

Tribal College and University Research Journal



EDUCATION IS THE ANSWER



Tribal College and University Research Journal

Volume 6, Spring 2022

The Tribal College and University Research Journal is published by the American Indian College Fund, with generous funding from the Henry Luce Foundation. The College Fund believes it is critical to support tribal college and university (TCU) faculty in conducting research that benefits Indigenous communities and disseminating research to both Indigenous communities and the wider research community. Lead authors on manuscripts conducted their research as faculty and staff at TCUs. Manuscripts are reviewed anonymously by an editorial board of Indigenous scholars within a range of academic fields. The journal editors work with authors to prepare manuscripts for publication throughout the submission, review, and revision process.

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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.

TABLE OF CONTENTS

WELCOME..... 1
CHERYL CRAZY BULL, PRESIDENT & CEO, AMERICAN INDIAN COLLEGE FUND

INTRODUCTION.....2
NATALIE YOUNGBULL AND ANNA LEES, EDITORS, TRIBAL COLLEGE AND UNIVERSITY RESEARCH JOURNAL

TECHNIQUES FOR REGENERATING OLD SEEDS..... 6
FRANK KUTKA, SHEILA BLACKMAN, ELIZABETH HOOVER, SARA ALAVI, KATHLEEN WU, AND ROWEN WHITE

CULTURE AS MEDICINE FOR THE BLACKFEET COMMUNITY: A PILOT INTERVENTION.....20
BETTY HENDERSON-MATTHEWS, MEGAN GORDON, SHAWNTYANA BULLSHOE, SIERRA MASON, AGNIESZKA RYNDA-APPLE, AND NEHA HENDERSON

REGENERATION OF CULTURALLY-SIGNIFICANT CONIFER TREE SPECIES IN THE L'ANSE INDIAN RESERVATION: IMPACTS FROM HERBIVORY BY DEER (WAAWAASHKESHI).....32
ANDREW KOZICH, KAREN COLBERT, GERALD (JERRY) JONDREAU, JOHN LUSTY, AND VICTORIA RIPLEY

RECRUITING NATIVE STUDENTS INTO SCIENCE: EVALUATING THE IMPACT OF BIOMEDICAL GENETIC RESEARCH AT TURTLE MOUNTAIN COMMUNITY COLLEGE49
TYLER J. PARIEN, LYLE BEST, PAT CONWAY, AND GENA GRANT

VISION FOR INDIGENOUS HONORS PROGRAMS AT TRIBAL COLLEGES AND UNIVERSITIES ..66
JOSHUA HOSKINSON, EDISON CASSADORE, AND CAMILLUS LOPEZ

WELCOME TO THE TRIBAL COLLEGE AND UNIVERSITY RESEARCH JOURNAL

Cheryl Crazy Bull, President and CEO
American Indian College Fund

Colleagues:

For this edition of the TCURJ, I reflected on what it means for us to support community-based research at TCUs. This past August, I commemorated 40 years of working in the tribally controlled education movement and, thankfully, I am still able to recall early experiences with Tribal faculty, community informants, students, and Tribal leaders where we worked on our understanding of what it means to be tribally controlled. Integrating Native knowledge and pedagogy came naturally to us while we were also in the position of having to navigate western institutions and practices. It created tension about the role of education and how TCUs could impact family and individual identity and prosperity. The tension was about how we could remain true to our identities while using the tools of western society to improve lives. We didn't think much about research - often, in those days, research was driven by external institutions and researchers. While there were places where TCUs engaged in research, it was limited.

The rise of research resources particularly through land-grant programming, environmental and sustainability funding, and an increased desire to support faculty and students voice and skills has dramatically shifted the emphasis on research. The tensions associated with research evolved as we shifted from responsiveness to externalities toward responding to internal (tribal and community) priorities and needs.

There are many pillars of community-based research - one pillar is credibility, another is relevance. Through the College Fund's support of faculty and student research and through our publication of the TCURJ, we are increasing the credibility of place-based, culturally, and tribally relevant research. We are showing our adaptability by using modern tools (peer review, publication) to honor and strengthen Indigenous narratives and solutions.

Your support of our research is important, you are supporting Tribal self-determination and our prosperity. Wopila, thank you.

Cheryl

Introduction

Natalie Youngbull, Editor

Anna Lees, Editor

Tribal College and University Research Journal

The Tribal College and University Research Journal (TCURJ) Volume VI continues the line of original research published by the American Indian College Fund (College Fund) as the ninth issue in the College Fund's Tribal College and University Publication Series. This volume represents the strength and resiliency of Tribal College and University (TCU) faculty, staff, and students to work through the publication process as we remain in a global pandemic that continues to disproportionately affect Indigenous peoples and communities in multiple ways. As editors, we carried forward our approach to working closely with each author and team through the review and revision process. Through this approach, we gained greater understanding of how to support each other as scholars across Indigenous communities. With each volume, our peer reviewers diversify based upon the content of submitted manuscripts. We are inspired by and grateful for their generous time and insightful feedback that strengthened each manuscript. We also express our gratitude to the College Fund for the dedicated resources toward hosting multiple writing retreats to carve out time and virtual space for the authors to engage in the revision and editing process. These writing retreats provided opportunities for authors to work with scholar mentors to guide them through revisions and learn more about the publication process. The opportunity to learn about the publication process is important as more TCU faculty, staff, and students engage in scholarly activities.

Volume VI publishes five articles that address topics in environmental science, health and wellness, and Native/Indigenous student academic success in higher education through empirical studies, a conceptual piece, and a literature review. Each article was collaboratively written by several authors. The empirical studies utilized a mix of methodologies, including Indigenous research methodologies and community-based participatory research, to center Indigenous perspectives throughout the research design, data analysis, and discussion of findings. In *Techniques for Regenerating Old Seeds*, authors Frank Kutka, Sheila Blackman, Elizabeth Hoover, Sara Alavi, Kathleen Wu, and Rowen White conducted a literature review on the diverse techniques to revive old seeds into healthy plants. Techniques were organized by levels, from traditional and least intrusive to most intrusive, to assist seed keepers and communities in the decision-making process on how to approach reviving relationships with different seed varieties. This literature review is timely as the food sovereignty movement grows and more Indigenous peoples and communities work to restore traditional harvests. Regenerated seeds have the power to replenish stocks with healthy seeds and carry forward food sovereignty goals of Indigenous communities to sustain our futures.

In *Culture as Medicine for the Blackfeet Community: A Pilot Intervention*, authors Betty Henderson-Matthews, Megan Gordon, Shawntyana Bullshoe, Sierra Mason, Agnieszka Rynda-Apple, and Neha John-Henderson investigated how participation in cultural activities positively influenced levels of cortisol, psychological stress, and symptoms of depression and anxiety among 24 Blackfeet adults. This research project is part of a larger collaborative partnership between Blackfeet Community College and Montana State University that aims to shift the narrative around chronic mental and physical health issues within Indigenous communities to a strengths-based approach to identify positive factors and practices that promote resilience. In place of a conventional literature review, the authors provided a historical account of the atrocities experienced by the Blackfeet Nation that provides greater understanding and impact of the traumas passed on generationally and ways in which community teachings and lifeways can facilitate healing. Indigenous research methodologies, particularly community input and Elders' cultural knowledge and perspectives, guided the framework and design of this research study. The findings highlight the impact of sharing traditional stories and visiting sacred places upon lower levels of psychological stress. This study underscores how influential cultural knowledge and place are to the overall health and well-being of Indigenous peoples and communities.

Studying the relationships between a tree community and the wildlife that reside within it, authors Andrew Kozich, Karen Colbert, Gerald Jondreau, John Lusty, and Victoria Ripley put forth *Regeneration of Culturally-significant Conifer Tree Species in the L'Anse Indian Reservation: Impacts from Herbivory by Deer (Waawaashkeshi)*. Through a mixed-methods approach, the study measured the impact of deer consumption upon the survival rates of several tree species in a conifer swamp. Indigenous research methodologies guided the study, where the researchers engaged in informal discussions with community knowledge-holders throughout the entire project and also received approval by the tribal council and the Tribal Institutional Review Board. This research builds off a larger research agenda to learn about existing relationships between other-than-human species among the rich conifer swamp area. The findings revealed that there is an unbalanced relationship between the tree community and local wildlife that merits further study. This research project, and previous projects within the larger research agenda, is a primary example of a strong research collaboration between TCU faculty and students. Thus far, over 20 students have collaborated across different projects through the research process, presentations, and co-authorships.

Advancing understandings of our relationships with land, water, and other-than-humans and cultural practices to sustain wellness, these initial contributions to TCURJ Volume VI offer important recommendations for both Indigenous and non-Indigenous communities interested in environmental sustainability. Towards those ends, we value the importance of bringing more Indigenous scientists into the field to further the contributions, which is featured in the article, *Recruiting Native Students into Science: Evaluating the Impact of Biomedical Genetic Research at Turtle Mountain Community College*. Authors Tyler Parisien, Lyle Best, Pat Conway, and Gena Grant

conducted a case study to understand the impact of participation in a biomedical genetic research program upon TMCC students' educational and career pathways. Community-based participatory research principles guided this collaborative project between faculty and students, and approval was received from the TCU and tribal research committees. Ten (10) TMCC graduates, who participated in the biomedical genetic research program, participated in 1-on-1 virtual interviews. The findings highlight the influential impact a TCU-based research program has on student pathways through four broad themes: experience, opportunities, education, and community. Implications from this study point to the need for more student research opportunities within tribal colleges, as they provide the space and environment for students to develop as community-based and community-driven researchers.

Contributing a framework for furthering Indigenous scholars through high education initiatives, *A Vision for Indigenous Honors Programs at Tribal Colleges and Universities*, written by Joshua Hoskinson, Edison Cassadore, and Camillus Lopez, conceptualized an Indigenous honors program within tribal colleges. Drawing up their own personal experiences, each author shared reflections and perspectives of a former honors student, an Indigenous intellectual, and a Tohono O'odham Elder. Tom Holm's (2003) Peoplehood Model guides the theoretical framing of an Indigenous honors program by accounting for four areas of thought around Indigenous identities: land, history, language, and ceremony. The authors assert that the Peoplehood Model offers a counter-hegemonic approach that provides a pathway toward indigenizing and reorienting TCU-based honors programs in the concept of love, which will allow students to counter settler-colonial influences in their daily lives. In addition, Indigenous honors programs should be unique to each TCU, based upon traditional and cultural teachings, values, and languages. As an example, the authors described how an Indigenous honors program would be structured at Tohono O'odham Community College based on its four core values. The article concluded with a discussion on how Indigenous honors programs can meld academic excellence and Indigenous identity toward Native-nation building.

In addition to the significant scholarly contributions these authors have shared, we want to note that four of the five articles published in Volume VI are faculty and student collaborations. We applaud TCU faculty who are making space for students in research and publication processes. Even more, we are inspired by these collaborative efforts completed through a global pandemic that continues to affect tribal colleges' ability to serve their students and communities. Tribal college students learn how to be responsive to community needs through community-based studies and engage with Indigenous research methodologies through active participation in research projects supported by faculty. These research opportunities do not exist at most non-Native serving institutions. Tribal college student researchers are developing a skill set that has the potential to help tribal communities achieve data sovereignty and develop culturally relevant research agendas.

The TCURJ remains an open-access interdisciplinary journal that continually strives to be accessible to Indigenous peoples and communities. With every new volume, a printed journal is sent to every TCU library and is fully linked through the College Fund's research webpage. In an effort to expand the TCURJ's reach, printed journals will be sent out to tribal libraries and Native American/American Indian Studies departments. We commend the College Fund's persistent support of the publication and dissemination of TCU-based research. We value the relationship fostered with the previous Faculty Development Program Officer, Cathy Noland, and current Vice-President of Research, Evaluation, and Faculty Development, David Sanders through the current and previous volumes. Néá'ésé and Chi miigwech to the College Fund staff, TCURJ reviewers, writing retreat faculty mentors, and authors for their contributions to Volume VI. We hope the articles serve as strong examples of successful faculty-student research collaborations.

Author Biographies

Natalie Youngbull (Cheyenne & Arapaho/Assiniboine & Sioux) is editor of the *Tribal College and University Research Journal* and Assistant Professor of Adult and Higher Education in the Educational Leadership and Policy Studies department at the University of Oklahoma. Her research interests include the experiences of American Indian Gates Millennium Scholars, Native/Indigenous student success, Native Nation Building, and intellectual leadership and capacity building within TCUs.

Anna Lees (Little Traverse Bay Bands of Odawa Indians, descendant) is editor of the *Tribal College and University Research Journal* and Associate 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.

Techniques for Regenerating Old Seeds

Frank Kutka

College of Menominee Nation

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Elizabeth Hoover

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Native American Food Sovereignty Alliance/Indigenous Seedkeepers Network

Food sovereignty is both the right of peoples to healthy food produced sustainably and to define their own food production systems. As the food sovereignty movement continues to evolve, more Indigenous people are searching for the seeds Native ancestors used to grow traditional crops. Sometimes gardeners have viable seeds of traditional varieties in abundance, and sometimes the only seeds still in existence have not been grown out for a long time and are now very old. Others have been collected decades ago and stored in museums for display. Age eventually leads to the death of seeds, and some of the old seeds will never germinate. However, sometimes old seeds are still alive but very weak, too weak to germinate on their own. Here we review the literature about the various ways in which gardeners and scientists have helped or may help to grow healthy plants from old, weak seeds that are still alive. Some of the methods are not traditional. Each person or group involved will have to make choices among the methods based on the likelihood of success, cultural norms, and other considerations. If successful, regenerated plants can become the basis for new stocks of healthy, vigorous seeds with which relationships can be rebuilt to help meet current and future food sovereignty goals.

Keywords: germination, rematriation, seed saving, seed sovereignty, seeds

Introduction

Indigenous peoples across the continent have been actively retaking charge of their food supplies to move towards better health and greater cultural and economic independence. This food sovereignty movement has grown rapidly. It began with elders who continued traditional ways, tribal farms, and new projects to revive and expand traditional skills and foods among the youth. Now, it has grown to include regional and national food conferences, Indigenous foods re-introduced by Indigenous chefs, seed-keeping networks,

and more (Mihesuah & Hoover, 2019). To support this movement, this paper reviews the literature and outlines the techniques that are used to regenerate healthy plants from older seed lots with lower germination rates.

Food Sovereignty

As defined by the international organization La Via Campesina, Food Sovereignty is “the right of peoples to healthy and culturally appropriate food produced through ecologically sound and sustainable methods, and their right to define their own food and agriculture systems” (Declaration of Nyéléni, 2007, p. 9). Indigenous American tribes have been working to integrate the struggle for food sovereignty into broader goals of self-determination. In this approach, food sovereignty “refers to a re-connection to land-based food and political systems,” (Martens et al., 2016, p. 18) and seeks to uphold “sacred responsibilities to nurture relationships with our land, culture, spirituality, and future generations” (Morrison, 2011, p. 111). This encompasses culturally, ecologically, and spiritually appropriate *relationships* with elements of those systems (Hoover, 2017).

Emphasizing reciprocal relationships with the landscape and the entities on it goes much deeper than simply gaining access and control over a piece of land (Raster & Gish Hill, 2017). Sovereignty, in this way, is framed as a relationship with all these entities that allows for the mutual benefit of all parties (Kamal et al., 2015). Cultural restoration is, therefore, an imperative for Indigenous food sovereignty (Kamal et al., 2015).

Seed Sovereignty

Another key component of food sovereignty is seed sovereignty. Vandana Shiva says seed sovereignty “includes the farmer’s rights to save, breed and exchange seeds, to have access to diverse open-source seeds which can be saved... It is based on reclaiming seeds and biodiversity as common and public good” (Shiva, 2012, para. 3). Heirloom seeds, those passed down through generations of Indigenous gardeners, are open-pollinated and breed true (Seed Savers Exchange, 2021). They are often discussed as the foundation of the food sovereignty movement for Indigenous communities, as living relatives to be protected from patent or modification, and also as partners for education and reclaiming health (Hoover & Sherman, 2019; Stevens & Brewer, 2019). As Clayton Brascoupe (Mohawk) director of the Traditional Native American Farmers Association notes, “we refer to these as our living relatives... if you have the ability to interact with your relatives through these seeds, you also have the ability to feed yourself” (Clayton Brascoupe, personal communication, 11 June 2014).

Prior to European contact, Indigenous horticulturalists in the Western hemisphere developed a vast variety of crops (corn, beans, squash, potatoes, chili peppers, and more) that would go on to provide up to 60% of the food for the world (e.g., Park et al., 2016). Each community developed their own distinct varieties of these crops. Generations of saving these seeds developed these heirlooms into landraces, varieties that are adapted to a community’s climate and cultural preferences for taste and appearance. These seeds nourished families and communities, filling stomachs and connecting gardeners and eaters to previous generations. Some of these heirloom seeds have continued to be passed down in Indigenous

families, and the ongoing relationship with them continues to support seed and food sovereignty. Seeds are often recognized as living beings filled with spirit, related to seed keepers through centuries of coexistence and coevolution (Jones, 1939; S. Martin, personal communication, April 2018).

However, this relationship with heirloom seeds has been broken as many Indigenous food systems were dismantled through forced relocations and forced assimilation (White & Hoover, 2019). In some cases, there is no living memory of once traditional foods. The stories that remain attached to those seed varieties and foods, or just the knowledge that the seed once came from the community and was shaped by ancestors, are enough to make some Indigenous gardeners want to bring these seeds home and grow them. These connections with heirloom seeds are described as “landscapes of remembrance” (Nazarea, 2005) and “edible memories” (Jordan, 2015). The desired experience of eating heirloom food that carries a story of relationship and its unique genetic code compels some people to work to track down heirloom seed varieties.

A growing network of Indigenous seed keepers is coalescing to “rematriate” Indigenous seeds to their communities of origin. The term rematriation has been developed as an alternative to the more conventionally used ‘repatriation’ in order to highlight the role of women seed keepers, and the circular work of reconnecting seeds with people, people with land, and the seeds back to the motherland where they were developed (e.g., White & Hoover, 2019). We work with seed keepers who have begun collaborating with institutions like the Science Museum of Minnesota and the Field Museum in Chicago to reconnect seeds that have been sitting on shelves away from their home communities for decades, back to the places where they originated and the descendants of the early seed keepers who first developed these varieties. For some plant species, this is a very reasonable expectation, while for others it is much less likely (Walters et al., 2005). When successful, this kind of reconnection could help revive food and agricultural aspects of traditional culture (Mt Pleasant, 2011; Waugh, 1916; Wilson, 1987).

