Roles of Community and Land in STEM Education for Native American Youth

A Dissertation

Presented in Partial Fulfillment of the Requirements for

the Degree of Doctor of Philosophy

with a Major in Education

in the

College of Graduate

Studies University of

Idaho

by

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May 2017

Authorization to Submit Dissertation

This dissertation of Melinda A. Howard, submitted for the degree of Doctor of Philosophy with a Major in Education and titled "Roles of Community and Land in STEM Education for Native American Youth," has been reviewed in final form. Permission, as indicated by the signatures and dates below, is now granted to submit final copies to the College of Graduate Studies for approval.

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Abstract

In response to growing national interests to promote participation of Native Americans in STEM fields, the focus of this dissertation is to explore culturally effective means of science education for Native American youth. Provided in the context of a three-year summer STEM project conducted with tribal youth, *Back to the Earth*, themes of community and land-based science education are examined as ways of providing meaningful and authentic learning opportunities for Native youth. Specifically, this thesis reports how integrating community (natural and human) with place-specific and land-based learning opportunities into modern science education can be accomplished through honoring communal narratives and fostering community capitals that work to achieve tribal visions of stewardship and sustainability.

The concepts of land and community are examined through two studies. First, I use anti-oppressive inquiry to analyze my role as a curriculum designer, educator, and researcher during the first year of the Back to the Earth camp. Student inclusion of Bigfoot into a STEM activity provoked my recognition and appreciation of Indigenous knowledge systems, the role of communal narrative in Indigenous education, and the importance of displacing cognitive imperialism. Second, an exploration of youth science attitudes and aspirations resulting from activities with tribal Natural Resources scientists provides evidence that youth gain science-related social and cultural capital from these encounters. With many youth desiring to protect the land for the benefit of the community, some through careers with Natural Resources, these findings reinforce tribal educational goals of encouraging scholarship, membership, stewardship, and guardianship of its youth.

These studies add to the body of knowledge related to Indigenous science education by providing alternatives to the cognitive imperialism of mainstream Western education. Indigenous knowledge systems can be privileged in science education by honoring the role of natural and human communities in a land-centered approach. Including such approaches in science education could result in opportunities that increase Native American participation in STEM.

Acknowledgements

Throughout my doctoral journey, I have been truly graced with outstanding individuals who have given their time, knowledge, and patience to guide and support me. First and foremost, my wonderful advisor, Dr. Anne Kern has optimistically believed in my abilities and been my best academic cheerleader and advocate. Anne, I have always appreciated how you made time to discuss my challenges and celebrate my successes, provide excellent feedback and advice, and continually support me to grow as a scholar. I'm so lucky to have you as a mentor, colleague, and friend! My fabulous committee members, Dr. Georgia Johnson, Dr. Fritz Fiedler, and Dr. Cynthia Annett have been amazing resources and confidants. You have each offered unique perspectives, counsel, and guidance throughout the process and I am grateful for not only your mentorship, but also your friendship.

I would also like to thank my colleagues and friends from the BTTE project who have generously shared their beautiful places, stories, knowledge, feedback, encouragement and kindness: Melodi Wynn and Ernie Rasmussen--you two have been such an amazing support to me! I don't know how to begin to show my gratitude and appreciation!--Nora Cornelius, Warren Seyler, Amy Rasmussen, Lisa Seyler, Francis Carson, Casey Flanagan, Brian Crossley, Caj Matheson, Bobbie White, LoVina Louie, Dr. Chris Meyer, Laura Laumatia, Gina Baughn, Quanah Matheson, John Mahoney, Cookie Allen and the many bright and inspirational young people. You have provided me valuable lessons of humility, respect, generosity, and the power of truly listening. You have not only influenced and contributed to this dissertation, you have also influenced me to be a better person. Lémlmtš/Lim lemtsh!

Additionally, I would like to offer my gratitude to Jillian Caldwell, Aimee-Navickis-Brasch, Nate Suhr, Kathleen Torso, and Sameer Honwad for their camaraderie and collaboration throughout this process. You have been so fun to work with and I have really enjoyed your friendship. Furthermore, I am also grateful for Dr. Bryan Maughan and Dr. Kathy Haynie for helping me to better understand qualitative research and analysis while encouraging me to "lean into the discomfort." I have learned so much from you both.

Last, but not least, this couldn't have been possible without the amazing support of my accommodating and loving husband, Brent, and my family and friends. You all have been my rock, my safety net, my shoulder to cry on, my sounding board, and my push to get it done. I love you!

Dedication

I dedicate this dissertation to my dear husband, Brent, and my children Morgan, Blake and James. You have unselfishly shared me with this demanding process, and I am forever grateful for your unconditional love, support, and encouragement.

I also dedicate this work to the young people of the Spokane and Coeur d'Alene Tribal communities. I believe in you and your visions for the future!

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Chapter 1: Introduction and Rationale

The purpose of this chapter is to provide an introduction and background to science education for Native American students and a rationale for Indigenous approaches to education. This chapter will also lay out the context for research presented in this volume.

Policymakers and educators in the United States have expressed concern about the adequate preparation of today's youth for a future in STEM (science, technology, engineering and math). With respect to political and economic security, it is estimated that the 75% of the fastest growing jobs will demand STEM skills, including the analytical, problem solving, and creative processes associated with it (Hakling, 2016). Apart from the need to rely upon a specialized STEM work pipeline, society as a whole will require the "curiosity and imagination to be part of the broader STEM economy" (Office of the Chief Scientist, 2014, p. 21). However, evidence suggests high rates of failure and departure from STEM academics and careers, most prominently amongst people of color (Museus, Palmer, Davis & Maramba, 2011). Although it is apparent that STEM education for all students is urgently in need of attention, Native Americans are among the most poorly represented demographic in the STEM fields (National Science Foundation, 2013). However, Native Americans--the Indigenous peoples' of the United States and the multiple tribes that represent them--have ancient and complex STEM practices grounded in the landscapes and cycles of their Indigenous homelands. Drawing upon these practices can yield fruitful opportunities for Native American youth in STEM education and careers.

Tribes manage more than 56 million acres of reservation land and another 10 million acres of allotted land under sovereign governance and typically desire to hire their own tribal members versus non-Indigenous individuals for such purposes (BIA, 2006; Van Cooten,

2014). Furthermore, scientists and policy makers around the world have recently come to appreciate and utilize Traditional Ecological Knowledge (TEK) in environmental and conservation work (Berkes, 2012; Ens, et al., 2015; Huntington, 2000; Pandey, 2003). In this sense, Native Americans have opportunities to fill a unique niche in STEM; however, multiple factors present challenges and 'leaks' along the pipeline to these careers. Although various deficit models exist to offer explanation of what and why such challenges exist for Native students (e.g. poverty, drug and alcohol abuse, high teacher turnover, low math scores), they tend to perpetuate a colonial mindset of oppressed subalterns (or as Medin & Bang, 2014, put it, maintaining an attitude of "What's wrong with these people that makes them unable or unwilling to be scientists?" p. 10). Thus, it is important to not only focus on symptoms of poor representation, but rather on the solutions of how to restore and maintain vitality. Otherwise known as a *desire-based framework,* we can explore the "complexity, contradiction, and the self-determination of lived lives" that offer a means for providing an antidote to damage-centered research (Tuck, 2009, p. 416).

One of the reasons the dominant educational culture, particularly in STEM education, may adhere to a deficit model is it inadvertently, or in some cases overtly, espouses the norms and values already endorsed in dominant hegemony (Kincheloe & Tobin, 2009). Therefore, students who do not value the positivistic and universalistic nature of Eurocentric science tend to underperform those that do. However, Native American communities know and understand the natural world more specifically through *place* via local, holistic, communal, and land-based means (Aikenhead & Michell, 2011; Cajete, 1999; Cajete, 2000)

The focus of this dissertation is to explore culturally effective means of science education and aspiration for Native American youth. Indigenous education holistically

attends to the whole person giving respect to individuality, but also as a means to serve the greater good of the human and natural community. Of central importance to Indigenous education is a spiritual relationship with and knowledge of the land (Cajete, 1994). The land is what connects and sustains all life, therefore it provides the context for much of the lifelong education of the individual and community. With this said, it is important to note that community comprises all members who share a place and cannot be separated: human inhabitants, plants, animals, fungi, water, geological landforms are all considered members of the community (Cajete, 2015; Fixico, 2013). Therefore, learning occurs with, from, and among the community. Learning from the community often consists of direct experience; however, thousands of generations of accumulated knowledge are passed down through story, myth, ritual, ceremony, and various other teachings from elders and other community members (Cajete, 2015). Within this knowledge is a rich understanding of the natural world, its relationships, and its processes - in another word, *science* (Cajete, 2000). By recognizing, respecting, and implementing Indigenous forms of education in science education for Native American youth, students are more likely to find meaning and have greater success in their science achievements and aspirations.

Rather than expand upon deficits and underrepresentation in the STEM workforce, I seek to extract how Indigenous ways of knowing and education are foundational to an Indigenous understanding of science. For Native American students, the leaky pipeline can be argued to have started with a colonized education system where Indigenous ways of knowing were eschewed for Eurocentric ways of knowing. Although success in a globalized world will certainly require a globalized education, of which Eurocentric ideals are a component, it is irresponsible to assume that success does not also include the knowledge

systems of Indigenous students' cultures, particularly in the context of their own homelands. These knowledge systems have been generated and refined according to the rhythms of their territorial homeland since time immemorial and have inherent value to its people. Therefore, an Indigenous response to the current status quo may include re-indigenizing not just *what* science, but *whose* science is to be learned throughout the education process (Medin & Bang, 2014).

Thus, the work laid out in this dissertation has been the result of three years of deep reflection on the powerful hegemony of *whose* science and *whose* knowledge is privileged in the dominant academic system as well as how scientific knowledge and applications have unique attributes within Indigenous communities that are often not addressed within the dominant education system. This starkly differs from when I began my doctoral journey, as I was entrenched in the system of Eurocentric knowledge and the discourse of the dominant. I was successful in my entire academic career because I was given a symbolic bag chock-full of skills and attributes that ensured my success in this system--elements that embodied the socio-cultural capital of the dominant, including but not limited to a middle-class upbringing, fair colored skin, a culturally-assumed gender role, an unquestioned following of the Eurocentric dogma learned in school, and with that, teachers who expected that I would succeed. I looked like the dominant, thought like the dominant, acted like the dominant, and was rewarded for being dominant. I did not know any other way. I had thought that anyone who was not as successful as myself just didn't have the same drive.

However, my doctoral education began to challenge those assumptions and opened my eyes to an awareness of power and privilege. These early lessons were hard, as I entered with bright eyes and unchecked privilege. However, as the months went by, I became more

aware of the inequities of power and privilege in the larger systems of our dominant society, specifically K-12 education, academic institutions, and bodies of government, although they exist in nearly all spaces of our society. These lessons have permeated throughout my research, with which I have attempted to reflectively and reflexively portray throughout these studies by positioning a framework of desire (Tuck, 2009). In other words, I have attempted to use research as a means to capture the desire of the two tribal communities that have participated in, collaborated with, and patiently guided a three-year National Science Foundation project called Back to the Earth.

Research Context: Back to the Earth

Each of these studies were based on a three-year National Science Foundation grant-sponsored project titled Back to the Earth (BTTE). BTTE was a community-based participatory research project involving a partnership between a land-grant University and two Plateau Tribes located in the Pacific Northwest. The project provided place-based and culturally-embedded STEM experiences, including after-school and summer camp opportunities, for youth in grades four through six between the years of 2012-2015. The communities involved with this project share a common watershed; therefore, the STEM experiences were centered upon past, present, and future tribal relationships with local water, flora, and fauna. Of particular importance was the historical tribal reliance upon salmonid species (i.e. salmon and trout) and current conservation work to restore habitat and reestablish healthy fish populations. Therefore, the camps and associated activities were themed upon various aspects of the importance that bodies of water and fish have on cultural and ecosystem health, and how our relationships with them have changed throughout time.

Participants

Because BTTE was a community-based participatory research project, all members involved with the project, including community members (e.g. elders, parents, community leaders, community scientists), youth participants, university project staff, and teachers are involved as research participants. Of special interest to the following studies, however, are the summer camp youth participants, teen mentors, and supporting community members. Youth participants were assigned to cohorts based on their year of entry into the program. For example, if a student participated in the 2013 BTTE camp, the first year offered, that student was placed in Cohort 1. Even if that student participated in the following years of camp, he or she was still considered to remain in that Cohort. A student who first entered the program in 2014 would be considered Cohort 2, and lastly a student entering in 2015 was considered Cohort 3.

These studies were informed by an Indigenous framework which includes "The 4 R's" of relationship, respect, reciprocity, and relevance (Kirkness & Barnhardt, 1991). Although the BTTE project and assumed research did not start out with an Indigenous approach, I attempt to provide useful, meaningful, and relevant findings to both tribal communities as a result of this work. In other words, I propose to use research methods that are respectful to each of the local communities participating in these studies with the tools available to me. Out of respect for the unique identities, histories, and socio-cultural dynamics of each tribal community involved in these studies, I attempt to decolonize my role in the research process by ensuring that the research will be for the benefit of Indigenizing education for each unique tribal community. Although these outcomes will be specific to

these communities, generalizable lessons will emerge that can benefit many other communities.

Studies

The following two studies comprise this dissertation:

1. *The Role of Story and Myth in Indigenous Science Education: Bigfoot in an ecological restoration plan.*
2. *Enhancing the Science Capital of Native American Youth: Affordances of outreach partnerships between Natural Resources community scientists and Native American youth.*

Overview of Chapter 2: Paper #1 - The Role of Story and Myth in Indigenous Science Education: Bigfoot in an ecological restoration plan.

This study uses anti-oppressive narrative inquiry to analyze my role as a curriculum developer, educator, and researcher of science education for Native American youth through the context of the 2013 (Year 1) Back to the Earth summer camp. Special emphasis was placed on a culminating three-dimensional modeling activity assigned to youth on the final day of camp in which participants were asked to apply scientific data to identify environmental concerns of a culturally-important creek and then addressed those concerns in designing a stream restoration plan. Of particular interest, stories involving Bigfoot were embedded in the youth's design plan. In this study, my recognition of traditional stories told through communal narrative, especially those of Bigfoot, was pivotal in understanding how multiple knowledge systems can inform applied ecological knowledge. This study sought to answer the following research questions:

- How are stories important in Indigenous education? Specifically, how did Bigfoot stories reveal learning opportunities for youth and myself?
- How was I suppressing the knowledge systems shared through story as a curriculum developer, educator, and researcher?

Study. In the summer of 2013, youth participants at the BTTE camp were assigned an activity in which they were asked to apply scientific data they had collected about a culturally-important creek to identify environmental challenges and propose solutions through a three-dimensional modeling activity. Premised on problem-based learning (Hung, Jonassen, & Liu, 2008) and place-based education (Gruenewald, 2003), students designed solutions to environmental problems (e.g. erosion, high water temperatures, low dissolved oxygen) identified in the creek they spent throughout the duration of their four-day summer camp. These solutions were demonstrated in a three-dimensional model students created with modeling clay, sticks, lichen, rocks, and other natural materials and then presented along with an oral description to members of the community.

After attempting to analyze the stream models and transcripts of student presentations with a detailed rubric that assessed the sophistication of how well problems were identified and solutions applied, I realized that the rubric was limited in its approach to only effectively assessing applications of Western science. Students had included figures representing Bigfoot in their models amongst other cultural figures (e.g. fish weirs, fish drying racks) despite only being instructed to identify problems with the creek and design solutions. However, Elders and other community members had told stories throughout the camp earlier in the week, and elements of those stories had made it into the design plans of the students.

Although I had initially thought of them as cute add-ons, I later came to realize the deeper meanings of the knowledge they represent.

Study Design. This study features a narrative of my experiences as a curriculum developer, educator, and researcher during the 2013 (Year 1) BTTE summer camp with field notes, artifacts, and documents collected during this time. Because the student stream restoration models are a central theme of this analysis, I used the physical models, transcripts of student presentations, and the initial rubric created for analysis. Furthermore, I analyzed research notes from the community meetings from Year 1 of the project through an anti-oppressive lens.

Significance and outcomes. By analyzing the power dynamics and privilege/oppression of knowledge systems in my roles during the first year of the BTTE camp, I provide a case study for the communities involved in this study, and others that have been suppressed for using their traditional ancestral knowledge, as a means for Indigenizing science education to incorporate such knowledge in their curricula. This study will also assist other researchers working with Indigenous populations to reflectively consider factors of privilege and oppression in their own work. We all have a responsibility to ensure we challenge the hegemony of the dominant systems and minimize oppression. With respect to Indigenous science education, recognizing that knowledge systems created between people and the environment they have anciently inhabited are highly valuable and deserve a place in education.

Overview of Chapter 3*:* Paper #2 - Enhancing the Science Capital of Native American Youth: Affordance of outreach partnerships between Natural Resources community scientists and Native American Youth

Many tribes desire to increase their youth's academic performance in STEM and to increase Indigenous STEM employment in their communities. The Department of Natural Resources, a leading tribal STEM employer in the tribes participating in the BTTE project, seeks to employ more tribal members for the purposes increasing economic opportunity, service to community, and sovereign land management (Meeting Notes, December 2013; January 2014). As such, each tribe is attempting to establish a "home grown" set of potential recruits. Given the camp theme of watersheds and fish, each Tribal Department of Natural Resources was heavily involved in the camp curriculum planning and implementation. Place-based activities were designed to both celebrate the land and provide an introduction to current environmental issues such as biodiversity loss, established invasive species, impaired streams, and other habitat degradation. Emphasis was also placed on the efforts used by the tribal communities to counter these challenges.

Through the direct activity design and implementation of these lessons, DNR staff developed a relationship with students by sharing their knowledge, skills, and general work-life with students. Students gained hands-on experience with local environmental concerns, scientific field practices (e.g. sampling techniques, species identification) and learned about mitigation and restoration plans. Through these experiences, students experienced "what it takes" to work in a DNR career while also gaining relevant scientific content and context. Over the course of the three-year span of summer camps, DNR staff built relationships with

youth, thus providing opportunities to increase the social and science capital to make DNR positions more accessible and attainable to the future career opportunities for students.

Archer, DeWitt, Osborne, Dillon, Willis and Wong (2015) found that students with access to high levels of science capital are more likely to achieve in school science, aspire to study science in university and science-related careers, and feel confident in a science identity. Although science capital is not seen as a specific "type" of capital, it is recognized as a collective interaction between other types of capital (e.g. social, cultural, economic) with specific application to science. In this sense, individuals or groups with access to such science capital are more likely to participate in science (Archer et al., 2015).

Although the term may be loosely defined, it can be argued to include access to informal science experiences (e.g. museums or learning centers), after-school science programs, scientific programming, science kits, or even interacting with adults supportive of science (Wong, 2015). Furthermore, access to individuals with scientific careers or education provide a form of social capital that can also elevate access to participate in science. The associated cultural capital of such individuals with "insider" knowledge of how to navigate the systems of science careers and education also increases access (Wong, 2015). Krasney, Kalbacker, Stedman and Russ (2015) propose that communities with higher access to social and capital are more likely to work toward improved environmental sustainability for the greater good of the community. In this regard, providing youth opportunities to develop social capital with environmental education could lead to more resilient social-ecological systems.

Study. With special interest in Indigenous student access to science and social capital, this study explored the affordances of DNR interactions with youth in a long-term

informal educational setting of the BTTE camps. The research questions addressing these relationships include:

- What are the affordances of community scientist (DNR) engaging in science outreach partnerships with Native American youth?
- What attributes of science capital do these interactions provide youth and how do these interactions influence science aspirations?

Study Design. Three years of field notes accumulated from youth camp activities with DNR staff informed the context of this study. Students participated in activities that included macroinvertebrate and zooplankton sampling, electrofishing, netting fish, hatchery tours, fish dissection, and stream restoration tours. To elicit ideas about how youth perceived the relationships and outcomes of those relationships, a series of focus groups were conducted with youth participants according to their cohort. Each focus group session included questions that recalled senses (i.e. smell, sound, sight, touch, taste, and heart) experienced at camp, and a photo elicitation interview (PEI) method (Epstein et al., 2006) to elicit memories of camp activities and relationships to key personnel, as well as open questions. Interviews were transcribed and open coded for emergent themes (Saldana, 2015) and then individual cases were extracted from each child's quotes and analyzed according to the following attributes of science capital: 1) Engagement in science in the BTTE camps 2) Aspirations in science 3) Evidence of science capital outside of the BTTE camps.

