well as the wellbeing of tourists. This also illuminated how the CGBRU complexified the topic of reintroduction for Teacher Hunter, which was a desired result because solving environmental problems means recognizing their complexities. Teacher Skier revealed the same concern for tourists and his stance towards grizzly reintroduction, like Teacher Alaska, seemed to get more negative with the more knowledge he gained. However, like the other two teachers, he was never explicitly negative towards reintroduction, he just wanted to make sure the various factors of this environmental problem were navigated in a nuanced and rigorous manner.

After asking the students to conduct interviews of people in the community on their opinion of grizzly reintroduction, Teacher Alaska was shocked by how many ranchers in the area "had concerns about grizzly bears" even though she thought grizzly bears would not be much of a problem for ranchers (Teacher Alaska, post-interview, p. 6). On the other hand, she thought it was "interesting talking to people who never hike, didn't have

110

much of an opinion or thought that abstractly it would be a good idea." (Teacher Alaska, Post-interview, p. 6) This illustrated an important difference in support among people who *know* how harmful and disruptive grizzlies might be versus the blind support by people who know very little about the species. These insights shed light on a different way knowledge interacted—less knowledge can mean more support. These examples showed the KAB model to be limited for the design of education programs for carnivore reintroduction. Knowledge about grizzlies does not imply positive attitudes are increased. Large carnivore reintroduction is more complicated than knowledge acquisition and the qualitative data from the teachers did an excellent job of illuminating why that is while also emphasizing the important environment ethos inherent in the Environmental Principles and Concepts and why they are so important for teachers.

Coding the follow-up interviews with the 5CCCs revealed that teachers were talking about these concepts without knowing it. In theory, this might have contributed to more positive attitudes amongst students because teachers did not simply increase student knowledge but pushed students to think about the various components inherent in the human side of human-wildlife coexistence. Because teachers were talking about these concepts it might be assumed they are bringing them to their students, which was in-line with what the CGBRU offered. A different analysis of my data might help shed light on this connection but was not within the scope of my dissertation.

Research question three

How do students and teachers think schools in possible reintroduction zones assist in the success of grizzly bear reintroduction? This inquiry sought to find out how schools in the Eastern Sierra of California (the possible reintroduction zone) might assist in the

111

success of grizzly bear reintroduction. In the context of this question, the term 'schools' identified the people involved (i.e., students, teachers, etc.). According to the qualitative data, the teachers were staunch in their attitudes towards reintroduction involving schools. All six teachers who started the study listed ways to involve students, while only one teacher (the teacher who exhibited the least amount of environmental and conservation knowledge) was unsure how the school might be involved. The three science teachers who completed the intervention all expressed a similar viewpoint: the reintroduction of grizzly bears to California cannot be successful without involving local schools and conducting a massive education campaign across California. This is not too surprising as this was, after all, the opinion of teachers, a type of person whose career depends on education. However, more importantly, teachers all gave many concrete ways that conservation managers could involve schools (see Table 7). I think these details can be very important for reintroduction planning, while utilizing the 5CCCs to code teacher ideas offered another layer of organization and consolidating that might be helpful for reintroduction planning.

As seen in Table 7, teacher ideas for school involvement were coded with the 5CCCs to assist the reintroduction mapping done by managers when navigating topics from interested citizens. The suggestions numbered 1, 6, 8, and 11 in Table 7 were ideas that when coded by the 5CCCs satisfied all five concepts. I believe the ideas that addressed all the concepts (numbers 1, 6, 8, and 11) were the most symbiotic concepts to benefit both schools and management practice. This coding mechanism can be repeated in other reintroduction projects to decide on manners in which managers can involve schools and might be expanded to community conservation more generally. In the case of grizzly

reintroduction those ideas are bring in wildlife managers to give updates; give students, teachers, parents a venue to learn and talk about their concerns; students can help collect data; and teachers can work with scientists to design a unit that covers all the topics of grizzly introduction (see Table 7).

While Teacher Alaska, Hunter, and Skier all held the belief that this type of reintroduction can and should not occur without involving schools, they went further to express how schools would tremendously benefit from the involvement as well. According to the teachers, this reintroduction could be a symbiotic effort for all involved. I think the findings are in support of this. The reintroduction of grizzly bears should involve the schools in reintroduction zones—this could increase the probability for a successful reintroduction project and coordinated educational units would benefit students, teachers, and school communities. The students' open-ended question concerning why they would not vote yes for grizzly reintroduction, shed light on the areas that students had a major misunderstanding (see Table 9). This helped contribute to answering RQ3 because many students would be more in support of grizzly reintroduction if they knew that grizzly bears would be protected if they were to be introduced and it would be very unlikely that grizzly bears would be killed off by humans again, which was their major worry. This misunderstanding is an example of a knowledge-based outcome very easily achieved by involving schools in a reintroduction project.

The way in which schools are involved will likely affect the success as well. Simply, being involved might not be enough. Teacher Alaska voiced the importance of the curriculum to remain unbiased and not attempt to persuade students to support grizzly

reintroduction but to provide students with the information on reintroduction they need, while allowing them to see the multiple perspectives so that they might then make their own decisions. Being able to articulate both the pros and cons of grizzly reintroduction is important to inculcate a preparedness in the next generation, which would assist in successful reintroduction.

