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Welcome

Cheryl Crazy Bull, President & CEO
American Indian College Fund

Mitakuyepi.
Greetings, relatives.

This journal, the first of its kind — a juried collection of research and scholarship by tribal college faculty — is rooted in our traditions of inquiry and investigation. The journal captures the diversity of research experiences of tribal college faculty and their students. Over the years, I have observed many different approaches to community-based research and find it very rewarding that the American Indian College Fund is able to facilitate the dissemination of the community-based research of tribal colleges through this journal. I am reminded of the words of Dr. Nate St. Pierre, President of Stone Child College: that tribal colleges are not just community centers, they are centers of the community. In that context, tribal colleges must from their missions and out of necessity, be engaged with research that is meaningful to the lives of our tribal citizens. Equally important is the role of tribal colleges to be a bridge between our traditions and contemporary society. This journal documents the roles of engagement, meaning, and bridging so vital to better lives for our students and their families.

The College Fund is pleased to be able to support faculty contributing to new knowledge from diverse perspectives in a way that is familiar to both the tribal world and to the academy. The processes and tools of research featured here honor culturally appropriate research practices and also meet the standards of review recognized by scholars throughout the world.

Enjoy and learn from the work of tribal college scholars.

Wopila, thank you.

Introduction

Ethan Yazzie-Mintz, Editor-In-Chief
Tribal College and University Research Journal

Welcome to the first issue of the *Tribal College and University Research Journal*, a journal of work by current faculty of Tribal Colleges and Universities (TCUs), published by the American Indian College Fund. This is the first academic journal of its kind devoted entirely to the publication and dissemination of research emerging from TCUs, and is the next step in a series of initiatives of the College Fund to make visible the high-quality and important research conducted by TCU faculty.

TCUs are tribally-controlled institutions of higher education, established to provide academic programs and degrees similar to community colleges and other institutions of higher education, in addition to a focus on the language and culture and needs of the tribal community in which they are situated. There are 37 Tribal Colleges and Universities, most of which are located in tribal communities across 14 different states; the first TCU was Navajo Community College (now Diné College), established in 1968 by the Navajo Nation.

As such, TCUs are models for place-based, personalized and localized higher education institutions. They are centers of learning in Native communities, teaching based on the values, culture, history, and language of the tribes or nations by which they are chartered. Often TCUs also provide services, through extended learning opportunities and partnerships, to the communities in which they are located.

Because TCUs are teaching institutions, in which the first responsibility of faculty and staff is teaching and advising students, TCUs are not as well known for the research conducted by faculty. In research institutions of higher education, doing and publishing research is part of the fundamental expectations of faculty; research is often connected to the researcher, and is not necessarily conducted in the community in which the institution is located. By contrast, TCUs operate as mission-driven, place-based institutions; therefore, the purpose of research is similar to the purpose of teaching: to serve the needs, values, history, and culture of the communities in which they are situated.

In line with the kinds of research being conducted at TCUs, the *Tribal College and University Research Journal* is designed to publish research from TCU faculty across a range of content areas using a variety of research methodologies. As the first journal of its kind, there are two major purposes for the journal: an educative purpose and a dissemination purpose. The review and editorial process is designed as a rigorous, peer-review process, similar to other academic journals, with the added educative component: ongoing support for authors, several of whom have never published their work before, in navigating the path through reviews, revisions, editing, and finalizing manuscripts, with the journal audience in mind. Ultimately, the purpose, as with other journals, is to publish these authors' works, and

disseminate the knowledge they generate to the wider world. As a result, this volume brings together works of inquiry that originate and are connected to TCUs in a variety of communities, and, like published pieces in other academic journals, also have implications and lessons for a wide range of communities, settings, and areas of research.

Three of the articles in this issue are focused on research in the science fields. In each case, the scientific inquiry is intimately tied to the lands and communities in which the TCU is situated (and the surrounding areas), and in which the faculty conducted their research.

In *Climate Change and the Sacredness of Water in Native America: A Case Study in the Keweenaw Bay Indian Community, Michigan, USA*, Andrew Kozich uses qualitative methodologies to understand the perspectives of members of the Keweenaw Bay Indian Community on the potential impacts of worldwide climate change on Native lands and communities in the Upper Peninsula of Michigan and the entire Great Lakes region. Three important themes emerge in Kozich's research: "(1) water resources are extremely valued; (2) climate change is happening and will have wide-ranging negative impacts; and (3) support for climate change planning is high and should include traditional ecological knowledge." In the political world, the existence of climate change as a phenomenon is frequently debated; Kozich's research sheds light on the potential impact of climate change on Native communities in the Upper Midwest of the United States, and the potential for traditional Native knowledge and insight to address the observed changes.

Marco Hatch and Sandy Wyllie-Echeverria use a variety of methods, including maps, personal journals, interviews, and archaeological records, to track the Olympia oyster in the waters of the Northwest. Their article, *Historic Distribution of Ostrea Lurida (Olympia Oyster) in the San Juan Archipelago, Washington*, is instructive in both its use of multiple data collection methods, data sources, and analytical strategies, and the connection the piece draws between the history of the species and the current state of the shellfish industry in the region. The relevance to the history and culture of the Native communities in the region is clear: "Coast Salish people are recognized stewards of coastal habitats, habitats that directly contributed to the survival and sustenance of these people…. these people protect and enhance ecologically important coastal habitats, which will positively influence ecosystem stability."

Mandy Guinn and Nicole Olson use innovative techniques to study predator and prey in North Dakota, looking to determine the economic impact of bats on North Dakota agriculture. As the authors assert, North Dakota is the leading producer of canola in the United States; however, the Diamondback Moth presents a potential barrier to the healthy development of canola crops. In *Molecular Evidence for the Consumption of Plutella xylostella (Diamondback Moth) in Bat Guano*, Guinn and Olson use molecular techniques and DNA analysis to determine the impact of bats in North Dakota as deterrents to the destructive effects of the moth on crops; their article presents innovative methods and analysis to attempt to solve a problem faced by the North Dakota agricultural community.

The three other articles in this issue are focused in the social sciences, primarily education. While each has a unit of analysis of the institution --- i.e., the TCU, and, in the majority of these pieces, their own institution --- the implications of their work reach far beyond, and are highly relevant to other TCUs, similar institutions, and other institutions of higher education.

One of the major challenges for Tribal Colleges and Universities, connected to both their purposes and reasons for being, is to provide a high-quality education to students that is connected to the culture, history, and values of the people and community in which they are situated. While all TCUs strive for this goal, there are gaps in theory and implementation. At Tohono O'odham Community College, faculty members Teresa Newberry, Adrian Quijada, Jorge Guarin, and Camillus Lopez, embarked on a process to create and implement an indigenous education model for the Life Sciences program that is rooted in the *Himdag*, the Tohono O'odham way of life; as such, it would be both culturally-connected and sustainable. Their article, *The Man in the Maze: An Indigenous Education Model*, documents this process, identifies application of the model to coursework, and points the way for similar institutions to tightly connect their mission and purpose to the education they provide.

In *Strategies for Retention, Persistence and Completion Rate for Native American Students in Higher Education*, Ahmed Al-Asfour and Marry Abraham study an issue that challenges TCUs, as well as other institutions of higher education: the retention of Native students from semester to semester and from year to year, and the persistence of Native students toward degree completion. A review of the literature and analysis of their own experiences as faculty lead them to identify six factors that can lead to success in this area: mindset, culture and spirituality, family support, quality interactions with faculty, mentoring, and student engagement.

Teaching and learning lies at the heart of every institution of higher education. The significant challenge for TCUs is providing high-quality teaching and learning that is also culturally-rooted and sustainable. In *Relationality and Student Engagement: Connecting Teaching and Learning at a Tribal College*, Brian Compton, Ted Williams, and Cheryl Crazy Bull use narrative, participant reflection, and analysis to describe the intense effort to strengthen teaching and learning at a TCU. The interdisciplinary, holistic, and systemic efforts of the institution in this area are critical to the TCU's success in this effort, linking faculty engagement in learning and improvement to improved experiences in teaching and learning for students. The authors conclude that:

> *Teaching and learning in Indigenous education settings must be holistic and systemic in that it occurs in an integrated manner within academic curricular, cocurricular, and extracurricular settings, is interdisciplinary, and responsive to Tribal, community, and student needs and expectations. When a college can establish and use a systemic approach to teaching and learning and accomplishes institutionalization through outcomes and program development as well as faculty development, student success along with Tribal priorities are furthered.*

Together these articles comprise a volume that is educational, insightful, aesthetic, and scientific, generating knowledge that originates in a particular community and serves particular needs, but carries important implications and lessons for the wider educational and scientific communities. It is an honor to be a part of the journey of this work to publication, and readers will gain much from the work presented here. Enjoy this powerful set of articles in the first issue of the *Tribal College and University Research Journal*, and thank you for being part of the process of making the work of these TCU faculty and researchers visible to a wider audience.

The Man in the Maze: An Indigenous Education Model

Teresa Lynn Newberry, Tohono O'odham Community College
Adrian Quijada, Tohono O'odham Community College
Jorge Guarin, Tohono O'odham Community College
Camillus Lopez, Tohono O'odham Community College

One of the challenges faced by institutions of higher education is to provide a high-quality education to students; one of the additional challenges of tribal colleges and universities is to ensure that the high-quality education they provide is rooted in the culture, language, history, and values of the communities in which they are situated and the tribes which they serve. In this article, Teresa Newberry, Adrian Quijada, Jorge Guarin, and Camillus Lopez, all faculty members at Tohono O'odham Community College (TOCC), investigate the development and implementation of an indigenous education model for the Associate of Life Science program at TOCC. The model is framed around a central cultural metaphor: the Man in the Maze, representing a holistic educational journey in the Himdag, the Tohono O'odham way of life. The authors document the process of identifying the metaphor, developing the model, and applying the model at the course level within the Life Sciences program, thus sharing the TOCC story while also providing guidance to other similar institutions of higher education addressing these same challenges.

Introduction

Tohono O'odham Community College (TOCC) is the institution of higher education of the Tohono O'odham Nation (TON) and is one of the 38 tribally-controlled colleges and universities in the United States. Located in the heart of the Sonoran desert of southern Arizona and northern Mexico, the Tohono O'odham Nation is home to the Tohono O'odham, or "Desert People." Before European contact, the Tohono O'odham were sovereign by virtue of their political, social, cultural, and religious structures and lived sustainably on their lands for thousands of years through application of their own unique knowledge and educational systems which are part of their *Himdag* (Tohono O'odham Way of Life). As with the Tohono O'odham Nation, Tohono O'odham educational institutions have historically been under the control of European missionaries, the United States government, or the Arizona State government utilizing pedagogy based on Western education philosophy. For generations, Tohono O'odham leaders and elders dreamed of a college, locally controlled and operated. With internal infrastructure development on the Tohono O'odham Nation, the people began to exert sovereignty over their educational institutions. *Nia, oya g t-taccui am hab e-ju* (Our Dream Fulfilled), the dream of the O'odham elders and educators, became a reality with the establishment of the College, chartered in 1998 by Legislative Council Resolution. The college opened its doors, welcoming the first class of students, during the spring semester of 2000.

The establishment of Tohono O'odham Community College (TOCC), as with all tribally-controlled education, is an act of cultural restoration (Crazy Bull, 2010) and reconciliation through deconstructing and challenging the dominance of Western knowledge (Kanu, 2006; Wilson, 2004). As such, TOCC has a mandate to preserve and strengthen the Tohono O'odham *Himdag*, which is stated clearly in our mission statement as follows:

> As an accredited and land grant institution, TOCC's mission is to enhance our unique Tohono O'odham Himdag by strengthening individuals, families, and communities through holistic, quality higher education services. These services will include research opportunities and programs that address academic, life, and development skills.

The mission statement defines the central institutional challenge of TOCC, which is not only to provide a higher education but to provide a higher education that enhances and strengthens the unique Tohono O'odham Himdag.

Since its inception in 2000, TOCC has endeavored to fulfill its mission; however, the path of deconstructing Western pedagogy and providing a higher education based on the unique worldview of the Tohono O'odham perspective has proven to be a great challenge as well as a path of discovery and innovation. Initial efforts focused on the enhancement of the *Himdag* by cultural integration at the course level by individual faculty and through the requirement of a Tohono O'odham history course and Tohono O'odham language course for all students. However, while this addressed the incorporation of content into the courses, it still primarily utilized Western pedagogical methods. It also resulted in a compartmentalized and sporadic approach to cultural integration as is common in most culturally responsive education (Castagno and Brayboy, 2008).

Program-level assessment at TOCC presented an additional challenge because program-level evaluation processes must not only measure student attainment in Western knowledge and skills but must also include a measure of mastery in cultural knowledge. In order to address this challenge and to serve as guiding principles for the college, TOCC adopted the T-So:son or cultural core values based on the Himdag. The four core values are T-apedag (health), T-pik-elida (respect), I-wemta (teamwork) and T-wohocududag (spirituality). Since 2009, program-level assessment has included the adoption of program-level outcomes to measure student success in applying and understanding the T-So:son. However, this has proven problematic because applying Western evaluation and assessment techniques to program-level assessment does not adequately measure the enhancement of the unique Tohono O'odham Himdag in our programs. The objective of this project is to address these issues by establishing a comprehensive, systematic and intentional approach to integrating our curriculum into the *Himdag* at TOCC based on the principles of indigenous pedagogy and indigenous evaluation methodology. The goal is to not only transform our institution but also to create a paradigm for deep cultural integration which can be used by other tribal colleges and minority-serving institutions.

Although much is written about the importance of culturally-responsive education, there is a lack of comprehensive restructuring of culturally responsive education that takes into account Indigenous epistemologies and tribal communities (Castagno and Brayboy, 2008). Therefore, there is a lack of guidance in the literature regarding the methodology for the creation of indigenous education models. A methodology for the creation of an indigenous education framework unique to the

worldview of tribal communities is needed to serve as a valuable guide for other tribal colleges or Native-serving institutions. This issue is clearly stated in the case of the Indigenous Evaluation Framework, which asserts that if evaluation is to help achieve educational goals, Native institutions need to practice evaluation in ways that reflect traditional values and ways of knowing (LaFrance & Nichols, 2009).

This paper explores the use of a central cultural metaphor upon which to frame an indigenous education model. According to Cajete (2005), in order to achieve the ideals of tribal education, American Indian education needs to be founded on a shared cultural metaphor that embodies tribal epistemologies. Additionally, according to LaFrance and Nichols (2010), evaluation processes that are robust enough to accommodate and value different "ways of knowing" must be based upon a cultural framework unique to each tribal community. For these reasons, this project proposes to create an indigenous educational model based on a cultural metaphor that will serve as a framework for curriculum development and program assessment. Cajete (2005) encourages the use of the cultural metaphors based on symbolic expressions because they reflect "the metaphysical, ecological and cultural constructs of a tribal epistemology" and "common understandings and shared foundations for traditional ways of learning." Modern research on brain-based learning suggests that information is most effectively and efficiently learned when presented in an overall framework (Bransford, 2000), which further strengthens the argument for presenting knowledge using a cultural metaphor as a framework.

Based on our need for both an indigenous education model founded on the unique tribal epistemology of the Tohono O'odham and an effective culturally-based method to evaluate our programs, this study proposes to answer the following questions:

- *What is an appropriate cultural metaphor upon which to frame an indigenous education and evaluation model for Tohono O'odham Community College?*
- *What is the methodology for creating and implementing an indigenous education and evaluation model at Tohono O'odham Community College?*

This study focusses on STEM education and the Associate of Science (A.S.) Life Science program; therefore, our objectives also include excellence in culturally-responsive STEM education, increased participation of Tohono O'odham in the STEM disciplines, and the development of a core of Tohono O'odham qualified to provide expertise in the STEM fields to the Tohono O'odham Nation. A projected outcome of this project is to create culturally competent, intentional learners who are equipped to address the challenges faced by a complex, global society. According to the American Association of Colleges and Universities (2002), the goal of education is to produce intentional learners who are integrative thinkers, can see connections between a variety of information sources, and are able to

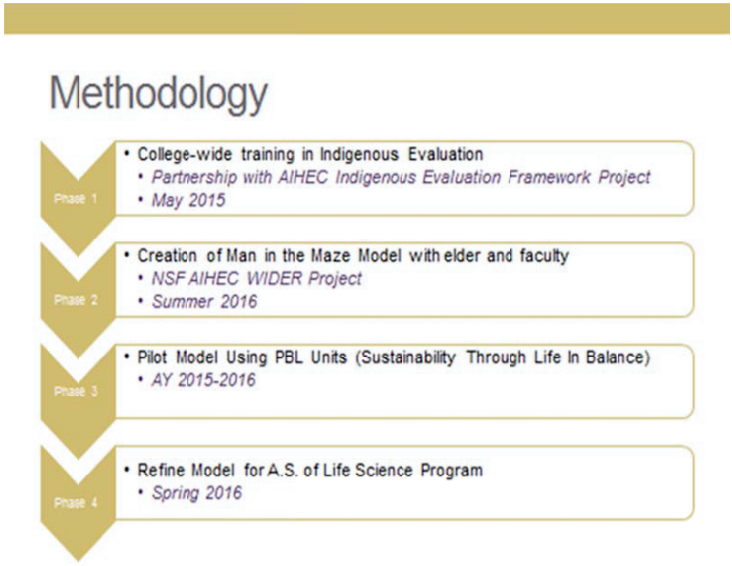
synthesize and analyze this information in order to make decisions and draw conclusions. The inclusion of traditional ecological knowledge through culturally-responsive education produces integrative thinkers because it promotes multi-contextual thinking and trains students to make connections across disciplines. It also empowers students to utilize their cultural knowledge and unique perspectives in problem-solving (Castagno and Brayboy, 2008; Kimmerer, 2002). Diverse professionals not only benefit their own communities, but benefit the rest of society with their culturally-based knowledge, motivation, and skills, and by bringing different perspectives to problem-solving that are critical in today's global society.

Methodology

In this paper, we document our process of finding an appropriate cultural metaphor for our indigenous education model and the creation of a program-level indigenous educational model based on this cultural metaphor. An overview of our methodology (depicted in Figure 1 below) is as follows:

- Step 1: *Provide training in indigenous education and evaluation methods*
- Step 2: *Develop an indigenous education model for curriculum development and assessment based on this cultural metaphor*
- Step 3: *Pilot the model through a course-level curriculum project in order to understand and explore the model*
- Step 4: *Based on the results of this pilot project, refine and develop a program-level assessment model*

Figure 1: ***An overview of the methodology used to develop the educational model for the Associate in Science (A.S.) Life Science Program.***



The methods are outlined in more detail below; however, it is important to note that an important element to the success of this project included partnerships with the American Indian Higher Education Consortium (AIHEC) as well as a collaborative approach to the work with much time for reflection and discussion.

This project was initiated by Indigenous Evaluation Framework Training provided by trained facilitators from the American Indian Higher Education Consortium (AIHEC), which brought together the majority of the faculty and elders at TOCC. This two-day training was based on materials and methods developed by AIHEC through the NSF AIHEC Promoting Research and Innovation in Methodologies for Evaluation (NSF AIHEC PRIME) project and the goal was to provide context and training for the development of an indigenous framework for education and evaluation specific to the Tohono O'odham culture and Ways of Knowing. It provided time and space for guided reflection and sharing of ideas on the educational pathways for the students at TOCC. Since American Indian education must be embedded in the epistemology and cultural knowledge (Cajete, 2005), we were searching for a cultural symbol that would provide a foundation for culturally-based education at TOCC. As a result of this workshop, the *Man in the Maze*, which is an important Tohono O'odham cultural symbol (Figure 2) representing a person's journey through life and reaching for one's dreams, was chosen as the cultural symbol and metaphor upon which to base our educational model.

Figure 2: ***The Tohono O'odham Cultural Symbol, The Man in the Maze.***

The next step in this project was to assemble a team of faculty and elders to begin to create the educational model based on the *Man in the Maze*. The selection of this team was a critical step to the success of this project because most successful institutional transformations begin with a small group of three to five key individuals who are powerful in the sense of information and expertise, reputations and have existing relationships (Kotter, 1995). Using this as a guideline, a team of science and math faculty

with expertise in indigenous education and experience in working with Tohono O'odham students along with a very well-respected elder with deep, revelational knowledge of the *Man in the Maze* model was assembled to move forward with the creation of the indigenous education model. During the summer of 2015, the elder taught the faculty members the deeper cultural meanings of the *Man in the Maze.* With this knowledge combined with each of our knowledges of content pedagogy, the faculty developed a preliminary educational model.

The next step in this process was to pilot the framework on a small scale in order to explore and study potential applications and synergies of the model. We took advantage of an NSF AIHEC Widening Implementation and Demonstration of Evidence-based Reforms (WIDER) grant to pilot the model using a problem-based learning approach since this was reflective of the natural learning process inherent in the journeys through the Man In the Maze. Additionally, since culturally-relevant curricula should allow students to become co-constructors of knowledge (Belgarde, Mitchell & Arquero, 2002) and since 21st century curriculum needs to engage students in the construction of knowledge (Clayton-Pederson & O'Neill, 2005), piloting our model using a problem-based learning approach was an appropriate application to test and study the model. Our project entitled, "Life in Balance: Using Problem-based Learning Model to Promote Sustainability and Improve Learning in Math and Science," involved the development and implementation of culturally-relevant, evidence-based teaching and learning practices associated with the Problem-Based Learning model (PBL) in four STEM courses at Tohono O'odham Community College (TOCC). These PBL units focused around the theme of "Sustainability through Life in Balance" by incorporating environmental sustainability, health and well-being, and incorporated T-So:son, or cultural core values.

