VOLUME 3

Tribal College and University Research Journal

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The TCURJ cover and logo design embodies concepts of Indigenous knowledge, community, and place. The design intentionally incorporates symbols to reflect the mission of the journal. Tribal colleges and universities (TCUs) are for the community and the research that comes from the TCU community is an act of strength and reclamation.

Tree - The trunk reflects the resilience and knowledge of the community. The leaves reflect the community being served by TCUs

Land - The land reflects the place of higher education and TCUs. The land also resembles an open book for education.

Sweetgrass braids - The braids acknowledge language, songs, and dances.

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WELCOME TO THE TRIBAL COLLEGE AND UNIVERSITY RESEARCH JOURNAL

Cheryl Crazy Bull, President and CEO
American Indian College Fund

Mitakuyepi.

Greetings, relatives.

For Indigenous peoples, the last few years have seen a very public resurgence of our activism along with an expectation that our voices will be heard because our voices matter. We have always been warriors and defenders of our ways of living, but the unfurling of the restraints that previously kept many Americans from attacking people of color including tribal people has made our resurgence even more vital.

As an educator, I view our institutions where tribal people are in the majority as the epitome of our Identity and the foundation of our resurgence in the socialization and education of our children and their families.

We need the voices of people at Tribal Colleges and Universities now more than ever. We need to share our history, our experiences, and our knowledge. Who we are makes a difference in the world that we live in. We know how to live in relationship with each other and with all other things on the earth, in the water, and in the sky. We know how to teach in a modern society – we are good at it.

Our research contributes to our tribal and non-tribal opportunities and expectations. Our research shares important knowledge in a way that bridges our traditions with contemporary experiences. The College Fund is so honored to support our Tribal College and University faculty as they do their great work of teaching and learning in our communities. Our faculty are on the frontlines of the education revolution, we are pleased to share their knowledge with you.

Wopila.

Thank you.

INTRODUCTION: SUSTAINING OUR FUTURES THROUGH TRIBAL COLLEGE AND UNIVERSITY RESEARCH

Anna Lees, Editor
Tribal College and University Research Journal

This issue, Volume III, of the *Tribal College and University Research Journal (TCURJ)* continues the work of previous issues in featuring manuscripts from tribal college and university (TCU) faculty across tribal nation regions. The *TCURJ* offers a unique outlet to disseminate research relevant to Indigenous ways of knowing and being within particular tribal communities, and is made possible by the commitment of Indigenous scholars across numerous institutions. Volume III is the fourth issue of the *TCURJ* published by the American Indian College Fund and the sixth issue in the College Fund's *Tribal College and University Publication Series*. Each article underwent an external review process gaining anonymous feedback from experts in their fields. The authors then worked closely with the editors to complete a thorough revision process toward publication. In this issue, we continue centering research relevant to tribal nation communities across disciplines and utilizing a variety of methodologies.

During times of substantiated concern regarding tribal sovereignty in relationship with the U.S. federal government, research from TCU faculty is crucial in making well-informed, research-based decisions to advance Indigenous community goals. Research from tribal colleges and universities (TCUs) published in this journal echo the call from Deloria and colleagues (2018) that while Indigenous peoples are deeply connected to histories, they should be viewed not through a historical lens, but through a lens of futurity. To ensure positive Indigenous futurities, is to resist settler-colonial methods of replacement (Tuck & Gaztambide-Fernandez, 2013); where whitestream curriculum frameworks adopt and replace Indigenous ways of knowing and being. Resisting such replacement processes by producing tribal and community centered research from TCUs works to secure a place for Indigenous ways of being for future generations. Engaging in research relevant to and driven by tribal nation communities is a radical act toward a postcolonial state (Simpson, 2017), and these efforts are happening each day across TCU campuses. This resistance offers an example of what Corntassel (2012) names *everyday acts of resurgence*, where scholars "confront existing colonial institutions, structures, and policies…(as) daily acts of renewal" (p. 89). This issue of the *TCURJ* aims to offer space for such research and we are committed to ensuring that knowledge production shared through publications is made widely accessible.

The research featured in this issue demonstrates ways in which TCUs and tribal communities are securing Indigenous futurities. The findings hold strong implications for the ways in which research from TCUs can work to ensure health and wellness through education for generations to come. The four articles published in this issue broaden our understandings of sovereignty by thinking thoughtfully about the path toward positive futures through the environmental sciences, and address complexities of higher education by honing in on factors of persistence.

In *Spatial and Temporal Distribution of Olympia oyster (Ostrea lurida) Larvae and Settlers within Fidalgo Bay, Washington,* authors Marco B. A. Hatch, Rosa Hunter, and Jefferson Emm depict the significance of Olympia Oyster (*O. lurida*) restoration efforts in the Salish Sea. Dr. Hatch and

colleagues emphasize the significance of the *O. lurida* to the Coast Salish peoples and put forth findings from a rigorous, quantitative study examining the outcomes of the restoration project.

The authors offer a rich account of the historical role the Olympia oysters played in Coast Salish communities and the ways in which trade and capitalism impacted the oyster population. The project demonstrates the profound impact of tribal and non-tribal governments, academic, and community researchers coming together to engage in efforts of environmental activism. This article inspires readers to consider what restoration projects are underway in the waters and lands of which they call home and take active efforts in contributing positively towards healthy environments for our more than human relations.

Authors Dennis Vickers and Chris Caldwell describe a tribally specific conceptual model for sustainable forest management in the article titled, *The Menominee Theoretical Model of Sustainability and Climate Change*. Vickers and Caldwell portray how the model drove community engagement with their forest home since time immemorial and offer a contemporary lens on how the model can offer a framework for sustaining complex community structures. In this article, the authors' share out a detailed framework grounded in Menominee epistemologies, deeply rooted in relationship with land across generations, and offer readers an opportunity to apply the framework in diverse settings. Vickers' and Caldwell's work is simultaneously critical and generous; making clear that the model is specific to the Menominee Nation, and also recognizing the significance of such a framework in advancing efforts of sustainable environmental management across tribal nations.

Expanding the research around Indigenous peoples' contemporary relationships with water, author Andrew Kozich puts forth *Anishinaabe Perspectives on Water Resources in Northern Michigan*. Interviewing 17 Keweenaw Bay Indian Community residents, Kozich examines Anishinaabe perspectives on local water resources. Of significance, is the focus on water sustainability interwoven with the sacredness of water in ceremony and culture. This qualitative research study offers new insight to Indigenous perspectives of water conservation during a time of widespread concern around water rights of tribal nations. Kozich centers the voices of participants and paints a rich, complex picture of relationships with water in a water-rich region surrounded by the Great Lakes. The findings of this study confirm the interconnected nature of human relationships with water in a relationship-based community. With growing concern around access to fresh water, and tribal nations working diligently to uphold treaty agreements in response to the growing commercialization of fresh water, Kozich's research holds profound implications for community-centered decision making and broader policy initiatives.

Closing this issue is *Factors that Influence the Persistence of Native American Students and Tribal Colleges and Universities*, by Kyndra Butler and Ahmed Al-Asfour. In this quantitative study, Butler and Al-Asfour investigate factors that significantly influence persistence of Native American undergraduate college students across two tribal college campuses. The authors' employ Vincent Tinto's Model of Institutional Departure to examine the malleable factors, such as belonging, that impact students' persistence toward higher education. Utilizing descriptive and inferential statistics, the authors identify five factors that impact persistence within the sample population. Findings from this study offer insight into the ways in which TCU faculty, staff, and administration may better address student needs, particularly around creating a college environment that encourages positive relationships between faculty and students. With school completion rates remaining an ongoing

challenge across degree levels, this research is essential to serving the holistic needs of Native youth through improved education.

This issue of the *TCURJ* is demonstrative of the commitment to continuing publication of research from TCUs through the American Indian College Fund. The work that goes into maintaining this journal is significant and is supported tremendously by Dr. Natalie Youngbull, *TCURJ* Editor and Faculty Development Program Officer, Dr. David Sanders, Vice President of Research, Evaluation, and Faculty Development, and Dr. Cheryl Crazy Bull, President and CEO. The publication process is only achievable by the generous service and expertise of the editorial review board. Additionally, we offer our utmost gratitude to Dr. Cornel Pewewardy for his ongoing support and mentorship as Dr. Youngbull and I take on the editorial roles of this very important publication. Please enjoy the articles in Volume III of the *Tribal College and University Research Journal* and share the findings from this research widely with colleagues and community. Chi miigwech for being a part of this important work of engaging research relevant to tribal nation communities to secure positive futures for the generations to be.

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Author Biography

Anna Lees (*Odawa*) is co-editor of the *Tribal College and University Research Journal*, and Assistant Professor of Early Childhood Education at Western Washington University. She partners with schools and communities to prepare teachers for the holistic needs of children, families, and communities by sustaining, reciprocal relationships with Indigenous communities.

SPATIAL AND TEMPORAL DISTRIBUTION OF OLYMPIA OYSTER (OSTREA LURIDA) LARVAE AND SETTLERS WITHIN FIDALGO BAY, WASHINGTON

Marco B. A. Hatch, Rosa Hunter, and Jefferson Emm
Northwest Indian College

The Olympia oyster, Ostrea lurida (O. lurida), were once plentiful in the Salish Sea and other areas along the west coast of North America. Currently, populations of O. lurida are severely depressed by a combination of habitat destruction, mismanagement, and indirect impacts. O. lurida restoration efforts have been met with mixed success. One restoration effort that has been successful is Fidalgo Bay, Washington near Anacortes, Washington. Starting in 2002 academic researchers, non-profits and the Samish Indian Nation have been actively engaged in supporting O. lurida restoration in Fidalgo Bay. The success of this restoration makes Fidalgo Bay an ideal location to study the biology of this culturally important species, including larval dynamics and settlement patterns. The purpose of this project is to identify the spatial and temporal distribution of newly settled Olympia oysters and planktonic larvae in Fidalgo Bay. This research will provide a framework to monitor restored Olympia oyster populations and plan new restoration efforts.

Keywords: Olympia oyster, Ostrea lurida, bivalve, restoration, larvae

Introduction

Olympia oysters (*Ostrea lurida*) have been an important part of Coast Salish people's lives for millennia, with oysters used for food and ceremony (Suttles, 1951). Guided by the desire to learn more about where Olympia oysters existed in the central Salish Sea in pre-contact times and historically, Hatch and Wyllie-Echeverria (2016) used a combination of archaeological data, ethnographic notes, and early explorer maps to discover the location of now locally extirpated oyster populations. This research resulted in the discovery of nineteen previously forgotten Olympia oyster reefs (Hatch & Wyllie-Echeverria, 2016) (Figure 1).

Olympia oysters are an ecologically important species, providing habitat for other organisms and improving water quality. These bed-forming oysters provide habitat and nursery areas for marine organisms (Scyphers, Powers, Heck, & Byron, 2011), as well as shoreline stabilization, water filtration, and biogenic bed habitat for other species (Gili & Coma, 1998; Zu Ermgassen et al., 2013). The Washington State Department of Fish and Wildlife (WDFW) realized the need to restore a healthy Olympia oyster population to the tidelands citing their role maintaining the health of marine ecosystems (Cook, Shaffer, & Dumbauld, 1998).

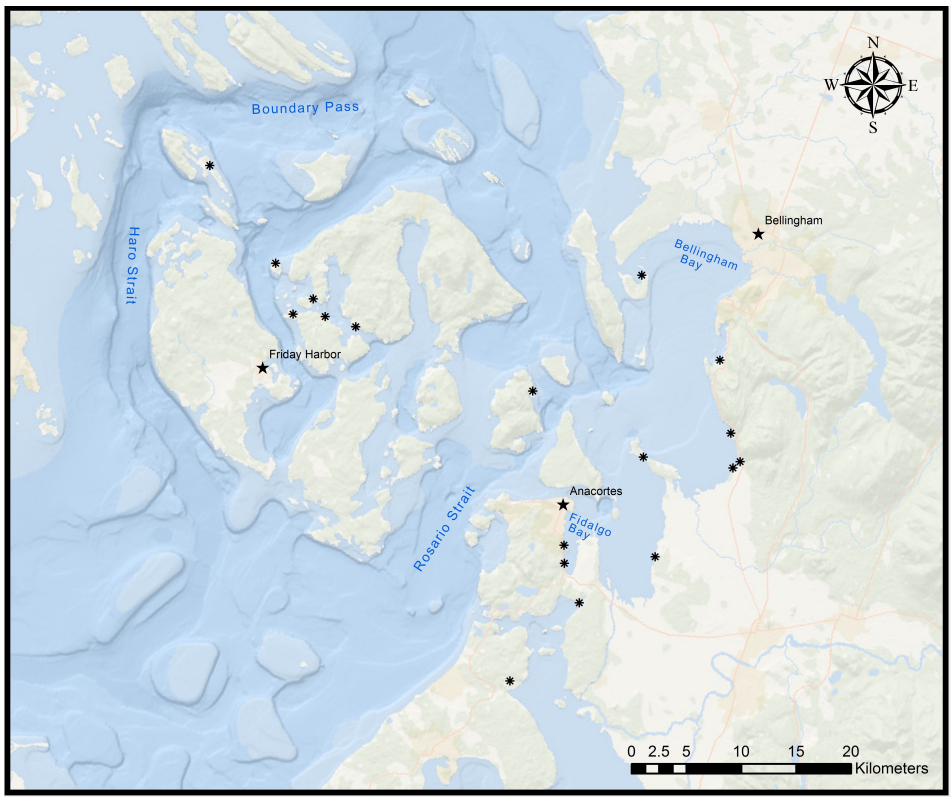

Figure 1. Map of the central Salish Sea showing locations of historic Olympia oyster beds (Hatch & Wyllie-Echeverria, 2016). Having knowledge on locations of historical Olympia oyster beds may assist on focusing restoration efforts in more effective locations. (Visualization by Sylvie Arques)

Olympia oysters are the only native oyster to be found from Baja, Mexico to Alaska. In the late 1800s, Olympia oyster populations began to plummet due to unmanaged harvesting and habitat destruction (Steele, 1957). Industrialization and heavy marine development along the west coast and in the Salish Sea contributed to the collapse of Olympia oyster populations and were driven to a point of near extinction by the mid-1900s (Zu Ermgassen et al., 2012).

During the California gold rush in the late 1800s and early 1900s, Olympia oysters were highly valued, with prices up to $1 per oyster in nominal dollars (i.e, the price at the time), or about $25 in the current economy. To feed this thirst for oysters, local California stocks were quickly overharvested and fishing efforts moved up the coast to Washington (Kirby, 2004). This resulted in schooners laden with oysters going from Willapa Bay and Puget Sound in Washington, to market in San Francisco, California. According to reports, records show that 10,000 bushels of Olympia oysters were harvested in Puget Sound in 1850 and 130,000 bushels by 1890 (Dinnel, Dolph, Elder, Woodward, & Woodward, 2011). Shellfish harvesting of wild Olympia oysters severely reduced the populations by the mid 1900s and wild harvest was prohibited in the 1980's. Concurrent with over-harvest in the early 1900's, increased sedimentation due to logging and direct dumping of wood waste suffocated many oyster beds (Dinnel et al., 2011). Although commercial harvest records from Fidalgo Bay, Washington are sparse, 10 kilometers (km) to the north there were commercial, viable populations of Olympia oysters from Samish Bay to Bellingham Bay.

Current restoration efforts prioritize areas that historically had Olympia oysters, with the idea that restoration will be more successful in areas that once held Olympia oysters. Many groups in Washington are actively involved in restoring Olympia oysters including the Washington

Department of Fish and Wildlife (WDFW), Puget Sound Restoration Fund (PSRF), and local tribes including the Samish Indian Nation and Swinomish Indian Tribal Community. In May 1998, the WDFW published the Department's plan for Olympia oyster restoration in Washington State and identified a number of priority restoration areas, including Fidalgo Bay (Cook et al., 1998). Together, local Coast Salish tribes, WDFW, citizen scientists and other government entities have a goal to rebuild populations of the only native oyster in the Salish Sea.

Fidalgo Bay has been the center of a large restoration project that began in 2002. Combined with the prehistoric existence of Olympia oysters (Hatch &Wyllie-Echeverria, 2016) and the involvement of two local tribes (Samish and Swinomish), Fidalgo Bay is an ideal place to understand the dynamics of these culturally important species. Fidalgo Bay is located between Anacortes and March's Point, Washington which has two large oil refineries and is bounded by the tidelands of the Samish Indian Nation and the Swinomish Indian Tribal Community, creating an interesting mix of heavy industry and Tribal land holdings. Dinnel, Peabody, and Peter-Contesse (2009) identified five reasons why Fidalgo Bay was selected for restoration:

1. Fidalgo Bay historically had Olympia oysters (Hatch &Wyllie-Echeverria, 2016).
2. Nearby relic populations can be used as hatchery seed stock, persevering local genetic diversity.
3. The Marine Resource Council and PSRF agreed to collaborate on an Olympia oyster rebuilding project in Fidalgo Bay.
4. Suitable substrate and conditions exist in South Fidalgo Bay.
5. The City of Anacortes authorized the project on city-owned tidelands under an old railway trestle.