Significance and outcomes. Currently, each community tribal DNR offers outreach opportunities for youth in and out of school settings; however, teachers are pressured to fulfill requirements set by the standard curriculum. As a result, students might be missing out on valuable experiences that could provide them enhanced science capital relevant to their

communities and social capital to navigate potential future scientific careers within the community. Evidence supporting relationships with community scientists could provide students increased access to these opportunities.

Although this study is limited to rural tribal populations, students in any community could benefit from working with community scientists. With an unequal distribution of science and social capital amongst communities (Archer et al., 2012), ensuring equitable opportunities for all students to achieve in science should be pursued.

Furthermore, this study provides evidence that communal contributions to youth learning opportunities in science can increase science-related capital for youth by demonstrating the connection and importance of science in their community. Therefore high quality outreach efforts that engage experts with youth in accordance with engagement and aspiration in community-relevant science has far reaching implications for contributing the next generation of tribal stewards and scientists.

Overview of Chapter 4: There's a crack in everything

This chapter discusses the research/learning journey I have experienced throughout the BTTE project and how that has had an impact on how I have come to appreciate research with/in Indigenous communities. I use the metaphor of light shining through the cracks of my veneer to describe this journey. My acknowledgement and appreciation for the various "R's" in the research process and the importance of positioning self, considering decolonization, and conducting research that benefits the communities are especially emphasized. Furthermore, I discuss the common threads that tie these research stories together: community and land. Lastly, a discussion about being an ally and/or accomplice to Indigenous communities through research is also presented.

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Chapter 2: Paper #1 - The role of story and place in Indigenous science education: Bigfoot in a youth-designed ecological restoration plan

Abstract

This study explores some of the ways in which the dominant science education system in the United States suppresses Indigenous knowledge systems and privileges Western knowledge. Using anti-oppressive inquiry through critical self-reflection, this study is situated in experiences I have encountered as a non-Indigenous doctoral student, curriculum developer, educator, and budding educational researcher on a three-year STEM education project with Native youth in two tribal communities in the Pacific Northwest. I describe the cultural tensions experienced between project stakeholders in attempting to plan and implement a culturally-relevant curriculum dominated by Western STEM, and how a pivotal moment in which youth incorporated Bigfoot stories into a stream restoration activity challenged my awareness of this paradox. Therefore, Bigfoot became my teacher in provoking my recognition and appreciation of Indigenous knowledge systems, the role of communal narrative in Indigenous education, and the importance of displacing cognitive imperialism.

This study adds to the dialogue that science education must be accessible for diverse learners, including culturally-appropriate and culturally-relevant pedagogies and curriculum, by challenging the status quo of hegemonic knowledge in the dominant system. Indigenous knowledge provides place-specific and contextually meaningful insights about the natural world, which is shortchanged if not provided consideration in its role within science education. As a result, this paper provides a space to consider how acknowledging and accepting diverse knowledge systems as ways of understanding the natural world, including

those outside of the dominant system, provides a more holistic and meaningful approach to science education.

Introduction

This paper provides a critical self-reflection about how I came to understand the privileging of Western knowledge systems and suppression of Indigenous knowledge systems in the dominant education system of the United States. This reflection is situated in experiences I have encountered as a non-Indigenous doctoral student, curriculum developer, educator, and budding educational researcher on a three-year National Science Foundation-funded STEM education project with Native youth. The project was an educational initiative that partnered with two local tribal communities to provide culturally embedded STEM camps and learning opportunities for youth in each community. Using anti-oppressive inquiry (Potts and Brown, 2015), I describe how I came to experience a growing cultural understanding of science education within the two tribal communities, including an epistemological view of coming to know the natural world through story.

The mysterious creature Bigfoot is of central importance to this reflective study, as he ultimately provided for my understanding that knowledge systems are situated in specific and culturally significant context. Much like Bigfoot's concealed and enigmatic existence, these teachings were revealed to me unexpectedly through tribal stories and student representations of knowledge. These experiences brought me to realize that I was not only privileging the knowledge system of my Western dominant culture, but that I was simultaneously suppressing knowledge systems that differ from my own. In this paper, I outline how Bigfoot became my teacher in provoking my recognition and appreciation of Indigenous knowledge

systems, the role of communal narrative in Indigenous education, and the importance of displacing cognitive imperialism (Battiste, 2013).

Jo-Ann Archibald, Stó:lo scholar best known for "storywork" (2008), states that stories encourage us "to think deeply and to reflect upon our actions and reactions" (Archibald, 2001, p. 1). Although this statement speaks to Indigenous stories, such as Coyote stories or the stories in which I learned about Bigfoot, I also believe the stories we experience in our everyday lives provide an opportunity to "think deeply and reflect" upon the lessons that endure through such experiences. For this reason, I wish to share my own story of how I came to understand the cultural tensions experienced in an educational partnership formed between myself and two Indigenous communities during the planning and implementation of a series of STEM camps for Native youth, including my own contributions toward those tensions. I do this with the intent of unearthing and analyzing my "actions and reactions" toward these cultural tensions as a means of opening dialogue about our personal responsibilities to acknowledge acts of oppression. Although this story is based on my own personal experiences, it is important to note that my story is only one of many woven together. All stakeholders involved with this project have their own story to tell and I do not wish to further hegemonic dominance by positioning my voice over theirs. However, I chose to tell this story based on lessons of humility; that in order to confront and resist oppression, we must first look at ourselves. For this reason, I use Potts and Brown's (2015) anti-oppressive inquiry to explore these "actions and reactions" of my roles in the process.

According to Potts and Brown, anti-oppressive theory is a post-structural and postcolonial extension of Marxist, feminist, and critical theories. It addresses the political practices of creating knowledge and how contributions toward oppression occur through

privileging identities and/or knowledge. The theorists argue that anti-oppressive research is comprised of the following three tenets:

1. Social justice is resistance in process and outcome. In other words, efforts toward social justice are not limited to the end goal; it is always in process. We must first challenge ourselves within the greater context of the status quo by continually reflecting on our process to "transform the enterprise of teaching and learning" (hooks, 1994).
2. All knowledge is socially constructed and political. Knowledge is an epistemological product of people and their interactions, and is positioned with biases, privileges, and power relations. Thus, truth is created, and therefore multiple, rather than existing as a singular external phenomenon. Anti-oppressive inquiry does not seek truth, but rather meaning and understanding. Knowledge can be used for oppression or resistance depending on how it is constructed or utilized.
3. Research projects elicit complex power relations with those involved with the research. Knowledge is about power and relationships between "the knower and the known, groups of knowers, knowers and any outside researchers, researchers and external institutions and ideological paradigms" (p. 263). With this said, researchers and the researched must examine the power relations between them and shift power to those being researched.

Through this anti-oppressive lens, I will examine the experiences I encountered in my various roles throughout the Back to the Earth research project for meaning and understanding of the following questions:

- How are stories important in Indigenous education? Specifically, how did Bigfoot stories reveal learning opportunities for youth and myself?
- How was I suppressing the knowledge systems shared through story as a curriculum developer, educator, and researcher?

Bigfoot may be considered by some to be an outlandish and unconventional teacher of science education and anti-oppressive inquiry, however his[1] teachings were revealed to me through communal stories shared at a STEM camp for Native American youth during the summer of 2013. Tribal community members engaged the youth with stories of Bigfoot throughout the week and during various cultural and STEM activities of the camp. While I understood that the youth were entertained and captivated by these stories, I did not understand that the stories carried substantial meaning. Rather, I dismissed the stories as merely that—just stories. However, after I began to recognize the inclusion of Bigfoot in student-created physical models of a creek, and again during research analysis, I came to understand that the stories provided teachings unique to epistemology and ontology of place. As such, this paper is an analysis of how Bigfoot came to symbolically represent my recognition and respect for multiple knowledge systems in two ways: (1) stories are a vital component of Indigenous education in that they transmit layered, multi-dimensional knowledge unique to place, community, ecosystem, values, and communal and personal

[1] In this text I choose to represent Bigfoot as a singular male, because of how he was represented to me in communal stories and student representations during activities in the summer camp. It should be noted that many Indigenous stories refer to Bigfoot according to both male and female sexes, as well as in singular form or family/communal units.

identity; and (2) the dominant culture privileges Western/Eurocentric knowledge systems and modes of education while eschewing, dismissing, and/or ignoring other knowledge systems, in this case Indigenous knowledge systems, and especially those shared through stories.

Culturally-Relevant STEM Education

Educators and advocates have long demanded that STEM education (science, technology, engineering and math) must be accessible for diverse learners, including culturally-appropriate and culturally-relevant pedagogies and curriculum (Lynch, 2000). With respect to political and economic security, it is estimated that 75% of the fastest growing jobs will demand STEM skills, including the analytical, problem solving, and creative processes associated with it (Hakling, 2016). Apart from the need to rely upon a specialized STEM work pipeline, society as a whole will require the "curiosity and imagination to be part of the broader STEM economy" (Office of the Chief Scientist, 2014, p. 21). However, evidence suggests high rates of failure and departure from STEM academics and careers, most prominently amongst people of color (Museus, Palmer, Davis & Maramba, 2011). Although it is apparent that STEM education for all students is urgently in need of attention, Native Americans are among the most poorly represented demographic in the STEM fields (National Science Foundation, 2013). With respect to tribal sovereignty, this lack of representation is especially concerning as a matter of tribal political, economic, and most importantly land security. In other words, for Indigenous people this is a matter directly affecting communities: it goes beyond national political and economic concerns and impacts the wellbeing of communal life on Indigenous lands towards Tribal sovereignty, natural resource management, and stewardship. Certainly, this call for culturally-relevant education is paramount under such conditions.

However, what is more ambiguous is what culturally-relevant education looks like for Native students, particularly when embedded in mainstream education. Although a vast literature pool exists on various theoretical aspects of Indigenous education, mainstream education largely attempts to address cultural relevance for Native students by means of an "Indianized" approach (Grande 2016, p. 60). In other words, curricula typically maintains a Western dominated focus without discussion of critical theory. Instead, surface-level cultural elements are inserted in the standard curriculum with attempts to make education "relevant." Some of my Native colleagues have referred to these attempts as "slap a feather on it" curricula to emphasize how these curricula are not Indigenized but rather tokenized. With that said, the question remains in how to effectively Indigenize rather than "Indianize" education. Indigenous scholars challenge these approaches by advocating for Indigenous education to vanquish the cognitive imperialism of mainstream education (Battiste 2013) and examine knowledge-power relations (Bang, Warren, Roseberry & Medin 2013). In other words, the entire education system must address the colonial stronghold on education. As this is recognized, education can become increasingly Indigenized by opening spaces for more holistic, monist, and communal practices (Aikenhead & Mitchell, 2011) and by including story as more meaningful modes of learning (Cajete, 2015).

The cognitive imperialism of mainstream science education is rooted in European history of the Enlightenment period and the Scientific Revolution. As such, objectivism, positivism and Cartesian Dualism form the basic tenets of understanding the natural world through modern science. It is important to note that this science has been used as a force for subjugating lands and relegating its inhabitants as resources throughout periods of exploration, exploitation, and colonization (Riding-in & Weeks, 2002). Certainly, the

approaches to knowing about the natural world for many Indigenous peoples differ from that of the Western mode of inquiry. Rather than understanding the world out of domination or control, Indigenous knowledge of the natural world is land centered and inextricably tied to the interconnectedness of all of its inhabitants. Yup'ik scholar Oscar Kawagley proclaims, "It was meaningless for Yupiaq to count, measure, and weigh, for their wisdom transcended the quantification of things to recognize a qualitative level whereby the spiritual, natural, and human worlds were inextricably interconnected" (Kawagley 2010, p. 90). The point of this paper is to not explore the intricacies of such differences but instead to recognize that the settler colonialist discourse of the mainstream educational model imbues a particular approach and worldview that differs from other knowledge systems, and that this dominant system often refuses to acknowledge that such differences exist. As a result, the knowledge systems of the dominant are privileged over any other, resulting in the oppression of those who adhere to the epistemologies and ontologies of their culture.

Before my experiences with the Back to the Earth project, which I will describe in the following paragraphs, I was unaware of the privilege and dominance associated with my entrenched knowledge system. Although I may have understood that different epistemologies existed, I was not aware at how much I had personally privileged Western knowledge systems until it was challenged. The tensions of these differences will be presented in vignettes of my experiences as a Non-Indigenous settler and member of the university team working with our tribal partners throughout the curriculum planning, implementation, and research of this STEM project with Native youth in tribal communities. These vignettes, and the analysis of their meanings, will include information from meetings with community members and the core university team, meeting notes and minutes, reports and handouts,

curriculum documents developed for the summer camps, recorded video, field notes, and self reflection. These data sources are considered by myself a gift, and include the seeking, listening, and learning that accompany the process of meaning-making and understanding. It is my hope that these stories, reflections, and meaning-making will invite educators within the dominant system to engage in reflexivity with their practice by questioning their own relationship to knowledge (i.e. the privilege associated with their knowledge, how it is constructed and utilized, and the pressure to maintain its dominance) while encouraging educators outside of the dominant system to resist cognitive imperialism through foregrounding their own knowledge systems.

Vignettes

My role in curriculum development

This story is told in the context of my experiences with a three-year STEM camp called Back to the Earth (BTTE). This NSF-funded project was a partnership between two tribes in the Pacific Northwest and a local land-grant research-intensive university I attended for my doctoral education. BTTE offered informal culturally-embedded STEM learning opportunities, most notably through summer camps, for students in the 4-8th grade and camp mentors in the 9-12th grade. The overarching theme of these camps was a shared watershed between the university and the two tribal partners. Our university team comprised of non-Indigenous settler professors and graduate students trained as Western scientists, engineers, and educators. I was involved with the university team as part of my stipulation as a graduate student with this institution, bringing in my background with biology and environmental education.

Before I continue, I must tell you about myself so you can understand my position in the project and how I came to work in this setting. I grew up in a typical, mainstream suburban American family in which I always had an interest in science. I applied this passion in my educational pursuits and obtained both Bachelor and Master of Science (MS) degrees in biology. During my Masters, I worked as a field technician with a nearby tribe collecting data for a habitat restoration study during which I became aware of the sovereign management of Native lands. I completed my thesis with this tribe looking at relationships between native and invasive aquatic species. However, I also became aware that non-Native individuals like myself held most of the tribal scientific management positions. It seemed to me a great paradox that the sovereign management of Tribal lands was held by non-Tribal individuals, which led to my interest in Native peoples, or lack-thereof, working in the "scientific pipeline."

After completing my MS, I began to teach introductory science courses for non-majors at two universities in the same region. One of these jobs led to a full-time position at a Jesuit institution that included teaching a lab science to elementary education majors and coordinating a science outreach program with local elementary schools. Because of the historical underpinnings with Jesuit missionaries and Native American education, the institution continues to maintain attempted relationships with tribal communities. However, these relationships are complex and contested. From my own perspective the relationships put forth by this Jesuit University, at least in my department, seemed somewhat disjointed and not overly successful. For example, Native high school students would spend a few weeks during the summer to research alongside science faculty members. However, the topics included common Western science research topics that I would suggest are out of

touch with the student's lives (e.g. exploring the chemical composition of amphibian glandular tissue). I knew we had a few Native students on campus and they did not maintain the same retention rates as their white peers, but I was perplexed as to the reasons why. It was this observation that prompted my interest in the barriers that exist for Native students in higher education.

I chose to leave my position with the Jesuit University and reassess my future plans after welcoming a new baby and feeling that I had reached a dead-end without a Ph.D. A few months later, the Principal Investigator of the Back to the Earth grant invited me to be involved with the project as a Research Assistant in conjunction with a Ph.D. program. Given my previous, albeit limited, experience with habitat restoration on tribal land as well as my interest in science education, I agreed.

The journey with the BTTE project began in the spring of 2012 at a retreat in a tribally owned and operated casino and resort center with the core university team and stakeholders from each identified tribal community. The purpose of this retreat was to gather input and organize collaboration on a vision for the project. This retreat first opened my eyes to the road that lay ahead of me and revealed elements that suggested I would be pushed out of my comfort zone to reflect on my own privilege and experience with oppression and power. For example, the retreat began with presentations about the history of how Native lands were allocated to non-tribal members and the subsequent ramifications on the culture and wellbeing of the tribes. While the presenter was a white woman who works for one of the tribes in the BTTE program and is greatly respected, another retreat attendee later came to her to tell her about the transparent "white guilt" she emanated through the presentation.

Although I did not directly witness the conversation, I heard about it through a back-of-the-room discussion.

> *Between feelings of humor and offense, I was surprised that something that was couched in historical fact was perceived as carrying a racial guilt. Nevertheless, the memory stuck. Did it stick because I hold on to some level of white guilt myself? Or is it because I wonder if a white person can be a legitimate ally to American Indian people without being viewed as attempting to cover up or hide the sins of historical mistakes? Is this work - science education research with American Indian children - something that I can appropriately and fairly do as a white woman?*

Later in the retreat there was a planning discussion about the project and how it should be implemented in the communities. There was a heavy feeling of tension in the room, as though parties were attempting to say what they needed to, but weren't being heard. A female tribal member pulled the group together and opened up a prayer to the Four Directions to ask for guidance. She did this by singing a loud and powerful song, rotating her body with each of the Four Directions and including the sky and the earth in her movement. Her voice boomed through the room and down the halls. It wasn't just heard--it was felt.

> *As a Westerner, this was shocking. I wondered if the casino patrons playing the slot machines below our conference room could hear her and what they were thinking as her voice reverberated through the walls. I wondered how other retreat attendees perceived it as well.*

Was this normal? For me it was both awe-inspiring and awkward at the same time. I didn't quite know how to react, but I could tell it was serious so I let myself be awkwardly immersed in the moment with my full respect and attention.

As time progressed after this initial retreat, we moved into the curriculum planning by holding several meetings with tribal members invested in the project. Our partners stressed the importance of having culture be the cornerstone to all of the camp activities and themes rather than as a mere "add on." They articulated that cultural preservation was at the center of their work, and that their ancestors were people of sophisticated thought. They also informed us of many ways their ancestors used STEM throughout their seasonal cycles, one example being the design, construction, and use of fish weirs, and their desire to include that as an engineering component of the camp. Although I recognized the application of the fish weir as fitting within the scope of STEM, I recall my overall attitude toward what tribal members shared after these meetings as "They don't want a STEM camp, they want a culture camp!"

This attitude, along with a lack of understanding of knowledge systems outside of my own, led me to privilege my scientific knowledge as superior to tribal knowledge. Although I did not see tribal knowledge as invalid, I did not have enough understanding of the tribal communities or their culture to understand how it worked. I only had my own culture to compare it to. Upon reflection, I now see that I was in no position to understand how culture was to be at the center of the curriculum. I couldn't see it because I was playing on the border—but mostly staying within the comfortable confines of my own border. I only understood the science I knew as legitimate science. This was revealed during one of the

early community meetings in which I learned of two rare amphibian species in a tributary stream near one of the reservations. I had complete enthusiasm and mentioned that we needed to include a visit to this location for the purposes of comparing "pristine" habitat with "degraded" habitat. I mentioned this after one tribal member had finished explaining her community's vision for the camp that included the ecosystem dynamics of beavers and their ability to use ecological engineering to restore streams and wetland habitats. Through her body language, I could tell that I demonstrated that I was not listening or respecting her input. I dismissed her ideas and that of her community, at least outwardly, for my own. In other words, I gave my ideas power over hers. I legitimized the science I wanted to do over what her community valued. After this encounter, I learned the community was beginning to grow outwardly frustrated with us; they figured it didn't matter what input they gave because we would do whatever we wanted to anyway.

Although my experiences leading up to my participation in the BTTE project provided me the initial interest of American Indian success in STEM fields, my first encounters with our tribal partners demonstrate that I held an extremely limited understanding of Indigenous ways of knowing. Furthermore, I was unsure of my role as a white woman in a research position with Native people. As a result, I was not at a place, cognitively or emotionally, to fully comprehend the messages being conveyed by our tribal partners during the early stages of our partnership. I interpreted discussions about the summer camp curriculum as "the University team will take care of the STEM if the Tribes take care of the culture." Even after tribal partners demonstrated their expertise in STEM content as related to their community and provided many attempts to describe ways culture and STEM are intertwined, I misunderstood their dialogue as a request for a "culture camp"

disguised as a STEM camp. It was not until I was immersed in the analysis of the student data of the first summer camp that I had a personal revelation in how cultural practices embody STEM.

Our team, myself included, was driven to provide a camp experience rich in (Western) STEM content and experiences. We saw this as a fulfillment of the grant and a necessary component of a STEM camp. The first year that BTTE was implemented, 2013, was arguably the most difficult due to tensions with this vision. Although our tribal partners repeatedly attempted to express the importance of genuine cultural integration in the curriculum, warning that culture must be considered first and foremost, the university team did not seem to understand what was being conveyed.