These units were developed using the indigenous evaluation framework and then used to evaluate the overall impact of the culturally-relevant PBL on student learning and success. We implemented the curriculum in our respective courses in Fall 2015. The elder consultant for the project supported the PBL units with guest lectures on the Man in the Maze and T-imigi (Kinship). T-imigi refers to the Tohono O'odham system of describing relatives and is a very important part of the Himdag. This topic was chosen for the Ecology PBL unit because of its focus on interrelationships between species.

The final step was to expand and refine the Man in the Maze model to reflect a student's educational journey through the Associate of Life Science program based on our experience and reflection of applying the model to our PBL units. This program-level educational journey incorporates a journey of self-knowledge, transformation and empowerment through a deepening sense of cultural identity combined with 21st century knowledge.

Data & Evidence

The Man in the Maze Model: Course-Level Application

As a result of the Indigenous Evaluation Framework training, the Tohono O'odham cultural symbol, the *Man in the Maze*, emerged as the natural symbol for a holistic educational journey founded on the *Himdag*. For the Tohono O'odham, the *Man in the Maze* symbol is rich in meaning on multiple layers and is reflective of one's journey toward both inner and outer knowledge through life. Based on our collective work in the training, it was proposed that STEM education at Tohono O'odham Community College be based on the *Man in the Maze*.

Our indigenous education model is framed on the wisdom regarding personal transformation and learning inherent in the cultural symbol, the *Man In the Maze* (Figure 3).

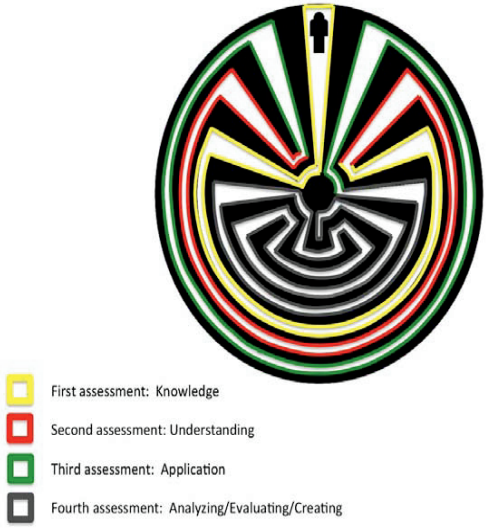
The *Man in the Maze* represents a person's journey through life and reaching for one's dreams. As explained by the elder, a person moves to the center of the Maze during major life transitions such as puberty and receives inspiration and transformation only to move further outward for the next cycle of the journey. He goes on to explain:

> *The Man in the Maze/I'itoi Ki: is a life-journey that follows a person's life cycle. It is a visual map that can be utilized to give a person a measurement tool. The dark spot in the center symbolizes the four major life sacraments that every person must pass through to complete the journey. The path leads persons to four encounters with the dark spot: Birth, Puberty, Responsibility and Acceptance to the completion of a life. The symbol can be adapted to any process or format as it provides an assessment for all persons involved to amend the material as completion is attained.*

In applying this to Problem-Based Learning, each journey through the maze and into the center represents a level of learning in the topic area of the PBL unit. Each journey in the maze ends in an assessment or evaluation and reflection on learning. Each successive journey represents deeper discovery. Each journey is more expansive and exploratory in nature while the final journey is less expansive but more in-depth. We applied these concepts to the problem-based learning in the following way: the first journey represents knowledge gathering, while each successive journey gathers more knowledge with the final journey delving more deeply into the problem or subject area. Since each journey represents a succession in one's life, we interpreted this as a mastery of a higher level of learning. Based on Bloom's taxonomy, these are:

- First assessment: *Knowledge*
- Second assessment: *Understanding*
- Third assessment: *Application*
- Fourth assessment: *Analyzing/Evaluating/Creating*

Figure 3: ***The Man in the Maze Educational Model incorporating Bloom's taxonomy; the colors for the different Bloom's taxonomy journeys in the Maze reflect one representation of traditional sequence of colors in the Tohono O'odham tradition.***



Piloting the Model: PBL Units

The faculty members chose topics that centered on the theme of sustainability and health and designed their PBL units based on the four journeys and levels of assessment embedded in the *Man In the Maze* model. For each course, a description of the use of the model is provided, followed by a table summarizing the goals and outcomes, and the methods of assessment, connected to each of the four journeys in the *Man in the Maze* model.

BIO100N: Concepts in Biology

Topic: Diabetes and Cancer risks on the Tohono O'odham Nation: Understanding the biological and cultural basis

During this PBL unit, students learn the biological principles that make people susceptible to cancer and diabetes, and explore why Native Americans are particularly vulnerable. Students discuss recent scientific advances in prevention and cure and how these issues are important in their communities.

During the development of the course, students learn the basic principles of cell biology and biological integration and apply them to diabetes and cancer as case studies. In addition to in class activities and assignments, students are engaged in discussions about socio-cultural aspects related to the influence of cancer and diabetes in their communities. Likewise, they receive an introduction and

explanation of Tohono O'odham Himdag and the concept of the Man in the Maze through a guest lecture by the elder. The *Man in the Maze* presentation focuses on the connection and implications between *Himdag* and the biological basis for human well-being.

Table 1: *BIO 100N: Overview of goals, outcomes, and assessments for the PBL units chosen in this study to illustrate Bloom's taxonomy journeys in accordance with the Man in the Maze model.*

Bloom's Taxonomy Journey	Goals and Outcomes	Assessment
First Journey: Knowledge	Describe the medical and biological basis of cancer and diabetes; describe the current situation of cancer in diabetes affecting Native Americans; describe the causes and habits that trigger cancer and diabetes.	Discussions, reflections and short homework assignments.
Second Journey: Understanding	Explain how diet and habits disrupts the balance in our cells and body to trigger cancer and diabetes; explain the factors and causes that are raising concerns on the Tohono O'odham Nation; interpret how Himdag values can support a preventive attitude towards cancer and diabetes.	Discussions, reflections and short homework assignments.
Third Journey: Application	Identify the specific factors affecting vulnerability to cancer and diabetes at the Tohono O'odham Nation.	Written research and assessment on medical papers, statistics and essays regarding cancer and diabetes at the Tohono O'odham Nation.
Fourth Journey: Analyzing/Evaluating/Creating	Analyze current policies and actions in place at Tohono O'odham Nation to reduce cancer and diabetes risks; develop a prevention plan to be implemented among students and staff at Tohono O'odham Community College that incorporates medical evidence and Himdag values towards cancer and diabetes prevention.	Essay for final grade on guidelines for the Tohono O'odham Community College to prevent diabetes and cancer.

BIO 105N: Environmental Biology

Topic: Ecology—Relationships and Ways of Knowing in the Sonoran Desert

This teaching/learning experience combines both traditional knowledge and 21st century content areas. It integrates cultural content through oral storytelling and O'odham language and bridges traditional and modern knowledge. The traditional content area shared through the storytelling is rich, multi-contextual and multi-dimensional. It includes: cultural history, language, identity, kinship, values, traditions, conflict resolution, social ecology, interaction with the lands and philosophy. In this PBL unit, students learn about Sonoran desert ecology, and Western and traditional ways of knowing, with a special emphasis on t-imigi or inter-relationships.

Students are introduced to the Western Scientific Method, the characteristics of Western Scientific Knowledge and Ecology via PowerPoint, lecture, readings, and informal discussion. After hearing the traditional O'odham story about the Wind and the Rain, the students compare the differences and similarities between the O'odham Way of Knowing and the Western Way of knowing

through a reflection paper and in-class discussion. The students attended a guest lecture by the elder on T-imigi (Kinship) and compare this traditional knowledge system to ecological interrelationships. The students then apply their knowledge of the scientific method and ecology through an Ecology Research Project, which is a collaborative, hands-on research project in which the students apply the scientific method and conduct field experiments. This project culminates in a group presentation.

Table 2: *BIO 105N: Overview of goals, outcomes, and assessments for the PBL units chosen in this study to illustrate Bloom's taxonomy journeys in accordance with the Man in the Maze model.*

Bloom's Taxonomy Journey	Goals and Outcomes	Assessment
First Journey: Knowledge	List the eight steps in the process of Western Science. Know the three rules for scientific experimental design. Define ecology. Describe biotic and abiotic interrelationships.	Quizzes.
Second Journey: Understanding	Identify an independent and dependent variable. Compare and contrast O'odham Ways of Knowing and Western Scientific Ways of Knowing. Explain how the Himdag value of t-imigi relates to ecology and the story of the Rain and the Wind.	In-class Assignment.
Third Journey: Application	Apply knowledge of ecological principles to create a hypothesis to an ecological question. Develop an experiment to test a hypothesis.	Desert Ecology Project: Experimental Design.
Fourth Journey: Analyzing/Evaluating/Creating	Conduct a field-based scientific experiment. Analyze and interpret data using mathematical and ecological principles. Prepare a scientific report and presentation. Reflect on understanding of the Himdag value of t-imigi.	Desert Ecology Project: Fieldwork, Project Data Analysis, Project Presentation, Reflection Paper.

BIO 154N: Global Change Biology

Topic: Climate Change on the Tohono O'odham Nation: The Water-Food Nexus

In this unit, students learn about climate change impacts on food and water resources in the Southwest and create a climate change adaptation plan for the Tohono O'odham Nation that includes traditional ecological knowledge, indigenous viewpoints on water and T-So:son or cultural core values. Students are introduced to the concept of traditional ecological knowledge and to indigenous perspectives on water. Students learn about the traditional and modern uses of food and water by the Tohono O'odham Nation including traditional ecological knowledge of water, food and climate. They also learn about predicted climate change impacts on water resources of the region and apply that knowledge to identifying potential impacts on food production and water use of the O'odham. Using a model that incorporates elders, water policy, and climate change science, students develop a culturally-responsive adaptation plan that addresses climate change impacts on the food and water resources on the Tohono O'odham Nation.

Table 3: ***BIO 154N: Overview of goals, outcomes, and assessments for the PBL units chosen in this study to illustrate Bloom's taxonomy journeys in accordance with the Man in the Maze model.***

Bloom's Taxonomy Journey	Goals and Outcomes	Assessment
First Journey: Knowledge	Describe traditional and modern uses of water on the Tohono O'odham Nation, describe traditional and modern food production on the Tohono O'odham Nation, and describe current and changes in temperature and precipitation patterns in the Southwest U.S.	Quizzes.
Second Journey: Understanding	Articulate indigenous perspectives and worldview of water, explain the relationship between water and food on the Tohono O'odham Nation, interpret the traditional O'odham calendar from the perspective of traditional food and water resources.	Discussions, reflections, and short homework assignments.
Third Journey: Application	Identify potential impacts of climate change on both traditional and modern water availability for the O'odham.	Individual written assignments.
Fourth Journey: Analyzing/Evaluating/Creating	Analyze water policy scenarios for inclusion of Native Americans as stakeholders and incorporating indigenous values, develop an adaptation plan for meeting the future water and food needs of the Tohono O'odham Nation that incorporates includes traditional ecological knowledge, indigenous viewpoints on water and T-So:son or cultural core values, evaluate a climate adaptation plan for comprehensiveness, scientific validity and inclusion of cultural values.	Analysis of stakeholder input in the Gila River Indian Community Case Study, Analysis of case study, Collaborative Group Project to create a Climate Change Adaptation plan for the Tohono O'odham Nation, Peer Review using rubric to evaluate other groups' Climate Change Adaptation Plans.

MAT 220: Calculus I

Topic: Limits and their Applications on the Tohono O'odham Nation: Understanding the Limit Concept by Using a Cultural Framework

Although the function concept is central to modern mathematics, it is the concept of a limit that signifies a move to a higher plane of mathematical thinking. As Cornu observed (1983) this is the first mathematical concept that students meet where one does not find the result by a straightforward mathematical computation. Instead it is "surrounded with mystery" in which "one must arrive at one's destination by a circuitous route" (p. 151).

The word "limit" itself has many connotations in everyday life which are at variance with the mathematical idea. An everyday limit is often something that cannot or should not be passed, such as a "speed limit." The terminology associated with the mathematical limiting process includes phrases such as "tends to," "approaches," or "gets close to," which also have colloquial meanings differing from the mathematical meanings.

Davis and Vinner (1986) suggest that there are seemingly unavoidable misconception stages with the notion of limit. One is the influence of the language, mentioned earlier, in which the terms remind us of ideas that intrude into the mathematics. In addition to the words are the ideas that these words conjure up, which have their origins in earlier experiences. Another source of misconceptions is the sheer complexity of the ideas, which cannot appear instantaneously in complete and mature form, so that some parts of the idea will get adequate representations before other parts will.

The introduction of the formal definition of limit does not obliterate more primitive dynamic notions; indeed, we often continue to nurture dynamic imagery in our teachings to give an intuitive flavor to rigorous proofs. Research points once more to the fact that, although the limit concept (in a formal sense) is a good mathematical foundation, it fails to be an appropriate cognitive root. If it is difficult to start with the limit process in subjects such as calculus, what alternatives are available?

In the first part of this PBL unit, students learn the concept of limit, apply its mathematical properties and explore how this central idea in Calculus could be presented via iPads. After this part is completed, students attend a lecture on the *Man in the Maze* presented by the elder. In the last part, students analyze, apply and connect the concept of limit by using the *Man in the Maze*. They have a discussion on how cultural values, such as the *Man in the Maze* could be used to produce a new way of presenting mathematical concepts such as the concept of limit.

Table 4: *MAT 220: Overview of goals, outcomes, and assessments for the PBL units chosen in this study to illustrate Bloom's taxonomy journeys in accordance with the Man in the Maze model.*

Bloom's Taxonomy Journey	Goals and Outcomes	Assessment
First Journey: Knowledge	Describe the mathematical and intuitive definition of limits. Describe the concepts used in this definition. Describe the misconceptions in the limit definition.	Students perform function graphics and explored them on the iPad. By using the tracing capability on it, students are asked to try to get as close as possible to a single point in the domain of a function. Using the zooming capability, as many times as they wish, they can get as close as they want to the given point in the domain.
Second Journey: Understanding	Explain how close is close in the limit idea. Explain the parts involved in approaching the limit.	Students are asked to Intuitively observe how close the value of the function corresponds to the point they want to get close to. Students are asked to create a "formal" definition of limit using their own words.
Third Journey: Application	Identify applications of limits in general and at the Tohono O'odham Nation in particular.	Students discuss at class the application of the concept of limits at the community and global level.
Fourth Journey: Analyzing/Evaluating/Creating	Analysis of the idea of reaching a limit. Develop a strategy for evaluation of limits. Interpret how the "Man in the Maze" can support an alternative way to define limits.	Students review the limit process. They are requested to create an approach to present this concept in their own words. Evaluation of their approach and modify their "formal" definition of limit if needed.

Results From the Application of the Model to PBL Units

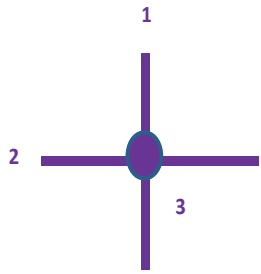
The PBL units served as a mechanism to study and test the *Man In the Maze* model. However, we are continuing to implement the PBL units and are collecting evaluation data for an on-going investigation and will be reporting that in more detail in future publications. For this project, applying the model to the PBL units gave us many understandings and insights to the model as follows. We realized that an essential component of the model is the inclusion of student self-reflection and self-assessment because that reflects both inner and outer learning and promotes student self-motivation. We learned that applying the model led to a backward design approach to curriculum design, where you determine your outcomes and assessments and then design the curriculum (Wiggins and McTighe, 2005). Therefore, the *Man in the Maze* is a model for curriculum design as well as evaluation and assessment. It serves as an indigenous curriculum map. We also learned that the *Man In the Maze* model reflects the natural learning process of inner and outer transformation through acquisition of knowledge and discovery. It promotes a culture of ongoing assessment and ensures that learning and assessment occurs at successive levels of Bloom's taxonomy. We also determined that the addition of the goals of strengthening identity, personal transformation and giving back to the community were missing elements in the model.

The Man in the Maze: Program-Level Application

Based on these insights and reflections learned from our PBL pilot project and on-going discussions amongst the elder and faculty, we then applied the *Man In the Maze* model to a program-level application for the A.S. Life Science program. The program-level *Man in the Maze* education model is based on the symbol embedded in the center of the *Man in the Maze* (Figure 4). This symbol begins with one vertical line which represents "somethingness" or unity which arises from nothingness. This is followed by a horizontal line which represents the duality which arises from unity. The point at which the two lines cross is the "center," which holds the spirit or the true person. The 1st, 2nd, and 3rd levels can also be viewed as body, mind, and spirit. According to our elder, in order to gain understanding in one's life, one's body, mind and spirit must be involved in this pursuit. The ultimate purpose of the journey in the *Man In the Maze* is the uncovering of the true self that lies within. In applying this wisdom to the educational process, the first, second and third layers (body-mind-spirit) correspond to curriculum-learning-true self. The first level is the curriculum or program level outcomes (PLOs) because this is the structure upon which the educational journey is framed. The second level is the learning that occurs as a result of the curriculum; this is measured through program-level assessment.

The third level is the student's journey toward the true self. This is accomplished through personal goal setting and deep self-reflection and culminates in a celebration of learning and a contribution to the community. The aims and goals of journey toward the true self include strengthening identity, personal transformation and giving back to the community. This is a holistic model of education because it takes into account the whole student as well as the relationship of the student with self, others and community. According to Deloria, Jr. (1999), indigenous education must acknowledge that "life is a unity" and must be founded on the "unified experience of being a human being."

Figure 4: ***The Center of the Man in the Maze: Levels 1, 2, 3/Body-Mind-Spirit/Curriculum-Learning-True Self.***



Each level --- curriculum, learning and true self --- has four journeys corresponding to the four journeys in the *Man In the Maze* (Table 2). The first journey is the introductory level which occurs during the first semester of the two year A.S. Life Science program. During the first semester, the student sets personal goals for learning and self-development. The student also identifies possible obstacles to meeting those goals. The curriculum during the first semester is designed at the introductory level and the assessment, using Bloom's taxonomy, is at the knowledge level. The second semester or journey focuses on reinforcement of PLOs and culminates in an assessment at the understanding level including a student self-assessment. In order for the self-assessment to be effective, according the wisdom in *Man In the Maze*, the student self-assessment needs to be honest and self-critical since the journey to the true self involves uncovering the layers which obstruct or veil the true self. It could also incorporate a mid-course adjustment such as a modification in the student's personal goals. In the *Man In the Maze*, the third journey relates to finding one's life purpose and takes on responsibilities, therefore, the third semester or journey continues to reinforce the PLOs through the application of knowledge. The final journey focuses on creating something of value using knowledge gained, and sharing with community. This incorporates the final assessment at the analysis, evaluation, and/or synthesis level. The student self-assessment includes a reflection on accomplishments and lessons learned. This journey culminates in a celebration which includes a presentation of capstone course projects to the community.

Table 5: ***Program-Level Application of the Man in the Maze Indigenous Model of Education.***

	Curriculum	Learning	True Self
First Journey:	Introduction of PLOs	Assessment at Knowledge Level (I)	Student Self-Assessment 1 (Identify Goals, Timeline & Obstacles)
Second Journey:	Reinforcement of PLOs	Assessment for Understanding (R1)	Student Self-Assessment 2 (Honest Check-in and re-evaluation)
Third Journey:	Reinforcement of PLOs	Assessment for Application of Knowledge (R2)	Student Self-Assessment 3 (Honest Check-in and re-evaluation)
Fourth Journey:	Creating something of value using knowledge gained and sharing with community	Assessment for PLOs (A): analysis, evaluation and synthesis.	Student Self-Assessment 4 (Celebration of knowledge & completion of journey; reflection on service to community)

Discussion

Reflection on the Man in the Maze Model

This educational model is congruent with principles of indigenous education which, according to Cajete (2005), should be based on "continuous development of self-knowledge, on finding life through understanding and participating in the creative process of living, on direct awareness of the natural environment, on knowledge of one's role and responsibility to community, and on cultivating a sensitivity to the spiritual essences of the world" (p. 71). The *Man in the Maze* visually conveys constructs of indigenous education described by Cajete (2005), such as the incorporation of cycles within cycles, the understanding that there are always deeper levels of meaning to be found in every learning-teaching process, and the recognition that there are developmental stages in the levels of maturity and readiness to learn unique to each learner. The model also incorporates elements of critical pedagogy (McLaren, 2003) such as acquiring critical, creative and hopeful thinking, transforming the self through transforming the social relations of teaching and learning and developing critical curiosity.

The educational journey symbolized by the *Man in the Maze* exemplifies endogenous education, educating of the inner self through illumination from one's own being (Cajete, 2005). The role of culturally-relevant visualizations as part of the learning process and self-reflection is an unexplored field

of study despite the evidence supporting the view that American Indian/Alaska Native students are visual learners (Pewewardy 2002, 2008). Our *Man in the Maze* model enhances self-reflection as a fundamental part of self-assessment in a cultural and social context. The model can be used as a tool to guide students to cognitively visualize achievements during the process of learning and self-transformation.

