PLANT BLINDNESS REPRESENTS THE LOSS OF GENERATIONAL KNOWLEDGE AND CULTURAL IDENTITY

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The Supervisory Committee certifies that this ***disquisition*** complies with North Dakota State University's regulations and meets the accepted standards for the degree of

DOCTOR OF PHILOSOPHY

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ABSTRACT

Elders from the Turtle Mountain Band of Chippewa Indians (TMBCI) who have gathered plants within the region have seen the plant numbers reduced and species of plants disappear. Their statements of concern for the plants and their hope for increased plant diversity led to the development of the current research study. Increasing plant knowledge is vital to rebuilding and maintaining the diversity of vegetation within the forest, grassland, and wetland habitats. The present study used an online survey to assess citizens' ability to identify plants that belong in wetland, grassland, and forest habitats in the area; names of plants; learn how citizens use plant features to find and identify plants; and where citizens gained their knowledge. The survey also gathered demographic data, which allowed authors to determine trends across different demographic groups including age and ethnicity. In total, 212 participants took the survey, the majority were female and 91% classified themselves as Native American or Alaska Native. Participants were readily able to identify forest and wetland plants correctly, but struggled distinguishing grassland plants from the other habitat types. Participants in this study demonstrated a preference for natural areas maintained for humans for recreation purposes. Although more wild habitats may not be in the top three choices for the average citizen to spend time in, forest did have the fourth highest selection. Building on the knowledge that can be learned in familiar and comfortable environments as well as moving into new and wild areas will be important in helping citizens understand the value of biodiversity and conservation in the future. Beyond the local area, this information is useful to researchers and scientists working with plant blindness and seeking to understand how people see and identify plants and how this may change across demographic groups.

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To the citizens of the Turtle Mountain Band of Chippewa Indians and Rolette County, thank you for taking the time to participate in the survey. I look forward to our next steps in reducing plant blindness and developing conservation areas.

DEDICATION

This dissertation is dedicated to my family. My maternal grandparents, Robert and Forda (Frantz) Marcil, paternal great-grand parents, Albert and Annie (Gourneau) Laducer, and paternal grandmother, Sylvia (Laducer) Brien. My parents Robert and Jeanette (Marcil) Laducer, my brothers and their wives, Jason and Denise Laducer, and Justin and Dr. Sasheen Laducer. Special dedication to my husband Matthew Richard Blue and our son Ranger M. Blue.

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CHAPTER 1. INTRODUCTION

Rolette County, North Dakota

The Turtle Mountain area is split by the international border between Canada and the United States (Figure 1). Being the international border, and having distinctly different land management practices on each side, creates unique plant communities. This dissertation, in general, will focus on the North Dakota side of the Turtle Mountains. The Turtle Mountains are in the north-central part of North Dakota, which includes Rolette County. Land use within the county is predominantly cropland, with interspersed pastureland and woodland (USDA, 2017). According to the 2017 Census of Agriculture, the number of farms within Rolette County decreased by 30% since 2012. While the average size of farms during this same time period increased by 37%, with 36% of the farms being greater than 1,000 acres in size (USDA, 2017). From south to north in the county, the topography changes from plains to rolling hills, formed by glacial till, and is covered in temperate deciduous forest.

This area has been the land that the Anishinaabe have known and have a recorded presence on since before 1738 (Law, 1953; Molberg et al., 1959 as cited in Disrud, 1968). In a September 2021 article featured in Science by Bennett et al. (2021), trace fossils of human footprints had been uncovered in White Sands National Park of New Mexico. The seed layers found near the prints were aged to be between 23 to 21 thousand years ago (Bennett et al. 2021). Continued research into origins and migrations of humans are continuingly supporting Native American legends and stories that tell of how the land has been traveled by tribes for thousands of years (Benton-Benai, 1988).

The Anishinaabe migrated from the East Coast prior to the arrival of the light-skinned people who were prophesized to destroy the Anishinaabe if they did not leave to go to the “place where food grows on the water" (Benton-Benai, 1988). The Anishinaabe settled in Canada, Michigan, Wisconsin, and Minnesota (Benton-Benai, 1988). After a period of time a portion of the Anishinaabe continued to move westward for the fur-trade (Richotte, 2009). After contact with fur traders, missionaries and settlers in the mid 1800's, the U.S. government took the fertile Red River Valley and plains in the 1863 and 1904 treaties. The Anishinaabe or Plains Ojibwe people came to be known as the Turtle Mountain Band of Chippewa Indians (TMBCI) by the federal government. The Ojibwe name for their homeland is Mikinock Wajiw or Turtle Mountains. When approached from the south the Turtle Mountains rise above the horizon in the shape of a massive turtle lying east to west. The rolling hills covered in deciduous forest remain home to the Turtle Mountain Band of Chippewa Indians (TMBCI) (Richotte, 2009).

Henderson et al. (2002) describes the Turtle Mountains as an island forest, that may not be as ecologically diverse or resilient as larger forest ecosystems, but are important environmental outliers as they contain species and ecosystems believed to be on the edge of their natural range. Island forests are described as being sensitive to relatively small changes in environmental conditions, making conservation of these areas important (Henderson et al, 2002). Citizens of the TMBCI have spoken about vast distribution of plants pre-settlement (Disrud, 1968). Potter and Moir (1961) described the Turtle Mountains as one of the most interesting and unique areas in North Dakota for its physiography and vegetation (Potter and Moir, 1961). Once settlements were developed after the year 1882, land-use development caused changes to flora of the Turtle Mountains (Stevens, 1920). Following settlement, extensive harvesting of timber and land clearing for agriculture contributed to the demise of the forest (Disrud, 1968). Disrud (1968) states, in addition to the reduction of the forested area, draining of wetlands was also a land-use problem, reducing habitat and plant communities within the Turtle Mountains.

Fergen et al. (2018) conclude from their research on land-use preference and environmental attitudes in the Northern Plains of the United States, that agricultural producers may pursue further land-use and energy development, and include wildlife habitat opportunities as long as it adds to their bottom line. Understanding attitudes and preferences of agricultural producers towards energy development and wildlife habitats will help in developing land-use plans (Fergen et al, 2018). Turner et al. (2104) state that few everyday citizens understand the changes in land-use, and fewer know of ecosystem services. They believe the increase in conversion of more land to farming acres and shift in land ethics away from ecosystem integrity makes community education essential for improving mental models for citizens in the Northern Great Plains (Terner et al., 2014). Communities and regional areas involved in developing conservation areas benefit from educational support through hands-on experiential and demonstration projects that are visible to the larger community for achieving not only preservation habitat but increasing the heterogeneity of plant communities within agricultural landscapes (Becerra et al., 2013; Mbah, 2019).

Figure 1.1. Aerial imagery of the Turtle Mountains of the United States and Canada, blue line denotes the countries border (Google Earth, 2021).

Importance of Plant Knowledge

The Ojibwe teach that the ultimate good for the people is the land that can and will supply all the people need to sustain life (Geniusz, 2015). Indigenous people throughout the world have both connection to and knowledge of their local environment. Their knowledge is not focused on one single purpose or environmental factor, but rather a holistic approach to understanding humans and nature in an ecosystem (Bear Don't Walk, 2019). Geniusz (2015) provides traditional stories and teachings regarding plants, she shares that just as the Earth's evolution is taught in science courses, the same cycle continues for the Anishinaabe teachings. Turreira-Garcia et al. (2015) conducted research in Rio Negro in central Guatemala on the distribution and transmission of wild edible plants. They found that the older women in the rural community knew more plants and their practical uses than males or other age classes. In their community research, the data showed that participants who acquired plant knowledge from their families were able to recognize more plants than others. Specifically, when individuals who had "knowledge transmitted from relatives" were compared to participants whose "knowledge (was) transmitted from other sources" (school, books, etc.) their average scores where higher (Turreira-Garcia et al., 2015).

Plant Blindness and Culture

We would regret a world without tigers and pandas, but we can never imagine a world where we can exist without plants (Knapp, 2019). When concerns of biodiversity are discussed usually the conversation focuses on animal diversity with plants being mentioned as a broad term of habitat structure. Biodiversity loss is a major environmental concern and it is crucial for people to understand the foundation of the trophic chains and ecosystems (Knapp, 2019, Pedrera et al., 2021, Amprazis & Papadopoulou, 2020). Wandersee and Schussler (1999) coined the term plant blindness and described it “as a person’s inability to: see the diversity of plants in their environment, understand the importance of plants to the biosphere, and view plants as inferior to animals”. Locally, more recent research on plant blindness among third grade students from North Dakota and Minnesota looked at plant identification during outdoor hikes (Comeau et al., 2019). Students were asked to draw the plant so that instructor would be able to return to the area and find the plant again based on their drawing. Results showed that the students have over-simplified mental models of plants, representing a lack of experience with identifying specific characteristics of plants. The authors determined that more environmental education within formal and non-formal settings to help combat plant blindness. “If the natural environment is generally going unnoticed, and more individuals are increasingly disinterested in learning about the local environment, then there is an increased risk of losing species that are important to the complex natural systems and cultures who use these plants” (Comeau et al., 2019).

Balding and Williams (2016) discuss that there is not one specific pathway to plant blindness, but believe both biological and cultural factors impact human relationships with plants. Individuals immersed in a plant-affiliated culture will have a lifestyle that enables their ability to value, identify, and recall plants (Baling and Williams, 2016). When individuals have experiences that enable them to identify individual plants, they are then able to develop the capacity to see the individual plants and not just a green forest (Balding and Williams, 2016). Wandersee and Schussler (1999) encouraged those who teach biology courses to expand students’ botanical horizons, help students to see the flowering plants and non-flowering plants, provide them the opportunity to see plants as more than just a backdrop. They encouraged discovery of individual plant species, which can lead to creating an empathetic connection with plants (Balding and Williams, 2016). Marguiles et al. (2019) advanced on this concept and state that plants should be considered wildlife, highlighting the similarities between plants and animals, such as the ability to sense, adapt, and interpret their environment. Which is further supported by Bouteau et al. (2021), who also believe it is important to take a holistic view of biological processes as a general characteristic of eukaryotes. Enabling people to be open to seeing the interdependent relationships among living beings and recognizing all living beings as relatives (Bouteau et al., 2021).

When people do not notice plants as often as animals, they tend to be less interested and less knowledgeable about plants (Parsley, 2020). Jose et al., (2019) encourages instructors of biology courses to present on equal numbers of plants species and animal species. In addition to classroom experiences, people should also take advantage of social media to share the love of plants as widely as possible, focusing people’s attention on the fascinating, underappreciated organisms (Jose et al., 2019, Stagg, 2021, Uno, 2021). Stagg’s (2021) research was built from existing teaching methods to expand knowledge of strategies to reduce plant blindness. Multimedia learning can assist in increasing interest in botany, in class activities that include memory requirements, art-based projects that foster appreciation of plant qualities and abilities, fieldwork, and informal learning experiences (Stagg, 2021). Creating and providing equitable opportunities for youth to experience plants, microbes, and animals will decrease plant blindness (Jose et al., 2019, Krosnick et al. 2021)

Community Education

When individuals do not understand the cause of environmental problems, it is easier to believe misinformation or misdirection (Robelia & Murphy, 2012). In a study by Kimmerer (2013), college students in a general ecology class were asked to rate their knowledge of positive interactions between humans and land, the median response was “none”. The study speaks to what the students are taught regarding environmental disasters and human degradation of the earth and asks how would the students know about the positive experiences if they have not had the hands-on experience with the natural environment (Kimmerer, 2013). Krosnick et al., (2021) created a Pet Plant Project within college courses where students grew a plant from seed to bloom. At the end of the project 73% of the 209 participating students stated they would continue to care for and maintain plants in the future. This project addressed plant blindness and will enable students to make informed decisions about public policy as it relates to plants and ecosystems (Krosnick et al., 2021)

Hungerford and Volk (1990) discussed increasing environmental educational experiences from awareness and gaining knowledge, to developing a sense of ownership and empowerment for students to become active citizens in their experiences. They discuss the importance of providing experiences in the natural environment through hands-on activities within the students local environment, also known as place-based learning (Hungerford and Volk, 1990). Semken et al. (2009) breakdown the personal sense-of-place and bond-to-a-place that develops from these experiences. They surveyed 400+ higher education students and concluded that all students should have the opportunity to repeatedly explore local natural environments and the development of emotional attachment as a benefit of students having repeat visits to these areas (Semken et al., 2009). Wals et al. (2014) discussed the convergence of environmental education and science education, they encourage science educators to support the context of scientific knowledge with integration of place-based experiences, and indigenous knowledge. Crosier (2019) explains that the place-based experience helps students to develop stronger ties to their community, increases an appreciation for the natural world, and creates an understanding of the purpose for volunteering. Place-based education can also be known as the pedagogy of community, bringing together environmental stewardship and learning in informal settings outside of the traditional classroom. During the research, participants stated that their outdoor experiences were deeply enriched and their appreciation and feeling of connection to the natural world increased through place-based experiences (Crosier, 2019).