I attribute the following three factors to this lack of understanding: 1) *Perceptions of Expertise.* Following Western social protocol, the university team identified with our professional roles and highlighted our expertise. We did not acknowledge the expertise of tribal members in the same way, and by doing so we assumed a position of power and rank. The tribal communities later stated that they did not care *what* we were, but rather *who* we were. In other words, we did not approach the partnership with an understanding of building genuine relationships with the community, but as self-appointed advisors. Our expressions of expertise needed to be humbled in favor of exposing ourselves as people who can learn from and respect one another. 2) *Grant Accountability*. The university team assumed responsibility for the accountability of the grant. We had agreed to deliver a series of STEM camps to both tribal communities with funding from NSF, thus the university team experienced tension in appeasing both the tribal partners and the grant-funder. Our Western interpretation of STEM pressured us to adhere to that responsibility by delivering the camps accordingly. 3)

Epistemological/Ontological Ignorance. The university team was so entrenched in our own culture, that it was difficult to comprehend or be open to the meaning of Indigenous culture. This factor has arguably been the most difficult to address because it cannot be didactically "taught" to outsiders like ourselves, especially in the short timeframe of a three-year grant project. Although we depended on our tribal partners to help us understand their culture and the STEM embedded within it, it is ultimately the relationships and spending time in the community that provides these opportunities to open epistemological and ontological awareness. This of course, takes time.

Because of these three factors, a very Western scientific approach was taken with the curriculum design and implementation during the early phases of the project. Despite the warnings, cultural aspects were in fact merely added on the side. For example, the entire approach of the first BTTE camp curriculum was to scientifically determine the problems associated with a culturally-significant creek: students collected data on erosion, water temperature, stream morphology, and presence of non-native species. "Cultural activities," as we initially called them, were incorporated and included building and installing a fish weir, telling stories, and going on a hike with an Elder. Although these cultural aspects were included, the university team maintained an emphasis and importance on the Western STEM. There was little integration between the activities that acknowledged or privileged Indigenous STEM or other Indigenous ways of knowing.

It could be argued that the university team attempted to create the curriculum by cherry-picking the cultural components shared by the tribal partners that seemed to fit within pre-existing ideas of what Western STEM would be included. The university team was immersed in our own understanding of the dominant system, and sorely unaware of the

worldview of our partners. Our understanding of place was one of geographical location in which humans interact with the environment. Although we attempted to adopt Gruenewald's (2003) theory of place, in which we would attend to the perceptual, sociological, ideological and ecological aspects of place, we seemed to only acknowledge that "places teach us about how the world works and how our lives fit into the spaces we occupy" (p. 621). Although Gruenewald discusses the political dimensions of place, including the impacts of colonialism and marginality, we failed to understand how these factors impact place and the people in them. Instead, we saw the curriculum as a means of using place as a context with which to do Western STEM and have it somehow be meaningful because it has been identified as culturally important. We thought youth could build perceptual dimensions by directly experiencing the place through structured activities and unstructured play, sociological dimensions by interacting with peers, community members, and the university team, ideological dimensions through "cultural activities" and studying how land use has changed over time, and finally ecological dimensions by learning about flora and fauna in the place. While these opportunities were meaningful to a certain degree, the curriculum lacked the depth that a substantive place-based curriculum is supposed to provide: an opportunity to reflect on how place impacts individuals/community and how individuals/community impact it (Bang, Curley, Kessel, Marin, Suzukovich III & Strack, 2014). As a result, the youth attending the camp went from one activity to another without having the meaning of place successfully woven within these contexts. The tribal community attempted to provide these opportunities throughout their involvement, but the university team overshadowed them by privileging the western STEM activities instead. This, of course created tensions between the university team and the tribal partners.

A pivotal moment occurred on the last day of the camp, however. Although the university team and the tribal community were at odds with the implementation of the curriculum for the reasons described above, the youth managed to weave the experiences together and open the doorway toward Indigenizing the curriculum themselves. They integrated the western STEM activities and the "cultural activities" together in their final activity in a holistic and meaningful way, of which I will now describe.

Bigfoot in STEM. On a Thursday morning in June of 2013, a group of 4th-9th graders gathered inside a cinder block building on a cool, gray, drizzly day. It was the last day of their four-day STEM summer camp, and we all had just feasted on a salmon lunch after listening to an Elder speak about the heart[2] being an important guide in the "Indian ways" of scientific understanding. Their attention was now focused on several plastic caddies holding various natural materials and shallow plastic trays filled with flattened clay. The students received instructions for a creative activity in which they were to design a restoration plan for the creek they had encountered throughout their week of camp via scientific and cultural activities. The students were to use the data they had gathered about the creek to determine the most pressing environmental challenges in and around the creek including:

- water quality analysis
- streamflow patterns and stream shape
- macroinvertebrate biological indicators
- substrate composition

[2] "Heart knowledge" is coupled with "head knowledge" in many tribal cultures (G. Johnson, personal communication, October 2015). Although head knowledge is tremendously valued, it is limited when the heart is not included. According to Archibald (2008), her Elders state "It is important to listen with three ears, the two on the side of your head and the one in your heart" (p. 8).

- electrofishing sampling of fish species inhabiting the stream.

Through this data analysis, students could address solutions to these problems by designing an environmental engineering plan that they would demonstrate in a three-dimensional physical model. The clay in the shallow trays represented the landscape surrounding the creek, while a barren straight line in the middle of the tray represented the creek. The caddies contained materials they could use in their design plan such as sticks, rocks, gravel and lichen as well as pipe cleaners and toothpicks. The students had to explain how each change was implemented in the model as if they were in the model themselves. In other words, they were not to just place rocks in the model, they had to describe how those rocks got there according to their design plan.

The kids began to mold the clay into meandering river banks, place gravel in the stream beds, line stream banks with lichen, put boulders in and around the creek, and place hay bales on empty creek banks. Chatter about fish, erosion, and dissolved oxygen took place and discussions about where to plant trees and how to keep cattle out of the stream could be heard amongst the excited exchanges. The students used their scientific knowledge of the creek's environmental concerns to propose and refine solutions through the creation of their three dimensional model of this creek.

As I moved around the room, I noticed a hominid figure made of black pipe cleaners appear in the corner of one group's model. The figure held a spear in one of its arms and a fish in the other. A fish weir stood across each bank in the creek below. A drying rack with pink pipe-cleaner fish hanging below it stood in the other corner. In another group's model, a fire pit and fish rack were twisted out of pipe cleaners and placed in the model. It too had a fish weir in the creek and a figure perched on the represented land above the creek. Although

the kids were engineering the creek to be more environmentally sound with scientific knowledge, they were also creating an ecosystem in which they were coexisting members. What I observed in that exercise was that students were apparently doing a lot more than merely objectively manipulating the environment: They were situating themselves in the place.

Throughout the week of camp, youth collected scientific data along the creek, but they also engaged with community members in traditional and cultural ways. They listened to stories about what the rivers used to be like before the hydroelectric dams were constructed, how their ancestors were River People who harvested 90-pound salmon and other aquatic species for food, how fish weirs were designed and erected in the rivers to capture and harvest fish, and about how Bigfoot would come down from higher ground to steal fish out of the weirs at night. Students would listen to these stories in the warmth and intimacy of a tipi set up near the creek, by the morning fires, or along the creek banks during activities. In addition to collecting data, the students were collecting stories and both were making their way into their design plans.

My role as a camp educator

Although the camps for each community had an overarching theme of the watershed, each community had their own sub-theme unique to their place. The methodological approach used by the university team to implement the curriculum was based on a structured version of problem-based learning. In this approach, students were tasked with identifying what factors, such as erosion or high water temperatures, were negatively impacting their streams and how they might be able to restore the streams through ecological engineering. Students were taught field skills in which they could collect data on their streams and also

met with professional scientists in the community from whom they also learned skills such as electrofishing.

The curriculum also included lessons in which tribal members taught students how to construct and install a fish weir, learn about the river by walking with an Elder, and overnight assignments to ask family members about their memories of the creek. Furthermore, students listened to stories ranging from historical narratives (e.g. how crayfish used to be caught for food, what the river was like prior to white settlement) as well as oral literature involving myth (e.g. Coyote) and tales (e.g. Bigfoot). On the last day of camp, an Elder came with a drum and talked to the children about respecting the natural world, understanding that the natural world is a teacher, and how that it is a Native form of science. As mentioned above, he coupled this with an emphasis on heart knowledge. He then taught the children about singing and drumming and we all commenced to participate in some dances.

Throughout the week, the curriculum was primarily taught by the university team, myself included. Although I had respect for the lessons taught by tribal members, I did not hold them in the same regard as the scientific curriculum we had designed. My team and I still privileged Western knowledge systems. It could be argued that the university team maintained power over the camp in how the curriculum was designed and implemented, although we thought we were honoring a partnership. In other words, we took the information that tribal members had told us in curriculum meetings and added them to the curriculum according to our own interpretation and scheduling. During the implementation, we allowed tribal members time to engage in "cultural activities." We, the university team, took it upon ourselves to provide a STEM camp as we saw fit, but merely provided the tribe some time slots to "teach the culture."

At the conclusion of the first year's camp, our tribal partners expressed concern with the way the partnership and resulting camp had unfolded. STEM content aside, they did not feel like they were equal members in the partnership, did not feel appreciated or valued, and pointed to our lack of humility. When analyzed through an anti-oppressive lens, the university team did little to challenge the status quo of science education other than attempt to "Indianize" the curriculum (Grande, 2016) rather than work with our partners to "Indigenize" it. Furthermore, our dominant presence as the university "experts" allowed us to maintain power in what knowledge, in this case Western STEM, was privileged. Although this was not done with any malicious intent, our control of how content was disseminated within the curriculum demonstrates that we made an exhibition of domination by bestowing privilege on Western STEM concepts. At this point, our guised partnership was more of a complex struggle for power.

My role as a researcher: Bigfoot in data analysis

After the 2013 summer camp had ended, I reflected on the final stream restoration activity as a tremendous feat of scientific understanding and application for the youth. Youth seemed to be able to successfully identify and apply several complex systems-level concepts with ecology and environmental engineering to identify problems within their creek (e.g. erosion, high water temperatures, high dissolved oxygen, low substrate diversity) and design solutions (e.g. erecting fencing to keep cattle from trampling creek beds, placing hay bales along creek banks, planting riparian shrubs for shade, increasing gravel spawning beds for trout). They appeared to translate data into action and problems into solutions, which was the intent of our STEM curriculum. It was now time to start looking at the data presented through the camps.

I initially looked at videos of student presentations, transcripts of the presentations, and artifacts of the student models and began to code and analyze for identification of environmental/scientific concerns and proposed solutions. I wanted to find a way to analyze the student representations of their knowledge through their model designs, and began to do so by creating a rubric. This rubric was developed to identify and quantify the level of representation in each of the following categories: identification of environmental/scientific concerns, evidence of reasonable and justifiable design solutions, and evidence of human interactions within the ecosystem (i.e. cultural representations). Ratings in the identification of scientific concern and solution ranged from zero to four, with zero indicating factors were not included or addressed in the model or data, while a rating of four indicated factors were included in the model or data along with an explanation of the problem/solution and includes a clear rationale for sources and impacts of concern. Human impact data were reported as being present or not present, with the rater being able to provide additional open-ended comments on observations.

Analysis of Student Physical Models. Members of the university project team (seven researchers, including two community liaisons, one a tribal member) rated the student physical models using the provided rubric. First they were given the rubric to analyze one model from each community. During this analysis the team was asked to pay particular attention to the following:

I. Holistic representation of the model,

II. Evidence of identification of riverine environmental concerns,

III. Evidence of engineering applications and

IV. Evidence for human interactions within the ecosystem.

After each researcher analyzed the two student models, the researchers came together to discuss their analysis and negotiate development of a final rubric. During these negotiation meetings, the main concern was in each researcher's ability to assess the most effective or assumptive criteria and "read" into the static models. While the research team felt they directly observed evidence of "Erosion control" such as planting of vegetation and ground cover on the banks of the mock creek, evidence of deliberate sites of "Food for fish or other animals" or areas of increased "Dissolved Oxygen" were more difficult to observe on the models themselves.

Even more difficult was the ability to assess the holistic representation of the models, particularly as they related to the ontological and epistemological aspects students used to inform their designs. As Western researchers, we were unable to understand the epistemological and ontological aspects that might influence youth's designs due to our own positioning, but also because we were unwilling to acknowledge that positions outside of Western STEM might influence the designs to the degree they did. We did not ask the students to consider factors beyond Western STEM in their design plans and instead only asked youth to consider the data sets from their fieldwork.

While not understood immediately, this narrow focus limited the University team's ability to recognize the holistic aspects of the students' design plans. For example, when University team adult educators interacted with youth during the building phase of their model design, they asked youth to describe the Western scientific and engineering elements of their designs. For example, adults would ask, "what did you do to address sediment?" or "why did you build a fence there?" During such questioning with one group, students explained their justification for controlling temperature and dissolved oxygen with planting

shrubs and grasses and then added, “Oh, and we made a Bigfoot!” The adult did not acknowledge that Bigfoot contributed to the design with any probing follow-up questions, but instead continued asking about problems and solutions that were instead privileged in the camp curriculum. Students were not given an opportunity to explain why Bigfoot was in their models, because it did not fit within the University team’s understanding of science. This presents problems with the data analysis since this aspect was essentially dismissed in the rubric.

Another reason for the difficulty in assessing the holistic nature of the models may be the reductionist nature of the rubric alone. We had already used it to compartmentalize aspects of the model according to the STEM categories listed. Even though the researchers may recognize the sum is greater than its parts, we were unable to categorize beyond the parts. To provide an example of this challenge, the following excerpt, a description of the model written by its student designers, is provided:

> We wanted to live in a more cultural place, so we went to explore the area we didn’t know. Then we found T. Creek. We realized it was an unhealthy habitat. We decited [sic] to live here and clean it up.
>
> We put some dirt on places were [sic] the creek was already flowing and dug some holes so the straight creek could meander. We planted trees so there wouldn’t be a lot of eroision [sic]. We had to chop some trees down to make houses so we put hay down to stop the erosion. There was still some bare dirt around the creek so we planted grass.
>
> We lifted rocks heavy as we could, we put them by the creek to make habitats for the fish. We reaslised [sic] we needed to eat, so we built a fish wear [sic] (weir). So we also built a fish hangers with fire under it. Bigfoot took the fish home and ate some. We found tracs [sic] so we built croad [sic] (crawdad) traps.

The example illustrates that the youth were modeling a direct interaction with their ecosystem in that they were inhabitants of their ecosystem. They indicate a level of dependence and consideration for the organisms in their ecosystem in addition to mere identification of problems and seeking solutions. The inclusion of cultural elements, such as

food collection and preservation, "living in a more cultural place" as well as including Bigfoot, were more difficult to assign to a rubric category.

> *I recall wondering what to do with Bigfoot. Where did he fit into the rubric? Was he considered a cultural icon, a human interaction? I certainly didn't consider him a part of STEM, so I could just plug him somewhere in the open ended culture category…but why did the youth include him? What did he have to do with stream restoration? Did the kids like the stories that much?*

Ultimately, the challenge was the rubric only allowed us to analyze the knowledge systems that our university team privileged from the project's inception--Western STEM and Western research. Additionally, the rubric itself was a Western tool designed by the university team, analyzed almost exclusively by the university team, and used to analyze the university team's effectiveness in teaching Western STEM concepts, arguably a way to pat ourselves on the back for a job well done. Potts and Brown suggest that anti-oppressive researchers ask themselves who does the analysis, what concepts frame the analysis, who benefits from the meaning making, and what analytic tools are appropriate. I think it is apparent that the university team had a heavy influence and advantage in each of these aspects of analysis and meaning making, leaving our tribal partners in the margins.

After attempting the rubric and realizing its limitations, the inclusion of Bigfoot in the models continued to haunt me more than anything else. I still wondered why the youth not only inserted him into their models, but included him as a key feature during their presentations. I could understand fish, crayfish, and even fish weirs and drying racks. Those were natural resources or tools that had direct application in harvesting and preserving those

resources. However, Bigfoot almost seemed to be a competitor—an enigmatic figure that could take those resources and leave the weir in disrepair.

At some point, I began to understand that the youth were restoring the creek with the full community in mind, not just restoring natural resources or manipulating a culturally-meaningful environment to health as we had intended them to do. Community in this case means all that are a part of the land and include the natural and human community as well as the mysterious. Aikenhead and Michell (2011) state that Indigenous people "celebrate mystery and living in harmony with the mystery in the inner and outer spaces of existence." It is considered an act of humility to acknowledge that there are many unknown mysteries about the natural world, yet remain aware that these mysteries are also part of the interconnected web. The stories about Bigfoot shared at camp acknowledged this mystery in that much is unknown about Bigfoot, but also give notice that he depends upon the same resources as humans. Bigfoot depends on the stream just as much as humans do. He is part of the community, thus part of the restoration plan.

Bigfoot stories as education

As described above, the students included Bigfoot in their models, notably the subject of some of the stories told to the campers by community members. According to the tribal stories, this creature lived (and possibly still does live) in areas of higher ground beyond the creek, had a horrible stench, and periodically raided fish out of the weirs at night. These raids would leave the weirs of the youths' Ancestors in disarray and reduce the harvest of fish, particularly Salmon, to feed the tribe. Therefore, their Ancestors had to repair the weirs and restart their fishing attempts after such events occurred, a major setback when up to 70% of their diet depended on these fish! In current time, dams, overfishing by non-Natives, and

environmental impairments have prevented the Salmon from populating the streams and sustaining the Native people and other ecological inhabitants of the area (Montgomery, 2005). As a result, weirs are no longer used to fish for Salmon. However, during the BTTE Camp students worked with community members to build and place a traditional fish weir in the creek; an action that is estimated to be the first time in over a hundred years to have occurred.

The stories of Bigfoot provide a way to connect children, in this case the campers, with traditional ways of their Ancestors and offer an insight into the relationships, challenges, and gifts they encountered in the natural world. As such, these stories also provide an insight into the future, should efforts become successful to return Salmon to this geographic location[3]. Although some of the stories mentioned Bigfoot in times past, one of the community members mentioned a story of how he recently came across a site of bedded down grass in the mountains, which "smelled like garbage." Through this story, the man reminded the listeners that Bigfoot is not obsolete but still likely an inhabitant of the region. According tribal knowledge, Bigfoot is a fellow member of the ecosystem dependent on many of the same things as humans. Bigfoot is a mirror, so to speak, of human needs.

Stories of Bigfoot are present in many Pacific Northwestern tribes (e.g. *S'cwene'y'ti* in Spokane, *Choanito* in Wenatchee, *Skanicum* in Colville, *Huppa* in Northern California). Elkanah Walker, a missionary in Washington State, is the first known non-Indian to write about the Native stories of Bigfoot in his 1840 diary. In this passage, he is referring to the Spokane Indians:

[3] The Upper Columbia United Tribes (UCUT), an organization consisting of the Spokane, Colville, Coeur d'Alene, Kalispel and Kootenai Tribes, is undergoing investigations in how to restore salmon populations above Grand Coulee Dam. Fisheries biologists from one tribal community believe that the children who attended the 2013-2015 summer camps might likely see the return of Salmon in the Creek they explored within their lifetime (C. Flanagan, personal communication, May 2015).

> Bear with me if I trouble you with a little of their superstitions. They believe in a race of giants, which inhabit a certain mountain off to the west of us. This mountain is covered with perpetual snow. They (the creatures) inhabit the snow peaks. They hunt and do all their work at night. They are men stealers.
>
> They come to the people's lodges at night when the people are asleep and take them and put them under their skins and to their place of abode without even waking. Their track is a foot and a half long. They steal salmon from Indian nets and eat them raw as the bears do. If the people are awake, they always know when they are coming very near by their strong smell that is most intolerable. It is not uncommon for them to come in the night and give three whistles and then the stones will begin to hit their houses. (Drury 1976, p. 122-123)

Other Bigfoot stories within Pacific Northwest tribes have been documented with similar versions of the creature. Most consider Bigfoot to be very human-like and some even refer to them as a type of Indian. Although some stories, as the one above, indicate that the Bigfoot steal men, women, or children, most claim that they are benign or harmless. They are considered to be very intelligent, good at hiding (sometimes even blending in with trees or other vegetation), will indicate their presence with vocalizations or ward off potential threats by throwing stones at their perpetrator (Meldrum 2007). Many stories of Bigfoot often include the intersection with humans by means of stealing food. They appear to have a fondness for fish, either raw or dried, as well as game, but will consume plant foods as well. In this sense, Bigfoot will raid human stores of food while it is being harvested or preserved. It is interesting to note that although stories of large hominid figures have appeared in many parts of the globe including China, Tibet, and Australia, a heavy proportion of tales and

sightings occur in the remote regions of the Pacific Northwest (Lozier, Aniello & Hickerson 2009).