A prediction of the model would be that the *Man in the Maze* will facilitate self-monitoring of individual progress (First and Second assessment), apply learning to other contexts and settings (Third assessment), and construct meaning from the content learned and from the process of learning it (Fourth assessment). The *Man in the Maze* would become a visualization of the continual process of engaging the mind that transforms the mind. Our future studies will measure the impact of the model as a visualization tool in the process of learning and self-reflection.

The concept of a human journey and labyrinths are universal concepts; however, the Man in the Maze symbol is uniquely shaped and informed by the history, environment and culture of the Tohono O'odham. It is important to note that this symbol is based on O'odham philosophy prior to European influence, so it reflects the circumstances and life of the O'odham through deep cultural time. On the other hand, the *Man in the Maze* continues to evolve and adapt in current times due to the influences of modern life and technology. Like language and other cultural knowledge, the *Man in the Maze* symbol is vernacular and, within the O'odham culture, there are variations of the representation of the model. The *Man in the Maze* model used in this paper is the most common one as interpreted and described by the authors. It is also important to acknowledge that there are many levels of meaning within the *Man In the Maze* metaphor which are not incorporated into this educational model, such as the four directions, the concept of the shadow self, and other meanings that are not meant to be revealed except in the O'odham language. Indeed, many of the deeper meanings embedded in the symbol are difficult or even impossible to articulate in the English language. The course-level indigenous education model is based solely on the four journeys through life, while the program-level indigenous education model is based on both the symbol in the center and the four journeys through life. In the future, through our experience in using this model, deeper understandings may unfold and these other levels of meaning may be incorporated into the model.

This project has provided the opportunity for us to take a team approach to education, which is fully in alignment with indigenous principles of education. It naturally led to the formation of a teaching-learning community consisting of the project faculty and elder as well as students. It also provided a vehicle for reflection and deep discussion amongst faculty and elders and has proven successful in aligning our curriculum in a deliberate, intentional and unified way to the tribal college mission of enhancing our *Himdag*.

The Application of the Man in the Maze Model to PBLs

PBL is supported by both brain-based and indigenous education theory. According to brain-based theory (Bransford, 2000), learning is stimulated through continuous interactions with the world; this direct experience is essential for the development of the brain, which imposes structure on the information gained through experience. From the perspective of tribal education (Cajete, 2005), knowledge is gained through firsthand experience of the world, explored more fully through ritual, ceremony, art, and appropriate technology, and then applied to the context of everyday living. Both theories support the active learning modes of teaching and suggest that activities which aid the mind in "making sense of" and "organizing" the material are the most effective. The *Man in the Maze* educational model guides this very sequence of learning activities as the learner moves from knowledge, to understanding, to application, and finally to synthesis, creation and analysis applied to real-world problems.

The *Man in the Maze* model would support a better understanding and application of brain-based learning theory and collaborative learning. According to brain-based learning theory, brain structure is altered by opportunities for learning in a social context (Bransford, 2000). Furthermore, based on brain research, Jensen (2008) suggests that educational settings should strengthen prosocial conditions, thus reinforcing the importance of creating a classroom with a positive learning community. Likewise, indigenous learning values relationships and reciprocity, includes peer learning and is collaborative in nature (Castagno and Brayboy, 2008).

As a final reflection on the PBL experience, we would like to note that this "new" PBL approach it is not an easy path. But this is true of life itself. There is no royal road, as Euclid is said to have remarked to Ptolemy. Given the complexity of the limit concept, cellular biology and ecological principles, the road ahead is surely not to attempt to ease the student's path by trying to avoid difficulties, for the over-simplification produces inappropriate concept images that only create problems later. A more helpful route is to provide the rich experience necessary to enable the student to attempt to confront the difficulties and negotiate a more stable concept, which can be facilitated through the *Man in the Maze* educational model.

Impact & Conclusions

The *Man in the Maze* has great potential as a robust and culturally-appropriate model for both the curriculum development in the design of the PBL units and program-level application for the Associate of Life Science Program. It is versatile in that it can be applied at multiple scales as well as in a broad range of discipline areas and teaching styles. It reflects the natural learning process of inner and outer transformation through acquisition of knowledge and discovery. It promotes a culture of on-going assessment and ensures that learning and assessment occurs at successive levels of Bloom's

taxonomy. It also has enriched our curriculum by adding a cultural understanding of topics ranging from mathematical limits to human well-being. It has provided a vehicle for reflection and deep discussion amongst faculty and elders and has proven successful in aligning our curriculum in a deliberate, intentional and unified way to the tribal college mission of enhancing our *Himdag*. It has created a sense of ownership and a basis for discussion and deepening in discussions of "enhancing the Tohono O'odham *Himdag*" through holistic education and forged powerful, positive relationships among cultural, math, and science faculty members. For these reasons, the *Man in the Maze* model will serve as a robust and culturally appropriate model at the course-level and for the A.S. Life Science program.

Our method of developing such a framework with larger input from the community of educators and elders, then piloting the framework with a small group of faculty and elders with checkpoints in order to understand and evaluate the model before expanding the model to the program-level, has proven successful. On a broader scale, with encouragement and approval of TOCC administration, plans are underway to consider the *Man in the Maze* education model as a college-wide educational framework. Thus, it promises to serve as a mechanism for institutional transformation by building a culture of collaboration and unifying and aligning our curriculum with our educational mission. Furthermore, by documenting our process of building the indigenous educational model, we are creating a model upon which other Native American-serving institutions can build a model that can serve their community.

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Climate Change and the Sacredness of Water in Native America: A Case Study in the Keweenaw Bay Indian Community, Michigan, USA

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Climate change is a scientific phenomenon that has recently been debated within the political arena; regardless of political viewpoint, the potential impact on communities is critical to understand and address. Andrew Kozich investigates climate change within Michigan's Keweenaw Bay Indian Community, which, like other indigenous communities worldwide, is facing potential environmental, economic, and cultural impacts from climate change, including the threat to its most sacred resources. With the objective of gaining insight into perspectives within the community on climate change, three key themes emerged from an analysis of interviews conducted, providing valuable insights for community and tribal leaders: 1) water resources are extremely valued; (2) climate change is happening and will have wide-ranging negative impacts; and (3) support for climate change planning is high and should include traditional ecological knowledge.

Introduction

There is little doubt across the scientific community that global climate change is occurring and will likely continue into the future (Intergovernmental Panel on Climate Change, 2014; National Oceanic and Atmospheric Administration, 2013; United States Environmental Protection Agency, 2014). Likewise, scientists are very certain that the climate phenomena observed over recent decades are not natural in origin but are caused by human activities such as fossil fuel combustion and land-cover change (Intergovernmental Panel on Climate Change, 2014). As trapped gases in the atmosphere cause the planet to warm, numerous weather-related events are correspondingly altered in ways that negatively impact human populations (e.g., increased storm intensity, more frequent floods, droughts and fires resulting from heat waves, and so forth). Scientists have therefore transitioned to the phrase 'climate change' over 'global warming', because the documented and anticipated changes include much more than just a warmer world (National Oceanic and Atmospheric Administration, 2013).

While negative impacts from climate change will be felt by many (in some fashion and to some degree), rural communities that are dependent on natural resources are particularly vulnerable (Karl, Melillo, & Peterson, 2009; Lal, Alavalapati, & Mercer, 2011; Thomas & Twyman, 2005). In the U.S., the rural communities that encompass 80% of the landscape have lower income, lower educational attainment, greater dependence on government programs, higher mortality rates, and fewer health and emergency services than urban centers (Lal, Alavalapati, & Mercer, 2011). These factors, combined with geographic isolation, result in a reduced capacity to overcome impacts of climate change.

Native American communities are particularly susceptible to negative impacts of climate change. Because Native worldviews and lifestyles typically include intimate relationships with the environment, impacts from ecological shifts, losses of natural and cultural resources, and losses of ancestral homelands would likely be more burdensome than for non-Native communities (Houser, Teller, MacCracken, Gough, & Spears, 2001). Many Native communities are additionally impaired by limited resources to

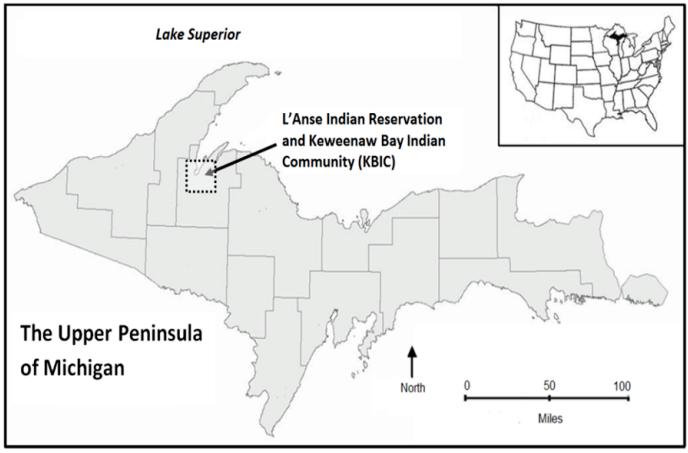
mitigate, adapt to, or cope with the consequences of climate change, particularly when issues such as health, poverty, unemployment, or substance abuse take precedence (Cozzetto et al., 2013; Lynn, MacKendrick, & Donoghue, 2011; Weinhold, 2010). This concern could particularly relate to the likelihood of increased severe weather events associated with climate change (Intergovernmental Panel on Climate Change, 2014). The marginal land bases and geographic isolation of many tribes rival that of most U.S. communities furthering risk from environmental changes and accessibility of resources to respond (Houser et al, 2011; Lynn et al, 2011). In previous generations, many Native communities could respond to environmental change by simply moving to another area. This adaptation strategy is not as feasible today, however, as tribal lands are legally-defined and not able to merely be re-located (Houser et al, 2001; Maldonado, Shearer, Bronen, Peterson, & Lazrus, 2013; Wildcat, 2013).

Native Americans' interconnectedness with the environment today is most often recognized through economic dependence on natural resources (Houser et al, 2001; Krakoff, 2008; Maldonado et al, 2013). Therefore it is easy to surmise how Native communities that rely on agriculture, forests, fisheries, or tourism could be particularly sensitive to environmental change. However, climate change impacts to Native communities could extend much further. Because Native cultures evolved through deeply-intertwined relationships with their environments, entire elements of culture can be irreparably altered when the environment undergoes drastic change. For instance, generations of accumulated knowledge, based on intimate familiarity with the environment, may be lost or rendered less relevant (Cochran et al., 2013; Downing & Cuerrier, 2011; Tauli-Corpuz et al., 2009; Turner & Clifton, 2009). Significant aspects of spirituality could be impacted by losses of sacred plant and animal species or traditional food sources (Cochran et al., 2013; Dittmer, 2013; Krakoff, 2008; Lynn et al., 2013). Many words in Native languages, relating directly to features of the local environment, may lose their meaning if the environment changes or the people have to relocate (Cochran et al., 2013; Downing & Cuerrier, 2011). In all, climate change impacts may not only affect Native Americans' livelihoods but their entire ways of living.

The impacts Native communities face from climate change also represent an issue of environmental justice. Proportionally, Native lifestyles contribute little to the causes of climate change, yet their communities are often the most affected by the consequences (Cordalis & Suagee, 2008; Krakoff, 2008; Lynn et al., 2011; Maldonado, Shearer, Bronen, Peterson, & Lazrus, 2013; Thomas & Twyman, 2005; Tsosie, 2007; Whyte, 2013). For some Native communities (e.g., Arctic and other coastal tribes), climate change impacts far exceed losses of natural resources or various aspects of culture; some are facing the ultimate injustice of seeing their homelands literally disappear from the map (Cordalis & Suagee, 2008; Crump, 2008; Krakoff, 2008). Considering the rapidity of environmental changes, the cultural trauma associated with relocation, and the unique and complex legal relationship between tribes and the U.S. government, many are viewing action on this matter as requiring the utmost urgency (Krakoff, 2008; Tsosie, 2007; Whyte, 2013).

While climate change impacts to Arctic, Pacific Northwest, and Southwest Native communities have justifiably received the most attention in the scientific literature, less is known about issues facing woodlands-area tribes of the Great Lakes region. In this area, changes have already been documented in air and water temperature, hydrological patterns, timing of seasonal events, occurrence of severe weather events, changes in forest cover types, and invasion of non-native species (Pryor et al., 2014; Schramm & Loehman, 2010; Superior Watershed Partnership, 2007). In an effort to help fill an important knowledge void, the remainder of this paper focuses on climate change and the Keweenaw Bay Indian Community (KBIC), an Ojibwa tribe from northern Michigan (Figure 1).

Figure 1: ***The location of the KBIC in Michigan's Upper Peninsula (Image: Kozich).***



Climate change poses numerous potential threats to members of the KBIC, who rely on predictable environmental conditions for the continuation of sacred and traditional activities. The KBIC is located along the southern shore of Lake Superior, within a delicate climatic zone that transitions between a humid continental climate to the south and a cool boreal climate to the north. Forests in this region are characterized by the southern extent of many culturally-significant plant species that provide food and medicines. Some of the most significant tree species, including sugar maple (*Acer saccharum*), northern white cedar (*Thuja occidentalis*), and paper birch (*Betula papyrifera*), are expected to be stressed by changing hydrological patterns, warmer temperatures, and the invasion of highly competitive, warmer-climate species from the south (Dickmann & Leefers, 2003; Pryor et al., 2014; Schramm & Loehman, 2010; Superior Watershed Partnership, 2007). Maple syrup production, a sacred and traditional activity for many Ojibwa, could be impacted by changes in regional forest communities.

The area's abundant stream and wetland ecosystems provide critical habitat for wild rice (*manomin*). This plant provides valuable nutrition and plays a central role in Ojibwa migration stories. Like maple syrup production, harvesting wild rice is considered a sacred tradition. However, wild rice abundance has already decreased in many areas, and further losses are expected as a result of the altered hydrologic patterns associated with climate change (Schramm & Loehman, 2010; Superior Watershed Partnership, 2007).

Climate change could severely disrupt the KBIC economy. The community relies heavily on healthy fisheries in nearby Keweenaw Bay and Lake Superior, but the region's waters have already experienced notable changes. Continuing warming of waters could pose serious threats to coldwater fish species, some of which are already in decline. Aquatic ecosystems are being disrupted by the invasion of numerous non-native fish, mussel, and plant species (Michigan Department of Natural Resources, 2015; National Tribal Air Association, 2009; Superior Watershed Partnership, 2007). Since non-native invasions are projected to increase with climate change, the local fishing industries that support numerous KBIC families could be severely impacted. Negative impacts to forest productivity and tourism could be equally likely and detrimental to the KBIC economy (Schramm & Loehman, 2010; Superior Watershed Partnership, 2007; Voggesser, Lynn, Daigle, Lake, & Ranco, 2013). Clearly there are reasons for the KBIC to be concerned about lifeways of the community in the face of changing climate.

Despite the challenges facing all Native communities, they possess knowledge that can uniquely qualify them to take a lead role in climate change adaptation strategies. Traditional ecological knowledge (TEK) has gained increasing merit among climate scientists and policy-makers for its value in understanding past environmental patterns, interpreting current conditions, and planning for the future (Alexander et al., 2011; Berkes & Folke, 2000; Cochran et al., 2013; Vinyeta & Lynn, 2013; Wildcat, 2009; Williams & Hardison, 2013). Many tribes view TEK as an important element of sovereignty and are now developing and adopting their own climate change adaptation plans.

On April 16 2015, the KBIC Tribal Council unanimously passed Resolution KB-016-2015, "To Establish a Climate Change Adaptation Initiative." By doing so, the KBIC joined numerous other tribes nationwide in the recognition that the consensus on climate change is clear and that it could pose substantial threats to Native lifeways. The resolution instructs the KBIC Natural Resources Department to lead a climate change vulnerability assessment as part of planning initiatives and to advise the Council on strategies and policy formulation in conjunction with relevant additional agencies.

This paper summarizes a crucial early step in the KBIC's climate change planning process. In advance of Resolution KB-016-2015, faculty and students of the Keweenaw Bay Ojibwa Community College (KBOCC) Environmental Science Department conducted semi-structured interviews with KBIC Tribal members to assess perspectives on climate change and gauge support for adaptation planning. This research represents the first phase of a broader, mixed-methods project, and to our

knowledge is the first such effort in the community. This is a critical first step because climate change will not have homogeneous effects across landscapes and therefore assessments of community-level impacts are needed (Duerden, 2004). Since understanding public views is a vital precursor to policy formulation, and policy actions are likely to be effective only if they have the support of the people they impact, this research simultaneously serves the community and adds to the literature by helping fill a notable knowledge void.

Research Design

Work began in late 2013 with the recruitment and training of a team of Keweenaw Bay Ojibwa Community College (KBOCC) student research assistants. We completed a comprehensive literature review, identified research objectives and methodology, and conducted pilot interviews. We formulated the following objectives to guide our work: (1) assess perceptions of climate change among KBIC members; (2) gain insight on how climate change could impact lifestyles of the KBIC; and (3) assess support for long-term mitigation and adaptation strategies.

Data were collected through semi-structured qualitative interviews with enrolled KBIC members. We chose this format with the goal of attaining rich insight to serve as the foundation for follow-up quantitative studies. A systematic random sample was used to invite community members to participate in interviews. With approval of the KBIC Tribal Council, we acquired a mailing list of all enrolled KBIC members age 18 or older residing in Baraga County (892 names), and sent every tenth person on the list a letter requesting participation. Fourteen letters were returned undeliverable. Thirty members agreed to be interviewed, resulting in a net response rate of 40%. Interviewees were not compensated for their participation, aside from the traditional gifting of tobacco for the sharing of their knowledge and time.

Interviews commenced in early 2014. Most were conducted in public meeting places such as the KBIC library, senior citizen center, or KBOCC campus (although some interviews with elders were conducted in interviewees' homes for their comfort and convenience). The semi-structured format promoted full engagement of interviewees, most of whom included stories at their own will to elaborate on points of interest, expertise, or concern. Interviews contained fifteen questions plus several probing-follow-ups, all correlated to the broader research questions of the project (see Appendix 1 for list of questions). Introductory questions were very conversational in nature and were designed to examine interviewees' cultural perspectives and general environmental values and beliefs before delving into topics specifically related to climate change. Interviews averaged 26 minutes in length and were digitally recorded. Interviewees supplied demographic data on a single-page written form at the conclusion of interviews. Student assistants took written notes to supplement audio recordings. Audio files were later

transcribed verbatim using GearPlayer 4 transcription software. Transcriptions were then analyzed at the item and pattern level to code into the three key themes described in this paper.

We interviewed sixteen males and fourteen females, with an age range of eighteen to eighty-four (Table 1). Ten interviewees identified themselves as tribal elders. The majority (63%) possess a high school education or less, while six (20%) completed a Bachelor's degree or higher. Twenty-one (70%) reported an annual income of $30,000 or less and twenty (67%) claimed full or part-time employment. Most employed interviewees work for the Tribe in some capacity, which is not a surprise since the KBIC is the largest employer in Baraga County. Interviewees included current and former Tribal Council members, education/social service professionals, and casino/resort employees. We also interviewed professionals whose day-to-day work puts them in direct contact with the environment, including foresters/loggers, commercial fishermen, wildland firefighters, and employees of the KBIC Natural Resources Department. All unemployed interviewees described themselves as either retired or tribal college students. Half of interviewees described their political identification as "independent," with the remaining favoring Democratic/liberal identification (40%) over Republican/conservative (10%). We inquired about political identification as a matter of standard demographic data-collecting protocol but did not frame climate change topics in terms of politics at any point in interview discussions. Since we anticipate conducting a follow-up, quantitative mail survey in the community (with a much larger sample size), potential relationships between demographic variables and change perspectives will be examined at that time.

Table 1: ***Descriptive statistics of interviewees.***

Category	N	Percent of interviewees
Gender		
Male	16	53%
Female	14	47%
Age		
18-30	8	27%
31-45	8	27%
46-60	8	27%
61 or older	6	20%
Education		
Some high school	3	10%
High school diploma	16	53%
Associate/trade degree	5	17%
Bachelor's degree	3	10%
Master's degree or higher	3	10%
Annual income		
Below $10,000	7	23%
$10,000 to $20,000	6	20%
$20,000 to $30,000	8	27%
$30,000 to $40,000	2	7%
$40,000 to $50,000	6	20%
$50,000 to $75,000	1	3%
Employment		
Employed full or part-time	20	67%
Unemployed/student/retired	10	33%
Political identification		
Democrat/liberal	12	40%
Republican/conservative	3	10%
Independent/other	15	50%

Due to the relatively small sample size (30), we do not assert that interviewees' views are wholly representative of the greater population. However, we are confident that through our sample we captured the diversity of perspectives anticipated from individuals across a wide range of demographic and socio-economic factors (Table 1).

Results

Analysis of transcripts resulted in the identification of three key themes expressed by interviewees: (1) water resources are extremely valued; (2) climate change is happening and will have wide-ranging negative impacts; and (3) support for climate change planning is high, and planning should include traditional ecological knowledge. Each theme is elaborated upon in the following paragraphs.