Traditional Native American education revolved around experiential learning (Cajete, 2005). Cajete (2020) provides context for Indigenous science and the Indigenous approach to the future building of Indigenous communities: “Indigenous science is a body of traditional, environmental, and cultural knowledge unique to a group of people which has served to sustain that people through generations of living within the distinct bioregion." Involving traditional knowledge keepers in teaching citizens about local ecosystems is beneficial to providing significant information about the natural history, encouraging citizens to reflect on their connections to place, and promote a connection to that natural environment through an emotional response or knowledge gained (Haywood et al., 2021). Creating opportunities, sharing knowledge, and providing positive experiences in the natural environment is a "cause and effect" relationship that has not yet been proven (Cruz et al., 2018). While the linear relationship has not consistently proven effective, the additions made to gaining knowledge through inquiry-based experiences, citizen science, indigenous knowledge, and community engagement have been found to be beneficial for sustainable community engagement (Wals et al., 2014).

References

Amprazis, A., & Papadopoulou, P. (2020) Plant blindness: a faddish research interest or a substantive impediment to achieve sustainable development goals? *Environmental Education Research*, 26(8), 1065-1087. https://doi.org/10.1080/13504622.2020.1768225

Balding, M., & Williams, K.J.H. (2016) Plant Blindness and the implications for plant conservation. *Conservation Biology*, 30(6), 1192-1199. https://doi.org/10.1111/cobi.12738

Bear Don't Walk, M.R. (2019). Recovering our Roots: The Importance of Salish Ethnobotanical Knowledge and Traditional Food Systems to Community Wellbeing on the Flathead Indian Reservation in Montana. Graduate Student Theses, Dissertations, & Professional Papers. 11494. https://scholarworks.umt.edu/etd/11494

Becerra, T. A., Engle, D. M., Elmore, R. D., & Fuhlendorf, S. D. (2013). Contrasting Preference for Grassland Landscapes Among Population Groups in the Central and Southern Great Plains. *Rangeland Ecology & Management*, 66(5), 529–538. https://doi.org/10.2111/REM-D-12-00174.1

Bennet, M.R., Bustos, D., Pigati, J.S., Springer, K.B., Urban, T.M., Holliday, V.T., Reynolds, S.C., Budka, M., Honke, J.S., Hudson, A.M., Fenerty, B., Connely, C., Martinez, P.J., Santucci, V.L., & Odess, D. (2021) Evidence of humans in North America during the Last Glacial Maximum. *Science*, 373(6562), 1528-1531. https://doi.org/10.1126/science.abg7586

Benton-Benai, E. (1988) *The Mishomis Book, The Voice of the Ojibway*. University of Minnesota Press. Minneapolis, MN.

Bouteau, F., Gresillon, E., Chartier, D., Arbelet-Bonnin, D., Kawano, T., Baluska, F., Mancuso, S., Calvo, P., & Laurenti, P. (2021) Our sisters the plants? Notes from phylogenetics and botany on plant kinship blindness. *Plant Signaling & Behavior*. https://doi.org/10.1080/15592324.2021.2004769

Cajete, G.A. (2005). *Serving Native American Students, In New Directions for Student Services*. Wiley Periodicals, Inc. 109, pp69-78.

Cajete, G. A. (2020). Indigenous Science, Climate Change, and Indigenous Community Building: A Framework of Foundational Perspectives for Indigenous Community Resilience and Revitalization. *Sustainability*, 12(22), 9569. https://doi.org/10.3390/su12229569

Comeau, P., Hargiss, C. L. M., Norland, J., Wallace, A., & Bormann, A. (2019) Analysis of Children's Drawings to Gain Insight into Plant Blindness. *Natural Sciences Education*. 48:1. https://doi.org/10.4195/nse2019.05.0009

Crosier, S.J. (2019) Examining a Sense of Place and Environmental Stewardship through Place-Based Education. (Doctoral dissertation) University of California-Davis.

Cruz, A.R., Selby, S.T., & Durham, W.H. (2018) Place-based education for environmental behavior: a 'funds of knowledge and social capital approach. *Environmental Education Research*, 24:5, 627-647, https://doi.org/10.1080/13504622.2017.1311842

Disrud, D.T. (1968) Wetland Vegetation of The Turtle Mountains of North Dakota. (Doctoral dissertation, North Dakota State University). *University Microfilms, Inc*., Ann Arbor, Michigan.

Fergen, J.T., Jacquet, J.B., Kasu, B., Barnett, M., Junod, A., & Kumar, S. (2018) Out Where the West Begins, Measuring Land-Use Preferences and Environmental Attitudes across the Great Plains Transition Zone. *Great Plains Research*, 28(2), 155-172.

Geniusz, M. S., (2015) *Plants Have So Much to Give Us, All We Have to Do Is Ask*. Anishinabe Botanical Teachings. University of Minnesota Press.

Google, (n.d.) [Turtle Mountains]. Retrieved January 4th, 2021, from https://earth.google.com/web/search/Dunseith,+ND/@48.95938386,-100.14680863,684.28927673a,79818.85202151d,35y,-0.00000145h,0.16496454t,0r/data=CigiJgokCaeJscvAtTtAEauJscvAtTvAGfz7gvosjEZAIS8Eeb1GVVDA

Haywood, B.K., Parrish, J.K., & He, Y., (2021) Shapeshifting attachment: Exploring multi-dimensional people-place bonds in place-based citizen science. *People and Nature*, 3, 51-65. https:// DOI: 10.1002/pan3.10174

Henderson, N., Hogg, E., Barrow, E., & Dolter, B. (2002) Climate Change Impacts on the Island Forests of the Great Plains and the Implications for Nature Conservation Policy: The Outlook for Sweet Grass Hills (Montana), Cypress Hills (Alberta-Saskatchewan), Moose Mountain (Saskatchewan), Spruce Woods (Manitoba) and Turtle Mountain (Manitoba-North Dakota). Government of Canada's Climate Change Action Fund, *Prairie Adaptation Research Collaborative* (PARC).www.parc.ca

Hungerford H.R., & Volk T.L. (1990) Changing learner behavior through environmental education. *The Journal of Environmental Education*, 21(3), 8-23

Jose, S.B., Wu, C-H., & Kamoun, S. (2019) Overcoming plant blindness in science, education, and society. *Plants, People, Planet*, 1:169-172. https://doi.org/10.1002/ppp3.51

Kimmerer, R.W. (2013) *Braiding Sweetgrass*. Milkweed Editions

Knapp, S. (2019) Are humans really blind to plants? *Plants, People, Planet*, 1:164-168. https://doi.org/10.1002/ppp3.36

Krosnick, S.E., Baker, J.C., & Moore, K.R.(2021) The Pet Plant Project: Treating plant blindness by making plants personal. *The American Biology Teacher*, 80(5), 339-345. https://doi.org/10.1525/abt.2018.80.5.339.

Law, L.T. (1953) *History of Rolette County, North Dakota and yarns of the pioneers.* Lund Press Inc., Minneapolis. P276

Marguiles, J.D., Bullough, L-A., Hinsley, A., Ingram, D.J., Cowell, C., Goettsch, B., Klitgard, B.B., Lavorgna, A., Sinovas, P., & Phelps, J. (2019) Illegal wildlife trade and the persistence of “plant blindness”. *Plants, People, Planet*, 1: 173-182. https://doi.org/10.1002/ppp3.10053

Mbah, M. (2019) Can local knowledge make the difference? Rethinking universities’ community engagement and prospect for sustainable community development. *The Journal of Environmental Education*, 50(1), 11–22. https://doi.org/10.1080/00958964.2018.1462136

Molberg, J.M., Vinje, M.E., Benson, O.B., Milligan, E.A, & Lindberg, J.O. (1959) Bottineau County Diamond Jubilee: a brief history of the County of Bottineau, North Dakota. Bottineau Courant. P52.

Parsley, K.M. (2020) Plant awareness disparity: A case for renaming plant blindness. *Plants People Planet*, 2, 598-601. https://doi.org/10.1002/ppp3.10153.

Pedrera, O., Ortega, U., Ruiz-Gonzalez, A., Diez, J.R., & Barrutia, O. (2021) Branches of plant blindness and their relationship with biodiversity conceptualization among secondary students. *Journal of Biological Education*, 1-26. https://doi.org/10.1080/00219266.2021.1933133

Potter, L.D., & Moir, D.R. (1961) Phytosociological Study of Burned Deciduous Woods, Turtle Mountains North Dakota. *Ecological Society of America*, 42(3), 468-480.

Robelia, B., & Murphy, T. (2012) What do people know about key environmental issues? A review of environmental knowledge surveys. *Environmental Education Research*, 18(3), 299-321. https://doi.org/10.1080/13504622.2011.618288

Richotte, K. (2009) We the Indians of the Turtle Mountain Reservation…”Rethinking tribal constitutionalism beyond the colonialist/revolutionary dialectic. (Doctoral dissertation). University of Minnesota.

Semken, S., Freeman, C.B., Watts, N.B., Neakrase, J.J., Dial, R. E., & Baker, D.R. (2009) Factors that influence sense of place as a learning outcome and assessment measure of place-based geoscience teaching. *Electronic Journal of Science Education*. 13(2), 136-159

Stagg, B. C. (2020) Developing a pedagogy for reducing ‘plant blindness’. (Doctoral Dissertation) University of Exeter, United Kingdom.

Stevens, O.A. (1920) Uses of Plants by the Indians. *Science*, 52(1335), 99-101.

Turner, B.L., Wuellner, M., Nichols, T., & Gates, R. (2014) Dueling Land Ethics: Uncovering Agricultural Stakeholder Mental Models to Better Understand Recent Land Use

Conversion. *Journal of Agriculture Environmental Ethics*. 27, 831-856. https://doi.org/10.1007/s10806-014-9494-y

Turreira-Garcia, N., Theilade, I., Meilby, H., & Sorensen, M. (2015) Wild edible plant knowledge, distribution and transmission: a case study of the Achi Mayans of Guatemala. *Journal of Ethnobiology and Ethnomedicine*, 11:52, 1-17. https://doi.org/10.1186/s13002-015-0024-4

Wals, A.E.J., Brody, M., Dillon, J., & Stevenson, R.B. (2014) Convergence between science and environmental education. *Science*, 344(9), 583-584.

Wandersee, J.H, & Schussler, E.E. (1999). Preventing Plant Blindness. *The American Biology Teacher*, 61(2), 82-86. www.jstor.org/stable/4450624

U.S. Department of Agriculture. (2017). Census of Agriculture, County Profile, Rolette County, North Dakota.

Uno, G.E. (2021) Plant blindness, science illiteracy, and the future of botany. *South African Journal of Botany*, pp277. https://doi.org/10.1016/j.sajb.2018.02.011

CHAPTER 2. PLANT BLINDNESS REPRESENTS A LOSS OF CULTURE

Abstract

Elders from the Turtle Mountain Band of Chippewa Indians (TMBCI) who have gathered plants within the region have seen the plant numbers reduced and species of plants disappear. Their statements of concern for the plants and their hope for increased plant diversity led to the development of the current research study. Increasing plant knowledge is vital to rebuilding and maintaining the diversity of vegetation within the forest, grassland, and wetland habitats. The present study used an online survey to assess citizens ability to identify plants that belong in wetland, grassland, and forest habitats in the area; names of plants; learn how citizens use plant features to find and identify plants; and where citizens gained their knowledge. The survey also gathered demographic data, which allowed authors to determine trends across different demographic groups including age and ethnicity. In total, 212 participants took the survey, the majority were female and 91% classified themselves as Native American or Alaska Native. Participants were readily able to identify forest and wetland plants correctly, but struggled distinguishing grassland plants from the other habitat types. They were most readily able to identify Chokecherry (*Prunus virginiana*) in the forest habitat, Wild Prairie Rose (*Rosa arkansana*) in the grassland habitat, and Water Milfoil (*Myriophyllum sibiricum*) in the wetland habitat. When identifying these plants, they typically used the common or local/tribal name to identify the plant. Information from this study will be used as a stepping stone for developing community education projects which may lead to establishing conservation areas for the benefit of native species in the different habitats. Beyond the local area, this information is useful to researchers and scientists working with plant blindness and seeking to understand how people see and identify plants and how this may change across demographic groups.