Over the 15-year history of this restoration, a variety of techniques have been employed and adapted. Early restoration efforts focused on augmenting the remnant population through seeding efforts, which added approximately 20,000 one-year-old Olympia oysters (Dinnel et al., 2009). Additionally, young-of-the-year oysters (oysters that were spawned the same year they were planted) were added in 2003, 2004, and 2006. Initial seeding efforts had a 90% survival rate of planted oysters, with later years having a lower survival rate (Dinnel et al., 2011). In 2006, the restoration strategy adapted to focus on habitat improvement. Specifically, substrate was improved through the addition of bare oyster shell which created a reef like structure near the trestle and Weaverling Spit (Dinnel et al., 2009). One measure of restoration success is the number of newly settled Olympia oysters, as this measures the capacity for the population to be self-sustaining. While recruitment can have high inter-annual variability, based on settlement bags placed in the intertidal for a year, recruitment tends to be highest near the restored population of Olympia oysters. The post-seeding densities in 2002 were 46 / m^2 and increased to 130 / m^2 by 2011 (Dinnel et al., 2011). However, questions remain about the seasonal pattern of settlement and where the larvae exist in the water column.

Purpose of Research

The purpose of this research is to identify the spatial and temporal distribution of Olympia oyster larvae and settlement patterns in Fidalgo Bay. Specifically, this project is testing the hypotheses that: (1) Olympia oysters will have higher rates of settlement near adult populations, and (2) larval abundance will have no correlation to the water column or tidal height. These results will be used by to help guide future Olympia oyster restoration efforts in Puget Sound and beyond.

Significance of Research

As the only native oyster on the west coast, Olympia oysters were an important food source for the Samish people. Traditionally, women collected oysters at low tides, the best of which occur around the summer and winter solstice. Similar to clams, Olympia oysters were steamed and eaten fresh. Unlike the larger clam species, they were not dried and stored for long periods. Clam beds traditionally were owned and inherited through the generations, however little is known about the ownership of oyster beds. Oysters are still served at Samish gatherings, however the non-native pacific oyster (*Crassostrea gigas*) is typically served, which grows well in Puget Sound. One of the Indigenous community goals of this research is to help Olympia oyster populations grow large enough to support harvest by Samish and other Coast Salish people.

Methods

Study Location

This study took place in Fidalgo Bay, Washington, located about 60 km south of the Canadian border, between Anacortes and March Point, Washington. March Point is home to a number of oil refineries. Fidalgo Bay is also surrounded by tidelands owned by the Swinomish Indian Tribal Community and Samish Indian Nation. In general, Fidalgo Bay is shallow and muddy with abundant eelgrass (Figure 2).

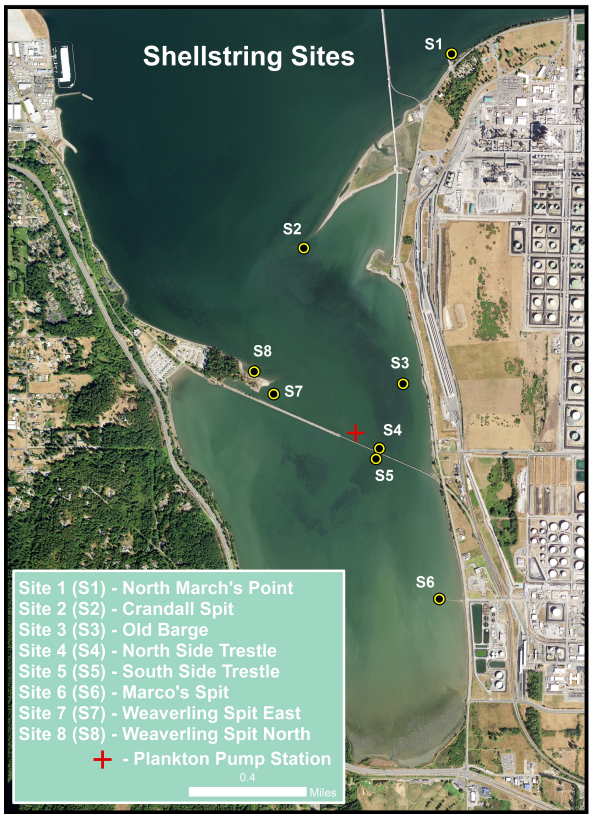

Figure 2. Location of shellstring sites used in this study. The shellstrings were used to measure recruitment in relationship to the distance from restored Olympia oyster population, located between sites 4, and 5. (Visualization by Sylvie Arques)

Recruitment

Recruitment was quantified using shellstrings or stacked pacific oyster (*Crassostrea gigas*) shells on a wooden dowel. To normalize recruitment area, only similarity sized flat right-valves were used. Shells were cleaned using a small wire bristle brush; a hole was then drilled in the center to allow them to be stacked along the length of a 24-inch-long, 5/16-inch diameter hardwood dowel. Each shellstring had eleven Pacific oyster shells per dowel with their nacre (inner) side facing down. White duct tape was used to wrap the tip of each dowel and labeled with its site location, station, and replicate using a paint pen (e.g. 1-A-1) (Figure 3).

Figure 3. To determine settlement, shellstrings were deployed for two weeks. Individual shellstrings included eleven pacific oyster shells, a 24" X 5/8" wooden dowel, with a labeled flag. A hole was drilled through the middle of each shell so 11 shells could be stacked nacre side down on the dowel. Shells were placed nacre side down to provide a three-dimensional substrate with vertical relief. When placed in the field, the bottom half of the dowel was to be pressed half way into the sediment to anchor the shellstring in place (Photo Jefferson Emm).

At each of the eight study sites, shellstrings were placed at -1 feet Mean Lower Low Water (MLLW) one meter apart parallel to shore. Placement of the shellstrings was done by inserting them into the sediment, done so by pressing the dowels down until the bottom shell was resting on the benthos.

Shellstrings were deployed for two weeks between June and August 2015, for a total of four sequential deployments (Table 1). After shellstrings were collected they were disassembled in the lab, with the bottom shell being discarded. The remaining upper ten shells were then used to determine recruitment.

Table 1
Mean number of Olympia oyster settlers per substrate for all eight sites and four deployments

Deploy-ment	Site 1	Site 2	Site 3	Site 4	Site 5	Site 6	Site 7	Site 8
1 6/17-6/30	* 0.1 ± 0.2	5.2 ± 8.3	20.6 ± 8.9	23.7 ± 5.9	26.2 ± 7.1	3.8 ± 1.4	1.6 ± 0.7	0.2 ± 0.2
2 6/30-7/15	0.1 ± 0.2	4.3 ± 1.5	32.2 ± 7.6	91.1 ± 13	106.0 ± 9.1	38.1 ± 2.4	2.5 ± 0.2	** 0.2 ± 0.1
3 7/15-7/31	0.0 ± 0.1	2.8 ± 0.9	5.0 ± 5.2	22.5 ± 6.5	11.6 ± 3.6	2.0 ± 1.16	0.4 ± 0.2	0.2 ± 0.33
4 7/31-8/11	0.3 ± 0.22	0.7 ± 1.3	7.8 ± 0.3	16.3 ± 1.7	80.0 ± 0.2	4.6 ± 2.0	4.4 ± 4.1	0.2 ± 0.3

Note. Deployment occurred in two-week intervals from June 17 to August 11. The first deployment for site 1 was collected late and estimated at 0.1 oysters /substrate (noted by *). The second collection at site 8 was lost and estimated at 0.2 oysters /substrate (noted by **) see methods for further details. Chi-Sq = 53.367, DF = 12, P-Value = 0.000
4 cells with expected counts less than 5.

Processing and Identification

Olympia oyster settlement was determined by counting the newly settled oysters on the nacre surface from each shell. Using a Leica EZ4D dissecting microscope, each spat was counted and marked with pencil to prevent double counting. To verify that individuals counted were in fact Olympia oysters, images were taken and shared with outside experts to assist with identification. For each deployment, a mean of means was calculated as the mean number of spat per shell on an individual shell string then the mean of spat per shell was calculated based on the three replicates (Figure 4).

Planktonic Larval Abundance

To determine where Olympia oyster larvae were within the water column, 100 L of water was filtered through a pre-filter of 330 microns (µm) and a collection filter of 105 (µm). Material retained on the 105 µm filter was collected in a 50 ml falcon tube and stored in 95% ethanol. Samples were collected with a plankton pump every Tuesday, starting on June 23, 2015, and ending on August 17, 2015, at a set location in Fidalgo Bay, just north of the trestle and Site 4 (Figure 2). Each sampling day consisted of four samples, a surface (30 cm depth) and bottom (30 cm above the bottom) sample completed during ebb and flood tides.

Larvae Enumeration

Olympia oyster larvae were identified and enumerated using an Olympus BX41 microscope with a DP70 camera adapter (Figure 5). Laval oysters were identified through comparison to hatchery raised reference samples, and secondary identification from an experienced Olympia oyster aquaculturist with experience identifying multiple bivalve species. All samples were stored in a 50 ml Falcon tube, which was shaken for ten seconds before 1 ml was aliquoted into a 1 mm^2 gridded Sedgewick Rafter cell. Each sample was measured using this method five times.

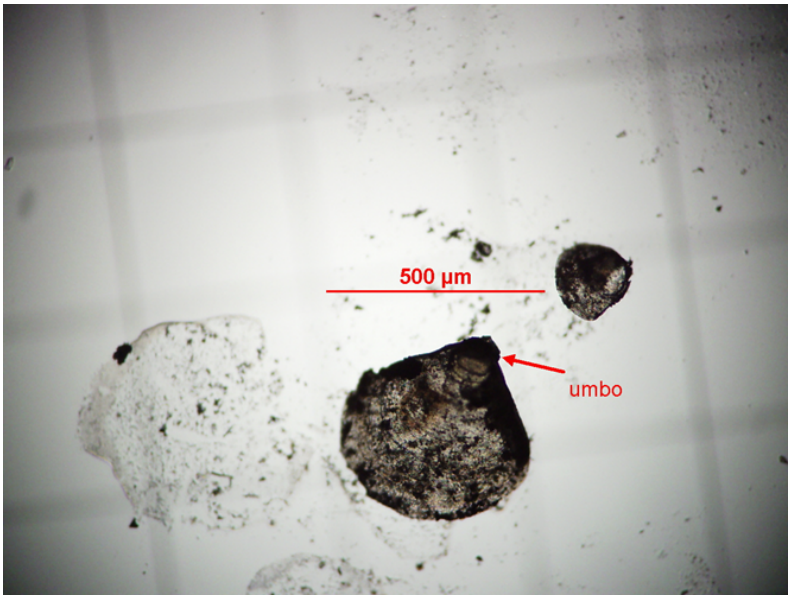

Figure 4. Image of Olympia oyster spat (newly settled oyster) taken at 100x was used using an Olympus BX41 microscope with a DP70 camera adapter. (Photo Rosa Hunter).

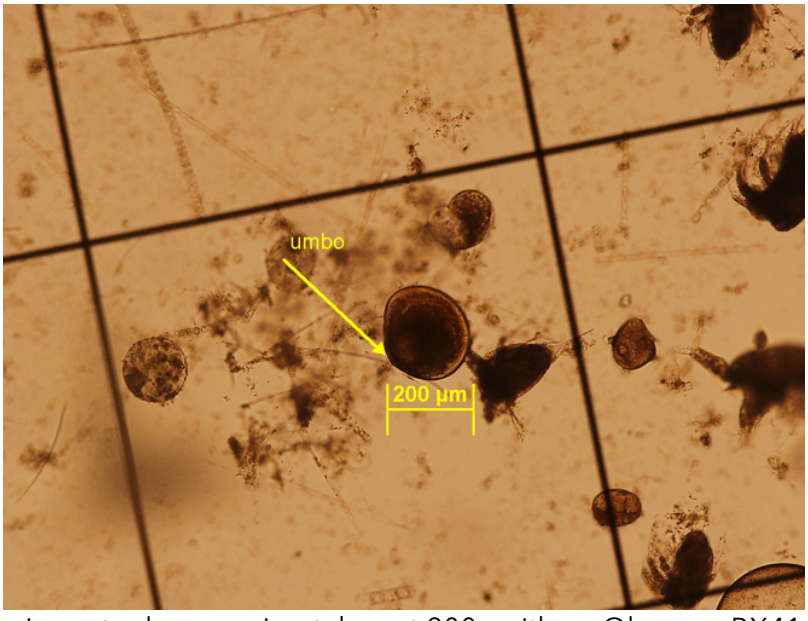

Figure 5. Image of Olympia oyster larvae using taken at 200x with an Olympus BX41 microscope with a DP70 camera adapter. Olympia oyster larvae are larger than many other bivalve larvae at ~250µm. Olympia oysters have a "fan-like" symmetrical characteristic in early development which is a feature more easily noticed in identifying Olympia oyster larvae (Photo: Jefferson Emm).

Statistical Tests

To test the null hypothesis that there was no structure in the temporal and spatial variability in settlement rate a chi-square test was performed using Mini Tab 16. A few data gaps had to be dealt with due to late or failed recovery of shellstrings. One shell string from the first deployment at site one was recovered two weeks late. Given that each deployment was intended to last two weeks, this shellstring was deployed for a total for four weeks. The settled oysters on this shellstring had a clear bi-modal structure, with a number of the settlers being much larger than what was observed for two week deployments and a number that were very small and had just settled. Newley settled oysters were easily identifiable as the larval shell was still visible. Using this bimodal structure, we excluded all newly settled oysters, as they would have settled after the intended deployment timeframe. All three shellstrings from the second deployment at site eight were never recovered. Based on the low variability between the deployments at site eight, the average number of settlers from deployment one, three and four was used for deployment two.

To test the hypothesis that there would be a greater number of newly settled oysters from sites closest to the Olympia oyster restoration site (sites four and five), a one-way T-test was performed comparing the mean number of settlers from sites closest to the restoration compared to the other sites, for all deployments.

To test the null hypothesis that larval water column depth (surface or bottom) was not related to tidal stage (ebb or flood) a chi-squared test was performed using Mini Tab 16. Pump sample dates were taken once a week for six consecutive weeks, starting June 23, 2015, and ending on August 17, 2015, with a double sample on July 21, 2015. Due to missing flood tide samples, the July 14 samples were excluded for analysis and the extra samples from the July 21, 2015 ebb tide were also excluded.

To test the null hypothesis that there was no difference in mean larval abundance at the surface or bottom water of the water column or between ebb and flood tides, a two-sample T-test assuming equal variances was performed using Excel 2010. Four T-tests were performed to show if there were any differences. The tests performed: (1) mean of total larvae sampled during flood and ebb tides, (2) mean of total larvae sampled at the surface and bottom, (3) for ebb tides only, mean larvae sampled at the surface and bottom, (4) for flood tides only, mean larvae sampled at the surface and bottom.

Results

Recruitment

For all shell string deployments, the average count of Olympia oyster settlers per settlement substrate ranged from 0.0 to 106.0 oysters/substrate (Table 1). The three highest values were from the second deployment (6/30-7/15) at Site 4 (91.1 oysters/substrate) and 5 (160.0 oysters/substrate), and fourth deployment at Site 5 (80.0 oysters/substrate). For the first deployment, Sites 4, 5, and 6 all ranged from 20 to 26 settlers per shell, whereas Sites 1, 2, 3, 7, and 8 ranged from 0.2 to 5.2 oysters/substrate. Sites 4 and 5 both had the highest values for the second deployment of 91.1 and 106.0 oysters/substrate, respectively. For the second deployment, Sites 3 and 6 also had similar values of between 32.2 to 38.1 oysters/substrate and Sites 1, 2, and 7 were between 5.0 to 0.0 oysters/substrate. The third deployment had the lowest maximum recruitment of any deployment with a maximum of 22.5 oysters/substrate at Site 4. The rest of the sites ranged from 0.0 to 11.6

oysters/substrate for the third deployment. The fourth deployment had the second highest maximum recruitment of 80 oysters/substrate at Site 5. Within each deployment, Sites 4 and 5 had the highest recruitment (Table 1). The chi-square test of Olympia oyster settlement by site and deployment resulted in a p-value of <0.000 with a chi-square value of 1554, 21 degrees of freedom, and six cells with expected counts of less than five.

The average number of oysters /substrate at Sites 4 and 5, which were near the restoration was between 11.6 (SD ± 3.6) and 106.0 (SD ± 9.1) oysters. Compared to sites away from the restoration area (Sites 1, 2, 3, 6, 7, 8), which had a lower average number of oysters /substrate which varied between 0.0 (SD ± 0.1) and 38.1 (SD ± 2.4). Comparing sites near the restoration (Sites 4 and 5) to sites away from the restoration (Sites 1, 2, 3, 6,7 8,) using a one-way T-test resulted in a critical value of 1.94 with a t Stat of 6.4 and 6 degrees of freedom, which resulted in a p-value of <0.00. Based on the resulting p-value of <0.05 the hypothesis that settlement was higher near the restoration site was not rejected.