It is beyond the scope of this paper to discuss whether Bigfoot is a real, extant organism. Certainly this discussion has generated both fascination and skepticism in the dominant society at many levels, from cult interest groups to academic anthropological inquiries. With this said, I recognize there is a level of risk in reporting the role of Bigfoot stories in dominant science education. Nevertheless, it can be claimed that the Indigenous oral traditions of stories about Bigfoot are plentiful in the Pacific Northwest (Meldrum, 2007). These stories emphasize Bigfoot as a fellow inhabitant of the land, therefore he is to be respected and cared for like all other relations in the ecosystem. With this said, "Indian thinking is inquiry into relationships and community, and it bears reminding us that the community extends beyond human relationships" (Fixico 2013, p. 7). Indigenous people affirm the role of relationships with all life, including those that the Western system may not recognize as living (e.g. rocks, geological features, water), therefore, they are not characterized or categorized as living or non-living, biotic or abiotic in the way that Western science does (Fixico 2013). From this perspective, the stories assert Bigfoot's membership in the family of relations and imbue lessons and themes about these relationships in the context of the shared land with all life. Therefore, the truth in the story need not be factual in a positivist sense, but rather provide a context for meaning. Robert Nash (2004), describes this element of truth in story:

> What makes a story true for all people in all times and places is not simply whether it can stand the test of scientific experiment … truth is what works best for the narrator and the reader in the neverending quest

> to find and construct narratives of meaning, both for self and others. (p. 33)

In this respect, Bigfoot's existence through story provides a context for constructing meaning about the ecosystem that is shared with other life. Bigfoot's needs reflect human needs and the needs of other animals in the environment; therefore, including Bigfoot in the ecosystem design reflects the benefit to the entire natural and human community.

Stories in Indigenous education

Indigenous education is a lifelong endeavor that includes honoring community not just within one's lifetime, but honoring ancestral and future communities as well. Communities are a part of the land, of which there is an "ancient understanding that Land is our first teacher and Her stories are embedded in us" (Davis, 2014, p. 88). Okanogan scholar Jeanette Armstrong states "We live on the land and we use the land and, in doing so, we impact the land: we can destroy it or we can love the land and it can love us back" (Armstrong, 2008 p. 68). She goes on to state that she thinks about her community, the land, each time a decision is made "How is it going to impact the land? How is it going to impact our food? How is it going to impact our water? How is it going to impact my children, my grandchildren, my great-grandchildren, what's the land going to look like in their time?" (p.71) To inform these decisions, one must have a deep connection with the land that is not only directly experienced, but also passed down through communal narrative over generations. Stories are the vehicles that convey, carry, and inform these lessons. They are "the wealth of our people; they are what give life and continuity to our existence; they are what link us with our collective past, and our collective future." (cited in Tsosie 2002, p. 303)

It is evident that stories found a way into how the youth began to understand the ecosystem of their place. From the Western perspective, the university team could only teach lessons on ecosystem dynamics limited to a Western worldview. Although situated locally, the patterns are based on cause and effect and not specific to place. For example, we can teach that riparian zones provide bank stability, reduce erosion, and increase shade, thus lowering water temperatures which in turn increase dissolved oxygen and reduce turbidity which are good for fish. However, having that information presented in context to the relationships the tribes have had with fish over countless generations, honoring ancestral knowledge and acknowledging future generations of not just humans, but of all the land and its inhabitants (including Bigfoot!) presents a far more meaningful educational experience for the youth. The youth would have created a different type of restoration plan for their creek had it not been for the cultural experiences with community members during the week of camp. It is not to say that their prior experiences with their Indigenous epistemology also did not influence the design, but the themes presented at camp were prominent in the youth's models. Fish weirs, crayfish, and most notably Bigfoot indicate that humans and the whole natural community are inextricably linked with the natural environment and all must be considered in all actions and decisions, such as the design challenge the youth were provided.

Gregory Cajete, Tewa scholar from Santa Clara Pueblo, advocates that story is urgently needed in contemporary Indigenous education at every level, including science. This includes stories that are generations-old as well as the creation of new stories. Communities are integral in the education of young people, and stories are one and the same. "Indigenous community becomes a Story that is a collection of individual stories ever unfolding through the lives of the people who share the life of that community. This large community is always

a living and animate entity, vitalized when it is nourished through the attention of its tellers and its listeners. When a story finds that special circumstance in which its message is fully received, it induces a direct and powerful understanding: this becomes a real teaching." (Cajete 1994 p. 169). Furthermore, Cajete (2015) argues that story helps to build the personal and communal mythology that helps young people to understand their individual and collective identity.

Anishinaabe literary critic Gerald Vizenor (1989) describes these as narrative wisps that inform the day to day within Indigenous life. However, Vizenor also warns that tribal stories can be misrepresented according to the hyperrealities that non-Indigenous people have created about Indigeneity. In other words, although few would argue that stories provide insight and meaning about the world, it is easy to misunderstand or misappropriate the meanings of stories if they are not considered within the knowledge system that sustains it (Kovach 2010, p. 97). For this reason some scholars such as Dakota scholar Elizabeth Cook-Lynn suggest that intangible cultural phenomena such as storytelling must be viewed as a cultural sovereign "jurisdiction" that needs protection from appropriation (Tsosie, 2002). Particularly in cases of popular culture, such as film and media, these appropriations can have far reaching implications on imagined cultural representations that are difficult to reverse. However, this notion of enacting jurisdiction over storytelling can seem "antithetical to the Anglo-American tradition of the author's autonomy to 'imagine' himself as—well, as *anything*" (Tsosie 2002, p. 301, emphasis in original). Tuck and Yang describe that these appropriations indicate settler motives toward innocence via settler adoption fantasies—a desire "to become without becoming" (Tuck & Yang 2012, p. 13). To put in another way, these appropriations allow non-Indigenous people movement to play with ideas of

Indigeneity that can compound hyperrealities and move against achieving greater understanding of tribal epistemologies. Although stories may be urgently needed in education, these warnings serve as a reminder that must be carefully considered in how they are enacted.

With respect to science education, many of the traditional stories, Bigfoot being only one example, contain embedded ecological and evolutionary knowledge (Aikenhead & Michell 2011). While this knowledge offers many parallels with respects to knowledge that has developed in the Western scientific paradigm, it should be noted that they are ultimately rooted in different philosophical frameworks. Again, this resonates with Kovach's words that it is paramount to situate the stories in the knowledge system that sustains it. Pierotti (2010) draws upon Yupiak scholar Oscar Kawagaley's proposed questions as a way of acknowledging worldview differences within the Western science encounter with Traditional Knowledge: (1) What is real (metaphysics) (2) What can we understand (epistemology) (3) How should we behave (ethics) (4) What is pleasing to the senses (aesthetics) and (5) What are the patterns upon which we can rely (logic)? We can use these questions to guide our understanding of stories and delineate between worldviews and knowledge systems.

An additional way to consider the implementation of stories is to also recognize that Indigenous stories do not follow the typical linear temporal narrative of Western culture, but instead are fixed to place (Basso, 1996). With that said, it can be argued that the stories must be told in the very places they are situated in. In this way, listeners espouse a corporal connection to the land in which the story is about by engaging the senses--feeling the wind, smelling the plants, hearing the water (Davis, 2014). This engagement is in stark contrast to what most children experience in the walled confines of their indoor classrooms. However,

when the storyteller and listener are situated in place, they are in relationship with each other and with place. They become part of the communal narrative that is the story.

Conclusion

Stories have a central role in Indigenous education, both historically and in modern times (Cajete 2015). Because Indigenous ways of knowing are steeped in relationships that transcend human-to-human forms (Fixico, 2013), stories provide a way of holistically teaching about the existence, survival, harmony and disharmony found within relationships with all life. According to Cajete (2015), ecological and mythical educations are woven together, lending to the notion that "an intimate relationship between ourselves and our environment is the essence of both our survival and our identity as a People" (p. 50). In this sense "*Indigenous mythic traditions emphasize a mutual, reciprocal relationship with the natural world. Therefore, our vast mythic legacies are ready to be used to sustain us, as they have done for generations*" (Cajete, 2015, p. 104, emphasis in original). This statement carries the urgent message that Indigenous stories transmit a way of life that is meaningful in context to places that have shaped the cultures of Native People for millennia. In the case of Bigfoot, the stories told during the summer camp of 2013 resonated with students in that this mutual, reciprocal relationship was highlighted in the student's ideals of an environment that could support healthy fish populations. In turn, these fish and other connecting ecological factors hold great hope towards restoration and sovereignty for these communities. Thus the ability to support humans and Bigfoot and the entire community holistically is of essence. Without Bigfoot, the story of the place would be incomplete.

I recently learned that the Indigenous people of Bhutan have stories about a large mountain-dwelling hominid creature similar to Bigfoot called Migoi. The stories of Migoi

are decreasing as the recent construction of a hydroelectric plant has made electricity more attainable and prevalent in Bhutanese homes, schools, and businesses (Beveridge, 2015). Because people are spending more time indoors and less time in the mountains, there are fewer opportunities for encounters, thus fewer stories shared amongst the community of such a creature. Although this does not mean that there is a loss of connection to land, it does indicate that the relationship to land is changing. With those changes, the communal story also changes. With this, I see the importance of story even more. If "stories remind us of who we are and of our belonging… hold[ing] within them knowledges while simultaneously signifying relationships," (Kovach 2012, p. 94) then I understand Cajete's urgent plea for stories within education – within place -- all the more.

After the 2013 camp, the university team met weekly with a tribal community member to gain a better understanding of place. She guided us toward gaining greater cultural competency in research, including the recognition of original territory, creation stories, ancestral background, and our journey to this place. She also invited us to recognize the privilege of being researchers with badly needed grant funds brought into a community to address educational inequity/ineffectiveness. She challenged us to be aware of the responsibilities that come with such privileges.

After we went through this process, we began planning for the 2014 summer camp. This time, we focused on celebrating place and the land. We acknowledged the ancestors, thought of the future, and honored the entire natural and human community and the responsibilities associated with being a member of that community. We addressed how STEM could be used as a tool toward those responsibilities. When I walked the creek in the spring, the site where we would again hold the camp, I saw it with fresh eyes. The ground

was spongy from the spring rains and run-off, young plants were emerging, and the creek swift. I saw a fawn suddenly spring up before me and run off from the safety of its grassy cover. This to me was symbolic of renewal and rebirth. We were starting again, focusing this time on the place, the land, the relationships with it that transcend time, and attuning to our personal relationships and responsibilities.

Throughout my journey, I have come to understand that STEM programs with Indigenous students go far beyond providing discrete components of Western STEM and Indigenous culture. The integration of Bigfoot stories into ecological restoration models provides one example of how storied traditions influence knowledge systems of place. Even more, I have come to understand my own story: that I am influenced by my own worldviews, but can now appreciate other knowledge systems and acknowledge that they take time and patience to know and understand. It is my personal responsibility to be aware of other knowledge systems and ensure that I do not allow the dominant system to stronghold my actions in suppressing them. This is easier said than done.

I have two pieces of Bigfoot paraphernalia to remind me of this responsibility: one is a bumper sticker that reads, “I am pro-Sasquatch and I vote” and the other is a magnet that reads, “Remember, this forest is the home of Bigfoot.” The bumper sticker is a play on Washington State voters who support salmon recovery efforts with “I’m pro-salmon and I vote.” I see the Sasquatch slogan taking the recovery efforts a step further, because if I am pro-Sasquatch, then I am committed to policy that ensures protection for Sasquatch, such as habitat preservation that also favors salmon recovery. In this way, it is about the community rather than the resource. It also means that I am pro-community and pro-youth, as I believe the youth who participated in the BTTE summer camp incorporated Bigfoot into their

restoration designs with community in mind. They are the next generation of stewards of the land, and I cannot ignore the knowledge that influences their understanding of that stewardship. I am also pro-Indigenized education, which centers Indigenous knowledge systems and ontologies at their core. Westernized concepts and educational practices are not necessarily excluded from this model, but carefully considered from an Indigenous framework in the reasons why and how they should be incorporated. Finally, by being pro-Sasquatch, I am also pro-knowledge systems outside of my own. Bigfoot pushed me to realize that the Western system is far from the only way. Remember, this forest is the home of Bigfoot. Remember, you are not the only one. Remember, you are a trespasser. Remember, you have responsibilities. Remember, there is much you do not know.

It is our responsibility as educators to understand what cultural relevance means and to challenge the cognitive imperialism of the modern education system. The only way we can do this is through cultural competence, humility, and genuinely getting to know our neighbors. It is our responsibility to examine knowledge-power relations and how we are a part of the larger system. It is also our responsibility to challenge those systems. Indigenous youth are not a cog in the Western education system. Their education should work for them. By providing students educational opportunities that honor and privilege their own worldviews, students can develop a rich understanding of their place and their responsibilities to it, including STEM concepts, in culturally-meaningful ways.

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This material is based upon work supported by the National Science Foundation under Grant No.1139657. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the National Science Foundation.

Chapter 3: Paper #2 - Enhancing the Science Capital of Native American Youth: Affordance of outreach partnerships between Natural Resources community scientists and Native American Youth

Abstract

The purpose of this paper is to explore how interactions between youth and community scientists, in this this case scientists in the Natural Resources sector, affect the science capital and aspirations of Native American youth. Based on Bourdieusian notions of science-related social and cultural capital, this study explores how interactions and relationships formed between Native American youth and community Natural Resources scientists during a series of summer STEM camps enhance youth science capital and encourage participation in the scientific pipeline. This study uses Photo Elicitation Interview (PEI) method with six youth camp participants during focus groups conducted after the completion of the multi-year camp series.

Transcripts of each focus group were coded for general themes and to determine each youth's 1) engagement in science during the camps 2) aspirations in science, and 2) evidence of science capital outside of the camps.

Findings indicate that youth broadly valued relationships with others and a sense of connection and responsibility to stewardship of the land. Individual cases demonstrate that youth reported varying levels of engagement and aspirations in science. Youth reporting greater access to science capital reported higher likelihood to aspire to scientific careers within the tribal community. However, other cases suggest youth with lower levels of science capital may experience "nodes of influence" during interactions with community scientists, leading to higher science aspirations. This study provides evidence that investing in youth

interactions with community experts can increase science-related capital for youth by providing opportunities that demonstrate the connection and importance of science in their community.

Introduction and Purpose

The purpose of this paper is to explore how interactions between youth and community scientists, in this this case scientists in the Natural Resources[4] sector, affect the science capital and aspirations of Native American youth. It is not uncommon for tribal Natural Resources departments to engage in outreach with youth to increase awareness and stewardship of work with the tribal department as well as promote the field for future employment of their tribal citizens. Very little is understood about how these interactions affect youth, particularly Native American youth whom are poorly represented in STEM (science, technology, engineering, and math) fields.

The Natural Resources sector has identified that education and outreach are crucial for improving scientific literacy and recruiting women and minorities in the Natural Resources fields (Association of Public Land-grant Universities, 2014). Employment has remained stagnant over the last several decades with white men holding the same percentage of positions as in the 1970's (Association of Public Land-grant Universities, 2014). Women in Agriculture and Natural Resources fields rank second to engineering for the lowest potential representation in the workforce, while minorities rank at the bottom of this list of 14 STEM disciplines (Sharik, 2013). The low representation of minorities in Natural Resource fields is especially concerning for Tribal Departments of Natural Resources (DNR), as they are in a unique position of sovereign governance and management of their land and natural

[4] Natural Resources will be capitalized within this paper to discern the sector and practice of Natural Resources management, whereas the natural resources of materials and substances found in nature will remain lowercased.

resources. Tribal entities have a desire to increase employment of their tribal members in the scientific workforce, yet non-Indigenous persons hold many of the professional and leadership positions within DNR fields. These positions often require advanced degrees, however Native Americans make up the smallest percentage of those who graduate with undergraduate degrees in STEM, let alone advanced degrees in these fields (Van Cooten, 2014). Many questions remain as to what contributes to such low representation in the STEM pipeline, as well as ways to mediate and thus increase participation.

Education and outreach have been identified as major themes needed to improve a scientifically literate public and increase diversity in the field, particularly of the next generation of stewards (Fink, Edge, & Hallerman, 2014). Outreach efforts have become increasingly prominent within many tribal Natural Resources departments to engage youth in natural resources education and awareness of employment opportunities. Examples of these outreach events include community cultural events, school presentations, field trips, summer camps and internship programs. Little research has been completed to understand how outreach efforts between community scientists and youth affect youth's science-related capital and aspirations toward science and employment in Natural Resources fields. Schielke, Schmidt and Scheppler (2014) have suggested that youth benefit from working with scientists in the classroom or in the field, but it is not well understood how these experiences shape youth in their science aspirations in addition to learning content and scientific processes. Therefore, this study seeks to answer the following research questions:

- What are the affordances of community scientist (DNR) engaging in science outreach partnerships with Native American youth?

- What attributes of science capital do these interactions provide youth and how do these interactions influence science aspirations?

Theoretical and Conceptual Framework

This study was informed by a sociocultural perspective on science education that draws upon human social interactions that exist within and amongst institutional and cultural frameworks (Lemke, 2001). These concepts include an exploration of how scientific knowledge and processes are socially reproduced and influenced by cultural and community purviews of the world. Drawing on the work of Vygotsky (1963), sociocultural perspectives emphasize that social interactions are central to learning (LaTour, 1987) and that collective tools created by these interactions help create a culture of community. These tools help us to understand how our behaviors affect and are affected by social and cultural factors, as well as by ecosocial systems (i.e. relating to ecosystems and society) in which we exist and rely upon the natural world (Lemke, 2001). Lemke (2001) articulates this notion by claiming that scientific knowledge, research, and education are constructed and enacted through human social activities. Thus, Lemke argues it is important for researchers to question the role of social interactions with individuals in science-related environments. Specifically, this study is concerned with how youth develop science interests and aspirations through the acquisition of science-related social and cultural capital within an Indigenous communal environment.

Science Capital

One aspect commonly recognized about individuals who are high achievers in science is they tend to come from more affluent families that have greater access to science capital, including social, cultural, and economic resources that support science learning (Aschbacher et al., 2010). Science capital is a conceptual tool developed by British theorist Louise Archer

and her colleagues to understand how children form their science aspirations. Science capital explains the knowledge, experiences, behaviors, attitudes, and values that allow for attainment, engagement, and participation in science (Archer & DeWitt, 2016). It is an extension of Bourdieu's theories of social reproduction (1984, 2001; Bourdieu & Passeron, 1990) where economic, social, cultural and symbolic resources, or capital, have an exchange value that can be used as social leverage in particular fields of context. With respect to science, science capital is not a separate capital, per se, but a collection of these four capitals that shape youth's access and participation in science (Archer, Dawson, DeWitt, Seakins & Wong, 2015; DeWitt et al., 2013). Therefore, science capital can be thought of as a means for understanding how this collection of capitals can influence the patterns that shape youth's aspirations in science (Archer et al., 2015).

Archer et al. (2015) claim the concept of science capital is important to consider in science education as it can explain some of the contributions toward the continued existence of social inequalities in the fields of science. Combined with habitus, or the internalized dispositions that influence a person's perceptions and reactions of the social world around them, how much of these four forms of capital someone has either adds to a person's social privilege or subordination within society (Archer & DeWitt, 2016). In other words, the amount and quality of capital an individual possesses and can use at his or her disposal allows for more or less leverage within a given field (Archer, DeWitt, Osborne, Dillon, Willis & Wong, 2012). Although affluence provides economic capital needed to purchase science-related materials, experiences, and tutors that help enhance an individual's participation in science (e.g. scientific books, kits, media, museum visits, summer camps), one does not need to be affluent to have high science capital. On the contrary, science capital

is largely influenced by social and cultural capitals that are not monetarily based (Wong, 2015).