Introduction

Since the term plant blindness was coined by Wandersee and Schussler (1999), awareness has increased, and it is more commonly discussed in scientific literature (Jose et al., 2019; Stagg, 2020; Colon et al., 2020; Amprazis et al., 2021; Predrera et al., 2021; Sanders et al., 2021). However, the impacts and ways to combat plant blindness are more obscure. In Native American and Indigenous populations across the world, the lack of plant awareness and loss of plant knowledge could have major cultural impacts. Traditionally used plants are plants that have been used by Indigenous people for the purpose of shelter, nutrition, medicine, ceremony, art, and/or jewelry (Densmore, 1974; Meeker et al., 1993). The survival and collectability of traditionally used plants requires the end to both habitat loss and the decrease in biodiversity (Meeker, Elias, & Heim, 1993). Biodiversity is essential to ecosystem resilience, and many species are needed to maintain ecosystem functions and services (Isbell et al., 2011). However, knowing this information and seeing the value in plants are not always synonymous, as plant blindness demonstrates (Wandersee & Schussler, 1999; Jose et al., 2019). Plant blindness is a complex phenomenon in which plants fade into the background of life and are found to be of little importance to the average person (Predrera et al., 2021). This also includes people who understand the importance of plants in an ecosystem, but do not see the diversity of plants (Balas & Momsen, 2014; Amprazis et al., 2021).

Much of the plant blindness work to date has focused on younger learners, including elementary, high school, and college age students (Perez et al., 2010; Bartoszeck et al.,2015; Bonnell et al., 2019; Colon et al., 2020; Amprazis et al, 2021). Surveys assessing plant blindness among various age groups have found that younger learners know little about plants and have a strong preference for animals (Wandersee & Schussler, 1999; Fritsch & Dreesman, 2015;

Balding & Williams, 2016). Additionally, Bartoszeck et al. (2015), discussed that while young children do prefer animals, they found after reviewing children's drawings, children were better able to identify plants they were introduced to and experience with their relatives. While Pedrera et al. (2021) found that secondary students knew little about plants, particularly native species. Perez et al. (2010) assessed college students in plant-related disciplines, and also found poor to fair awareness of native species, specifically wild flowers (Perez et al., 2010). Information on youth learners is important; however, little research has been conducted on adults and their understanding of plants.

The research that has been done looking at adult plant knowledge is sparse at best, and mainly focuses on specific citizen groups (Turreira-Garcia et al., 2015; Loki et al., 2021; Srinivasan et al., 2022), understanding how citizen science can monitor plant species (Crall et al., 2015; Marceno et al., 2021), or phenology (Fuccillo et al., 2015; Kosmala et al. 2016). Looking to understand plant knowledge of indigenous groups, Turreira-Garcia et al. (2015) presented information about a Mayan community in Guatemala, specifically individuals in the mountain communities who learned plant knowledge from relatives, and found they knew more plants and developed better plant recognition skills than individuals who acquired their knowledge in school or on their own. Loki et al. (2021) assessed fishermen in Hungary and asked if they recognized freshwater plants and what name they called them. Answers included both botanical (scientific) and folk (local) names for the plants, and researchers found fisherman had greater accuracy naming and identifying common plants and those related to fishing (Loki et al., 2021). Most recently, Srinivasan et al. (2022) surveyed healers from Indigenous communities in India. Through this process researchers learned of new medicinal purposes for plants and new plants they didn't know existed in the area (Srinivasan et al., 2022). This study exemplifies how knowledge held with the people isn't always recorded and/or available to a wider audience.

It has been hypothesized that individuals immersed in a plant-affiliated culture will experience language and a lifestyle that aids in detecting, recalling, and valuing plants (Bartoszeck, 2015; Terrera-Garcia, 2015; Balding & Williams, 2016; Comeau et at., 2019); however, no empirical research to date has addressed the topic. Plant blindness for the average person is a loss; however, for Native Americans and many Indigenous cultures it is a loss of cultural identity. Bear Don't Walk (2019) provides a perfect example, as an elder states, tribal people are only Indian on paper if they are not connected to the land or knowledgeable of traditionally used plants. However, while not documented, Native American groups feel there appears to be less knowledge of plants as time passes. To the authors' knowledge, there are no studies to date that focus on Native American populations to assess plant knowledge or the impacts of plant blindness.

The current study sought to assess the Turtle Mountain Band of Chippewa citizen knowledge of local plants in forest, wetland, and grassland systems. Determining if and how people are able to identify plants, the names they use, and how their knowledge varies across ecosystems. Specific objectives include: (1) assessing plant knowledge across ecosystems; (2) determining trends in plant identification and naming; and (3) evaluating if demographic factors play a role in plant knowledge.

Methods and Materials

The Turtle Mountain Band of Chippewa Reservation is a 9.66 kilometers x 19.31 kilometers area within Rolette County, North Dakota, with a diversity of plants that have been used by people for thousands of years as sources for food, medicine, tools, and shelter. This area has been the land that the Anishinaabe have known and have a recorded presence on since before 1738 (Disrud, 1968). The Anishinaabe migrated west to the area from what is now the east coast of the United States and settled in parts of Canada, Michigan, Wisconsin, and Minnesota (Benton-Benai, 1988). After a period of time, a portion of the Anishinaabe continued to move westward due to the fur-trade (Richotte, 2009). The Anishinaabe, or Plains Ojibwe people, came to be known as the Turtle Mountain Band of Chippewa Indians (TMBCI) by the federal government. The Ojibwe name for their homeland is Mikinock Wajiw or Turtle Mountain. When approached from the south, the Turtle Mountains rise above the horizon in the shape of a massive turtle lying east to west. The rolling hills, covered in a deciduous forest, remain home to the TMBCI today (Henderson et al., 2002; Richotte, 2009).

The total land area for the study area is 2,340 km^2 (USCB, 2019). Rolette County, North Dakota, where TMBCI is located, 2019 population according to the U.S. Census Bureau (USCB) was 14,179, which is a 1.7% increase from the 2010 census population measurement of 13,939 (USCB 2019). There are six communities within the county and one tribal reservation. The population of the county is measured to be 78% American Indian/Alaska Native, 18.4% white, and 2.1% Hispanic or Latino (USCB, 2019). Land use is predominantly cropland with interspersed pastureland and woodland (USDA, 2017). According to the 2017 United States Department of Agriculture (USDA) Census of Agriculture, the number of farms within the county decreased by 30% since 2012. While the average size of farms during this same time period increased by 37%, with 36% of the farms being greater than 4 km^2 in size (USDA, 2017). The majority of the plains within the county have been converted to agriculture use or pastureland. While the total area for the county is 2,340 km^2 area, the amount of land in farms is 2,072 km^2 with 1,513 km^2 being cropland, 249 km^2 being pastureland, 166 km^2 woodland, and

145 km^2 listed as other (USDA, 2017; USCB, 2019). When leaving the plains and traveling into the Turtle Mountains, one can travel from about 475 m above mean sea level (AMSL) upwards to about 735 m AMSL at the highest point (Google Earth, 2021).

This study area was specifically chosen due to expressed concern regarding reduced numbers of plant species traditionally used by Ojibwe people. The study sought to assess plant knowledge of citizens in the area; therefore, an online plant survey was developed and offered to Rolette County citizens through social media outlets. Originally the survey was intended to be face-to-face, however due to COVID-19 restrictions, the survey was redesigned to be offered online through Qualtrics (Qualtrics XM, Provo, Utah). The survey was designed to: assess plant knowledge of citizens; determine how they identify plants; and if they can identify plants that exist in grassland, forest, and wetland habitats in the area. The survey contained a diversity of questions including demographic questions, fill in the blank, and matching questions to match which plants exist in different habitat types. The final survey document can be found in Appendix A.

The survey was reviewed by two focus groups. The initial focus group was made up of six people including natural resource and plant professionals. This focus group reviewed the goals of the research and the accuracy and effectiveness of the questions in achieving these goals. They provided feedback on format, question design, and provided guidance on how to collect the data that best fit the goals of the research. Based on this focus groups' feedback, the ability to select from multiple age ranges was created to help track age groups and their survey responses. Grouping plants into habitats was also reviewed, and the group discussed the appropriate plants for each habitat and the average level of experience respondents might have in identifying species. The second focus group was made up of three Anishinaabe tribal citizens who reviewed the survey to approve of any tribal knowledge that may be shared within the survey. The second focus group approved of the survey design and the information to be collected and shared.

In addition to focus groups, there were numerous entities that required approval of the survey before it could be deployed. Authors sought and received approval from the North Dakota State University (NDSU) Institutional Review Board (IRB) (location conducting the research), the Turtle Mountain Community College (TMCC) Research Committee (located within the study area and emails of college staff utilized as part of study), and the Tribal Nations Research Group who functions as the TMBCI IRB. Once participants opened the survey there was a disclaimer stating participants must be 18 year of age or older to participate and by continuing with the survey they understood their responses would be anonymously recorded for research purposes. All surveys were anonymous, though demographic information was gathered to determine certain categories to which participants might belong. At the end of the survey, participants could choose to provide contact information to be included in a drawing for a blanket purchased by an author; however, this information was separated from survey answers and whether they choose to enter the drawing or not did not impact the results of the survey or how their data was treated in any way.

Once IRB and similar approvals were completed, the survey was uploaded into Qualtrics and double checked for accuracy. The TMCC research committee approved of the use of the tm.edu listserv to send emails to all employees of TMCC who resided in the study area. The Qualtrics survey link was distributed to a total of 700 email addresses through this listserv. The link was also provided on the author's, who lives in the study area, personal Facebook account and made available for public viewing and sharing of the survey link. The survey link was shared 50 times by a diverse group of citizens including individuals, local groups, and area politicians.

The initial survey questions focused on demographics (Appendix A) asking age category, race, and if participant lived in the study area. The next question asked participants to correctly identify (among multiple images) the plants that can be found in grassland, forest, and wetland habitats, the main habitats in the study area. Table 1 lists the scientific names of the plant images presented to participants for each habitat type and which answers would be considered correct. The next question asked participants to provide a name for a plant image, to learn the names most commonly used by participants to identify plants in the area. The names could be scientific, common, local, or Anishinaabe names. All plant images presented were taken by the authors within the study area.

Table 2.1. Names of plant images shown in survey questions according to habitat type. A * is provided by each species that is correctly found within the designated type of habitat