Planktonic Larvae

Weekly plankton pump samples were taken from June 23, 2015 to August 17, 2015 at the surface and bottom of the water column on both ebb and flood tide cycles. The flood tide samples on July 14, 2015 were not obtained. A second set of ebb samples were also taken on July 21, 2015. The number of Olympia larvae ranged from 0.1 (SD ± 0.05) larvae/L to 15.7 (SD ± 7.8) larvae/L (Figure 6). The three highest values recorded were from ebb surface samples on July 14, 2015 (ebb surface sample 1 and 2), and July 7, 2015, with values of 15.7 (SD ± 7.8), 6.4 (SD ± 3.7) and 7.5 (SD ± 3.7) larvae/L respectively. In general, the highest larval abundance was observed between July 14 and July 21.

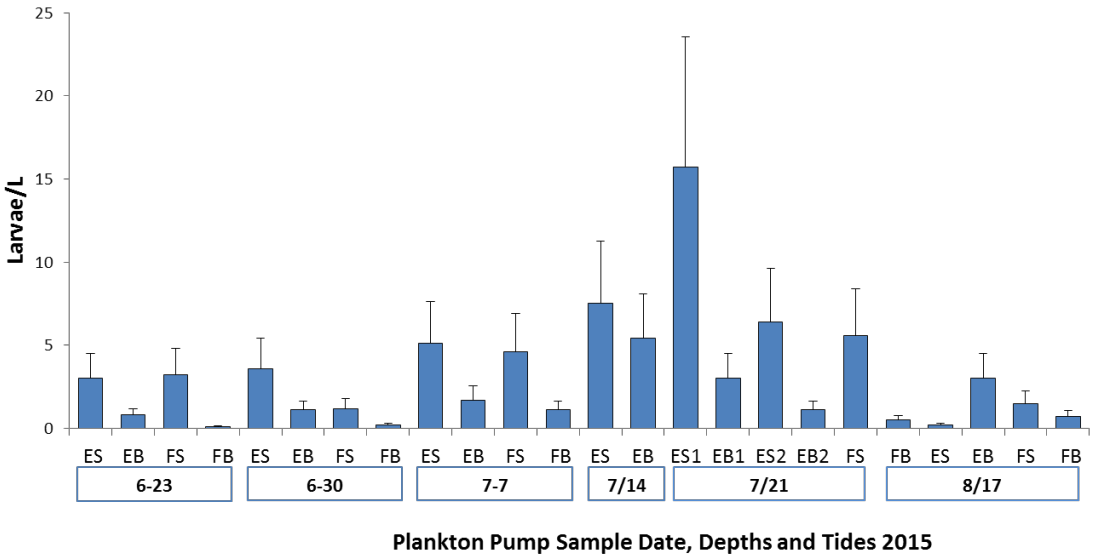

Figure 6. Distribution of Olympia oyster larvae through time. Each sample date had four pump samples except 7/21/15, which had six pump samples from two extra ebb samples and for 7/14/15 no flood samples were taken. Mean values and standard deviations from the complete count of five subsamples are presented. *ES= ebb surface, EB=ebb bottom, FS= flood surface, FB= flood bottom, 1= first pump, 2 = second pump, Error bars = SD larvae/L.*

Statistical Results

The chi-squared test of larval distribution in the water column showed a significant difference with a p-value of <0.000 with a chi-square of 53.4, degrees of freedom of 12 and four cells with expected counts less than five. The four T-tests resulted in a failure to reject the difference of means for samples collected on a flood tide compared to an ebb tide. The null hypothesis of no difference between surface and bottom samples was rejected for all samples, samples collected during ebb tides and samples collected during flood tide (Table 2).

Table 2
Results from statistical analysis or larval position in relationship to tidal flow

Hypotheses	P-Value	Results
Null: there is no difference the combined surface and bottom number of larvae when comparing tidal stages flood and ebb tides	p = 0.12 *t* (24)	with a p-value of 0.12, we fail to reject the null hypothesis.
Null: there is no difference between the number of larvae sampled at the surface and bottom, when combining flood and ebb tides	p > 0.004 *t* (25)	with a p-value of > 0.004 the null hypothesis is rejected (p-value = <0.05)
Null: For ebb tides only, there will be no difference between the mean number of larvae sampled at the surface and bottom	p > 0.03 *t* (14)	with a p-value of > 0.03 the null hypothesis is rejected (p-value = <0.05)
Null: For flood tides only, there will be no difference between the mean number of larvae sampled at the surface and bottom	p > 0.03 *t* (10)	with a p-value of > 0.03 the null hypothesis is rejected (p-value = <0.05)

Note. To determine if there is structure in the distribution of Olympia oyster larvae at with depth and based on tidal stage, four null hypotheses were tested using a two-tailed t-test.

Discussion

In support of the first hypothesis that settlement will be higher near the restored population, the chi-square results supported that there was structure in the recruitment and not all sites had equal amounts of settlers. The T-test results supported the hypothesis that the mean recruitment is higher at sites (4 and 5) near the restoration compared to sites away from the restoration (Sites 1, 2, 3, 6, 7, and 8). Sites 4 and 5 also had the second highest and highest recruitment, respectively, for any given deployment. On the east side of Fidalgo Bay, Sites 3 and 6 had higher recruitment compared to sites on the west side of Fidalgo Bay. Sites 1, 2, 7, and 8 all had low recruitment as well, with Site 1 having the lowest. These results supported earlier findings by Dinnel and colleagues (2011), which found

recruitment was highest near the restored populations on the east side of Fidalgo Bay and lowest at the north end of March Point and Weaverling Spit (near Sites 7 and 8 from this study, see Figure 1).

The finding that recruitment was markedly higher on the east side of Fidalgo Bay compared to the west side was interesting as both areas were rather close. A number of factors could be driving this variability in recruitment, such as suitability of habitat, settlement cues, and circulation patterns. The east side of Fidalgo Bay had received considerable habitat enhancements as part of the ongoing restoration programs (Dinnel et al., 2011). The habitat enhancement was designed to reduce habitat as a limitation for recruitment (Brumbaugh & Coen, 2009). However, this study did not assess recruitment habitat quality. Research with other oyster species has shown that a biogenic substrate increases settlement (Barnes, Luckenbach, & Kingsley-Smith 2010). In Fidalgo Bay, the restored substrate provided a three-dimensional structure which may also alter the biological communities, which in turn may provide additional settlement cues for Olympia oysters. Circulation models that include the release of passive larvae with a planktonic period of 7-14 days have the highest larval delivery to the east side of Fidalgo Bay, near the restoration site and the barge site (Grossman, 2013). In Fidalgo Bay, the combination of enhanced substrate and circulation driven larval retention are both likely contributing to the pattern of increased settlement on the east side of the bay.

Temporally, recruitment followed a lunar cycle, with alternating two-week patterns of higher and lower recruitment. The first deployment had a high of 26.2 oysters/substrate compared to the second deployment, which had a high of 106.0 oysters/substrate. This was followed by a high of 22.5 oysters/substrate for deployment three and a high of 80.0 for deployment four. While prior research has looked at the total settlement over a spawning and growing season, the finer temporal scales have not been analyzed. This pattern was a little perplexing given that each deployment spanned a similar time over a neap (low tidal exchange) tidal cycle. This resulted in all deployments experiencing a series of extreme low tides and more moderate tides. However, the lowest tide of the study period occurred on July 2, 2015, during the second deployment, which also had the highest recruitment of any deployment. In Southern California, a strong temporal signature has been found in Olympia oysters' larvae with the greatest settlement in June (Seale & Zackerl, 2009). While this study also collected settlement substrate every two weeks, the authors presented monthly averages so we cannot directly compare this finding of a monthly peak to their temporal pattern.

In an attempt to determine the patterns of larval abundance in the water column, we compared the number of larvae found at the surface and bottom of the water column across the entire study, during flood tides, and during ebb tides. For all three of these analysis, the mean number of larvae was higher at the surface compared to bottom. This result was in contrast to Peteiro and Shanks (2015) which found that Olympia oyster larvae perform tidally-timed vertical migrations to enhance retention within Coos Bay estuary, Oregon. Whereas, the larvae in Fidalgo Bay, on average, had higher abundance at the surface regardless of the tidal direction. One protentional explanation of this difference is that the Coos Bay estuary had bi-directional flow, with surface water flowing out of the estuary and bottom water flowing in during an ebb tide, with the opposite pattern during a flood. Based on this flow the larvae in Coos Bay can alter their high in the water column to "ride" the tide in or out of bay. Compared to Coos Bay, Fidalgo Bay was shallower and had less fresh water input, which could result in unidirectional flow. If Fidalgo Bay was in fact primarily a unidirectional flow system, that would explain the stable pattern of more larvae near the surface. Additionally, the total number of larvae was compared based on tidal stage (flood or ebb) which did not result in a significant pattern.

Prior research on the behavior of mollusk larvae has shown that larvae can alter their position in the water column. Depending on species, mollusk larvae may be more abundant in surface waters during day light hours while others are more abundant at night (Armonies, 1992). While this study did not capture the diel patterns of larvae, it does appear that Olympia oyster larvae prefer the surface. Higher larval abundance in the surface was also consistent during ebb and flow tides.

Conclusion

At the nexus of land and sea littoral species take the brunt of anthropogenic impacts, both from land change and changing seas. For Olympia oysters, these impacts started over 100 years ago resulting in major population declines (Baker, 1995). More recently, the cultural and ecological value of Olympia oysters has been realized and restoration projects are underway around Puget Sound (Blake & Bradbury, 2012).

Many diverse groups are coming together to foster the renewal of Olympia oyster populations, including local, state, federal, and tribal agencies, non-governmental organizations, institutions of higher education, and aquaculture industry. This has spawned restoration projects small and large around Puget Sound and these projects can benefit from increased knowledge about the fundamental life history of Olympia oysters. These partnerships are also vital to the success of restoration projects. For example, buy-in and support from local tribes is often required to gain access to tidelands. Non-governmental organizations can provide citizen scientists to help with on-the-ground restoration and monitoring. The aquaculture industry can provide seed stocks and oyster growing expertise. Local, state and federal agencies can provide support in the way of their experiences. Colleges and universities can provide research expertise to better understand the science behind successful restoration projects. Together these groups can help restore the culturally and ecologically important Olympia oyster.

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THE MENOMINEE THEORETICAL MODEL OF SUSTAINABILITY AND CLIMATE CHANGE

Dennis Vickers and Chris Caldwell
College of Menominee Nation

The Menominee people of northeast Wisconsin have managed their forest home sustainably for centuries. In recent years members of this community documented their approach to sustainable forest management in the form of a conceptual model that can be applied to other localities and resources. This conceptual model reflects traditional American Indian values and suggests the collaborations mankind will need to mitigate and adapt to climate change. Documenting these sustainable forest management experiences as a model makes the underlying approach broadly applicable to communities, large and small, and preserves flexibility across a wide range of ecosystems.

Keywords: *conceptual model, traditional ecological knowledge, sustainability, climate change.*

Introduction

The ability to adapt and survive in this world is more likely when relationships between the people and the land are strong. For Indigenous peoples, the strength of these relationships includes an understanding of not only the land, but also core cultural values such as respect, reciprocity, and responsibility. Often these values are interwoven throughout individual and community ways of life. These espoused and applied values, therefore, build on each other in an ever-unfolding complex pattern that can be seen as inherent resilience. This is a resilience that is evidenced by Indigenous people's millennia long presence on landscapes throughout the world in spite of colonialist and imperialistic endeavors. Today, the consequences of human caused climate change presents a new threat to Indigenous peoples' inherent resilience, relationships and other dimensions of community life.

Over the last decade, the College of Menominee Nation Sustainable Development Institute (CMN SDI), in collaboration with other Indigenous peoples, federal agencies, academic institutions, and non-profit groups, has investigated climate change and its impacts on the Menominee community and other tribal communities. Working from an Indigenous perspective while collaborating with western science has led to opportunities to examine climate change from multi-disciplinary ways of knowing and provide a richer understanding of environmental issues. Much of this work has been developed through self-reflection guided by the Menominee Theoretical Model of Sustainability (MTMS)[1] developed through the CMN SDI. This article further develops the work of the CMN SDI in relation to Indigenous peoples and climate change.

[1] The expression *Menominee Theoretical Model of Sustainability* is used here to signify that this model is a product of the Menominee community. In other literature, the model is called the *Sustainable Development Institute model* (SDI model) to signify the caretaker status the Institute has been given for this intellectual property.

Menominee History: A Story of Inherent Resilience

For the Menominee people, their presence and relationships in the Great Lakes landscape across different eras can be traced by names associated with them. For example, the Menominee people refer to themselves as Kayaes Matchitiwuk which translates to *original people* and is one indication of their millennia long connection to place. Neighboring tribes referred to the Menominee as Mano'minini'niwûk, (*wild rice men*), and the French referred to them as Foilles Avoine (*wild oats people*) (Beck, 2002). Eventually, the name Omāēqnomenēwak (*people of the wild rice*) was used by the people to refer to themselves in their own language. Over time, the social, political, and geographical impacts of colonialism caused the Menominee to consider new ways of relationship with their forested environment (Beck, 2002). In relatively recent times, a new name has been ascribed to Menominee in reference to their human environmental relationships. Maeqtekuahkihkiw Kew Kanāħwihtahquaq (*the forest keepers*) has been used in reference to the work being done by the tribe in its sustainable forestry operations.

The Menominee people have sustainably managed their natural resources in northeast Wisconsin for more than 160 years (Grignon, Alegrai, Dodge, LaRock, & Martin, 2004), and have produced sustainable timber yields since the current reservation was established in 1856. Today, Menominee forestry continues to be world renowned for producing high-quality timber and economic resources for the community while maintaining and enhancing the health of the forest ecosystem (Pecore, 1992). The Menominee have maintained sustainable forest yields for more than 16 decades and harvested over 2.5 billion board feet of saw timber during this time (Burgess, 1996). The present reservation, situated about 50 miles northwest of Green Bay, Wisconsin, is approximately 230,000 acres, with over 95% of that held in sustained yield management status. Approximately 63% of this productive forest land is fully stocked with stands of numerous species, including white pine, sugar maple, red oak, birch, beech, ash, and hemlock (Menominee Tribal Enterprises, 2012).

Late in the Twentieth century, Menominee tribal leaders, community members and academics from the College of Menominee Nation (CMN) worked together to understand the Menominee sustainable forestry experience and document their approach to sustainable development in the form of a theoretical model. This model conceptualizes sustainable development as the process of maintaining the balance and reconciling the tensions among six interconnected dimensions of community life: 1) land and sovereignty, 2) natural environment (including human beings), 3) institutions, 4) technology, 5) economics, and 6) human perception, activity, and behavior (Dockry, Hall, Van Lopik, & Caldwell, 2016).

Within the model these strategists identified a generalized framework for a better understanding of how the Menominee have related to their homeland for millennia. This includes a major shift during eras of European colonialism and American Settler Expansion, from one based on seasonal rounds to one based on confinement to a limited land base. While prospects were dire for the Menominee during these periods of time, it also created an example of adaptation that has been credited to a statement made by Chief Oshkosh circa 1854, when asked how the Menominee should harvest timber from the forest (Menominee Tribal Enterprises, 2012):

"Start with the rising sun and work toward the setting sun, but take only the mature

Kiskahakituaq enes yoh skimohkahah anokiwen yom skinik enakah, tapehnen kesekew

trees, the sick trees, and the trees that have fallen. When you reach

Metekok, wehsekesewak metekok, mesek kayes-papeciwak metekok. Kaniw ehpeh,s

the end of reservation, turn and cut from the setting sun to the rising sun

Piyahtaeyaek enes, Kiskahakituaq enes yoh skinik enakah yom skimohkahah enahkah

And the trees will last forever"

Mesek metekok yom kakekaehkamet".

Since then, tribal forest management has changed over the years as technology has changed, yet the underlying values of Chief Oshkosh's statement continue to anchor and guide decision making for the forest, the nation, and the people. This continued following of Chief Oshkosh's teaching is important because the statement creates a future vision for how the Menominee will continue to care for the forest and how the forest will continue to care for them, even in uncertain times. This example provides opportunities for further reflection as the Menominee now face new uncertainties in the face of continued impacts by invasive species and shifting seasons. This combined assault on the strong cultural forest relationships that have sustained the Menominee over generations is under threat from a range of known and unknown impacts. For example, changes to plant phenology in the Menominee forest point toward potential impacts on the timing of cultural activities like the harvesting of medicinal plants and maple sugaring, as well as contemporary management activities like the use of understory plant associations to determine forest site productivity.