Water Resources are Extremely Valued

Perspectives on the region's water resources are very relevant considering the numerous potential impacts to them that could result from climate change. We began interviews with a series of open-ended questions about the local environment and asked interviewees to elaborate on anything that is particularly special to them. Many interviewees described the area as their ancestral homeland or discussed the significance of its forest resources. However, interviewees focused most intently on the area's water resources, including Lake Superior and the region's numerous streams and wetlands. Twenty-two interviewees (73%), like the one below, named water as the most important natural feature of our area, describing its sacredness to them personally and to the broad community:

> Just the beauty of it, the lake, the waterfalls, and all the streams. There's just so much nature here. We go out walking by the bay and we also have these beautiful tall trees and it's all remarkable. And the fresh air; you can feel a difference in the air when you go down by the water. I just spend time with the Creator in the outdoors a lot, laying tobacco down by the water and praying, so that's where I go for my therapy in a sense. I love water. It's definitely my spirituality. It helps me to connect. The water is most important. Our sacred animals and plants rely on it, and it is a big part of our culture. (Interviewee #4)

We then asked interviewees to discuss the importance of outdoor recreation, expecting that lifestyles and the environment are intertwined for most residents in the community. Because climate conditions could potentially affect a wide range of outdoor activities, interviewees' responses could help assess broad, lifestyle-altering impacts of climate change. The typical interviewee described several examples of important outdoor recreational activities, and many included stories to emphasize their points. Twenty-five interviewees (83%), such as this one, specifically identified water-related recreation as the most important:

> We go out we do river walks and stuff like that and we'll will find a waterfall that we've never seen before. And there's usually brook trout so I always carry my pole. Fishing is a big one. I love fishing the rivers, and one of my favorite things to do to do is find a nice little bank and get a fire going and cook outdoors. We're always at the beach and swimming. I enjoy boating and look for any opportunity to go out with someone. Collecting black ash in the swamps for baskets, harvesting wild rice, and stuff like that is important too. (Interviewee #1)

When asked about their greatest local environmental concerns, twenty-two interviewees (73%) discussed water-related issues as the most pressing. Interviewees shared concern for water quality, surface water levels, water temperature changes, impacts to fish and wildlife, impacts to wetland ecosystems, and reduced snowpack or winter ice cover. Several interviewees described the traditional sacredness of water in Ojibwa culture, supporting their statements with examples from Ojibwa creation or migration stories. Interviewees also discussed contemporary issues involving water that are

intertwined with culture, including its importance in ceremonies that carry on today and its role as providing habitat for wild rice, a significant food source. The interviewee below related global water problems to potential local cultural impacts:

> Water is going to be a really big issue coming up here. I'm afraid of more people wanting our fresh water because there's more and more of a shortage around the rest of the country. And clean water — that is the other part too. Lake Superior is still one of the cleanest large fresh water bodies. I'm concerned about the Lake Superior fisheries, our rivers, our wild rice, and being able to keep doing all our cultural activities related to water. (Interviewee #2)

It is important to note that in none of our interview questions did we specifically prompt interviewees to discuss water. Responses involving water arose through the context of initial, open-ended questions that were broad in design and intended to gain background insight on interviewees' general relationships with the environment. These topics also occurred early in interview conversations before the topic of climate change was mentioned. Through numerous examples, interviewees illustrated the inseparable relationships between water and Ojibwa culture. Overall, 18 of 30 interviewees made connections between water and the sustainability of sacred plants and animals or traditional activities such as wild rice harvesting, maple syrup collecting, and fishing.

Climate Change is Happening and Will Have Wide-Ranging Negative Impacts

Interviewees were near-unanimous in the belief that climate change is already happening in the region; 29 of 30 interviewees agreed it is already underway while one was unsure. As a follow-up, we asked interviewees if they believe climate change will *continue* happening in the future; 23 said "yes" and seven were unsure. Put another way, none of the 30 interviewees disagreed that climate change is happening or that it will continue into the future.

Climate change awareness appears largely based on observation, as all 30 interviewees stated that they have personally witnessed long-term environmental changes during their lifetimes. Interviewees' responses on this topic were deep and insightful, particularly among tribal elders. Nineteen interviewees, like the one below, specifically described changes they've noted in the intensity or frequency of precipitation events in the region:

> Well for starters, the weather just seems weird now. The U.P. [Upper Peninsula] is known for getting huge amounts of snow in the winter but I noticed the last two winters we didn't get that much. We've had some heat waves and we've had some mild winters now, but I think the first winter I was here it was like 30 below. Last year alone the rain patterns were really weird through the summer, like we had some really long dry spells, then we just got dumped on with rain all at once. It seems like we didn't have any just normal kind of rain. When it rained it poured. (Interviewee #14)

Interviewees also described how seasonal patterns in recent years are different from what they recall from their childhood. Several interviewees described the changes they've noticed in the timing of

seasonal events, discussing both winter and summer weather. Like many interviewees, this one related observations to popular outdoor activities such as swimming:

> The lengths of the seasons seem different now. I remember winter being much longer, with huge amounts of snow. It doesn't seem as intense anymore and the timing seems to be off. Recent years have been really weird. I remember as a kid we couldn't swim in the lake until mid-to-late August, but now by June the water's warm enough to swim. (Interviewee #13)

Several interviewees made similar comments about seasonal weather patterns and added observations related to corresponding ecological changes. This interviewee linked warmer temperatures to invasions of insects that previously didn't inhabit the region (likely referring to the recent "tick boom" in Michigan noted by researchers):

> The past five years I would say were so noticeably different than they used to be. Lately we haven't really had winter start until December. Then when summer comes it's like 90 degrees tomorrow and then it stays like that throughout the whole summer. I don't remember that from when I was a kid. And now the different types of bugs we see that come with the hotter weather that we never had before…It's all very concerning to me. (Interviewee #15)

Fishing is an extremely popular activity in the community, and for many KBIC members it holds cultural, recreational, and economic significance. One of our interviewees has been a commercial fisherman for over 30 years, and he provided a powerful, detailed account of changes affecting the Lake Superior whitefish and lake trout fisheries:

> The lake's pretty warm and right now there's no fish out there. By this time, usually the fish are cold and you can go out there for days. Usually right now you'd get the bottom turning up. Those southwest winds come and start stirring it up and all of a sudden the fish head north. And that's when you get the washing machine effect. It gets all stirred up and gets back to normal at 50 degrees. But it's not happening now. Right now it's 58 and that's too warm for the fish. And we've got northeast winds warming it up even more, dragging down the thermocline. You can tell month-by-month from what you're getting in your nets. I look at my records at what I was getting back in 1994 or 1995 at this exact time of year. It's unbelievable the amount of fish I was getting back then at this time. It's been changing, and it makes it tough for me to break even. (Interviewee #27)

A long-time recreational fisherman provided a similar account of changes over time in the region's smelt streams. As indicated in this passage, smelting traditions, which are very popular among the KBIC, appear to be affected by environmental changes:

> I don't know if it's the water temperatures, but back in the day we'd go smelting and we wouldn't even have to work at it. You could dip a couple nets and have a couple 10-gallon buckets ready in about an hour at the most. And then you could sit there and party it up all night. But nowadays you have to go look hard for them. You have to look everywhere and hope to be at the right stream at the right time. It's so unreliable. Back then you could count on them like clockwork, but now you have to chase them down. (Interviewee #21)

We asked interviewees to identify specific negative impacts that they anticipate the community could be facing from climate change. Responses were wide-ranging and included cultural, economic, and human health-related impacts in addition to ecological ones (Table 2). Many interviewees described more than one impact they anticipate, like this one who summarized several in a concise response:

> It's not just going to be tree species; it's not just going to be wildlife; it's not just going be fisheries. It's going to affect housing, roads, and drainages too. Public works is going to have to be aware of these changes so they can incorporate them into their projects moving forward. It's going to affect everything to some degree. Health too. And economic development will be hit. If no one wants to come here to hunt or snowmobile or whatever, we're going to be losing revenue. So it's a tough one. It's not going to be business as usual. (Interviewee #1)

Table 2: ***Community-level climate change impacts anticipated by interviewees (note that many interviewees listed more than one response).***

Response	N	Percent of interviewees
Negative impacts to outdoor recreation	14	47%
Negative impacts to fisheries	13	43%
Reduced surface water levels	10	33%
Loss of medicinal plant species	9	30%
Human health impacts	7	23%
Negative impacts to culture (nonspecific)	7	23%
Negative impacts to wild rice	6	20%
Negative impacts to significant wildlife species	6	20%
Negative impacts to maple syrup	6	20%
Impacts to tourism-dependent businesses	6	20%

Support for Climate Change Planning Is High, and Planning Should Include Traditional Knowledge

One of the primary objectives with this research was to gain insight on interviewees' opinions related to long-term climate change planning. Across interviewees, we found the overall level of support to be high, as 29 of 30 provided examples of planning strategies the KBIC should consider. Respectively, interviewees tended to focus on one example of a strategy and then go into substantial depth on it. As a result, support for specific strategies was fairly evenly divided across three areas: increasing awareness, investing in renewable energy, and consulting with scientists or other tribes for advice. The interviewee below was one of several who believe the Tribe should focus primarily on educational and outreach activities to increase awareness and influence lifestyle norms across the community:

> I don't think people are going to change if they don't see other people doing it too. The main thing right now is to be proactive and look into the future, get people involved and get people knowledgeable about it. I think that is the first step definitely. Then the second step would be like promoting the change and actually getting people buying in and doing it. It would be huge. (Interviewee #3)

Several interviewees, like the one below, focused on research and investment in renewable energy sources. Many described examples of renewable energy developments that they believe the Tribe should consider:

> Alternate energies, solar power, wind energy, all those need to be researched more heavily. There's also ways to produce fuel for our cars using wood. And there are plenty of ways to sustainably manage forests. There are plenty of ways to produce energy that would make a difference. Put some geothermal heat here or something over there just to show that we're trying to incorporate this. Maybe not to fully sustain the place on green energy, but why not put a couple things in? A couple solar panels would help cut costs plus it would show that we're trying to do this. And a lot of people don't realize how hilly this region is. We're set up pretty good for wind power. There are areas around here where the wind blows like crazy. It doesn't take much of a breeze to turn those propellers. They build them pretty light. Blow on it and it will be spinning. (Interviewee #8)

Collectively, interviewees elaborated much more on mitigation strategies than adaptation strategies; few described steps specifically related to planning for adjustments to inevitable changes (and those who did typically only made reference to the management of KBIC Tribal forests or fisheries operations). However, 29 of 30 interviewees indicated that traditional ecological knowledge (TEK) has an important role in the planning process. Of these, 18 described how efforts to promote and share TEK could help re-connect the community with its traditional environmental values and behaviors. Many interviewees, like the one below, alluded to the traditional regard for future generations as being a necessary component of climate change planning:

> We didn't call natives the stewards of the land for no reason. And if you look back, all of the centuries and thousands of years that we've been here, we've always believed in sustaining our resources, no matter what they are. We always believed in only taking as much as we need, and you make sure you do it in a way that you promote the continued growth for future generations. We need to get back to that. But as American people now we are selfish, and it's about politics and money, and because of that we might screw ourselves in the future by not supporting the seven generations theory. (Interviewee #21)

Nine interviewees discussed how the Tribe's collective TEK, particularly that of elders, should be combined with modern science to create effective strategies for the community. One interviewee emphasized the importance of listening to those whose knowledge could contribute meaningfully to solutions:

> First, I think our council should just be listening. I think they should listen to the scientists and to our people at natural resources that are studying this. And listen to the elders who have noticed a lot more than the rest of us. Maybe then they can lead the way and make sure we can all adapt and survive. If you think about history, we should be the ones with the understanding of how to do stuff like this. We should be the ones who can figure this stuff out. (Interviewee #30)

Overall, 25 of 30 interviewees stated that they are concerned about the impacts climate change could have on the community. As a concluding question, we asked interviewees what sources of information they rely on for information on climate change. The top responses were roughly evenly split between television, the internet, and general word-of-mouth. Although interviewees appeared reasonably informed on climate change topics, only eight stated that they receive climate change information from science journals, government reports, or local scientists or educators. Nonetheless, as the preceding section illustrates, interviewees had considerable insights to share on the topic.

Discussion and Conclusion

Although the effects of climate change may not yet be as obvious in the Great Lakes region as they are in other Native American communities, findings show that interviewees in the KBIC are keenly aware of climate change concepts and possible impacts to the community despite relatively low levels of educational attainment across our interview sample. In keeping with traditional knowledge, it appears that interviewees' perspectives on climate change are formed largely through direct interaction with the environment, observation, and word-of-mouth information sharing. The insight they shared provides richness that speaks to all three of our initial research objectives.

Assess Perceptions of Climate Change among the KBIC.

Interviewees were in near-agreement that climate change is occurring, as evidenced by the 29 of 30 who stated so in interviews. Interviewees drew from numerous lines of evidence to support their beliefs, mostly based on personal observation of environmental changes they've noticed in the area. Interviewees were typically long-term residents who spend substantial amounts of time outdoors engaged in a variety of recreational, cultural, and professional activities, and the stories they shared indicate that their beliefs were based on personal observation and stories of others' observations. Many, for example, cited changes they've noticed in weather patterns, features of water bodies, or involving the plant and animal species of the area (e.g., many shared observations involve fish). This body of knowledge, collected through accumulated direct observations and shared by word-of-mouth across the community, is reflective of traditional ecological knowledge. Many researchers agree that this type of insight from Native communities could be extremely valuable in broader climate change planning initiatives (Alexander et al., 2011; Berkes & Folke, 2000; Cochran et al., 2013; Vinyeta & Lynn, 2013; Wildcat, 2009; Williams & Hardison, 2013).

While interviewees were very aware that climate change is happening, few cited scientific reports or spoke in scientific language to support their beliefs. For example, phrases like "greenhouse gases" or "fossil fuel emissions" were rarely spoken in interviews. While many admitted that they didn't fully understand the scientific details involved, most attributed climate change to human activities and

effectively linked warmer temperatures to altered weather patterns and disturbed ecological processes. The fact that many interviewees proposed mitigation solutions involving alternative energy sources indicates the awareness of a link between energy consumption and climate change, even if most interviewees did not explicitly describe it.

Gain Insight on How Climate Change Could Impact Lifestyles of the KBIC.

Interviewees cited many examples of the ways that climate change could negatively impact lifeways within the community, and most were very concerned about how these changes could affect future generations. Interviewees discussed numerous ecological impacts, threats to human health, and negative impacts to the community's economy that relies largely on fishing, recreation, and tourism. Many interviewees' concerns integrated cultural aspects, typically involving traditional foods, sacred plant and animal species, or impacts to traditional outdoor activities that persist as important aspects of life across the community.

Perhaps most notably, interviewees' deeply-held values towards water emerged at numerous points throughout many interviews. A key finding from this research is the extent to which the region's water resources characterize lifestyles for traditional and non-traditional community members alike. While some focused on fishing, outdoor recreation, or day-to-day activities to illustrate the importance of water resources, others emphasized its sacred place in traditional Ojibwa culture. Many used examples from traditional stories to link changing water conditions to disruptions of deeply-held Ojibwa cultural values. Some remarked that if climate change continues, changes to water resources would affect Native communities such as the KBIC more than typical non-Native communities, considering the cultural impacts involved. Sentiments of this sort speak to the many environmental justice aspects of climate change, agreeing with numerous researchers who believe Native communities will bear a disproportionate burden of future climate change scenarios (Cordalis & Suagee, 2008; Krakoff, 2008; Lynn et al., 2011; Maldonado et al., 2013; Thomas & Twyman, 2005; Tsosie, 2007; Whyte, 2013; Wildcat, 2013).

Assess Support for Long-Term Mitigation and Adaptation Strategies.

Speaking to this objective, we found most interviewees well-versed in examples of ways that the Tribe could emerge as a leader in climate change response strategies. The development of renewable energy sources drew considerable attention among interviewees, with many expressing particular support for the implementation of wind and solar technologies on the reservation. Others discussed their support for educational/outreach efforts by the Tribe to increase climate change awareness among the community. The strongest theme to emerge related to this objective, however, is that nearly all interviewees discussed the need to incorporate traditional knowledge in the Tribe's planning process.

Many interviewees, agreeing with researchers nationwide, suggested that traditional knowledge holds an important place alongside modern science in the search for solutions. The engagement of elders was identified repeatedly as a necessary component. These insights will prove most valuable to the KBIC Tribal Council as they develop a climate change adaptation plan for the community.

On the local scale, findings from this work will serve as a foundation for ensuing research by providing richness to help guide the development of a follow-up mail survey in the community. The survey will involve a sample size large enough to be considered representative of the population and will allow for statistical analysis of results. By combining qualitative and quantitative ("mixed-methods") research, we will equip the KBIC Tribal Council with the insight necessary to confidently go forth with long-term climate change planning. A thorough awareness of the community's perspectives will help ensure that policy actions will be supported and effective.

On the global and national scales, and perhaps most importantly, our findings help fill a notable knowledge gap related to climate change and indigenous communities. At the time of this research, few articles in the scientific literature were found to examine climate change through the voice of woodlands-area cultures. Our efforts help introduce Native communities, particularly the KBIC, to conversations on this important topic. Other tribes may certainly benefit from outcomes of the KBIC's upcoming climate change planning process. Since climate change is a global phenomenon, a greater number of voices will more thoroughly illustrate challenges and can potentially help develop culturally-relevant adaptation strategies.

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APPENDIX A: *KBIC Climate Change Interview Protocol.*

1. How long have you lived in the area?
2. What do you like about the area? What makes it special?
3. What kinds of things do you do outdoors?
4. To you, what's important about our environment? What makes it important to the community? Please include anything that comes to mind.
5. From what sources do you typically hear information about the environment?
6. Do you have any concerns for our local environment?
7. Tell us about any changes you've observed in our environment during your lifetime.
8. Tell us what you've heard about climate change. What comes to mind when you hear people talking about it?
9. Do you believe climate change is already happening? Do you believe it will happen in the future?
10. [If yes to previous questions] What do you think is causing it?
11. Are you concerned about it? [If yes] Please share any concerns you may have about possible effects from climate change.
12. How do you think it could affect lifeways within our community?
13. How do you think it could affect you personally?
14. Do you think our community leaders should be taking action to address climate change? What should we be doing? Can you think of any solutions or strategies the KBIC leaders should consider? Would you support these types of actions?
15. Tell us about anything you think is important about traditional ecological knowledge. Do you think it should have a role in climate change planning?
16. Is there anything else you'd like to add? Do you have any questions for us?

Historic distribution of *Ostrea lurida* (Olympia oyster) in the San Juan Archipelago, Washington State

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The Ostrea lurida (Olympia Oyster) is a species that has become rare in the region of the Salish Sea in the Northwest United States. Once a flourishing species, research is being undertaken to restore the Ostrea Lurida, as part of a larger initiative to work with the Coast Salish tribes, "recognized stewards of coastal habitats." Marco Hatch and Sandy Wyllie-Echeverria use a variety of methods --- including personal diaries, logbooks, maps, and interviews --- to reconstruct the history of the species to support current restoration efforts. Through the utilization of these data sources, nineteen formally forgotten O. lurdia beds were discovered in the North Puget Sound region of the Salish Sea. These data will help correct the shifting baseline syndrome through the creation of a baseline that includes pre-contact ecological information. In so doing, the authors contribute to the current species restoration efforts as well as to the development of innovative research methods to support future efforts in the field.

Introduction

Many marine organisms have been harvested and impacted by human activity for millennia. In the recent past, several fisheries worldwide have declined or collapsed (Jackson et al., 2001; Pitcher, 2001). While attention focuses on recent declines, it is often forgotten that some species were overfished to the point of local extirpation (extinction) before modern record-keeping (Dayton, Tegner, Edwards, & Riser, 1998; Jackson, 2001). One example of a species harvested to local extinction before being recorded is the Stellar sea cow (*Hydrodamalis gigas*), which, based on archaeological evidence, ranged from California to Japan (Domning, 1981). By the time Vitus Jonassen Bering, the famous Russian cartographer and explorer, sailed into the Bering Sea in 1740 during his Great Northern Expedition, the Stellar sea cow existed only on remote and uninhabited Commander Island. Once discovered and because it was a large, slow moving sea mammal, the sea cow was hunted to extinction by 1769 by those hunting for seal pelts and other marine species (Domning, 1981). The failure to recognize the historic loss of a species in the modern epoch is known as the *shifting baseline syndrome*, which is defined as using one's first experience with an ecosystem as a baseline despite the fact that the ecosystem has already been degraded (Pauly, 1995).

Modern human activity has altered virtually every square mile of the ocean (Halpern et al., 2008). Most current activity directly or indirectly decreases the abundance and health and/or distribution of marine species. For example, North Atlantic shark populations have declined up to 75% from 1986-2001, based on longline bycatch data, which is the number of non-target species caught in long multi-hook fishing lines (Baum, 2003), a finding that was much larger than expected due to sparse baseline data for these species. This research assumes that the 1986 shark population data represents a baseline against which future estimates of abundance can be compared; however, this assumption cannot be tested without a true baseline.