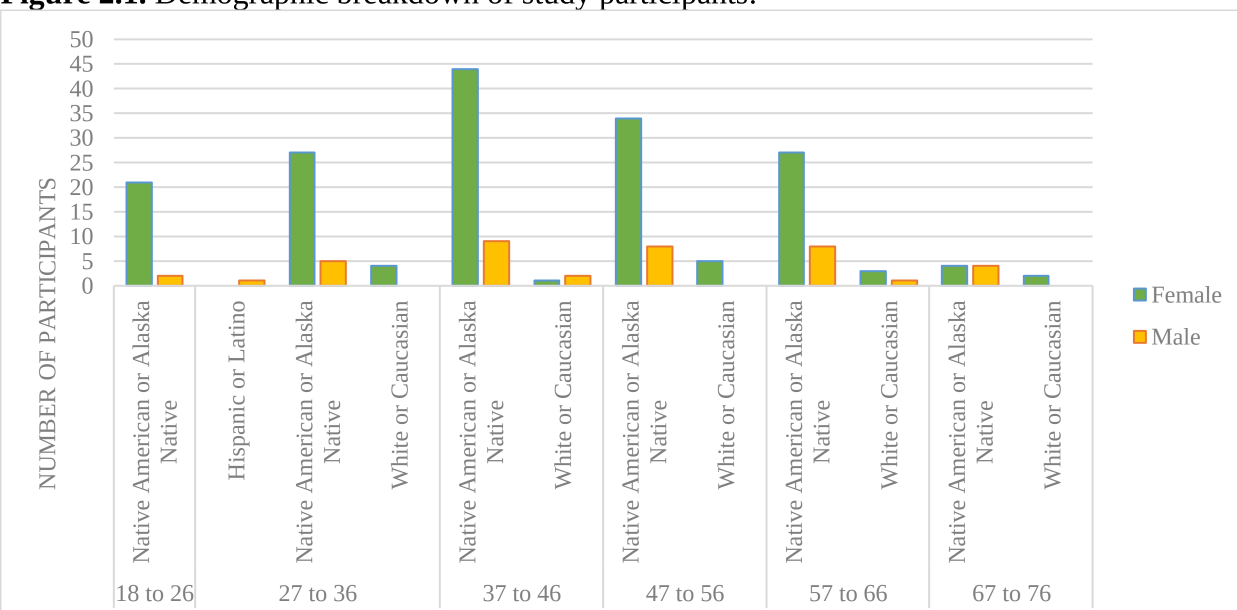
Grassland Habitat	**Wetland Habitat**	**Forest Habitat**
(Mix of grassland, forest, and wetland plants)	**(Mix of grassland, forest, and wetland plants)**	**(Mix of grassland, forest, and wetland plants)**
**Sisyrinchium angustifolium*	**Sagittaria cuneata*	**Actaea rubra*
Cornus canadensis	*Zizia aurea*	**Viola canadensis*
**Cypripedium parviflorum*	**Scirpus microcarpus*	**Prunus virginiana*
**Gaillardia aristata*	**Petasites sagittatus*	**Smilax ecirrhata*
**Ratibida columnifera*	**Schoenoplectus tabernaemontani*	**Pyrola asarifolia*
**Helianthus maximiliani*	**Chara vulgaris*	**Aquilegia canadensis*
Aralia nudicaulis	*Apocynum androsaemifolium*	**Rosa woodsii*
**Rosa arkansana*	**Impatiens capensis*	**Heracleum lanatum*
**Penstemon albidus*	**Mentha arvensis*	*Typha x glauca*
**Pulsatilla patens ssp. multifida*	**Myriophyllum sibiricum*	**Fragaria virginiana*
**Monarda fistulosa*	**Scutellaria galericulata*	**Ribes oxyacanthoides*
Rudbeckia laciniata	*Lonicera dioica*	**Amelanchier alnifolia*
Typha x glauca	**Potamogeton crispus*	**Corylus cornuta*
**Dalea candida*	**Typha x glauca*	**Cornus sericea*
**Symphyotrichum ericoides*	**Persicaria amphibia*	**Maianthemum stellatum*
**Lilium philadelphicum*	**Urtica dioica*	*Scutellaria galericulata*
Impatiens capensis	*Geum triflorum*	**Corallorhiza maculata*
**Achillea millefolium*	*Pulsatilla patens ssp. multifida*	*Monarda fistulosa*
**Geum triflorum*		*Sisyrinchium angustifolium*
**Platanthera aquilonis*		*Penstemon albidus*
Sagittaria cuneata		*Persicaria amphibia*

Results and Discussion

Participants

The 'opt-in' online survey for this study was available from September 1st, 2020, through December 31st, 2020. The use of an online survey allowed participants to participate at their convenience and pace (Herrick et al., 2019). In total, 225 individuals started the survey, with nine individuals being removed as they were not current or previous citizens within the study area. An additional four participants were removed due to not responding to any of the questions. A small portion of the participants left questions blank, as they may not have known an answer or chose not to answer. However, as long as a participant answered at least one question, their response was included in the survey results. In total, the survey was taken by 172 females and 40 males; of which 91% identified as Native American or Alaska Native, 8% as White or Caucasian, and 1% as Hispanic or Latino. In comparison, the USCB for the study area reports that 78% of the population is American Indian and Alaska Native, 18.4% White or Caucasian, and 2.1% is Hispanic or Latino (USCB 2019). Indicating that the results do not match perfectly with the USCB, but they are relatively close and would be considered representative of the population of the study area. The age group with the most participants was the 37 to 46 age group, while the age group with the least participants was the 67 to 76 age group (Figure 2.1).

Figure 2.1. Demographic breakdown of study participants.



Identification of Habitat to Which Plants Belong

Three of the survey questions asked participants to select plant images associated with a specific habitat including: forest, wetland, and grassland. The forest habitat had 21 images to choose from, with 15 plant images being forest plants. There were 18 images in the wetland section, with 13 being wetland plant pictures; and in grassland there were 21 images, with 15 being grassland plants. The data for each image/species included a count of how many times that plant was selected, divided by the number of people that answered the question. For example, cattail was chosen as a wetland plant 134 times, and there were 152 survey participants who completed the wetland question; therefore, cattail was correctly chosen 88% of the time by participants. This percent was then averaged across all correct images for the type of habitat to determine the average of grassland, forest, and wetland plants that were correctly or incorrectly identified within their habitat type. The complete list of attempts for identifying plants to habitat, forest, wetland, and grassland can be found in Appendix B.

Some species were more easily identified as part of a certain habitat, and others were less easy to identify (Appendix B). In total, 135 participants answered the forest habitat question, with an average of 44% correct. Participants incorrectly identifying wetland plants as forest plants 18% of the time, and grassland plants as forest plants 17% of the time. The wetland habitat question had 152 participants, with an average of 49% correct. Forest plants were incorrectly identified as wetland plants 20% of the time, and grassland plants as wetland plants 12% of the time. The grassland habitat question had 136 participants with an average of 51% correct. Forest plants were incorrectly identified as grassland plants 47% of the time, and wetland plants as grassland plants 27% of the time. Overall, it appears participants were most easily able to identify grassland plants, closely followed by wetland, and then forest plants. However, they had the most difficulty distinguishing grassland plants from forest plants. This study tested survey participants on their knowledge of commonly known plants that would be easily identifiable by persons living in area, and plants that would be identifiable to an avid plant person. The reasoning for this type of testing was developed from previous research which presented information on individuals ability to easily identify plants considered to be numerous, well known, beneficial, or easily accessible versus plants not as well-known nor easily accessible (Turreira-Garcia et al., 2015; Loki et al., 2021; Poncet et al., 2021).

Each of the three habitats have distinct plants which were selected more often by participants, such as, hybrid cattail (*Typha x glauca*) for wetlands, Maximilian sunflower (*Helianthus maximiliani*) for grasslands, and chokecherry (*Prunus virginiana*) for forest. Within each of the habitats, the less numerous or easily accessible plants were not selected as often, such as jewelweed (*Impatiens capensis*), green bog orchid (*Platanthera aquilonis*), and starry false solomon seal, (*Maianthemum stellatum*).The most commonly selected plants are all very common and have a certain type of distinctive feature that makes them stand out. For example, Maximilian sunflower has a bright yellow showy flower, chokecherry is a fruiting shrub that people in the area often use to make jellies and syrup, while the hybrid cattail is found in nearly every lake and pond within the study area and has a distinctive leaf structure and seed head. Other studies have shown that more common and distinctive plants are easier to identify (Schussler & Olzak, 2008).

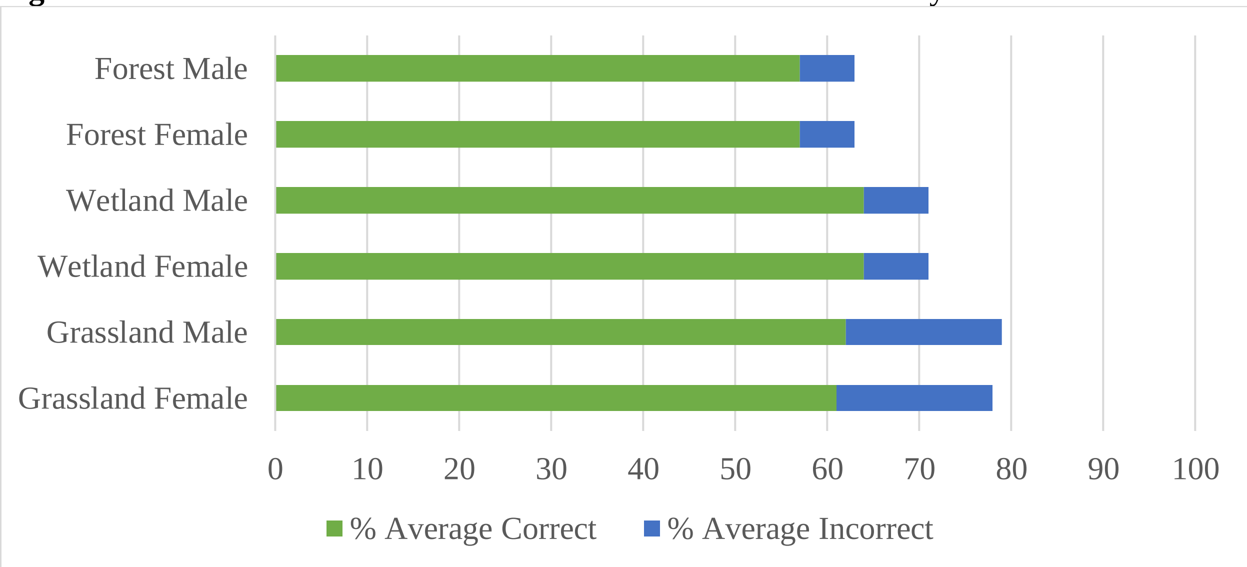
Attempts by participants to identify grassland plants was 1,619 attempts, while attempts for wetland plants was 1,068, and forest was 1,033 attempts. The grassland habitat list was the first list of plant images for participants in the survey, followed by wetlands, then forest plants. It is possible participants felt they knew the most about grassland plants compared to wetland and forests plants. It is also possible that viewing the images online may have been tedious compared to a paper survey and there was less participation as they continued the survey. Daikeler et al., (2022) analyzed 110 online studies on web-based surveys and found that while web surveys can be reliable and have a relatively high response rate, the web-based survey response rate was lower than rates of other survey modes.

Demographic Effect on Plant/Habitat Identification

Gender

Authors chose to remove comparisons between races due to the low number participants that did not identify as Native American (Figure 2.1). The survey was taken by over 90% Native Americans or Alaskan Native; therefore, answers were considered to be representative of the Native American population in the area. Comparing Native American males and females identification of plants by habitat showed similar results for each of the three habitats (Figure 2.2). Meaning males and females correctly and incorrectly identified plants in a very similar way, and there were larger differences in ability to determine forest, wetland and grassland plants, as opposed to differences in identification by gender. This is different than some previous literature that indicates that gender may play a role in plant knowledge (Schussler & Olzak, 2008; Turreira-Garcia et al., 2015), and specifically showing that women often have more plant knowledge than men (Perez, 2010; Turreira-Garcia et al., 2015; Levy, 2018; Bruschi et al., 2019).

Figure 2.2. Native American Male and Female Identification of Plants by Habitat.



Age

The different age groups were analyzed for plant identification ability in the grassland (Figure 2.3), wetland (Figure 2.4), and forest (Figure 2.5) habitats. The 57-66 year old age group completed the most attempts for grassland habitat (Figure 2.3), with the highest percentage of correct attempts. The 37-46 year old age group had the second highest percentage of correct attempts. While the 18-26 year old age group had the lowest percentage of attempts correct. Reviewing the wetland identification data, the 47-56, 57-66, and the 67-76 age groups had approximately the same amount of plant correctly identified, while the 57-66 age group had the highest percent of incorrect . The 18-26 age group had the lowest percentage of correct attempts at 58%. The forest habitat (Figure 2.5), had to the lowest total attempts among the age groups. The 37-46 age group had the most correct attempts in addition to the highest percent of correct attempts, with the 67-76 age group a close second. The 18-26 age group had the lowest percent of correct attempts. Reviewing the total averages between the different habitats, the greatest percent of average correct attempts was in the wetland habitat, followed by grassland, then forest. The lowest percent average of incorrect attempts was in the wetland habitat, followed by forest, then grassland habitat.

Figure 2.3. Age Groups Grassland Plant Identification.