Climate Change and Indigenous Peoples

Impacts of climate change on Indigenous peoples in the United States continue to be identified as increased research, projects, and reports are developed that are led by, or in collaboration with, Indigenous peoples and tribal communities. Norton-Smith and colleagues (2016), provide the most current and comprehensive assessment of these issues through the use of three frameworks: 1) tribal sovereignty and self-determination, 2) traditional knowledges and culture, and 3) community health. Through these Indigenous perspectives, the authors identify historical and contemporary actions that have led to and can provide solutions for addressing climate impacts on tribal communities. In this respect, the ideas of federal trust responsibility to tribes through treaties are described in addition to tribes' rights and responsibilities to govern themselves for the benefit of their own members. This governance must take into consideration the impacts that changes occurring in the natural environment will have on their relationships, and how these changes may impact the health and wellbeing of tribal communities overall.

In similar fashion, the Menominee Theoretical Model of Sustainability (MTMS) maintained and applied by the CMN SDI seeks to identify and address climate change impacts on tribal communities in a more holistic and expansive way than other western models might. The following sections provide an overview of some of these issues and their applications in the context of MTMS.

Menominee Theoretical Model of Sustainability Application: Investigation and the Potential for Solutions

MTMS is represented in a simple visual format – six interlocking hexagons labeled to depict the dimensions that must be considered when searching for sustainable solutions (Figure 1), with the middle section providing a space for recognition of place-based investigations. Strategies that guide the long-term sustainability of the Menominee forest might be conveyed in other ways — a chronicle

of deliberations or a catalog of the underlying management principles – but these representations would lack the flexibility and generative capacity the model provides.

Figure 1. Menominee Model of Sustainable Development

The model can be seen as a blueprint to better understand the *Traditional Ecological Knowledge* (TEK) that has informed the Menominee as they manage the forest, where TEK is understood as Whyte suggests:

> "...the concept of TEK should be understood as a collaborative concept. It serves to invite diverse populations to continually learn from one another about how each approaches the very question of 'knowledge' in the first place, and how these different approaches can be blended to better steward natural resources and adapt to climate change." (Whyte, 2013, p. 10)

This attribution more closely aligns with the Climate and Traditional Knowledges Workgroup (CTKW) description of traditional knowledge as grounded in symbiotic relationships of Indigenous peoples and places—a nature-culture nexus (Climate and Traditional Knowledges Workgroup, 2014). The MTMS facilitates understanding environmental issues that impact human-environment relationships, including those resulting from climate change. The Menominee phrase Netaenawemakanak (*all my relations*) is a local example of the traditional knowledge embedded within the MTMS.

Management of the Menominee forest can be viewed as a collaboration of interests, influences, and intentions. The common thread is the knowledge reflects the autochthonous relationship the Menominee have with the forest – they originated from the land near where they currently reside and retain an intimate relationship with place. This relationship goes well beyond being *from* somewhere—the Menominee embrace the land as part of their community. The natural environment includes the people living in a place, and the resident living entities, including humans, are a principle factor determining the character of the place. Using the model leads to knowledge that reflects the interests of the entire natural environment including the human component. The

knowledge is not exclusively knowing-that (propositional knowledge) nor knowing-how (pragmatic knowledge), though it may include both. It is a more encompassing self-knowledge where the self is the entire ecosystem, including the humans and all of their facets (institutions, technologies, and so on). It is knowledge constructed through a deliberative process that is intentionally inclusive.

The Menominee regard the health of the forest and the health of the people as one (Dockry, et al., 2016). To seek one is to seek the other; to achieve one is to achieve the other. This quest for community health is informed through deliberations guided by the dimensions of the MTMS:

Table 1.

Dimensions of the Menominee Theoretical Model of Sustainability

Land and sovereignty has specific legal and cultural significance for the Menominee and other American Indian people as they continue sovereign control over their territories. For non-American Indian communities, this dimension reflects how decisions are made for their land and community.
Natural Environment goes beyond natural resources to include individual people and communities, along with plants, animals, rocks, water, air, and so on. Counting this broad range of things within the natural environment dimension reflects the Menominee understanding that everything is related and that all interests matter, not only human interests.
Institutions includes structures that develop and enforce rules of behavior and social interactions among humans, plants and animals, and the environment. For the Menominee, institutions include the Menominee clan system, tribal government, the College of Menominee Nation, Menominee Tribal Enterprises, and so on.
Technology includes the broad range of "how humans do things…or how humans get things done" (Dator, Sweeney, & Yee, 2015, p. 2), both ancient (e.g. Menominee methods for building birch bark canoes or processing wild rice) and modern (e.g. equipment for producing high-quality saw timber in a modern sawmill, or Geographic Information Systems used to implement sustainable forestry management activities).
Economics incorporates multiple scales, ranging from individual households, to the tribe, region, nation, globe. Economics for the forest involves reconciling the interests of individuals engaged in subsistence harvesting with commercial timber harvesting for sale internationally.
Human perceptions, activity, and behavior represents individual perceptions, activities and behaviors to community understandings, values, and collective pursuits. This dimension incorporates everything from Menominee cultural beliefs and practices to the creation of forestry management plans that limit timber harvesting to sustainable levels.

This six-fold cluster has proven sufficient for decision making – all important considerations fall within one dimension or another. Significant decisions must take into account the natural environment and proceed to consider relevant technologies, economics, and institutions. The human reactions (perceptions, activities, and behaviors) resulting from decisions represent the community's

acceptance and the boundaries, and land and sovereignty define the parameters within which actions are possible.

In Western terms, the Menominee community is a coupled human and natural system (Liu, Dietz, Carpenter, & Folke, 2007). The model represents those dimensions of the system that must be considered to maintain balance, stability, and sustainability. Favoring or neglecting one dimension leads to imbalance, instability, and unsustainability. Western concepts of sustainability, in contrast, mainly focus on economic development and struggle to avoid damaging the natural environment and the social fabric, although voices advocating more inclusive development are beginning to speak, "Sustainable development often leads to strong trade-offs, mostly in favour of economic growth. Inclusive development responds by focusing mainly on the social and environmental aspects of development and on current generations." (Gupta, Pouw, & Ros-Tonen, 2015, p. 541).

The MTMS, because it locates humanity as one of many interrelated contributors within the natural environment, recognizes intrinsic value in the other-than-human parties by design. Furthermore, because the model explicitly guides considerations to non-economic human interests (institutions, technologies, perceptions, activities and behaviors) it produces results that balance economic and other interests. From a systems thinking perspective, the model's dimensions represent complex, self-organizing systems (or subsystems) functioning as an interrelated nexus and interrelated though a multifaceted variety of balancing and reinforcing feedback loops. As is customary in systems thinking, the goal is to look beneath the events into patterns or trends and ultimately beneath these to underlying systemic structures. In the course of investigations, the study moves from reactions to anticipations to design and ultimately transformation (Meadows, 2008).

Figure 2. Extended Menominee Model of Sustainable Development

Change within one of these dimensions affects the other dimensions in an ever-unfolding diffusion of responses to change (see Figure 2), whether externally driven or inherent to the dynamism of a specific dimension (Dockry, et al., 2016). From an epistemological point of view, understanding changes in one dimension requires understanding changes in others. When the model is used to facilitate investigations, the dimensions represent topical areas populated with real-world systems.

When the model is used to facilitate collaborations, the dimensions represent parties at interest, either directly (e.g. institutions; human perceptions, activities and behaviors) or indirectly (e.g. parties who hold relevant economic interests, or advocate for preferred technologies). The MTMS is grounded on two principles that are traditional for the Menominee and other Indigenous communities worldwide. First, all things are related and ultimately made up from the same ingredients (Dockry, et al., 2016). This common ontology is the basis for an expectation of mutual respect as a basic moral principle. Second, one should consider the effects and implications of one's actions far into the future to insure the interests of descendants and descendants of descendants are taken into consideration (Clarkson, Morrissette, & Regallet, 1992).

The MTMS was documented after-the-fact. Persons knowledgeable regarding how the Menominee community managed its forest worked to describe the factors that became important in the decision making in ways that would help others understand the roles these factors played. The resulting model is useful for projecting historically significant insights into future community management decisions while allowing for the creativity of each new generation of decision makers. A model (as compared to a set of policies, procedures, or principles) guides but doesn't determine decisions. The model's flexibility is vital for its ongoing usefulness in two ways: (1) it is pertinent for a wide range of community development initiatives, not only forest management, and (2) it is applicable to any community sharing common institutions and technologies, occupying a single environment over which it has sovereignty, that is interdependent economically, and perceives, acts, and behaves as an organic whole.

Menominee Model: Indigenous Peoples and Climate Change

A proven record of accomplishment for establishing and maintaining sustainable living is especially valuable as we move into a period defined by a critical need to mitigate and adapt to the effects of decades of unsustainable practices. For the Menominee and many others, climate change will bring about unwelcome changes outside their control,

> Yet the landscape that fostered their cultural development is rapidly changing and is projected to change more in the future. Climate change could impact sugar maple, ash, and red oak trees as well as wild rice by changing weather patterns, increasing runoff pollution, facilitating the spread of invasive species, and shifting ecological zones (Hitch, Conaway, & Hill, 2014, p. 1).

In contrast to historic stability, the average annual temperature on the Menominee reservation is projected to increase at a rate about four times greater than what has been observed for the state as a whole since 1950 (Center for Climatic Science, 2009). Wisconsin generally will see an average annual temperature increase of 4 – 9° F by the middle of this century[2]. The increase is projected to be slightly larger in the far north-central part of the state and slightly smaller along Lake Michigan. Winter average temperature on the Menominee Reservation is projected to increase 7.5 – 8° F, while spring average temperatures increase 6 – 6.5° F, summer average temperatures increase 5.5 °F, and autumn average temperatures increase 6 °F. There will be 14 – 18 more 90° F days, 16 fewer below

[2] Projections are based on the A1B emission scenario, considered a mid-line scenario for both carbon dioxide emissions and economic growth.

0° F nights. According to these climate models, average annual rainfall on the Menominee reservation will increase 3 inches per year by 2050.

What will characterize these coming decades? Because of the lack of historical precedents, there is considerable uncertainty as to what specific conditions will develop and when. Changing factors may pass threshold values and the results may be non-linear. Changes will likely be fast paced and will extend to levels unprecedented in human history. Considering this predicted future through the lens of the MTMS suggests many initial questions or avenues for investigation, both for Menominee lands and other places. In the model's terms, the coming climate changes mark a major repositioning of vital elements in the Natural Environment dimension. This repositioning will generate imbalances between Natural Environment and other dimensions.

When applying the model to a specific investigation/deliberation it is useful to consider what conflicts arise between model elements when one element comes out of balance. Considering the approaching frictions between the Natural Environment dimension and the other five serves to develop a narrative regarding to climate change impacts on a tribal community:

Table 2.

Questions Generated by the Menominee Theoretical Model of Sustainability

Human Perception, Activities and Behaviors	How will humans respond to climate changes? How will long-standing cultural practices (*e.g. wild ricing, maple sugaring, medicinal plant gathering*) evolve? How will the stories that go with these activities be adapted for future climates? What steps can be taken now to reduce the impact of a projected reduction in the health of sugar maple trees? (Morin, et al., 2018)
Land and Sovereignty	If culturally important species migrate off tribally controlled lands due to change in species habitat, what decisions or policies must the tribal leaders consider? Will opportunities for adaptation, such as carbon offsetting become a consideration if more familiar economic ventures like timber harvesting and wood manufacturing decline?
Technologies	Should the tribe move more quickly to adopt renewable energy technologies (solar generation of electricity and heat, wind energy, biomass generation) as a means to ameliorate climate change or for more cost-effective solutions to energy needs? Does the tribe have the workforce and expertise to do this?
Economics	Change in the climate will lead to changes in species composition in the forest – will there be impacts to how the tribe harvests timber and markets products based on what the forest yields when external markets don't use those yields?

Institutions	Is the current set of institutions on the reservation adequate to address these questions and other impacts that may arise from climate change? How will existing tribal government departments cooperate to implement helpful adaptations or mitigations?

As important as this is – focusing inquiries into the most promising areas – more important still is the model's use in guiding formation of collaborations and in structuring discussions and negotiations. For example, one important use of the model has been to set the research agenda for the Sustainable Development Institute at the College of Menominee Nation. For climate-change related research this agenda includes forging partnerships to determine optimal climate-change responses for the Menominee people and others. One such partnership is the Visualizing Forest Futures (VIFF) project, a partnership with the Pennsylvania State University (PSU)[3], which explores how traditional knowledge (TK) can inform the development of modelling and visualization tools to create a better understanding of how values inform decision-making for highly uncertain futures. This project was developed as part of another partnership involving the CMN SDI and led by PSU, called the Sustainable Climate Risk Management (SCRiM) network. This network focuses on the better understanding the complex tradeoffs with decision-making in the context of deep uncertainties as they pertain to climate change.[4]

Table 3.

College of Menominee Nation Sustainable Development Institute Efforts within the Menominee Theoretical Model of Sustainability Dimensions

Dimension	Examples
Land & Sovereignty	Are integral to the process of sustainable development. The Menominee Nation has a firm experiential basis for their understanding of this process. They know firsthand the horror of termination, and the struggle for restoration of their status as a federally recognized Indian tribe. While political restoration has been accomplished, other aspects of restoration are yet unfinished. Central to our research and extension mission is the commitment to those topics and activities that re-affirm tribal sovereignty and preserve the tribal estate.

[3] See *Climate change impacts on Menominee nation's forest home focus of NSF funding* in Penn State News, October 2016.

[4] See *SCRiM: A Transdisciplinary Research Network for Sustainable Climate Risk Management*, at www.scrimhub.org.

Dimension	Examples
Natural Environment	The long and successful Menominee experience in sustained yield forestry is the cornerstone of its community's sustainable development. SDI has prioritized forest products, forest ecology, enhanced commerce of timber products, and value-added forest products as immediate topics relevant to its scholarship and research and extension mission.
Institutions	In aiding in the development and maturation of the institutional life of the rural and reservation communities which we serve, we ensure the longevity of our efforts, maximize the impact of our initiatives, and position our own institution firmly within the community context which has charted our mission.
Technology	We believe rural and reservation communities are dependent on the foresight of their institutions to assure access to the new wave of information technology. We are committed to forwarding the development of information infrastructure. We are attuned to the potential electronic commerce, medicine, and judicial practice, advancing local access to technological innovations, and complementing our academic goals of advancing technological literacy.
Economics	Initial entry into extension services to forward this dimension are in nascent development, with an initial emphasis on cooperating with the local business incubator, offering workshops for potential entrepreneurs and service as a research resource for tribal enterprise. We anticipate the local regions designation as an enterprise community will provide additional training opportunities.
Human Perception, Activity, and Behavior	A priority for our research lies in projects which assure access to safe and reliable food and water resources. To that end, we anticipate complimenting research efforts in sustainable forestry with new initiatives in permaculture, ethnobotany, and preliminary investigation of the feasibility of aquaculture and hydroponics production.

The CMN SDI's primary mission involves using the MTMS as a communication focal point to help the Menominee community identify environmental issues and explore tools and resources for the development of solutions. The CMN SDI also collaborates with others seeking new ways of identifying issues, understanding context, and developing solutions for their own communities. This outreach has led to working with like-minded collaborators in organizations such as Rising Voices, the Indigenous Peoples Climate Change Working Group, the Indigenous Phenology Network, the Indigenous Design and Planning Institute, and State University of New York College of Environmental Science and Forestry (SUNY ESF) Center for Native Peoples and the Environment.

Conclusion

No one yet knows what social and natural adaptations will be required for humanity to weather the storms it has engendered. To the extent we collectively find well-informed, inclusive, effective responses, we reduce the misery climate change will bring for humans and others sharing the planet and enhance our prospects to achieve a broadly based, sustainable wellbeing. Whether the insights that underpin these responses are informed by scientific insight, TEK, or other forms of understanding matters little. What matters is that we find the collective will to collaborate, and the effective conceptual tools to help us collaborate effectively.

As humanity considers and implements remedial and adaptive measures necessary to preserve quality of life on the planet, following the MTMS can lead to optimal outcomes across a broad range of interests. Traditional values inform the Menominee people about the vast richness and complexity of the world and how to live within it sustainably. The conceptual model they use can be the vehicle for other communities to consider as they seek to maintain environmental and social balance to achieve a similar level of sustainability. Building upon the MTMS at the CMN SDI continues work done by earlier representatives of the institution, such as Dr. Holly Youngbear Tibbets and Melissa Cook, and also extends the insights of tribal leaders throughout Menominee history who faced many difficult decisions in times of great uncertainty, yet continued to move forward with the best interests of future generations.