However, there are other long-term benefits that having numerous, locally adapted varieties bring to a community. First, as each has its own unique genetic makeup, they directly contribute to breadth in local crop species and genetic diversity. That breadth provides some insurance of successful crops even with weather variation from year to year, and it could very well be the key to food security in a changing environment (Bowles et al., 2020; Gaudin et al., 2015; McClusky & Tracy, 2021; Meldrum et al., 2018; White & Hoover, 2019). Also, increased local genetic diversity within crops opens up possibilities for ongoing adaptation and the development of new varieties over time (Heider et al., 2021; Kutka, 2011; Wilker et al., 2020). To achieve all of these benefits, healthy seeds that germinate readily are necessary.

Unfortunately, during storage seeds age and eventually become weak and die (Ashworth, 2002; Wilson, 1987). First, the seeds begin to lose vigor which reduces early vegetative growth and can reduce plant stands (Orzolek, 1991; Tekrony & Egli, 1991). If storage is above 13% relative humidity, storage fungi can begin to infect the seeds (Anderson & Baker, 1983). As aging continues, the integrity of the cell membranes in the seeds begins to fail. This

causes the leakage of key cellular components like sugars, starches, and minerals during the germination process, thereby, increasing problems with bacteria and fungi (Anderson & Baker, 1983; Blackman et al., 1996; Brown et al., 1996; Filgueiras, 1981; Moon & Meru, 2018; Porteous et al., 2019). The ability to synthesize starches, proteins, and ATP also begins to fail, and this is followed by increasingly weak germination rates (Anderson & Baker, 1983). Because of very long storage periods in some cases, and storage conditions that were not always ideal for maintaining high rates of germination among seed lots, some of those working on seed rematriation projects are finding that some older lots of seeds are not capable of successful regeneration through planting out in the garden. This situation can be a roadblock to successful rematriation efforts and to hopes for renewing relationships with plant variety partners. Clearly, addressing the problem of old seeds with weak or no obvious germination might help to overcome this roadblock when this is a biological possibility.

Review of Techniques

Our team and this review came together from common experiences with valuable seed lots with very low germination. Some of us were working with Indigenous communities hoping to revive traditional varieties from very old seeds, one of us carried out research on rescuing old seeds donated to the USDA, and all of us reviewed the literature for sources of techniques over the years. Some sources on basic seed saving mention some special techniques to help seeds to germinate, and some of the more intrusive techniques are a part of biotech and seed science curricula. From these, we interviewed experts on seed germination and how to handle older seeds. We also searched online using Scholar and similar databases. Once a technique was identified, adding terms like “aged seed” or species names helped to find sources that demonstrated that the techniques applied to seeds with which we were familiar for this specific purpose.

We have arranged the techniques that we have identified beginning with the traditional and least intrusive to seed partners, to the newest and most intrusive techniques. This is to facilitate the decision-making process among seed keepers and their communities about which techniques are right for them and their seeds as they seek to revive relationships with these varieties to further expand food sovereignty. The levels build upon one another, so specific practices used in one are generally also part of the following higher numbered levels that go further still.

Level 0 - Normal Planting

With normal planting, farmers and gardeners take fresh seeds from safe storage and plant them at the right time and at the right depth into the soil of their gardens or fields. Ceremonies are sometimes held for the new seeds to renew relationships with them (Terrylynn Brant, personal communication, 14 October 2021). Vigorous seeds are more competitive with other plants, diseases, and pests, and are more likely to successfully establish new plants (e.g., Filgueiras, 1981; Mondo, Cicero, et al., 2013; Mondo, Nascente, et al., 2016; Orzolek, 1991). At the end of their lives these plants are likely to reproduce good seeds of the parent variety so that they can be maintained into the future (Ashworth, 2002).

Most farmers and gardeners can learn the basics of saving healthy seeds and can carry out these techniques. This is the traditional approach to much of Indigenous agriculture and seed management (e.g., Mount Pleasant, 2011; Wilson, 1987).

The plants that result from seeds treated with most of the following levels of intrusion should also have the ability to reproduce good seeds of the parent variety. Farmers and gardeners should be able to maintain that variety into the future using traditional Level 0 techniques provided that the seed is grown and stored well and regenerated often enough. Generally, there is no expectation of long-lasting effects of regeneration of older seeds upon later generations if the attempt is successful.

Level 1 - Seed Treatments

If seeds are too weak to outgrow bacteria, fungi, or other pests in the soil, they may be treated with chemicals to control these pests and boost rates of establishment (Orzolek, 1991). Some Indigenous farmers treated seeds with wood ash to overcome pests or disease (e.g., Mathers, 1981; Onion, 1964). Teas from tobacco, mayapple, and other plants are also used for pest control (Terrylynn Brant, personal communication, 14 October 2021). Commercial seeds are often planted with coatings of fungicides or insecticides for the same purposes (e.g., Holbert & Koehler 1931; Radmer et al., 2017), although wood ash can still be effective in some cases (Ekpo & Banjoko, 1994). Treatments may also include surface sterilization of the seed coats or hulls with sodium hypochlorite (bleach) to reduce bacterial or fungal infection of the seeds, although this may not be enough for seeds with significant infections (Blackman et al., 1996; Mangena & Mokwala, 2019).

Level 2 - Seed Soaks and Priming

Seeds may be soaked in a solution for a few hours or days before planting to introduce chemicals that encourage germination. For instance, Haudenosaunee farmers will often soak seeds in medicines to help them germinate (Stevens & Brewer, 2019; Waugh, 1916).

Other chemicals have also been found to increase germination rates. Hydrogen peroxide can increase supplies of oxygen to germinating embryos and improve germination with old or large seeds (Dufková et al., 2019; Liu, Porterfield, et al., 2012). Potassium nitrate supplies macronutrients but may also help balance plant hormones in germinating seeds (Farajollahi et al., 2014). Gibberellic acid (GA) is a naturally occurring plant hormone that positively controls germination and plant growth. In a healthy seed, GA is generated as the seed takes up water. GA treatments can induce signs of germination days earlier and increase germination rates in aged or dormant seeds in some cases (Ardebili et al., 2019; Bhattacharya & Khuspe, 2001; Cornea-Cipcigan et al., 2020; Lima et al., 2019). Alternatively, soaking seeds may reduce the levels of abscisic acid (ABA) in the seed coats, thereby increasing GA activity (Mangena & Mokwala, 2019).

Some aged seeds will germinate better if they are first allowed to take up moisture very slowly, so that they cannot germinate, and then dried back down to storage moisture content - again very slowly. This technique is called osmopriming and has been shown to enhance the germination of seeds, including older seeds (Orzolek, 1991; Soeda et al., 2005), although

the mechanism is not fully understood. There are also bacterial seed priming techniques that have been used successfully to increase germination. Bidabadi and Mehralian (2020) report improvements in germination rate, germination speed, and early growth of developing plants when seeds of a medicinal plant were soaked in a suspension of *Bacillus polymyxa* for twenty minutes before planting. "Bio-priming" with a bacterial suspension has been shown to work for many species (Liu, Chen, et al., 2019a and 2019b; Lutts et al., 2016; Mahmood et al., 2016; Rozier et al., 2019). Priming requires laboratory equipment and skills, although some bacteria that promote germination are now available commercially as a seed treatment that farmers can use.

Level 3 - Growth Chambers

Old seeds may be germinated indoors or in growth chambers before planting outside or into containers. When germinated indoors, the seeds can be kept at warmer temperatures that promote vigorous germination, as when plants for commercial production are first started in flats (e.g., Courter & Vandemark, 1964). Hidatsa and Haudenosaunee farmers were known to regularly presprout seeds indoors in some cases (Waugh, 1916; Wilson, 1987). Seed treatments may also be used to control bacteria and fungi in these situations.

Level 4 - Sterile Growth Media

Germination rates may be increased by starting seeds on sterile agar growth media in petri plates in growth chambers indoors (Bhattacharya & Khuspe, 2001; Mangena & Mkwala, 2019; Mohamed-Yasseen, 2001; Porteous et al., 2019). The medium can be supplemented with carbohydrates, amino acids, minerals, vitamins, and hormones to supply the seeds with some of the foods and minerals that the seeds are not able to fully supply (Kauth et al., 2008). Murashige and Skoog is a medium commonly used for seed and tissue culture (Bhattacharya & Khuspe, 2001; Kumar & Loh, 2012). The agar medium may have antibiotics and/or fungicides to control diseases, fungal symbionts may be added, and the seeds will likely be washed or treated to reduce bacterial and fungal spores on the hulls (e.g., Mangena & Mkwala, 2019).

Level 5 - Seed Coat Removal

Germination rates can be increased when seed coats are removed, or when they are weakened with ultrasound (Chandler & Jan, 1985; López-Ribera & Vicente, 2017; Mangena & Mkwala, 2019). Part of this increase appears to be due to increased oxygen uptake (Pesis & Ng, 1986), or it may be due to easier extension of the roots and shoots (S. Blackman, personal observation). Aseptic conditions, nutrient-rich growth media, and optimal temperatures are also helpful in successful development of healthy plants in these situations.

Level 6 - Embryo Rescue

If removal of the seed coat is not enough to get seeds to grow into plants, it may be possible that the embryos can be surgically removed from some seeds and grown out on a special growth medium in sterile petri plates in growth chambers. This kind of embryo rescue has been used successfully for many species (Blackman et al., 1996; Brown et al., 1996; Moon & Meru, 2018; Porteous et al., 2019). It is also used in plant hybridization.

Level 7 - Embryo Tissue Culture

The most intrusive technique that may rescue a variety from a weak lot of old seeds appears to be tissue culture. In this case, a few cells may be cultured from a still functioning growing point or from a cotyledon that still greens up. As for embryo rescue, these cells would be grown on a sterile growth medium in a petri plate kept in a growth chamber (e.g., Ali et al., 1991). It may well be the case that rescuing old seeds in this way would have the same potential for somaclonal variation, induced and inherited changes in phenotype, that is often observed when culturing plants from just a few cells (Bednarek & Orłowska, 2019). Any plants that resulted would be descendants of the parent variety, but there is the possibility that they would not be identical to the parent stock.

Discussion

With each increasing level of physical intrusion into the seeds and their environments, the complexity and likely also the expense of the task increases. Success with any of them is not assured, and everyone will not have access to all of the equipment and supplies listed above. Likely, the older and weaker the seeds, the more intrusive the technique that will be needed to successfully help some to regenerate, although some old seed samples will simply be dead. However, physically dead seeds may still hold value as reminders of the parent variety.

Some varieties will be more readily rescued from just one or a few plants than others. For species that normally self-pollinate themselves, like beans or tomatoes, these might be reproduced easily from any of these techniques as long as one plant grows to maturity (Ashworth, 2002). Varieties of outcrossing species that normally do not self-pollinate, especially corn, could not be easily reproduced from just one or a few plants. A rescued plant might have to be self-pollinated just to save something of the parent variety, although under some conditions it may be difficult to get corn plants to shed pollen and silk at the same time (Blackman et al., 1996). As with many of the regeneration techniques above, assistance from experienced seed keepers and breeders could be helpful as inbred lines of corn do not make productive varieties.

Conclusion

There is a range in techniques available for germinating old seeds that still show some signs of physical life, even very minimal ones. Some can be adapted by farmers and gardeners, but others require skilled technicians and special equipment. Some are traditional among Indigenous peoples, and some are novel to all of humanity. Clearly, decisions will need to be made by the seed keepers looking towards seed and food sovereignty before attempting to rescue a traditional variety that now exists solely as an aging collection of seeds. Techniques that look the most likely to succeed with the resources available will have to be chosen and applied in a way that is also respectful of seed keepers, the seeds, and their unique relationships. If technical assistance will be required, finding an understanding person with the necessary skills will also be important. As seed scholar Jack Kloppenburg (2010) describes, "Seed sovereignty will be manifested as a system encompassing peasants, farmers, Indigenous peoples, plant scientists, public scientific institutions and seed

marketers" (p. 163). One key to this process, when it is appropriate, is the development of respectful understandings and trust among seed technicians and the communities of origin for the seeds. In this way, some old seeds may be rescued, and relationships renewed in order to benefit current and future generations.

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Author Biographies

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Sheila Blackman teaches in the area of sustainable agriculture, and has published in the area of seed physiology throughout her career, largely on the mechanisms underlying seed longevity. Her past work includes the development of techniques to rescue aged maize seed, accomplished while she was employed at the USDA.

Elizabeth Hoover is an associate professor in the Environmental Science Policy and Management department at the University of California Berkeley whose work and publications focus on food sovereignty and environmental justice for Native communities. Elizabeth serves on the executive committee of the Native American Food Sovereignty Alliance (NAFSA) and the boards of North American Traditional Indigenous Food Systems (NATIFS) and the Freed Seed Federation.

Sara Alavi is a Master's student in Social Anthropology on the Medical Anthropology track at SOAS University of London. She graduated from Brown University in 2021 with honors in Health and Human Biology.

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Rowen White is a Seed Keeper/farmer from the Mohawk community of Akwesasne. She is the Program Director for the Indigenous Seed Keeper Network, which is an initiative of the Native American Food Sovereignty Alliance, a non-profit organization aimed at leveraging resources to support tribal food sovereignty projects. She is the chair of the Board of Seed Savers Exchange, the largest public access seed bank in North America. She has been working in Indigenous seed sovereignty initiatives as a farmer mentor, facilitator, curriculum developer and strategic consultant for two decades.

Culture as Medicine for the Blackfeet Community: A Pilot Intervention

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Blackfeet Community College (BFCC) Student Interns recruited 24 adult participants from the Blackfeet community to participate in a pilot study of a "Culture as Medicine" Intervention. The intervention consisted of Blackfeet elders sharing traditional stories and hikes to culturally sacred places on the reservation. There was a significant decline in psychological stress over the course of the intervention. Individuals who reported more childhood trauma had greater declines in cortisol from the start to the end of the study. The findings provide initial evidence that participation in Blackfeet culture may reduce stress for community members.

Keywords: community based participatory research, Blackfeet culture, stress, cortisol, childhood trauma

Introduction

While American Indian communities suffer from disproportionate exposure to trauma and stress and have suffered greatly because of European colonialism and genocide, they also demonstrate resilience. Even after having their culture and ways of being attacked repeatedly by the government, the Blackfeet people are still here and are proud to be Blackfeet. Our children, who are not taught about our own history in school, have begun seeking knowledge about what happened to us in the past and why. Our people are now interested in learning the Blackfeet language and ways. This time in history represents a time of healing, and the tremendous resilience of the Blackfeet people must be acknowledged.

Historical Atrocities

The resilience that is evident in the people of The Blackfeet Nation, located in Northwest Montana, is particularly remarkable given the tremendous loss of their culture and traditions due to the events that led up to the boarding school era. Some of these events had to do with exposure to infectious pathogens that came along with white settlers. In 1780, the Blackfeet first came in contact with smallpox, resulting in one-third of the Blackfeet Nation dying. In 1837, the Blackfeet Nation went through an outbreak of smallpox that killed even more of their people. In 1860, more white settlers began to enter Blackfeet country. Then in 1864, an outbreak of bacterial scarlet fever had broken out, and by spring of 1865, over 1,100 Blackfeet people had died.

The Blackfeet people have also endured many atrocities, including murder. On a cold day on January 23, 1870, the sleeping camp of Heavy Runner was attacked by the cavalry and infantry of Colonel Eugene Baker. Baker was looking for the band of Mountain Chief to arrest five members of the band for the killing of Melcome Clark. Baker's Scout informed the commander that they had the wrong camp, but it made no difference. As the camp of Heavy Runner lay sleeping, Baker charged the camp killing all the women, children, and elders. Chief Heavy Runner had run out of his lodge waving signed papers from the government stating they were compliant with the agency. Sadly, Chief Heavy Runner was shot while holding the signed papers. After the killing was over, the soldiers burned down the tribe's belongings, leaving the frozen corpses of women, children, and elders on the ground. This horrific day is known as the Bear River Massacre, Marias Massacre, and Baker's Massacre.

In the early 19th and 20th centuries, American Indians were forced to abandon their traditional ways and assimilate when the federal government worked to eradicate language and traditional practices by forcibly removing children from their homes. Within these residential schools, children were given European American hairstyles and European American names. They were forbidden to speak their Indigenous languages and were told to abandon their cultural identities. The children of the residential schools were mentally, physically, emotionally, and sexually abused. Many of the children were either starved or beaten to death for speaking their language and for practicing their culture (Lomawaima & McCarty, 2006). Indigenous children from the Blackfeet Nation come from first, second, or third-generation survivors of these Indian residential schools. These traumas are passed through shared stories and experiences from one generation to the next. Separately, during the 20th century, the Blackfeet people endured another trauma when many had their medicine bundles stolen. These bundles were illegally sold to museums around the United States. The loss of these medicine bundles impacted the Blackfeet greatly, further stripping them of their identity and culture.

Today, American Indian communities have disproportionately high incidences of chronic mental and physical health conditions (Indian Health Services, 2021). A related body of work documents the relationships between trauma and these poor health outcomes in American Indian communities (Bassett, Tsosie, & Nannauck, 2012; Bassett, Buchwald, & Manson, 2014; John-Henderson et al., 2020; Skewes & Blume, 2019). However, less is known about the factors and experiences that may promote resilience. To positively affect the health and well-being of American Indian communities, more work is needed in this area.

Research Collaboration

Through a strong and collaborative partnership between Blackfeet Community College and Montana State University, we have developed a program of research that has been dedicated to this cause. The findings from this work have highlighted the importance of social connectedness and a sense of belonging in the Blackfeet community (John-Henderson et al., 2019). For example, we found that a greater sense of belonging strongly correlated with reduced biomarkers of disease risk, particularly for Blackfeet community members who experienced high levels of early life trauma (John-Henderson et al., 2020).

The goals and methodology of the current project extend upon previous work which has investigated the relationship between stress and health in North American Indigenous communities. Much of this prior work identifies historical trauma and the loss of Indigenous practices and values as root causes for the poor health outcomes observed in these communities. For example, Wolsko et al. (2007) outlined how both enculturation and acculturation are implicated in the stress, coping, and well-being of the Yup'ik of the Yukon-Kuskokwim Delta. Further, as described by Dr. Joseph Gone and other scholars in a large body of work, Indigenous culture can be utilized as "medicine" to address historical trauma and reduce persistent health disparities in these communities (Gone et al., 2019; Gone & Looking, 2011; Hartmann & Gone, 2012; Rowan et al., 2014). In one example, traditional Pikuni Blackfeet cultural practices were used to inform the development of an immersion camp for 4 Blackfeet adult males being treated for substance use disorder (SUD) (Gone & Calf Looking, 2015). More broadly, prior work suggests that Indigenous culture may alleviate the wounds of historical trauma, offering a promising remedy to the mental health issues which disproportionately affect these communities (Gone, 2013; Hartman et al., 2019). Separately, culture and spirituality in Indigenous communities have been found to provide a sense of coherence and identified as key factors capable of reducing health-compromising behaviors and negative health outcomes (Hazel & Mohatt, 2001; Martell et al., 2020; Lafromboise, Medoff, Lee, & Harris, 2007; Lafromboise & Bigfoot, 1988; Morse, 2000; Manson, 2020).