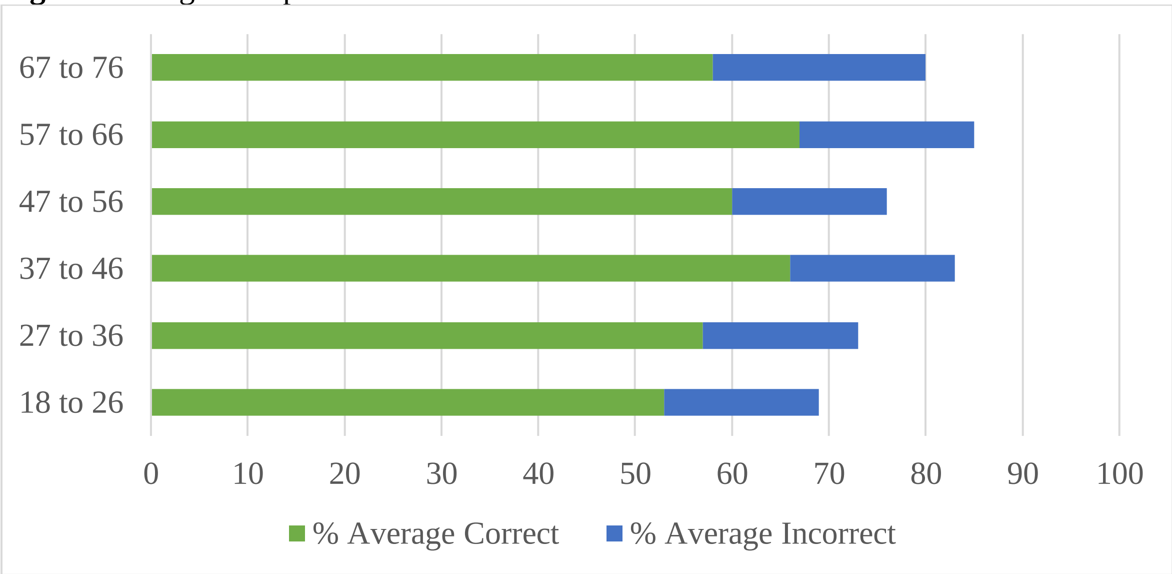


Figure 2.4. Age Groups Wetland Plant Identification.

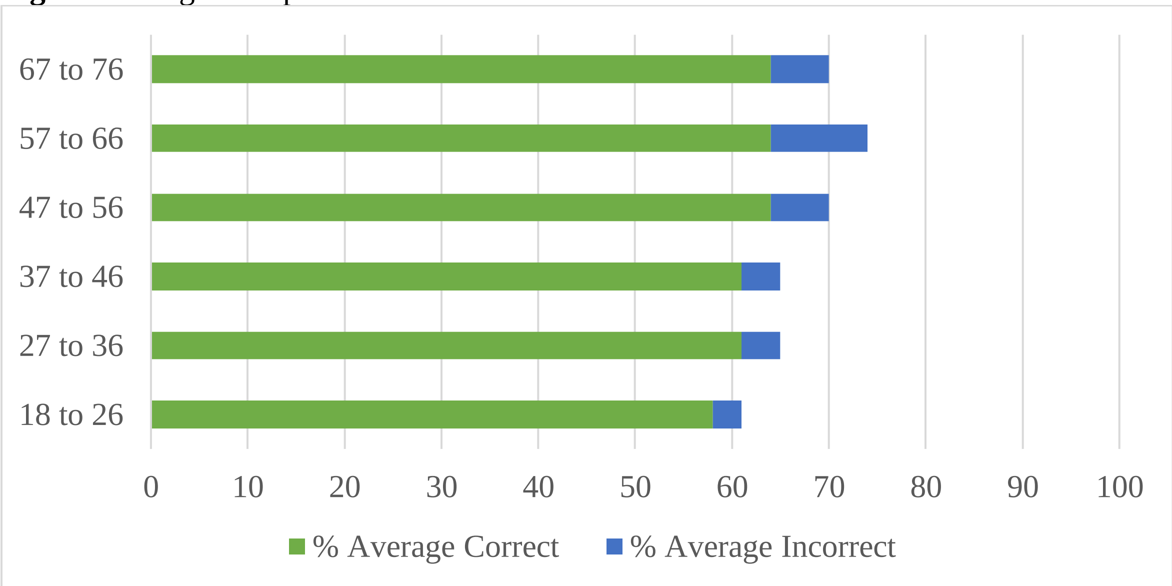
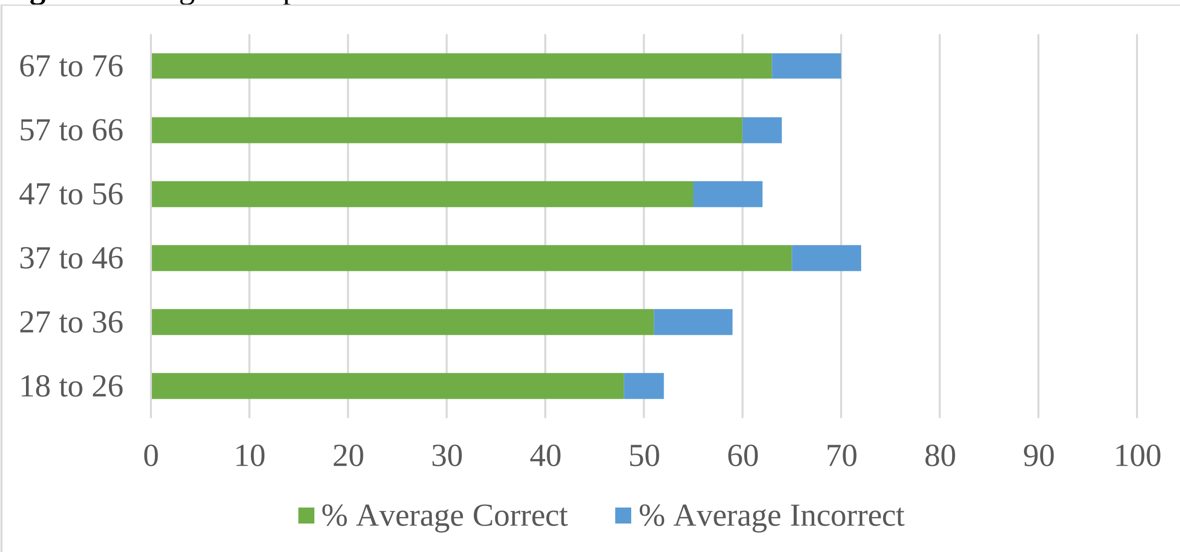


Figure 2.5. Age Groups Forest Plant Identification.



Overall, the average citizen was able to identify 48% or more of the plants within the three different habitats. The plant identification across ages and habitats shows that 18-26 age group were least able to identify plants correctly, and the 27-36 age group were always the second least able to identify plants correctly. While participants in the 37-46 age group and older plant identification abilities varied across habitats. The results of the younger groups being less able to identify plants speaks to their inexperience in identifying plants within the study area. This result is consistent with research that has been done in different parts of the world, measuring limited knowledge of plants in youth (Perez et al., 2010; Fritsch & Dreesman, 2015; Poncet et al., 2021). These results may be indicative of plant blindness in younger generations or a lack of education and experience. Either way, within the Native American culture it represents a loss of knowledge and culture passed down to younger generations.

Poncet et al. (2021) report that among indigenous societies, formal schooling was of minor importance and even potentially detrimental to the environmental knowledge of youth. However, identifying and applying conservation strategies to areas with traditionally used plants can be used to support culture and aid in teaching about plants to younger generations (Pesek et al., 2009). Bear Don't Walk (2019) reported a common theme in supporting traditional plant areas, discussing a great interest in resurgence of Salish plant-food knowledge among the youth. These methods would be areas to explore how to improve plant knowledge of youth in Native American and Indigenous populations.

Role of Cues in Background of Images

When reviewing the results authors wondered if participants were using the background of images for cues to identify the habitat to which the plant belongs. Each habitat and images provided for that habitat were categorized according to cues that may have been provided in the background. For forests, the cues were leaves, leaves/grass, leaves/branches, and grass. The wetland cues were water and no water, and the grassland cues were grass, leaves, and leaves/grass.

The forest plants were separated by the most dominant plants within the background, four of the 15 plant images had leaves in the background, four had leaves and grass, five had leaves and branches, and two had only grass (Figure 2.6). Wetland plants were separated by the presence of water, eight of the 13 wetland plant images had water in the background, and five had no water (Figure 2.7). The grassland plants were separated by grass, leaves, and grass and leaves, ten images had grass in the background, three had grass and leaves, and two had leaves (Figure 2.8).

Figure 2.6. Forest Image Background Cues.

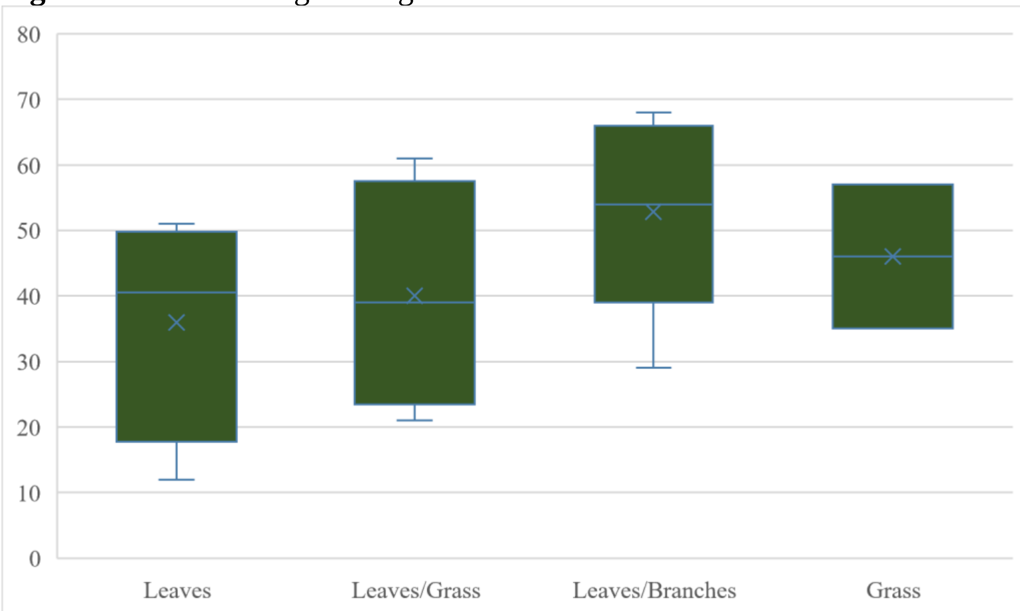


Figure 2.7. Wetland Image Background Cues.

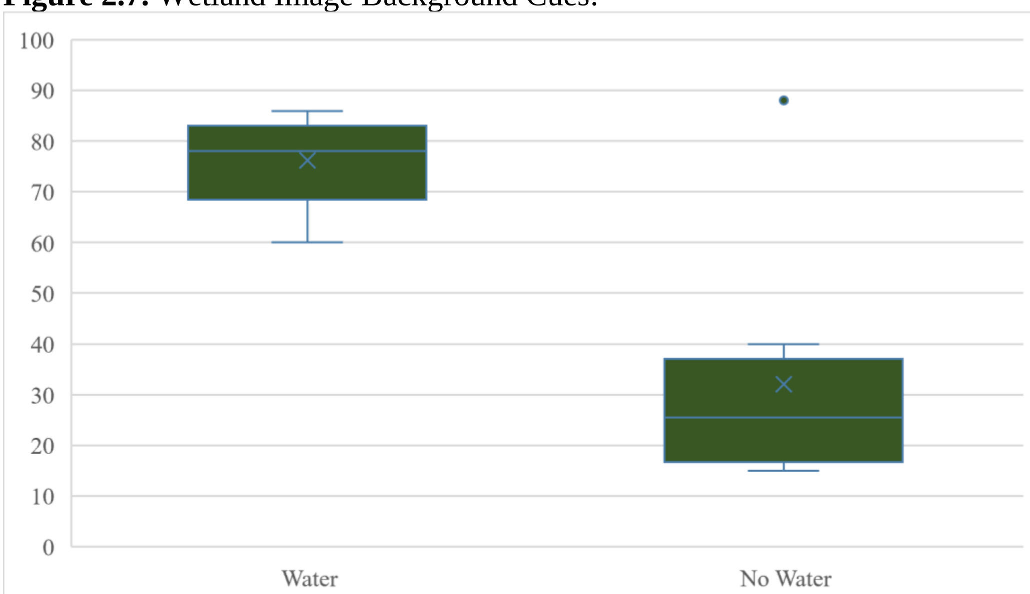
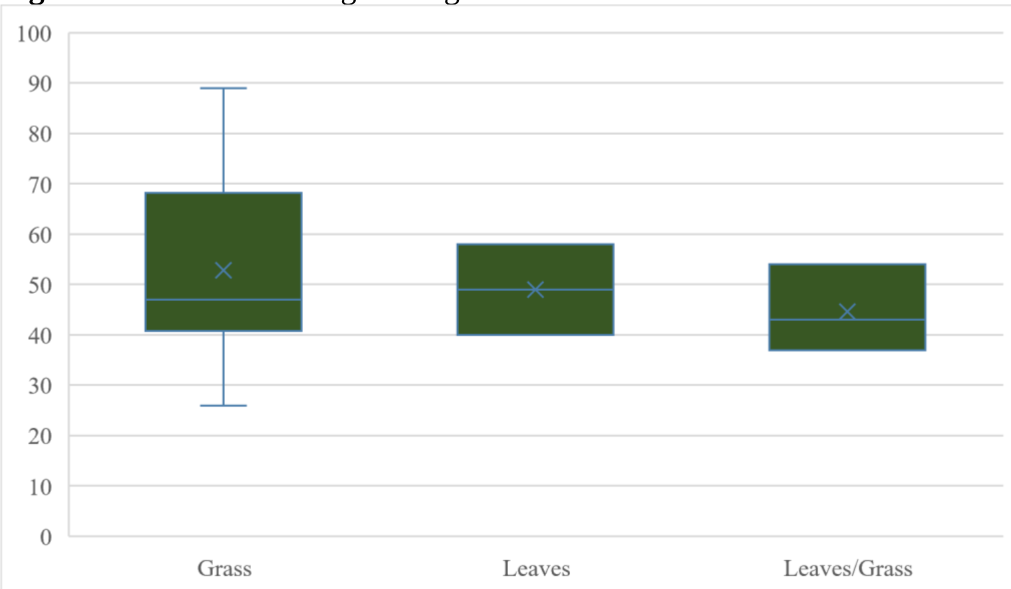


Figure 2.8. Grassland Image Background Cues.