Ostrea lurida (*O. lurida*)

In this paper we focus on the commercial harvest of the Olympia oyster (*Ostera lurida)* which began in the late 1800's and early 1900's. The Olympia oyster (*Ostrea lurida*) is a small, bed-forming oyster, about five centimeters in shell length (Baker, 1995; Cook, Shaffer, Dumbauld, & Kauffman, 2000). Historically, *O. lurida* occurred in the intertidal zone from Southeast Alaska to Cabo San Lucas, Baja California Sur (Mexico) (Dall, 1914; Fitch, 1953). The larvae settle "under the surfaces of shells" in the intertidal region (Hopkins, 1935). Early experimental study demonstrated that this behavior was not related to light sensitivity but rather to a "swimming position of the larva whereby it is commonly maintained in the water with the foot upward (Hopkins, 1935). Fossil records indicate that *O. lurida* was abundant in this region during the period of late Pleistocene (Arnold, 1909; Atwater, Ross, & Wehmiller, 1981; Valentine, 1959). Commercial harvest for *O. lurida* first started in San Francisco Bay, CA, in the early 19th century (Steele, 1957). The influx of settlers and wealth resulting from the 1849 Gold Rush increased the demand for fresh oysters, possibly leading to local overfishing. In the late 1800s and early 1900s, *O. lurida* was fished to local extirpation in many parts of its range; however, this incident has received little attention (Kirby, 2004). Depleted San Francisco Bay oyster beds were replenished with seed oysters from the Oregon Coast until they were also overfished; the oyster harvest then moved further north into Willapa Bay and Puget Sound in Washington State (Kirby, 2004). In Willapa Bay, commercial harvest began in 1851 and peaked at 250,000 bushels in 1874, then declined to 90,000 bushels in 1896 and continued to decline until all commercial harvest ceased in 1936 (Baker, 1995; Steele, 1957). A similar chain of events occurred in Samish Bay, a large coastal embayment (indented coastline) in the northern Puget Sound region, which contained large natural *O. lurida* beds until overharvest decimated the populations by the late 1800s (Cook, Shaffer, Dumbauld, & Kauffman, 2000).

Although little is known about commercial harvesting in the San Juan Archipelago in the central region of the Salish Sea, *O. lurida* was once relatively abundant at sites in this region, but is now absent or rare (Dinnel, Peabody, & Peter-Contesse, 2009). In the pre-history period (before events were recorded), the oyster was consumed in great quantities by the Northern Straits Salish People living in this area; Native groups harvesting *O. lurida* included the Swimonish, Lummi, Sannich, Songish, and Samish (Suttles, 1951).

After colonization, Europeans began to rationalize the landscape and shorelines once populated with conifer trees growing to the water's edge replaced by open grassy areas and broadleaf trees throughout the Salish Sea including the San Juan Archipelago (Suzuki & Grady, 2007). Most islands were clear-cut to build commercial and residential structures, clear land for farming, and provide fuel for lime kiln operations (White, 1992) Land-use modification increased the sediment supply to nearshore, smothering extant populations and covering available attachment sites, potentially contributing to the local extirpation.

To correct these conditions, an inter-government agency, the Puget Sound Nearshore Ecosystem Restoration Project (PSNERP), was created in 2001; it was charged to "develop an effective, large-scale ecosystem restoration program for the Puget Sound nearshore" (Goetz et al., 2004) and, as such, to encourage the implementation of programs designed to restore populations extirpated since European occupation of the Puget Sound Region. The PSNERP was guided by two restoration directives: (1) "evaluate significant nearshore ecosystem degradation of Puget Sound"; and (2) "protect and restore natural processes that create and maintain Puget Sound nearshore ecosystems" (Goetz et al., 2004).

An assessment of environmental degradation is more meaningful if an historical baseline can be established against which an existing condition can be compared (Dayton, Tegner, Edwards, & Riser, 1998; Jackson, 2001). Without this information, those charged with quantifying ecosystem decline risk underestimating the level of degradation that occurred. The objectives of our research are to: (1) outline a method to utilize ethnographic and archaeological data and information to guide the restoration of Puget Sound nearshore habitats; and (2) provide an historical baseline for the restoration of *O. lurida* in the San Juan Archipelago.

Methods

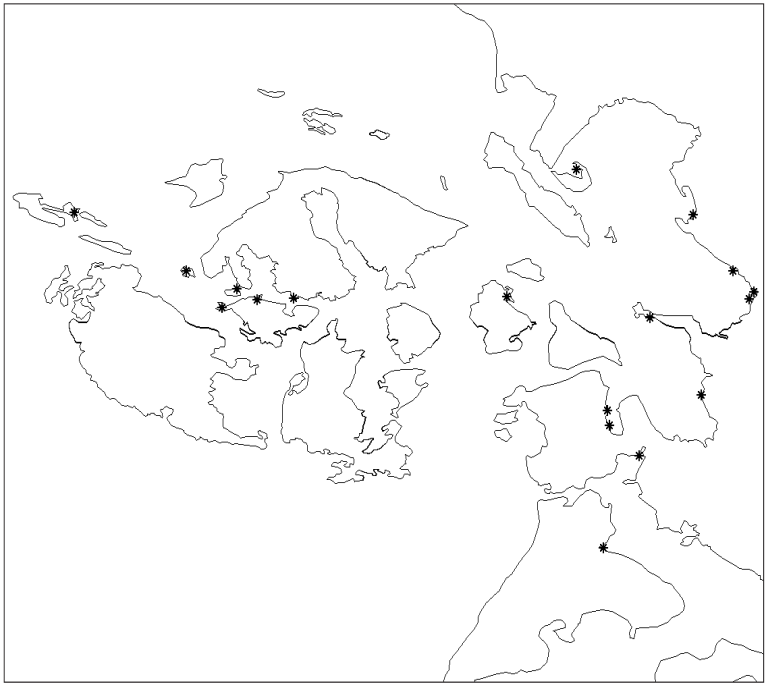
In this study we examined archeological reports, ethnographic studies, cartography created by early explorers and personal journals from European settlers. From each of these sources we extracted ecologically-relevant data and information useful in describing the distribution and/or abundance of *O. lurida* in the San Juan Archipelago. The records we searched included holdings archived at the University of Washington Special Collections, Western Washington State collections at Western Washington University and Washington State Department of Archaeology and Historic Preservation. Each record was evaluated for credibility and entered into our database, noting location and species observed (Strauss & Corbin, 1990). For geospatial analysis and integration with other research efforts, these data were mapped using ArcView GIS 3.2a (www.esri.com).

The Washington State Department of Archaeology and Historic Preservation curates site reports from every permitted archaeological site in Washington State; these reports often list the species of animal remains found in the archaeological site. Additionally, some reports contain information about age of site, season of occupation, minimum number of individuals in the site, and weight of shell and bone recovered. For this study, we report only the presence or absence of *O. lurida.* Archaeological materials range in date from 6,000 years old to contact by Europeans.

Results

Eighteen *O. lurida* beds were found using archaeological and ethnographic data (see Figure 1 below). These data came from eight archaeological reports and two ethnographic documents. Suttles (1951) collected ethnographic data through interviews with elders conducted in the late 1940s and early 1950s. Many of these elders spoke of places where their grandparents harvested *O. lurida*. Assuming the interviewee was 70 years old and a 25-year generation time period, then going back two generations to the interviewees' grandparents, the maximum age for Suttles' data would be 120 years, or, in calendar years, 1820. Suttles was primarily concerned with how, when, and where people harvested plants and animals. Given that purpose of this research and the importance of oysters to Native people, the information provided can be viewed as reliable.

Figure 1: ***The eighteen starred locations representing data points for Ostrea lurida either derived from ethnographic data or found in archaeological reports.***



Archaeological reports yielded eight of eighteen historic *O. lurida* beds. Two of the sites are located in Skagit County (site numbers SK214 and SK43) and six are in San Juan County (site numbers SJ246, S229, SJ245, SL340, SJ 286, and SK137). *O. lurida* beds were assigned to a shoreline nearest the

archaeological site. Ethnographic literature provided the location for most of the *O. lurida* beds, giving the location of eleven of the nineteen locations. Suttles (1951) provided the location of five *O. lurida* beds. Original field notes, compiled by Sally Snyder and housed at the University of Washington's special collection, also yielded five collecting locations. These notes are from personal interviews conducted. Personal journals and early explorer maps were examined but did not yield data for the study species within the study area.

Discussion

We demonstrate the value of ethnographic and archaeological data to describe a baseline for Olympia oyster distribution in the San Juan Archipelago. Because studies designed to characterize species assemblages in the intertidal region of the San Juan Archipelago occurred after extirpation, the distribution and abundance of this oyster in this region was not known.

The Olympia oyster is a good example of a species that has suffered from the shifting baseline syndrome. Harvest started in 1851 in Willapa Bay and shortly after in Puget Sound (Steele, 1957; Trimble, Ruesink, & Dumbauld, 2009). However, this intense harvest was short-lived, with oyster farmers turning to Pacific and Eastern oysters by the early 1900s. Over 100 years later, the existence of Olympia oysters is often not acknowledged by the general public. While Washington supports a $184 million per year shellfish aquaculture industry, the majority of the oysters raised in Washington are the non-native Pacific oysters (Northern Economics, Inc., 2013).

While this study identified eighteen areas where *O. lurida* beds once existed, there are most certainly more that have yet to be identified. There also are certainly many other marine organisms that have suffered reduced abundance compared to pre-European contact as well. These declines should be investigated where possible. For many systems, we will never know what they looked like before 1492 due to the lack of pre-contact materials left behind and the magnitude of impacts associated with colonization. However, the shoreline system offers a unique opportunity to understand a lesser-impacted system due to the relatively large amount of prehistoric data. The collection of plants and animals from the shoreline was important to Native Americans because of ease of collection and high calorie content (Erlandson, 2001).

While historic data is extremely important to consider when studying modern ecosystems, the limitations of the data must also be understood. Two major limitations for this type of historic ecology are: (1) asynchronous time scales, and (2) negative evidence. The asynchronous nature of both archaeological record and ethnographic research is an important caveat to this work. While our data show evidence that these animals existed in discrete spatial locations it does not accurately constrain

their temporal existence. While we identify locations of pre-historic oyster reefs, our findings cannot be used to support the lack of oysters at a particular location.

Several potential limitations of this work relate to the ability of materials to preserve over long periods of time. Archeological materials represent fauna that, where harvested, were discarded into the shell midden, or the discarded waste from processing food, which creates a large trash heap often with a large amount of shell content, and did not decompose when recovered during excavation. However, each of the necessary steps from harvest to preservation introduces its own bias. The Coastal Salish did not harvest all of the flora and fauna available to them and, accordingly, not all species are found in archaeological sites. Additionally, harvest of an organism does not guarantee that it will be discarded in a shell midden. Coastal Salish groups would often discard the remains of a particular species into the water rather than the shell midden (Stein, 1992). This may have occurred for any combination of sanitary and cultural reasons. In addition, due to the selective nature of preservation, many faunal remains are not preserved (Waselkov, 1987). For example, the chitinous exoskeleton of Dungeness crab (*Metacarcinus magister*) does not preserve as well and is rarely recovered in shell middens, whereas the thick calcium carbonate shells of bivalves such as the butter calm (*Saxidomus gigantea*) are often recovered in great numbers. Another source of error is that the oysters in the shell midden under examination might not have come from the shore nearest the shell midden.

Observational data include ethnographic data and interviews with cultural informants. While most ethnographers were primarily concerned with cultural practices rather than location of harvest, the original interview transcripts often mention harvest locations; however, some ethnographic data is unusable due to changes in the place names over time. Additionally, to be ecologically relevant, a data source must identify a species and a discrete spatial location; for example, the existence of clams on the west side of Orcas Island is not relevant but the existence of Olympia oyster reefs on the west side of Broken Neck Point, Shaw Island, is relevant.

Coast Salish people are recognized stewards of coastal habitats, habitats that directly contributed to the survival and sustenance of these people. For example, practices such as clam gardening, the active management of beach morphology for the benefit of clams, and the identification and cultivation of underwater meadows of the seagrass, *Zostera marina* (Augustine & Dearden 2014; Cullis-Suzuki et al., 2015), point to the likelihood that these people protect and enhance ecologically important coastal habitats, which will positively influence ecosystem stability. As a consequence, we strongly suggest that studies like ours guide restoration programs being considered by the Puget Sound Nearshore Ecosystem Restoration Project.

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Strategies for Retention, Persistence and Completion Rate for Native American Students in Higher Education

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A significant gap exists in higher education between Native American students and students of other races, ethnicities, and cultural backgrounds in retention, persistence, and graduation rates. The disparity exists across institutions of higher education, and is an acute challenge at Tribal Colleges and Universities (TCUs), institutions created to serve Native American students. Ahmed Al-Asfour and Marry Abraham, faculty members at Oglala Lakota College, study the research literature in this area as well as their own work and experiences, identifying six factors that positively impact Native American students' success in higher education: mindset, culture and spirituality, family support, quality interactions with faculty, mentoring, and student engagement.

Introduction

Student retention is a major problem for higher education institutions throughout the world. In the United States, retention is also a challenge for many colleges and universities. The retention of minority students remains the most challenging and pressing issue for mainstream higher education institutions (Love, 2009). Native American tribes established higher education institutions to meet the needs of their people because mainstream colleges and universities have not in the past and currently do not have the capacity to accommodate the needs of this group. Tribal Colleges and Universities (TCUs) were established in response to poor retention and graduation rates of Native American students enrolled in mainstream higher education institutions. This paper investigates retention issues for Native American students and recommends potential solutions.

Tribal Colleges and Universities

Higher education, as offered by TCUs, was conceived in the late 1960s to make higher education more accessible to reservation populations (Schmidt & Akande, 2011). These TCUs play an important and necessary role as traditional mainstream colleges and universities "have struggled to accommodate American Indians and create environments suitable for their perseverance resulting in degree completion" (Guillory & Wolverton, 2008, p. 58). Guillory and Wolverton (2008) found that, due to failure by mainstream higher education to accommodate Native American students' needs, tribal leaders felt the need to be in control of their own educational destiny. Hence, these leaders began to use old buildings, double-wide trailers, and other available infrastructure as places to provide higher education in their communities (Ambler, 2009). From these humble beginnings, tribal colleges were established as an alternative to serve Native American students (Williams, 2007).

TCUs present themselves as unique educational providers because they approach education differently than do mainstream higher learning educational institutions. TCUs base their education philosophy on the principle that tribal students should not have to abandon their cultures, traditions,

languages and most importantly, their families, in order to obtain an education (Opp, 2007). These institutions prioritize facilitating education relevant to Native American reservations and nearby communities. Williams (2007) described TCUs as a whole-community approach to higher education and vocational education, while Al-Asfour (2012) found that "Tribal colleges are unique entities in that they work around the needs of students and their communities, not vice versa" (p. 23). Many of the students attending TCUs fit the definition of non-traditional students. Most of the students are single parents or have other dependents, are older than twenty-four years of age, and are part- or full-time employees; and some students have a combination of all of these characteristics (Bergstrom, 2012; Schmidt & Akande, 2011); as a result, many TCU students attend school part-time, adding additional barriers to degree completion.

Tribal higher education institutions maintain philosophies of academic access similar to the open enrollment policies of community colleges (Al-Asfour & Bryant, 2011). TCUs are unique in that students attending them are supported in retaining their cultural identity. This cultural identity serves as a key motivator for the success of many students (Orbe, 2008). The American Indian culture permeates every aspect of the institutional mission, vision, policies, and curricula of TCUs. However, TCUs face several challenges to continue their operations and ability to provide open access to students, including a lack of funding, dilapidated facilities, and the low income levels and poor academic preparation of many of their students; despite these challenges, these institutions manage to continue opening their doors for their communities (Schmidt & Akande, 2011; Williams, 2007).

Defining Retention

Retention definitions appear unique to the mission of colleges and universities and appropriate to their student populations. Higher education institutions mold their retention definitions to fit the accreditation criterion of their selected accrediting body. The Integrated Post-Secondary Education Data System (IPEDS) is available for additional guidance. IPEDS defines retention as:

> A measure of the rate at which students persist in their educational program at an institution, expressed as a percentage. For four-year institutions, this is the percentage of first-time bachelors (or equivalent) degree-seeking undergraduates from the previous fall who are again enrolled in the current fall. For all other institutions this is the percentage of first-time degree/certificate-seeking students from the previous fall who either re-enrolled or successfully completed their program by the current fall. (National Center for Education Statistics, 2015, p. 9)

According to the Federal Register (2014), the expectation for a four-year higher education institution is to matriculate first-time degree seeking bachelor's degree scholars with no more than 150% time attempted. This means a four-year degree should be obtained in no longer than six years. The

measurement can be used for other higher education institutions offering degrees such as certificates and associates programs, as well.

IPEDS' definition of retention appears to be tailored more towards mainstream colleges and universities. Due to the unique nature of TCUs a comparison of retention and persistence definitions amongst TCUs can be beneficial for future strategies. In addition, comparing retention and persistence numbers with likeminded colleges and universities provides a more accurate representation of the student population. Research on the following selected TCUs indicates the similarities and differences in their retention definitions. Oglala Lakota College (OLC), a tribal college located on the Pine Ridge Reservation in South Dakota, defines retention rate as "the percentage of returning freshman in the following semester calculated as proportion of total number of entering freshmen."(Oglala Lakota College, n.d., p. 1). In addition to retention, the persistence rate is defined as "the number of students returning over total number students multiplied by 100" (Oglala Lakota College, n.d., p. 1). Although retaining students from the start of their courses to graduation is the ultimate goal, persistence is just as important. Those students that, at one time or more, stopped attending and then returned to complete their degree are encouraged to persist.

Sitting Bull College (SBC), a tribal college located on the Standing Rock Reservation in North Dakota, defines retention as "students that enroll in the fall and return the following fall." (Sitting Bull College, 2014, p. 9). SBC identifies persistence as "students [who] enroll in the fall and return during the spring" (Sitting Bull College, 2014, p. 9). On the other hand, for the College of Menominee Nation (CMN), a tribal college located on the Menominee Reservation in Wisconsin, "retention rates measure the percentage of first-time students who are seeking bachelor's degrees who return to the institution to continue their studies the following fall" (College of Menominee Nation, 2013, p. 1). According to the same source, CMN relies heavily on the IPEDS definition of retention at their institution.

All of the colleges listed remain as members of the Higher Learning Commission (HLC) accrediting body. The HLC criterion for retention allows the colleges the freedom of defining their own retention goals that also include persistence and completion. The goals must be "ambitious but attainable and appropriate to its mission, student populations, and educational offerings" (Arkansas State University, n.d., p. 1). HLC also requires the institutions to define the process used to collect and analyze the data and how that data is used to improve retention and persistence within the institution in the future.

As previously mentioned, the retention process is subject to a first-time full-time degree-seeking student within a bachelor's program. This categorization makes it difficult for TCUs that have programs other than a bachelor's degree, such as certificates and associates, to track the students they matriculate consistently. In addition, mainstream higher education institutions dismiss other factors, excluding the students that are part-time, have transferred in, or have not declared a major. Some colleges, such as

College of Menominee Nation, only include the students that start in the fall term resulting in the students that start in a term other than fall to be omitted from the calculations. Persistence emerges as easier to track, when the definition puts the concept from term to term, and there is no exclusive categorization of degree-seeking students.

Retention Issues

TCUs face unique challenges in increasing retention. These challenges include geographic remoteness, small facilities, and limited housing opportunities, and the fact that the majority of TCU students are demographically "non-traditional." TCUs hold an open admissions policy in the majority of academic programs (Bergstrom, 2012). Open admission creates additional challenges for retention as there is a greater chance students will be admitted who lack adequate preparation to succeed in college courses. More preparation may be needed for these students prior to their attending and succeeding in the college-level courses required to earn a degree. The additional preparation might prolong the process of obtaining a degree because the students may need to attend supplementary courses to prepare them for college courses resulting in additional pressures for the students to succeed. Open enrollment also allows for students to attend courses needed for job skills training, which results in the student having a stronger commitment to their job than on their studies (Opp, 2007).

Reservation life possesses challenges in and of itself (HeavyRunner & DeCelles, 2002). Students cope with matters such as excessive unemployment (Al-Asfour, 2014b), and high morbidity rates including suicides and alcohol related deaths. Such deaths occurring within families not only pose an emotional strain on the student, but at times leave the student in a position where they become the sole provider for their family. Single parents deal with additional burdens, including daycare issues, car troubles and increased poverty (HeavyRunner & DeCelles, 2002).

Native American Students' Success at Higher Education Colleges & Universities

Significant issues affecting Native American students' success have been discussed among administrators, college educators, and community members at the local, state, and even at the federal level in the United States (Bailey, Jenkins, & Leinbach, 2007; Crisp, 2010). Native American students who attend higher education often encounter different obstacles than do other ethnic groups. Scholars have debated for many years that Native American students have different goals, attitudes, and beliefs (Jackson & Smith, 2001; Schmidtke, 2010). Administrators and educators must then understand these differences to create an atmosphere of success for these students. Although TCUs were created to increase the possibility of Native Americans earning degrees by including culture, pride and degree options that pertain to reservation life, the graduation rate of Native American students remains low.