Research Framework

Unlike most traditional research endeavors, we did not start with a formal literature review. Instead, a group of 8 interns from Blackfeet Community College sat down in the Southwinds Lodge conference room to brainstorm ideas for the next direction of the research program. Looking back, it is interesting to note that our intuitions and ideas were very much in line with the previous findings and theories from scholars in this area, as described earlier. We knew that we wanted to shift the focus of the work into a more positive direction, focusing on the strengths of our community, and we prioritized identifying ways to reduce high levels of stress in the Blackfeet community.

It was not our goal to develop a project grounded in previous theory or based on previous intervention efforts in other communities or groups. We wanted the work to be specific to our community and its needs. Prior work has made clear that effective interventions in Indigenous communities must utilize strategies identified by community members (Gonzales & Trickett, 2014; Grant et al., 2015). In addition, prior work has emphasized that culture and the perspective of elders should inform the development of these interventions (Trimble, 2020). Our approach to this work was in line with this knowledge.

We wanted to help the people in our community improve their health given disproportionately high levels of hypertension, heart disease, diabetes, and many other chronic health conditions in our community. Extending our previous work, we felt it was important to understand whether fostering a connectedness to Blackfeet culture through an intervention could reduce disease risk. Specifically, we investigated whether greater connectedness to the Blackfeet culture would

correlate with reduced psychological stress, anxiety, and biomarkers of stress. As a team, we designed an intervention for Blackfeet community members based on culturally relevant stories, traditions, and places. We felt that learning about the traditional ways of our people, the traumas they have endured, and the resilience the community has displayed, would be beneficial to the health and well-being of our people.

Overall, the goal of this work was to determine whether the experience of cultural immersion would positively affect outcomes that can contribute to risk for the diseases that affect the Blackfeet community. Specifically, our research question was, "To what degree does Blackfeet oral storytelling and visits to Blackfeet culturally sacred places correlate with changes in cortisol levels, levels of psychological stress, and symptoms of depression and anxiety?" We also investigated whether childhood trauma would relate to the magnitude of changes in these outcomes in response to the intervention. Our work makes an important contribution to the existing literature focused on Indigenous culture as a healing and protective factor. Specifically, we tested whether the experiences of listening to elders' stories and of going to culturally sacred places were associated with positive changes in health-relevant outcomes.

Methods

This two-week long study was approved by the Blackfeet Nation Institutional Review Board. The research team was made up of Blackfeet Community College students who were trained to conduct human subject research. We learned to conduct analyses of biomarkers in the lab located in the Math and Sciences Building on the Blackfeet Community College campus. We recruited 24 adults from the Blackfeet reservation. To be eligible to participate in this study, participants had to self-identify as Blackfeet and be older than 18. After confirming eligibility, at the initiation of the study, participants were asked to sign an informed consent form at the Math and Sciences Building on the Blackfeet Community College campus.

After consenting on the first day of the study, participants completed a survey which measured demographics, symptoms of depression and anxiety, levels of psychological stress, and adverse childhood experiences. Between 8 and 10 am participants donated saliva samples using a Salimetrics saliva collection kit (Salimetrics, 2021a). These saliva samples were stored and later used to measure cortisol levels by enzyme-linked immunosorbent assays (ELISA) (Salimetrics, 2021b). We decided to measure cortisol in this research project since it is linked to many chronic conditions that disproportionately affect the Blackfeet Community (Schoorlemmer et al 2009). Further, we hypothesized that cortisol levels would decline following culturally focused exercises, given that previous research found that cortisol levels decline following storytelling and other positive experiences (Brockington et al., 2021; Hunter et al., 2019). Following saliva sample collection, participants ate lunch. After lunch, participants engaged in a discussion of culturally significant stories and places on the Blackfeet reservation. We chose to do this because we wanted to hear about stories that were significant to them after hearing elders speak on the same subjects. Only a few participants chose to speak, and those who did, shared stories that had been shared with them by family members and spoke of places on the reservation which were meaningful to them.

Over the course of the next three days, participants returned for 1.5 hour-long visits with distinguished elders of the Blackfeet Nation. During these visits, we adhered to cultural protocol when visiting an elder. The elders were not limited to a specific discussion topic. Each dignitary told their own truth of what they have come to know in this world and gave guidance through unwritten traditional stories that they believed would benefit the participants' well-being. Each elder would discuss the original territory of the Blackfeet people along with discussing traditional places where they were given their sacred ceremonial objects. During each visit, dinner was served to the elders and participants.

During the first four days of the second week of the study, we guided participants on hikes to the culturally significant places the dignitaries had discussed. One of those places was St. Mary Lake. St. Mary Lake is where the Blackfeet people were given one of their strongest medicine bundles. Participants also visited what is known among the Blackfeet people as Running Eagle Falls. Running Eagle Falls is known for the story of a strong Blackfeet woman who was beyond courageous and went on war parties with the men of the camp. On the fifth day of week 2, participants once again completed the questionnaire and provided a final salivary sample. Participants were provided compensation at the end of the visit.

Measures

Demographics

All participants self-reported their age and biological sex.

Psychological Stress

We measured perceived psychological stress using the Perceived-Stress Scale-10 (PSS-10). The PSS-10 is the most widely used psychological instrument for measuring perceptions of stress. (Cohen et al., 1983). It is a measure of the degree to which situations in one's life are appraised as stressful. Participants completed this measure three times over the course of the study. Once at baseline, once after the week of sharing stories and discussing culturally significant locations on the reservation, and once again after hiking to culturally significant places on the reservation.

Adverse Childhood Experiences

Participants completed the Adverse Childhood Experience (ACES) Study questionnaire (Felliti et al., 1998) as a measure of exposure to traumatic events during childhood. Participants indicated if they had experienced any of the ten listed adverse childhood experiences before the age of 18.

Salivary Cortisol. All salivettes were stored in the Blackfeet Community College lab in a -80°C freezer following the manufacturer's recommendation. After the completion of the study, Blackfeet student research interns used the salivary cortisol by ELISA (Salimetrics, 2021b) to quantify levels of cortisol in participants' salivary samples before and after the interventions. As with the psychological stress measure, these samples were collected three times over the course of the study. As noted previously, we chose to measure cortisol

because of its implication in mental and physical health conditions, which disproportionately affect our community.

Statistical Analyses

All statistical analyses were conducted using SPSS software (Version 25; IBM, Armonk, NY). We first examined descriptive statistics for our sample and then looked at Pearson bivariate correlations between variables of interest. We tested whether there were significant declines in our psychological stress and cortisol outcomes using paired sample t-tests. Based on our previous work, which found that community members who reported more childhood trauma benefitted the most from feeling more connected to the community (John-Henderson et al., 2020), we also tested whether community members who reported more childhood trauma had greater declines in cortisol and psychological stress over the course of the study compared to those who reported lower levels of childhood trauma.

Results

The average age of our participants was 34.67. Sixty-two percent of our sample identified as female, and 38 percent identified as male. We examined correlations between variables of interest at baseline. Before the intervention began, individuals who reported more adverse childhood experiences had higher levels of salivary cortisol ($r=.42, p<.05$). Age and gender were not related to cortisol at any of the three time-points. Individuals who had higher cortisol levels at the start of the study had greater declines in cortisol from the beginning of the study to the end of the study ($r=.84, p<.001$).

Perceived psychological stress was measured before the intervention, after the first week of storytelling, and once again after the week of hiking to culturally significant places. Using a paired samples T-test, we compared levels of psychological stress at the beginning and end of the study. On average, psychological stress was lower at the end of the study ($M=17.38, SD=4.85$) compared to psychological stress at the start of the study ($M=20.5, SD=5.78$). This difference was statistically significant, $t(23)=3.41, p<.01$.

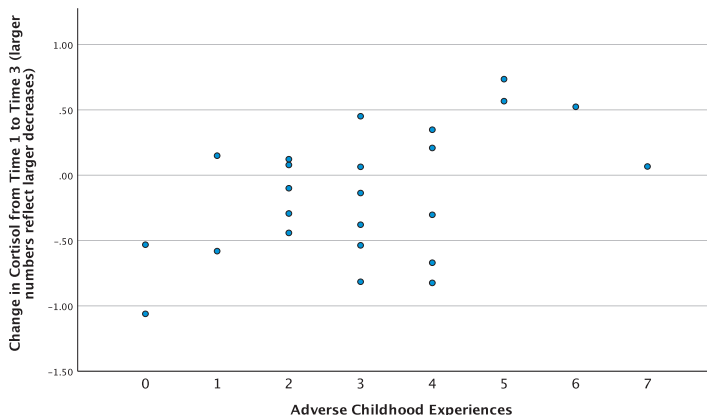
Additionally, to better understand which component of the intervention contributed to this overall decline in psychological stress from the beginning of the study to the end of the study, we compared average levels of psychological stress at the beginning of the study to levels after the storytelling and to levels of psychological stress following the hikes. The decline in psychological stress from baseline ($M=20.5, SD=5.78$) to after hearing the elders' stories ($M=19.42, SD=5.60$) was not statistically significant, $t(23)=1.25, p=.23$. However, the decline in psychological stress from this point to the end of the study ($M=17.38, SD=4.85$) was statistically significant, $t(23)=2.65, p=.01$. Adverse childhood experiences were not correlated to changes in psychological stress across the course of the intervention.

While there were no statistically significant declines in salivary cortisol associated with the intervention, we did find adverse childhood experiences were related to the magnitude of cortisol decline following listening to elders' stories ($r=.54, p=.02$). Adverse childhood experiences were also related to the magnitude of subsequent decline following the hikes to sacred places ($r=.50, p=.01$). Specifically, individuals who reported more adverse childhood

experiences had greater declines in cortisol in response to each component of the intervention compared to those individuals who reported fewer adverse childhood experiences. This finding suggests that the intervention may be particularly beneficial for individuals who have faced high levels of trauma during childhood (See Figure 1).

Figure 1

Scatterplot Showing Relationship Between Adverse Childhood Experiences and Changes in Cortisol From the Start of the Study to the end of the Study. Larger Numbers Reflect Greater Declines in Levels of Cortisol.



Discussion

This research was founded on our beliefs and evidence from our previous work, which suggests that providing experiences that promote connection to the Blackfeet culture and history will improve the health of our people. We acknowledge that the findings reported here extend on a body of work of prior scholars who have made important contributions to our understanding of the potential of culture to positively affect health in Indigenous communities (Gone, 2013; Gone et al., 2019; Gone & Looking, 2011). As summarized in this introduction, a wide body of work on the connections between stress, trauma, and health-relevant outcomes in Indigenous communities emphasizes the potential for culture, narratives from elders, and spirituality to promote better health in these communities. The project described here is grounded in the context of this prior body of work and is in line with theory emphasizing the relationship between cultural connectedness and health in Indigenous communities.

Overall, our work indicates that sharing stories and sacred places with community members may positively affect mental and physical health by lowering levels of psychological stress. Interestingly, significant declines in psychological stress were observed from the beginning to the end of the study and from after the elders' stories to the measurement following the hikes to sacred places. However, there was no significant decline in psychological stress from baseline to following the elders' stories. It could be that more time exposure is needed to this

type of intervention to observe statistically significant effects, or it could be that the most benefit comes from actually taking community members to culturally sacred places to allow them to make their own connection to the culture and place. This will need to be further tested in future work.

Moreover, our data indicates that individuals who experienced high levels of trauma during childhood benefited the most from the intervention with regards to the biological correlation of stress (i.e., levels of salivary cortisol). Our statistical analyses indicated that this relationship was evident in declines in cortisol following listening to elders' stories and again in declines in cortisol following hiking to culturally sacred places. This is particularly important given the high rates of trauma observed in our community. High levels of cortisol may put our community members at greater risk for a wide range of chronic diseases. As such, it is important to understand culturally relevant interventions which lower levels of cortisol, and in doing so may, promote better health for our community members.

A central component of this intervention was the stories that our elders shared. Through these stories, we (the researchers and participants), witnessed the hardships our ancestors have faced along with the wisdom and beauty they shared. For many Indigenous communities, our stories and historical places represent who we are as people. Our stories, our mountains, and our hills are more than just places and stories; they are our history that represents us as resilient people. While settlers desired our extinction, our people have demonstrated tremendous resilience despite the historical trauma and abuses we have faced.

Reflections

Towards the end of the two weeks, we were able to sit down with the participants and talk about how participants felt after this experience. Participants had the opportunity to share personal stories with the group. In a safe and open environment, we heard many of our participants speak about their upbringing and how they were not given the chance to learn the history of our people due to the boarding school trauma, which continues to adversely affect our community today. Many of our participants spoke about positive progress with regard to acceptance. Specifically, they noted that they felt their children were growing up in a more accepting society. For this iteration of the project, we did not record or transcribe these conversations. In future work, we plan to record similar interviews with participants' permission as we feel that this information is important and could help inform future research projects.

There are important limitations to note. In the current work, it is not possible to isolate the unique effects of physical activity and cultural experiences during the hikes on our measured outcomes. To better tease apart the unique contributions of physical activity and cultural experiences to shaping cortisol levels and levels of psychological stress, we plan to add an additional condition that would involve physical activity in a place which is not culturally sacred. While physical activity during the hike may have impacted cortisol levels, we did not measure cortisol immediately following the hike. Furthermore, based on previous work, we

might expect cortisol levels to increase following physical activity (Hill et al., 2008). Another limitation is that we did not measure interactions and social experiences associated with the intervention. In future work, we plan to obtain more qualitative data about perceptions of social interactions that occur during these projects to better understand how the nature of social interactions may contribute to our observed effects.

This work provides initial evidence to support the notion that the health of our community members may be improved through interventions and programs which work to foster or revitalize a connection to our culture and history. Psychological stress is a risk factor for numerous health conditions which disproportionately affect our community (Cohen, Janicki-Deverts, & Miller, 2007). Similar interventions, which work to reduce psychological stress, could help improve the health of our community. Furthermore, our findings raise the possibility that community members who experience high levels of childhood trauma, may benefit the most from such interventions and programs. In conclusion, based on the findings from this research, we plan to engage in future efforts focused on the development of accessible interventions which would provide our community with the opportunity to reconnect with our traditions, history, and culture.

Acknowledgments

We would like to thank all participants for their contribution to this work. We hope that your participation will contribute to efforts to improve the health of our community.

Research reported in this publication was supported by the National Institute of General Medical Sciences of the National Institutes of Health under Award Number P20GM103474. The content is solely the responsibility of the authors and does not necessarily represent the official views of the National Institutes of Health.

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Author Biographies

Betty Henderson-Matthews is the Math/Science chair at Blackfeet Community College. Over seven years, she has worked in partnership with Montana State University on research projects centered on the idea that Blackfeet People need to be tied to the Blackfeet culture and spiritual places.

Megan Gordon studies Health Science at Blackfeet Community College. She plans to earn a Medical Laboratory Science degree. She has been a research intern working with Betty Henderson-Matthews since 2018.

Shawntyana Bullshoe is a proud member of the Blackfeet Nation. As a young cultural ambassador among her community, Shawntyana strives to preserve her language and culture through her traditional teachings.

Sierra Mason is a student at Blackfeet Community College with an AA in health science. As a student research intern, I helped develop a research project that lowered stress levels and improved health for community members. Sierra feels fortunate to have been a part of such an incredible research program.

Dr. Agnieszka Rynda-Apple is an immunologist at Montana State University where she studies how initial immune recognition of viruses shapes subsequent susceptibility to respiratory bacterial infections. Dr. Rynda-Apple earned her PhD in Veterinary Molecular Biology from MSU, and before re-joining MSU, completed a postdoc in cancer immunology at Dartmouth College.

Dr. Neha John-Henderson's research focuses on the identification of risk and resilience factors which contribute to or reduce health disparities in vulnerable populations. Dr. John-Henderson earned her PhD in Psychology at UC Berkeley and completed a postdoctoral fellowship in Cardiovascular Behavioral Medicine at the University of Pittsburgh.

Regeneration of Culturally-Significant Conifer Tree Species in the L'Anse Indian Reservation: Impacts From Herbivory by Deer (Waawaashkeshi)

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To the Anishinaabe peoples of the Great Lakes region, northern white cedar (Thuja occidentalis; Ojibwa: giizhik) is a particularly sacred plant with numerous medicinal and ceremonial uses. However, cedar populations are threatened across the region due to difficulties with regeneration. Populations of white-tail deer (waawaashkeshi) are above historical norms, due to reductions in natural predators such as the gray wolf (Canis lupus; Ojibwa: ma'iingan). Cedar is a favorite winter food source of deer, and ecologists agree that over-browsing by deer is likely the leading cause of cedar decline. Small cedar seedlings are protected while buried under snowpack, but as they grow, they become susceptible to browsing and often perish before reaching the canopy. Cedar are the dominant species in many riparian (stream-side) wetlands that provide critical links between aquatic and terrestrial ecosystems. Reductions in cedar could result in long-term ecological changes. We examined four conifer tree species of these ecosystems to compare apparent browsing by deer. While we found cedar and hemlock (Tsuga Canadensis; Ojibwa: gaagaaimizh) abundant in the smallest size class, there is a significant decrease of both species in larger size classes compared to the other species. Our findings support the conclusion that cedar and hemlock are being over-browsed by deer, and that both species could face long-term declines with the current populations of deer in the area.

Keywords: environmental science, regeneration, cedar, hemlock, whitetail deer

Introduction

The Native American group known as the Anishinaabe, meaning "original person" (Benton-Banai, 1988), is one of the largest Indigenous groups in North America. Anishinaabe are known by various regional names such as Chippewa or Ojibwa/Ojibwe/Ojibway (same pronunciation), with cultural relatives Ottawa (Odawa) and Potawatomi (Bodewadomi) across much of the same ancestral homeland centered on the Great Lakes region.