The box and whisker plot results of the forest images indicates that participants may have used leaves/branches as a background cue, but otherwise results were similar across backgrounds. It appears that background cues were not used with grassland plants. However, for wetland plants it is likely participants used water as a cue to wetland plant identification, with 76% of participants (n=578 attempts) using water as a cue. The outlier within the no water background of the wetland images is the selection of the cattail image. Meaning that whether water is present or not, cattail is an easily recognizable wetland plant for the area, which based on the authors' knowledge is true and unsurprising.

Naming Plants

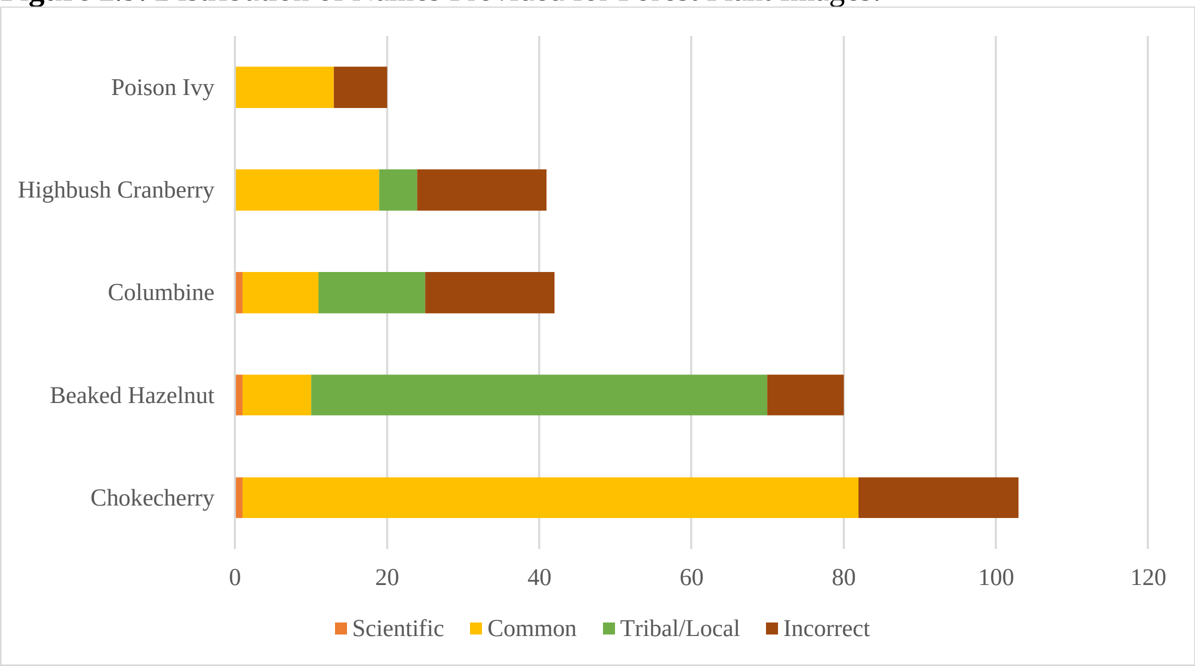
In the next set of questions, participants were asked to provide a name for plants found within the three habitats. Forest, wetland, and grassland habitats each had five plant images for participants to identify. The names participants provided could be scientific, common, local, or Anishinaabe names. Within this study, a name is considered local when multiple people within an area name a plant, and it is consistently identified without concern to field guides and scientific names. Any names given that did not fit the previously mentioned criteria were placed in the unknown/incorrect category. Attempts made to provide names for the plants for Forest, Wetland, and Grassland plants are found in Appendix C.

Participants attempted to name the forest plants most often, followed by grassland and wetland plants. Within the forest plants, a total of 314 attempts were made to provide a name for the plants (Figure 2.9). Only one participant provided a scientific name, and they did this for three of the plants. The forest plant that was named correctly most often was the chokecherry (*Prunus virginiana*), and was named correctly most often as the common name (n=82). Chokecherry is a popular berry within the study area, found within a diversity of edible products. It has also been used as a medicine by the Anishinaabe and Lakota people (Densmore, 1974; Kant et al., 2015).

The plant that was identified correctly the most using a tribal name was the beaked hazelnut (*Corylus cornuta*) (n=60) (Appendix C). The tribal/local name for beaked hazelnut that is used within the study area is a spelling variation of pucon, which is believed to have evolved from the Anishinaabe word ‘bagaan’ which means a nut, hazelnut, a peanut (Ojibwe People’s Dictionary, n.d.) and the Cree word for nut to be ‘pakan’(Dictionary of the Cree Language, 1865). Pucon is a favored fall treat if you find it before the squirrels. Among Indigenous people across Canada, which borders the study area, beaked hazelnut is known as a food source due to its natural fats and vitamins, while also being used as a medicinal resource for colds, ear infections, and other ailments (Armstrong et al., 2018).

The plant with the greatest diversity of names that were identified as unknown/incorrect (n=45) was highbush cranberry (*Viburnum opulus*). Poison ivy (*Toxicodendron radicans*) had the lowest number of attempts for naming. Poison ivy is found throughout the Turtle Mountain Forest of the study area, and is considered to be a harmful plant. People who are highly sensitive to the oil of poison ivy and break out in a terrible rash should learn how to accurately identify the features of the plant. Poison ivy, ‘leaves of three let it be’, is the phrase shared to help people identify the plant, the shades of green of poison ivy vary, but are not distinctly different from the nontoxic plants nearby. Therefore, it requires some plant knowledge in identifying poison ivy from other plants (Ozturk et al., 2008).

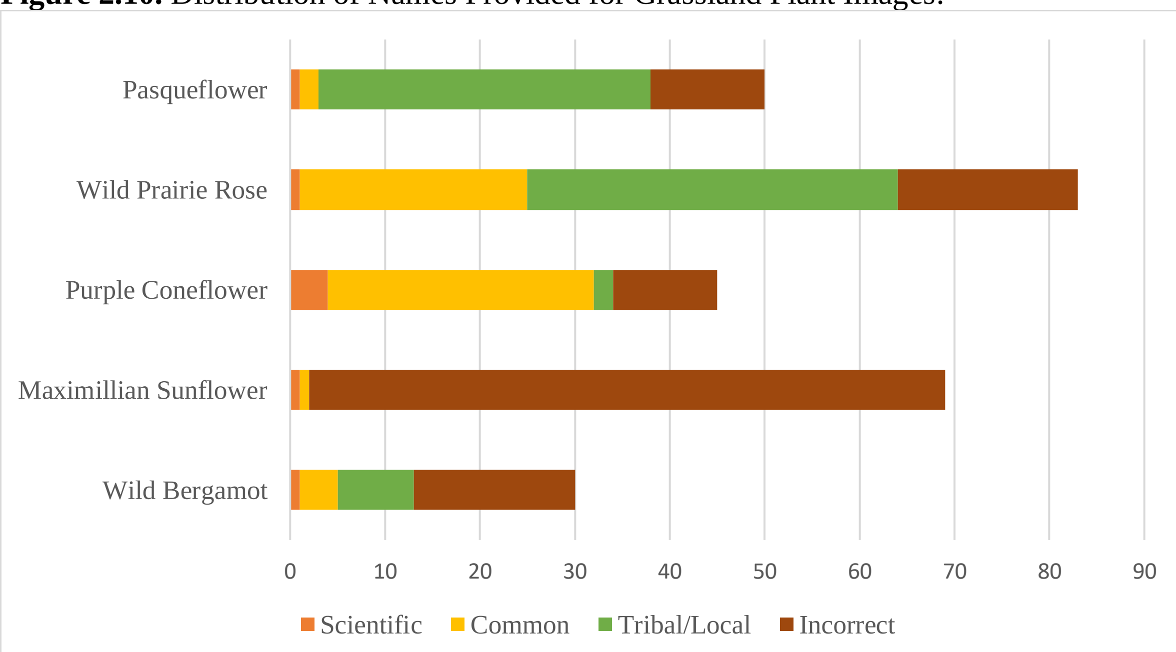
Figure 2.9. Distribution of Names Provided for Forest Plant Images.



Participants attempted to name grassland plants a total of 277 times. Survey participants provided the most common names for purple coneflower (*Echinacea purpurea*) (n=28), in addition to the most scientific names (Figure 2.10). The wild prairie rose (*Rosa arkansana*) had the most repeated tribal/local name of snakeberry (n=39). Wild prairie rose was identified by the red fruit or seed capsule, rose hips, and is now locally known as snakeberry, although it is used as a source for vitamin C (Geniusz, 2015). When local people have identified the plant that they call snakeberry, it has consistently been in reference to the “rose hips”. Rose hips are an accessory fruit on the rose plant. Within the study area there are two common rose plants, Rosa arkansana, and Rosa woodsii.

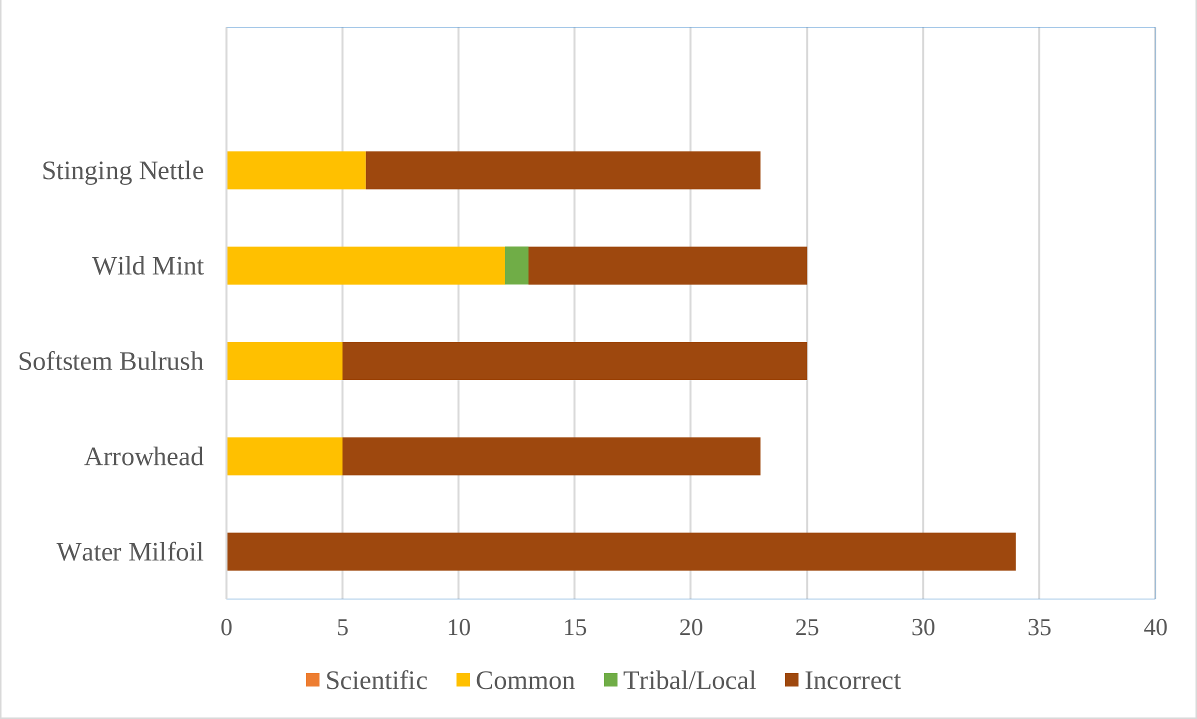
The Maximilian sunflower (*Helianthus maximiliani*) and the pasqueflower (*Pulsatilla patens ssp. multifida*) also had an interesting proportion of local names provided, with many local people incorrectly identify Maximilian sunflower (n=44) as sunflower and some as black-eyed susan, which are both considered incorrect. Wild bergamot (*Monarda fistulosa*) names that were provided were horse medicine and elk medicine, as parts of the plant can be used to help relieve an upset stomach. Thirty-five people provided the name crocus flower for Pulsatilla patens ssp. multifida flower. This again is a locally used name, but not the common name used in field guides such as the National Wildlife Federation, Field Guide to Wildflowers of North America (2010), and Northland Wildlflowers, The Comprehensive Guide to the Minnesota Region (2001).