Relating findings to the literature

The field of conservation education shed light on attitudes towards large carnivores, but few studies investigated student attitudes specifically (Ambarh, 2016; Dieser & Bogner 2018; Oražem, et al., 2021; Oražem, et al, 2019; Oražem & Tomazic, 2018); even fewer investigated teacher attitudes (Bussing, et al., 2019), and none looked at large carnivore reintroduction and teacher and student attitudes simultaneously. Beyond the conservation education literature, it is widely accepted that teacher pedagogy and teacher attitudes directly affect how science is taught and the subsequent results of student learning (Shrigley, 1983). In the context of reintroduction science and conservation education, teacher attitudes and the connection to student learning or attitudes had yet to be accessed. My RQs focused on teachers and students in a carnivore reintroduction context to fill this hole and look deeply at the human side of a growing area of interest for conservation managers—keystone reintroduction.

A commonly used framework for environmental education, the Knowledge-Attitude-Behavior (KAB) theory, suggested that increased cognitive levels (knowledge) lead to attitudinal changes (beliefs and opinions) and attitudinal changes in turn lead to behavioral changes that increase environmental responsible actions, known as environmentally responsible behavior (ERB) (Marcinkowski & Reid, 2019). This

114

engaged a two-part assumption—increased knowledge leads to positive attitudinal changes, which in turn leads to desired behavioral outcomes (2019). Despite the criticisms of KAB being simplistic and assumptive by nature, it remains a fundamental model for going about doing conservation education.

A recent study regarding student knowledge and attitudes of brown bears found that the more knowledge a student gained about brown bears the more interested the student was to learn more, the more proconservation values they exhibited, and the less fear they report having (Oražem et al., 2021). My findings supported this connection between knowledge and attitudes in students but contradicted it in teachers. These contradictions are not unique as much of the literature is riddled with inconsistencies in knowledge leading to desirable attitudes in the context of wildlife conservation. For example, in the case of Kamil et al. (2019), though they found an increase of knowledge after the program's completion, more students still report an intent to hunt deer (komodo dragons' main food source and therefore an undesirable ERB). Oražem et al. (2021) acknowledged that other factors such as where participants lived, whether they owned a dog, had hunters in the family, bred livestock, or frequented zoos played a part in students' tolerance of bears. While locating these factors begins to dissect the complexities of what knowledge means in this context, it does not establish a useful framework. Correspondingly, these factors were based in knowledge, but it was too simple to conclude that is *all* they were. According to carnivore management scholars, one must look to more than a knowledge landscape to successfully navigate the conflict a carnivore can bring to a human landscape, as various socio-cultural practices, beliefs, relationships, histories, and values need to be considered to understand carnivore tolerance within a community (Sjölander-

Lindqvist, Johansson & Sandström, 2015). For example, Western et al., (2019) were interested in human-lion coexistence within rural areas of Kenya, Zimbabwe, and Tanzania. They found that an individual's desire to see current lion populations maintained or increased was highly site specific. In many cases the unique political situation in a certain area caused a lack of trust, communication, and leadership that led to an overall low predator tolerance. The long-term coexistence of lions and humans was confounded by pre-existing cultural beliefs or a general distrust of government and therefore conservation programming (2019).

The inconsistencies in the literature illuminated the complexities of human-carnivore coexistence. Choosing knowledge as the initial outcome of education strategies for carnivore reintroduction projects will not necessarily lead to better attitudes and behavior. To avoid the chance of something going poorly, the literature called for a different framework one beyond the KAB model to address the inherent complexities in carnivore conservation projects. RQ1 and RQ2 further illuminated the limitations of using the KAB framework in this context and argued to replace it with a framework more specific to carnivore management. This offered a concrete solution that might need further study yet nevertheless gives a pedagogical groundwork from which the field can grow.

The CGBRU

The point of the CGBRU was not to convince young Californians to blindly support grizzly reintroduction in the future but to help them use scientific techniques to come to their own rationale and informed decision—much how carnivore managers and conservationists work in the real world. When educational design takes on this type of framework that goes beyond the simplistic KAB framework and looks at the concepts

116

specific to carnivore management (5CCCs), it might encourage students to: 1. *Trust* the wildlife management team because they have gained first-hand experience of what might take place; 2. Learn about and articulate the various voices *representative* to the project; 3. Grasp the different *knowledge spheres* involved and reiterate them (be they traditional, cultural, historical, informal, indigenous, scientific, etc.), as well as show them the various knowledge pathways they can take to participate in a growing and important field; 4. *Communicate* the benefits and drawbacks of grizzly reintroduction to their family and friends as well as the most up-to-date research or evidence from the conservation scientists; 5. Take on *leadership* roles as non-elected citizens because they are involved in the project, understand it, and feel as if their voice could be lifted to assist their community. Sjölander-Lindqvist, Johansson and Sandström's framework for carnivore coexistence (2015) is difficult to implement in society at large, but all these themes can be addressed in a school setting as a framework in curricular design. My study showed how to do this so that others looking to adjust curricular design for reintroduction projects will have a framework that acknowledges the natural complexities that KAB does not.

Creating a landscape of coexistence is exceedingly complex but by looking at conservation at site specific communities with a contextualized lens gives CE the greatest likelihood of success. Schools offer excellent insight into community context. Where this framework seems most feasible is in a controlled environment of a school or classroom setting, where human-wildlife conflict can be safely discussed amongst students and others in a school community. One way to do that is to take the 5CCCs into consideration in curriculum design for areas that need CE surrounding large and possibly dangerous

animals—educators can look at the concepts as learning outcomes, or designing units to address these concepts as themes, topics, or goals.

This study does not mean to condemn the KAB model but rather shed light on how the condition of K needs to be more nuanced and rigorous. It is not to say knowledge ought to be minimized, the opposite is true. Rather, the assumption that K can always lead to A is not helpful for a conservation education framework. KAB as a complete framework is less effective and less appropriate in a conservation education context and especially in pedagogies surrounding wildlife reintroduction. Focusing on enhancing knowledge for knowledge's sake is an incomplete manner of looking at conservation education outcomes and is too simplistic to address the emotional, political, and cultural complexities inherent in reintroduction, while the 5CCCs can more specifically address the needs of students, teachers, and students' families in reintroduction zones as well as contribute to conservation goals.