Traditional Anishinaabe worldviews include strong environmental ethics. Plants and animals are considered other-than-human relatives who have spirits (manitous) and gifts to share (Callicott & Nelson, 2004; Kimmerer, 2015). Following traditional teachings, humans' relationships with the environment should be respectful and reciprocal as part of *mino-bimaadiziwin* ("living a good life") as well as ensuring the well-being of future generations (Callicott & Nelson, 2004; Geniusz, 2015; Kimmerer, 2015; Rheault, 1999). This worldview certainly applies to individual species, which is often a familiar concept to non-Indigenous

observers who are aware of species held sacred by Indigenous groups (e.g., eagles, bears, etc.). However, traditional Anishinaabe worldviews encompass a much broader scope. All of nature is sacred, its balance depends on proper relationships, and there are consequences for disregarding teachings about respect and reciprocity (Callicott & Nelson, 2004). As biologists agree, entire biological communities are made up of numerous species of plants and animals that are dependent on each other (including humans), which in turn depend on a stable physical habitat (i.e., rocks, soil, water). A key difference in Anishinaabe worldviews is that humans are not at the top of a hierarchical arrangement in nature (Callicott & Nelson, 2004; Kimmerer, 2015). Humans are one of many components of complex systems, and our actions, intentional or otherwise, can disrupt the balance of biological communities. The importance of proper relationships with nature has long been recognized and valued by Anishinaabe peoples (Benton-Banai, 1988; Callicott & Nelson, 2004; Danielson, 2002; Geniusz, 2009; Geniusz, 2015; Johnston, 1976; Kimmerer, 2015; Wilson, 2008).

With Anishinaabe environmental worldviews as a foundation, in this paper, we expand on previous research on relationships in forested wetland communities in northern Michigan (Kozich et al., 2021; Wilson, 2008). The northern Great Lakes region is characterized by the abundance of forested wetland ecosystems known as rich conifer swamps. These diverse ecosystems are also commonly called “northern conifer wetlands” (Dickmann & Leefers, 2016), “cedar swamps” (Kost, 2002), and “lowland swamps” (Pregitzer, 1990). They are often adjacent to lakeshores and streams as riparian ecosystems. In these low-lying settings, the swamps are often fed by cold groundwater as it slowly moves down-slope (Kost, 2002). The constant supply of groundwater, and the mineral nutrients it carries, results in rich, peat-accumulating soils that can support high biodiversity (Kost, 2002; Pregitzer, 1990).

Many conifer trees (trees with year-round needles) are adapted to the damp conditions of rich conifer swamps and create dense shade and cool micro-climates that benefit many other organisms. Mosses, lichens, liverworts, and many amphibian species are common in rich conifer swamps, including over 30 plant and animal species that are considered rare (Kost, 2002). The shaded conditions also help keep streams cool by minimizing heat and evaporation due to sun exposure (Johnson, 2004; Kost, 2002). Many fish species, including brook trout (*Salvelinus fontinalis*; Ojibwe: *maazhamegoons*), rely on the cold-water stream habitats common to rich conifer swamps (Jobling, 1981; Nuhfer et al., 2015). The roots of large conifers along stream-banks provide valuable habitat structure and protective cover for fish (Anglin & Grossman, 2013; VanDusen et al., 2005). Downed trunks and branches over streams create shady pools of deeper water required by brook trout (Kost, 2002). The canopy of conifer trees thus plays a key role in the balance of these diverse and intricate systems.

Four conifer species stand out as key components of rich conifer swamps, with northern white cedar (*Thuja occidentalis*; Ojibwe: *giizhik*) as the most characteristic of the group. Cedar belongs to the genus *Arborvitae*, which means “tree of life” in Latin (Barnes & Wagner, 2004; MSU, 2015). It provides critical winter cover and food for white-tail deer (*Odocoileus virginianus*; Ojibwe: *waawaashkeshi*) and many other animal species. It is strong, slow-growing, and shade-tolerant, and it displays remarkable abilities to adapt and survive in

otherwise harsh habitat conditions. It is tolerant of saturated, acidic soils and can survive after being tipped or even toppled by wind, which is a common occurrence with trees in wet habitats due to shallow root systems (Barnes & Wagner, 2004; Danielson, 2002; Kost, 2002).

Cedar is one of the most sacred plants in Anishinaabe culture, representing health and the continuity of life and is used for purification of the body and spirit (Geniusz, 2015; Johnston, 1976). Stories and songs about "Grandmother Cedar" illustrate the Anishinaabe view of plants as relatives (Geniusz, 2015). It is present at ceremonies such as sweat lodges, drum circles, and powwows. Its medicinal properties as a tea are helpful in treating coughs, headaches, and blood ailments (Danielson, 2002; Dickmann & Leefers, 2016; Meeker et al., 1993). Cedar leaves are often placed in shoes to ensure safe travels and are hung above doorways to purify homes (Benton-Banai, 1988). Its strong, rot-resistant wood has many uses on lodges, canoes, and utility items. The many gifts cedar provides are summarized in a story by Nancy Jones (2013):

And then there is the next one. The cedar tree, that was another one that was asked, "How will you help the Anishinaabe?" Nanabosh asked. "Oh there are a lot of ways I can help the Anishinaabe," he said. "When somebody has a child, when a couple has a child, they will use my wood to make the cradleboard," he said. "I will give him all the love that I have to offer to the child. I shall bestow many visions onto him for the duration that he is in the cradleboard. And he shall dream too. The child will have healthy bones, have a straight spine, strong and straight bones just be totally healthy if one uses the cedar. I have many uses that I can give them, when they want to make medicine from my being a tree. When someone is making a canoe that is one use that will be used to make the strips of cedar on the bottom when someone makes it. They can make a cedar bark covering for their shelter when they want to stay warm during the winter." That is the one, the cedar bark, that will be utilized for a roof covering. And also these trees they will make other things like rice knockers, how it was said. This is where it will come from. "There are many ways I can help the Anishinaabe. I shall care for them too" (pp. 106-107).

Stories like the one above illustrate the wide-ranging values of traditional ecological knowledge (TEK) in Anishinaabe culture. Aside from highlighting its variety of human uses, cedar is personified as a relative that can communicate about the gifts it can offer. By presenting non-human species as sovereign beings, foundations for respectful and non-hierarchical relationships can be established (Callicott & Nelson, 2004; Kimmerer, 2015). Cultural worldviews established and shared through traditional stories like this result in the 'balance with nature' that is so often associated with Indigenous peoples (Booth, 2003; Callicott & Nelson, 2004; Geniusz, 2015; Johnston, 1976; Jones, 2013; Kimmerer, 2015).

Like cedar, hemlock (*Tsuga canadensis*; Ojibwa: *gaagaagimizh*) is a slow-growing, long-lived conifer tree historically common to forests of the upper Great Lakes region. Although it is common on drier upland forests, it is also tolerant of the damp, shady conditions of rich conifer swamps (Barnes & Wagner, 2004; Geniusz, 2015; Kost, 2002; Meeker et al., 1993).

Hemlock's dense foliage provides important habitat for many wildlife species, including deer, rabbits, and porcupine (Geniusz, 2015). Like cedar, hemlock has many medicinal properties. For example, Anishinaabe peoples have traditionally used twigs as a treatment for dysentery and needles to make a rich medicinal tea (Meeker et al., 1993). Deer appear aware of the antiseptic properties of hemlock as well; it is believed that they seek refuge in the litter beneath hemlocks to treat impacts from skin injuries and parasites such as worms and insects (Geniusz, 2015).

Balsam fir (*Abies balsamea*; Ojibwa: *aninaadag*) is a short-lived tree that is similarly common to rich conifer swamps, although it appears most often as a shade-tolerant understory tree more often than a canopy-level dominant one (Barnes & Wagner, 2004; Geniusz, 2015; Kost, 2002; Meeker et al., 1993). Balsam fir has numerous medicinal uses, as a treatment for headaches, colds, and ailing joints, among others (Meeker et al., 1993). Its pitch can be used as an effective sealant and water-proofer for canoes and baskets (Dickmann & Leefers, 2016). Nancy Jones re-tells additional stories of its uses:

Oh me too, I shall help in many ways. For instance, when the Anishinaabe makes camp, they will use my boughs as a floor when they need something to lie on. And for instance these things, the way I look, it is if someone pokes at the lumpy pitch, the blistery part of that tree, from there they will get medicine. The medicine they will get from here, and they will know later on how to use this medicine. There is a reason for why I look like this, when the tree has all this sticky pitch. There are many uses for this. They will use this for flooring, and others will use this when they make medicine. They will have dreams as to how to use it (Jones, 2013, p. 107).

Black spruce (*Picea mariana*; Ojibwe: *gaagaagiwanzh*) is remarkably tolerant to harsh habitat conditions, including cold climates and saturated, acidic bogs (Barnes & Wagner, 2004; Geniusz, 2015; Kost, 2002). Black spruce is also common in rich conifer swamp communities, and Anishinaabe peoples have long known its many important uses. Its roots are strong and pliable and can be used as various-sized cords to tie nearly anything (Dickmann & Leefers, 2016; Geniusz, 2015). Like balsam fir, its pitch is very resinous and makes an effective sealant (Dickmann & Leefers, 2016). The inner bark can be ground up and used as a medicine to treat a wide range of ailments (Dickmann & Leefers, 2016; Geniusz, 2015). Its needles are rich in vitamin C and can be used as a medicinal tea (Geniusz, 2015; Meeker et al., 1993).

Relationships in rich conifer swamp ecosystems are delicate and complex, with subtle changes capable of disrupting their natural balance. Many disturbances in rich conifer swamps are easily attributable to human activities (e.g., climate change, careless timber harvesting, and hydrological changes). Other disturbances, however, are less obvious and may only be noticeable over long time scales as forest communities undergo gradual changes. A current concern among ecologists is the decline of cedar across the Great Lakes region, and its cause is widely agreed to be a trophic cascade, or a food chain domino effect, involving gray wolves (*Canis lupus*; Ojibwe: *ma'iingan* and white-tail deer (*Odocoileus virginianus*; Ojibwe: *waawaashkeshi*). Wolves are a top predator across the forests of the

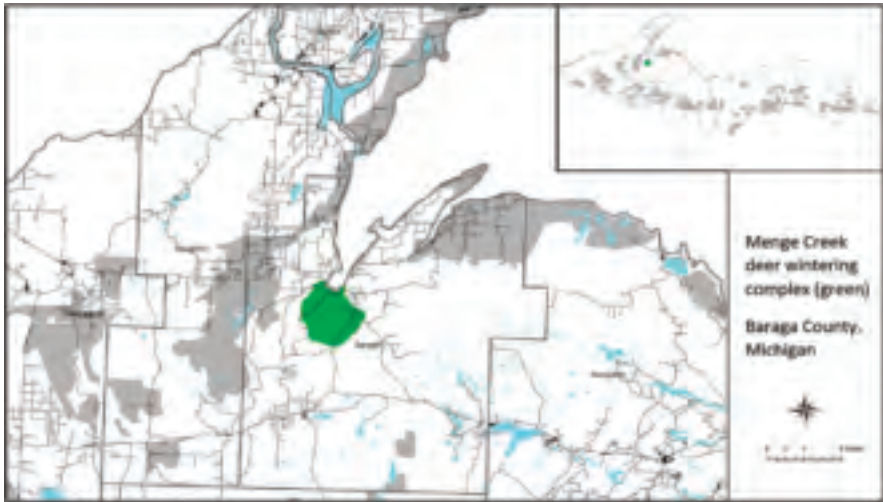
northern Great Lakes region, and deer are among their preferred prey. Deer, in turn, consume cedar leaves as a primary food source. When wolf populations are not capable of keeping deer populations in balance, deer populations dramatically increase. Their overpopulation, in turn, results in a dramatic decrease of cedar, which has been demonstrated by abundant literature (Cornett et al., 2000; Forester et al., 2009; Reuling et al., 2019; Rooney, 2001; Van Deelen et al., 1996; White, 2012). Other studies have found similar impacts to hemlock, another preferred food source of deer (Anderson & Loucks, 1979; Borgmann et al., 1999; Frelich & Lorimer, 1985; Rooney et al., 2000; Rooney & Walker, 2003; Salk et al., 2011). It appears that the human preference for reduced wolf populations is altering the species composition of rich conifer swamps, which could result in wide-ranging ecological and cultural impacts as other species emerge as dominants in the absence of mature cedar and hemlock (Danielson, 2002; Rooney & Walker, 2003; Salk et al., 2011; Van Deelen et al., 1996; Waller & Alverson, 1997; White, 2012). The common finding across the literature is that small cedar and hemlock seedlings are largely protected under winter snow-pack, but as they grow, they become susceptible to browsing by deer (with few reaching maturity). Our research goal was to quantify survival rates across several tree species in a rich conifer swamp to infer how deer browsing could be affecting species composition of the ecosystem.

Methods

Our objectives with this mixed-methods research were to expand on our previous studies of relationships in floodplain forests involving tree species composition, canopy density, and groundwater inflow (Kozich et al., 2021). In this paper, we explore relationships between the tree community and wildlife species that inhabit them. The study site is within the L'Anse Indian Reservation, home of the Keweenaw Bay Indian Community (KBIC). We compared the regeneration of cedar, hemlock, balsam fir, and black spruce along Menge Creek (Figure 1), a small second-order stream that traverses dense forest communities. Many floodplain areas of Menge Creek feature rich conifer swamps, and the watershed as a whole is recognized as an important deer wintering complex by the Michigan Department of Natural Resources (MDNR, 2015).

Figure 1

Menge Creek deer wintering complex (image: MDNR, 2015)



Our research team included faculty from Keweenaw Bay Ojibwa Community College (KBOCC) with a combined background in ecology, forestry, and data analysis. Two KBOCC Environmental Science majors assisted with this project, including one whose contributions served as the foundation of the required Capstone independent research project he successfully defended for his fall 2020 graduation. The research team included KBIC tribal members and descendants.

Following Indigenous research methods, members of the research team gained preliminary community insight through informal discussions with key knowledge-holders (e.g., elders, natural resource personnel, nearby residents), exchanged knowledge with each other throughout all steps of project, and treated all inhabitants of our study site as our relatives (Wilson, 2008). Research protocols were approved by key KBIC personnel, including the KBIC Tribal Council and the KBOCC Institutional Review Board. Preliminary findings were shared with the KBOCC community by a student research assistant in December 2020 as part of his capstone research project. Applications of this work, through this paper, are intended to support Indigenous knowledge, sovereignty, and nation-building.

Our project design was guided by community insight through an online survey conducted in April 2020. The survey was conducted by a student research assistant with the goal of capturing a glimpse of community perspectives on topics such as the importance of cedar, the current state of deer herd management, the role of hunting, and diminished wolf populations in the area. The survey was promoted for two weeks through all KBOCC social media outlets. It contained 15 Likert-scale questions and two open-ended questions for

respondents to share any additional knowledge, observations, or opinions (see Appendix 1 for the full list of survey questions). Participation was voluntary and without compensation. All respondents provided their informed consent and were aware that their participation assisted in KBOCC scholarly research.

Figure 2

Location of sampling plots along Menge Creek



In summer 2020, we selected our study area along Menge Creek (Figure 2). We chose a study area within the vicinity of our previous research that we suspected to fit the profile of a rich conifer swamp. After reviewing topographical maps, we examined the site in person to confirm the plant community, floodplain gradients, groundwater seepage, and saturated peat-accumulating soils that are characteristic of rich conifer swamps (Kost, 2002). Downed trees were common across the surface as well as the stream. We documented all four tree species focal to our research (cedar, hemlock, balsam fir, and black spruce) as well as others typical of rich conifer swamps such as yellow birch (*Betula alleghaniensis*; Ojibwe: *wiinizik*), white spruce (*Picea glauca*; Ojibwe: *gaawaandag*), red maple (*Acer rubrum*; Ojibwe: *zhiishiigimiwanzh*), and mountain maple (*Acer spicatum*; Ojibwe: *zhaashaagobiimag*). All characteristics of this site were determined to represent rich conifer swamps, as described in ecology literature (Kost, 2002). See Figures 3 and 4.

Figure 3

Rich conifer swamp community of Menge Creek



Figure 4

A cedar seedling in sample plot #7



We used transect and quadrat sampling to inventory our four focal species at the study site. We established two parallel transects, one on each side of Menge Creek. Each transect contained five sample plots (quadrats) equally spaced 40 meters apart from each other. Each of the 10 sample plots was 6 meters by 6 meters in area. Within each sample plot, we counted all individual cedar, hemlock, balsam fir, and black spruce trees. Following methods common across the literature, we then separated all individuals into three size classes based on height (Cornett et al., 2000; Frelich & Lorimer, 1985; Reuling et al., 2019; Rooney, 2001; Rooney et al., 2000; White, 2012):

- Class 1 = <0.5m tall (small seedlings protected under snowpack in winter)
- Class 2 = 0.5m to 3m tall (saplings vulnerable to browsing by deer)
- Class 3 = >3m tall (trees not vulnerable to browsing)

For statistical analysis, we separated the four tree species into two groups based on deer feeding preference. We characterized cedar and hemlock as 'browsed' because they are known as preferred food sources. Balsam fir and black spruce were characterized as 'unbrowsed' since they are unpalatable food sources. Our assumption was that if browsing is not affecting recruitment (the progression from seedling to maturity), all four species will demonstrate similar distributions of individuals across all size classes. However, since our study site is in a known deer wintering complex, we hypothesized that the recruitment rates of cedar and hemlock from class 1 to class 2 would be significantly lower than that of balsam fir and black spruce.

We did not monitor actual deer behaviors through field cameras or other such devices. We did not exclude deer from our sample plots through fencing or other deterrents. Since our study area is in a known deer wintering complex, and over-browsing is a well-documented phenomenon in our area, we made a simple but critical assumption that survival rates of individual trees across size classes are reflective of deer browsing behaviors (Cornett et al., 2000; Reuling et al., 2019; Rooney & Walker, 2003; White, 2012).

Results

Thirty-nine KBIC Tribal members and descendants completed our community survey. Among notable trends, respondents expressed the value of cedar, as 82% agreed that cedar is a culturally important tree to them. Respondents appeared less certain about the cultural value of hemlock, with 41% agreeing and 54% expressing no opinion. Respondents appeared fairly aware of potential impacts from deer browsing, as 59% agreed that too many deer could affect cedar and hemlock populations (31% had no opinion); however, only 49% agreed that cedar and hemlock are in decline in our area (48% expressed no opinion). Regarding wolf populations, 62% agreed that wolves are important for keeping deer populations in control. As for the open-ended questions, 24 respondents shared thoughts about deer populations in our area, 17 of whom expressed that the local populations are high. We received fewer comments about cedar and hemlock populations (15), with no discernable trends in responses.