Eneq
(*That is all*)

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ANISHINAABE PERSPECTIVES ON WATER RESOURCES IN NORTHERN MICHIGAN

Andrew Kozich
Keweenaw Bay Ojibwa Community College

Growing human demands are threatening the sustainability of global water resources. The development of proactive water policies requires a thorough understanding of human-water relationships, especially in the water-rich Great Lakes basin, as conservation becomes an increasingly important management objective. However, few researchers have examined residents' perspectives on water resources, including underlying values, beliefs, and attitudes related to conservation. Native American perspectives on water have received even less attention in the scientific literature. To help fill this void, I used semi-structured interviews to examine Anishinaabe perspectives on water resources across the Keweenaw Bay Indian Community of northern Michigan. While water holds tremendous cultural significance to interviewees, most feel that traditional views and values are not widespread in contemporary lifestyles and few are concerned about water conservation. This research provides a rich foundation for follow-up quantitative research using an established theoretical model to explain household conservation intentions.

Keywords: Anishinaabe, conservation, Great Lakes, water

Introduction

North America's Anishinaabe ("First People", also commonly referred to as Ojibwe or Chippewa) have resided in the Great Lakes region for countless generations largely because of the sacredness and life-supporting attributes of water. While traditional Anishinaabe values related to water are well-documented, little is known about potential relationships between modern water-related views and water conservation behaviors. This paper examines the intersection of water-related values and behaviors in the Keweenaw Bay Indian Community (KBIC) of Northern Michigan.

Water and 'Lifeways'

Anishinaabe lifeways – contemporary ways of being that incorporate traditional cultural values – are inexorably linked to the region's abundant water resources. For instance, the location and abundance of various fish species historically determined the seasonal movements and semi-nomadic lifestyles of many Anishinaabe tribes to ensure critical sustenance throughout the year (Ettawageshik, 2008; Gagnon, 2016; McGregor, 2012) and are still revered as a valuable food source today. Wetlands provide critical habitat for many plants critical to Anishinaabe lifeways; *giizhik* (northern white cedar), *aagimaak* (black ash), and many others are sacred for ceremonial or medicinal purposes or for making a wide range of goods (Danziger, 1979; Densmore, 1979).

Water is also a unifying theme in creation and migration stories and in cultural traditions and ceremonies. For example, the traditional seven fires story includes a prophecy instructing the Anishinaabe to migrate westward until reaching the place and where food grows on the water – a reference to *manoomin* (wild rice) historically abundant throughout the Great Lakes (Benton-Banai,

1988; Danziger, 1979). Reynolds (2003) described that for the Sokaogon Ojibwe Tribe of Wisconsin, "wild rice was also the cultural fabric that bound the people together, as the foundation of their legends, songs, and ceremonies" (p. 147). Like fishing, the harvesting of wild rice remains an important tradition to many Great Lakes Anishinaabe.

In traditional Anishinaabe worldviews, Earth is said to be a woman whose water purifies and nurtures all life. Its purifying attributes are emphasized in the traditional story of the great flood that the Creator brought about to rid the world of evil and usher in an era of renewal (Benton-Banai, 1988; Johnston, 1976). Benton-Banai (1988) further stated "Water is her life and blood. It flows through her, nourishes her, and purifies her" (p. 2). Reynolds (2003) explained the feminine symbolism traditionally associated with water, as its "…life force was symbolized by its rush from the mother preceding birth" (p. 148). Women were the traditional water-gatherers and the ones to lead ceremonies intended to protect it. This tradition continues to be recognized through women being the "keepers of the water", and is expressed through the revival of water ceremonies and leadership of Anishinaabe women (Gagnon, 2016; Kozich, 2016; LaDuke, 2017; McGregor, 2005, 2012, 2013; Szach, 2013; Whyte, 2014; Woboditsch, 1994).

Contemporary Water Issues

Because of the immense value of water to the Anishinaabe, traditional culture and contemporary lifeways alike can be greatly impacted by the destruction or degradation of water resources. There are abundant instances of Indigenous environmental injustices due to industrial contamination, disregard of treaty rights, and effects from pipelines (Ettawageshik, 2008; Gagnon, 2016; LaDuke, 1999, 2017; Whyte, 2017). Despite challenges, however, many Anishinaabe tribes are simultaneously rediscovering traditions and exercising treaty rights to resources in ceded territories, including reviving traditions such as spear-fishing (Ettawageshik 2008; Gagnon 2016). The annual planting and harvesting of *manoomin* is once again becoming a sacred tradition despite habitat declines in many areas (Reynolds, 2003; Great Lakes Indian Fish and Wildlife Commission [GLIFWC], 2007, 2008; Kimmerer, 2013). Across the Great Lakes region, tribes appear to be increasingly expressing sovereignty through their own natural resource management, particularly involving water resources (GLIFWC, 2018). Furthermore, the importance of water and the related injustices facing Indigenous communities garnered substantial mainstream attention through the "water is life" movement that united tribes in response to the Dakota Access Pipeline (Whyte, 2017).

While the Great Lakes region is one of the most water-rich areas of the world, there are reasons to be concerned about water's local-scale sustainability in light of contamination events, increasing human demands, and climate change (Great Lakes Information Network [GLIN], 2018; International Joint Commission [IJC], 2016; United States Environmental Protection Agency [USEPA], 2014). And at the same time that the scholarly literature shows increasing attention to Indigenous environmental issues, there appears to be voids in our understanding of contemporary Indigenous perspectives on water-related values and conservation. This is important because unlike many non-Native Great Lakes residents, members of Anishinaabe communities will likely face disproportionately negative impacts from reduced water availability (GLIFWC 2007). This paper highlights Anishinaabe perspectives on the management and conservation of Great Lakes water, which is critical considering the immense value of water in Anishinaabe lifeways. Increasing our understanding of water-related values, beliefs, attitudes, and conservation behaviors across all Great Lakes peoples

will benefit broad policy efforts calling for conservation (Floress, Aakamani, Halvorsen, Kozich, & Davenport, 2015; IJC, 2016).

Household Water Conservation

In times of water scarcity, households play an important role in regional conservation planning because they are typically the first targets for reductions of use. Furthermore, conservation is now emphasized as a key component of the 2008 Great Lakes-St. Lawrence River Basin Water Resources Compact. The Compact is a state and federal law prescribing how regional stakeholders will work collaboratively to ensure the sustainability of Great Lakes water resources (Council of Great Lakes Governors, 2015; Great Lakes-St. Lawrence River Basin Water Resources Compact, 2008). States and provinces bounding the Great Lakes are required to develop and submit water conservation plans every five years (Great Lakes-St. Lawrence River Basin Water Resources Compact, 2008). Insight on residential water use is therefore critical for agency personnel tasked with developing and implementing these plans.

Mainstream examinations of household water use reveal few consistent trends describing who conserves and why. Studies often report conflicting relationships between water use and traditionally-examined demographic variables such as income, age, or gender (Hurlimann, Dolnicar, & Meyer, 2009; Jorgensen, Graymore, & O'Toole, 2009). For instance, some researchers have found higher-income households likely to use more water, while others have found them likely to use less because they can afford to install water-saving appliances or fixtures (Millock & Nauges, 2006; Lam, 1999). Older residents are typically more inclined towards conservation but they also spend more time in the home, leading to higher household water use (Lyman, 1992; Russell & Fielding, 2010). Women tend to be more environmentally-conscious than men, but they often use more water by taking longer and more frequent showers (Domene & Sauri, 2006; Willis, Stewart, Panuwatwanich, Williams, & Hollingsworth, 2011). It seems that clarity on this research topic is greatly needed.

The inconsistency of traditional demographic variables to explain household water use has led to the call for research frameworks that instead examine socio-psychological variables such as beliefs, norms, and attitudes (Farrelly & Brown, 2011; Floress et al., 2015; Heberlein, 2012; Randolph & Troy, 2008; Russell & Fielding, 2010). Constructs from the field of psychology, such as the Theory of Planned Behavior (TPB), have shown promise in explaining household water use based on attitudes, perceived behavioral control, and perceived norms, although no published TPB-based studies appear to have been conducted with Indigenous participants.

The TPB proposes that intentions to perform a behavior are determined by three variables: 1) attitudes towards the behavior, 2) perceived social norms surrounding the behavior, and 3) perceived control over the performance of the behavior (Ajzen, 1991). Intentions to perform a behavior will be high if these three factors all support the performance of it (Ajzen, 1991; Fishbein & Ajzen, 2010). Regarding household water conservation, the TPB predicts that conservation behaviors will be the most likely for individuals who perceive the ability to conserve, perceive that important others approve of conservation, and have a positive attitude towards conservation. All TPB variables have been shown as effective predictors of household water conservation, although most studies have occurred in water-stressed contexts (Clark & Finley, 2007; Lam, 1999, 2006; Trumbo & O'Keefe, 2001).

Research Questions and Objectives

The broad objective of this research is to more fully understand the range of variables that could influence intentions to conserve household water among Anishinaabe residents. It is a novel approach in that it is based on a theoretical framework not known to have been applied to a water-rich context or in an Indigenous community. Qualitative findings will serve as a rich foundation for potential follow-up quantitative studies based on the TPB, with the additional ability to compare and contrast Anishinaabe and non-Anishinaabe perspectives. The specific research questions are:

- How do the region's water resources influence lifeways in the area?
- To what extent are traditional Anishinaabe values involving water still prevalent?
- Are community members taking personal steps to conserve water, and do they perceive others to be doing so?

This research serves additional roles besides providing a foundation for follow-up studies. Qualitative research can provide richness and depth not possible through surveys or other quantitative methods, which can be particularly valuable with Indigenous participants (e.g., storytelling). This research reflects the efforts of a tribal college researcher and student assistants to conduct community-based research supported by, and to provide valuable insight for, Keweenaw Bay Indian Community (KBIC) tribal leadership. It also enhances the scholarly literature by sharing insight from an under-represented population.

Methods

Semi-structured interviews were conducted with KBIC residents of Baraga County, Michigan, between June and October 2017. Interviews were chosen as the data-collection method due to their ability to capture initial, wide-ranging perspectives that are assumed to exist across the community (Babbie, 1995; Becker, 1998). Before conducting interviews, the research methodology was co-developed by Anishinaabe advisors, KBOCC faculty and students who participated in pilot interviews.

Table 1
Demographic characteristics of interviewees (N=17).

Demographic category	**Number of interviewees**	**Percent of interviewees**
Male	8	47%
Female	9	53%
Age		
18-39	5	30%
40-59	6	35%
60 or older	6	35%
Tribal Elder		
Education		
Some high school	0	0%
High school diploma	4	24%
Some college	10	58%
Bachelor degree or higher	3	18%

Demographic Category	Number of interviewees	Percent of interviewees
Household annual income		
Less than $20,000	4	24%
$20,000 to $40,000	3	18%
$40,000 to $60,000	7	41%
$60,000 to $80,000	2	12%
$80,000 to $100,000	1	6%
more than $100,000	0	0%
Home type		
House or mobile home	14	82%
Apartment, condo, or similar	3	18%
Home water service type		
Municipal (city) water	10	59%
Well water	7	41%

A combination of convenience and snowball sampling was used to garner interviews. A research assistant (enrolled KBIC tribal member) helped promote the research project across the community to recruit potential interviewees, many of whom later suggested other neighborhood acquaintances to be approached. In recruiting interviewees, the only demographic variables controlled for were gender and age. Interviews occurred in participants' homes and at KBOCC. Researchers conducted seventeen interviews and summarized demographic traits in Table 1. While findings from this sample are not intended to be generalizable to the larger population, the mix of interviewees provided a snapshot of the range of perspectives across the community (Babbie, 1995; Becker, 1998).

Table 2

Interview questions.

Water and life in the Great Lakes

1. How long have you lived in the area?
2. How close do you live to any water body? What is it like? How often do you see it?
3. Do you enjoy spending time around water? What do you like to do? How often?
4. What comes to mind when you think about the Great Lakes area?

Concerns about our water resources

5. Do you have any concerns about water in our region?
6. Do you think the government is doing enough to protect our water? If not, what do you think should be done?

Water and Anishinaabe culture

7. What are your thoughts on traditional Native American values involving water?
8. Do you see the same values being expressed by people in the area today?
9. Do you participate in any cultural activities involving water?
10. What would you share with the general public about what water means to you?

Perspectives on household water conservation

11. Do you do anything in particular to try to conserve water in your household?
12. Do you use water for outdoor activities like watering the lawn, gardening, washing cars, and so forth?
13. Do you plan to take any steps to conserve water in the future?
14. Do you think other people in the area are doing anything to conserve water?

Conclusion

15. Is there anything you would like to add? Do you have any questions?

As Table 2 shows, interview questions were grouped into four broad themes: 1) water and lifeways in the Great Lakes region; 2) concerns about our water resources; 3) water and Anishinaabe culture; and 4) perspectives on household water conservation. Questions designed to enrich potential follow-up quantitative research were linked to key elements of the TPB, including water-related values, beliefs, norms, attitudes, and conservation behaviors and intentions. The semi-structured format welcomed interviewees to share stories, elaborate on topics of interest or concern, and raise points not addressed by our pre-determined list of questions. Interviews averaged 26 minutes long and were recorded and transcribed verbatim. Transcripts were first analyzed and coded at the item level; upon completion of item-level coding, similar codes were grouped into themes and sub-themes to identify important patterns across interviews, following established social science research protocol (Babbie, 1995; Becker, 1998; LeCompte & Schensul, 1999). Patterns are reflected in the key themes described in the subsequent sections.

Results

The following paragraphs summarize the broad themes that emerged from the synthesis of the 17 interview transcripts. Key findings are grouped into three themes correlated to research questions: (1) water and lifeways, (2) traditional and contemporary values, and (3) water conservation. Where appropriate, numbers and percentages of interviewees expressing similar views are included for clarity.

Theme One: Water Strongly Influences Lifeways in the Area

Interviewees view and interact with water on a frequent basis. Describing the nearest water body to their home, 13 of 17 interviewees (76%) stated that they live either "about a mile" or "less than a mile" from the nearest water. All 17 said they view this water body every day, typically on their way to work or school. All described Keweenaw Bay as the nearest water body, although two additionally mentioned a smaller water body such as a stream or pond on their property.

Interviewees spend a lot of time near the water, typically through leisure activities or as part of their job. When asked what they like to do around water, most interviewees responded with abundant examples of water-related activities (see Table 3). Most commonly, interviewees described the water as a place to go for relaxation, while roughly half also mentioned fishing or exercise-related activities such as walking, running, or swimming. Fourteen interviewees were asked how often they visit the water for any activities they mentioned, and 10 stated that they do so multiple times per week. Responses to these questions indicate that most interviewees are very familiar with nearby water resources and regularly take advantage of their proximity for personal enjoyment. Notably, several older interviewees elaborated on physical activities they used to do near the water, such as swimming and fishing, and remarked that they no longer do these things "as often as they used to" or "as often as they'd like."

Table 3

Interviewees' water-related activities. Most reported more than one.

Activity	Number of interviewees	Percent
Viewing/sitting/relaxing near water	12	71%
Walking/running near water	9	53%
Fishing	9	53%
Swimming/wading	8	47%
Taking dogs to water	5	29%
Boating/canoeing	4	24%
Interact with water as part of job	4	24%

Interviewees provided a broad range of responses when asked what comes to mind when they think about Great Lakes water resources (an intentionally broad question). Responses fell into one or more of the six categories summarized in Table 4. Interviewees typically described multiple things that come to mind, including the abundance, cleanliness, and soothing effect of the water. Interviewees, such as the one below, suggested that this combination of factors results in the character and uniqueness of the Great Lakes region:

> I think that just all the water is the number one thing that comes to mind. No place has the water like we have here…whether you're talking about big lakes, rivers, swamps, snow…we have it all and I think it's what makes this place what it is. And to me that means it's really clean here and really pure. I think that soothing quality of being around cool, clean water is really important. And how it cleans the air too. That's what I think of.

Table 4

What comes to mind when thinking about the Great Lakes region? Most interviewees provided multiple examples.

Response	Number of interviewees	Percent
Abundance of water	8	47%
Scenery/beauty/serenity	8	47%
Fishing/food resources	5	29%
Importance to Anishinaabe culture	5	29%
Cleanliness/purity of water	4	24%
"It's home"	3	18%

Interviewees elaborated at great length about their concerns for Great Lakes water, indicating its high value in their lives. Interviewees typically provided several examples of concerns (see Table 5). The most common theme among responses, shared by 14 of 17 interviewees (82%), involves pollution. Some interviewees elaborated by providing specific examples of pollution sources, such as mining. Remaining concerns were fairly evenly spread across several other categories (see Table 5). Notably, only three interviewees mentioned concerns related to water supply, and one interviewee stated no concerns whatsoever.

Table 5

What concerns do you have about Great Lakes water resources? Most interviewees provided multiple examples.