Figure 2.10. Distribution of Names Provided for Grassland Plant Images.



Wetland plants had the least amount of attempts to provide a name for the plants (n=130). Among the wetland plants, wild mint (*Mentha arvensis)* had the most common names given of all the wetland plants (n=12) (Figure 2.11). Wild mint (*Mentha arvensis)* is a fragrant species that may be identified more by its aroma then by appearance. It was the only wetland plant to have a tribal name submitted. Participants often referred to water milfoil (*Myriophyllum sibiricum)* as seaweed, which is incorrect, but also a term that some people locally give to all submerged vegetation. Water milfoil had the most attempts to name it and all of them were unknown/incorrect names (n=34). Stinging nettle (*Urtica dioica)* had a low number of attempts, and of those that answered, a large percent were incorrect. A small portion of people identified stinging nettle as poison ivy. This is likely due to the irritation that is caused by stinging nettle when it interacts with skin, similar to poison ivy, though poison ivy rash symptoms include redness, itching, swelling and blisters (Allen, 2004). Soft stem bulrush (*Schoenoplectus tabernaemontani*) and arrowhead (*Sagittaria cuneata*) both had only common names attempted (n=5). Overall, for wetland plants common names were most often correct, but overall there were more incorrect answers than correct according to the Wetland Plants of the Northern Great Plains (2012), (Appendix C).

Figure 2.11. Distribution of Names Provided for Wetland Plant Images.



Densmore (1974) studied plants used by Anishinaabe. When learning the names of plants, they found that one plant could have many names, and one name could refer to different plants. The appearance of plants, the place where it grows, a property of the plant, or the primary use of the plant are typically part of the name given to the plant (Densmore, 1974; Meeker et al., 1993). Similarly, many people within this study wrote the name, black-eyed susan (*Rudbeckia hirta*) for the flower of the Maximilian sunflower (*Helianthus maximiliani*) which are similar, but not identical. Black-eyed susan appears to be a generalization for flowers that have yellow petals and a daisy like appearance.

When researching the local name "snakeberry", which is currently used to describe the Rosa spp., the name was first used to describe berry plants within the Turtle Mountain region that should not be eaten, specifically baneberry (*Actaea spp*.). The transferring of the name snakeberry from baneberry to wild rose plants is a form of plant blindness, as people are generalizing the plants as being the same due to having red fruit. Individuals did not see the differences between the species and passed on the name to younger generations. Anishinaabe knowledge of plants involves knowing more about the plants than the scientific terminology, understanding plants as an individual and understanding the gifts that they share has helped the Anishinaabe to know a diversity of plants through history (Meeker et al., 1993). Using tribal names or local names enforces the Anishinaabe teachings, language, and culture. Teaching traditional ecological knowledge and scientific ecological knowledge on the land allows students to build a relationship with the land and develop an understanding of reciprocity for the gifts of the land (Kimmerer, 2012). Educators and industry are encouraged to combine their abilities to provide experiences for plant education and hands-on plant experiences in natural landscapes in a diversity of courses to help build plant knowledge (Becerra et al., 2013; Comeau et al., 2019; Perez et al., 2020).

Conclusion

Identifying a plant to its natural habitat based on a single image may not be difficult for people knowledgeable about plants. However, for someone who visits a habitat only during a specific season, a single image may not represent the characteristics of the plant they know. This enforces the idea that people may know plants during a particular stage or season, but do not readily identify the plants' other characteristics. This study showed that the citizen population could identify commonly found plants (abundant in the study area) or those with distinctive features such as fruit, showy flowers, or aroma. However, other plants were more obscure and challenging. The most correctly identified plants were chokecherry (berry-producing shrub), wild prairie rose (state flower for study area, with showy pink petals), and wild mint (aromatic). As past studies have suggested, utilizing plants that are commonly found or considered helpful in some way, such as traditional or foraging plants, would be a good way to teach plant knowledge.

Within the study area, there are multiple languages spoken in addition to English; Anishinaabemowin, Mitchif (Intertwined Language of French/Cree/Anishinaabemowin), and Cree Language. The multiple languages contributed to the diversity of names provided by participants, in addition to the common and scientific names. While the scientific community has developed consistent naming for plants, this study demonstrates that to fully assess and teach plant knowledge, researchers and educators need to be open and receptive to other naming nomenclature.

Many citizens within the 67-76 age bracket did not have electricity or running water within their homes until the 1960s, demonstrating the lack of modern resources, that also crossed over to medicines. Conversations with local citizens in their 70s and older discuss that many of their elders knew the plants for nutritional and medicinal uses. It was a benefit to a family to have people within their home who knew of the plants to help an upset stomach, earache, pneumonia, and worse. This knowledge still exists within the study area; however, this study shows a general trend that younger people in the area possessed less plant knowledge, which has also been observed among local residents. If this trend continues, it would be a loss of cultural identity for the community. However, with cultural revitalization movements, authors are hopeful to imagine a day when every family would have a person knowledgeable of the benefits of the local plants.

Overall, the study was the first of its kind to successfully assess plant knowledge of a large Native American population. It would be useful to expand this research across other cultures in the region and other indigenous populations around the world to determine how life experience impacts plant knowledge and the value placed on plants. Additionally, further research to understand the exact mechanisms that will increase plant knowledge would be useful. Information from this study is useful to both researchers and educators in understanding the underlying mechanisms that lead to plant blindness, how it changes across demographics, and what can be done to mitigate the issue.

References

Allen, P.L.J. (2004). Leaves of Three, Let Them Be: If It Were Only That Easy. *Pediatric Nursing*, 30(2), 129-135.

Amprazis, A., Papadopoulou, P., & Malandrakis, G. (2021). Plant blindness and children's recognition of plants as living things: a research in the primary schools context. *Journal of Biological Education*, 55(2), 139-154, https://doi.org/10.1080/00219266.2019.1667406

Armstrong, C.G., Dixon, W.M., & Turner, N.J. (2018). Management and Traditional Production of Beaked Hazelnut, (k'áp'xw-az', Corylus cornuta; Betulaceae) in British Columbia. *Human Ecology*, 46, 547-559. https://doi.org/10.1007/s10745-018-0015-x

Balas, B., & Momsen, J.L. (2014). Attention "Blinks" Differently for Plants and Animals. *Life Sciences Education*, 13, 437-443, https://doi.org/10.1187/cbe.14-05-0080

Balding, M., & Williams, K.J.H. (2016). Plant blindness and the implications for plant conservation. *Conservation Biology*, 30(6), https://doi.org/10.1111/cobi.12738

Bartoszeck, A.B., Cosmo, C.R., Silva, B.R. da, & Tunnicliffe, S.D. (2015). Concepts of Plants Held by Young Brazilian Children: An Exploratory Study. *European Journal of Educational Research*, 4(3), 105-117.

Bear Don't Walk, M.R. (2019). Recovering our Roots: The Importance of Salish Ethnobotanical Knowledge and Traditional Food Systems to Community Wellbeing on the Flathead Indian Reservation in Montana. Graduate Student Theses, Dissertations, & Professional Papers. 11494. https://scholarworks.umt.edu/etd/11494

Becerra, T.A., Engle, D.M., Elmore, R.D., & Fuhlendorf, S.D. (2013). Contrasting Preference for Grassland Landscapes Among Population Groups in the Central and Southern Great Plains. *Rangeland Ecology & Management*, 66(5). https://doi.org/10.2111/REM-D-12-00174.1

Benton-Benai, E. (1988). *The Mishomis Book, The Voice of the Ojibway*. University of Minnesota Press. Minneapolis, MN.

Bonnell, K.J., Hargiss, C.L.M., & Norland, J.E. (2019). Understanding high school students' perception of nature and time spent outdoors across demographics. *Applied Environmental Education & Communication*, 18(2), 113-127. https://doi.org/10.1080/1533015X.2018.1438935

Brandenburg, D.M. (2010). *National Wildlife Federation, Field Guide to Wildflowers of North America*. Andrew Stewart Publishing Incorporated.

Bruschi, P., Sugni, M., Moretti, A., Signorini, M. A., & Fico, G. (2019). Children’s versus adult’s knowledge of medicinal plants: an ethnobotanical study in Tremezzina (Como, Lombardy, Italy). *Revista Brasileira de Farmacognosia*, 29(5), 644–655. https://doi.org/10.1016/j.bjp.2019.04.009

Chadde, S.W. (2012) *Wetland Plants of the Northern Great Plains*. Createspace Independent Publishing.

Crall, A.W., Jarnevich, C.S., Young, N.E., Panke, B.J., Renz, M., Stohlgren, T.J. (2015) Citizen science contributes to our knowledge of invasive plant species distributions. 17(8), 2415-2427. https://doi.org/10.1007/s10530-015-0885-4

Colon, J., Tiernan, N., Oliphant, S., Shirajee, A., Flickinger, J., Liu, H., Francisco-Ortega, J., & Mccartney, M. (2020). Bringing Botany into Focus: Addressing Plant Blindness in Undergraduates Through an Immersive Botanical Experience. *BioScience*, 70(10), 887-900. https://doi.org/10.1093/biosci/biaa089

Comeau, P., Hargiss, C.L.H., Norland, J.E., Wallace, A., & Bormann, A. (2019). Analysis of Children's Drawings to Gain Insight into Plant Blindness. *Natural Sciences Education*, 48:190009. https://doi.org/10.4195/nse2019.05.0009

Daikeler, J., Silber, H., & Bosnjak, M. (2022). A Meta-Analysis of How Country-Level Factors Affect Web Survey Response Rates. *International Journal of Market Research*, 64(3), 306-333, https://doi.org/10.1177/14707853211050916

Densmore, F. (1974). *How Indians Use Wild Plants for Food, Medicine, & Crafts*. Dover Publications, Inc. New York.

Dictionary of the Cree Language (1865). Cree word for Nut. *A Dictionary of the Cree Language, As Spoken by the Indians of the Hudson's Bay Company's Territories*. Society for Promoting Christian Knowledge, London.

Disrud, D.T. (1968). Wetland Vegetation of The Turtle Mountains of North Dakota. (Doctoral dissertation, North Dakota State University). *University Microfilms, Inc*., Ann Arbor, Michigan.

Fritsch, E.M., & Dreesmann, D.C. (2015). Secondary School Students' and Their Parents' Knowledge and Interest in Crop Plants: Why Should We Care? *International Journal of Environmental & Science Education*, 10(6), 891-904, https://doi.org/10.12973/ijese.2015.282a

Fuccillo, K.K., Crimmins, T.M., de Rivera, C.E., Elder, T.S. (2015) Assessing accuracy in citizen science-based plant phenology monitoring. *International Journal of Biometeorology*. 59(7), 917-926. https://doi.org/10.1007/s00484-014-0892-7

Geniusz, M. S. (2015). *Plants Have So Much to Give Us, All We Have to Do Is Ask*. *Anishinabe Botanical Teachings*. University of Minnesota Press.