Data from our sampling plots are shown in Table 1. The total individuals and relative abundance across all four species were fairly even in the class 1 size (seedlings), but cedar and hemlock almost disappeared in class 2, where black spruce was clearly dominant.

Table 1

Data from our 10 sampling plots, comparing total individuals and relative abundance across all species and size classes.

		Species	Class 1	Class 2	Class 3
Browsed species	Cedar	N	257	2	50
		%	29.1%	1.2%	64.1%
	Hemlock	N	229	5	13
		%	25.9%	3.0%	16.7%
Unbrowsed species	Balsam fir	N	219	53	9
		%	24.8%	32.3%	11.5%
	Black spruce	N	178	104	6
		%	20.2%	63.4%	7.7%

N = total individuals; % = relative abundance.

We hypothesized that cedar and hemlock are disproportionately experiencing a lack of progression from size class 1 to size class 2. While the evidence in Table 1 seems to make this statement clearly, we used several measures to test the hypothesis statistically. An independent-samples t-test was run to determine if there were differences in populations between classes. There were no outliers in the data, as assessed by inspection of a boxplot. Populations for each class were normally distributed, as assessed by Shapiro-Wilk's test ($p > .05$), and there was homogeneity of variances, as assessed by Levene's test for equality of variances ($p = .335$). Between the two groups of tree species, there is a statistically significant difference in the populations of groups between class 1 and class 2 ($p = .001$). Although our methods prevent us from proving that deer are the cause (i.e., no behavioral observations), our hypothesis is supported. Cedar and hemlock are not progressing to larger size classes at a similar rate to balsam fir and black spruce.

Additional analytical steps yielded results consistent with the test results above. For instance, there were no significant differences between the two transects (east bank plots versus west bank plots). Ungrouping the browsed and unbrowsed species made no statistical difference either. It is very clear that in our study plots, something is causing severe mortality in cedar and hemlock seedlings as they grow beyond 0.5 meters in height.

Discussion

Our interests with this ongoing research are to continue learning about relationships between other-than-human species within the setting of the rich conifer swamp communities of Baraga County, Michigan. We began in 2015 by implementing a stream temperature monitoring program for waters of our area that provide critical habitat to cold-water fish

species with study sites including Menge Creek. We then expanded the scope of our work to investigate relationships between forest canopy cover and water temperatures in Menge Creek (Kozich et al., 2021). Our current interests, described in this paper, take the next step of examining relationships between the charismatic trees that inhabit rich conifer swamps and the wildlife species that rely on them for food and shelter. Throughout the journey of this work, over 20 KBOCC student assistants have gained hands-on research experience, delivered presentations at conferences, and co-authored publications in scholarly journals. Several have continued their stream-related work through ongoing employment at the KBIC Natural Resources Department, leveraging the familiarity they gained with local stream ecosystems as KBOCC students. While we are very pleased with how our work reflects Indigenous research methods, we also acknowledge that a lot remains to be learned.

Our findings on the decline of cedar and hemlock in our area are not necessarily surprising, as numerous other scholars and practitioners across the Great Lakes region have noted the same phenomena with deer browsing as the apparent explanation (Borgmann et al., 1999; Cornett et al., 2000; Forester et al., 2009; Reuling et al., 2019; Rooney et al., 2000; Rooney, 2001; Rooney & Walker, 2003; Salk et al., 2011; Van Deelen et al., 1996; White, 2012). This appears to be a complex issue to resolve. To restore balance to the area's forest communities, the apparent solution would be to simply reduce deer populations so cedar and hemlock seedlings can successfully reach maturity. Research involving exclosures such as fences has shown that tree populations can dramatically increase without the browsing pressures of deer (Anderson & Loucks, 1979; Cornett et al., 2000; White, 2012).

However, as Waller and Alverson note (1997), deer herd management for reduced populations is feasible in ecological aspects but challenging in human aspects. Many hunters and passive wildlife viewers prefer abundant deer and would likely disapprove of intentionally reduced populations. The restoration of wolf populations to historic levels, as a means to cull deer herds, is similarly problematic among much of the public as well, often due to safety concerns or anticipated impacts on farm animals or pets. The continuation of high deer populations in the Great Lakes region is expected to result in further long-term impacts to the species composition of forest communities due to losses of cedar and hemlock (Frelich & Lorimer, 1985; Salk et al., 2011; Van Deelen et al., 1996; Waller & Alverson, 1997; White, 2012).

Further complicating matters in our research setting, KBIC members may not view increased hunting as a feasible solution for reducing deer herds. In previous research, we described local fishing harvests that have never approached sustainable quotas, and many survey participants cited harassment from the non-Native community as a factor (Kozich et al., 2020). With ongoing controversies surrounding treaty rights, and fears among Tribal members exercising them, it seems reasonable that 'more hunting' may not be a simple solution to restoring ecosystem balance.

In our previous Menge Creek research, we found evidence of forest tracts within the watershed that already appeared to be transitioning towards other dominant tree species as cedar and hemlock have been reduced (Kozich et al., 2021). In all sample plots, cedar was

only present in large, mature individuals as midstory layers were dominated by balsam fir, black spruce, or red maple (Kozich et al., 2021). Findings from this updated expansion of our work are very similar, indicating that long-term trends are already in motion and cover an area of the floodplain larger than previously known.

Long-term reductions of cedar and hemlock pose cultural impacts for future generations of Anishinaabe peoples. Respondents to our community survey expressed cultural values associated with these trees as well as concerns about their sustainability. The potential inability of future generations to collect cedar and hemlock could alter long-standing ceremonial traditions and provide fewer medicinal options. Even if cedar populations do remain intact in some areas, access to them could be difficult for elders considering the remote and rugged nature of the region. Although the Anishinaabe are undoubtedly adaptable people, there seems to be a degree of tragedy involved with ecological and cultural impacts that are theoretically preventable. If Anishinaabe worldviews regarding balance, respect, reciprocity, and relations could gain traction with the non-Indigenous public and relevant decision-makers, perhaps the trend of forest community impacts could be reversed and some semblance of natural balance could be restored. Re-examining human roles in nature, following Indigenous teachings, seems to be the critical first step in this regard. Otherwise, due to the ongoing colonization of nature-based on human preferences (i.e., few wolves), permanent changes to forest communities seems inevitable (Fischer-Kowalski & Haberl, 1998).

Our research in this area will continue, and we are excited about many possibilities for expansion. A limitation with our current progress is that we took no measures to definitively prove that deer browsing is the cause of cedar and hemlock mortality. Although our data (and parallel research in the literature) clearly support this notion, an opportunity for follow-up would be to employ field cameras to record deer behaviors in study plots. Partners in the KBIC Natural Resources Department can likely offer assistance and wisdom with this task. With adequate funding, another opportunity would be to replicate a deer enclosure experiment in study plots over a number of years to examine possible changes in cedar and hemlock survival compared to non-enclosed plots. Other studies have found that seedlings' surroundings, including the presence of other species as deer deterrents, can reduce browsing (Borgmann et al., 1999). As wolf-deer-plant relationships appear to be a topic of much interest in our community, we are excited for whatever directions our efforts will involve next.

Conclusion

In keeping with Indigenous research methodology, all KBOCC Environmental Science research is place-based, community-based, and is intended to provide tangible benefits to those who call this sacred area home. All persons involved in this research are from the local community and have vested interests in our study sites and our research findings. To each of us, our research is sacred in our own respective ways. As continuous learners, our projects involving stream, forest, and wetland communities will continue and expand. As we learn more about the complex wetland ecosystems in our area, we will continue sharing what we

learn with the local community and all interested scholars and practitioners who can benefit from our efforts.

Acknowledgements

We acknowledge that our study area lies within ancestral, traditional, and contemporary lands and waters of many Indigenous nations, including the Anishinaabe. We also acknowledge our many more-than-human relatives who call this region home and have done so since time immemorial. As the original caretakers of these lands and waters, we are most grateful to all our relatives, and we thank all who practice stewardship and care today in partnership with local, state, federal, tribal, and other governance entities throughout the Great Lakes region.

This research was funded by the U.S. Department of Agriculture National Institute of Food and Agriculture's Tribal College Research Grants Program, award #2021-38424-33454. We thank the KBIC and KBOCC administrators who supported our research, the community members who shared their knowledge through our survey, and KBIC Wildlife Biologist Erin Johnston for the valuable guidance provided. We also appreciate the editorial staff of Tribal College and University Research Journal and the anonymous reviewers who helped improve the quality of this manuscript.

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Andrew Kozich is the Environmental Science Department Chair at KBOCC, with a background in forestry, water resources, environmental policy, and Anishinaabe Studies. As the mentor of 20 or more Environmental Science majors per semester, he guided this student-led research project and contributed the majority of the writing.

Karen Colbert is the lead Math faculty at KBOCC and serves as a data analyst and consultant on special research projects (including student-led research). Karen is a PhD student in Computational Science and Engineering at Michigan Technological University, with research grounded in improving data analytics assessments for Indigenous communities.

Gerald (Jerry) Jondreau is a KBOCC adjunct instructor in courses focusing on forest resources and Anishinaabe culture. He has served as the KBIC Tribal Forester and is the owner of Dynamite Hills Farms, where he and his family produce natural foods such as maple syrup. Jerry is an enrolled member of the Keweenaw Bay Indian Community.

John Lusty is a fall 2020 KBOCC Environmental Science graduate (with honors). The research presented in this manuscript represents an expansion of the work John completed for his required capstone independent research project. He and Dr. Kozich designed the project, conducted the literature review, and led the data collection.

Victoria Ripley is a current KBOCC Environmental Science major who assisted with data collection for this project. She is a valuable student assistant in departmental research projects involving stream ecology, fisheries management, and groundwater contamination. Victoria is a descendant of the Keweenaw Bay Indian Community.

Appendix 1: Questions contained in community survey, conducted April 2020.

1. What is your age?
2. Are you a KBIC Tribal member or descendant?
3. How long have you lived in Baraga County?
4. Cedar is a culturally important tree to me.
5. Hemlock is a culturally important tree to me.
6. Wolves are important for helping control deer populations in our area.
7. Conifer tree species such as cedar and hemlock are declining in our area.
8. Our area should consider expanded hunting to help control deer populations.
9. Cedar and hemlock trees are vulnerable to harm from deer over-population.
10. Climate change could threaten cedar and hemlock populations in our area.
11. Logging is negatively affecting cedar and hemlock populations in our area.
12. Other human activities could be harming cedar and hemlock populations in our area.
13. I am concerned about nature being out of balance in our area.
14. Please share any observations you've made about changes in cedar and hemlock populations in our area.
15. Please share any thoughts on current deer populations in our area.

Note: questions 4-13 used a 5-point Likert scale.

Recruiting Native Students into Science: Evaluating the Impact of Biomedical Genetic Research at Turtle Mountain Community College

Tyler J. Parisien, Lyle Best, Pat Conway, and Gena Grant
Turtle Mountain Community College

Increased minority representation in STEM fields is needed to create a STEM workforce that represents United States' diversity and incorporates Indigenous ways of knowing (NACME, 2016). Eagan et al. (2013) found that participation in an undergraduate research program significantly increased students' intent to enroll in a STEM degree program. This qualitative research study sought to discover how students' participation in biomedical genetic research at Turtle Mountain Community College (TMCC) impacted their educational and career paths. Data were gathered through a brief demographic questionnaire and semi-structured interviews with 10 former student research assistants in the biomedical genetics research program at TMCC. Through manual coding, the data were analyzed to answer the research question. Students described how TMCC research experiences directly impacted their educational and career paths with students indicating that the experience had prepared them for future careers in research. The study's findings provided strong evidence that working as a student research assistant at TMCC positively impacted participants' knowledge, skills, self-efficacy, and community.

Keywords: research, self-efficacy, STEM, tribal colleges and universities, career

The purpose of this qualitative case study was to explore how participation in biomedical genetic research at TMCC impacted students' educational and career paths. College freshmen student's initial interest in majoring in science, technology, engineering, and mathematics (STEM) disciplines has increased, especially with underrepresented racial minority students (Eagan et al., 2013). Many organizations and colleges are working to increase the numbers of underrepresented racial minority students in STEM fields. There is a considerable need to increase minority representation in STEM fields in order to create a STEM workforce that represents the diversity of America and incorporates Indigenous ways of knowing (NACME, 2016). Eagan et al. (2013) found that participation in an undergraduate research program significantly increased students' probability of intent to enroll in a STEM degree program.

Despite substantial advances and extensive efforts to bridge the gaps, a significant divide remains between the educational attainment of minority students and their majority peers (Carpi et al., 2016). According to the National Science Foundation (NSF, 2019), the percent of science and engineering degrees earned by American Indian and Alaska Natives (AI/AN) dropped between 2000 and 2017 from 0.7% to 0.4%. The seemingly decreasing presence of Native American people in STEM disciplines has been attributed to many reasons. For

example, Indigenous people often have trouble picturing themselves in a STEM career due to a lack of perception of ability to overcome barriers, lack of role models, stereotypic images of scientists, cultural differences, and society presenting STEM as a place not for Indigenous people (Parisien, 2020; Williams & Shipley, 2018).

Federal funding, through the National Science Foundation (Instructional Capacity Excellence in TCUP Institutions, ICE-TI) and National Institute of Health (IDeA Network of Biomedical Research, INBRE), has supported academic programs to increase Native Americans' participation in STEM programs (National Academies of Sciences, Engineering and Medicine, 2017). The purpose of this study was to describe one tribal college's experience with an INBRE-funded program to increase interest in STEM careers among Native American students in a rural, upper Midwest tribal community. In this paper, the authors will discuss factors that influence AI/AN students' retention and success in STEM programs, the Biomedical research program at TMCC, and the findings of this study.

Factors Influencing College Success

Keith et al. (2016) conducted a literature review and identified seven factors that influenced AI/AN students' college retention and graduation and the factors impacted on educational goals and achievement (p. 699):

1. Characteristics of AI/AN students (more likely older, female, single parents, and have strong family ties than other students);
2. academic preparation (underprepared for college);
3. cultural values and strengths (cultural discontinuity hypothesis and macrostructural explanations);
4. self-efficacy (an individual's belief in their capacity to execute behaviors necessary to produce specific results, like success in a STEM field);
5. personal disposition, including personal goals and level of motivation (a person's true character, attitude and outlook that leads them to act in a certain way or perform an undertaking);
6. college experiences (such as mentoring, especially in the first year); and
7. higher education institutions, including tribal colleges, community colleges, and 4-year institutions (support services and programming to support Indigenous people).

Research reviewed by Keith et al. (2016) found that addressing self-efficacy in an educational environment can help Indigenous students feel more capable of success. Native American people also have a strong connection to their culture. When there is a connection between culture and goals, there is a greater sense of self-efficacy that can assist in helping Native American people feel more capable of success.

Cultural Values and Strengths

The third factor, cultural values and strengths, is related to the cultural discontinuity hypothesis. It suggests that “underrepresented minority college students,” including Native American students, may experience discontinuity between their cultural value of communal (prosocial) goals. This includes strong family ties and giving back to their community (Jackson et al., 2016), and values associated with STEM careers. Boucher’s (2017) research regarding a similar concept, communal goal incongruity and women’s pursuit of careers in STEM, stressed the importance of demonstrating how students can achieve communal (prosocial) goals. One way to achieve this may be to include content regarding the importance of prosocial utility value in textbooks (Zambrano et al., 2020).

Lee (2018) focused on the concept of responsibility to community and identified crystallized identity as one way to support multifaceted perspectives, including responsibility to community. Lee (2018) suggested that being able to hold different facets of values, both prosocial and STEM, allows one to persist and to successfully complete a STEM degree. Page-Reeves et al. (2017) found that even though there are significant differences in background – geography, discipline, and work sector – Native American STEM professionals found strength in their identity. Data suggests that a strong sense of Native “self” is something that interviewees drew on for strength and that provided them with the foundation for their success in STEM (Page-Reeves et al., 2017; Parisien, 2020). Both Page-Reeves et al. (2017) and Parisien (2020) reaffirmed the importance of ethnic identity for the persistence of Native American students in STEM programs and careers.

Keith et al.’s (2016) review of related research included family support in two factors, sociodemographic characteristics and cultural values and strengths; they described both the strengths and barriers associated with family ties. In his review of the literature regarding factors influencing AIAN postsecondary persistence, Lopez (2018) also noted the mixed influence of family including family support through encouragement and motivation and family obligations that lead to a decision to leave college.

Lopez (2018) identified institutional support (e.g., support services, faculty instruction and mentoring, and financial support) and tribal community support, which might also be both a support and a challenge. Student’s motivation to give back to their community, connection, and culture may also be both supportive and a challenge because of conflicts between university and tribal cultures. Both Lopez (2018) and Keith et al. (2016) identified K-12 academic preparation as an important factor influencing success in completion of a STEM degree. In an attempt to supplement academic preparation, and to bridge a gap between STEM and cultural values, a STEM research opportunity was brought to a tribal college campus.

TMCC’s Biomedical Genetic Research Program

The North Dakota IDeA Network of Biomedical Research Excellence (NDINBRE) was created to build the research capacity of the four baccalaureate institutions in the state and to increase participation of underrepresented individuals in STEM careers through partnerships with tribal colleges (Conway et al., 2012; Sens et al., 2017). NDINBRE is funded by the

National Institute of Health (NIH) through Institutional Development Awards (IDeA). The NDINBRE has partnered with North Dakota tribal colleges, including Turtle Mountain Community College's (TMCC) Biomedical Genetic Research Program, since 2004.

Dr. Lyle Best taught "Introduction to Human Genetics" at TMCC from 1998 through 2011 and was intrigued by the idea that engaging tribal college students in an ongoing biomedical research study could bring genetics into sharper focus as an area of science and could contribute to improved health. Additionally, implementing a biomedical research study would serve as an explicit effort to recruit Native students into a STEM field. On a broader scale, involvement of students in such a study could provide (a) "hands-on" experience in research design, (b) the ethical and regulatory considerations in human subject research, (c) statistical analysis and translation of results to the participants, and (d) the tribal community and the scientific community through publication. In addition to the above, the DNA obtained in a genetics study would be analyzed in the TMCC laboratory by the students, giving them valuable technical expertise to enhance future academic or job success. Dr. Best acted on this idea and pursued funding from NDINBRE. Through this collaboration, the TMCC Biomedical Genetic Research Program was established. Dr. Best's tenure as a family practice physician established his interest in pre-eclampsia, which would end up being the primary focus of genetic research at TMCC.