Response	Number of interviewees	Percent
Pollution (in general)	14	82%
Treaty rights/environmental justice	4	24%
Pollution from mining	3	18%
Health of fisheries	3	18%
Climate change	3	18%
Invasive species	3	18%
Excessive withdrawals/transfers	3	18%

Confidence in the government to protect our water resources is low, as all but one interviewee stated that the higher levels of government are not doing enough to protect our water. Several noted in their responses, however, that local agencies such as the KBIC Natural Resources department are doing important work to protect water. Many interviewees, like the one below, linked their concerns about government oversight with impacts to Anishinaabe culture:

> Water is life. I believe that's why we have so much sickness too. You know, not only what we eat, but what we live in. Years ago, when were brought up on the fish, everything was clean, that's what we were brought up in. It's not clean anymore, some of our stuff, our traditional foods can't grow, and that's due to the disregard of the United States government and the dollar bill.

Theme Two: Traditional Versus Contemporary Water Values

The following paragraphs describe findings from this two-part research question designed to gain insight on traditional values versus current values. The first interview question related to this topic was intentionally broad ("What are your views on traditional Native American values regarding water?"), and interviewees' responses tended to be wide-ranging. The open-ended nature of this question was designed to allow interviewees to lead the discussion into topics most relevant to them. Follow-up questions directed the focus toward interviewees' perceptions of community members' contemporary views on water. Three key sub-themes emerged from this segment of interview discussions.

Water is life. The first notable sub-theme relates to the notion that "water is life", with five interviewees using that phrase verbatim. Overall, eight interviewees provided broad responses that related to this perspective. These responses tended to describe traditional views of the inter-connectedness of the natural world, the reliance on water among all living things, spirituality related to water, and the corresponding need for humans to be respectful of water. The interviewee below provided a response that touches on many of these traditional values:

> Natives just had so much respect for everything in our environment. Everything was family – the trees, birds, rocks, plants, water, the sun – it was all family and because of that we had the upmost respect for it all. You don't want to harm your family, and because they give to us, we rely on everything in the natural world for us to live. When we would take we would always give something back –tobacco – because we knew we

> were dependent on it all. Water doesn't depend on us, but we depend on it to survive. So do all the other living things in the world. So we value the water, we love the water, we need to pray for the water, the water gives us life, and the water has a spirit. Without water we would not have life. There was always that reverence and respect for it, and we wouldn't ever take it for granted.

Several interviewees further linked the necessity of water for all life with its important role in Anishinaabe cultural identity. The passage below reflects this connection, and includes phrasing about cultural identity that similarly occurred in other interviews:

> Water is a big part of our stories. And all the stories are about life and what it is to be Ojibwa. So that means that our life revolves around water, which is part of the land, and so it's all kind of tied together. All life comes from water. That's why we worry so much about taking care of it and showing that we respect it and will look after it. We need it. And the fish and everything else that rely on it…and even the rice and other plants…. they're a big part of who we are and they need water. So, I really believe that without water, we wouldn't be the people we are. It's part of us and we're part of it. That's what I was always told and I think it's really good ways to bring up people still.

Traditions and stories. While related to the "water is life" sub-theme, seven additional interviewees focused on water's role in Anishinaabe stories, traditions, or lifeways and provided specific examples to illustrate their points. Many discussed topics such as the Anishinaabe migration and the importance of fish or wild rice. As highlighted below, many interviewees made clear links between the abundance of water in the region and its role as a gift from the Creator and a life-provider for the people:

> This is where our people have been for countless generations. We came here because it is the place where food grows on the water. The water makes up the life in our bodies and supports the rice and the rice nourishes us. Everything is connected and it all starts with water. Water is everywhere here and it's everywhere in our traditional stories, our ceremonies, our songs, and our prayers. This water is our life and it's a gift from the Creator. We have to take care of it. We have to not pollute it and not waste it.

> Water is everything to us. We came here for the rice…you know our teachings say that we were supposed to find the food that grows on the water. Everything about life revolved around water. I was watching a film recently that talked about even the sugarbush has water, like the tree's sap is the water that flows through it like the water that flows through us. And everything involving fishing…you know we always had different places to catch fish, depending on the time of year. So yeah, pretty much everything about our traditional life here is all about water and how we need to respect it and take care of it.

Women as water-keepers. A third sub-theme involves the traditional Anishinaabe role of women as keepers of the water. Five interviewees, including the ones below, specifically included references to this tradition in their responses:

> The women were the water-keepers; we were the ones to care for the water. I'm happy that we have so many women doing important work nowadays at the NRD [Tribal Natural Resource Department], but I think overall our women need to get

> together more to care for the water. Whether it's just getting together for water ceremonies or walks or praying for the water or being the ones to speak up and be community leaders, that's what we need to do. It's the women that need to lead the way.
>
> I grew up very traditional as a woman of this tribe. We are the keepers of the water, our job is to watch the water and it's kind of interesting because traditionally that's what I should be doing, [being] a keeper of the water. I take it very seriously, and traditionally I'm doing what I should be doing.

As a summary question on this topic, we asked interviewees what they would like to share with non-Natives about the importance of our water resources if they had the opportunity to do so. Many interviewees, as indicated by the passage below, emphasized the importance of cultural identity, traditional worldviews regarding the inter-connectedness of all life, and the importance of thinking about future generations:

> I think the biggest thing is that water is a really big part of who we are. Don't take that away from us. Don't foul up our water. Don't kill our fish. I think most people don't have the same kinds of connections to the world around them that we do. I know some do, but I don't think it's as big of a part of who they are. I think that's why they don't think as much as we do about future generations, because they don't become part of their environment the way we do. They don't have the same attachment. But we do. This part of the world, with all the water we have, this is our traditional country and even though it's not all ours anymore, it's still a part of us. Just be respectful and thankful and take care of it so it's there for all of us.

We also asked interviewees if they felt that traditional Anishinaabe values regarding water are still being expressed in the community today. Only one of 17 interviewees confidently replied "yes". Six stated that traditional views are not being followed, with responses that typically included references to disregard on the part of the young generation or comments such as, "we've lost our way." Responses from the remaining 10 interviewees can be described as mixed, with phrasing such as "it depends on the person" or "some people do and some people don't." A key finding is that few interviewees expressed confidence that traditional values and perspectives related to water are still common across the community, despite the fact that concerns for pollution-related issues appears strong.

Theme Three: Few interviewees plan to adopt conservation Steps in the Future.

In this segment of interviews, questions were asked with the goal of inferring a relationship between water-related values and water-related behaviors (with conservation as the example). A key finding in this area is that interviewees provided few straightforward responses when describing their own household water conservation behaviors or plans for potential future conservation.

When asked about current conservation behaviors, responses varied greatly between indoor and outdoor uses of water. The majority of interviewees (nine) provided vague explanations of their own indoor conservation efforts, using phrases such as "I try not to waste it" or "I do what I can" instead of listing tangible examples of conservation behaviors they have adopted. Among those who clearly provided examples of conservation, four explained that their home has water-saving appliances or fixtures, four claimed to take short showers, two said that they limit toilet-flushing, and two said that

they collect and re-use rain water for their gardens. Only one interviewee flatly stated that she does not put forth any effort to conserve. Despite interviewees' lack of details about indoor water use, all 17 interviewees stated that they use very little water for outdoor purposes such as lawn-watering or car-washing:

> You know, I have some flowers that I might have to water every now and then when we don't get enough rain. But besides that, I just don't think we really do much more than that. We get enough rain to keep the grass green and the cars clean so I can probably count on one hand the amount of times I'll even hook up a hose in any year.

Regarding plans for future conservation efforts, responses were again vague overall. Six interviewees expressed interest in conservation strategies but did so only using phrases such as "I'll do what I can" or "I should do better." Eleven indicated that they are already doing what they can to conserve or that they do not know how to use less than they already do – which may be supported by the fact that interviewees use very little water outdoors. Only one interviewee responded with a simple "no" when asked about plans for future conservation.

Interviewees largely shared the impression that most people in the area are not concerned with water conservation. When asked if they think others in the area are doing anything to conserve water, 14 of 17 (83%) responded "no" or "probably not." However, like the interviewee below, many followed with remarks on the abundance of water in the area as a likely explanation for conservation views in the community:

> I just think most people around here are like us -- they don't use a lot of water to start with, but they probably aren't too worried about running out either. I'm no expert but I don't think we have to worry about running out of water. I just think we need to keep clean what we have and we'll be fine. Just be respectful with how much you use and don't pollute it.

Overall, interviewees' responses indicate that water conservation simply is not as salient of a contemporary topic in the community as water pollution. Interviewees appear consistent in their views that water is abundant in the region and that traditional Anishinaabe values regarding water are very important. Results indicate that across interviewees, perhaps the most important stewardship behaviors with water involve preventing the degradation of it, as supported by the widespread concern for pollution (see Table 5) and the abundant comments about pollution-related current issues (e.g., DAPL). Expansion and clarity on these topics is an ideal focus for future research.

Discussion and Conclusion

This research provides several implications for the broader literature on water issues, including potential links between traditional Anishinaabe values and conservation behaviors. Regarding regional planning under the Great Lakes Compact, for example, Indigenous communities may not be ideal targets for conservation if our interviewees' responses are representative of the greater Indigenous population (Great Lakes-St. Lawrence River Basin Water Resources Compact, 2008). We found very limited instances of outdoor water use, which can be among the most consumptive of household water uses. Another common response among interviewees was that they "don't know how to use less water than they already do", again supporting the notion that water managers might be wise to look elsewhere for conservation targets. Despite these intriguing findings, however, the

author suggests a cautious interpretation considering the research methodology used and the possibility for alternate explanations to interviewees' conservation behaviors.

Applications of the Theory of Planned Behavior

The sample size of this research does not support analyses of demographic patterns in terms of water use, but the rich findings can provide foundational insight for follow-up studies based on the TPB. For example, interviewees' attitudes toward water conservation could likely be described as positive, which would support pro-conservation behaviors. However, interviewees' limited plans for future conservation could be explained by the findings that 1) perceived control (i.e., perceived ability to conserve) appears low because most interviewees already use little water, and 2) perceived norms regarding water conservation appear low as the majority of interviewees believe few others in the area are specifically taking steps to conserve. According to the literature, the lack of perceived control and perceived conservation norms could out-weigh positive attitudes towards conservation and therefore limit intentions to conserve (Ajzen, 1991; Clark & Finley, 2007; Fishbein & Ajzen, 2010; Trumbo & O'Keefe, 2001). Thus, this research is aligned with that of others.

Follow up Research on Contemporary Values

Regarding traditional Anishinaabe culture, the majority of interviewees appear familiar with traditions, stories, and values related to water and consider sacred as described by many authors (Benton-Banai, 1988; Danziger, 1979; Densmore, 1979; Johnston, 1976; Kimmerer, 2013; Reynolds, 2013). Interviewees tended to share the most wide-ranging and personal insights in response to questions about traditional water-related values, citing many traditional stories and ceremonies that are part of Anishinaabe cultural identity. Combined with the frequency and variety of water-related activities, water certainly does appear to greatly influence day-to-day lifeways among interviewees.

The extent to which interviewees perceive traditional water-related values to exist today is less clear. The majority of interviewees indicated limited confidence that traditional ways are being followed as strongly as in previous generations. Clarity on this question is advised for potential follow-up research, possibly through a survey instrument with a larger sample size and a limited choice of responses. It is noteworthy, however, that a majority of interviewees expressed the "water is life" sentiment (or similar), reflecting wider Indigenous environmental movements such as the response to the Dakota Access Pipeline construction (LaDuke, 2017; Whyte, 2017).

Links between Values and Behaviors

The final research question involves a potential link between values and behaviors that could be quantifiable in follow-up research. Based on the literature, a likely hypothesis would state that individuals expressing strong water-related values would be the most inclined towards household water conservation (Ajzen, 1991; Babbie, 1995; Fishbein & Ajzen, 2010). Interview findings provide intriguing insight on this question. An initial review of interview transcripts shows that few people intend to conserve water and therefore perhaps there is no link between values and behavior. However, a closer examination shows that the reason for limited conservation intentions appears to be that interviewees are already using little water to begin with. Therefore, no conclusion can confidently be drawn from these findings, which again welcomes follow-up efforts to clarify using a longer and more in-depth interview process. Follow-up research might also benefit from an increased emphasis on the topic of pollution as an example of a water-impacting behavior, since 14 of 17 interviewees discussed pollution topics without specifically being prompted.

Limitations of Research

Findings from this research are limited by several considerations, including the relatively small sample size (n=17) and the inability to infer that responses are representative of the broader community. The average interview length of 26 minutes may be considered short by some researchers, although we found interviewees to elaborate as hoped on questions related to traditional values, contemporary lifeways, and conservation, which were the focus of the research. Nonetheless, findings serve as an intriguing foundation for follow-up studies and also provide valuable additions to the literature on water resource perspectives from community voices not often included in the scientific literature. Repeating this work across numerous Great Lakes Anishinaabe communities could yield more powerful findings that policy-makers and water resource managers would be advised to review.

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FACTORS THAT INFLUENCE THE PERSISTENCE OF NATIVE AMERICAN STUDENTS AT TRIBAL COLLEGES AND UNIVERSITIES

Kyndra Butler and Ahmed Al-Asfour
Oglala Lakota College

The objective of the study was to determine which primary variables in Vincent Tinto's 1987 Model of Student Departure had the greatest influence on the persistence of Native American students who attend Tribal Colleges and Universities. The findings from the study revealed that five major primary factors influenced persistence among Native American college students. The factors included: Pre-entry Attributes, Goals and Commitments, Institutional Experiences, Regulatory Personal Integration, and Goals and Commitments.

Keywords: student departure, Native American, higher education, persistence, retention

Introduction

Despite a growing body of literature in Native American studies in higher education, scholars and educational administrators currently have limited understanding of Native American students in higher education in the areas of retention, persistence and competition. Prior to the mid-1960s, higher education at public and private colleges and universities in mainstream America did not meet the needs of Native American students. Guillory and Wolverton (2008) stated that "mainstream colleges and universities have struggled to accommodate American Indians and create environments suitable for perseverance resulting in degree completion" (p.58). The current context of higher education continues to underserve Native American students, resulting in ongoing challenges toward degree completion (Al-Asfour & Abraham, 2016).

Ogunwole (2002) reported that Native Americans comprise one percent of the nation's population; similarly about one percent students enrolled in institutions of higher education are Native American (National Center for Education Statistics, 2017). While the enrollment percentages mirror the population, persistence rates for Native American students are low. One report indicated that 85% of American Indians who begin college never complete (Tierney, 1992). More recent enrollment numbers for Native American students have increased to a level that is nearly an over representation, yet they persist in higher education at the lowest rate of all minorities (Larimore & McClellan, 2005). Studies that focus solely on the factors and barriers that contribute to the persistence and completion rates for this population find that these rates are considerably less for Native American students than for students who identify with other racial/ethnic groups (Al-Asfour & Abraham, 2016; Tierney, Sallee, & Venegas, 2007). The research presented in this paper aims to better understand factors that influence Native American student persistence in higher education.

Persistence Factors for Native Americans

The literature reveals that some persistence factors among Native American college students are central and specific to particular tribal nations and the location of those nations (Al-Asfour & Abraham, 2016; Huffman & Still, 1986). Al-Asfour and Abraham (2016) conducted a literature

review study on strategies for retention, persistence and completion rate for Native American students in higher education. The study found six factors that positively impact students' success in higher education: mindset, culture and spirituality, family support, quality interactions with faculty, mentoring, and student engagement.

A study of Sioux tribal students attending a college in South Dakota revealed that retention of Native cultural traditions may contribute to higher educational success (Huffman & Still, 1986), therefore, supporting culture capital and enculturation. A similar study was conducted at the University of Alaska Fairbanks that supported the idea of allowing Alaska Natives to hold on to cultural identity resulted in greater persistence and academic success (Barnhardt, 1994). Another study acknowledged the fact that not all tribal nations have the same characteristics and revealed that reservation and non-reservation students have different needs and concerns (James, 1992). While these studies may seem outdated, more recent studies (Al-Asfour & Abraham, 2016; Ambler, 2009; HeavyRunner & DeCelles, 2002) reaffirm the findings.

A study conducted at the University of New Mexico (UNM) revealed that the most important influences on successful completion of baccalaureate degrees identified by Native American graduates were family relationships; primarily psychological and financial support from immediate and extended family (HeavyRunner & DeCelles, 2002). Personal motivation, dedication, friends, teachers and counselors also contributed to persistence toward graduation. UNM serves many tribally affiliated students that include Apaches, Pueblos, and Navajos. To increase the participation rate of students as well as increase the persistence to graduation rate, administrators implemented a Native Task Force that identified specific problems and formulated recommendations in the areas of curriculum and testing, financial aid, student developmental academic programs, and overt institutional commitment (Al-Asfour & Abraham, 2016). The variables, student academic programs, institutional commitment, curriculum and testing and financial aid were found to be significant, however, maintaining cultural identity or heritage to influence persistence was not mentioned (Guillory & Wolverton, 2008). Some of these variables are discussed in the next section.