Both frameworks function for different reasons. The KAB model works well for environmental education units that hope to teach students something so to encourage a simple behavior. KAB works well in an environmental education unit where the learning outcome is concrete and is associated with a simple behavioral outcome. For instance, teaching students to turn the lights off in the room as they leave to save energy is a learning outcome that can be well met by using the KAB framework. A student can realize the environmental problem of wasting energy and as a result the student will likely shift their attitude and start to turn the lights off when they leave a room. The pedagogical equation is simple: it not only saves money but can help save energy, which helps save the planet. In this example, learning about the problem and solution

(knowledge), can shift a person's opinion about it (attitude), which can reinforce an action that changed, namely, to shut the lights off when they leave a room (behavior). Pushing an environmental agenda is effective for various forms of environmental education but not in the case of large carnivore or keystone reintroduction. However, looking for a behavioral outcome, as one might in the typical KAB model, is insufficient when the learning objective is carnivore tolerance, or abstaining from hunting, or voting for reintroduction—the ERB might not be as clear cut. The KAB model is limited because increased knowledge does not always lead to a desirable behavior that are in line with management goals (Glikman et al., 2012; Kamil et al., 2019; Løe & Røskaft 2004; Marker et al., 2003), and pushing an agenda for the support of something so complex as large carnivore reintroduction may erode trust and have the opposite results desired. Pushing a certain behavior does not properly prepare a population to deal with a complex environment problem.

Implications and the future of conservation education

I encourage conservationists to find value in working alongside educators to enhance their program goals. Utilizing a framework that seeks learning outcomes based in Trust, Representation, Knowledge Spheres, Communication, and Leadership might be a middle ground where conservation managers and educators can speak the same language and create successful pedagogy that assists in grizzly, carnivore, or keystone reintroductions in general. Conservation managers of large charismatic carnivores such as the grizzly bear, wolf, puma, lion, etc. should not make a superficial recommendation for education without understanding how or what to recommend. Now there is something concrete and specific to suggest.

119

In addition to supporting learning outcomes amongst students, using this pedagogical framework can solve issues in the community as well. For instance, farmers and hunters sometimes feel excluded from conservation management decisions, which give them a feeling of distrust towards conservation projects (Sjölander-Lindqvist, Johansson and Sandström, 2015). Emphasizing farmers and hunters as stakeholders in grizzly reintroduction encouraged students to explore and talk about farmer and rancher perspectives, which might increase feelings of trust, leadership, knowledge spheres, communication, and representation. This type of pedagogical model could mollify those who are against the reintroduction of grizzly bears to California for unfounded reasons and might be helpful with other keystone or carnivore programs.

Furthermore, encouraging students to investigate myriad perspectives on complex issues to articulate their own thoughts on an issue requires critical thinking. This practice of thinking critically about a practical problem is relevant to students even outside of reintroduction zones as it helps teach students about strategizing to solve a future crowded with inherently complex environmental problems, such as the eradication of species and the benefits and drawbacks to species reintroduction with a more interdisciplinary approach. This same model can be used for other carnivore reintroduction or management projects to inspire students in reintroduction zones and beyond to become articulate on the issues from varied perspectives and engage in the inevitable and necessary dialectic inherent to carnivore management. Increasing critical thinking in science classrooms by borrowing themes from carnivore management prepares future California for something as dramatic as grizzly reintroduction, while pushing an agenda for kids to blindly support reintroduction or to exhibit a desired

behavior does not. The CGBRU evolved as the project did—since data analysis the CGBRU has been altered to include the teachers' inputs and suggestions found in teacher journals and has been made available for free on the California Grizzly Research Network website (calgrizzly.com).

Further Study Needed

Regretfully, my research process was deeply impacted and considerably weakened by the Covid-19 pandemic. I hope that research like the kind I originally set out to conduct is considered in the future. A study that can bring researchers into the community to work alongside teachers to gain in-depth ethnographic insight would be very informative. Alongside classroom visits, rigorous pre/post measures for students with larger sample sizes (as originally planned) is also very desirable. Further assessment of science-based units surrounding carnivore reintroductions ought to be made as well. If possible, conservation educators working on current or long-term keystone reintroduction projects or even carnivore tolerance programs ought to investigate the effects the 5CCCs has on both learning outcomes as well as management goals. Further coding analysis using the 5CCCs as learning outcomes in carnivore conservation projects ought to be investigated as well. Conservationists and educators are encouraged to experiment with these concepts further in zones experiencing predator-human conflict.

Investigating how schools can be involved in reintroduction projects involving large and possibly dangerous animals, the 5CCCs can be utilized to code teacher, family, or student suggestions to uncover ideas that involve all five concepts (as seen in Table 7). This mechanism might be useful in narrowing down what ideas should or should not be used. Further assessment of this methodology would also be helpful.

Table 7 also shed light on the way identity can be discussed in a STEM context—many of the best suggestions that satisfied all 5 of the 5CCCs illuminated how students think of themselves as scientists or how students identify as being able to conduct science or be a part of a scientific project such as the reintroduction of brown bears. This discussion can further complexify and contextualize the importance of thinking and navigating complex topics in conservation education, as it has shown to do in science education research. I think this topic of identity would be helpful and ought to be explored in the future research surrounding conservation education.