According to Bourdieu, social and cultural capital provide "insider knowledge" and social connections that influence the the operations and habitus of fields. Science-related social capital includes access to social networks such as individuals with science-related jobs and science-related knowledge, whereas science-related cultural capital refers to attainment of scientific literacy, knowledge, and science-related qualifications (Archer, et al. 2015). Science capital is not fixed, but is rather contextualized according to its particular field; therefore, science capital resources do not have an equal symbolic or exchange value in all settings or contexts. In other words, a particular set of science capital resources may be valued differently in, say, a university physics research lab than in a Natural Resources department. Furthermore, science capital resources may be valued differently in school science settings than they are in a child's out of school setting. This can be problematic for youth who come from otherwise non-dominant cultural backgrounds when school science environments do not value their existing science capital, resulting in difficult "border crossings" between such environments (Aikenhead, 1996). For a Native American student, the Native scientific knowledge and practices, including land-centered Traditional Ecological Knowledge (TEK), that are experienced in the home or community may not be valued within the context of school science where Eurocentric science practices and ideologies are dominant. Thus, students may decide that science is "not for me" if their existing science capital is not esteemed within the formal science education setting.

Although Archer provides a construct that appeals to a Western context where individual aspirations are valued and rewarded, tribal contexts typically prefer a communal

approach to success where outlooks are favored for the greater good of the community. Santa Clara Pueblo scholar Gregory Cajete argues that for Indigenous people, "knowledge is most useful to community members and to the enduring well-being of the community and culture" (2015, p. 12). The importance of this notion lies in that community is where "Indigenous people come to understand the nature of our personhood and our connection to the communal soul of our people" (Cajete, 2015, p. 23). Community guides "individual and group identity within the web of all-interpenetrating symbolic culture" (Cajete, 2015, p. 24). Within this model, community work is done for the benefit of all members of the community where all members work as an integrated unit. It is important to note that community is not limited to humans, but also the natural community that interacts within and co-inhabits the land (Aikenhead & Michell, 2011; Armstrong, 2008; Pierotti, 2011). If science is not presented to youth in a way where they can meaningfully apply the value of science in their full human and non-human community, they may not identify science as having a communal attribute worth investing in.

Contextual learning experiences that occur during field trips, informal learning, or other out-of-school experiences with science have been shown to increase scientific knowledge, content retention, interest, and even continued participation in science (DeWitt & Storksdiek, 2008; Kinder, Messner, Larese-Cassanova, Lott, Cachelin, & LaLonde, 2015; Rennie, 2007). For Native students in particular, place-based contextual science learning opportunities provide holistic and relevant means in which to learn and apply scientific concepts to land and community (Simpson, 2014). In this sense, place shapes knowledge which in turn shapes selfhood (Kincheloe, McKinley, Lim, & Barton, 2005). Therefore, opportunities that lend to learning from *place* are arguably more meaningful to Native

youth's conception of science than through learning opportunities that are otherwise unrelatable outside of the youth's community. Along these lines, students may benefit from working directly with scientists that work in the community, whether in the classroom or in the field (Schielke, Schmidt & Scheppler, 2014). However, these experiences have the potential to vary considerably, so it is unknown how they impact youth's interests and aspirations in science.

Through the conceptual and theoretical sociocultural perspectives in science education, primarily science capital and Indigenous community, we address the aforementioned research questions within the context of a series of grant-funded summer STEM camps conducted with Native American youth, grades four through six, in the Pacific Northwest.

Methods

Context: Back to the Earth

This study was part of a larger project funded by the National Science Foundation in which two tribal communities and a land-grant university in the Pacific Northwest provided culturally-relevant, place-based STEM camps for Native American youth. This project, Back to the Earth (BTTE), was implemented in 2013 and invited youth in grades 4-6 to participate in a series of summer camps, each lasting two to three weeks, over the course of three summers. Each tribal community is geographically located within a shared watershed; therefore, this watershed was incorporated as an overarching theme of the BTTE camps. Each community tailored the camps to celebrate its unique cultural connections with the land while addressing environmental concerns affecting culturally-significant locations along the watershed. For example, one community (i.e. the River Community) culturally identifies

with the major river flowing through the watershed, while the other community (i.e. the Lake Community) culturally identifies with the large natural lake in the watershed. More specifically, activities in both camps included learning about and observing sections of the shared watershed by raft or canoe, participating in storytelling, studying stream morphology and water quality, singing and drumming, learning and applying traditional ecological knowledge and Western scientific knowledge, and engaging in traditional STEM activities while participating in culturally relevant projects, such as building and installing a fish weir (Kern, Howard, Navickis-Brasch, Fiedler, & Cadwell, 2015).

Furthermore, youth learned about the ecosystem dynamics between the human and natural communities that coexist within each place. Salmonid fish (i.e. trout and salmon) are centrally-important in these dynamics as they are highly culturally-significant to each tribal community for their nutritional, spiritual, and economic contributions to well-being and subsistence (Montgomery, 2005). As a result, salmonid fish became a prominent theme within the broader watershed focus of the camps. Specifically, the curriculum included factors that have contributed to the decline or absence of these fish as well as the current work being done to restore populations in each community. For example, the River Community has been implementing efforts to restore salmon populations whose migratory routes have been blocked from the erection of several large dams while the Lake Community is restoring cutthroat trout populations that have been decimated from competition from predatory invasive species, amongst other factors.

For every camp series, youth participated in a week of camp in their home community and one week of camp combining youth from both communities. During the final year of camp (2015), youth took turns hosting camp for both communities to showcase their

land and culture. In this sense, youth gained opportunities to deepen connections with their home community during the first two years while sharing and experiencing each other's communities during the final year.

Tribal Departments of Natural Resources (DNR) staff from each community were active leaders in the curriculum design, implementation of activities and lessons provided, and topical presentations about current scientific practices used in wildlife and fisheries management. DNR staff were interested three objectives: 1) informing youth of pertinent environmental concerns in their community 2) engaging youth in ways DNR conducts work to address these concerns and 3) making DNR careers relatable and interesting to youth (meeting notes January 2014).

Informing Youth of Environmental Concerns. DNR staff worked from each community with the curriculum committee to share which environmental concerns they felt should be presented to the youth. Each curriculum meeting included a discussion of how the BTTE project could integrate STEM learning with the work of the DNR agencies. Furthermore, we discussed which of the environmental concerns to address with the youth as well as which sites were best represented--typically those with substantial pollution, degraded habitat, and presence of invasive species (identified by the tribes as "uninvited guests") as well as those restored to more "pristine" conditions. For the Lake Community, which is the focus of this study, these factors were particularly concerning for the culturally-significant ełtumish (Lake Community language for Westslope cutthroat trout, *Oncorhynchus clarki*). Therefore, the Lake Community's DNR has put a great deal of focus and effort into restoration of the cutthroat through habitat restoration, planning and design, and monitoring the biological, chemical, and physical trends affecting the cutthroat populations. They are

able to address these ecosystem issues by integrating Western science and traditional approaches to restoration, including TEK and Indigenous management strategies, some of which will be described below.

This work is important to the Lake Community Tribe due to the community's mission to restore, protect, expand, and reestablish fish populations to historical and cultural harvest opportunities (meeting notes, January 2014). Residential fish, such as cutthroat, historically made up 75% of the Tribe's diet, but over the last several decades, survival rates of juvenile cutthroat have declined from 20 per cent to only 2 per cent each year. Thought to be caused by environmental degradation and predation by the introduced Northern pike (*Esox lucius*), the Tribe had to "redefine its relationship" with the cutthroat and make the difficult decision to close fishing for this species in 1993. According to one tribal member "What took place one hundred years ago is impacting us today. Tribal members have not been able to fish these waters for twenty years and that was a hard decision to make" (meeting notes January 2014). With this said, it was important to the Tribe that youth understand the nature of this decision and what it means to the tribal community and the future of cutthroat: Cutthroat are not just a natural resource, they are a cultural resource (meeting notes, January 2014).

One of the unique ways that tribal DNR professionals in the Lake Community are restoring cutthroat habitat is by working with Hnmulshench (Lake Community language for Beaver) to rebuild stream resilience. Hmnushench is considered a gift to the community and referred to as "the four-legged engineer who can engineer better than any two-legged engineer" (meeting notes, January 2014). Rather than using expensive and invasive efforts with machinery, the tribal scientists have been encouraging the beavers to do much of the work of returning streams to more natural channel patterns. This, accompanied with other

restoration techniques such as riparian enhancements, adding woody debris to streams, and activating historical stream channels, has led to improved habitat (i.e. increased water quality, species diversity, etc.). DNR staff felt it would be beneficial for the youth to learn about the promise of these restoration sites and how these improvements would benefit the ecosystem. As a result, this method of restoration was included in the curriculum in the broader context of cutthroat restoration and watershed dynamics.

Engaging Youth in Fieldwork. During the camps, DNR staff from each of the two tribal communities led activities with youth that incorporated several field techniques used in DNR careers such as macroinvertebrate analysis, zooplankton tows, gastric lavage[5], aging fish through scale patterns, and population sampling with various netting techniques and electrofishing.[6] Youth also toured a fish hatchery at the River Community to see where and how young kokanee (*Oncorhynchus nerka)*[7] were being reared for the mitigation of salmon lost to dams. During this visit, youth were able to watch fisheries technicians insert PIT tags[8] into the juvenile kokanee. DNR scientists also led students in dissections of different fish in each community, including perch, bass, and pike so they could gain an understanding of fish anatomy and identify the stomach contents of larger predatory fish.

During these activities, DNR staff would describe the scientific processes associated with their work and how the fieldwork allows them to collect data to understand population dynamics and management strategies. Typically field activities in which youth participated

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[5] Gastric lavage is a technique in which stomach contents of a fish are extracted via a pump to analyze what the fish last ate.
[6] Electrofishing is technique in which fish are temporarily stunned by an electrical impulse in streams and lakes. Fish are collected for species identification and measurement before release.
[7] Kokanee are a species of land-locked sockeye salmon reared, in part, as an effort to mediate loss of salmon migrations that resulted from dam impedances.
[8] PIT tags are a passive radio transponding device that tracks migration patterns of organisms, in this case salmonid fish.

were followed up with lessons about the broader implications of such work. For example, youth learned about food webs after conducting the zooplankton tow in one of the small lakes in the River Community and identifying the species of zooplankton collected under microscopes. Additionally, youth applied their knowledge of plankton food webs to a lesson about bioaccumulation of PCBs and heavy metals in fish and humans after analyzing the stomach contents of dissected predatory fish.

It is important to note the youth were active participants in the fieldwork that they engaged in with DNR staff. For example they were on the boats collecting zooplankton, in the creek sampling macroinvertebrates, netting fish in the creek during electrofishing, and placing fish scales under microscopes to count age rings. Although a few simulations were setup to make clarify topics (e.g. beach seine nets), youth were largely expected to do the work and apply scientific skills with the guidance of DNR staff.

Making DNR Careers Relatable. Nearly all of the DNR staff who engaged with the youth in the camps talked to the kids in group presentations or through more personal conversations about the nature of their jobs and what experiences and education it took for them to get those jobs. They described their work as fun and satisfying. Additionally, the DNR staff emphasized to youth that "they are the future of this work and that they too need to take these jobs." Although they encouraged youth to go to college and come back to serve their communities, they also stressed that there are jobs in DNR that do not require a four-year college degree, such as field technicians. They emphasized the best jobs (higher paying and more personal autonomy) require such a degree, however, it was not the only way to work for DNR. In all, they provided the message that the all youth are wanted and welcome in DNR jobs and that they have the capability to enter the field.

Participants

Youth from the Lake Community who participated in at least two of the three annual BTTE camps were invited, with parent/guardian consent, to participate in one of two focus groups with their BTTE peers in the spring of 2016. Focus groups were divided amongst youth according to their camp cohorts. Youth who entered the program in 2013 and attended three BTTE camps belonged to Cohort 1, while youth who entered the program in 2014 and attended two BTTE camps belonged to Cohort 2. The focus group with Cohort 2 was conducted at the participant's elementary school in a meeting room near the school office. The youth of Cohort 1 attended schools in different towns, so the focus group was conducted at a university satellite branch to accommodate a convenient midpoint. Each focus group included two to four youth of mixed sexes. Focus groups lasted between 40 and 60 minutes and were audio recorded.

The participants in Cohort 1 were in Middle School at the time of the focus groups, although they first participated in the summer STEM camps when they were entering into the 4-5th grades. Cohort 1 participants attended three BTTE summer camps over the course of three years. Participants in Cohort 2 were in the 5th grade at the time of the focus group, but started attending the summer STEM camps prior to starting the 4th grade. Each participant in Cohort 2 had attended two BTTE summer camps, although one participant was sent home from camp early because of behavior challenges.

The purpose of the focus groups was to elicit discussion between the youth participants about their experiences in the camps, particularly with lessons or activities conducted with DNR staff. The focus groups began with a prompt to recall the most memorable experience from the BTTE summer camps according to the six senses, which was

commonly used during the camps: sight, smell, sound, touch, taste, and heart. The sharing of these memories led into discussions about what youth learned about their land during the camps, what they love about their land, what they are concerned about their land, and what they think DNR is doing to help their land.

Midway through the focus group, participants were each provided a set of 17 photos taken during activities led by DNR staff from the 2013, 2014, and 2015 summer camps. The photos included youth participating in macroinvertebrate analysis, electrofishing, fish dissection, zooplankton tow, the hatchery tour, river rafting, scale aging and gastric lavage, restoration site tour, meeting a wildlife biologist, and netting techniques. Although river rafting was not a DNR-specific activity, it was included because DNR staff members participated and talked about fish monitoring studies they are doing along the stretch. The photo sets were used as part of a photo elicitation interview (PEI) method (Epstein, Stevens, McKeever, & Baruchel, 2006) to prompt youth to recall and share the experiences they encountered throughout their camp participation. Photos were chosen to include both youth and DNR staff members so that memories of both could be recalled. The photo sets were identical for all groups and included photos from camps in both communities. This was done for consistency and to accommodate for the youth who attended camps in both communities. Additionally, we were interested to find out what youth claimed they remembered from activities whether or not they actually attended. Youth were allowed to review all the photos in the set, and were then asked to order from their most favorite activity to their least favorite activity and share out loud why they chose to order them that way. They were also asked if they recognized any DNR staff in the photos and discuss whether or not they would be comfortable talking to them. Lastly, the youth were asked what jobs they would like to do

when they grow up, what science they do at school and home, and who supports them the most in science. It should be noted that youth were told that "science" could include both school science and Indigenous science to acknowledge that both were valued in this context.

Data Analysis

Audio recordings of the focus groups were transcribed verbatim and initially open coded for themes pertaining to each cohort. Each child's contribution to the focus group was then extracted out of the transcript and assembled into stories, or cases, as the activities pertained to each child. Each of the cases were analyzed for the following attributes of science capital: 1) Engagement in science in the BTTE camps 2) Aspirations in science 3) Evidence of science capital outside of the BTTE camps. Engagement was considered high if youth claimed enthusiasm for a particular science topic or activity, medium if neutral responses were given about a science topic or activity, and low if they described dislike or choosing not to engage in a topic or activity. Aspirations were considered high if youth expressed a strong desire to achieve in a science-related career pathway, medium if moderate or undecided, and low if indicating little to no desire for a future career in science. Evidence of science capital outside of BTTE include descriptions of science-related activities or experiments, television shows, books, kits, outings, knowing people with science-related jobs, and people who are supportive of success in school and/or Indigenous science. Participation was not specifically analyzed in this study, as the participants willingly chose to participate in the BTTE camps and the activities within. However, some examples of participation in science are exhibited in the analysis of science capital outside of the BTTE experience.

Limitations

This study is limited to a population of youth who willingly participated in an extracurricular summer STEM camp, which was provided free of charge due to external grant funding. Therefore, the economic capital needed for youth to participate in such experiences was provided for them to access such an experience. Furthermore, it is unknown how such experiences would impact youth who might not willingly choose to participate in an activity such as the one included in this study.

Cases

The following cases were selected out of the focus groups to highlight a range of student experiences, personalities, backgrounds, and interests of the youth participants. Each case was created by extracting individual themes with supporting quotes from the focus group transcripts along with observations of the youth during the summer camps made by the researchers. Youth were assigned pseudonyms to ensure confidentiality.

Jasmine	Cohort 1	High engagement about water quality and macroinvertebrates, high science aspiration, high science capital. Wants to work for Natural Resources.
Sam	Cohort 1	High engagement about cutthroat trout and native fish, low science aspiration, low science capital. Does not think he wants to be a scientist, but mentioned that, "sometimes their (fish) lives depend on it."
Ivy	Cohort 2	High engagement about fish, high science aspiration, medium science capital, but high science-related social capital. Wants to work with fisheries and wildlife.
Kathy	Cohort 2	Medium engagement and participation, medium science aspiration, low science capital. Interested in fish.
Nathan	Cohort 2	Medium engagement, with highest interest in trees and forestry. Medium science aspiration (forestry), low science capital. Wants to be a firefighter like his brother.
Kolby	Cohort 2	High engagement about wildlife biology, medium engagement with other activities, low science capital. Wants to be a wildlife biologist.

Figure 1. Focus group participants and the levels of engagement and aspirations in science elicited during the focus group sessions.

Jasmine

Jasmine attends a science magnet school located outside of the reservation and has expressed an interest in working in a scientific field when she grows up. Although she is unsure exactly which direction she would want to go, she indicates interest in working in "something close to this field" and says "it would be really fun and a great learning experience to work with anyone in that department [DNR])." She claims that she is unsure what draws her to want to work with DNR other than she says "it interests me and I think it would be educational" but also indicated that she might want work with "macroinvertebrates and the microscopes...I thought those were really interesting." She has stated that she was influenced to want to enter a scientific career from hearing about a distant mine that polluted and "ruined a river over there" and wants to "just to protect our natural state."

Jasmine appears to take an interest in water quality and is concerned about the presence of heavy metals, algal blooms, face wash microbeads, and building developments negatively impacting the lake, which is physically and culturally in the heart of her community's ancestral homelands. She mentioned that her land is special because of the "history of the lakes and the rivers. They are different from other places...over here the Tribe has made a big impact on keeping up with the watershed and the quality of our lakes and water."

Jasmine mentioned that DNR scientists helped her learn about "the insects inside of the water...the macroinvertebrates. We looked at those under microscopes and it was nice to know what is in the water… it isn't just water, there is stuff in the water and that stuff affects everything else." Jasmine found the electrofishing and fish dissection to be the most memorable activities with DNR. "I just remember having the waders on and just being able

to look at all the fish." However, she said that the fish dissection was not her favorite activity because of the smell and because she felt that she did not have much guidance, she felt she was "just aimlessly cutting away." Jasmine picked out a fisheries biologist as a recognizable DNR staff member because she has "seen him on multiple occasions" but she could not recall where other than "different occasions other than camp." She did say that she would "probably" be comfortable approaching him and talking to him outside of camp.

Jasmine does a lot of science in school and describes her life science teacher the previous year as "overly qualified" and that it "was really fun.. I liked that class." She also says she had recently taken up gardening at home "and that is totally a science." She said that the people who support her the most in science are her sister who is "more of a cultural type" and her best friend's mother who works for Natural Resources in Lake Management and "definitely keeps me up to date on some of the stuff that is happening."

Sam

Sam is a quiet young man who attends a school in a community 25 miles outside of the reservation. He does not have much of an affinity for school science, but has a cultural appreciation for water and fish.

> Sam: ...I like all the rivers all over this land. That there's lots of fish around here, and that is what I see on this land.
> Me: What is it about the rivers and the land? Why is that important to you?
> Sam: Because the river for us a long time ago, the river was technically life as we knew it.

Sam is concerned that "one of the very important fish, the cutthroat trout, is going endangered" and added "knowing it is one of the biggest [culturally important] fish in the community at this moment and knowing that it is going endangered and has the possibility of going extinct is scary...It would mean a lot for the community, and it would really hurt us if it

goes extinct." He goes on further to say that he would make changes to the land to benefit the fish and the water:

Me:	What would you change based on what concerns you?
Sam:	To get the water back fresh and get the cutthroat trout population to increase. That would help.
Me:	And you say it would help, what would it help?
Sam:	It would help the community. In hearing stories of how the river did a lot for us a long time ago, and it hurts to know that every minute the river is just getting worse.
Me:	What do you think is making it worse?
Sam:	Metal, lead, iron, stuff like that.

Sam recalled visiting the fish hatchery as a memorable activity and "seeing all the fish, different kinds of fish and seeing hundreds of fish." He remembers it because he "thought that they were keeping fish there so that they could reproduce safely, so that they can raise the population." He chose activities such as rafting, visiting the fish hatchery, electrofishing, visiting beaver habitat (the restoration site), and catching macroinvertebrates as his favorite activities, but stated the fish dissection was his least favorite activity because "It's just not really the thing I do…[but] looking at the scales was pretty fun, but I don't think it was the best." When I asked if he liked learning about fish in their natural habitat or being reared as little babies rather than cutting them open or taking pieces off of them, he agreed.