Higher education institutions that serve large numbers of Native American students need to understand the strategies that help Native American students become successful in their educational endeavors. By gaining insight into these strategies, administrators and educators begin to examine models to increase the success rates of Native American students. Identifying barriers to Native American students' success is not enough. TCUs strive sufficiently to improve Native American student matriculation rates until colleges of all categories start to demonstrate a willingness to remove barriers and implement new strategies in order for Native American students to excel in their education (Pewewardy & Frey, 2004).

Factors for Native American Students' Success

Researchers in this field identify a variety of factors for Native American students' success. The factors most frequently cited for Native American students' success in the literature are the following: a) mindset; b) culture and spirituality; c) family support; d) quality interactions with faculty; e) mentoring; f) student engagement; and other related factors (HeavyRunner & DeCelles, 2002; Korkow, 2008; Schmidtke, 2008.).

Mindset

Schmidtke (2008) found several factors contributing to Native American student success in post-secondary education. The first theme is a mindset of success. Having the desire and determination to attend college is not enough. Students need to have the will and determination to succeed regardless of the barriers that are encountered throughout the journey of obtaining a post-secondary degree. Having the success mindset remains important; however, other factors such as the ones discussed below are also extremely important for Native American students' college success.

Culture and Spirituality

Native American students who were immersed in their culture(s) during their college years were more likely to persist in their education; HeavyRunner and DeCelles (2002) found that the best examples of such persistence prevailed at TCUs. Native American students avail themselves of their traditional culture, and it functions as a mechanism to guide their educational model. TCUs create a nurturing cultural environment suitable for their students. In addition, TCUs engage more Native-oriented student organizations to enable students to be more involved with their cultural and spiritual heritage. TCUs were able to bring cultural values, tribal elders, and college courses together to improve college experience and help with increasing retention of students (HeavyRunner & DeCelles, 2002).

Family Support

TCUs focus on total family involvement throughout the course of the education experience their students receive. According to HeavyRunner and DeCelles (2002), family members play a major role in Native American students' success. The authors recommended that family members engage and connect with the students' college experience. Because family members in Native American communities are close to each other and their cultures are considered collectivist, engaging family in the circle of support endures as important to increase the odds of success. Schmidtke (2008) and Makomenaw (2012, 2014) also found that family and extended family support play a role in student persistence. Families provide encouragement and support, an essential for many Native American students and an important contributor to Native American students' success in higher education.

Quality Interactions with Faculty

Faculty interactions with Native students emerged as one of the major themes in the literature available on student retention and persistence. Wenzlaff and Brewer (1996) found that establishing a connection with professors is one of the important factors for success in higher education for Native Americans; this was supported by the work of HeavyRunner and Marshall (2003). According to these scholars, Native students tend to do better when there are interactions with faculty members that allow encouragement and support of their students. Schmidtke (2008) found that one of the issues discussed in Native American student success is the importance of finding help when needed. Help should come from all stakeholders; most importantly, it should come from instructors. Demmert (2001) argued, "social and economic factors influencing poor academic performance could be mitigated by teachers that become involved in community activities and spend time with community members" (p.18).

Mentoring

Researchers indicate that mentoring is an important component to the success of Native American students (HeavyRunner & DeCelles, 2002; Korkow, 2008; Wenzlaff & Brewer, 1996). Mentoring develops students' relationships as they participate in social, cultural, recreational and tutoring programs. Through mentoring, students learn best practices from one another. The authors also indicate that mentoring programs are especially important with students at risk of dropping or failing their courses.

Student Engagement

Junco, Heliberger, and Loken (2011) found that students who engage in different types of academic discussions using social media had a higher grade average than those who do not. This was also supported by Demmert (2001), who found the best approach to increase student success is student

engagement. When students feel engaged in the academic life, the likelihood of them becoming successful in college increases, and their retention rates improve. Flynn, Duncan, and Jorgensen (2012) found three important dimensions of support to increase student success and retention in college: *institutional*, *social*, and *interpersonal*. Each category has an essential role in student engagement vital to the success of all students.

Subsequent to reviewing the literature on Native American students' success in higher education, it is apparent that TCUs are an ideal fit for many Native Americans. The majority of traditional Native American students who attend mainstream colleges off the reservation experienced difficulties with their transition to college, a conclusion supported by a study three decades ago (Huffman, Still, & Brokenleg, 1986), and confirmed by Huffman (2003); TCUs accommodate student needs and provide education tailored to their cultures and traditions, in addition to providing the education students would receive at mainstream institutions.

Korkow (2008) suggested that Native American students' success in higher education continues as "a multi-faceted process consisting of external and internal strengths, which are utilized to overcome barriers so that the student can fulfill a commitment to change conditions in Indian Country" (p. 99). Korkow states that it is "imperative to encourage this personal commitment to change in each Native student" (p.99). Personal commitment refers to students having self-efficacy to succeed in their education and become future leaders in Indian Country.

In part because mainstream colleges and universities seem unable or unprepared to provide all of the required needs to accommodate Native American students, TCUs are a great fit for Native students, who want to keep their cultures, languages, and traditions, while obtaining higher education degrees. TCU's, as stakeholders in their communities, are able to more successfully meet the unique needs of Native American students.

Strategies for Improving Student Retention, Persistence, and Completion Rates

The retention strategies implemented should be tailored to fit the student body and the TCU's needs. The factors for success are a useful guide to determining the strategies needed for each institution. According to Kuh (2006), student engagement is an important aspect of student success. Encouraging students to be part of an educationally purposeful organization such as a Student Senate, Nursing Club, or any other club or organization relevant to their degree furnishes the student a sense of belonging and introduces the student to another side of college life. Students will have a chance to develop meaningful relationships with other students they missed meeting in their classes but feel they can relate to, giving students peers to turn to when faced with unique barriers. This strategy can change a student's mindset from a feeling that they are alone and cannot follow through, to a feeling they belong and can complete.

Implementing the cultural and spirituality aspect within a TCU sounds like a redundant issue. The students continue to be exposed to cultural subjects within their required curricula at TCUs. However, students need to have the exposure to their culture daily. In order to accomplish daily exposure, especially when a student is not taking a cultural course for the semester, faculty and staff must be involved in strengthening the culture within the institution at some level. This may not be a problem for Native American instructors, but non-native faculty and staff must be involved in the native culture in any way they possibly can (Korkow, 2008).

Whether it be engaging in conversation about the history or current events happening on the reservation or striving to learn the Native language, the students will gather that the faculty and staff are supportive of their culture on more than just a required curricula level. Korkow (2008) found that connecting with students on a cultural or spiritual level is critical as the student will be more apt to discuss their difficulties and other pressing issues presenting barriers to their success.

Although campus staff members play a huge role in student success, faculty members continue to be especially vital. Faculty members are in contact with their students regularly. The professional status of the faculty member is something the students may desire to exemplify. Faculty members might connect with students by relating their own stories of personal challenges and obstacles overcome. Faculty should also try to interact in as many activities as possible outside of the classroom to connect on a personal level with the student (Korkow, 2008; Kuh, 2006). Faculty must also have a reasonable schedule to work with the students outside of classroom time. One-on-one assistance with struggling students can be a key to their academic success. The more comfortable a student is with faculty member, the more willing they will be to work with the instructor one-on-one (Korkow, 2008). Communication between faculty members and students is essential to students' success, particularly to increase retention and persistence (Al-Asfour, 2014a).

All universities should have some form of early alert system in place, to alert the institution to students who are experiencing academic difficulty. The early alert system may include information useful to both the counselors and the faculty in order to open lines of communication with students, faculty members, and other staff. Such information should include the reason for the early alert, including but not limited to: attendance, grades, or personal needs, one-on-one assistance needs, the efforts the instructor made to resolve the situation, and future plans to maintain communication with the student. The effectiveness of the early alert system depends on the proactive and diligent mindfulness of parties involved (Kuh, Kinzie, Buckley, Bridges, & Hayek, 2006).

Instructors may also increase classroom engagement by tailoring lectures and assignments to relevant issues the students better relate to. The process of allowing the students to make the connection with their academic world and their personal world invites open discussion and a better understanding of the curricula (Kuh, Kinzie, Buckley, Bridges, & Hayek, 2006). With Native American students having

such a high rate of adult learners, real-life experiences become more readily available and can be more beneficial in becoming competent with the subject material. Likewise, recognizing the talents and experiences of the adult learners adds diversity and welcomes new perspectives into the classroom.

Faculty should recognize the prior education of the students and also recognize academic deficiencies the students carry when beginning their post-secondary education (McCabe, 2000). McCabe (2000) reports that only 42% of all students entering post-secondary institutions graduate from high school with the necessary skills to begin college-level work. Students entering universities need to be tested to evaluate their skills prior to taking college-level courses (Arendale, 2010). Students who test below required college-level readiness should be required to take and pass remedial courses prior to being enrolled in college-level courses. Pérez and Nordlander (2004) also noted that some Native American students who received their high school education solely on the reservation, fall short concerning the exposure to subjects such as Shakespeare and other historical literary artists. Some reservation high schools may center their focus more on Native American literature. Mainstream universities seeking to retain Native American students may increase student success in these literary courses for their Native American students by offering courses related to Native American literature.

Proper mentoring produces a huge positive impact on retention. Along with knowing the students on a personal level, mentors should know the students' academic strengths and weaknesses. Schedules can be made to balance the students' strong subjects with subjects they struggle with. Mentors should be in constant contact with their students.

Conclusion

This article investigates retention, persistence definitions, and factors for Native American students' success in higher education. The literature review related to Native American students in higher education provides a great deal of useful information for faculty, administrators, and other stakeholders on the issue of student retention and persistence. Despite TCUs having increases in enrollment, Native American students' retention and persistence remain the lowest among all ethnic groups. Hence, the need for developing strategies to tackle this challenge looms as the most essential campaign in the continuation of TCUs.

Student retention is critical for TCUs, and has implications for academics (creating a strong and appropriate educational environment), finances (federal funds, such as the Pell Grant, are tied to retention), and student success. A focus on retention emerges as not only the right step to take, but presents itself as part of the mission of many TCUs. For example, OLC's mission focuses on "rebuilding the Lakota nation through education" (Oglala Lakota College, 2015, p. 1). Because the general purpose of TCUs is to rebuild and improve their respective tribal higher education programs, it is imperative for TCUs to focus on retention, persistence, and degree completion in a timely manner.

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Molecular Evidence for the Consumption of Plutella xylostella (Diamondback Moth) in Bat Guano

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Understanding the foraging ecology of bats in North Dakota is essential for establishing the economic value of bats for agriculture. In this article, Mandy Guinn and Nicole Olson investigate the role that bats play in reducing or eliminating one of the barriers to agricultural production in the region. North Dakota is the nation's leader in canola production, generating approximately 90% of America's canola crop. However, the Diamondback Moth (Plutella xylostella) is a canola pest of major concern, as it can devastate every part of the canola plant, from its leaves to the seed pods. P. xylostella is known for its resistance to insecticides; however, bats have the potential to be a natural pesticide. Guinn and Olson use innovative, molecular techniques to determine whether and the degree to which bats are preying on P. xylostella, and to develop an estimate of the economic value bats contribute to North Dakota agriculture.

Background and Purpose of Research

Basic understanding of population distributions and habitat requirements is essential to ensuring the viability of populations under stress. Insectivorous bat populations in the eastern United States have recently been threatened by a fungal condition that ultimately causes death by starvation during hibernation (Blehert et al., 2009; Gargas et al., 2009; Meteyer et al., 2009; Reichard & Kunz, 2009). This fungus, *Pseudogymnoascus destructans* (formerly *Geomyces destructans)*, may become visible as a white powdery substance concentrated around the bat's ears, nose, and wings and has become popularly known as white-nose syndrome (Courtin et al., 2010; Meteyer et al, 2009; Puechmaille et al., 2010; Reichard & Kunz, 2009). Although it is not known if white-nose syndrome is the ultimate cause of death, bats infected with the fungus generally show signs of starvation (e.g., lack of body fat) and emerge earlier from the hibernacula when food is unavailable (Buchen, 2010).

White-nose syndrome was initially reported in New York in 2006 and has rapidly spread to several other states on a western progression. As of 2010, the fungus had spread to nine other states and continued to kill between 90 and 100 percent of hibernating bat populations in the affected regions (Buchen, 2010). According to the U.S. Fish and Wildlife Service, in 2012, the fungus had been reported in 16 U. S. states, all with similar bat mortality rates (Warnecke et al., 2011). The fungus has now been reported in twenty-five states and five Canadian providences with the most recent occurrence as far west as Michigan and Wisconsin, reported in 2014 (White-Nose Syndrome, n.d.). The fungus is spreading into the Great Plains region of the United States and the elimination of key pollinators in these regions may have devastating effects on crops and other important plant species (Blehert et al., 2009). It is predicted that bats provide an average of $22.9 billion/year in value for croplands (Muller et al., 2013). An initial key to understanding, preparing for, and attempting to mitigate the impact of white-nose syndrome on mid-western bat populations is to have a clear understanding of bat habitat and distribution in the region as well as to determine the economic value bats provide annually for local and

regional agriculture. However, very little information or data is available on the habitat, distribution, and foraging ecology of bats within the Northern Great Plains.

Because of the lack of data and the timely topic, several projects were designed to address the lack of data in three areas of bat ecology: prey preference, prey abundance, and foraging habitat. In 2014, a baseline study that melded these three areas was initiated. This study resulted in the collection and molecular analysis of fresh bat droppings, enabling the isolation and identification of insect remains in bat guano. This method provided a non-invasive way to study both foraging preference and ecology patterns of the bats without harm or removal of bats from the larger population. Because testing for insects is a broad topic, the scope of work was narrowed down to focus on one moth species, the Diamondback Moth (*Plutella xylostella*). This species is one of the most widely-studied insects because of the detrimental effects it has on agricultural and in particular the Canola crop family. North Dakota is the largest producer of Canola and within the distribution range of this moth. We focused our efforts on determining if bats were foraging on the Diamondback Moth. This process presented additional problems because generally soft-bodied creatures are difficult to identify in droppings relative to those species that contain hard exoskeletons which are more difficult to break down. It is also not easy to extract DNA from already digested and degraded fecal materials. Despite the challenges, we developed methods that were successful in identifying both soft- and hard-bodied insects.

North Dakota has eleven insectivorous bat species that help control insect populations. It is estimated that bats can eat up to half their weight in mosquitos, moths, and beetles nightly. Worldwide, bats provide $23 billion in economic benefits and about $4 billion in relief from insect herbivory in the U.S. (Riccucci & Lanza, 2014). However, specific economic value for bats is not known. It is also unknown if bats are main predators to specific crop pests in North Dakota. One of the more important crop pests for North Dakota is the Diamondback moth (*Plutella xylostella).*

The Diamondback moth is a highly studied insect worldwide because it has become the most destructive pest of *Brassicaceae* plants. Plants in the family *Brassicaceae* include but are not limited to canola, mustards, cabbage, rapeseed and radishes. Annually, the moth causes an estimated $1 billion in crop damage. In large numbers, this petite moth has been known to destroy entire fields of *Brassicaceae* crops from the leaves to the root, rendering them unmarketable. More concerning, the moth has developed resistance to all major pesticides including DDT, *Bacillus thuringiensis*, and other synthetic insecticides used as control methods (Talekar et al., 1993). In 2001, the Diamondback moth was documented for the first time in North Dakota. Although North Dakota produces many crops in the *Brassicaceae* family, one crop of major concern is canola because North Dakota is the primary producer for the United States. Annually North Dakota produces 90% of the canola crop for the entire United States (Kandel & Knodel, 2011).

Due to the moth's small size and destructive nature, rainfall and wind are the only documented deterrents for this particular species, affecting both adult activity and larvae development. Cool, windy weather also limits adult lifecycles by affecting females, which will often die before they lay eggs (Ahmad & Ansari, 2010). Another plausible, but undocumented, method of control could be natural bio-control agents such as birds and bats. The purpose of this study was to use molecular analysis of bat guano to determine if bats at our collection sites are foraging on the Diamondback moth.

Methods

Site Selection

Since very little is known about the bats species in North Dakota, collection sites were not randomly selected. Instead, North Dakota was sectioned into "hotspots" of agricultural land dense with canola crops that were likely to also be inhabited by bat populations. This method was used in order to increase the chance of successful bat captures to improve the likelihood of obtaining a large number of guano samples. This also increased the likelihood that Diamondback moths were available to bats as potential prey sources. Hotspots were identified as locations that contained a large amount of slow-moving or free-standing water, as insectivorous bats would likely concentrate near these areas for foraging. The additional criterion for hotspots was: sites that contained sufficient roosting structures (tree rows, buildings, etc). Lastly, any known bat roosting areas within the state were also sampled.

Samples were collected from a total of five locations. Locations included a barn located twenty miles south of Anamoose, ND. The site was completely surrounded by agriculture and was within one mile of the nearest canola field. The second sampling site was located north of Bismarck, ND, at Cross Ranch State Park. This park is also known for a significant number of roosting areas and is located adjacent to canola fields. The third site was located east of the Missouri River from Cross Ranch State Park in an area called Painted Woods, in a small abandoned barn located in the middle of agricultural fields. The fourth site was located at United Tribes Technical College campus in Bismarck, ND. This is a semi-rural setting with dilapidated historic structures that shelter several hundred bats per year. Bats were collected from both the attics and canopy-covered walking path that circles the campus. This site had a large population of bats and maternity colonies. The final site was located five miles north of Wyndmere, ND, at a residence in which bats were inhabiting the house.

Guano Collection

Guano collection started in early June and lasted until mid-July. Weather permitting, mist nets and triple high nets were placed within three feet of roosting locations before dusk. Mist nets were deployed when acoustic detectors picked up bat activity. All bat captures and handlings were done in accordance with the American Society of Mammologists Guidelines for the Capture, Handling, and Care

of Mammals, the US Fish and Wildlife Service's Disinfection Protocol for Bat Field Studies, the University of North Dakota Institutional Animal Care and Use Committee, and the North Dakota State University Institutional Animal Care and Use Committee. Upon capture, bats were removed immediately from the nets to reduce stress and further entanglement. Bats were placed in a sanitized cloth bag for approximately one hour or until guano samples were deposited. After the allotted time, bats were sexed, aged, weighed and a forearm measurement was taken. Bats were released immediately following the health screening. Guano was collected from the cloth bags and placed in sterile vials with sterile tweezers (to reduce cross contamination). Vials were stored in a freezer at -20 degrees until analysis. A total of 122 bats were captured during the study period and of those, only 56 deposited viable guano samples.

DNA Extraction

High-quality DNA was purified from all 56 samples using a ZR fecal DNA microprep kit (Zymo Research). Prior to extraction, all fecal samples were subjected to five minutes of bead bashing to help lyse the remaining tissue in the guano. After bead bashing, the samples were purified using the manufacturer's protocol. Stable samples were held at room temperature overnight.

Polymerase Chain Reaction

Two independent sets of primers were used to target an approximate 650 base pair region of the mitochondrial cytochrome oxidase I (COI) locus. Mitochondrial DNA was targeted rather than the nuclear DNA because of the higher copy number and because it has been shown to be more effective when used on degraded insect remains. The first primer set used was NANCY: CCCGGTAAAATTAAAATATAAACTTC and K698: TACAATTTATCGCCTAAACTTCAGCC. Primer sequences were provided by a moth specialist, Rebecca Simmons, from University of North Dakota. A total of 14 DNA samples were prepped and optimized on campus using NANCY and K698 primer sets and Qiagen HOTTaq PCR kits. Each PCR sample contained: primer in 1ul, primer K698 in 1ul, DNA – 2ul, H20 – 6ul and 2x Promega GoTaq Green Master Mix in 10ul, for a total of 20ul. When optimization was unsuccessful, all the samples were sent to Functional Bioscience Laboratory to assist with optimization. Functional Biosciences processed the samples with NANCY and K698 oligos and then repeated with the second set of oligosnucleotides independent of the first set. The second set of primers, ZBJ-ArtF1c: AGATATTGGAACWTTATATTTTATTTTTGG and ZBJ-ArtR2c: WACTAATCAATTWCCAAATCCTCC, has also been shown as an affected set in targeting the primary COI gene in insects (Zeale et al., 2011). PCR thermocycler conditions were as follows: samples were held at 94 degrees C for 3 minutes followed by 34 cycles of 95 degrees C for 1 minute, 45 degrees C for 1 minute, 72 degrees C for 1.5 minutes, followed by a 5 minute holding cycle at 72 degree C. Products

were run on a 1.5 agar gel and the remaining sample were sequenced using an ABI 3730xl DNA Sequencer.

Results

Within the capture sites, a total of 122 bats were captured from early June to mid-July, 2015. Of the total bats caught, there were three predominant species which included the silver hair bat (*Lasionycteris noctivagans*), the little brown bat (*Myotis lucifugus*) and the big brown bat (*Eptesicus fuscus*). A small number of northern long-eared bats (*Myotis septentrionalis*) were also captured. Female bats were the dominant sex with a ratio of approximately 1:20 or 5% being males. Only the big brown bat (*Eptesicus fuscus)* and little brown bat (*Myotis lucifugus*) produced sufficient numbers of guano samples to be analyzed for this study.

Of the 56 fecal samples processed, 20 samples amplified successfully and 16 samples produced high-quality sequence results. Only sequences with high-quality phred scores of 20+ were used for analysis (meaning that there is less than 1% chance the base pair identification is reported in error). Genetic sequences were saved as Fasta files, which were analyzed using Genbank BLAST search.