Finally, I find a problem with the KAB model is that it does not end with an ecological metric. Its problematic to end with behavior because its anthropocentric. To end after B, implies that conservation's goal is contained within the realm of human behavior. It does not necessarily imply ecological health. One can assume ERB (environmentally responsible behavior) leads to ecological health but without testing or looking into it as an imperative it cannot be a certainty. Missing from the field is the discussion of whether ERB connects to tangible ecological results. While my study does not attempt to include an ecological metric, I think it can push the field to strive for a more balanced and interdisciplinary approach that might allow future research to investigate how using the 5CCCs in pedagogy can allow an ecological measurement component. Anthropocentrism is natural but illogical because it hinders human survival. It is better to think about the ecological systems as intertwined and co-arising with human systems. When Orr (1992) spoke about a student's ability to say, 'what then?' he was talking about the health of nature and a restoration of ecological balance—something sorely missing from EE practice and research. By focusing on management goals in

pedagogy as a framework for the educators, the focus shifts from behavior of humans to a

more encompassing effect on human-wildlife coexistence, which might make the

ecological component measurable within the scope of conservation education research.

References

Aguayo, C., & Eames, C. (2017). Using mobile learning in free-choice educational
　　settings to enhance ecological literacy. *Teachers and Curriculum*, *17*(2), 7-14.

Berkes, F. (2004). Rethinking community-based conservation. *Conservation
　　Biology*, *18*(3), 621-630.

Braschler, B., Mahood, K., Karenyi, N., Gaston, K. J., & Chown, S. L. (2010). Realizing
　　a synergy between research and education: How participation in ant monitoring helps
　　raise biodiversity awareness in a resource-poor country. *Journal of Insect
　　Conservation*, *14*(1), 19-30.

Brennan, A. (1994). Environmental literacy and educational ideal. *Environmental Values*,
　　April, 3-16.

Brosius, J. P., & Russell, D. (2003). Conservation from above: An anthropological
　　perspective on transboundary protected areas and ecoregional planning. *Journal of
　　Sustainable Forestry*, *17*(1), 39-66.

Bogner, F. X. (1998). The influence of short-term outdoor ecology education on long-term
　　variables of environmental perspective. *The Journal of Environmental Education*,
　　29(4), 17-29.

Büssing, A. G., Schleper, M., & Menzel, S. (2019). Do pre-service teachers dance with
　　wolves? Subject-specific teacher professional development in a recent biodiversity
　　conservation issue. *Sustainability*, *11*(1), pp. 1-24.

Can, Ö. E., D'Cruze, N., Garshelis, D. L., Beecham, J., & Macdonald, D. W. (2014). Resolving human-bear conflict: A global survey of countries, experts, and key factors. *Conservation Letters*, *7*(6), 501-513.

Chalmin-Pui, L. S., & Perkins, R. (2017). How do visitors relate to biodiversity conservation? An analysis of London Zoo's 'BUGS' exhibit. *Environmental Education Research*, *23*(10), 1462-1475.

Chandra, D. V. (2014). Re-examining the importance of indigenous perspectives in the western environmental education for sustainability: "From tribal to mainstream education". *Journal of Teacher Education for Sustainability*, *16*(1), 117-127.

Chawla, L., & Cushing, D. F. (2007). Education for strategic environmental behavior. *Environmental Education Research*, *13*(4), 437-452.

Cole, A. G. (2007). Expanding the field: Revisiting environmental education principles through multidisciplinary frameworks. *The Journal of Environmental Education*, *38*(2), 35-45.

Cutter-Mackenzie, A., & Smith, R. (2003). Ecological literacy: The 'missing paradigm' in environmental education (part one). *Environmental Education Research*, *9*(4), 497-524.

D'Amato, L. G., & Krasny, M. E. (2011). Outdoor adventure education: Applying transformative learning theory to understanding instrumental learning and personal growth in environmental education. *The Journal of Environmental Education*, *42*(4), 237-254.

Decker, D. J., Riley, S. J., & Siemer, W. F. (Eds.). (2012). *Human dimensions of wildlife management*. Johns Hopkins University Press.

Dieser, O., & Bogner, F. X. (2019). Intervention impact on young students' associations

    about wolf and lynx. *Society & Animals*, *27*(5-6), 544-574.

Emerson, R. M., Fretz, R. I., & Shaw, L. L. (1995). *Writing ethnographic fieldnotes*.

    University of Chicago Press.

Espinosa, S., & Jacobson, S. K. (2012). Human-wildlife conflict and environmental

    education: Evaluating a community program to protect the Andean bear in

    Ecuador. *The Journal of Environmental Education*, *43*(1), 55-65.

Estes, J. A., Terborgh, J., Brashares, J. S., Power, M. E., Berger, J., Bond, W. J., Marquis,

    R. J., Oksanen, L., Oksanen T., Paine R.T., Pikitch E.K., Ripple W.J., Sandin S.A.,

    Scheffer, M., Schoener T.W., Shurin, J.B., Sinclair, A.R.E., Soule`, M.A.,

    Virtanen, R., & Wardle, D.A. (2011). Trophic downgrading of planet Earth.

    Science, 333(6040), 301-306.

George, A. L., & Sandhaus, E. A. (2016). 14. Outreach and environmental education for

    reintroduction programs. Millspaugh, J.J, Angermeier, P.L., Slotow, R. (Eds.)

    In *Reintroduction of fish and wildlife populations* (pp. 341-366). University of

    California Press.

Giannetta, C. (2018). Increasing the effectiveness of conservation messaging by drawing

    connections with related political, social, and economic issues. *Applied*

    Environmental Education & Communication, *17*(3), 239-253.

Glikman, J. A., Vaske, J. J., Bath, A. J., Ciucci, P., & Boitani, L. (2012). Residents'

    support for wolf and bear conservation: The moderating influence of

    knowledge. *European Journal of Wildlife Research*, *58*(1), 295-302.