Sam could not identify any DNR staff members in the photos. He claimed, "I don't remember any of the scientists." He also says he does not know what he wants to do when he grows up yet. When asked what he thinks it would be like to work for DNR he said, "I don't know if I want to work there." However, he also added "I think it would be cool, because you'll be working with not only the river and the wildlife that lives in the water, and sometimes their lives depend on it."

Sam had been attending his current school for only one semester at the time of the focus group, but said that he did not find his science class to be interesting and did not do any

hands-on science or use any materials. When asked if he did any science at home he answered "I don't know. If I encounter scientific things in my house, I don't really detect it that much." He said that his dad supports him the most in science because he has learned things from him and that "he used to...work on the river on fish and trying to get the metal out of the river."

Ivy

Ivy claims that she desires a career that will "help with fisheries and wildlife." She has an older sister, who lives at home, who has been involved in the Tribe's summer youth program in fisheries as well, and she admits that this is one of the reasons she also wants to enter this field. She mentions confidence in doing tasks that were difficult for others to do, such as the fish dissection. "I liked it when other people in my group wouldn't dissect them, so I dissected them all. I think I dissected six fish." Most of Ivy's memories from the BTTE camp were located around fish. Her most memorable activities with the DNR scientists included electrofishing, macroinvertebrates, dissecting fish, and learning about the nets that DNR fisheries uses to sample fish populations and said she liked doing that. She remembered specifics including there were three types of nets used and "one of them was for big fish and another was for smaller fish. The smaller holes are for the smaller fish and the bigger holes are for the bigger fish." She also recalled details about the stomach lavage activity and connected that with finding a whole kokanee in the stomach of the pike she dissected.

Ivy also recalls a swimming location with "so many dead fish on that side of the lake, that we went to, that no one swam." She picked out a photograph of a fisheries biologist as someone she recognizes and said she knows him because "he has taught me a lot about fish and stuff." She remembers raising fish for two years at school, but states "now we don't really do anything." She watches a show called Venom Hunters on TV and has a crystal

growing kit at home but has never used it because she is worried about making a mess. She says that after experiencing the summer camp she wants to go into the summer youth program to "recognize fish when I see them."

Nathan

Nathan was sent home from the camp early because of behavior issues, but he was quiet and reserved during the focus group and often refrained from answering questions unless he was directly asked. He had many positive memories around the camp including "I liked when we were in the woods and did work tagging... fish and there were, like, fire people and everything. It's because my brother was there." He liked being in the wilderness and the trees that "smelled like vanilla." Nathan chose the fish hatchery as his favorite activity with DNR because "I liked looking at the fish." His second favorite activity was looking at macroinvertebrates but claimed his "feet was hurting" from sharp rocks. He liked putting on the waders and electrofishing because he liked catching the fish and using the electrofishing wand. He picked a DNR staff member as being someone he knew because "he taught me about the [electrofishing] wand and stuff." Nathan stated that the DNR staff "taught me how they [organisms] lived and how the environment is" and also said that the DNR is doing the work of their ancestors "by teaching us how to keep the environment good and more healthy." Nathan wants to be a basketball player or a movie actor when he grows up. When asked what it would be like to work for the DNR, he says it would be "hard" but that you would be "meeting new people" and he agreed that he would want to work for DNR. However, when asked again about how many of the youth in the group would want to do a job like the DNR staff, he stated that he wants to be "a firefighter like my brother." Nathan

says he does “water experiments” at home to “watch people reacting with different waters. Hot and cold. I got two cups and do it.”

Kathy

Kathy has an exuberant personality and liked reflecting on the food available at the camp. She stated that she was concerned about the “water” and “the fishies, that maybe the fishes might come extinct.” When asked which fish she was worried about, she could not identify any by name but mentioned “the one with the big mouth.” Other students attempted to figure out which fish she was referring to by listing different species such as catfish and pike. She agreed that she was concerned for the pike, although Ivy challenged her and said that the cutthroat are the ones to be worried about since they are being eaten by pike.

Kathy chose the dissection as her most memorable activity, but because of how “they felt...it was cold inside and had a feeling and stuff” and “that he was probably crying in heaven.”

Kathy also picked the activity with nets as one she enjoyed “because I like to catch the fishes to see what kind they are.” Kathy doesn’t know what she wants to be when she grows up, but says that a job with DNR would be “entertaining.” She also mentioned twice that they “don’t really do anything” for school science and that the school has new laptops but “we just use them for like tests and stuff. We don’t really get to do anything with science stuff.” Kathy likes to watch cooking shows and “Bigfoot” on TV. At home, she says she does science by opening up “this brown, like, deer poop” that is in her garden and “there is like bugs on it.” She also talks about doing an experiment with a friend where she put Alka seltzer in a bottle and “it fizzes up and we watched it like fizz out.” Kathy mentioned that her “phone” and her cousin support her the most in her science education. When asked about what the BTTE camps would have been like without the activities that the DNR led she said

it would have been "boring" because "we wouldn't learn that much stuff when we were there, and like the history. We would have been sitting around and stuff, instead of going places and learning about fish and stuff." She also said that BTTE made her want to join the summer youth program so she could learn about "the fisheries, like different kinds or other fish." and reiterated with "I really want to be in fisheries so I can be in a boat and see different kinds of fish and how other people work, and learn how to get them in and stuff."

Kolby

Kolby enthusiastically recalled memories from the camp, particularly events with his friends. He was very talkative during the focus group and often redirected questions to talk about such memories. He was excited when the photos were presented to the group and exclaimed "Are these pictures of us!?" When the group was asked about camp memories that "make their hearts sing," he said, "when we did all those trust games" because "we worked together when we paddled." He really liked geocaching activities, looking at petroglyphs, and "the beautiful water."

During the photo elicitation, Kolby immediately pulled out a photo of a wildlife biologist from Community B's tribal DNR and said "Oh yeah, I remember that. That was awesome!" [It was] when this one hunting guy came and showed us all these skulls and showed us his skins." Although Kolby couldn't remember exactly what the biologist talked about, he went on to explain that he liked how the DNR staff member brought booklets about hunting for them to keep. When he was prompted to pick out his favorite activity with DNR, he again pulled out the photo with the wildlife biologist standing in front of the big game skins. When asked which DNR staff member he would recognize and would feel comfortable talking to, he again chose the wildlife biologist and said "This guy, cause I liked

the way he taught us about hunting and stuff...and it makes it more interesting, so I think I will try to do it one of these times."

Kolby said that the DNR is doing the work of his ancestors with "how they used to hunt and stuff." When the group was asked if they might actually consider a job with DNR, Kolby quickly said "I want to be like this guy! Yep that guy!" and pointed to the photo of the wildlife biologist. Although Kolby was drawn to the wildlife biologist's presumed connection with hunting, Kolby also said that visiting the hatchery was fun because of "seeing all the little baby fishes" and talked briefly about catching stoneflies during the macroinvertebrate activity.

Kolby wants to be a football player when he grows up and likes to watch cooking shows at home. He also offered some commentary about episodes of the "Bigfoot" show that Kathy mentioned she watches. Kolby reiterated what other students said about the lack of science at school and said, "all we are doing is watch [sic] 'get smarter' videos" in which Nathan added, is "where we watch this guy do experiments." Kolby responded to the question about science at home with, "I'm sorry to say, but I don't think we do any science at our house. We just shoot baskets and go inside to watch TV." He mentioned that his grandfather is the one who supports him the most with his science education "but he can't do it no more, he's passing." Kolby did confirm that he would like to do work like the DNR scientists and said he thought that to get that kind of job, DNR scientists have to "go to college, learn from the earth, and learn from other people."

Discussion

Analysis of the overall group's discussion indicated the youth were positively receptive to the activities with DNR during BTTE. They indicate the camps would have been

"boring" or "uneventful" or "not fun" if the camps did not include activities with the DNR because they would not have learned as much about the land and fish. The youth appreciated being able to go different places and having hands-on activities with DNR. However, youth were initially vague in their descriptions about what they learned from DNR, including statements such as "to take care of the environment" or "protect the animals so they don't become extinct." As the focus groups continued, particularly during the photo elicitation, the youth began to provide more detail about what skills and knowledge they learned from the DNR scientists, including knowledge about native and non-native fish, sampling techniques, and how to use equipment. All youth from Cohort 2 claimed they were all more likely to want to apply for the summer youth program (i.e. high school internship program with DNR) when they become old enough or work for DNR as adults. Ivy and Jasmine both stated that they were interested in careers related to DNR when they grew up, while the other youth initially listed other aspirations such as basketball player, football player, or movie actor. However, when asked what they thought it would be like to work for DNR, all students said that it would be "fun" or "interesting." It is unknown how much of these claims were due to genuine interest or a result of social desirability bias.

Two prominent themes emerged that suggested that 1) relationships and 2) connection to the land were important to the youth. Although these themes were mentioned specifically for DNR-related activities, they were also prominent for activities that did not involve DNR scientists (e.g. swimming, geocaching, etc.)

Connection to the Land and Ancestors

The youth described various aspects of the land that were meaningful to them, most prominently water and fish. Rafting and canoeing the watershed had a large impact on the

youth and their relationship with the land. Jasmine claimed that the she now notices the river "...in a different way. Before, I didn't really pay attention to it, so it was mindlessly there. Now I look at the different bushes and leaves and plants...I pay more attention to it." Many youth included the water as being something important to them, whether it be through memories of touching the water, looking at "the beautiful water," or by stating that it is special because the lakes and rivers are different from other places because of the rich history of the Tribe, and that those waters bring life. Along with the water, youth discussed their concern for the fish within those waters, primarily the possibility that cutthroat might become extinct on their land.

Community and Relationships

The youth described multiple facets of community and relationships, including relationships with other youth and adult members of the community as well as the natural community. For example, when youth were prompted to share experiences that made their *hearts sing*, they described the experiences rafting on the river together and how playing trust games, working together to paddle, and having the guidance of their group mentors was important to them. Others talked about watching the sunrise with their friends and how having all the people around them talking and having a good time as the sun rose made their heart sing. Youth often brought up how they liked working together during activities and when their family members were present during the camp.

Youth also described the importance of learning from others and learning from the earth. They appreciated the stories that were shared by Elders and about the history of the people and animals on the land. Many of these stories have both mythological and ecological underpinnings that helped explain the interactions and responsibilities that the human and

natural communities share with the land (Howard, under review). These values about responsibilities to the natural community carried over with the youth when they discussed how the DNR scientists had taught them about how the animals lived, what those animals need to survive, and that the youth should respect and care for the land and animals. Along similar lines, the youth considered fish and other animals as being "part of the community," thus creating a responsibility to care for them.

Youth also discussed that they felt the DNR scientists provided certain affordances to the community through their work. Some youth mentioned that the DNR scientists gave back to the community by sharing their knowledge and "teaching us to do better." One student said the DNR scientists helps share traditional knowledge of plants by sharing their knowledge during community events. Another student claimed that work to increase cutthroat trout would "help the community" because of the cultural connections the community has with the fish. The youth said they appreciated the contributions that the DNR scientists made during the camp in that they made learning interesting and taught them things about their land and the animals that live on it.

Individual Youth Experiences

Although the youth from the focus groups identified the importance of connections to land as well as community and relationships as central themes, the cases extracted from the focus groups show the unique ways that each youth interpreted their interactions with DNR scientists during the camps. While all of the youth experienced working with the DNR scientists in the BTTE camps for at least two seasons, each youth brought in their own interests, funds of knowledge, and range of preexisting science capital. Each youth experienced a different impact with the DNR scientists in this context, thus the possibility of

the DNR scientists to individually influence their potential science trajectories was apparent. These cases demonstrate the encounters and activities that youth engage in with the DNR scientists can impact their engagement, participation, and aspirations in science in various ways.

The cases show that some youth, such as Ivy and Jasmine, show strong potential and interest for a career in the natural sciences, while others, such as Sam, demonstrate less of a desire to pursue such a field. For example, Sam's descriptions of his school science and at-home science experiences indicate he is exposed to low science capital. Although he expressed no interest in a scientific career or other scientific aspirations, he does demonstrate a deep concern for cutthroat trout, particularly the community ecology of the trout with respect to the intricate relationship that his community has had with this species over countless generations. Sam's experiences in the BTTE program provided him many opportunities to explore the environmental concerns that affect cutthroat trout in greater depth along with the cultural implications of their ecology and life history. Sam recognized the disappearance of the cutthroat trout from his land "would mean a lot for the community and it would really hurt us if it goes extinct." He seems to understand that this would be a significant cultural loss for the Tribe, not only as a means of subsistence, but cultural identity. Sam does not want his community to experience this loss and believes that "to get the water back fresh and get the cutthroat trout population to increase" would help the community.

This being the case, Sam showed high interest in the DNR-led activities that addressed the restoration and monitoring of cutthroat and other native fish populations. For example, he chose the visit to the fish hatchery as one of his favorite activities with "all the

different kinds of fish and seeing hundreds of fish" and "keeping fish there so that they could reproduce safely so that they can raise the population." Even if Sam decides to not pursue a scientific career, he could take these experiences to someday advocate for policy that increases efforts to improve water quality and fish populations, promote educational programs, or engage in other forms of environmental and cultural preservation advocacy within his community.

Contrarily, Ivy and Jasmine both show a strong propensity toward a scientific career in natural resources. Not only did both mention that they liked the activities and liked science, they both specifically mentioned that they are seriously considering careers in these fields. Jasmine and Ivy differ from the other youth interviewed in that they both possess high science-related social capital in which they know somebody close to them who currently works in the field, an indicator that they may be more likely to enroll in advanced science courses as they progress through their education (Lyons, 2006). Ivy's sister has worked in the summer youth program, and the mother of Jasmine's best friend works for the tribal Lake Management department. Even still, both girls demonstrate differences in how their interactions with DNR during the camps have affected them.

Ivy's interests lie predominantly with fish and the fisheries department. She was enthusiastic about dissecting the fish and indicated pride that she was the only one out of her group who was willing to do the dissecting. This is important for her identity development to recognize herself an agent of science and for others to view her in this light (Holland, Skinner, William & Cain, 2001). She also emphasized liking the activities that included field monitoring techniques (e.g. electrofishing, gastric lavage) and remembered specifics about how and why they are conducted (e.g. why gastric lavage is performed on fish, how net

gauges catch different sizes of fish). Furthermore, she demonstrated confidence in her knowledge about fish species to challenge Kathy's comments about wanting to save the pike, a non-native fish that eats young cutthroat.

Me:	Are there any fish you are particularly concerned about?
Ivy:	Cutthroat!
Kathy:	The one with the large mouth.
Kolby:	Catfish?
Ivy:	The one that you don't want? Pike?
Kolby:	Pike!
Kathy:	Yeah that one.
Me:	You are worried about the pike? What are you worried about with the pike?
Kathy:	That they might come extinct one day.
Kolby:	You mean....
Kathy:	Vanishing...are eaten.
Me:	So you are worried that the pike might go away.
Kathy:	Yeah.
Me:	(To Ivy) And you are worried about the cutthroat?
Ivy:	Yeah. Cause they are getting eaten by the pike! The babies!

Her conviction in her content knowledge, skills, and attitude of "this is for me" demonstrate her confidence in science. This will continue to be important as she continues to develop her scientific identity with herself and others (Holland et al., 2001).

Jasmine, on the other hand, had a different level of conviction about her scientific self, as she appears to show more of a commitment toward the work that the tribal community has done to address water quality issues. She mentioned this when talking about how the lakes and rivers are different than other places because of the effort the Tribe has put into water quality as well as feeling strongly about not wanting the waters in her community to share a similar fate as the mine-polluted river in Colorado. Jasmine has specific concerns about water quality that were not addressed during the BTTE camps (e.g. face wash microbeads and fertilizers from the golf course), however, she added to her existing capital with knowledge about other environmental concerns and field techniques to measure them.

For example, Jasmine was particularly drawn to macroinvertebrate sampling and learning about the fish that inhabit the streams and lake. Therefore, her experiences with the DNR scientists enhanced her already high science capital and reaffirmed her aspirations to work in a similar field.

Kolby, Kathy and Nathan were more moderate in their expressions of how the activities with the DNR scientists have affected their science aspirations. Although Kolby did not seem to discuss much of the scientific components of the activities he experienced with the DNR scientists, he was especially enthusiastic about his encounter with the wildlife biologist. This one experience seemed to have made Kolby want to be like this biologist, or at least "try to do it one of these times." Although he reports low science capital and little interest in science, he seemed to have felt a connection with what the wildlife biologist shared, which could have a prominent influence on his future science aspirations.

Although Kathy and Nathan both said that they would want to join the summer youth program and would consider careers in DNR, they seemed to vacillate on expressing their scientific interests. On one hand, Kathy seemed to be interested in science at home and claimed that she "really want to be in fisheries" and work for the summer youth program, she also claimed that she did not know what she wanted to do when she grew up. Kathy was interested in activities where she could capture and look at the fish, yet she also did not identify why this was of interest to her. Furthermore, she did not seem to understand the significance of the cutthroat trout was the species of tribal concern and instead was concerned about the welfare of non-native species such as pike. Her mostly non-scientific reflections about the camp made her claims to scientific aspirations toward a career with the

DNR agency somewhat unconvincing. Nevertheless, this is not to say that these experiences did not influence her toward science-related aspirations.

Nathan was largely interested in forests, and he mentioned that he wanted to be a firefighter like his brother. Although he had interest in the activities that involved fish and macroinvertebrates, it is unknown if Nathan might have responded more favorably to a camp that focused on forestry-related science. However, his experiences with the DNR scientists provided him with science-related social capital through interacting with the DNR staff and science-related cultural capital by providing him science content and skills, particularly with electrofishing which he found interesting. These opportunities expand his scientific knowledge about the land beyond the capital that his firefighter brother provides him.

Conclusion

One of the most prominent affordances for youth working with the DNR scientists is the ability to foster an appreciation for the responsibilities that all tribal members of sovereign nations have towards being guardians, or protectors, of their natural resources. Natural resources are a vital component of native Nations, and their sovereign management is a crucial factor in the broader scope of their wellbeing and tribal identity. Some tribal education departments in the Pacific Northwest have adopted leadership programs to prepare students to "make meaningful contributions to Nation Building among Native nations" (Visionary Leaders, 2014, p. 1). Although natural resources are an important piece of this, guardianship of resources encompasses a responsibility for the people to "protect their way of life, their land and natural resources, their elders and their children, their languages, their cultures, their way of being in the present and for those yet to be born" (Visionary Leaders, 2014 p.1). The vision for this level of responsibility with guardianship includes the adoption

of four central tenets, or “four pillars,” which include scholarship, membership, guardianship, and stewardship.

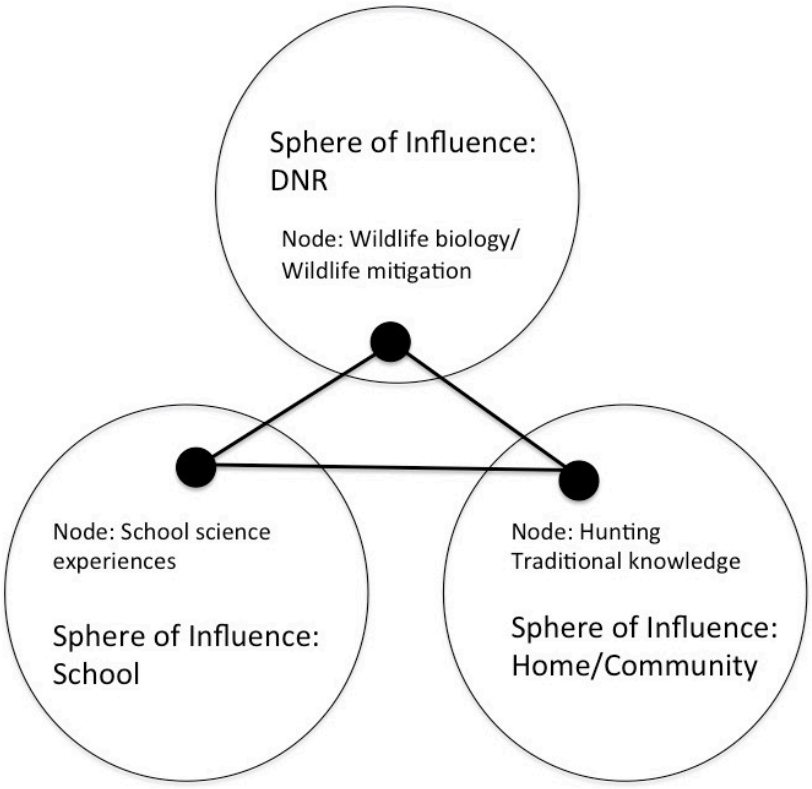
These four pillars embody tribal vitality with individual and communal responsibility to “care for all things with integrity, responsibility, accountability and social awareness in all spheres of life, human, animals, natural resources, and the cosmos, looking at each other from the heart” (Lake Community Tribal Department of Education, personal communication 2016). Under such a vision, we argue that fostering relationships between youth and members of the scientific community, as part of the broader tribal community, comprises one vital component toward sovereign management of land, culture, and community. These relationships help solidify the responsibilities that all members of the community hold in being stewards and guardians of the land, and encourage youth to have an active role in those responsibilities. In this capacity, the tribal DNR has the ability to foster the development of the youth capacity for Nation building by providing opportunities for youth to learn about the work that is being conducted for “all spheres of life.” This has strong implications in developing relevant scientific literacy for all youth, despite their scientific aspirations. Furthermore, these interactions can increase youth’s exposure to science-related capital that inform their scientific aspirations and provide leverage in gaining entry into the scientific careers that directly serve their community.