Pre-eclampsia (sometimes called "toxemia") of pregnancy is an inflammatory state that occurs in about 7% of pregnancies worldwide, including American Indian populations (Best et al, 2017). In developed countries, it can usually be detected during prenatal care and the mother - if/when it begins to threaten her life (even though this often puts the infant in danger due to prematurity). Genetic risk factors influencing pre-eclampsia were chosen as a study question because it offered a relatively well-defined phenotypic endpoint for analysis, occurring at an early life stage (as opposed to cancer, for instance) and thus well suited for a case-control design study.

Although research at TMCC's genetics lab primarily focused on pre-eclampsia, the equipment and student workforce allowed for expansion and collaboration with other genetic research projects. The program at TMCC also collaborated with and provided laboratory services for three other genetic research studies investigating genetic influences on asthma, infant obesity, and the effectiveness of an anti-clotting medication, giving students experience in other areas of medicine. Through this experience, students have quickly become adept at laboratory procedures and have greatly increased their understanding of the other elements of successful biomedical research programs. Student research assistants have been contributing authors on the seven peer-reviewed publications derived from the study. So far, 49 students have participated in the Biomedical Research program at TMCC since its inception.

Higher education is an essential tool for capacity building and assisting Native American communities in reaching their goals of self-determination and self-government. In order to better assist Native American people, we must first understand their unique needs and how programs can or have fostered success. Additionally, society presents STEM as not a place for

Native American people. However, there is a need for the STEM workforce to incorporate Indigenous ways of knowing and to represent the diversity of America (NACME, 2016). Based on the literature above, there is a significant reason for thinking that an investigation examining the experiences of student researchers would yield socially significant findings. This investigation was pursued to answer the following research question: How has participation in biomedical genetic research at TMCC impacted students' educational and career paths?

Methods

This study employed community-based participatory research principles and was a collaborative study that included TMCC faculty and a student intern from the TMCC Education program. Approval for this study was received from TMCC's research committee and the Turtle Mountain Tribe's Tribal Nations Research Group (TNRG).

Case study methodology is an empirical method that investigates a contemporary phenomenon in-depth and within its real-world context (Yin, 2018). A qualitative case study allows the researcher to focus on uncovering a detailed understanding of the specific phenomenon based on rich and detailed data; data comes from subjective experiences and perceptions of the individuals sharing their stories (McMillan, 2012). This study sought to explore participants' perceptions and experiences in their own words; thus, leading to the researcher's choice of a qualitative case study approach.

Qualitative data collection included a student demographic survey (see Appendix A) and one-on-one semi-structured interviews (see Appendix B) with participants. Yin (2018) describes case study methodology as an empirical method that investigates a contemporary phenomenon in depth and within its real-world context. Additionally, semi-structured interviews allow the researcher to disclose hidden facets of human and organizational behavior because the participants respond in their best way to address the interview question (Qu & Dumay, 2011). The researchers chose semi-structured interviews as an instrument for data collection to allow for greater interaction with the participants. The interviews explored the participants' experiences conducting biomedical genetic research at TMCC and how these experiences have impacted their educational and career paths.

Description of the Sample

The principal investigator of the Biomedical Genetic Research at TMCC campus, Dr. Best, recorded the names of all the students who participated in the biomedical research project since its inception in 2004. Forty-nine potential participants were identified and contacted via email and invited to participate in this study (see Appendix C). The study includes 10 participants who agreed to participate (see Table 1). Nine were female; all were enrolled members of Turtle Mountain Band of Chippewa. Five students were in the age range of 25-34 years at the time of the interview. Seven had completed a bachelor's degree and four received an advanced degree.

Table 1.*Study Participant Demographic Information*

Participant	Tribal Affiliation	Gender		Age (at time of interview)	Degrees	Years as Student Researcher
		Male (M)	Female (F)			
Participant P1	Turtle Mountain Band of Chippewa	F		18-24	A.S., A.A.	3
Participant P2	Turtle Mountain Band of Chippewa	F		35-44	A.S.	6
Participant P3	Turtle Mountain Band of Chippewa	F		25-34	B.S.	1.5
Participant P4	Turtle Mountain Band of Chippewa	F		35-44	B.S., M.S., PhD	4.5
Participant P5	Turtle Mountain Band of Chippewa	F		25-34	A.S., A.A., B.S.	1.5
Participant P6	Turtle Mountain Band of Chippewa	F		25-34	A.S., A.A.S	<1
Participant P7	Turtle Mountain Band of Chippewa	F		25-34	A.S., A.A., B.S.	3
Participant P8	Turtle Mountain Band of Chippewa	F		45-54	B.S., M.S.	<1
Participant P9	Turtle Mountain Band of Chippewa	F		34-44	B.S., M.S.	1
Participant P10	Turtle Mountain Band of Chippewa	M		25-34	B.S., M.S.	1

Data Collection

Data for this study was collected over a period of three months from the ten former student research assistants who responded to the invitation. Each participant was given detailed information about the study; they then signed an informed consent form prior to filling out a google forms demographic questionnaire. Once informed consent was obtained and the questionnaire was completed, a one-on-one semi-structured interview was conducted virtually using Zoom.

Data Analysis

Recordings of the interviews were transcribed utilizing speech-to-text software (Rev); the researcher read each of the ten transcription files carefully using personal judgment and context as critical factors in organizing and analyzing the data. The researcher then created codes and coded the interviews. Codes were a word or short phrase that symbolically assigned a summative, salient, essence-capturing, and/or evocative attribute for a portion of language-based or visual data (Saldaña, 2013). A case study researcher has no formulate,

recipe, or software like statistical analysis to produce the outcome from the data (Yin, 2018). The researcher coded transcriptions utilizing pattern matching techniques (Yin, 2018). After coding the data and organizing the data into topics, the topics were further condensed into themes based on their meaning.

Results

This study intended to explore how participation in biomedical genetic research at TMCC has impacted students' educational and career paths. The perceptions and experiences of former student research assistants allowed their stories to be told and provided examples of how research opportunities at tribal colleges and universities affected their lives. Four primary themes emerged from the data: (a) Experience, (b) Opportunities, (c) Education, and (d) Community.

Theme 1: Experience

The theme for experience emerged from the codes of research, conferences, poster presentations, and publishing. Study participants discussed the impact of the experience of getting to do research, attending conferences, and presenting their findings through either poster presentations or publications. Some participants stated that they did not feel like they were "smart" enough to conduct research until they had the opportunity to participate in the TMCC project. For example, Participant P1 stated:

I thought you had to be a complete genius to do research and I didn't feel like I was smart enough to be involved in research, so actually being involved in the research and learning about the actual process of it made me feel more comfortable with it.

Participant P4 stated: "...when I was there, students felt they are not smart enough to work on a genetics and preeclampsia study and how many students don't pursue an opportunity because they're fearful that they're not good enough."

Study participants spent a good deal of time reflecting on the experience they gained attending research conferences and presenting their findings through poster presentations. Participant P5 stated: "I got to do a couple presentations for the genetics lab...my first poster presentation; Dr. Best helped me a lot...my second poster I got to present at Cankdeska College." Highlighting the experience gained through researching, participant P2 stated: "because of my experiences with Dr. Best, I was already familiar with reading articles and knowing what they're about...so being part of the research lab really helped a lot with that." Underlining the importance of this experience, participant P10 stated: "This program helped me tremendously because I was a pretty outgoing person before anyway, but it opened doors per se, getting involved and presenting research." The experience participants gained through this research strengthened their knowledge base and ability to navigate higher education and STEM careers.

Theme 2: Opportunities

The theme for opportunities emerged from the codes of networking, mentoring, confidence, motivation, and career goals. Study participants often mentioned the opportunity to network with other students, the community, and other researchers. The opportunities to network and receive mentoring from Dr. Best helped build their confidence as scientists, researchers, and presenters. Former student research assistants also discussed how this program motivated them and either solidified their career goals or pushed them to pursue a career they never thought they could do. Students discussed an increase in confidence and motivation through networking and mentoring provided by Dr. Best.

Participant P4 outlined the importance of this opportunity: "I never had an interest in biomedical research but working in the biomedical research and getting familiar with it opened a lot of doors for me, and it helped me to think critically, and I learned a lot." Giving emphasis to how participation as a student researcher impacted their educational and career path, participant P5 stated: "I got to meet so many awesome people, and it just kind of changed the way that my degree was really headed, and it changed the classes that I was interested in." Participant P7 often reflected on the mentorship she received from Dr. Best, stating: "To have people that are willing to mentor you and to guide you along whatever track you want to choose and to push you to see your potential, that was the most impactful thing for me." Stressing the importance of this experience on self-efficacy, participant P3 stated: "Being able to gain that confidence and present in front of people was a big motivator for me." Participants often reflected on the opportunities they had throughout their tenure as a student researcher and how these opportunities affected their self-efficacy and motivation in higher education.

Theme 3: Education

The theme for education emerged from the codes of journal clubs, genetics courses, and INBRE Conferences. Some years while overseeing the research on campus, Dr. Best also offered a Genetics course to TMCC students, which was often mentioned by study participants. Participant P10 stated: "I was required to take his genetics class, and then we also had meetings with him and he would give us articles to read and talk about it and stuff like that...we get a better understanding like what we were doing and how to conduct research and how it works." Emphasizing the impact of the journal clubs, participant P2 stated:

Being a part of the lab really helped in a lot of ways, working under a doctor you gain a lot of knowledge and insight and I learned a lot of things I never knew, like with the weekly journal clubs. I gained a lot of insight on research and things that are going on nationwide as far as genetics and research.

Nearly every participant mentioned the opportunity to attend an INBRE conference at the University of North Dakota and discussed how that experience helped them in many ways. Participant P1 stated: "They would have this conference at UND and what you would do is the students would go and present a poster and listen to other students giving presentations on their research." Participant P7 discussed the opportunity to draw their own conclusions about

the research and pursue publications from their findings. Participant P7 also indicated that they found a passion for the research and hoped to continue pursuing studies of their own later in life. Although this opportunity was not based on education, through Dr. Best's commitment to the project, students gained valuable knowledge and education as part of their participation in the program.

Theme 4: Community

The theme for community emerged from the codes of community and public health, wanting to give back, and impact of research on the community. Participants often recalled the impact this research can or does have on the Native American community and what the discoveries made can mean for the health disparities that are seen in Indian Country. Participant P1, P2, P5 and P7 all mentioned that this experience has created an interest in them towards the public health arena, while Participant P4 has actually pursued a career in Epidemiology and works with Native American public health research. Participant P4 stated:

I told Dr. Best I am thinking about going into research and Dr. Best told me that as a researcher I'm going to have a huge community impact with the work that I do, but it often goes unnoticed...I told Dr. Best that is not important to me and once I pursued public health, it's like doors just started flying open for me.

Participants also stated that participating in this research influenced their career goals, but most of them already knew what they wanted to do. Nearly all participants stated that they wanted a career where they would have the ability to give back to their community. Participant P3 stated:

Engineering is so broad of a field, but being able to be back home and give back to the community, working with the Tribe is one of the best professional things I could ask for, I always wanted to help people and Dr. Best really broke it down and opened up a lot of resources for me to pick a career where I can give back to my community.

Highlighting the importance of this research opportunity in a tribal community, participant P1 stated:

Being involved in the research and learning about the actual process of it and everything, it made me feel more comfortable with it...especially with being involved in it in a home setting...TMCC feels like a homey atmosphere and it was more comfortable.

Jackson et al., (2016) highlighted discontinuity between Native Americans' tribal cultural value of prosocial goals, including strong family ties and giving back to their community, associated with STEM careers. The findings of this theme reinforced that notion as participants often discussed how this opportunity allowed them to give back to their community or consider a STEM career that can allow them to help Native American people.

Discussion

The findings of this study support the assumption that research experiences at TMCC have a direct impact on students' educational and career paths, which was affirmed by all ten participants. The four major themes that emerged were education, experience, opportunities and community, with each having subthemes. Many students indicated that the experience had prepared them for the future, specifically in the area of research. Participants frequently mentioned that the experience was interesting, and it increased their confidence and motivation.

Indigenous people bring Indigenous ways of knowing into STEM fields; therefore, there is a considerable need to increase Indigenous representation in STEM. The United States is diverse and it is imperative that the workforce of the U.S., specifically the STEM workforce, represents the diversity of people and ideas. Low participation of Indigenous people in STEM disciplines is attributed to factors such as (a) lack of exposure, (b) lack of interest, (c) lack of confidence, (d) lack of a sense of belonging, and (e) lack of goal congruency (Parisien, 2020; Williams & Shipley, 2018). Participants often indicated that their positions as student researchers combated these factors by exposing them to STEM research, creating an interest in the STEM fields, and boosting their confidence as researchers. Additionally, participants specifically addressed this opportunity's impact and the effect it had at a tribal college in their hometown. Participant P1 even indicated that TMCC felt "homey" and offered a greater sense of belonging to the student.

Jackson et al. (2016) and Lee (2018) outlined responsibility to the community or wanting to give back to the community as a factor that may prevent Native American people from pursuing a STEM degree or career. Although the participants took diverse career paths, nine pursued a degree or career in a STEM field, and one obtained a degree in business. Nine of the participants stated they were either considering or planning to pursue an advanced degree and one had already completed a terminal degree in epidemiology.

The results of the study provided the researchers with a deeper understanding of the impact a biomedical genetic research opportunity on a tribal college campus had on student participants. The study's findings provided strong evidence that working as a student research assistant for TMCC has positively impacted participants' knowledge, skills, self-efficacy, and community.

Limitations

According to Yin (2018), limitations can exist in qualitative research that may affect the study's findings. The researcher sought to identify and acknowledge the study's limitations to make recommendations for further research. The study provided a greater understanding of the contributions of a biomedical genetic research opportunity at a tribal college; however, the study was limited to one tribal college. Nevertheless, the sample could be representative of other tribal college research programs with similar demographics. Another limitation of this study was the sample size. The study only included 10 participants, primarily female. Although study invitations went out to all 49 potential participants, only 10 participants

responded to recruitment and followed through with participation. The researcher did find that the 10 interviews led to data saturation.

Implications

As previously mentioned, the purpose of this study was to explore how participation in biomedical genetic research at TMCC impacted students' educational and career paths. The study provided former students the opportunity to describe their experiences and identify factors such as mentoring and hands-on activities that influenced their abilities. The research experience also opened up new career opportunities for participants. These findings have implications for Native American students who are unsure about exploring research opportunities and implications for professionals who wish to further this research. Additionally, these findings offer direction for institutions of higher education, tribal colleges, and employers who may consider starting a similar program. Creating a space for Native American students to pursue research opportunities allows for a feeling of comfort and they may be more likely to pursue opportunities that they feel are available for them specifically.

Participants frequently mentioned the opportunities made available to them through this experience. Opportunities ranged from networking, mentoring, education, and career goals to confidence and motivation-building. Allowing a space for Native American students to pursue opportunities specific to them, while also in their own communities (tribal colleges), allows for a feeling of comfort when pursuing these opportunities. Since starting this program, Dr. Best's aim has been to eventually have a community member clinician or research scientist assume direction of the program. The administrative, staffing, and instrumental capital acquired during the years of this project put TMCC in an enviable place to continue and expand.

Creating space for research opportunities such as this at Tribal College and Universities (TCUs) is a valuable and beneficial endeavor. Qualitative research allows the researcher to incorporate the perceptions and experiences of Native American students, which helps mainstream higher education institutions and policymakers better understand the value and benefits of such research opportunities. When research funding is set aside for higher education, funding should also include opportunities for TCUs. This allows for a unique space and opportunity for Native American students. Through the study findings, policymakers and researchers can continue to learn the way Native American students perceive, operate within, and experience higher education and future research.

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Author Biographies

Dr. Tyler Parisien is an enrolled member of the Turtle Mountain Band of Chippewa with his hometown region being within the beautiful Turtle Mountains in North Dakota. Tyler earned his Doctorate of Education in Higher Education from Concordia University-Portland. Tyler currently resides at home and works for the Turtle Mountain Community College (TMCC) in Belcourt, North Dakota.

Dr. Lyle Best served for 21 years as an Indian Health Service clinician at Belcourt, ND. In the subsequent 24 years he has taught genetics at Turtle Mountain Community College and been the principal investigator for three studies of genetic factors influencing various medical conditions in American Indian communities.

Pat Conway, PhD, MSW, Senior Research Scientist at Essentia Institute of Rural Health, taught social work for twenty-five years. She has conducted research in rural and tribal communities regarding health, higher education, violence, and behavioral health areas. She is a Native Americans into Medicine teaching team member with the University of Minnesota Center of American Indian and Minority Health.

Gena Grant is a Student Research Intern at Turtle Mountain Community College. She is Secretary of Chapter SNDU (Student North Dakota United) for Cohort 17 Elementary Education and President of the Health & Fitness Advisory Board at TMCC (Turtle Mountain Community College).

Appendix A: Demographics Survey

Recruiting Native Americans into Science

Please fill out this demographic survey for the research project being conducted at TMCC titled: Recruiting Native Students into Science: Evaluating the Impact of Biomedical Genetic Research at Turtle Mountain Community College.

Gender: Female Male Prefer not to say Other

Age: 18-24 25-34 35-44 45-54 55 or more

Race-ethnicity: White Black or African American Asian or Asian American
 Hispanic or Latino American Indian or Native American Prefer to identify as
Mixed-Race Other

Title: Mr. Mrs. Miss. Ms. Dr. Other

Tribal Affiliation (If applicable): _____

Current employment status: _____

Years in current position: _____

Other jobs since working as an SRA for Dr. Best: _____

Do you plan to continue your education? _____

How many years have you worked with the Genetic and Pre-Eclampsia Study at TMCC?

Do you currently work or contribute to a tribal community in any way? _____

Appendix B: Interview Protocol

Interview Protocol

Recruiting Native Students into Science: Evaluating the Impact of Biomedical Genetic Research at Turtle Mountain Community College

Time of the interview:

Date of the interview:

Interviewer:

Interviewee:

Introduction:

Hello, my name is Dr. Tyler Parisien, and I am the primary researcher on this study. You volunteered to participate in this study, and I wanted to give you a brief description of the study. The purpose of this study is to evaluate how participation in biomedical genetic research at TMCC has impacted students' educational and career paths. Current and former participants will be asked to describe (1) their experiences in the program, (2) their current educational and career status and aspirations, and (3) the program's impact on their education and career. We will conduct semi-structured interviews with participants who have worked with the biomedical genetic research at TMCC. The study findings may contribute to the current educational research about Native Americans and completion of college degrees in Science, Technology, Engineering, and/or Mathematics (STEM) careers. This research will also potentially highlight the service the genetics research lab is providing to the Turtle Mountain community and TMCC student participants.