Gore, M.L. (2004) *Comparison of interventions programs designed to reduce human-bear conflict: A review of literature*. Department of Natural Resources, Cornell University, HDRU Series No. 04-4, https://ecommons.cornell.edu/bitstream/handle/1813/40392/HDRUReport04-4.pdf?sequence=1

Greenwald, Noah. (June 18, 2014) Sent to the Honorable Sally Jewell Secretary of the Department of the Interior. "Petition to the U.S. Department of Interior and U.S. Fish and Wildlife Service, for Development of a Recovery Plan for the Grizzly Bear (*Ursus arctos horribilis*) across its Native Range in the Conterminous United States." https://www.biologicaldiversity.org/species/mammals/grizzly_bear/pdfs/Grizzly_Recovery_Plan_Petition_.pdf

Grúňová, M., Brandlová, K., Svitálek, J., & Hejcmanová, P. (2017). Environmental education supports conservation action by increasing the immediate and long-term environmental knowledge of children in west Africa. *Applied Environmental Education & Communication*, *16*(1), 3-16.

Hassan, R., Yahya, N. K., Ong, L. M., Kheng, L. K., Abidin, Z. Z., Ayob, A., & Jainal, A. M. (2017). Public awareness program and development of education toolkit for green sea turtle conservation in Sarawak, Malaysia. *International Journal of Environmental and Science Education*, *12*(3), 463-474.

Heimlich, J. E., & Ardoin, N. M. (2008). Understanding behavior to understand behavior change: A literature review. *Environmental Education Research*, *14*(3), 215-237.

Hines, J. M., Hungerford, H. R., & Tomera, A. N. (1987). Analysis and synthesis of

    research on responsible environmental behavior: A meta-analysis. *The Journal of*

    Environmental Education, *18*(2), 1-8.

Hiroyasu, E. H., Miljanich, C. P., & Anderson, S. E. (2019). Drivers of support: The case

    of species reintroductions with an ill-informed public. *Human Dimensions of*

    Wildlife, *24*(5), 401-417.

Hungerford, H. R., & Volk, T. L. (1990). Changing learner behavior through

    environmental education. *The Journal of Environmental Education*, *21*(3), 8-21.

Jacobson, S., Mcduff, M., & Monroe, M. (2006). *Conservation education and outreach*

    techniques. Oxford University Press.

Jensen, B. B. (2002). Knowledge, action and pro-environmental behaviour. *Environmental*

    Education Research, *8*(3), 325-334.

Kamil, P. I., Susianto, H., Purwandana, D., & Ariefiandy, A. (2019). Anthropomorphic

    and factual approaches in Komodo dragon conservation awareness program for

    elementary school students: Initial study. *Applied Environmental Education &*

    Communication, *19*(3), 225-237.

Kinslow, A. T., Sadler, T. D., & Nguyen, H. T. (2019). Socio-scientific reasoning and

    environmental literacy in a field-based ecology class. *Environmental Education*

    Research, *25*(3), 388-410.

Kollmuss, A., & Agyeman, J. (2002). Mind the gap: Why do people act environmentally

    and what are the barriers to pro-environmental behavior?. *Environmental*

    Education Research, *8*(3), 239-260.

Kraus, S. J. (1995). Attitudes and the prediction of behavior: A meta-analysis of the empirical literature. *Personality and Social Psychology Bulletin*, *21*(1), 58-75.

Kruse, C. K., & Card, J. A. (2004). Effects of a conservation education camp program on campers' self-reported knowledge, attitude, and behavior. *The Journal of Environmental Education*, *35*(4), 33-45.

Lawton, J. H. (1994). What do species do in ecosystems? *Oikos*, *71*(3), 367-374.

Löe, J., & Röskaft, E. (2004). Large carnivores and human safety: A review. *AMBIO: A Journal of the Human Environment*, *33*(6), 283-288.

Louv, R. (2008). *Last child in the woods: Saving our children from nature-deficit disorder*. Algonquin books.

Marcinkowski, T., & Reid, A. (2019). Reviews of research on the attitude–behavior relationship and their implications for future environmental education research. *Environmental Education Research*, *25*(4), 459-471.

Marker, L. L., Mills, M. G. L., & Macdonald, D. W. (2003). Factors influencing perceptions of conflict and tolerance toward cheetahs on Namibian farmlands. *Conservation Biology*, *17*(5), 1290-1298.

Mascia, M. B., Brosius, J. P., Dobson, T. A., Forbes, B. C., Horowitz, L., McKean, M. A., & Turner, N. J. (2003). Conservation and the social sciences. *Conservation Biology*, *17*(3), 649-650.

Mertens, D. M., & Wilson, A. T. (2018). *Program evaluation theory and practice*. Guilford Publications.

Mifsud, M., & Verret, M. (2015). Perceptions of the Maltese public towards local marine protected areas. *Journal of Teacher Education for Sustainability*, *17*(1), 48-57.

Mobley, C., Vagias, W. M., & DeWard, S. L. (2010). Exploring additional determinants of environmentally responsible behavior: The influence of environmental literature and environmental attitudes. *Environment and Behavior*, *42*(4), 420-447.

Moschkovich, J. N., & Brenner, M. E. (2000). Integrating a naturalistic paradigm into research on mathematics and science cognition and learning. Kelly, A.E., Lesh, R.A., (Eds.) *Handbook of research design in mathematics and science education* (pp. 457-486). Lawrence Erlbaum Associates.

National Research Council. (2013). *Next generation science standards: For states, by states.* The National Academies Press.