Theoretical Framework

An important factor in explaining persistence towards degree completion is that students benefit from a supportive environment (Love, 2009), and there are several factors that influence persistence among Native American students specifically. Tinto (1975) developed an important model concerning student withdrawal that suggests, "Withdrawing from college is like withdrawing from society, or in effect, is like committing suicide" (Tinto, 1975, p. 4). The model maintains that students who withdraw from college have failed to integrate either academically or socially in a college environment (Tinto, 1975). Even though this model has not been used in measuring persistence among Native American students, it was used for other minority groups such as African American and Hispanic students (Yeager & Walton, 2011). Tinto's (1993) Model of Student Departure employed malleable factors other than fixed traits (e.g. sex, age). Such malleable factors include institutional experience and integration (personal and normative), such as belonging, that seem to be responsive to support campus environments and psychological interventions (Strayhorn, 2012; Yeager & Walton, 2011).

Subsequent to thorough review of different theoretical models, the researchers deemed that Tinto's Model of Student Departure was the most suited to employ in this study. Tinto's (1987) model

identified five primary variables that influence student departure/persistence. The factors included: pre-entry attributes, goals and commitments, instructional experiences, regulatory personal integration, goals and commitments. Based on these variables, Tinto's model further explained that pre-entry attributes – family background, skills and abilities, prior schooling – inform the creation of goals and commitments, intentions as well as institutional commitments that are tested by institutional experiences, academically (academic performance and faculty interactions) and socially (extracurricular activities and peer interactions). Those institutional experiences then influence the regulatory personal integration – academic and social – of the students. Integration then influences the creation of the second set of goals and commitments –intentions as well as institutional commitments – that are also affected by external commitments, and this leads to the decision to either depart or persist.

For the sake of this study, the researchers utilized Tinto's 1987 model of Institutional Departure, which has been adapted from the 1975 version. Pavel and Banks (2001) have validated Tinto's (1987) model in relation to Native American students. Figure 1 summarizes this model.

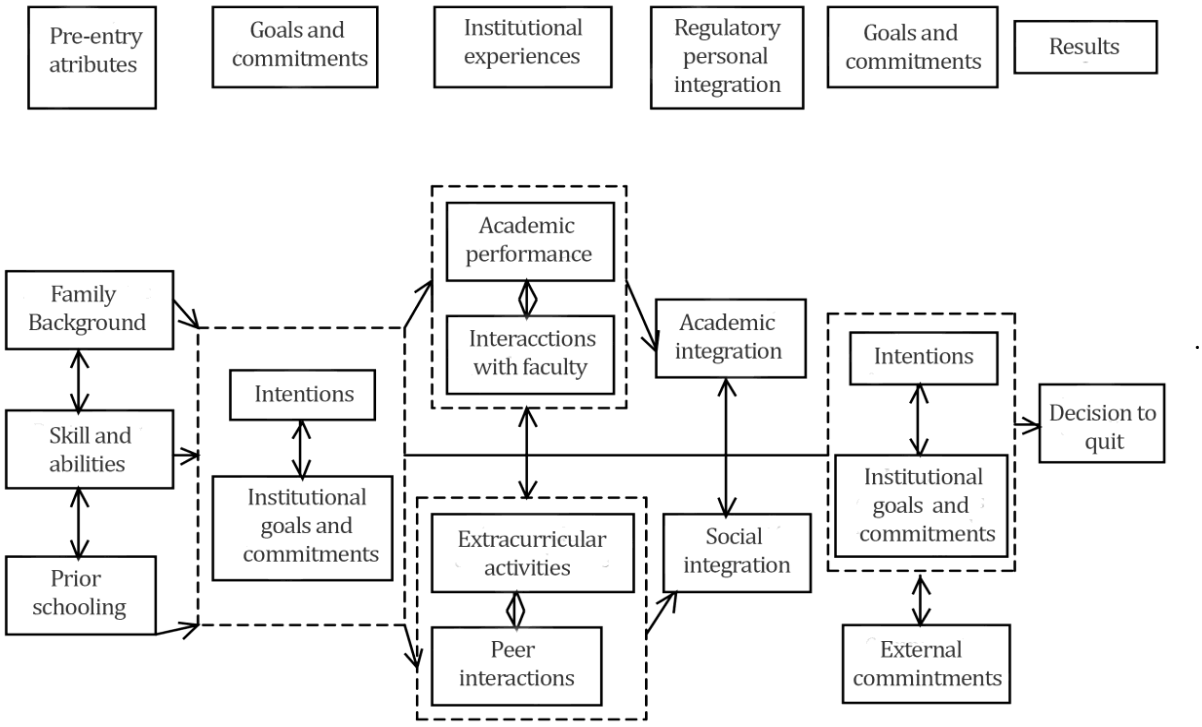

Figure 1. Tinto's Model of Institutional Departure. Tinto's Model (1987) Adapted from Tinto (1975): A longitudinal Model of Institutional Departure.

Research Question

This study analyzed the variables that influence the persistence of Native American students who attend Tribal Colleges and Universities (TCUs). The purpose of this study was to determine which of the primary variables (pre-entry attributes, goals and commitments (1), institutional experiences, regulatory personal integration, goals and commitments (2)) in the selected theory have the greatest influence on the persistence of Native American students who are enrolled at TCUs.

The research question guiding this study was: *Which of the variables that also correlate with Vincent Tinto's Model of Student Departure and derived from the College Persistence Questionnaire are most significant in the persistence of Native American students at Tribal Colleges and Universities?*

Methodology

Population and Sample

Traditional and nontraditional Native American students attending one of two TCUs in the Midwest region of the United States comprises the sample for this study. The first institution utilized in this study (Institution A) was a four-year, public tribal college. The enrollment was approximately 1,366 students, including 1,330 undergraduate students. Of the total population, 39% were part time students and 61% were full time; approximately 67% were female and 33% were male (National Postsecondary Student Aid Study, 2015-2016). The second institution utilized in this study (Institution B) was a private, not-for-profit two-year tribal college that had been declared a land-grant institution. The total enrollment (excluding transfer students) per semester was approximately 132 full and part time students, which equated to approximately 264 students per academic year and a student-to-faculty ratio of seven to one. Of the total student population, 48% attended part-time, and 52% attended full time. The percentage of females enrolled was 61.4% and percentage of males enrolled was 38.4%, Enrollment by race/ethnicity was 88.2% Native American, 6.3% African American, 3.9% White and 1.6% unknown (National Center for Education Statistics, 2015).

The sample in this study included undergraduate students who were enrolled freshman and re-enrolled sophomores from each participating institution. The enrolled freshman in the 2013 (fall) academic year and the re-enrolled sophomore students were enrolled as freshman in fall 2014 and subsequently re-enrolled in spring 2015 as sophomores. The re-enrolled sophomore students had completed a full academic year. The sample included 44 participants from institution A and 14 participants from institution B, for a total of 58 participants.

Instrumentation

The instrument that was utilized for this research study was the College Persistence Questionnaire (CPQ), which enabled users to: (a) identify students at risk of dropping out; (b) discover why an individual student is likely to discontinue his or her education, and (c) determine variables that best distinguish undergraduates who will persist from those who will not persist at their institutions. The survey included 32 questions that measured student responses based on questions that pertained to institutional characteristics and student experiences. The statistical instrument was validated in the August, 2009 issue of *The Journal of College Student Development* (Grisaffe, Davidson, & Beck, 2015).

These variables that distinguished persistence from non-persistence are listed in sequence: (1) pre-entry attributes, (2) goals and commitments (a), (3) institutional experiences, (4) personal/normative integration, and (5) goals and commitments (b). Each variable within Vincent Tinto's 1987 Model of Student Departure and Persistence contained ten sub-variables: academic integration, motivation to learn, academic efficacy, financial strain, social integration, collegiate stress, advising effectiveness, degree commitment, institutional commitment, and scholastic conscientiousness. The dependent variable in this study was persistence (Pascarella, Terenzini, & Wolf, 1986). All variables, as represented by survey items, were analyzed without differentiation

based on any hypothesized independent-dependent relationships among them. The variables and sub-variables are depicted in Table 1.

Table 1
Variables indicated in Vincent Tinto's Model of Student Departure & College Persistence Questionnaire.

Pre-Entry Attributes	Goals & Commitments (1)	Institutional Experiences	Integration	Goals & Commitments (2)	*Outcome: Depart or Persist*
Academic Efficacy	Motivation to Learn	Collegiate Stress	Academic Integration	Institutional Commitments	
	Advising Effectiveness	Financial Strain	Social Integration	Degree Commitment	
				Scholastic Conscientiousness	

Data Analysis

Data analysis, performed by the researchers using SPSS data analysis software, consisted of all relevant descriptive and inferential statistics and tests including Regression. As recommended by Creswell (2008), the data was analyzed for reliability and validity. Several limitations for inferences may exist. First, the population consisted of TCUs that may be distinctly different in many respects from mainstream colleges and universities in the U.S. Therefore, the results obtained from TCUs may not be generalized to non-tribal colleges and universities. Second, although a census sample of three TCUs was intended in this study, not all TCUs chose to participate in the study. One tribal college did not grant access to their students for the survey. Third, the participating TCUs were quite small in terms of enrollment, and the resulting sample sizes were proportionately small.

The statistical tool used in this study is Multiple Linear Regression, which allowed the researchers to examine how multiple independent variables were related to a dependent variable. The rationale of using the tool was to take information pertaining to all the independent variables and use it to formulate a more accurate prediction about why things were the way they were. The strength of each variable was also tested using Multiple Regression. Incorporating a Linear Regression enabled the researcher to make predictions about variable "Y" based on knowledge about variable "X." The general purpose of multiple regressions was to learn more about the relationship between several independent or predictor variables and a dependent variable or criterion variable.

Findings

The objective of this study was to determine which primary variables in Tinto's (1987) Model of Student Departure had the greatest influence on the persistence of Native American students who attended TCUs. In this section, the researchers present the findings of this study.

Instrument Recoding

Each factor was recoded to represent and explain hierarchy in scale. An important benefit of a factor analytic approach is that the formation of psychometrically credible scales often clarifies the relationship among variables. Depending on the content of the question, responses were converted to 5-point favorability scores based on whether the response indicated something positive or negative about the student's collegiate experience: 5(2) = very favorable, 4(1) = somewhat favorable, 3(0) = neutral, 2(-1) = somewhat unfavorable, 1(-2) = very unfavorable. (Verbal labels were taken into consideration for response scales. Ex. "how satisfied", "very satisfied", "very dissatisfied".)

Descriptive Statistics for Benchmarks and College Persistence Questionnaire Items

Tables 2 (Institution A) and 3 (Institution B) provided the sample mean and standard deviation for each of the 32 survey questions that reflected the nine variables, which included, academic integration, motivation to learn, academic efficacy, financial strain, social integration, collegiate stress, advising effectiveness, degree commitment, institutional commitment, and scholastic conscientiousness. All responses were coded using a 5-point Likert Scale.

Using codes for each response, researchers ran descriptive statistics in SPSS to generate the mean and standard deviation for each question under each factor. As depicted in Table 2, the question "How confident are you that this is the right college or university for you?" had the highest mean score for the Institutional Commitment factor (M = 16.11; SD = 2.599), while the question "How much pressure do you feel when trying to meet deadlines for course assignments?" had the lowest mean score for the collegiate stress factor (M = 8.14; SD = 2.699).

Table 2
Descriptive Statistics for Institution A (4-year University)

N = 44	*M*	*SD*
Persistence	1.57	0.501
Academic Integration	11.93	2.564
Motivation to Learn	11.66	2.123
Academic Efficacy	12.20	1.936
Financial Strain	9.77	3.556
Social Integration	10.45	2.267
Collegiate Stress	8.14	2.699
Advising Effectiveness	11.05	3.840
Degree Commitment	13.57	1.500
Institutional Commitment	16.11	2.599
Scholastic Conscientiousness	12.18	2.375

Table 3, Institution B, indicated the greatest mean score in the institutional commitment factor (M = 17.21; SD = 1.888), while collegiate stress had the lowest mean score (M = 9.43; SD = 2.738). The academic integration factor depicted in College Persistence Questionnaires (CPQ) "How would you rate the quality of education you are receiving at your institution?" had M 11.71 with the standard deviation of SD= 1.637.

Table 3

Descriptive Statistics for Institution B (2-year Community College)

N = 14	*M*	*SD*
Persistence	1.57	0.514
Academic Integration	11.71	1.637
Motivation to Learn	11.43	2.027
Academic Efficacy	13.07	1.685
Financial Strain	11.21	4.594
Social Integration	10.50	2.902
Collegiate Stress	9.43	2.738
Advising Effectiveness	10.79	2.833
Degree Commitment	14.29	1.204
Institutional Commitment	17.21	1.888
Scholastic Conscientiousness	12.21	2.547

Multiple Regression Results

Pearson correlation tests were created for each factor to examine the inter-correlations. Multiple Regression tests were conducted to examine how the independent variables (academic integration, motivation to learn, academic efficacy, financial strain, social integration, collegiate stress, advising effectiveness, degree commitment, institutional commitment, and scholastic conscientiousness) were related to the dependent variable (persistence). A Pearson correlation was run to evaluate the relationship among the CPQ factors to answer the research question. Significant correlations between the ten factors to persistence and to each other were observed.

In Table 4 (Institution A), academic integration and advising effectiveness shared the strongest relationship with a numerical correlation of 0.681. Advising effectiveness and institutional commitment shared a strong relationship with a numerical value of 0.617. There was a strong relationship between degree commitment and institutional commitment at Institution A with a value of 0.597. Contrarily, the variables social integration and degree commitment shared the weakest relationship with a value of -0.002. Social integration and collegiate stress indicated a numerically weak correlation with a value of -0.022. Academic efficacy and social integration also shared a weak relationship with a numerical value of -0.085. Persistence and academic integration indicated a positive relationship; however, the relationship was not numerically strong, 0.031.

Table 4

Pearson's Correlation Test for Each Variable (Institution A)

Pearson's Correlation	P	AI	ML	AE	FS	SI	CS	Adv. Eff	DC	IC	SC
Persistence	1	0.031	0.055	0.189	0.113	0.115	0.096	0.131	0.179	0.164	0.224
Academic Integration		1	0.265	0.434	0.309	0.218	0.499	0.681	0.452	0.549	0.098
Motivation to Learn			1	0.125	0.048	0.260	0.057	0.184	0.150	0.226	0.156
Academic Efficacy				1	0.294	-0.085	0.498	0.384	0.439	0.379	0.224

Pearson's Correlation	P	AI	ML	AE	FS	SI	CS	Adv. Eff	DC	IC	SC
Financial Strain					1	-0.099	0.495	0.268	0.430	0.350	-0.182
Social Integration						1	-0.022	0.334	-0.002	0.232	0.222
Collegiate Stress							1	0.513	0.474	0.528	0.163
Advising Effectiveness								1	0.262	0.617	0.428
Degree Commitment									1	0.597	0.114
Institutional Commitment										1	0.155
Scholastic Conscientiousness											1

Note. Inter-correlations in factor-variables for Institution A (n =44) are presented above the 1. P = persistence, AI = academic integration, ML = motivation to learn, AE = academic efficacy, FS = financial strain, SI = social integration, CS = collegiate stress, Adv. Eff. = advising effectiveness, DC = degree commitment, IC = institutional commitment, SC = scholastic conscientiousness

Table 5 indicates the strength of relationships of the independent variables for Institution B. Academic integration and advising effectiveness had the strongest relationship, 0.732. Collegiate stress and advising effectiveness shared a strong correlation, 0.638 and academic integration and institutional commitment shared a correlation with a value of 0.593. The weakest relationship was motivation to learn and financial strain at 0.039. There was also a weak correlation between degree commitment and scholastic conscientiousness, 0.048 and institutional commitment and scholastic conscientiousness with a numerical value of 0.054. Persistence and academic integration indicated a positive relationship; however, the relationship was not numerically strong, 0.026.

Table 5

Pearson's Correlation Test for Each Variable (Institution B)

Pearson Correlation	P	AI	ML	AE	FS	SI	CS	Adv. Eff	DC	IC	SC
Persistence	1	0.026	-0.253	0.038	-0.056	*0.516*	-0.297	-0.068	-0.036	0.102	-0.160
Academic Integration		1	-0.238	0.482	0.448	0.049	0.476	0.732	0.201	0.593	0.256
Motivation to Learn			1	-0.257	0.039	0.248	-0.341	-0.344	0.261	0.255	-0.123
Academic Efficacy				1	0.127	-0.259	0.493	0.245	0.368	0.237	0.534
Financial Strain					1	-0.107	0.157	0.341	0.475	0.402	-0.215
Social Integration						1	-0.339	0.248	0.286	0.386	0.172
Collegiate Stress							1	0.638	0.287	0.219	0.559
Advising Effectiveness								1	0.357	0.412	0.476

Pearson Correlation	P	AI	ML	AE	FS	SI	CS	Adv. Eff	DC	IC	SC
Degree Commitment									1	0.377	0.480
Institutional Commitment										1	0.054
Scholastic Conscientiousness											1

Note. Inter-correlations in factor-variables for Institution B (n =14) are presented above the 1. P = persistence, AI = academic integration, ML = motivation to learn, AE = academic efficacy, FS = financial strain, SI = social integration, CS = collegiate stress, Adv. Eff. = advising effectiveness, DC = degree commitment, IC = institutional commitment, SC = scholastic conscientiousness.