Questions:

1. How many years and at what capacity have you worked in the Biomedical Genetic Research at TMCC?
2. What are your experiences in the program? (i.e., content, relationships, opportunity to present research)
3. How has the program influenced your interests in STEM?
4. How has the program affected your current or past educational goals?
 - a. What were your educational goals prior to participating in this program? After this program?
5. How has participation in the program changed your career goals?
 - a. What were your career goals prior to participating in this program? After this program?
6. What effects has participation in the program had on your career choices?
7. What other factors have influenced your career goals?
8. What other factors have influenced your educational goals?
9. Do you perceive your experience as a student researcher impacted your educational journey? If so, in what ways?

10. Do you perceive your experience as a student researcher impacted your career/professional journey? If so, in what ways?

Prompts:

Prompts and Probes used to encourage in-depth exploration of experiences:

Prompt-Can you tell me a bit more about that?

Probe- What do you mean by " _____ "?

Is there anything else you would like to add?

A Vision for Indigenous Honors Programs at Tribal Colleges and Universities

Joshua Hoskinson, Edison Cassadore, Camillus Lopez¹
Tohono O'odham Community College

Tribal colleges and universities need to support the intellectual growth of motivated Native students in a manner that fosters Indigenous identity and Native-nation building so that Indigenous groups have the capacity to handle complex 21st-century issues. Through philosophical analysis of the Peoplehood Model, we offer a vision for the creation of Indigenous honors programs to support these students. This vision consists of four primary characteristics that Indigenous honors programs should adhere to facilitate learning through service to local communities. Lastly, we offer a case study of an Indigenous honors program at Tohono O'odham Community College.

Keywords: Indigenous; honors program; service learning; service leadership

Philosophies, mission statements, and visions underlying honors programs at colleges and universities of a Western orientation vary slightly from institution to institution; however, each carries a common theme of understanding purpose. The language used to craft these statements center around terms such as "innovation," "opportunity," and "community of scholars," which, on the surface, seem endearing to the student who is hopeful for their future following graduation. It seems as if these honors programs at Western institutions are preparing their students to change the world, to make a difference, and to face novel challenges with unique and innovative solutions that integrate multiple disciplines. Certainly, this common theme of purpose is admirable; however, there are aspects to this understanding which hint at a darker, more sinister consequence of Western culture and ideology. Images of colonization of thought and identity, exploitation of the self, and an orientation towards productivity to benefit a capitalist managerial regime arise. These are consequences that honors programs at all institutions of higher education, including tribal colleges and universities (TCUs), need to grapple with as honors programs prepare students for 21st-century issues.

Honors Programs at Western Institutions

The concept of honors programs at Western institutions of higher education originates as derivations of programs of study at German and English universities, primarily that of the

¹ Authors are listed with TCU faculty first and then alphabetically. This article was written collaboratively and order of authorship does not indicate the degree of contribution.

tutorial system at Oxford University (Rinn, 2003). The Oxford tutorial system focuses primarily on the relationship between an individual student and a tutor. This tutor was a highly accomplished and distinguished professor in a specific academic subject of interest to the student. These student-tutor relationships are highly individualized and holistic on the part of the student, where students are not prescribed a set of academic courses as found in American universities but guided socially and academically to promote intellectual and social success and prosperity (Rinn, 2006). This tutorial system was integrated into the American higher education system primarily through the work of Frank Aydelotte. Aydelotte was a Rhodes Scholar at Oxford University from 1905 to 1907 and instituted a tutorial-style honors program during his presidency at Swarthmore College from 1921 until 1940 (Rinn, 2003).

Honors programs of the modern day have moved beyond the Western idyllic tutorial system of addressing the needs of high-performing students and towards an educational environment by which their existence needs to be continually justified. As a result, higher education institutions have been driven by an increased focus on education spending, which has driven the development of program-level assessment and evaluation for honors programs (Young et al., 2016). As part of this framework for program evaluation, Sederberg (2008) created the basic characteristics of a fully developed honors program, as developed by the National Collegiate Honors Council (NCHC). These foundational characteristics are bureaucratic and administrative, although, upon review, there is a semblance of the origins in the Oxford tutorial system, such as in this characteristic: Faculty participating in the program should be fully identified with the aims of the program. They should be carefully selected on the basis of exceptional teaching skills and the ability to provide intellectual leadership to able students.

However, Aydelotte's (1921) vision of honors programs, which focuses on the intellectual and personal growth of the individual student through a holistic lens, becomes lost and devalued in the context of the collective shift in priorities on the part of Western institutions. Due to limited financial resources, there has been a marked shift in priorities away from the holistic growth of students toward program evaluations to justify their allocation of funding (Sederberg, 2008; Young et al., 2016). This need to justify their existence is a marked consequence of the capitalistic managerial regime currently in power in Western academia; if the honors program does not yield increased financial or institutional benefits, it stands to be removed for 'better performing' academic programs. The supremacy of a capitalist mindset entrenched in the program evaluation and description of honors programs, founded on the principles of productivity and distinguishment, infiltrates through all faculty, students, and staff. Perhaps, because of this bureaucratic framework of honors programs, it makes sense these pressures are passed on to honors students throughout their lives (Rinn & Plucker, 2019).

Honors Programs at Tribal Colleges and Universities

These characterizations are also juxtaposed with the increasing need and desire to support Native students who excel in intellectual pursuits. To meet this need, TCUs have been created to support the specific needs of Native students. TCUs have two generalized missions: (1)

support for revitalization of culture, language, and identity for Native nations, and (2) support for individual and tribal self-determination and Native nation-building (Crazy Bull et al., 2020). This involves the creation of institutions that are controlled by individual tribal nations as a demonstration of tribal sovereignty. This allows for the development of a curriculum that prioritizes Indigenous epistemologies, ontologies, and axiologies, which includes “multigenerational teaching, particularly finding ways for elders to bring their knowledge into schooling” (Crazy Bull et al., 2020, p. 24-25). With this radical shift in prioritization on the part of TCUs, they serve as fertile ground for consideration of fundamentally different conceptualizations of education, honor, and honors programs.

Increasingly, TCUs grapple with how to best support Native students in a manner consistent with the mission and vision of each institution. Honors programs, therefore, have been considered to accomplish this task. However, if a Western model of honors programs remains the foundation for the honors programs at TCUs, then the same issues as described above would persist. TCUs, therefore, need decolonizing approaches to not only prevent the persistence of these maladies but also to empower and support Indigenous identity. In the present article, we offer our own reflections on honor and honors programs that form our foundational philosophy for an Indigenous honors program, offer a vision for Indigenous honors programs at TCUs, and then provide an example of an Indigenous honors program.

Critical Reflections and Syntheses on Honor and Honors Programs

Our ideological foundation of a novel, Indigenized conception for honors programs at tribal colleges and universities stems from our own lived experiences, reflections, and syntheses with honor and honors programs in various educational settings. Through these critical reflections and syntheses from each of the authors, characteristic principles of an effective and Indigenized honors program emerge in our efforts to elucidate the vision for Indigenous honors programs. As such, we provide three critical reflections, one from each of the authors: (1) reflections from a former honors student at a Western institution of higher education, (2) reflections from an Indigenous intellectual, and (3) reflections from a Tohono O’odham elder.

Reflections from a Former Honors Student at a Western Institution of Higher Education

My experiences with honors programs, and what must be valued in honors programs, focuses and derives from my student experience participating in an honors program at a four-year university in the United States with a Western orientation. This honors program offered students the opportunity to pursue their intellectual interests within the context of a community of scholars. However, I was primarily exposed to learning environments in my academic courses that assigned additional papers, projects, or other activities to make a particular course an “honors” course. These extra assignments were usually created within the context of an agreement between the instructor and me and were formalized through an “Honors Contract,” which stipulated the requirements for the specific paper, project, or other assignment.

In general, these “Honors Contracts” are usually administered under the assumption that honors students can complete *more* work under the same time frame as the other students enrolled in the course. This orientation towards producing copious amounts of academic

works often leads students to have a “quantity over quality” mindset that adds undue stress and pressure for students in these honors programs. This production mindset repeatedly overwhelms students in ways that can impair their mental health, such as facilitating procrastinating behaviors arising from their perceived need for perfection that can impose psychological distress (Closson & Boutilier, 2017; Hunt & Eisenberg, 2010; Rice et al., 2006; and Rice et al., 2012).

Honors students also fall under several assumptions by higher education, such as honors students primarily handle stress through reasoning, are fully oriented adults, and yet can be classified as “just like other students” by other students, faculty, and staff (Owens & Giazzoni, 2010, p. 39). These negative psychological and social consequences, in our view, may condition the student to be more accepting of overwork, overstress, and “fast-paced, demanding working environments” that abuse their employees under the auspices of productivity in a capitalistic managerial regime. In this view, institutions of higher education are currently preparing students for careers in which they are fungible assets, in which their “productive” Kafkaesque lives (or lives mired in unnecessarily complicated, bureaucratic processes as described in the works of author Franz Kafka) promote the “productivity” of the workplace (Freire, 1970; hooks, 1994).

These concerns, as well as my own experiences, also give rise to a more fundamental educational concern: these assignments are often at the same academic level as the other course assignments. In my experience, instructors across all academic disciplines repeatedly write assignments that confined student achievement to the operationalization of the lower levels of Bloom’s taxonomy (i.e., knowledge, understanding, application) rather than the higher levels (i.e., analysis, evaluation, creation) (Anderson & Krathwohl, 2001). This takes several different forms -- a longer expository research paper or projects centered on “going more into detail” about a specific subject covered in a particular course. On the instructor’s part, the creation of these types of assignments stem from a lack of training on teaching higher levels of Bloom’s taxonomy, an apathetic attitude toward honors students, or a lack of awareness of the implications of their additional projects or assignments.

Either way, it is one of the arguments of the present article to emphasize that “honors” assignments cannot be about the *volume* or *quantity* of work -- rather, the work needs to require higher-order thinking skills, which is the quintessential nature of an honors program (Lewis & Smith, 1993; Miri et al., 2007). A shift from “remembering-driven” assignments (or assignments focused on lower-order thinking) to “creating-driven” assignments (or assignments focused on higher-order thinking) can allow students to synthesize multiple disciplines to identify new and innovative solutions to current, vexing problems plaguing contemporary society, particularly in Indian Country.

Reflections from an Indigenous Intellectual

In my own academic journey, I recently came full circle with noted scholar bell hooks at a book festival lecture and, subsequently, a book signing afterwards at The University of Arizona. It was, indeed, a meeting that I had long waited for because her writing that

deconstructs oppression in her famous, often quoted, phrase of "imperialist white supremacist capitalist patriarchy" (hooks, 2003) kept me from dropping out of graduate school. Along with her writing, books had a way of sustaining me through the most challenging times while living in Ndé/San Carlos Apache ancestral lands. Bringing these two events together, indeed, was profound and what hooks wrote in the book that I brought for her to sign was equally profound on that day because it was about making connections and sustaining relationships.

These events at a major university also made me think about my mother and her commitment to education. Education for her, like Acoma Pueblo writer Simon Ortiz (1993), was a way for her to "fight back" (p. 35) against the domination of colonization. She once asked me to look around at the houses on San Carlos Apache ancestral lands and then pointedly asked, "Why do we live in these conditions?" This rhetorical question was prompted by her own family's profound poverty, poverty that is common in most of Indian Country. Through her own education, like Ortiz (both born in 1941), she was able to synthesize experiences by analyzing the consequences of colonization and asking that question that had, and still has, profound implications for one's Indigenous identity. In this way, education was a "way out" of poverty, but it was also a way to challenge the dominant status quo. Education empowered her in resisting and in a will to "fight back" (Ortiz, 1993, p. 35).

Asserting one's agency through obtaining an education is a part of that but striving for academic excellence is envisioned here as a way of challenging what hooks (2003) has identified as "imperialist white supremacist capitalist patriarchy." Like most Indigenous cultural beliefs, striving to be the "best" is not just to serve oneself, but it is about striving to be the best for one's group, village, community, tribal nation, etc. Common in most Indigenous communities, everyone works collectively because it was and is about survival both before Euro-American encroachment and what Joy Porter (2005) has termed ongoing "paracolonialism" (p. 59). Connections within relationships are what counter the historical legacy of colonization and what has been termed "historical trauma." Reinforcing compassion within educational relationships counters the trauma of the history of colonization and thereby strengthens both individuals and Indigenous communities.

Reinforcing compassion within educational relationships, and by extension, institutions, should be linked to the historical context and motivations for the tribal college movement and re-envisioning honors programs in TCUs. Certainly, sovereignty and self-determination in United States federal Indian policy were key legal frameworks for Indian Country to develop tribal colleges and universities to build self-sustaining communities and tribal nations by educating their respective memberships and citizens. However, along with Forbes (1998), the envisioning of sovereignty and self-determination should be extended to what Warrior (1992, in Forbes 1998) terms "a way of life" (Forbes, 1998, p.18) and Forbes terms as "self-supremacy" and "group-supremacy" (Forbes, 1998). Indigenous honors programs at TCUs, indeed, would reinforce what Warrior and Forbes extend out beyond legal definitions to Indigenous agency based on collective consciousness evident in many tribal cultural and spiritual beliefs (Warrior, 1992). In re-envisioning honors programs, students would be

learning service leadership to others where one's individual identity is framed and defined by the group and that this love of collectivity counters oppression and domination brought about by the historical legacy of Euro-American colonialism.

Reflections from Camillus Lopez, Tohono O'odham Elder

"We will plant our crops and pray for rain. If the rain comes we will eat again for the year. If the rain does not come, we will take whatever is out there and make a life out of it."
- O'odham Proverb

"The Voice of the people is the Voice of the Creator." - O'odham Proverb

To survive in the Sonoran Desert, the inhabitants had to rely on each other. The sharing and caring for all life bore "himdag," a way of life that sustained O'odham for centuries. When a hunter attained game, it was shared with all. When edible food was gathered, it was separated and the whole community shared it. When children reached maturity, they were encouraged to help the elders of the community. Someday they will be the elders of the community, and the young would serve them. In this way, people knew that they could survive in the desert. When individuals attained a skill and became experts, it was noted throughout the land that their community produced experts in a skill such as hunting, basket making, clay pottery making, sport, fighting, and spiritual gifts. The "experts" did not "bask in the spotlight" and were not encouraged to. The "community" was the recipient of praise and admiration. The community supports their members so that the expert members can perform. When the stories in the O'odham Creation myth are told, the morals, values and rules/laws of the community are mentioned to remind O'odham of what is expected of them. It implies that the community is a priority.

Orientations toward Community

Community orientation must be a central theme of honors programs at institutions of higher education. The present article will argue that honors programs must be oriented both around students' internal motivators (i.e., personal growth and excellence) and students' external motivators (i.e., community and service leadership) to provide opportunities for students that are inspiring and empowering to orient students to serve their local communities. We believe honors programs that center around empowering students' sense of personal growth and excellence not only instill a sense of philomathy but also support students' self-esteem and self-worth such that students have the desire to grow to be the best version of themselves. This is especially relevant to the creation of honors programs at TCUs, as this community orientation of honors programs reflects Indigenous traditions, beliefs, and values in a global sense. Our focus for the present article is to propose a vision for Indigenous honors programs for TCUs, derived from the Peoplehood Model (Holm et al., 2003), that can facilitate the growth and excellence of the individual student through service leadership by emphasizing the concepts of relationality and respect for those relationships. By making service leadership the crux of an Indigenous honors program, students can express their individuality within the context of their own communities, thereby, creating opportunities for students to grow to the best possible version of themselves.

Theoretical Framework of an Indigenous Honors Program

The theoretical formulation of an Indigenous honors program emerges through a critical analysis of the Peoplehood Model as described by Holm et al. (2003). By viewing the development of an Indigenous honors program through the context of land, history, language, and ceremony, our own theoretical vision can be thought of as an application of Holm et al.'s (2003) Peoplehood Model to honors programs. In this way, our aim to have service leadership, taking the form of intergenerational, community-oriented learning, being the centerpiece of our honors program can be accomplished.

The Peoplehood Model

In teaching Native American literature courses, class discussions are framed by introducing the Peoplehood Model (or Matrix) (Holm et al., 2003). Though this model was originally proposed for ways to conceptualize tribal sovereignty, it is used in Native American literature courses to envision how political sovereignty can be extended as "identity sovereignty" in the sense that the act of writing is counter-hegemonic (hooks, 2003). For most Indigenous writers, as in Ortiz (1993), this allows one to "fight back" (p. 35) while being educated by the dominant culture. Indeed, Indigenizing one's educational process is a form of counter-hegemonic resistance and agency and the Peoplehood Model not only orients how Native American literature courses are framed and useful for literary interpretation and analysis, but it should also be applied to how an Indigenous honors program should be conceptually organized.

Within the Peoplehood Model, four distinct areas are thought of as relevant for Indigenous identities. They are "Land," "History," "Language," and "Ceremony." These areas are distinct, yet they are interconnected by a synergistic interrelationship. Language is key for enacting a relationship with land in the sense of sacred sites, place names, and so on. Language, too, is needed to convey the intimate relationship to history, for history is not dead because the ancestors are always with you. Finally, language links to ceremony because speaking the original Indigenous language is crucial for the efficacy of spirituality within ceremonies. All these aspects of Indigenous identities form an integral whole that Euro-American colonization attempted to de-link, and Indigenous writers, in general, are attempting to re-link.

In a vision of honors programs at TCUs, the Peoplehood Model should be invoked as a guide for conceptualizing the initiation of such programs. Academic excellence here is not meant to showcase the individual. Rather, Indigenizing honors programs at TCUs means focusing on academic excellence in the sense of upholding and sustaining service leadership to the communities served by the specific TCU. Service leadership should be framed by the Peoplehood Model so that students would be required not only to demonstrate academic excellence, but such students would be required to connect that excellence to sustaining language and its connection to land, history, and ceremony.

Characteristics of an Indigenous Honors Program

The Peoplehood Model, with its emphasis on land, sacred history, ceremony, and language, serves as a foundational framework for integrating Indigenous identity into honors programs. However, appreciating and operationalizing the counter-hegemonic approach of the Peoplehood Model provides a path forward for honors programs to Indigenize. To accomplish this, we wish to propose four characteristics of an Indigenous honors program that center on the concept of love. The utilization of the concept of love as the foundation for honors programs may seem strange or foreign initially. However, if honors programs at TCUs are reoriented to center on love, it allows students to better resist the influences of colonization and hegemony that are prevalent in their daily lives. Harjo (2004a) discusses the extent to which the concepts of colonization are jarring to the Native person:

Colonization teaches us to hate ourselves. We are told that we are nothing until we adopt the ways of the colonizer, until we become the colonizer. But as Native people, we never fit into that system, and most of us have no wish to fit there. The tension of who we truly are and who we are forced to become is often unbearable, and is the source of virulent self-hatred (p. 62).