BLAST analysis revealed four distinct insect orders within the guano; Diptera, Coleoptera, Lepidoptera, and Siphonaptera. The most predominant insect order in little brown bat guano was *Aedes vexans*, the mosquito known to be a carrier for dog heartworm. While the predominant insect order found in big brown bat guano was *Melanotus simillis*, a common crop pest among corn and potato crops. Although insects such as the *Drosophila* (fruit fly) and *Anthicus cervenus*, a small brown beetle were identified, their match rate was considered low and are now included in Table 1 which shows only those sequences that produced a high DNA match rate when processed with the BLAST Genbank.

Table 1: ***List of prey found using BLAST sequencing. Results shown are from nine Eptesicus fuscus and eleven Myotis lucifugus. Only sequences that matched another sequence in the BLAST database with a similarity of 84% or greater are displayed.***

Order	Family	Genus	Species	Similarity %
M. lucifugus				
Diptera	Culicidae	*Aedas*	*vexans*	99.0%
		Ochlerotatus	*dorsalis*	99.0%
	Sepsidae	*Saltella*	*nigripes*	88.0%
Coleptera	Curculionidae	*Orchestes*	*avellanae*	84.0%
Lepidoptera	Coleophoridae	*Colephora*	*glaucicolella*	99.0%
E. fuscus				
Siphonaptera	Ctenophthalimidae	*Stenopia*	*tripectinata*	86.0%
Coleoptera	Malvacaea	*Melanotus*	*similis*	99.0%
	Dytiscidae	*Colymbetes*	*dolabratus*	95.0%
Leidoptera	Pterophoridae	*Emmelina*	*monodactyla*	99.0%

Discussion

Until recently, practical means for studying the foraging habits of bats required manual dissections of guano pellets with attempts to physically identify partial insect remains and match them to a reference collection. This method was labor-intensive and presented many biases when mostly hard-shell bodies were identifiable. Molecular analysis provides a cost/time-effective and efficient way to eliminate some of the primary biases. However, the use of fecal matter continues to complicate the molecular process because DNA fragments are partially digested and degraded. Therefore, by utilizing the COI locus of the mitochondrial genome, we were able to successfully amplify these fragments and identify both soft and hard-bodied organisms. Because these techniques are relatively new, we focused on obtaining one single band from the PCR samples. In the future, cloning the PCR results prior to sequencing the results may result in multiple bands per sample and increase the number of prey identifiable within each sample.

None of the samples contained Diamondback moth DNA. However, there are several reasons that this may have occurred. Reports from producers in North Dakota suggest that the Diamondback moth population was low for 2015. This may be a direct result of the 17.8 inches of rainfall recorded during the 2015 growing season when *P. xylostella* is most abundant. Because of record low sightings of the moth in North Dakota during the primary growing season, it is possible that they were also not available to bats as a main food source during this year.

Even though the Diamondback moth was not found within the guano it is important to further identify those species that were found and consider their environmental impacts. Of the twenty samples

sequenced, insects including: *Aedas vexans,* a harmful mosquito linked to dog heartworm; *Ochlerotatus dorsalis,* a mosquito linked to West Nile virus; *Saltella nigripes,* a common fly; and *Melanotus similis,* a soil-inhabiting pest that damages corn, potato, and soybean crops. All of these pests have been known to negatively impact agriculture, traditional practices, and mammalian livelihood.

Although these methods provided a baseline dietary analysis for the two bat species, the current methods only resulted in a single band per PCR sample and limited the prey outcomes. Future studies will include cloning PCR samples to provide multiple bands per sample and increase the potential to identify more than one species of prey. Other possible methods for future research is to expand the study area, sample size and time of sampling (include morning hours). Lastly, we have considered manipulating feeding in an artificial roost to determine the bias ratio of hard-bodied vs. soft-bodied prey presence in bat guano.

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Relationality and Student Engagement: Connecting Teaching and Learning at a Tribal College

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Institutions of higher education are driven by teaching and learning. Tribal Colleges and Universities (TCUs) are driven by teaching and learning that is connected to the culture, language, values, and history of the tribes they serve. In this article, Brian Compton, Ted Williams, and Cheryl Crazy Bull describe one TCU's intensive efforts over several years to improve teaching and learning through a college-wide initiative. Through narrative, participant reflection, and analysis, the authors find that the initiative, while still evolving, has had a great impact on the work of faculty and the experiences of the students at the TCU, particularly in strengthening faculty skills, increasing student engagement, and building a learning environment that is culturally rich, rooted in relationships, and meaningful to students and faculty. The theory guiding the initiative is that supporting and encouraging the development of knowledge, skills, and abilities of faculty leads to growth in the knowledge, skills, and abilities of student. The authors find, through their own experiences with and analysis of the impact of the initiative, that the connection between teaching and learning is strong, and the initiative's work on improving faculty skills --- primarily in the areas of teaching methodologies, content knowledge, and cultural context --- leads to increased student learning and engagement.

> *As Tribal college faculty, it is crucial that we embrace relationality as central to how we teach. It is through relationality that students engage with what really matters to them and find success in their educational pursuits.*

This paper discusses the impact of over nine years of intensive support of a teaching and learning initiative at a Tribally-chartered post-secondary institution (hereafter the College) primarily serving students from throughout the Pacific Northwest. Since 2007, faculty, administration, and students have focused resources and instructional efforts on the institutionalization of a transformative Teaching and Learning Initiative (hereafter the Initiative). The theory behind the Initiative is that the improvement of faculty skills in the areas of cultural context, teaching methodologies, and content knowledge positively impacts student learning. Faculty learning occurs in relationship to the unique Tribal experiences of students and in response to the at-risk socio-economic environment from which most students come. The Initiative's design and implementation is informed by both Indigenous thought and practice, and Western knowledge about education and student success.

Tribal Colleges and Universities (hereafter TCUs) translate student persistence and engagement strategies as they relate to their place and cultural identities. Cajete (1999) described what must be present to create Indigenous learning, specifically in terms of building an Indigenous science framework: recognizing that Native science is learned in many ways, connecting to soul and sense of place, creating an extended family of learning, making meaningful connection to life, creating authentic learning experiences, sharing and giving voice to Native thoughts, immersion, exploration, appreciation, personal experience, health, and leadership.

Through a survey of students at Tribal colleges, Saunders (2011) found that programs at Tribal colleges that support student social and cultural interests facilitate students' paths to degree attainment, preparing students for careers and jobs that are highly valued by students and increasing student persistence and engagement: "… they (TCU students) also realize the importance of their education as preparation for life. Students want to be in a college that supports their culture, beliefs, and values" (p. 115). Students understand the intrinsic value of education for self and society. Self-actualization (the achievement of their potential) was highly rated by students responding to Saunders' survey and is described as the most valuable implication of his study.

Characteristics of TCU faculty identified by Crazy Bull (2010), that are necessary for faculty to successfully support students' Native identities and place-based TCU missions, include: faculty ability to be responsive to students and to relate to students of different cultures, faculty readiness in both attitude and ability to integrate cultural information, faculty belief in the value of both historic and contemporary Native knowledge, and the ability of faculty to teach from an interdisciplinary perspective. These characteristics, along with an appropriate knowledge base in Indigenous ways of knowing (history, sociology, political science, literature, science), are essential to creating a climate of student engagement and success.

Context for the Teaching and Learning Initiative

Tribal colleges and universities are institutions established for the purpose of providing culturally responsive, integrated, place-based education to Native students, supporting their identities while simultaneously ensuring the acquisition of Western skills necessary for contemporary life (Crazy Bull, 2015). The post-secondary educational experiences of most Native students rarely emerge from formal educational experiences that integrate Native beliefs and practices. Tribally-controlled educational institutions provide an education rooted in Native knowledge. This is a tremendous challenge because the very structure of higher education institutions, on an academic calendar year with prescribed course delivery and predetermined curricula, is foreign to the experiential, natural, and adaptive learning environments traditionally used by Native people. TCUs have to be creative in their approach to learning so students can navigate these often contradictory experiences.

At the center of the Initiative is the mission of the College, which emerges from the premise that it is through education that the College can promote Indigenous self-determination and knowledge. As a Tribal college, its primary focus is the creation of place-based, dynamic, and academically excellent educational opportunities that derive from community and individual interests and needs, and which promote the identity and value of Tribal cultures and ways of knowing. Because of its large regional service area and the fact that the College serves students from all over North America, the College acts

with sensitivity to the diverse Tribal constituencies it serves while supporting the priorities of its chartering Tribe.

Foundational to the experiences of the College is its commitment to being a community of learners for faculty, staff, and students. As a result, the College frequently finds overlapping and interdisciplinary interests across all parts of the College. The Initiative influenced academic program development and student experiences based in the learning organization nature of the College.

Historically, the College engaged in various approaches to education to attempt to adapt its self-determination model to Western delivery systems. The Teaching and Learning Initiative discussed here was initially articulated in the Woksape Oyate (The People's Wisdom) project. The current Teaching and Learning Initiative Plan (2012-2017) sustains and builds upon the goals and accomplishments of the Woksape Oyate grant which funded the Teaching and Learning Initiative from 2007 through June 2012, and aligns with the College's Assessment Plan (2012-2017), the Achieving the Dream Implementation Plan (2012-2016), the College's Strategic Plan and Core Themes (2010-2017), and other faculty initiatives, such as faculty inquiry groups.

The College started its first bachelor's program the same year that the Initiative began in 2007. In 2009, the College had its first bachelor's graduate. In that year, only 1 of the 48 graduates at the College, or 2%, were at the Bachelor's level. Since that time the number and percentage of bachelor's graduates have steadily increased. As of 2015, the College has implemented four bachelor's programs. In 2015, 32% of the graduates were at the bachelor's level. This trend towards increasing numbers and percentages of graduates at the bachelor's level is indicative of the College's shifting focus toward bachelor's level programming. This shift toward being a bachelor's level institution makes the Initiative more important as faculty must support students' development for a longer period and to a deeper level than before.

Early in this process, the College's educational leadership committed to understanding and acting from a Native research paradigm in improving teaching and learning. Several faculty and administrators read and discussed the work of the Opaskwayak Cree scholar, Shawn Wilson, who in his book, *Research is Ceremony: Indigenous Research Methods*, uses storytelling and relationship as a research methodology. Wilson tells the story of his life work as a Native researcher to his sons, weaving his story throughout his discussion of his life's research describing an Indigenous research paradigm. In this paper, the authors have adopted this approach, weaving storytelling and description as our research methodology to explore the development of a Teaching and Learning Initiative at a Tribal college, moving between the insights of a faculty participant in the Initiative and our analysis of the work and benefits of the Initiative. The authors chose this methodology because it not only resonated with the experience of our faculty researcher but reflected the commitment of the faculty and administration to model Indigenous research methods and presentation.

> *Teaching and learning, respect for diversity, and a place-based and relational perspective have been part of my life for as long as I can remember. Both of my parents were teachers. As a child I grew up directly across the street from and attended a laboratory school at a university that was formerly a normal school established to train teachers. Beyond being the place of my first school experience, the university was the world of many of my earliest explorations. At school I was in constant contact with innovative teaching in a diverse student-and-teacher environment; outside of school I explored the grounds, arboretum, greenhouse, pond, classrooms, labs, and other buildings of the nearby campus.*
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> *One of the most profound memories I have from childhood was spending a summer with my family in the Pacific Northwest where my father, a high school biology teacher, studied plant ecology at a local college, and where I first became acquainted with and felt a connection to the Pacific Northwest. Later, as an undergraduate student in botany, I was privileged to work with a teacher, advisor, and mentor who opened my eyes to the relationships between people and plants from local and global perspectives. He also introduced me to some of the botany and Indigenous peoples of Ecuador; it was from him that I also began to learn of Ecuador's colonial history. And he taught me a great deal about the experiences of oppressed people, given his own experiences of oppression having come from an immigrant Italian-American family. I remember him not only for instilling within me a passion for ethnobotany, but also for how he openly embraced opportunities to interact with students and others of very diverse backgrounds, many of whom experienced personal struggles in finding their own places within academia and the world at large. Through his influence and that of my parents, I eventually learned of the works of Paulo Freire and others who wrote about the educational experiences of oppressed people.*
>
> *Through my experiences with my university mentor and ongoing discussions with my parents, I learned that my mentor and father had grown up together and eventually both attended the same university—the same one I did—and had positive experiences with a botany professor and department chair who mentored them as undergraduate students. They in turn helped me feel connected to that botany professor in what I would later recognize as being part of an intergenerational experience of relationality involving people, plants, and place.*
>
> *Upon completion of my master's degree in botany I returned to the Pacific Northwest to pursue and complete a Ph.D. in Botany studying the relationships between plants, Native peoples, and their languages of the central coast region of British Columbia. A few years after completing my doctorate, I was offered a teaching position at a tribal college at which I continue to teach using a variety of methods that have helped deepen my understanding about the nature of interdisciplinary teaching at a Tribal college.*

In this paper, Brian Compton, a faculty scholar at the College, shares the story of his growth and development as a faculty member, and the impact of this work on student-centered and student-directed learning (the authors use italics when entering into the faculty member's story to help the reader distinguish between his story and the descriptive narrative). He does so with the encouragement of his co-authors who have recognized his passion for teaching, learning, and enquiry; his willingness to share openly regarding his experiences, processes, and thoughts regarding teaching and learning; and his participation in the Teaching and Learning Initiative since its inception. His contributions are influenced in large part by his history of involvement in teaching and research with Indigenous students and communities in British Columbia, Canada, and Washington spanning three decades.

Key Components of the Teaching and Learning Initiative

There are five components comprising the formal NWIC Teaching and Learning Initiative:

- Implementation of a Native-based teaching and learning philosophy, ensuring incorporation in program and course design and with the scholarship of teaching and learning
- Incorporation of best practices into all aspects of teaching and learning including orientation, mentoring and training of full-time and part-time faculty in best practices and methodologies
- Providing opportunities for advanced study for Native faculty
- Incorporation of cultural responsiveness and integration in the faculty evaluation process
- Use of data and evaluation to substantiate the development of the intellectual capacity of the faculty with a particular focus on improvement of instructional practices, cultural and content knowledge, and the impact on student learning

These components are especially important in light of the fact that the majority of faculty at Tribal colleges are not American Indian or Alaska Native, have a range of exposure to Native communities extending from little or no experience to having lived and worked in Native communities for years, and are usually hired for their content knowledge and not necessarily for their Tribal experience. In academic year 2013-14, the TCUs employed 1,860 full- and part-time faculty. American Indians or Alaska Natives made up 19% of full-time faculty and 24% of part-time faculty, demonstrating that there is significant opportunity to implement strategies that influence non-Native faculty engagement in support of student success (American Indian Higher Education Consortium, 2014). In light of these circumstances, it became clear that the college needed to create an intentional process to support faculty to increase their capacity to teach at Tribal colleges. It was from this realization that we created the Teaching and Learning Initiative.

The Initiative strives to influence the knowledge base of faculty in the following areas of focus: *Knowledge of Institutional Identity*, *Knowledge of Students' Tribal Identity*, *Access to Indigenous Ways of Knowing*, *Promotion of a Climate of Academic Rigor and Social Responsibility*, and *Support for First-Year and First-Generation Students*.

Knowledge of Institutional Identity

In the first years of the Initiative, faculty had persistent opportunities to learn about the historical development of the Tribal colleges and to connect with the founders of the College and those individuals who have consistently supported the College's development in order to deepen faculty's knowledge of institutional identity. As the Initiative matured, the focus shifted to grounding the faculty in the College's philosophy of teaching and learning, and promoting greater understanding of students' sense of place and identity.

Knowledge of Students' Tribal Identity

Tribal college students come from culturally rich experiences with a strong link between their identity and their place, be that their homelands or the Tribal environment they choose to live in. Since the majority of faculty at the College is non-Native, they often lack a cultural compass from which to facilitate student learning. Deliberate interactions with Native faculty, community resources, Native administrators, and Native scholars help faculty connect content knowledge with cultural knowledge and supports the institutional commitment to student success.

Access to Indigenous Ways of Knowing

Students and community resources are the best source of knowledge about Tribal life for faculty. There is a growing body of scholarship and research available to faculty about Indigenous ways of knowing, much of it published. There are also many gatherings of Tribal scholars, researchers, and faculty including affinity groups and organizations, that also include student participants who can serve as faculty resources. A significant challenge in faculty access is the varying degrees of openness each Tribe has in publicly sharing its cultural knowledge. Part of the Initiative's efforts is to help faculty navigate that challenge and, in particular, to encourage their focus on student contributions to cultural integration and the importance of imparting content knowledge and skills.

Promotion of a Climate of Academic Rigor and Social Responsibility

Most of the students who enter the College need to take developmental education courses. Most need to take one or more developmental math courses and many also need to take developmental English and reading courses. The College emphasizes that faculty must develop and utilize approaches that continue to support student maturation of skills in English, reading, and math for success in college-level courses.

As the College has evolved from an associate degree-granting institution into a bachelor degree-granting college, faculty and students have increased their engagement in experiential and collaborative learning. Faculty create numerous opportunities for service learning, conducting relevant research, fostering critical thinking skills, and supporting students' engagement of their learning within their personal experiences, families, communities, and tribes.

Support for First-Year and First-Generation Students

The majority of students at the College are first-generation college students, meaning that neither parent has earned a four-year college degree. Schmidt and Akande (2011) found in their study of first-generation students at Tribal colleges that these students face significant challenges, including lack of role models, lack of preparation, and financial concerns. They found that Tribal colleges established

community and cultural identity that help students navigate those challenges. In addition to extensive academic and personal support, all degree-seeking students at the College take a series of foundational courses designed to ensure that students approach their education with an understanding grounded in cultural sovereignty, language, history, leadership, Tribal economies, Tribal education, and the history of tribal relations with the federal government.

Teaching and Learning Philosophy

The teaching and learning philosophy articulates the restorative role of education in strengthening the Tribal identity of students. The principles of student success that are the basis for the College's institutional student learning outcomes reflect this philosophy:

1) Native leadership – to acquire a quality education
2) Way of life – to give back
3) Inherent rights – to apply Indigenous knowledge
4) Community-minded – to utilize education through work

> *My commitment to a culturally- and place-based science pedagogy emerged out of my earlier family and academic experiences, work with Canadian First Nations in their traditional homelands, and the intention of supporting my students' learning. While working with various Canadian First Nations prior to teaching at the College, I was involved with numerous individuals and their communities regarding varied aspects of traditional and contemporary First Nations experiences. This included consideration of aspects of language, culture, history, geography, plants, animals, and other topics. Working on these topics with and in service to several First Nations helped me to realize not only the depth and breadth of the interrelationships between those peoples and their homelands, but of the central significance of relationality as a unifying element of those considerations.*

Science Bachelor's Program Outcomes

The current program outcomes for the College's science bachelor's program reflect a focus on relationality, stating that, "Awareness of self and knowledge of relational ancestry has been, and continues to be, an essential quality of Indigenous peoples. This awareness provides guidance and accountability to carry out the work of the ancestors for future generations. Relationality and self-location position Native environmental scientists to lead in the restoration and revitalization of the environment." Furthermore, upon successful completion of this program, students will be able to: demonstrate self-location within inquiry-based research, value relationality in the practice of Native Environmental Science, and evaluate and interpret environmental laws, policies, and acquired rights, and advocate for inherent rights (Bachelor of Science in Native Environmental Science, 2015).