These experiences provide opportunities for youth to recognize that science can enable positive outcomes that benefit their community. With the example of cutthroat trout, youth learned about the cultural and ecological importance of this species and how DNR works to restore these populations for the greater good. The restoration of this species goes beyond ensuring that the populations are healthy--it includes the possibility to restore a

cultural and spiritual connection between the land and whole community. The scientists approach restoration through implementing traditional scientific knowledge and practices alongside Western scientific knowledge and practices, thus validating ancestral knowledge. Typically only Western scientific knowledge is validated and valued in the school science classroom, thus youth benefit from encountering the use of both in an applied scientific setting.

Although we do not know how these experiences will ultimately influence the youth along their STEM trajectories, they allow youth to engage in novel "spheres of influence" beyond school, home, and television (Archer, DeWitt & Wong, 2014; Wong, 2015). Aspirations are largely influenced by structural forces that include social class, gender, and ethnicity; however, other forces including institutional and free-choice science experiences (e.g. spheres of influence) also impact lifelong learning and aspirations (Falk, 2005). What's more, we can argue that experiences embedded within these spheres have the capacity to influence youth via particular *nodes of influence*. In other words, specific experiences within and across these forces may be the triggers that resonate with youth to affect later choices. For example, Kolby states he has little interest in school science or science at home and even the activities that resonated with many youth at BTTE were barely mentioned. However, Kolby was extremely interested in what the wildlife biologist provided and said with conviction that he wanted to "be him." Thus, the encounter with this biologist may have been a node of influence in Kolby's science aspirations, as he may not have been interested in a scientific career prior to this one experience had the wildlife biologist had not made an appearance at the camp. This could allow him to make connections between wildlife mitigation conducted by the DNR agency, interests at home (hunting) with science content

and processes learned at school (see Figure 2). Another example, Jasmine's awareness of the polluted river in Colorado became a turning point for her in which she realized that she did not want her home waters to experience a similar fate. In this capacity, her science-related knowledge, skills, and processes have provided her a context of meaning and application according to this point of interest. The fate of the distant river and her care for her home waters became her node of influence in which her spheres of influence, including the experiences with the DNR scientists, provided meaning. For Sam, who exhibits low science capital and science aspiration, his experiences with recognizing the importance of cutthroat trout in his community and an awareness of the environmental factors that threaten the trout



could contribute a node of influence that might have a yet-to-be-seen influence on his science trajectory.

Figure 2. Hypothetical illustration of interaction between nodes of influence within and across spheres of influence.

This study points to the importance of community-investment in developing youth access to science capital for Native American youth. Although this type of investment would be beneficial for all youth, Native American communities have a high level of coherence and commitment to the responsibilities associated with community membership and stewardship. In this respect, tribal community scientists working with youth help to not only provide science capital, but also work to challenge settler discourse in dominant science education where Eurocentric science is privileged and often uncontested (Bang, Warren, Rosebery & Medin, 2013). This notion has further implications in that Bourdieusian conceptions of capital according to Archer, et al. (2015) are not merely based on the accrual of capital, but in the struggle over capital (Jensen & Wright, 2015). With the DNR agency just being one example of a field in the larger institution of "science" where minority representation is especially low, the struggle to obtain the capital necessary to participate is substantial.

By providing opportunities for tribal DNR to foster relationships with youth through contextual and community-based science experiences where Western and Indigenous knowledge is valued and youth are upheld in their promise to support the community, the struggle for the accrual of science-related capital has the potential to diminish. Furthermore, such experiences can create a bridge between what capital is valued in the institution of school science with that of the community, thus reducing the severity of border crossings youth might otherwise encounter. Instead of community scientists working to remain in power policing their own interests, they have the ability to reach out to tribal youth to provide them social and cultural capital needed to 1) have a vested interest in the stewardship and management of tribal lands, and 2) obtain tribal DNR employment if they desire.

Through personal encounters with DNR staff on multiple reservations, this appears to be a shared sentiment among similar communities that are working towards common community goals .

This study has provided evidence that promoting community-based engagement between youth and scientists can increase science-related capital for youth by providing opportunities that demonstrate the connection and importance of science in their community. These opportunities add to youth's spheres of influence as well as stimulate new nodes of influence within and across these spheres that have the potential to enhance engagement and aspirations in science. Therefore high quality outreach efforts that engage experts with youth in accordance with engagement and aspiration in community-relevant science has far reaching implications for contributing the next generation of tribal stewards and scientists.

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This material is based upon work supported by the National Science Foundation under Grant No.1139657. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the National Science Foundation.

Chapter 4: There's a crack in everything

"There's a crack in everything, that's how the light gets in." (Cohen, 1992).

"the most objective assessment is one that takes the personal viewpoint fully into account" (Douglass & Moustakas, 1985 p.43).

The research that has been presented in preceding chapters has been the result of a journey intertwined with communal voices that have guided the research process. I have learned to listen, and through that, have come to recognize the power that land, place, and community imbue in learning and being in the world. This sense of place, and being in harmony with each member of the community, is embedded in many of the cultural traditions of the communities in these studies which cannot be separated from education. In fact, these traditions embody the core of an Indigenous education (Cajete, 1999; 2015). The goal of this chapter is to present the learning journey I have encountered throughout the BTTE project and how that has had an impact on how I have come to appreciate research with/in Indigenous communities. Furthermore, I will discuss the common threads that tie these research stories together: Community and land. This research has resulted in more than generating knowledge. I have also unearthed recesses of myself and what makes for a meaningful partnership. Light has been given a chance to shine through the cracks of my being.

At the onset of the BTTE project, I was not working *with* the tribes but *for* them, creating a dichotomy of power and air of expertise that I was not aware of until directly pointed out by the tribal communities involved in the project with us. I thought of myself as a partner, as did the rest of the university-assembled BTTE team; however, a half-listening team of "university experts" wielding money and ideas is hardly a partner. Regardless, the grant cycle began with good intentions and a system rooted in Western ideals of what

constitutes science and research. We could provide our expertise in science, engineering, education, and research, while the tribal partners could provide their expertise in that thing called culture. Put another way, we saw what *we* could provide and had expectations for what *they* would provide. It was transactional and product-based, not relational or reciprocal.

However well intentioned we were at the beginning of the research, Smith (1999) cautions that being well intended is not enough: Western forms of research tend to expand and maintain colonialism. Researchers with Indigenous communities have a responsibility to ensure that research is not done *on* these communities but rather *with* the communities (Kovach 2010; Menzies, 2001). It was not until the objectionable practices of our research team--not because they were unsound in a Western sense, per se, but because they were uncouth in an Indigenous sense--was called out by each of the communities. This prompted long reflections on our own history, ideals, and cultural influences that had to be addressed before we were able to begin to understand the gravity of this responsibility.

For myself, these long reflections allowed the light to begin to seep through the cracks of my veneer. I began to appreciate and consider what responsible research in, with, and for Indigenous communities might look like (Menzies, 2001). Notably, it invited me to awaken to and ruminate upon of the role of the "4 R's" in Indigenous communities: Respect, relevance, reciprocity and responsibility (Kirkness & Barnhardt, 1991). These "4 R's" have become a staple in considerations for Indigenous knowledge, education, and research methodologies by providing the basic outline of Indigenous ethics in these contexts (Archibald, 2008; Castleden, Morgan & Lamb, 2012; Kovach, 2010; Wimmer, 2016). Before I proceed with explaining how I came to understand these tenets in my research, I will provide a brief overview of their meaning and application.

The Research "R's"

Respect. First and foremost, having respect and honor for all individuals, the collective community, and the knowledge, customs, voices, and beliefs of those within is a primary core value in Indigenous relationships. Smith asks the question, "What is respect, and how do we know when researchers are behaving respectfully? What does respect entail at a day -to-day level of interaction?" (1999, p. 97). While this question does not have a simple answer, ensuring that the researcher is open minded enough to truly listen to the needs and values of the community without enacting judgment or appropriating the culture or knowledge is of vital importance (Bishop, 2008; Carjuzaa & Fenimore-Smith, 2010; Smith, 1999).

Relevance. The methods and products of research must be relevant to the community of study. Historically, researchers have used studies in Indigenous communities for their own promotion and benefit, with results intangible to the community (Smith, 1999). Still today, the academy normalizes this form of research practice as part of the democracy of knowledge production (Ermine, Sinclair & Jeffery, 2004). Research with Indigenous communities should explore issues of pertinence and priority to the community rather than those of the researcher's interests. This is not to say that the researcher cannot or should not have ideas in the research process, but the research interests and processes must be mutually agreed upon by the researcher and community involved.

Reciprocity. Research should be a mutual and cooperative exchange where the researcher is expected to give to the community and not just take. This goes hand in hand with relationality, in that the sharing the true self is valued upon developing true and meaningful relationships. Often in Western research, especially under the guise of

objectivism, the researcher remains distant from the research subjects, resulting in a one-sided power imbalance that in turn evokes an air of "unearned advantage and conferred dominance" (McIntosh, 1998). The researcher expects the participants to share for the sake of academic knowledge production while exempt of the duty to share anything of themselves. According to Fine, Tuck, and ZellerBerkman (2008), "For those imbibed in privilege, to know someone is to expect them to reveal themselves, to tell themselves, to give up their sovereignty, while at the same time shielded by their privilege, never having to show their own bloodstains, track marks, piling bills, or mismatched socks" (p. 169). Contrarily, Blodgett et al. (2011) provide the following recommendation from one of their research participants:

> When you nonnative researchers come into our community you need to come with your palms up and open...to do meaningful research you have to sit down and visit. I'm not going to tell you everything unless I know you or feel I can trust you. In that sense, I think our people need to read you as a human person. That's when the community will accept you and you are able to connect with the right people who will make your journey and the research process easier." (p. 528).

Therefore, giving oneself to the community is a move toward balancing the scales of inequity within the research process.

Responsibility. Both the researcher and the communities have responsibilities to the methods that inform the research, the knowledge that is shared, and ensuring that the knowledge is not appropriated. The researcher must ask whom the research benefits along with its implications while accepting the responsibility of the knowledge that is being constructed (Potts & Brown, 2015). Ultimately there is a responsibility to ensure the research

is beneficial to the land, to the community, and to Indigenous people (Kovach, 2005; Smith, 1999; Wilson, 2008). We must ask ourselves *is the research done "in a good way?"*

Although other scholars have added or reconceptualized the "R's," including Relationships, Relationality, Resistance, Reflexivity and Representation (Houston, 2007; Kovach 2010; Martin, 2002; Nicholls, 2009; Wilson, 2008), what is important to note is that they are not discrete units, but intertwine as a basic protocol for conducting research with/in Indigenous communities (Aveling, 2013). These R's, in combination with efforts toward decolonization that I will discuss later, became a staple with how I began to conduct my own research. Nado Aveling, a white woman who has conducted research with Indigenous communities in Australia, claims that as non-Indigenous people, we cannot pretend to imagine that we know about Indigenous epistemologies or experiences, we can only use what we do know (2013). Like Aveling, I do not claim to know about the epistemologies or experiences in the research presented, but I do know that I have experienced a shift in how I have come to approach research, and these shifts have resulted in outcomes that more holistically represent the communities involved in the BTTE project.

This shift has been particularly evident in my struggles and growth in the study outlined in Chapter Two, in which I was interested in looking at how youth in the first year of the BTTE summer camp constructed models of an environmental engineering design. I was interested in analyzing the aspects that included the identification of problems and developing solutions according to Western scientific and engineering knowledge and processes. These were the elements that I favored both what was taught during the camp and what I deemed worthy of research. Certainly, the youth were able to accomplish some remarkable feats in this context: They were able to understand complex ecological concepts

and develop engineering solutions to mediate for the environmental concerns in their environment. It could be argued that any educator would have been impressed. However, the collective efforts to produce this lesson did not fully incorporate the voice of the tribal community, and it certainly was not voiced as a topic of concern for research.

On the margins of the university-team-designed BTTE camp that year, members of the community came to tell the young people stories, share the history of the land, and to tell them what science, including Indigenous science, means to their community. The youth listened, and they demonstrated what they heard in their models. The community members had been trying to tell us what issues were important in the community, but the university team did not seem to have the toolkit necessary to hear what was being shared. Our "R's" were underdeveloped, misconstrued, or absent altogether. We did not respect the Indigenous voices or knowledge being shared in the capacity to understand the role they played in the project development or the research. In other words, the voices were present, but not truly heard by the university team. We were too stuck in our own agenda to genuinely listen. Furthermore, the research project that I embarked on was my own personal interest, largely because I helped to design that lesson and I was pleased with the outcomes that the youth had created. That is, the research that I originally outlined was meaningful to me, but not particularly relevant to the community. Regarding reciprocity, we were giving our expertise, not our real selves. We thought that our reciprocity was the work we were putting into designing and implementing curriculum for the community rather than the real work of developing personal relationships and giving back to the community in genuine ways. This was compounded by the fact that we had only worked with the community for a less than a year, from a distance, and with minimal effort to develop a real and meaningful relationships.

Lastly, we did not understand our responsibility to ensuring that the research was done in a "good way" for the sake of the community, and for the sake of our responsibility to counter the ineffective and often irresponsible research others have conducted with Indigenous communities.

This frustrating reality for our tribal partners led them to the decision to help our university team understand the "R's" and conceptualize how we, as researchers, have a choice in whether we contribute to the modern process of colonization with our research, or move toward allying with our Indigenous partners toward decolonization (meeting notes, October, 2013). This, of course, is a challenge that bears tremendous responsibility. What does colonization in today's society look like? How do we work toward decolonizing ourselves, our research, and our contributions to society?

In the title of their 2012 paper, Tuck and Yang directly warn us that "decolonization is not a metaphor." In other words, the act of decolonization is a large and very real task toward the "repatriation of Indigenous land and life" (p. 1) and not merely another term for social justice. Tuck and Yang (2012) claim the roots of colonization run deep throughout Western society, particularly driven by settler colonial discourse. That is to say, the forces of colonization come largely from settler ideologies presented throughout multiple facets of historical and modern society (e.g. media, arts, education, property rights, laws, knowledge generation, etc.) (Tuck & Yang, 2012; Tsosie, 2002). Particularly relevant to existing within modern Western society is how coloniality has emerged from colonialism:

> Coloniality... refers to long-standing patterns of power that emerged as a result of colonialism, but that define culture, labor, intersubjective relations, and knowledge production well beyond the strict limits of colonial administrations. Thus, coloniality

> survives colonialism. It is maintained alive in books, in the criteria for academic performance, in cultural patterns, in common sense, in the self-image of peoples, in aspirations of self, and so many other aspects of our modern experience. In a way, as modern subjects we breathe coloniality all the time and everyday (Maldonado-Torres, 2007, p. 243).

Decolonization, then, is a challenge against not only the settlement and control of Indigenous people of an area (i.e. colonization) but also resisting the broader implications of coloniality. This presents a responsibility for settlers, like myself, to self-locate and ask questions about how we acknowledge Indigenous peoples, homelands, and knowledge, and in what ways we enter--as invited guests, trespassers, visitors, etc. (Snelgrove, Dhamoon, & Corntassel, 2014). How does this self-location position our responsibilities to Indigenous people? How does this position our research? Will we choose to use our research to contribute to the status quo, or challenge it (Potts & Brown, 2015)?

Re-search

Blodgett, Schinke, Smith, Peltier and Pheasant (2011) claim that research itself "is a metaphor for colonization (p. 522). Research with/in Indigenous communities carries a responsibility to challenge the status quo of coloniality and work toward decolonization. Choosing Indigenous methodologies (Chilsa, 2011; Kovach, 2005; Wilson, 2008) or anti-oppressive research (Potts & Brown, 2015) provide various means for researching as a form of resistance (Brown & Strega, 2015). Within my own research practices, anti-oppressive research and reflexivity (Berger, 2013) allowed me to finally open up to the ideas and forms of resistance that the community had tried to convey earlier in the project, including those lessons provided by Bigfoot. In other words, I began to reexamine, or re-search, the process

and subject of the research I was engaging in. Instead of positioning the research on those things that I thought the Western system would be interested in consuming (i.e. STEM learning), I began to pay heed to what I was too blinded to observe previously in the camp (i.e. the role of community and place in STEM learning). Years of training in the Western conception of what constitutes research originally convinced me that the first position included topics worth exploring. When place and community were privileged and centered in the research, however, it became meaningful because such positioning allowed me to recognize, legitimize, and value the worldviews, realities, and knowledge of the community and their roles in science education. Furthermore, this positioning promoted the implementation of these Indigenous facets of community into additional land-based/place-based science curricula aligning with traditional values and pedagogies, not only for this community, but other Indigenous communities as well. The role that communities play in the education of Indigenous youth is vital for their success (Cajete, 1994; 2015).

The Role of Land and Communities in Science Education

The two studies presented in this volume both include the prominent theme that communities and land play vital roles in the education of Native American youth. For example, in Chapter Two, youth spent time playing, exploring, and learning in a culturally-significant creek, from which the teachers included the university-team, tribal community members, the land, and the stories that they shared. Although youth were directed by the university-team to view the creek as something to be studied and fixed, the tribal community members shared stories with the youth about how the creek has benefitted the community over time and how the youth can give back to the creek by being stewards. The creek and all relatives living amongst it are members of the community deserving care, respect, and

stewardship. These include relatives we may not likely encounter, such as Bigfoot, or those who will hopefully return one day, like Salmon. As a member of the community, it is important to respect and consider all the relatives in the community and their rightful place within the land "with integrity, responsibility, accountability and social awareness in all spheres of life." (Lake Community Tribal Department of Education, personal communication 2016).

Communities were also a prominent theme in the research presented in Chapter Three in which sociocultural relationships between youth, Natural Resources community scientists (DNR), the land, and other community members (human and non-human) afford the building of science capital that is contextually and culturally relevant to the community. Youth appeared to understand that the cutthroat trout rightfully belong in the streams of the land and that they positively affect the wellbeing of the cultural and communal ecosystem. This has demonstrated important implications for youth in their science interests and/or aspirations that could contribute to future advancement through the STEM pipeline. With a land-based approach and through the context of culturally-significant fish, the community scientists help youth develop and refine interests in STEM in their communities through various nodes of influence. In this sense, the science interests and aspirations youth exhibit are connected to the responsibilities to the community, not merely through the acquisition of science capital alone.

The results of this study are meaningful to the community involved in this research, because they were interested to learn more about how integrating scientific experts from the community into educational opportunities that use tribal land as an extension of the classroom would impact youth. They have a strong desire to see the youth holding these

positions as leaders of the community, and stewards and guardians of the land. The director of education in this community has repeatedly expressed her desire to keep the youth in the pipeline so that they can serve the greater good of the community and "promote our people" (meeting notes, November 2014). This study provides evidence that not only community experts, such as scientists, are important for youth science education, but the land and other community members contribute to this as well.

Implications for Further Research

The findings from these studies ultimately leads to a call for more research on how land and community can be implemented into modern education for Indigenous youth. As momentum with decolonizing education continues, our understanding of Indigenized education, including the incorporation of land and community, must also continue to be explored. Provided that I am non-Indigenous, it is not my place to consider what forms of research must be pursued. However, the research that I have conducted does lead to additional questions and provides the recognition for additional exploration.