Indeed, the reorientation of students' attention towards love elicits power and strength and enables the student to counter the negative effects of colonization and instead focus on Indigenous traditions, beliefs, and values. Love is counter-hegemonic because it allows oneself to counter the historical trauma one has endured in life. Love is empowering because it enables oneself to imagine a future in which Native nations can advocate against colonization effectively through excellence in education.

Therefore, it is essential that Indigenous honors programs always operate within the context of love. Harjo (2004b) emphasizes that "Love is the most powerful force in the world. It cannot be destroyed. Love is where we come from and where we are going" (p. 138). The enduring power of love can enable the students, faculty, and staff at TCUs to no longer use colonial Western ideologies as the foundation for honors programs, and instead use the traditions, beliefs, and values honored by their respective Native tribes. As such, these honors programs can achieve the goal of decolonizing their programs in such a way that can empower and enable the student to achieve their academic goals without also being immersed in an ideology and worldview that is foreign to them. In our view, honors programs can decolonize themselves through utilizing our four characteristics that reflect Indigenous values instead of Western values. These four characteristics, presented in a progressive manner, are the following: (1) love of one's self, (2) love of one's community, (3) love of one's excellence, and (4) love of one's learning.

Love of one's self

All relationships require nurturance for them to thrive. Although several types of love exist and have been identified, the primary love in relation to envisioning an honors program at a TCU begins with a love of one's self. Self-esteem, indeed, is an act of self-love. If love develops within one's self, such love creates a degree of self-respect to the extent that you do not allow

others to violate your own integrity. Nurturing a sense of integrity is fundamental to an assertion of counter-hegemonic agency despite the socio-economic conditions in Indian Country left by colonization. Colonization sought to destroy all the interconnected relationships identified in the Peoplehood Model. All those links are not only about relationships, but they are also about sustaining, nurturing, and honoring those relationships with respect. This sense of respect begins with self-love. Indeed, being self-loving is an act of resistance and agency and, thus, by extension, this sense of agency extends the legal aspects of sovereignty and self-determination in countering the legacy of historical trauma. This is so because it is reaffirming self and develops one's capacity to be selfless in loving and serving others.

Love of one's community

Self-love, however, cannot stand on its own for its own narcissistic sake in an Indigenous-oriented honors program at a TCU because of a self-less orientation to communities traditionally found in all communities in Indian Country. Despite increasing socio-economic challenges facing many contemporary Indian communities, what we propose is a counter-hegemonic stance. Self-love translates into a need to serve a student's respective Indigenous community by reaffirming and re-acknowledging one's own interconnections to not only clan, village, district, chapter, land-based tribal nation, but it also translates into loving by acknowledging relationships to everything around you because of the sacred interconnections as in Wilma Mankiller's (2004) assertions:

When traditional indigenous people speak of their relatives, they are referring to every living thing, not just human kinship. The very identity of traditional tribal people is derived from the natural world, the land, and the community. They understand their own insignificance in the totality of things (p. 190).

Orientation towards "the totality of things" in the greater sense of what community means must be emphasized in an Indigenous-based honors program because it emphasizes the greater synthetic relationships of everything around a human being, and, by extension and implication, the love and spiritual power of one's existence. The service-learning component of an Indigenous-based honors program should relate to an expression of self-love in all relationships and generate and extend it to provide selfless service leadership dedication to a particular community's issues that need to be addressed. This selfless service from a greater sense of self-love not only expresses commitment to community, but it also expresses counter-hegemonic agency against the demoralization and domination of historic colonization and ongoing "paracolonialism" (Porter, 2005, p. 59).

Indeed, one's love of community relates to the ideas of the sense of home and reciprocity found in Indian Country. Home sustains you because that is where the ancestors originated, or they are with you. Reciprocity figures in that relationship because it is about giving back to the memory and knowledge of the ancestors, as Ortiz (1993) has asserted. Love of one's community relates to reciprocity because it is about serving and strengthening the totality in honoring relationships. For this reason, a crucial component of any TCU enactment of an honors program is the idea of reciprocity and, no doubt, love of one's community.

Love of one's excellence

Excellence is centered squarely on promoting and cultivating Indigenous identity and prosperity. Land, sacred history, ceremony, and language are all innately tied to Indigenous identity, and, through education and advocacy, these requisite constituents of Indigenous identity can persist into the future. However, this education and advocacy work cannot be completed haphazardly; rather, the work must be completed with enthusiasm and deep love for our communities and backgrounds without mediocrity. It is through this sense of enthusiasm and a dedicated work ethic that one can promote Indigenous identity in the 21st century. In this way, we would be pursuing *excellence* in our work and studies.

It is through the relationships that the Indigenous person has to human and non-human entities that one can understand their own identity (Edge, 1998), as well as the gifts, talents, and interests one possesses and pursues in their life. Oftentimes, community members, through their interactions and engagements, recognize unique gifts and talents individuals may possess. For instance, one may be incredibly skilled in the work of agriculture, another in the work of textiles, and another in construction. Each of these unique gifts and talents these individuals possess and pursue is in deep love and service to their communities, and since their work is in service and love, one must be committed to pursuing excellence in their work.

There are other community members, who are the subject of the present article, especially interested and curious about intellectual pursuits. These may include, but are certainly not limited to, learning languages and cultures, history and politics, or natural and social sciences. As with the work in agriculture, textiles, and construction, these intellectual gifts and talents must also be valued, cultivated, and honored as they allow our communities to understand and appreciate the world they live in and contribute to their lives equally as other avenues of excellence. As such, opportunities for this cultivation must exist, and Indigenous honors programs at TCUs are the best place to pursue avenues of excellence in intellectual pursuits while educating and advocating for Indigenous identity.

To best accomplish these goals, Indigenous honors programs must adhere to three pillars for excellence as intellectual pursuits are considered to serve their communities:

- (1) Academic excellence must be valued, and mediocrity cannot be accepted;
- (2) Intellectual capacity should not be denigrated or limited; and,
- (3) Sharing of expertise to build our communities is essential.

This love and admiration for excellence in academic settings, as long as it is centered on honoring and serving our communities, must be a centerpiece for Indigenous honors programs. Pursuing academic excellence, valuing and appreciating intellectual capacity, and sharing expertise by working with others to solve complex problems are ways to pursue excellence. As such, love of one's excellence must be a third characteristic for Indigenous honors programs in service to their respective communities.

Love of one's learning

As for the fourth characteristic of an Indigenous honors program, following love of one's self, love of one's community, and love of one's excellence, it seems natural to include the obvious remaining characteristic -- the love of learning. This passion for inquiry, discussion, and curiosity found within children, and hopefully within students, faculty, and staff at TCUs, deserves cultivation and fostering and thus must be the mission of educational programs such as honors programs. Philomathy, in addition to contemporary issues plaguing Indigenous communities, is often the drive that motivates students, faculty, and staff to pursue higher learning in the first place. Thus, fostering students' sense of philomathy must also be an orientation and guiding principle for Indigenous honors programs.

The development of an Indigenous honors program that cultivates and fosters a culture of philomathy requires support of students' higher-order thinking skills (Anderson & Krathwohl, 2001; Lewis and Smith, 1993; Miri et al., 2007) and problem-solving strategies. In this way, students would be better equipped to face the challenges in their communities. Since students commonly enrolled in honors courses and programs have shown to excel in intellectual pursuits, it is their curiosity and the skill set of critical thinking that must be fostered, or else honors programs are doing students a disservice. If we foster curiosity and philomathy, while uplifting and maintaining their cultural identities, then these Indigenous honors programs will have succeeded in addressing problems besetting Indian Country.

A Vision for an Indigenous Honors Program at Tohono O'odham Community College

These characteristics of Indigenous honors programs, grounded in our foundational philosophies from our experiences, as well as the Peoplehood Model (Holm et al., 2003), serve as guidelines for our honors program at Tohono O'odham Community College (TOCC). However, these characteristics of Indigenous honors programs are generalized such that they can be applied to all TCUs that aspire to develop an honors program. Indigenous honors programs at each TCU, including TOCC, must be specifically designed to reflect the traditions, beliefs, and values for the Native Nation(s) each TCU primarily serves as part of their specific mission statement. Here, we briefly describe the T-Şo: Şon, or core values, which serve as the Tohono O'odham cultural foundation for the mission and vision of TOCC specifically such that our honors program can be specific to the Tohono O'odham people.

Core Values of Tohono O'odham Community College

TOCC centers on four (4) core values that all college activities operate within the traditions, beliefs, and values of the Tohono O'odham people. This is not to say this is an exhaustive list of core values; rather, this is an extremely simplified version that can be easily understood by those learning about the Tohono O'odham culture for the first time. These descriptions are also not meant to represent the understanding of these core values for all Tohono O'odham; different communities may have different understandings of these core values. However, we will proceed with these definitions and understandings as these are used by TOCC for its college operations and activities. These core values are the following: *T-Wohocudadag*, *T-Apedag*, *T-Pi:k Elida*, and *I-We:mta*, and will be briefly described below.

T-Wohocudadag

T-Wohocudadag, translated to *Our Beliefs*, represents the spiritual understandings and cosmologies of the Tohono O'odham people that relate to life's biggest questions. These questions can include, but are not limited to, questions about the purpose and meaning of life, what happens after death, the nature of existence, and other similar existential questions. Within the realm of *T-Wohocudadag* are statements that the Tohono O'odham believe to be true that provide a foundation for all other beliefs and activities.

T-Apedag

T-Apedag, translated to *Our Well-being*, represents the value of goodness, wholeness, and health of the person and of institutions (e.g., TOCC). This is oriented towards the whole person, as the physical, spiritual, emotional, and mental well-being of everyone must be taken into consideration. This directly affects our interactions and relationships with the self, other people, and non-human persons (e.g., the land), as each relationship must bring well-being to each person. The most important way to remember *T-Apedag* is consistent self-reflection on one's role in the universe and how to consistently live a better life.

T-Pi:k Elida

T-Pi:k Elida, translated to *Our Deepest Respect*, is the most complex yet important of the core values. Fundamentally, this core value is a deep respect that different persons in the community have with each other. This originates from a recognition that everyone is a Being created by Creator, with specific skills, understandings, and experiences that can contribute to the well-being and welfare of the entire community. In this case, a deep respect and valuation for everyone materializes into respect for their perceptions, perspectives, and preferences. Valuation of one's feelings within this context best parallels the concept of unconditional love for each individual and self. Each person has a soul, and this soul yearns to love and to be loved, as well as yearns to be with other ephemeral beings. Our life purpose and mission should be centered around these deep, loving relationships throughout our brief experience with life.

I-We:mta

I-We:mta, translated to *Working Together*, is the most straightforward of the core values, however, it is crucial for our lives. To maintain the well-being and welfare of everyone, whom we deeply respect as a created Being, everyone should work together to accomplish goals together. This need for other people, and to maintain these relationships with other community members, makes service and helpfulness to others one of the most important values of Tohono O'odham society. Our lives are not to be oriented towards elevating or glorifying the self for personal gain. Our lives must be oriented towards the welfare of our communities and to others.

Each one of these core values, identified by our community of elders to inform TOCC professional practice, is crucial to incorporate not only into our courses and assignments, but also at the programmatic level. From these core values, we have a mandate from the Tohono

O’odham people to orient ourselves and our curriculum away from Western culture and ideologies and towards its own. In this way, we can hope to avoid the implications and pitfalls of pursuing a purely Western-oriented education while maintaining a sense of cultural identity. This sense of “Indigenizing” our curriculum and programs towards Tohono O’odham traditions, beliefs, and values, as exemplified by the core values described above, has been crucial to the development of our own Indigenous honors program.

Description of the Honors Program at Tohono O’odham Community College

Service-learning and community service is at the heart of our honors program at TOCC. This decolonizing orientation towards honoring communities through excellence in service, in addition to our foundational philosophies expressed through our experiences, has been instrumental in developing the program requirements themselves. The essential mechanics for the program involve (1) proposed entrance requirements, (2) descriptions of the honors program tracks, and (3) the service-learning experience, and each of these reflect not only traditional academic requirements but also the core values of TOCC.

Proposed Entrance Requirements

Our proposed entrance requirements involve students actively enrolled and participating in courses at TOCC that have completed 12 or more units of coursework. Eligible students for the standard honors track must also maintain a cumulative grade point average (GPA) of 3.50 or above, however, conditional eligibility and admission may be granted if a student does not meet the minimum GPA requirements. This conditional admission would be granted to the student for one semester, after which, students must have obtained the minimum GPA requirement. If the student is unable to complete this requirement, however, they may continue to participate in the honors program through our service and leadership track, which focuses on students who reflect the Tohono O’odham traditions and values like those reflected in the TOCC core values that are considered honorable by our community of elders. If that is the case, under this consideration, students can be eligible for entrance into the honors program.

Descriptions of Honors Program Tracks

Once admitted into the honors program, as stated above, there are two different tracks: the “Honors Track” and the “Service and Leadership Track.” For the purposes of the present article, we maintain similar language used in the bureaucratic organization of honors programs at Western institutions of higher education. This is used only for the purposes of simplified communication of fundamental ideas. However, it must be of emphasis that in future iterations of an Indigenized honors program that the concept of a program “track,” as well as the names of each “track,” must be changed in accordance with the cultural traditions of the tribal nation each TCU serves. For the “Honors Track,” students complete a minimum of 12 units of honors coursework within their area of study, maintain a cumulative GPA of 3.50 or above, and complete the service-learning experience by graduation. For the “Service and Leadership Track,” students would only need to complete the service-learning experience by graduation; however, they may optionally undertake honors courses if it is their wish. These

honors courses are developed through an agreement between the instructor and the student through an honors contract. To actively prevent the issues of overwork, stress, and lack of critical thinking often plaguing honors courses at other colleges and universities, the honors contracts at TOCC are designed differently. Instructors must adapt a pre-existing assignment, project, or other activity that is assigned to all students in the course so that honors students delve *deeper* into the subject material of the course. Instructors also are required to identify how their adaptation of their assignment has students engage with higher order thinking skills of Bloom's taxonomy. It is worthy to note that future research should reconsider the concept of higher order thinking skills, as well as Bloom's taxonomy as defined by Anderson & Krathwohl (2001), within Indigenous epistemologies, ontologies, and axiologies (Cajete, 1999; Smith, 2002). Not only does this limit the amount of coursework honors students are engaged with, but it also creates an academically challenging yet supportive environment where students critically think about the subject matter. Lastly, the honors contracts are required to identify how the modified assignment reflects one or more of the TOCC core values.

Service-Learning Experience

It is our service-learning experience, culminating into an honors project, which occurs towards the end of their honors program that reflects our integration of Indigenous identity into the honors program the most. Towards the end of their academic degree program at TOCC, honors students are required to meet regularly with a faculty advisor within their area of study to develop a service-learning project related to their field of study. This usually stems from a current, vexing problem that students would like to address and, working with their faculty advisor, develop an honors project to specifically address that problem. Development of the service-learning experiences may involve consulting with a community of elders and college administrators to make sure students are meeting the requirements to engage in such service projects while being respectful to Tohono O'odham culture. Once students complete their service-learning experience, ideally immediately preceding graduation, students would present their projects to our larger college community.

How is the Honors Program at Tohono O'odham Community College Indigenous?

Our adherence to the core values of *T-Wohocudadag*, *T-Apedag*, *T-Pi:k Elida*, and *I-We:mta* deeply reflect our four characteristics of Indigenous honors programs. Love of one's self, love of one's community, love of one's excellence, and love of one's learning are essential to each of these core values. By integrating these core values into our programs and curriculum, we are thereby instilling love into them. If our honors program can support our students' ability to recognize their own value, the importance of service to their community, how pride in one's work promotes excellence in service, and the joy of learning new things, by default, we would be empowering these students to embody these core values honored by the Tohono O'odham community. In this way, we would have been successful in prioritizing Indigenous traditions, beliefs, and values in our program, and thus would have been successful in Indigenizing the honors program at TOCC. By accomplishing these goals through loving mentorship and guidance, as well as consideration of the whole student instead of solely their academic achievements, we would enable students to successfully achieve excellence in

their academic coursework in a supportive academic environment that respects and prioritizes Indigenous identity. In our view, this would provide the foundation for students to achieve their psychological and self-fulfillment needs in Maslow's hierarchy (e.g., belonging, self-esteem, and self-actualization) (McLeod, 2018) as well as skills necessary to counter hegemonic and colonizing ideologies. In this way, we are empowering students for success in higher education programs in a meaningful way through prioritizing Indigenous thought.

Conclusion

This philosophical analysis of the characteristics of an Indigenous honors program, through the synthesis of our foundational experiences, the Peoplehood Model, and TOCC's core values, creates a dynamic vision for the creation of such programs at tribal colleges and universities. We aim for this vision to positively transform and shape honors programs at TCUs so that academic excellence and Indigenous identity can work together to serve communities. However, we recognize the application of these Indigenous traditions, beliefs, and values to honors programs at TCUs is in its infancy. Future research recommendations will have to consider the impact this application has on Native student retention, graduation rates, persistence through higher education, psychological distress, and personal well-being. Rinn and Plucker (2019) recognize the immense value of honors programs in supporting high-ability college students; however, their considerations are for honors programs at institutions of a Western orientation. Indigenous honors programs have potential to transform institutions to allow Native students to engage with higher order thinking skills, and it is exciting to consider the implications of this approach. If our vision for Indigenous honors programs is successful, we would be able to prepare students for their potential role to contribute to Native nation building. In this way, Native nations across our local, national, and global communities will be able to have the capacity to transform the 21st century.

Acknowledgements

We would like to acknowledge the generous contributors at Tohono O'odham Community College for their support and insights while we have been continuing to develop this honors program. Special thanks to Dr. Curtis Peterson, President Paul Robertson, Stefany Paredes, TOCC Faculty Senate, TOCC Board of Trustees, Dr. Ken Vorndran, and the AZTransfer Honors Community of Interest for their special assistance with this program. We also would like to recognize Danny Lopez, former Tohono O'odham Language and Culture instructor, for his teachings that continue to guide us. Our honors program was initially conceived by Dr. Edison Cassadore. His work has been especially important to the creation of the TOCC honors program.

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