Another faculty member at the College, who also serves as a department chair, describes the role of place-based education as the opportunity to support the students as they link the content of courses to the physical place that is their home or, for some, to facilitate a connection to a Tribal homeland. This connection creates a contextual experience that faculty have seen increases student

engagement which in turn enhances their learning, reflected in the following writing of the faculty member highlighted in this paper:

> *During the summer of 2009 I attended the 29th International Conference on Critical Thinking. While attending the conference I became very aware of the dearth of Native perspectives and contexts in the discourse on critical thinking presented there. Following the conference, I began to look elsewhere for manifestations of Native experiences linked to critical thinking. I found evidence of it presented by Native authors, e.g., in the works of Michael Yellow Bird (2005, pp. 9-29), and CHiXapkaid (Pavel) and Inglebret, (2007, pp. 93-109). Other authors addressed the concept of "Indian thinking," describing it in relationship to uniquely Native perspectives, traditions and values, as well as the physical and metaphysical world (Blue Spruce & Thrasher, 2009; Fixico, 2003). While elsewhere not explicitly labeled as "critical thinking," this concept is implicit and embodied in a multitude of other aspects of Native thought and discourse using comparable language. Further, it may reside within a broader cultural context and may be implicit within established cultural practices.*
>
> *Reflection on my prior teaching experiences in light of the framework of the Teaching and Learning Initiative helped me to put my ideas about the informative and transformative powers of critical thinking, place-based education, and student-centered active learning approaches into practice in my teaching. While all of these components had been part of my prior educational experiences, the Teaching and Learning Initiative helped me to focus on each of the components and see how they could come together in relation to each other. Most importantly, I became more reflective and intentional in how I could bring all of these elements in relationship and recognize and respond to them when they emerge spontaneously in my classes, as described by Crazy Bull (2010). I also realized that since these are the same skills I want to engender in my students I could be more intentional in helping students develop them. To that end, the students I work with also sometimes engage in a collegial approach to deconstructing curriculum that serves to further assist me in redirecting my efforts in education. This can then lead to the mutual construction and evaluation of new knowledge where students bring their diverse knowledge and skills to the emergent creation of content that may support or even transcend the original intended content, expanding awareness and understanding of both the content in the process and the process itself. And, as other faculty have found and noted, the inclusion of Native scholarship alongside standard texts and other curricular offerings allows for more continuous critical exploration of ideas that can yield far more comprehensive understanding of multiple bodies of knowledge from multiple cultural perspectives.*
>
> *The continued practice of critical thinking, including metacognating with students, combined with transparency about the institutional and program student learning outcomes used in student and program assessment, and the broadening of academics to more fully embrace culturally-conscientious considerations, can help to identify and enhance students' passions in contexts that are more inclusive and relevant than typical academic environments. This is essentially an academic framework with notable touchstones that supports students' explorations of relationality with respect to academic pursuits of significance to Indigenous peoples. The successful combination of all these elements can also support students in transcending the frequently tremendous culturally-conflicting challenges of an academic lifestyle. And it may help them to be successful in academically and culturally relevant and rigorous efforts directed at preparing them and engaging them in critically important work necessary to support of the mission of the College.*

Incorporation of Faculty Development and Best Practices

One of the foundational goals of the Initiative is to increase the intellectual capital of faculty and to ensure that it results in the improvement of student learning. The College defines intellectual capacity as the ability of the faculty, students, staff, and administrators, to:

- connect to the historic and modern Native experience
- develop inter-relationships among content and cultural knowledge
- identify and practice effective teaching strategies
- utilize Native critical thinking and analytical skills
- link their personal philosophy of teaching and learning with the institutional philosophy of teaching and learning
- incorporate Indigenous assessment and evaluation methods

The College strives to provide access to best practices for faculty through shared readings, training, workshops, and conference participation. A virtual learning center and link to the Initiative through the faculty homepage on the College's website shares instructional resources and complements other faculty resources. A methodologies section on the Teaching and Learning Initiative website, called the "Toolkit," includes a collection of faculty-generated best practices. An introduction to the resources available on the Teaching and Learning website is now part of the annual new faculty orientation.

Opportunities for Advanced Study for Native Faculty

The College invested in a "grow our own" practice to increase both the numbers and the contributions of Native faculty. Several Native students and faculty pursued and earned higher degrees and participated in educational activities designed to deliberately improve their academic and leadership skills. This effort supports both the need for highly-qualified faculty as the College evolves as a four-year degree-granting institution with a growing focus on research and scholarship, and has create a cadre of Native faculty who can lead the continuous improvement process that frames the College's development and informs the teaching and learning initiative. Now Natives serve as three of the four academic department chairs, all currently pursuing their PhDs with institutional support. The fourth department chair has already earned her PhD.

Culturally Responsive Faculty Evaluation

Student and faculty evaluations now incorporate cultural indicators, assess instructional methodologies and their usefulness, and are designed to inform a continuous improvement approach for faculty.

Faculty must discover who their students are culturally, socially, and individually to more effectively support their learning. Relationship-building is a key indicator for faculty and student success and includes how well faculty know the history of Native people, attend or know about ceremonial

events, know something about the history of Indian education, and includes the willingness of faculty to explore (Cajete, 1999). Through the influences of Native presenters and what has been learned from cultural educational activities, the College's instructional leadership revised the annual faculty self-evaluation forms and process to more fully incorporate cultural indicators. This process is currently being reevaluated in order to create a more holistic faculty process from the initial job announcement and then through all aspects of faculty experience at the College. At the Fall 2015 Teaching and Learning Institute, an annual convening of faculty and a key component of the Initiative, Native faculty, who are also department chairs and academic leaders at the College, facilitated a process in which they posed a series of essential questions to the faculty asking them to self-reflect, to more intentionally and fully consider the circumstances of students' lives, to examine their own wellness and their integration of values into their courses and to explore their support of Indigenous research and methodologies. Faculty was asked to incorporate two new approaches in their teaching practices starting fall term. The faculty will report their new approaches and how those changes in approach influenced their classroom practices following the end of fall term.

In the early years of its development, the Initiative used action research in teaching and learning to introduce faculty to evaluation of their practices and to build faculty instructional resources. The application of the essential questions by faculty and their status reports is a form of action research. Faculty will then be requested to continue to evolve their approaches based upon what they and other faculty learned and to report on their findings at the end of each subsequent term.

Data and Evaluation of the Initiative

Currently the primary evaluative strategies for the Initiative are faculty and academic leadership observations, faculty evaluations, and evaluations of pre-service and in-service activities including the Teaching and Learning Institute.

Faculty members provide insight into their understanding of the historic and modern Native experience through periodic focused questionnaires and through evaluation feedback of the workshops, speakers, and other faculty activities. The annual Teaching and Learning Institute provides a place for faculty to build their capacity as teachers at a four-year Tribal college and build upon previous years' work. Evaluations of the six Institutes thus far indicate very high agreement by faculty that the Institutes help to build their capacity to teach at a four-year Tribal college. The faculty is expected to leave the Teaching and Learning Institute with concrete tools and ideas that they can apply in their classes.

Critical Findings and Observations

The Teaching and Learning Initiative has been evolutionary and emergent in its contributions. It is evolutionary as it builds the knowledge, skills, and abilities of students by supporting the development of knowledge, skills, and abilities of faculty. It is emergent in that the College community is still gaining an understanding of what the institution is learning, doing, and becoming with the Initiative. The College's development as an Indigenous institution is increasingly rooted in a deep understanding of Indigenous relationality. Kovach, et al. (2015), in a study of Indigenous experiences with post-secondary education and social work programs in Canadian higher education institutions, identified common understandings of Indigenous knowledge that form Indigenous relationality:

1) Indigenous worldviews are animated ("it is epistemologically a verb, not just a noun" (p.36)) and intersected with story. Story demonstrates relationships in a world that is living.
2) Indigenous knowledge is rooted in place and protocol; it is about connections with others and with the land.
3) Community is central to Indigenous knowledge.
4) Elders and knowledge holders are the resources that teach and reinforce values such as reciprocity and responsibility.
5) Indigenous knowledge is embodied knowledge in that it infuses identity and cannot be separated from the experiences, history, and life of individuals.

Faculty observes students connecting their knowledge and sense of self to their learning both in the classroom and outside of it. Their experience affirms that students stand in relationship with their place (homelands), with community, and with the education in which they are engaged.

> *Having taught at the College since 2002, I have had the opportunity to observe and participate in the evolution of the College prior to and following the development of its first bachelor degree program to the present. This has provided me the ability to reflect on my own development as a Tribal college faculty as well as that of the institution and its students and faculty.*
>
> *The College has changed during this time from having a faculty focus on institutional student learning outcomes that essentially mirrored aspects of the general education requirements of associate degree programs throughout our state to the incorporation of institutional and program outcomes that focus on the relationship of teaching and learning to aspects of Indigenous identity, place, and community. Within the recently revised science bachelor's degree program outcomes, sense of place and relationality figure prominently, and are deliberately considered as foundational to further outcomes regarding inquiry with specific reference to Indigenous methodologies and communication with emphasis on multiple means of effective communication to a broad range of Indigenous and other audiences.*
>
> *The experiences of several current and recently graduated science students demonstrate evidence of significant student engagement as related to aspects of Indigenous identity, place, and community. One student, who has since gone on to complete graduate studies and now teaches at the College, focused on aspects of fishing in her home community in northern Alaska with respect to traditional and ongoing practices and policy matters. Other students with personal and family ties to fishing have researched aspects of fishing as related to other local Tribal concerns—including traditional and contemporary aspects of halibut fishing—as well as the details of the Indigenous experiences through videography within the broader context of fishing practices and rights as championed by the late Billy Frank, Jr. and as related to the Boldt Decision of 1974.*

> *Another student, with ancestral ties to local Coast Salish lands and culture, pursued projects related to people and plants in place, focusing on sustainable gardening with traditional food plants. His work is now reflected in a Native food plant installation at the College campus, which he has recently been employed to more fully develop following his graduation. The nature and significance of Indigenous food systems from a Coast Salish perspective is the topic of inquiry for yet another student, whose previous personal and academic experiences have been brought to bear upon a broader and more Indigenous set of topics than she had considered prior to attending the Tribal college. Her current work involves a reframing of the concept of health in Indigenous communities with respect to human and environmental considerations based on ancient, contemporary and future practice. Several other current students are examining a range of topics related to health in various cultural and community terms with a view to the much broader implications and applications in Indigenous and global terms.*
>
> *Yet another student who came to the College after having had negative academic experiences elsewhere and who lacks direct connections to her ancestral lands and her people, recently declared the science bachelor's program and has continued to make positive strides despite housing, financial, and other challenges. While in conversation with her recently regarding a number of academically-challenging and related matters, I asked if the stress she was experiencing was different than she may have experienced in past academic situations in order to determine if there may be particularly unique contributors that perhaps I could help her to resolve. Her immediate response was that now her education really mattered to her. It is clear from my work with her that this derives from her experiences at the College studying and connecting with—amongst other things—aspects of botanical, ethnobotanical and Native environmental ethics topics, experiencing good mentorship from our current Science Writing Mentor, and now undertaking the development of her degree plan.*

The Teaching and Learning Philosophy has served as a compatible resource in many aspects of institutional development, including the development of key concepts associated with the Bachelor of Arts in Native Studies Leadership program. The essential questions discussed earlier represent the expectation that faculty self-reflect, model wellness, affirm the uniqueness of the institution, and support Indigenous research pursued by students.

> *During the most recent Teaching and Learning Institute, I participated in the discussion regarding several essential questions presented by representatives of the Coast Salish Institute. And I indicated that a new approach that I would take in my instructional practice for the upcoming year would be to share the Teaching and Learning Institute essential questions with several students for their consideration and feedback. The questions were developed to be answered by faculty and deal with the faculty role in supporting self-determination for students, the society for which we are preparing students, how faculty model wellness and integrate values into their courses, and how they empower and support students in the use of Indigenous research methodologies. However, I presented them to students with the request that they also consider them from a student perspective, especially as related to their studies.*
>
> *Although the number of students who participated in discussion of the essential questions was small, their feedback was compelling. Those particular students all have declared the science bachelor's program and were in the process of beginning to develop unique plans of study that include individualized studies curriculum based on their particular interests.*
>
> *Their feedback included positive and reflective commentary on the concepts expressed in the essential questions, especially as related to Indigenous education. Student feedback also included how use of the essential questions could improve the curriculum of the course in which they are beginning to develop their degree plans. And it led to focused discussion on the nature and value of interdisciplinary work,*

> *which allows for a more holistic approach to education which may involve a broader range of research considerations that may transcend the more standard approaches of Western science. This approach also allows for a focus on more humanistic matters that may draw from and relate to axiological and other aspects of Indigenous education as discussed by Cajete (1999) and Indigenous research as discussed by Wilson (2009). Their comments reflect what I perceive as a growing recognition of and attention to aspects of relationality in those students' studies and lives.*

Faculty dialogues about student learning and best practices in teaching have increased along with greater comfort with self-assessment and examination of the important connection between instructional practices and evidence of student learning. Native faculty have emerged as the leaders of the scholarship and research framework that is the basis of faculty development and the Initiative, and the collaboration between Native faculty and administrators and non-Native faculty has improved and is continuing to be strengthened. Foundational knowledge about the cultural and educational experience of Native people is promoted throughout the curriculum, daily lives, and instructional practices of the College. This has evolved into greater instructional and institutional understanding of how outcomes can be used to inform teaching practices. Faculty are increasingly more adept at navigating the challenging implications of Incorporating cultural outcomes in their teaching --- i.e., that students will demonstrate a sense of place and an understanding of what it means to be a people, two of the core institutional student learning outcomes. In the context of diverse Tribal cultures and experiences and the commitment to Tribal and personal sovereignty, greater understanding of teaching and learning creates a renewed emphasis on student-directed learning.

> *I've noticed that there are numerous parallels between student and faculty experiences in teaching and learning. I've found that sharing my experiences in teaching and learning with my faculty colleagues may result in richly rewarding as well as sometimes frustrating conversations and interactions. I believe that each faculty member must find those approaches that work for him or her, just as I have and will continue to do. In my discussions with faculty there are often differences in how we explore and reflect on methods and philosophies but I have seen that we are moving more toward seeing these differences as challenges and opportunities for collaborative discourse and growth rather than as irreconcilable conflicts.*

> *Activities conducted during the most recent Teaching and Learning Initiative represent in my view a significant turning point in terms of establishing Indigenous leadership in teaching and learning and more fully developing an academic framework in which all faculty, Indigenous or otherwise, may continue to improve their efforts. In particular, the focus on self-reflection and the exploration of values in support of students' academic attainment represented an opportunity for faculty and others to find common ground while also recognizing the diversity of faculty with a view to finding ways to move forward together.*

> *As I and my faculty colleagues at the College move forward in this initiative, I am reminded of the work of Deloria and Wildcat in their book* Power and Place *(2001) in that the nature of improving the teaching and learning environment is an emergent process that can't be reduced to any single set of contributors but instead is an organic process and requires the ongoing best efforts of everyone in the community.*

As one faculty has described throughout this paper, students learn in increasingly meaningful ways when they are given the opportunity to explore the connections and relationships among people and their geographic, historical, and contemporary place. Students demonstrate their deepening understanding of themselves in relation to the world around them. Student opportunities to lead teaching, to engage in reciprocal teaching, and to explore what type of learning works for them reaffirm traditional Tribal learning environments that are place-based, experiential, and which honor individual experiences, knowledge, gifts, and talents. Faculty have observed that students are increasingly able to deconstruct curriculum which results in redirection of the instructor's efforts and allows for a more collegial, continuous, and critical exploration of ideas that can yield far more comprehensive understanding and application of multiple bodies of knowledge and truly support the College's mission of self-determination.

Teaching and Learning Vision for Tribal Colleges and Universities

Tribal colleges serve such distinctive place-based populations with students who bring both abundant knowledge and tremendous obstacles to their college experience that a focus on teaching and learning impact is essential to student success. Faculty must be adept at serving a myriad of needs – cultural, academic, social, and spiritual. The teaching and learning initiative discussed in this paper provides a road map for how colleges can support greater student achievement and engagement.

Because, as we have seen, relationality is a significant contributor to student engagement and student engagement is crucial to students continuing their education and graduating, we believe the concepts of relationality must be more fully promoted throughout all aspects of teaching and learning at each college, as supported by the work of Kovach, et.al (2015).

Identifying the direct and indirect outcomes of more engaged student learning in a manner that can be shared with others is useful. The most likely route for this is full engagement and reporting of integrative formative and summative assessment of student learning at the course, program, and institutional levels. A core set of student performance data related to course grades, course completion, and degree attainment complement student learning outcomes assessment. These are all academic exercises that organize the Tribally-specific approach that underpins relationality. These are also exercises that require collaboration, thoughtful discussion, and diverse contributors which increase the representation of the outcomes as rooted in Tribal knowledge. This experience also integrates with the expectations of the accreditation process in a way that supports the missions of Tribal colleges.

Leadership at all levels of practice and the support of the governing systems of each college is essential to continued success and progress in achieving the goals of any teaching and learning initiative. Improving student success through faculty development requires time and resources, especially faculty time and financial support for continuing inquiry, research, and professional development.

Observable results of this effort in terms of student engagement, student and faculty collaboration, incorporation of place-based Indigenous knowledge, and the development of theories of relationality and Indigenous pedagogy need to be documented and disseminated as a valuable contribution to the body of knowledge about Tribally-controlled education and tribal colleges.

Transparency is necessary to critical thinking methodology and is recommended in terms of faculty communication to students regarding not only course outcomes, but also of program and institutional outcomes. Faculty discussion of the coordination of all levels of outcomes which will be used in student and program assessment suggests that students respond positively to knowledge of and interaction regarding the outcomes by which they will be assessed.

Teaching and learning in Indigenous education settings must be holistic and systemic in that it occurs in an integrated manner within academic curricular, cocurricular, and extracurricular settings, is interdisciplinary, and responsive to Tribal, community, and student needs and expectations. When a college can establish and use a systemic approach to teaching and learning and accomplishes institutionalization through outcomes and program development as well as faculty development, student success along with Tribal priorities are furthered. Institutions can also use strategies such as action research, faculty inquiry groups, and improved faculty evaluation to increase results and positively impact student engagement.

> *Based on my experience in teaching at Northwest Indian College, I have come to understand that the question of what comprises good teaching and learning at a Tribal college cannot be sufficiently answered in the same ways that it would be at other institutions whose missions, educational philosophies, and curricula do not seek primarily to serve and benefit Indigenous people and their communities. With this awareness in mind, I regard consideration of relationality as a critical underpinning of efforts to continuously improve teaching and learning at the College. This approach is based on the recognition of, respect for, and application of traditional Indigenous perspectives and practices involving the importance of worldviews, values, relationships, roles, responsibilities, methods, and other matters in teaching and learning. A focus on relationality can improve teaching and learning but requires self-reflection by faculty regarding who they are as well as why and how they teach at a Tribal college. It also requires their ongoing willingness to participate in work that may seriously challenge their personal and professional perspectives on education and about themselves and may require that they change their approach to teaching and learning. Most importantly, this work and other aspects of the Teaching and Learning Initiative can contribute significantly to faculty collaboration in support of fostering student engagement and students attaining their educational goals.*

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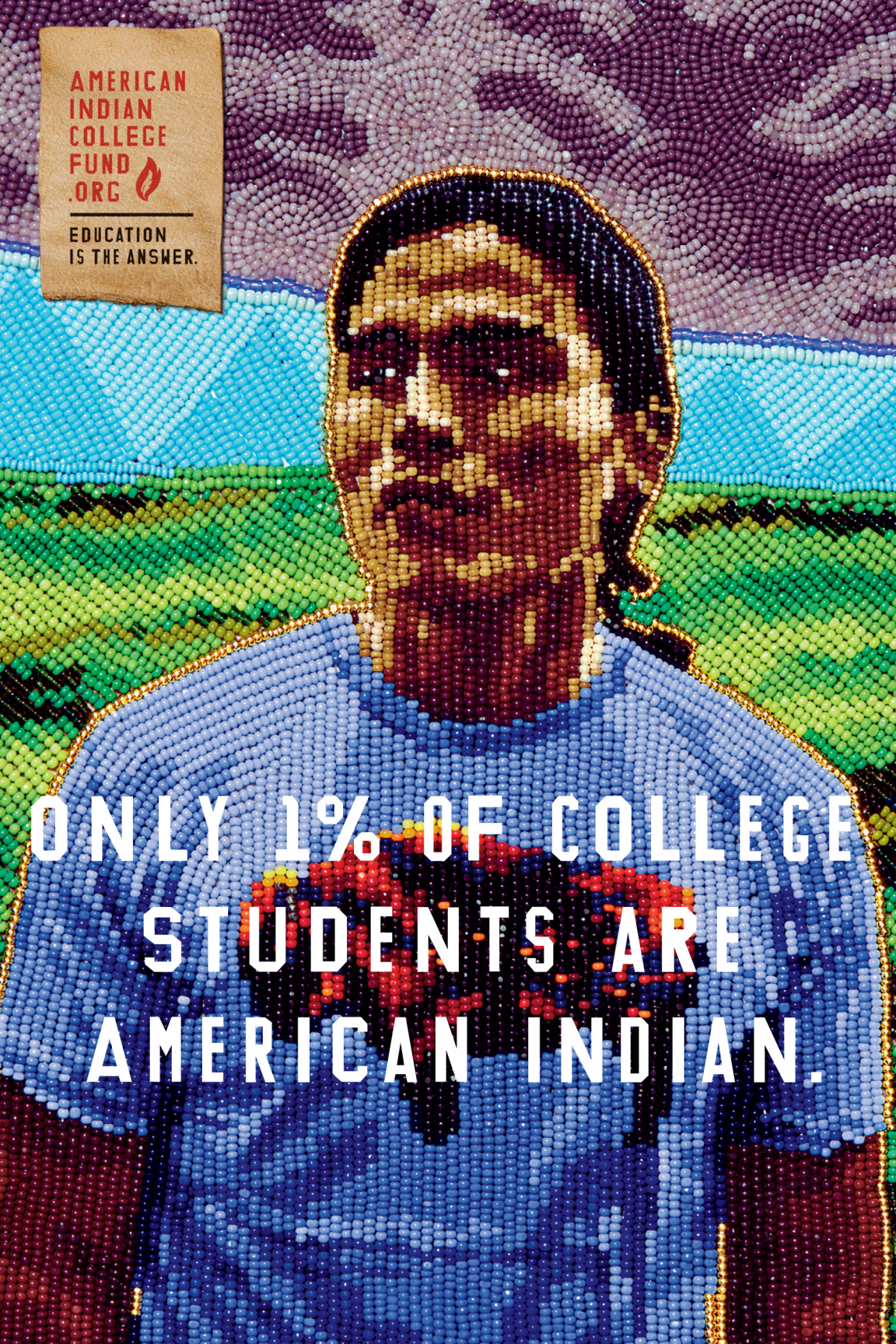
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