For example, under Archer and colleague's current conception of science capital (Archer & DeWitt, 2016), the construct is limited to application in Western formal education and culture. Although their work includes students of Black Caribbean, Bangladeshi, Pakistani, Indian, and Chinese ethnicities in the British education system, and have indicated that minority ethnic students participate in science in diverse ways (Wong, 2015), it does not address how science capital itself may be varied or have different leverage within communities. This is particularly relevant for Indigenous communities that utilize both Indigenous and Western knowledge systems in their scientific agencies. I propose investing additional research in identifying more specifically what constitutes science capital within

Indigenous communities, and determining which avenues enhance youth access to relevant science capital for recruitment and retainment in the scientific pipeline. For example, youth interactions with community scientists, as outlined in Chapter Three, are only one way of increasing science-related social and science capital. Science capital within Indigenous communities likely also includes access to other community experts, such as Elders and other knowledge keepers, as indicated through the student use of Bigfoot stories in scientific applications. This is important in the face of recent research that posits stories can provide benefits to youth in science education (Fleer, 2013; Hadzigeorgiou, 2016; Kahraman, 2015; Kokkotas, Malamitsa, & Rizaki, 2010), yet others have advocated for a limitation on including only stories that are couched in a historical premise (Klassen, 2014; Klassen & Klassen, 2014). Considering the Western education system privileges Western Eurocentric contributions to science, research that does not include the value of Indigenous stories could lead to further alienation of Native Americans in the scientific pipeline. This leads to additional questions, such as how these forms of science capital have leverage within Indigenous communities and how they can be incorporated into mainstream education, affordances of the reciprocal nature of sharing science capital (i.e. what does the party sharing science capital gain?), issues of appropriation or misuse, as well as how Native youth living in urban environments are affected by access to Indigenous forms of science capital. Although the Indigenous communities themselves will be the ones to determine the practicality of exploring these questions, the changing landscape of Indigenous education would likely benefit from understanding more about these issues.

Ally or Accomplice?

Our tribal partners in the BTTE project have challenged each of us to "be an accomplice, not just an ally" (meeting notes October 2013, November 2015). More specifically, this challenge relates to both personal and academic roles within the academic system as well as issues outside of the academy: "Instead of just bringing your 'expertise,' be an accomplice to tribal causes. Fight the systems!" (Meeting notes November 2015). Although it can be relatively easy to proclaim an alliance with Indigenous communities, being an accomplice means something more substantial. An article published on the Indigenous Action Media website states, "Too often, Indigenous liberation struggles for life and land, by nature, directly confront the entire framework to which this colonial and capitalist society is based on" ("Accomplices, Not Allies," 2014). Therefore, to be an accomplice means to question and fight the incredibly large and powerful system with which we are imbedded. Academics have unique tools that can assist with this task, as they "seek ways to leverage resources and material support and/or betray their institution to further liberation struggles. An intellectual accomplice would strategize with, not for, and not be afraid to pick up a hammer" ("Accomplices, Not Allies," 2014).

While I would like to say that I am willing to take on the role of accomplice, I realize that it is not an either/or proclamation. You do not decide to be an accomplice, nor do you get selected to be an accomplice. You either are or you are not. However, with this also comes complexity and messiness as we make contradictory choices in our lives. Eve Tuck describes this as "complex personhood" in which we, as human beings, are lured and pulled in different directions because "all people remember and forget, are beset by contradiction, and recognize and misrecognize themselves and others" (Gordon, 1997, p. 4). Collectively

recognizing these complexities provides a way to absorb the contradictions for a sort of collective balance. In other words, "it is our work to afford the multiplicity of life's choices for one another" (Tuck, p. 421). This is not to say that we are not accountable for our actions, as we most certainly are. However, this points to the complexity that at times, we may be accomplices, and at other times we may find ourselves being colonizers. As a researcher, being reflective in the process and using reflexivity about the nature of the research (i.e. who the research is for, how it is being conducted, and what or who the research is privileging) is a first step, and only then can we determine if the work has the capability to "pick up a hammer." To challenge a system, the first aspect to challenge is ourselves (Potts & Brown, 2015).

While I feel greatly privileged to have taken this journey, my odyssey is nowhere near complete. In fact, it has only just begun. I have come to appreciate the tremendous task of decolonizing the systems that threaten Indigenous people and understand that I have a role to play in that process, with research being one tool. For that, I am committed to remain an ally, and when I rise to the occasion, an accomplice.

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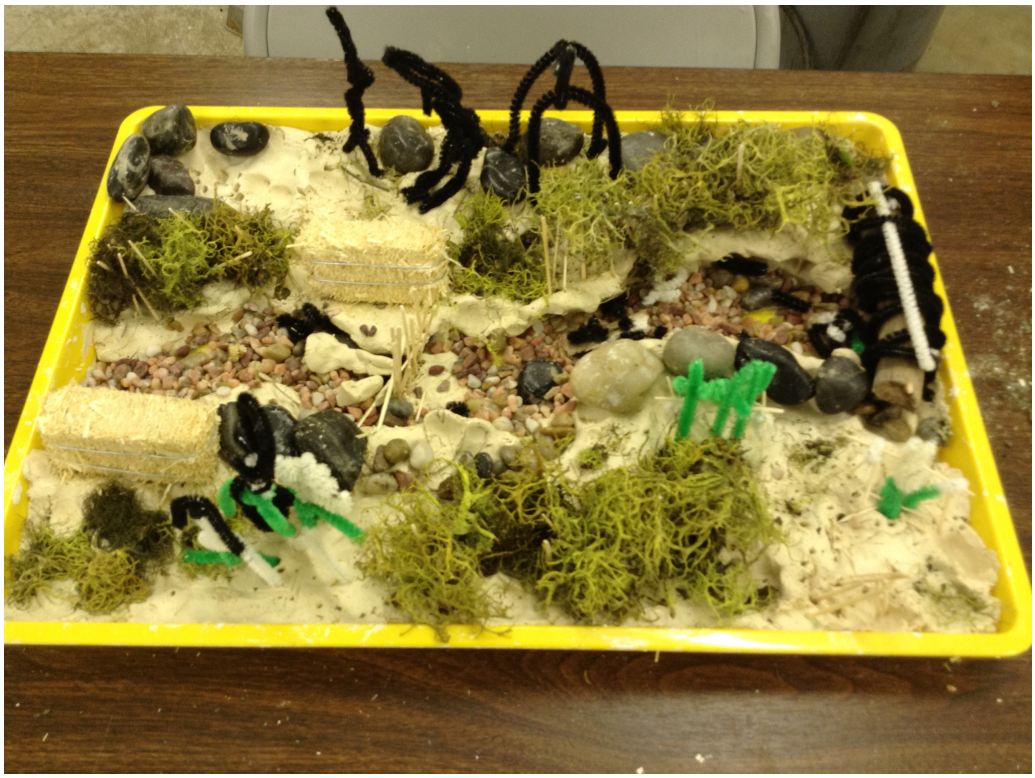
Appendix A: Student Stream Restoration Models



Appendix B: Stream Restoration Model Assessment Rubric

BTTE Stream Restoration Models 2013 Assessment

Thank you for agreeing to be a rater of student work with this rubric. The following rubric will be used to analyze the culminating stream restoration modeling activity from Back to the Earth Camp Summer 2013. Each team of students was comprised of 4-6th graders, guided by a teen mentor. Although everyone was considered a steward of the creek throughout his or her camp experiences, each team was entrusted as a guardian to one section of the creek for environmental restoration. In this activity, teams were instructed to use their observations and knowledge, including the data they collected via their camp experience. Each team determined environmental problems, designed an engineering solution, created a three-dimensional model of their restoration plan, and presented their model and solution to the community. Students were expected to justify each action represented on their model.

This rubric consists of four sections:

I. Holistic representation of the model,
II. Identification of environmental concerns,
III. Evidence of engineering applications and
IV. Evidence for human interactions within the ecosystem.

Please use all available media sources, including video of student presentations, transcripts of presentations, and photos of the models, to serve as evidence in making your ratings. You might consider the following process, iteratively moving between the data sources, rubric elements, and your own questions:

1) Before engaging with the rubric, familiarize yourself with the photo of the model and watch the video in entirety.
2) Read through the rubric and note some general findings from these data sources, as well as your questions
3) Familiarize yourself with any additional data sources
4) Begin to make careful entries onto the rubric form, noting questions
5) Review data sources that can shed light on remaining questions
6) Complete as much of the remaining rubric entries as you are comfortable with

If you feel uncomfortable rating any section, you may omit it from your review. However, we value any data you can provide.

Again, thank you for your participation.

Group members:_____

Teen Leader:_____ Date of Model Build:_____

Rater's Name_____ Date of Rating:_____

Part I: Holistic Representation

Please use the video presentation, transcripts, and photos of the model to rate your overall impression of how the group exemplified a holistic representation of the model. Consider the inclusion of stewardship and guardianship, use of multiple sources of knowledge, connection with tribal values, and overall integration of elements.

Part II: Evidence for identification riverine environmental concerns in the model and/or data

Please use the video presentation, transcripts, and photos of the model to rate how the group addressed environmental concerns in their system. You may write comments in each box to support your rationale. For the overall assessment, please rate according to your overall opinion rather than as a summary of the categories above.

STEM: Identification of riverine environmental concerns	0 Concern is not addressed or included in model/data	1 Concern is included in model/data, but no explanation or context is provided	2 Concern is included with some explanation and context of problem provided; sources and impacts of concern are not evident	3 Concern is included in model with explanation or context of problem provided that includes clear rationale for sources and impacts of concern
Erosion				
Substrate complexity				
Stream complexity (shape, depth)				
Temperature				
Dissolved Oxygen				

Turbidity				
Other (Does not easily fit in a category)				
Overall assessment of presented concerns				

Part III: Evidence for engineering applications in the model and/or data.
Please use the video presentation, transcripts, and photos of the model to rate how the group proposed solutions to the concerns addressed in their system. You may write comments in each box to support your rationale. For the overall assessment, please rate according to your overall opinion rather than as a summary of the categories above.

Evidence for Engineering Applications in Model/Data

STEM: Application of Engineering	0 Model/data does not include this engineering application	1 Model/data includes limited/unclear evidence of this engineering application or inappropriate use of application	2 Model/data includes some evidence of this engineering application and its appropriate use	3 Model/data includes clear evidence of innovative and efficient use of this engineering application
Erosion control (Natural or manmade)				
Substrate complexity (pebbles)				
Stream complexity (meandering, depth)				
Shade (overhanging bank, veg)				
Resting/hiding places for fish				
Food for fish or other animals				

Breeding sites (small cobble, high DO, low temp, shallow)				
Other (Does not easily fit in a category**)**				
Overall assessment of engineering application				

Part IV: Evidence for human interactions within the ecosystem as presented in the model and/or data

Please use the video presentation, transcripts, and photos of the model to indicate how each group represented human interactions within their system. Please place a check mark next to those items that are present with a corresponding list or commentary of what was presented.

Area of Focus	✓= Yes	Commentary / List
Gathering places		
Dwellings		
Food capture/harvest/ preparation		
Preservation/Sustainability of Historical Foods (First foods)		
Identification of organisms (list all plants, animals, fungi, etc.)		
Interaction with organisms other than food		

Indigenous technology* (list all)		
Eurocentric technology* (list all)		
Integrated technology* (list all)		
Ceremonial sites/spaces		
Other		

**Examples:*
Fish weir = Indigenous technology
Fish counting station = Eurocentric technology
TEK ⟷ Western Science = Integrated technology (cannot be easily separated)

Appendix C: Institutional Review Board Approval Letter

University *of* Idaho
Office of Research Assurances
Institutional Review Board
875 Perimeter Drive, MS 3010
Moscow ID 83844-3010
Phone: 208-885-6162
Fax: 208-885-5752
irb@uidaho.edu

To: Anne Kern

From: Sharon Stoll
Chair, University of Idaho Institutional Review Board
University Research Office
Moscow, ID 83844-3010

Date: 2/8/2016 4:12:06 PM

Title: Affordances of Youth Partnerships with Community Scientists

Project: 16-1098
Approved: February 08, 2016
Renewal: February 07, 2017

On behalf of the Institutional Review Board at the University of Idaho, I am pleased to inform you that the protocol for the above-named research project is approved as offering no significant risk to human subjects.

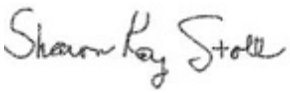
This study may be conducted according to the protocol described in the application without further review by the IRB. Every effort should be made to ensure that the project is conducted in a manner consistent with the three fundamental principles identified in the Belmont Report: respect for persons; beneficence; and justice.

This IRB approval is not to be construed as authorization to recruit participants or conduct research in schools or other institutions, including on Native Reserved lands or within Native Institutions, which have their own policies that require approvals before Human Participants Research Projects can begin. This authorization must be obtained from the appropriate Tribal Government (or equivalent) and/or Institutional Administration. This may include independent review by a tribal or institutional IRB or equivalent. It is the investigator's responsibility to obtain all such necessary approvals and provide copies of these approvals to ORA, in order to allow the IRB to maintain current records.

As Principal Investigator, you are responsible for ensuring compliance with all applicable FERPA regulations, University of Idaho policies, state and federal regulations.

This approval is valid until February 07, 2017.

Should there be significant changes in the protocol for this project, it will be necessary for you to submit an amendment to this protocol for review by the Committee using the Portal. If you have any additional questions about this process, please contact me through the portal's messaging system by clicking the ‘Reply’ button at the top of this message.



Sharon Stoll

Appendix D: Letter of Support from Coeur d'Alene Tribe

COEUR D'ALENE TRIBE

850 "A" Street, P.O. Box 408
Plummer, Idaho 83851

February 3, 2016

Re: Letter of Support for Mindy Howard

Dear Institutional Review Board committee members,

The Coeur d'Alene Tribe's Fisheries program has worked in cooperation with the University of Idaho's Back to the Earth project since 2012. PHD student Mindy Howard has worked extensively with our program planning, organizing and implementing this project as a community liaison between the Tribe and University. Throughout her work on the BTTE camp and other special projects we have developed a strong working relationship based on trust and open communication. It has come to our attention that Mindy is interested in collaborating with our department on a research project that would provide insight into the role DNR has in influencing student awareness of local environmental concerns, what role we have in influencing student science aspiration and how this benefits our program and community. As we begin the planning process for this year's BTTE camp these are questions that would afford us valuable insight into the planning process and how to best move forward in our efforts. Mindy has worked to build strong relationships with our youth and I feel with the tribe as a partner, she would be well suited to implement this type of research here in the community.

We are pleased to offer our support and feel that this project aligns well with the outcome goals of our department. Please contact me if you have any questions.

Gina Baughn

Gina Baughn

Natural Resource Education Specialist
Coeur d'Alene Tribe
Department of Natural Resources, Fisheries

Appendix E: Parent/Guardian Consent Form

Informed Consent
Research Study: The Affordances of Youth Partnerships with Community Scientists

Information and Purpose: The focus group for which your child is being asked to participate is a part of a research study that is focused on determining the importance of youth relationships with science professionals such as Natural Resources staff on aspirations in science, science–related careers, and awareness of local environmental concerns.

Your Child's Participation: Your child's participation in this study will consist of a discussion in a focus group lasting approximately one hour. Your child will be asked a series of questions with other camp participants about his/her experiences in the Back to the Earth Camp as they relate to activities with Natural Resources staff. Your child is not required to answer any questions and questions may be skipped. At any time your child may notify the researcher that he/she would like to stop the interview and participation in the study. There is no penalty for discontinuing participation.

Benefits and Risks: By participating in this study, your child will likely not gain any direct benefit, yet his/her responses have the potential to contribute to more opportunities for youth to work directly with science professionals in the community. There are no perceived risks associated with participating in the study.

Confidentiality: The focus group session will be audio recorded; however, your child's name will be assigned a pseudonym to protect identity. No identifying information will be associated with any part of the written report of the research. All information and interview responses will be kept confidential, although it cannot be guaranteed that other child participants will not share responses outside of the focus group. The researcher will not share individual responses with anyone other than the research committee.

If you have any questions or concerns, please contact the researcher Mindy Howard (University of Idaho graduate student) or her supervisor (Dr. Anne Kern).

Dr. Anne Kern
Dept. of Curriculum and Instruction
College of Education
University of Idaho-Coeur d'Alene
208.292.1402
akern@uidaho.edu
1031 N. Academic Way
Coeur d'Alene, ID 83814

Melinda (Mindy) Howard
Graduate Student
University of Idaho-Coeur d'Alene
425.891.3255
509.242.1213
howard.mindy@gmail.com
1031 N. Academic Way
Coeur d'Alene, ID 8381

Informed Consent
Research Study: The Affordances of Youth Partnerships with Community Scientists

By signing below I acknowledge that I have read and understand the above information. I am aware that my child can discontinue participation in the study at any time.

Signature_____

Printed Name _____

Name of Participating Child _____

Date_____

Appendix F: Student Assent Form

STUDENT ASSENT FORM

Research Study: The Affordances of Youth Partnerships with Community Scientists

Dear Student,

We are asking you to help inform how the *BTTE* activities impact your understanding of science, engineering, and technology as they relate to your awareness of environmental concerns; your attitudes about science, engineering, and technology; and your interest in science, engineering, and technology related careers though participation in the *BTTE* project. We will be asking you to participate in interviews and/or focus groups to learn about how these activities in BTTE have affected you. The interviews and focus groups will be private and secured using a digital audio recording device and associated transcripts will be kept in a locked file cabinet accessible only by the researcher, Mindy Howard, the project PI, Anne Kern and the UI-BTTE research committee. Your name will not be given to any University staff. We'll use this information to inform our quest in answering specific questions we have about the activities you are involved with. You do not have to answer any questions you are not comfortable with and you are allowed to withdraw at any time with no penalty.

There are no risks to you for helping with this study beyond what you would experience in a typical day. You won't be identified in any written reports on this project. All interview transcripts will be kept locked in a safe place at the University of Idaho. Please choose whether you would like to help or not in the space below and return this form to your teacher or the BTTE team.

If at any time you have questions, you may contact:

Dr. Anne Kern
Department of Curriculum and Instruction
College of Education
University of Idaho-Coeur d'Alene
208.292-1402
akern@uidaho.edu
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University of Idaho-Coeur d'Alene
425.891.3255
howard.mindy@gmail.com
1031 N. Academic Way
Coeur d'Alene, 83814

Please choose if you want to participate or not, then sign and return the bottom part to your teacher or BTTE team. Thank you for your cooperation.

I _____ **DO** choose to participate in the BTTE research project.
(Your name- please print)

Signature _____Date _____

Investigator Name

_____Date_____

I _____ **DO NOT** choose to participate in the BTTE research project.
(Your name- please print)

Signature _____Date _____

Investigator Name

_____Date_____

Appendix G: Youth Focus Group Interview Protocol

Interview #_____
Date_____/_____/_____

Interview Protocol

Script

Welcome and thank you for your participation today. My name is Mindy Howard and I am a student at the University of Idaho. Part of my job as a student is to do research on questions I have about learning. I am interested in learning about what the BTTE camps were like for you and how those experiences shape things you think about and do. In this case I am interested in your experiences with the activities done with the fisheries and wildlife people from DNR. Today I would like us to talk about these experiences. Before we begin, I want you to know that you do not have to answer any of the questions and you may stop or take a break at any time. Just let me know and I am happy to honor that. You will not get in trouble if you decide to stop.

Do you have any questions or concerns before we begin? Do I have your permission to proceed?

1. At the camps we talked a lot about using our six senses to observe the world around us. Write down your most memorable senses. When you are done, we will share out loud. If someone shares something you didn't think about before, you can write it down.
    a. Smell
    b. Sight
    c. Touch
    d. Sound
    e. Taste
    f. Heart

2. Over the last three years of camp we have done lots of activities, many of them about the land and the environment. What can you tell me about some of the things you learned or got to know about the land/your place?
    a. Things you love about the land/place
    b. How the land/place is special
    c. Things about the land that you are worried about
    d. Is there something about the land/place you wish you could change? Why?
3. We are going to look at some pictures from the camp. Each of you will get a set. Take out the pictures and look at them. Organize them into piles or clusters on the paper in any way you like. When you are done, write a word or phrase that describes each pile/cluster.
4. Now organize the pictures from the activities you liked the most to the ones you liked the least. If you didn't do the activity, put that picture to the side.
    a. Why did you like this one the most?

   b. Why did you like this one the least?
5. Pull out a picture of someone you enjoyed working with. What was it about this person you liked? What did they teach you?
6. What kind of job do you think you want when you grow up? What do you think it would be like to work for DNR?
7. What do you think the scientists you met had to do to get their jobs?
8. What kinds of science do you do at school? What are your favorite science materials you get to use?
9. What kinds of science do you do at home? What kinds of science materials or shows do you use/watch?
10. Who supports you the most to learn and do well in science (can be at home, school, or other places)? Do you have any family members or relatives who are scientists?

Appendix H: Photos Used During Youth Focus Groups