Nisbet, E. K., Zelenski, J. M., & Murphy, S. A. (2011). Happiness is in our nature: Exploring nature relatedness as a contributor to subjective well-being. *Journal of Happiness Studies*, *12*(2), 303-322.

Oražem, V., & Tomažič, I. (2018). The vocational upper secondary schools students' knowledge and their attitudes toward wolves. *Journal of Baltic Science Education*, *17*(6), 918-934.

Oražem, V., Tomažič, I., Kos, I., Nagode, D., & Randler, C. (2019). Wolves' conservation through educational workshops: Which method works best? *Sustainability*, *11*(4), 1124-1141.

Oražem, V., Smolej, T., & Tomažič, I. (2021). Students' attitudes to and knowledge of brown bears (Ursus arctos L.): Can more knowledge reduce fear and assist in conservation efforts? *Animals*, *11*(7), 1958-1976.

Orr, D. W. (1992). *Ecological literacy: Education and the transition to a postmodern world*. SUNY.

Rickinson, M. (2001). Learners and learning in environmental education: A critical review of the evidence. *Environmental Education Research*, *7*(3), 207-320.

Ripple, W. J., Estes, J. A., Beschta, R. L., Wilmers, C. C., Ritchie, E. G., Hebblewhite, M., ... & Schmitz, O. J. (2014). Status and ecological effects of the world's largest carnivores. *Science*, *343*(6167), 151-163.

Roberts, K., & Kruse, J. (2019). Repairing the relationship between students and nature. *The Clearing House: A Journal of Educational Strategies, Issues and Ideas*, *92*(1-2), 23-27.

Saltan, F., & Divarci, O. F. (2017). Using blogs to improve elementary school students' environmental literacy in science class. *European Journal of Educational Research*, *6*(3), 347-355.

Seddon, P. J., & Armstrong, D. P. (2016). 2. Reintroduction and other conservation translocations: History and future developments. Millspaugh, J.J, Angermeier, P.L., Slotow, R. (Eds.) In *Reintroduction of fish and wildlife populations* (pp. 7-28). University of California Press.

Seddon, P. J., & van Heezik, Y. (2013) 10. Reintroductions to "Ratchet Up" public perceptions of biodiversity: reversing the extinction of experience through animal restorations. Bekoff (Ed.). In *Ignoring nature no more* (pp. 137-152). University of Chicago Press.

Shrigley, R. L. (1983). The Attitude concept and science teaching. *Science education*, *67*(4), 425-42.

Shulsky, D. D., Baker, S. F., Chvala, T., & Willis, J. M. (2017). Cultivating layered literacies: Developing the global child to become tomorrow's global citizen.

International Journal of Development Education and Global Learning, *9*(1), 49-63.

Sjölander-Lindqvist, A., Johansson, M., & Sandström, C. (2015). Individual and collective responses to large carnivore management: The roles of trust, representation, knowledge spheres, communication, and leadership. *Wildlife Biology*, *21*(3), 175-186.

Stankey, G. H., & McCool, S. F. (2004). Social sciences and natural resources management: An assessment of advances. Mafredo, M.J., Vaske, J. J., (Eds.) In *Society and Natural Resources: A Summary of Knowledge*, pp. 21-34.

Thomas, R. E., Teel, T., Bruyere, B., & Laurence, S. (2019). Metrics and outcomes of conservation education: A quarter century of lessons learned. *Environmental Education Research*, 25(2), 172-192.

Tomažič, I. (2008). The influence of direct experience on students' attitudes to, and knowledge about amphibians. *Acta Biologica Slovenica*, *51*(1), 39-49.

Treves, A., Wallace, R. B., Naughton-Treves, L., & Morales, A. (2006). Co-managing human–wildlife conflicts: A review. *Human Dimensions of Wildlife*, *11*(6), 383-396.

Ulug, M., Ozden, M. S., & Eryilmaz, A. (2011). The effects of teachers' attitudes on students' personality and performance. *Procedia-Social and Behavioral Sciences*, *30*(1), 738-742.

Wallace, D. S., Paulson, R. M., Lord, C. G., & Bond Jr, C. F. (2005). Which behaviors do attitudes predict? Meta-analyzing the effects of social pressure and perceived difficulty. *Review of General Psychology*, *9*(3), 214-227.

Western, G., Macdonald, D. W., Loveridge, A. J., & Dickman, A. J. (2019). Creating

    landscapes of coexistence. *Conservation & Society*, *17*(2), 204-217.

Zelezny, L. C. (1999). Educational interventions that improve environmental behaviors: A

    meta-analysis. *The Journal of Environmental Education*, *31*(1), 5-14.

Appendices

Appendix A: Teacher Interview Protocol

Pre-Interview:
  Thank you so much for meeting with me today. As I have explained previously, I am interested in the role schools can play in wildlife conservation efforts. Wildlife conservation can take on a lot of different forms, but lately folks have been talking about reintroducing species that used to be here. Large carnivores like grizzly bears have been one target for this, because they are ecologically important, and a unique and symbolic species in the state. But the success of programs like this can be really challenging, and has everything to do with local attitudes and education. So, today, I'm going to ask a bit about you but mainly about reintroducing large carnivores, specifically grizzly bears to your area and the manner in which you as a teacher, your school, and/or your students might become involved.

1) Remind me again what you teach … what would you say brought you to this school

   to teach _____?

a) And what is it you like about living in this area specifically?

2) Do you use what you might consider environmental education in your classroom? If

   so, please describe.

3) In what ways do you consider your school a place where the community gathers to

   solve local problems?

a) Do you have an example of this occurring?

4) What are any wildlife conservation projects you have been involved with?

a) (If they seem to know about conservation) … How does your conservation experience

   play out in your classroom?

b) What do you think about the relationship between local conservation and bigger state

   efforts like reintroduction?