Coefficients Results and ANOVA Summary

The coefficients in Table 6 for Institution A indicated the significance of each factor independently. Levels of significance ($p < .05$) in the coefficient table were tested to determine the extent in which each factor significantly contributed to the multiple regression model. Each of the ten factors indicated a p value of .359 or greater. There were no numerically significant factors.

Table 6

Coefficients for Institution A

	UC		SC			Correlations		
Model	B	Std. Error	Beta	T	Sig.	Zero-order	Pt	Pt
(Constant)	-.047	.981		-.048	.962			
Academic Integration	-.031	.052	-.159	-.590	.559	.031	-.102	-.096
Motivation to Learn	-.004	.042	-.018	-.100	.921	.055	-.017	-.016
Academic Efficacy	.041	.053	.158	.767	.448	.189	.132	.125
Financial Strain	.020	.030	.142	.666	.510	.113	.115	.109
Social Integration	.027	.042	.122	.643	.524	.115	.111	.105
Collegiate Stress	-.015	.044	-.083	-.354	.725	.096	-.062	-.058
Advising Effectiveness	-.002	.042	-.017	-.053	.958	.131	-.009	-.009
Degree Commitment	.031	.083	.094	.381	.706	.179	.066	.062
Institutional Commitment	.016	.051	.084	.314	.755	.164	.055	.051
Scholastic Conscientiousness	.043	.046	.203	.930	.359	.224	.160	.152

Note: Dependent Variable: Persistence, Pt = Partial, UC = Unstandardized Coefficient, SC = Standardized Coefficient.

The coefficients in Table 7 for Institution B indicated the significance of each factor independently. Of the ten factors, social integration was the only factor with statistical significance. The level of significance for factor Social Integration, $p < = .019$.

Table 7

Coefficients for Institution B

Model	UC	SC				Correlations		
	B	Std. Error	Beta	T	Sig.	Zero-order	Pt	Pt
(Constant)	1.496	1.396		1.071	0.363			
Academic Integration	0.132	0.120	0.421	1.104	0.350	0.026	0.538	0.169
Motivation to Learn	-0.107	0.060	-0.424	-1.778	0.174	-0.253	-0.716	-0.272
Academic Efficacy	0.180	0.097	0.592	1.867	0.159	0.038	0.733	0.285
Financial Strain	0.034	0.038	0.306	0.910	0.430	-0.056	0.465	0.139
Social Integration	0.335	0.072	1.892	4.667	0.019	0.516	0.938	0.713
Collegiate Stress	0.202	0.078	1.076	2.583	0.082	-0.297	0.831	0.395
Advising Effectiveness	-0.219	0.083	-1.210	-2.630	0.078	-0.068	-0.835	-0.402
Degree Commitment	-0.062	0.153	-0.145	-0.406	0.712	-0.036	-0.228	-0.062
Institutional Commitment	-0.183	0.088	-0.671	-2.079	0.129	0.102	-0.768	-0.318
Scholastic Conscientiousness	-0.164	0.073	-0.814	-2.234	0.112	-0.160	-0.790	-0.341

Note: Dependent Variable: Persistence, PT = partial, UC = Unstandardized Coefficient, SC = Standardized Coefficient

In Tables 8 and 9 the F ratio and level of significance were analyzed to define the degree to which the factors had significance in predicting the dependent variable. To determine the amount of variance in the dependent variable, persistence, the Sum of Squares or R^2 was used. In Institution A, the significance level for factors was .910. The significance level for factors at Institution B was .141.

Table 8

Analysis of Variance for Institution A

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	1.294	10	0.129	0.449	.910[b]
	Residual	9.502	33	0.288		
	Total	10.795	43			
2	Regression	0.000	0	0.000		
	Residual	10.795	43	0.251		
	Total	10.795	43			

Table 9
Analysis of Variance for Institution B

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	3.189	10	0.319	3.985	.141[b]
	Residual	0.240	3	0.080		
	Total	3.429	13			
2	Regression	0.000	0	0.000		
	Residual	3.429	13	0.264		
	Total	3.429	13			

Summary, Recommendations, and Conclusions

Vincent Tinto initially introduced the Model of Persistence and Student Departure in 1975, and later presented an adapted version of that same model in 1993. The model remains a major theoretical framework of reference for higher education institutions across the nation (Association for the Study of Higher Education (ASHE)-Education Resource Information Center (ERIC), 2004). There continues to be alarming concern in higher education, particularly within TCUs, of the low rates of academic success, persistence and graduation, of Native American students. This study contributed to the paucity of research in the areas of retention, persistence and completion rate of Native American students in higher education by adding critical knowledge to the field of higher education at TCUs. The findings highlighted the importance of pre-entry attributes, goals and commitments, institutional experiences, regulatory personal integration, and goals and commitments to Native American student success in higher education.

Although the percentage of Native American students represents a small sample of post-secondary educated individuals, the final and most immediate set of influences in shaping student persistence includes students' own experiences in various areas of their academic and nonacademic lives (Pascarella & Terenzini, 2005). The issue of persistence resonates currently, especially among Native American students and TCUs. In 2011, the National Center for Education Statistics reported that 35% of Native American students faced four or more risk factors that directly affect their persistence to completion as compared to the 22% of undergraduate students overall. Only about 35% of first-time, full-time, Native American students who planned to earn their bachelor's degree reached their goal within four years; 56% achieve it within six years (National Postsecondary Education Cooperative, 2006). The following section offers a further discussion and analysis of findings from this study.

Discussion and Analysis of Findings

The information contained in the data and derived from the analysis have been integrated with the research question of this study to provide rich understandings of the variables and sub-variables that pertained to Native American students and persistence at TCUs. The findings in the composite analysis revealed that sub-variable, social integration, was the strongest factor in correlation with the dependent variable, persistence. Of the ten factors presented in the CPQ and of the five primary

variables within Vincent Tinto's Model of Student Departure, social integration, in isolation had statistical significant strength in correlation to student persistence.

Findings were not applicable in indicating exactly what factors directly influenced persistence significantly. The analysis indicated that of the ten variables, none were significant in predicting persistence; nevertheless, the analysis did show the inter-relationship between the factors themselves. Pascarella and Terenzini (2005) documented that a thorough study of persistence required a complicated research design that can explicate not only the direct relationships of each constellation of variables on persistence, but also how the interactions between the constellations affected persistence. The analysis of this study revealed that Institution B, a Tribal community college with small enrollment, shared a positive significance in social integration and persistence as compared to Institution A, a 4-year Tribal University with a much larger enrollment.

In a previous research study conducted by Pascarella and Terenzini (2005), Native American students and other minority groups who attended community colleges that were strategically designed for them and their cultural preservation often overlooked the importance of out-of-class experiences, which meant that social integration was neglected as it pertained to persistence or the intent to persist. In this study, the students who attended Institution B, a community college located in a rural area of the Midwest, indicated responses that placed value on the importance of socially integrating into the collegiate environment and/or climate. The factor was found to have a high level of significance to the variable persistence. Taken together, this body of research provided some evidence that links students' classroom experiences to persistence (or at least, intent to persist). Active forms of teaching increased student social integration and commitment to an institution, two factors understood to be directly related to increases in the likelihood that a student will persist. Pascarella and Terenzini (2005) documented that the greater the student engagement and participation in college activities, as measured by time and effort put into educationally purposeful activities, the more likely the student would be to persist.

Sub-variables derived from the CPQ such as academic integration and advising effectiveness in the current study were determined to be statistically significant predictors of persistence in correlation within the two variables only, and both variables were significant findings in both institutions. The findings in research studies conducted by Anaya and Cole (2001) and Tinto (1998) corroborated the findings in this study. The authors and their research suggested that faculty-student interaction and high-quality instruction were reliable and viable predictors of academic integration and persistence. The findings revealed that factor-variables, academic integration and advising effectiveness shared a strong relationship with significant probability values, but provided deficient evidence of significant values in predicting the actual dependent variable, persistence. Larimore and McClellan (2005) found that frequent and varied interactions with faculty in academic contexts among Native American students at TCUs could positively influence academic integration. Similarly, the study concluded that Native American students who earned good grades in college felt a stronger intent to persist academically, and opportunities for Native American students to engage with faculty and staff members at an academic level in areas such as mentoring and advising led to higher rates of students in higher education (Larimore & McClellan, 2005).

In contrast, the factor/sub-variable social integration in relationship to degree commitment in institution A, was found to be one of the weakest correlations. Findings indicated that although social integration and degree commitment may be important factors in predicting persistence

independently, the relationship between the two variables was statistically weak. Demonstrated through CPQ item, "After beginning college, students sometimes discover that a college degree is not quite as important to them as it once was. How strong is your intention to persist in your pursuit of the degree, here or elsewhere?" Many of the students participating in this study from institution A, answered "neutral". These findings were inconsistent with prior research conducted by Al-Asfour and Abraham (2016) who documented that students who have a high degree commitment tend to be more likely to persist than students who see little value in a college degree. Foundational studies regarding Native American students in higher education reported that due to the community and cultural connections, students who had favorable experiences and support were often influenced positively in their decision to persist (Boyer & Martin, 1997; 2005).

Findings of this research revealed collegiate stress and advising effectiveness to be factors with weak correlations. Both sub-variables had little significance in influencing the dependent variable persistence and a statistically weak relationship between the two. Students, who were pursuing an associate's degree from institution B, answered CPQ item "Students differ quite a lot in how distressed they get over various aspect of college life. Overall, how much stress would you say that you experience while attending this institution?" While their responses varied, findings revealed that many students answered "some stress" to this item.

Recommendations Based on Results

The composite factor/sub-variable and primary variable found to be the strongest predictor in influencing persistence in Native American students who attended Tribal Colleges and Universities (TCUs) was social integration (integration, primary variable 4). Benchmarks in this factor found to be significant were: "How much do you think you have in common with other students here?", "How much have your interactions with other students had an impact on your personal growth, attitudes, and values?", and "How much have your interactions with other students had an impact on your intellectual growth and interest in ideas?".

Because of these findings, a closer look at the role of student environments within different institutional settings, specifically, TCUs is recommended. Native American students who attend TCUs should continue to participate in comprehensive orientation programs, mentoring groups, community volunteering and other programs that enhance and nurture the campus climate and how students engage and experience it. The researchers also recommend that students participate in a persistence questionnaire upon entry to the institution along with an initial survey of extra-curricular activity interest. Additionally, administrators, faculty and staff should continue to implement best practices and strategies focused on social integration and the importance of linking social and academic integration with the intent to persist.

Results from this study indicated that both institutions shared a strong correlation among the academic integration and advising effectiveness sub-variables which aligned with Tinto's primary variables 2 and 4, goals and commitments (1) and integration. The findings in this study made clear that institutions of higher education must provide an academic environment that prompts conducive learning, evaluative feedback, and quality instruction with the continued preservation of culture and heritage. Administrators should continue to infuse and encourage positive relationships between faculty and students. The authors of this study recommend the exploration of the role of organizational behavior that may provide administrators broad insight into how it influences student

persistence. Administrators at TCUs may be able to gage which institutional policies and practices can create student environments that encourage persistence.

Conclusion

Tribal colleges and universities (TCUs) have served and continue to serve as pillars of support for Native American students' educational pursuits, culture and community. This study, on the factors that influence the persistence of Native American students at TCUs, provided some insight of the factors that predict and lead to their persistence. Some findings in this study supported Vincent Tinto's (1987) Model of Student Departure showing statistical significance in integration (social, academic), and goals and commitments (advising effectiveness). TCUs should continue to support their students in the efforts to persist by considering all measures possible.

There were some limitations to the study to be noted. First, this study only included students from two institutions. Second, the selection of two very different tribal institutions, along with results of the factorial analysis provided modest evidence that these results may be generalizable. Third, one of the most severe problems faced by researchers examining Native American contexts was small sample sizes. While it is possible for a sample of 1,000 individuals to represent an entire country with high accuracy, Native Americans constitute only 8.8 percent of the U.S. population so the national random sample of 1,000 would be expected to yield about 8 Native Americans (Kuh, Kinzie, Schuh, & Whit, 2005). Another limitation of this research was that the primary source of data was collected by participants completing one survey, the CPQ. The data analysis assumed that participants responded to each question honestly and accurately. Due to the number of participants and respondents, the findings of this study may not be generalized to all Native American undergraduate students at all TCUs.

Although some limitations existed, the findings of primary variables and sub variables in this study provided possible connections to persistence of Native American students and may enable practitioners to recognize the importance of local environments in persistence decisions and can adapt research findings to their local contexts to maximize institutional efforts. TCUs have become another avenue for Native American students to achieve the education they need and deserve. Achieving educational goals and overcoming all obstacles to achieve those goals are often difficult paths to travel. It is our hope that the knowledge and continuous efforts to understand and acknowledge the plight of Native American students, tribes, cultures, communities and higher educational systems be sought after with an eagerness that transcends throughout research history.

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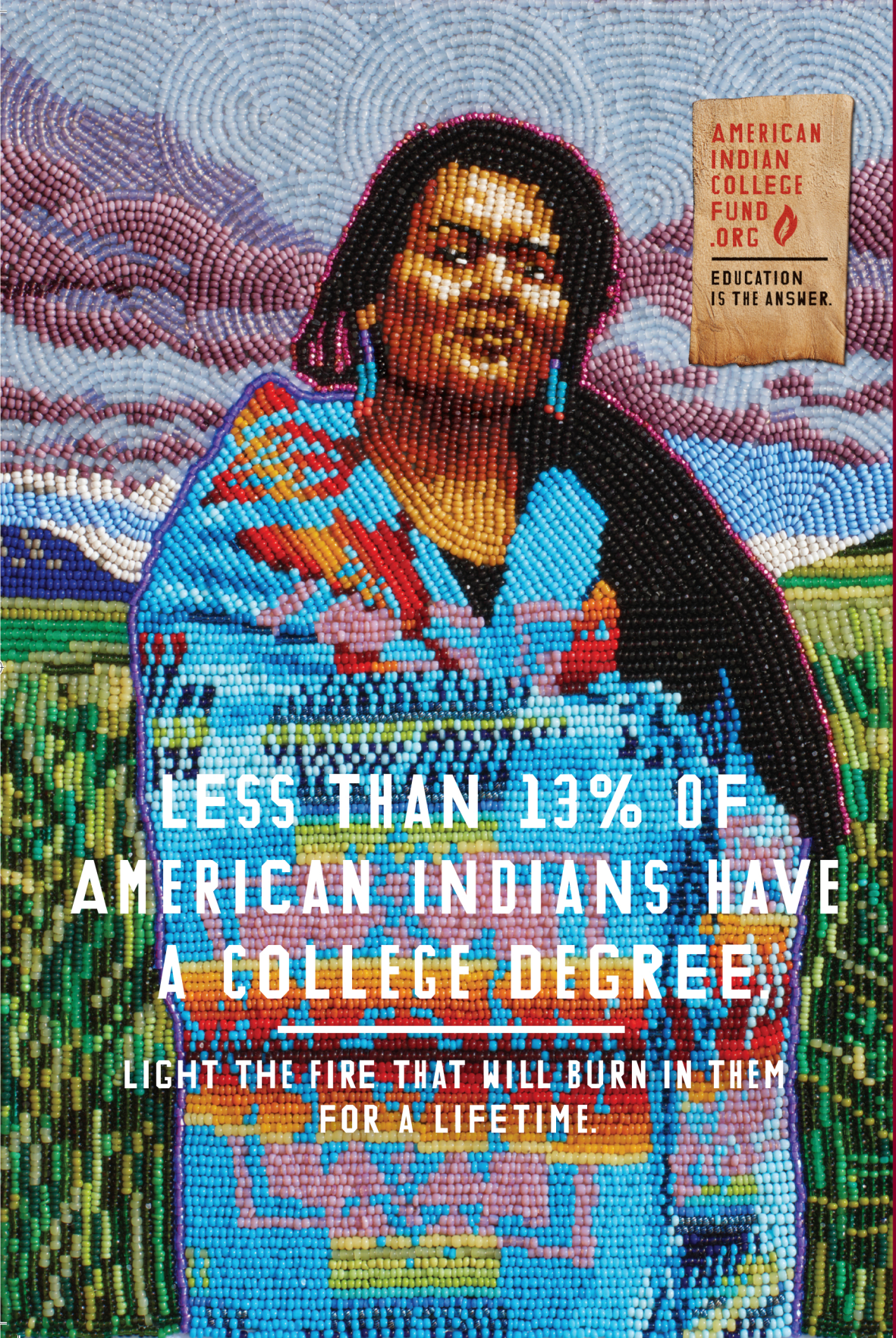

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