5) Describe any benefits or drawbacks you see to teachers collaborating with scientists

   who are involved in local conservation efforts.

6) What kind of large carnivores (a predator that preys on other mammals and is at the   top of the food chain) live nearby that you know of?

a) What are your thoughts on their role in local ecosystems?

b) Have you or do you know of anyone who has encountered a large carnivore? Or have you heard stories like this?

c) How would you feel about encountering one?

d) Some say the ecological benefits of having these large carnivores nearby outweigh the danger of an encounter, what are you thoughts on this idea? Do you tend to agree or not? Why?

7) Please share any of your thoughts on human and large carnivore co-existence.

8) What do you think about grizzly bears, in general?

a) How do you think about them differently from black bears?

9) Have you heard any talk about reintroducing grizzly bears in your community? If so, what have you heard?

10) If Grizzly Bears were to be reintroduced to your area, do you think your school should be involved? If yes, how? If no, why not?

11) If there was a vote about whether to reintroduce the grizzly bear to your area what information or involvement would you need to make an informed decision? What questions would you ask? What would your vote be and why, if you do not mind sharing. Is there anything that would change your mind?

12) How do you think your school could impact the success of a grizzly reintroduction project?

13) Is there any other information or opinions you'd like to share regarding the reintroduction of grizzly bears?

Post-Interview:

Hi Again. Since we last talked you have been introduced to the idea of grizzly bear re-introduction, learned about how to talk about this topic with your students and have also been given the chance to watch your students contemplate and vote on whether grizzly bears should be reintroduced or not. In what ways, would you say, your *knowledge* surrounding grizzly bears has changed since we first met?

1) If your *attitudes* towards grizzly bears changed since we first spoke, can you describe how they have changed, if at all?

2) In what ways, if any, would you say your *behavior* around animals, wildlife, or nature has changed since we first spoke?

3) What level of control do you believe people should have over wildlife populations?

4) Should animals receive the same kind of protection or justice that people do?

5) What are your thoughts on the grizzly reintroduction lessons? For instance…

a) How informative were they?

b) Was the information relevant?

c) Do you think the lessons had a potential to change the students' attitudes? Values? Behaviors?

6) Please share your current thoughts on human and large carnivore co-existence. Have they changed since the first time we spoke? Describe.

7) Do you think grizzly bears should be reintroduced to CA? Has this opinion changed? If yes, do you think they should be reintroduced to your region?

8) Whether you prefer it or not, if Grizzly Bears were to be reintroduced, how do you think your school (teachers, students, school community, and programs) could involve itself in that reintroduction?

a) In what way could your school be involved more generally?

b) In what way might the actions of your school have impact on the success and survival of the reintroduced bears?

9) What changes would you like to see to the curriculum with respect to how it might shape student attitudes, behaviors, or values surrounding reintroduction?

Appendix B Student Survey

Pre-Survey

Do you give your assent for researchers of this study to use this data for the purpose of research and possibly publication? Your identity will remain anonymous and you can remove yourself from the study at any time. If you change your mind it will not affect your grade in any way. You must give your assent to continue with the survey. Do you give your assent?
Yes
No

Have you taken an environmental education class, course, or workshop previously?
If Yes, please describe
No

Have you ever been to an outdoor summer camp or gone on a trip where you lived close to nature for a week or longer?
Yes
No

On the following scale please indicate how often environmental issues (like climate change, plastics in the oceans, endangered wildlife, and etc.) are discussed in your household? (0 = not at all; 10 = constantly)

On the following scale please indicate your level of concern for environmental issues. (0= not at all concerned 10 = it is my biggest concern)

On the following scale please indicate your level of concern for local wildlife issues (local endangered species, local wildlife conservation projects, etc.).
(0= not at all concerned 10 = it is my biggest concern)

Is an adult mountain lion larger, smaller or about the same as an adult bobcat?
Larger
Smaller
About the same
I don't know

Have you ever encountered a mountain lion in the areas around your school?
Yes
No

Which of the following animals are extinct in California? (pick all that apply)
California Condor
California Spotted Sea Turtle
Black Bear
California Grizzly Bear

Which of these four images is a grizzly bear?

List all the types of large carnivores (a predator that preys on other mammals and is at the top of the food chain) you know to exist in the wild areas around your school.
On the scale indicate how fearful you are of nature.(0 = not at all afraid; 10 = terrified)

How would you rate your family's opinion of large carnivores living near your home?
(0=negative opinion, 5=neutral opinion, 10= positive opinion)

A mountain lion is spotted around your school, what is your reaction?
(pick all that apply)
Fearful- "The animal may attack me or someone I love!"
Curious- "I want to try and see the lion for myself."
Indifferent- "I don't know why people like or dislike mountain lions."

Positive- "I am so happy these amazing animals live in this region!"

How would you feel if a grizzly bear was seen in an area near your school campus? (pick all that apply)
Fearful- "The animal may attack me or someone I love!"
Curious- "I want to try and see the lion for myself."
Indifferent- "I don't know why people like or dislike mountain lions."
Positive- "I am so happy these amazing animals live in this region!"

What level of control do you believe people should have over wildlife populations?
All wildlife should be in zoos
Wildlife should be moderately controlled
Wildlife populations should only be controlled in some cases
Wildlife should never be controlled
Should animals receive the same kind of protection or justice that people do?
Always
Sometimes
Never

If you were to encounter a large carnivore such as a mountain lion on your school campus, do you feel prepared?
Yes
No

To the best of your knowledge, is your school involved in local wildlife conservation efforts?
Yes
No

The Californian Grizzly bear (the animal on the CA state flag) was driven to extinction by humans in the 1920's. There are other types of grizzly bears alive and well in places like Alaska and Montana. Do you think grizzly bears should be reintroduced (put back into the wild) to CA?
Yes
No
Why or why not?

If yes, do you think they should be reintroduced to your region?
Yes
No
Not Sure
I do not think they should be reintroduced at all

If grizzly bears were to be reintroduced, how do you think your school (teachers, students, school community, and programs) could involve itself in that reintroduction?

If grizzly bears lived in your area would you act differently when you were outdoors?
Yes
No

If you saw a grizzly bear while on a hike what would you do?

If grizzly bears were living in your area would you be interested in hunting them?
Yes
No

Is there any other information that you know or opinions you'd like to share regarding the reintroduction of grizzly bears in the area?
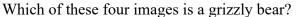
Post-Survey
Name:
Age:
Grade:
Teacher:
On the following scale please indicate your level of concern for environmental issues. (0= not at all concerned 10 = it is my biggest concern)

On the following scale please indicate your level of concern for local wildlife issues. (0= not at all concerned 10 = it is my biggest concern)

Which of these four images is a grizzly bear?

Which of the following animals are extinct in California? (pick all that apply)
California Condor
California Spotted Sea Turtle
Black Bear
California Grizzly Bear

List all the types of large carnivores you know to exist in the wild areas around your school.
On the scale indicate how fearful you are of nature. (0 = not at all afraid; 10 = terrified)

How would you quantify your family's opinion of large carnivores living near your home?
(0=negative opinion, 5=neutral opinion, 10= positive opinion)

A mountain lion is spotted around your school, what is your reaction?
(pick all that apply)
Fearful- "The animal may attack me or someone I love!"
Curious- "I want to try and see the lion for myself."
Indifferent- "I don't know why people like or dislike mountain lions."
Positive- "I am so happy these amazing animals live in this region!"

How would you feel if a grizzly bear was seen in an area near your school campus?
(pick all that apply)
Fearful- "The animal may attack me or someone I love!"
Curious- "I want to try and see the lion for myself."
Indifferent- "I don't know why people like or dislike mountain lions."
Positive- "I am so happy these amazing animals live in this region!"

What level of control do you believe people should have over wildlife populations?
All wildlife should be in zoos
Wildlife should be moderately controlled
Wildlife populations should only be controlled in some cases
Wildlife should never be controlled

Should animals receive the same kind of protection or justice that people do?
Always
Sometimes
Never

Do you think grizzly bears should be reintroduced (put back into the wild) to CA?
Yes
No

If yes, do you think they should be reintroduced to your region?
Yes
No
Not Sure
I do not think they should be reintroduced at all

If grizzly bears were to be reintroduced, how do you think your school (teachers, students, school community, and programs) could involve itself in that reintroduction?

What is your opinion of the grizzly curriculum you did in your classroom?
On the scale please indicate how interesting you thought the grizzly lessons were.
(0= completely boring 10= fascinating)
What was your least favorite part of the grizzly lessons?
Lesson 1
Lesson 2
Lesson 3
Lesson 4
Lesson 5
What was your favorite part of the grizzly lessons?
Lesson 1
Lesson 2
Lesson 3
Lesson 4
Lesson 5

Did participation in these lessons change anything about you or your family's opinions that you would like to share?

If grizzly bears lived in your area would you act differently when you were outdoors?
Yes

No

If you saw a grizzly bear while on a hike what would you do?

If grizzly bears were living in your area would you be interested in hunting them?
Yes
No

Is there any other information that you know or opinions you'd like to share regarding the reintroduction of grizzly bears in the area?

Appendix C Student Quizzes

Top of Form

Quiz 25 Grizzly Bear part 1

The respondent's email (**null**) was recorded on submission of this form.

1.Email *

2.FIRST NAME *

3.LAST NAME *

4.What animal is on the California State Flag? *

20 points

Mark only one oval.

Alaskan Grizzly Bear

Black Bear

Mammoth Bear

California Grizzly Bear

5. What best describes the California Grizzly Bear? *

20 points

Mark only one oval.

There is a large population living in California

It is Extinct, no longer living
They are protected, no hunting them.
They are endangered, a low population lives in California

6. When was the last California Grizzly bear killed? *
20 points

Mark only one oval.
2021
1849
1925
2010

7.What do Grizzly Bears mainly eat? *
20 points

Mark only one oval.
Tamales and Enchiladas
Plants and Berries
snakes and lizards

In-n-Out Cheeseburgers and chocolate shakes

8. What kind of Bears do we have in Mammoth? *
20 points

Mark only one oval.
Black Bears
Brown Bears
Grizzly Bears
Mammoth Bears

9. Can black bears have different color fur like tan, brown or grey? *
20 points

Mark only one oval.
Yes
No
10. Where do Grizzly Bears live now? *
20 points

149

(c) Tom WalkerGetty Images

Mark only one oval.
Mostly Hawaii
All over the United States
Nowhere
Small parts of Wyoming, Montana. Alaska and Canada

11. Do you think Grizzly Bears should be brought back to California? (Opinion question. No wrong answer) *
20 points

Mark only one oval.
Yes, Grizzlies should live in California
No, Grizzlies should not live in California
Maybe, I need to learn more about how they would bring them back.

12. How fast can Grizzly Bears run? *
20 points

Mark only one oval.
not very fast, they are really slow
about 100 mph
40 mph
5-15 mph

13. How much does a Grizzly weigh when they are first born? *
20 points

Mark only one oval.
40 pounds

1 pound
80 pounds
20 pounds

14. The Winter Soldier was best friends with.... *
20 points
Mark only one oval.
Iron Man
Hulk
Captain America
Spider-Man
Bottom of Form