Henderson, N., Hogg, E., Barrow, E., & Dolter, B. (2002). Climate Change Impacts on the Island Forests of the Great Plains and the Implications for Nature Conservation Policy: The Outlook for Sweet Grass Hills (Montana), Cypress Hills (Alberta-Saskatchewan), Moose Mountain (Saskatchewan), Spruce Woods (Manitoba) and Turtle Mountain (Manitoba-

North Dakota). Government of Canada's Climate Change Action Fund, Prairie Adaptation Research Collaborative (PARC).www.parc.ca

Herrick, R., Mendez Morehouse, J., Pryor, B., & Davis, J.A. (2019). Surveying American Indians with Opt-In Internet Surveys. *American Indian Quarterly*, 43(3), 281-305. https://doi.org/10.5250/amerindiquar.43.3.0281

Isbell F., Calcagno, V., Hector, A., Connolly, J., Harpole, W.S., Reich, P.B., Scherer-Lorenzen, M., Schmid, B., Tilman, D., van Ruijven, J., Weigelt, A., Wilsey, B.J., Zavaleta, E.S., & Loreau, M. (2011). High plant diversity is needed to maintain ecosystem services. *Nature*, 477, 199-203. https://doi.org/10.1038/nature10282

Jose, S.B., Wu, C-H., & Kamoun S. (2019). Overcoming plant blindness in science, education, and society. *Plants, People, Planet*, 1, 169-172. https://doi.org/10.1002/ppp3.51

Kant, J.M., Larson, G.E., Burckhard, S.R., Berdanier, B.W., & Meyers, R.T. (2015). Contemporary Use of Wild Fruits by the Lakota in South Dakota and Implications for Cultural Identity. *Great Plains Research*, 25, 13-24.

Kimmerer, R.W. (2012). Searching for synergy: integrating traditional and scientific ecological knowledge in environmental science education. *Journal of Environmental Studies and Sciences*, 2(4), 317-323. https://doi.org/10.1007/s13412-012-0091-y

Kosmala, M., Crall, A., Cheng, R., Hufkens, K., Henderson, S., Richardson, A.D. (2016) Season Spotter: Using citizen science to validate and scale plant phenology from near-surface remote sensing. *Remote Sensing*, 8(9), 726. https://doi.org/10.3390/rs8090726

Levy, A., Orion, N., & Lesham, Y. (2018). Variables that influence the environmental behavior of adults. *Environmental Education Research*, 24(3), 307-325. https://doi.org/10.1080/13504622.2016.1271865

Loki, V., Nagy, J., Nagy, A., Babai, D., Molnar, Z., & Lukacs, B.A. (2021). Known but not called by name: recreational fishers' ecological knowledge of freshwater plants in Hungary. *Journal of Ethnobiology and Ethnomedicine*, 17(63), 1-16, https://doi.org/10.1186/s13002-021-00489-2

Map showing the Turtle Mountains of Rolette County, North Dakota, Google Earth. earth.google.com/web/. Accessed December, 29, 2021.

Marceno, C., Padulles Cubino, J., Chytry, M., Genduso, E., Gristina, A.S., La Rosa, A., Salemi, D., Landucci, F., Pasta, S., Guarino, R. (2021) Plant hunting: exploring the behaviour of amateur botanists in the field. *Biodiversity and Conservation*, 30(11), 3265-3278. https://doi.org/10.1007/s10531-021-02248-x

Meeker, J.E., Elias, J.E., & Heim, J.A. (1993). *Plants Used by the Great Lakes Ojibwa.* United States: Great Lakes Indian Fish and Wildlife Commission.

Moyle, J.B.& Moyle, E.W. (2001). *Northland Wildflowers the Comprehensive Guide to the Minnesota Region*. University of Minnesota Press.

Ojibwe People's Dictionary (n.d.). Definition of Bagaan. https://ojibwe.lib.umn.edu/main-entry/bagaan-na, Retrieved January, 2022.

Ozturk, M., Uysal, I., Gucel, S., Mert, T., Akcicek, E., & Celik, S. (2008). Ethnoecology of Poisonous Plants of Turkey and Northern Cyprus. *Pakistan Journal of Botany*, 40(4), 1359-1386.

Perez, H.E., Adams, C.R., Kane, M.E., Norcini, J.G., Acomb, G., & Larsen, C. (2010). Awareness of and Interest in Native Wildflowers among College Students in Plant-related Disciplines: A Case Study from Florida. *HortTechnology*, 20(2): 368-376.

Pesek, T., Abramiuk, M., Garagic, D., Fini, N., Meerman, J., & Cal, V. (2009). Sustaining Plants and People: Traditional Q`eqchi' Maya Botanical Knowledge and Interactive Spatial Modeling in Prioritizing Conservation of Medicinal Plants for Culturally Relative Holistic Health Promotion. *EcoHealth*, 6, 79-90, https://doi.org/10.1007/s10393-009-0224-2

Poncet, A., Schunko, C., Vogl, C.R., & Weckerle, C.S. (2021). Local plant knowledge and its variation among farmer's families in the Napf region, Switzerland. *Journal of Ethnobiology and Ethnomedicine*, 17(53), https://doi.org/10.1186/s13002-021-00478-5

Predrera, O., Ortega, U., Ruiz-Gonzalez, A., Diez, J.R., & Barrutia, O. (2021). Branches of plant blindness and their relationship with biodiversity conceptualization among secondary students. *Journal of Biological Education*, 1-26, https://doi-org.ezproxy.lib.ndsu.nodak.edu/10.1080/00219266.2021.1933133

Qualtrics XM. (2005). Copyright Year 2020. Version 7.2020. Qualtrics, Provo, UT, USA.

Richotte, K. (2009). We the Indians of the Turtle Mountain Reservation…"Rethinking tribal constitutionalism beyond the colonialist/revolutionary dialectic. (Doctoral dissertation). University of Minnesota.

Sanders, D., Eriksen, B., Gunnarsson, C.M., & Emanuelsson, J. (2021). Seeing the green cucumber: Reflections on variation theory and teaching plant identification. *Plants, People, Planet*, 1-11. https://doi.org/10.1002/ppp3.10248

Schussler, E.E., & Olzak, L.A. (2008). It's not easy being green: student recall of plant and animal image. *Journal of Biological Education*, 42(3), 112-119, https://doi.org/10.1080/00219266.2008.9656123

Srinivasan, P., Subramaniyan, V., Gk, T., Krishnasamy, K., Jeyalachagan, S., & Palani, M. (2022). A Survey on Medicinal Plant Knowledge among the Indigenous Communities (Tamilians) in the Delta Regions of Tamil Nadu, India. *Journal of Herbs, Spices, & Medicinal Plants*, 28(1), 36-72, https://doi.org/10.1080/10496475.2021.1962474

Stagg, B. (2020). Developing a pedagogy for reducing 'plant blindness'. (Doctoral Dissertation) University of Exeter, United Kingdom.

Turreira-Garcia, N., Theilade, I., Meilby, H., & Sorensen, M. (2015). Wild edible plant knowledge, distribution and transmission: a case study of the Achi Mayans of Guatemala. *Journal of Ethnobiology and Ethnomedicine*, 11(52), 1-17, https://doi.org/10.1186/s13002-015-0024-4

U.S. Census Bureau, (2019). QuickFacts Rolette County, North Dakota. https://www.census.gov/quickfacts/rolettecountynorthdakota Accessed February 12, 2021.

U.S. Department of Agriculture. (2017). Census of Agriculture, County Profile, Rolette County, North Dakota.

Wandersee, J.H, Schussler, & E.E. (1999). Preventing Plant Blindness. *The American Biology Teacher*, 61(2), 82-86, https://doi.org/10.2307/4450624

CHAPTER 3. UNDERSTANDING HOW CITIZENS GAIN THEIR PLANT KNOWLEDGE AND CHARACTERISTICS THEY USE TO IDENTIFY PLANTS

Abstract

This is the first project to investigate plant knowledge of a large Native American population, a group that plant blindness research has hypothesized may have increased plant knowledge due to the cultural value of plants. This is also the first study to assess Native American plant knowledge, understand where it is gained, and how it changes across demographics. In total, 212 participants took the survey, the survey was taken by 172 females and 40 males; of which 91% identified as Native American or Alaska Native, 8% as White or Caucasian, and 1% as Hispanic or Latino. Even though participants had some plant knowledge, the number of plants they could identify was small, indicating the presence of plant blindness even within a plant-affiliated culture. Additionally, younger people, even though they were adults, could name and identify fewer plants than the older generations. Survey results represented that most plant knowledge was gained through family and extended family interactions. Therefore, while formal education likely could show gains in plant knowledge, this research emphasizes the importance of utilizing family ties and the passing down plant knowledge through lived experiences. Results of this study show it is vital to continue with plant education at any age and to make sure educational experiences with plants don’t solely focus on formal education settings, but instead include family, culture, and outdoor areas where an average citizen can learn about plants.

Introduction

Understanding citizen knowledge of plants and their opinions of the biodiversity within ecosystems can aid in decreasing threats to biodiversity (Becerra et al., 2013; Sharrock & Jackson, 2017; Mbah, 2019; Cordeiro, 2020; Elliot et al., 2020). The inability of people to notice plants is a concept known as plant blindness (Wandersee and Schussler 1999). An example of plant blindness would be people seeing the green leaves of the diverse plants from the forest floor to the canopy and thinking that they are all the same plant, just different ages (Comeau et al., 2019). Plants that are not flowering or producing fruit can be quickly assessed by the human mind and disregarded (Kahneman, 2011; Knapp, 2019). Thorpert and Nielsen (2014) report when forests are seen from 20m away or more, the colors of the forest are perceived as a ‘color mass’ versus when people view plants from 7m away, where they are able to identify the color of the different parts of the plant. When individuals have experiences that enable them to identify individual plants, they can develop the capacity to see the uniqueness of different plants (Balding and Williams, 2016; Sanders et al., 2021).

Balding and Williams (2016) discuss that there is no specific pathway to or away from plant blindness. It is hypothesized that individuals immersed in a plant-affiliated culture likely have a lifestyle that enables their ability to value, identify, and recall plants (Pesek et al., 2009; Turreira-Garcia et al., 2015; Balding and Williams, 2016). However, little research has investigated these ideas using empirical data to verify the claims. A small number of studies describe the insights of traditional ecological knowledge and the transfer of knowledge among family members (Kimmerer, 2012; Pearce et al., 2015; Turreira-Garcia et al., 2015; Cajete, 2020), which are commonly used in plant-affiliated cultures. However, to authors’ knowledge, few research studies to date have explored the influence of culture and life experience on plant knowledge.

Plant blindness is a global phenomenon, but it does not need to be a permanent feature where it is presently observed (Margulies et al., 2019). The Turreira-Garcia et al. (2015) study assessing traditional plant knowledge of people in Rio Negro, Guatemala, showed that for 76% of participants, knowledge of wild edible plants was conveyed from relatives. Specifically, parents were identified as the most important source of knowledge for young people (Turreira-Garcia et al. 2015). Traditional knowledge of medicinal plants has come from generations of human experience (Smith, 1932; Pesek et al., 2009; Kimmerer, 2012; Barreau et al., 2016, Bear Don't Walk, 2019; Srinivasan et al., 2022) and sharing what is understood with others who value the traditional view of life. Learning how to identify plants is challenging, and learning to identify plants on your own using a key is even more challenging, as it requires a person to dedicate time to learning plant anatomy and taxonomy prior to identifying the plants. Acquiring plant knowledge requires repeated exposure to plants in their natural setting (Kirchoff et al., 2014). Wandersee and Schussler (1999) encouraged those who teach biology courses to expand students' botanical horizons, help students to see the flowering and non-flowering plants, and provide students the opportunity to see plants as more than just a backdrop. They also encouraged discovery of individual plant species, which can lead to creating an empathetic connection with plants (Balding and Williams, 2016).

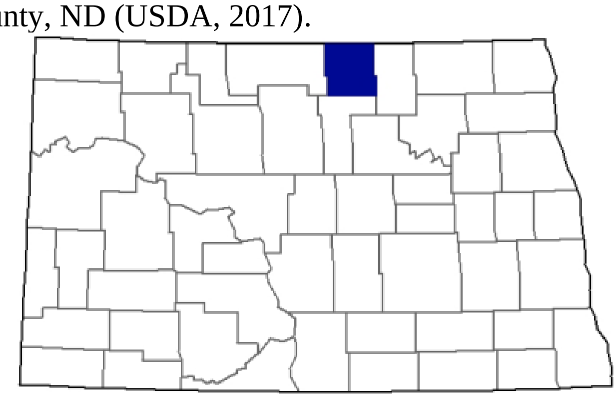
Much of the past research regarding the connection between environmental knowledge, attitudes, and behavior of citizens toward nature has typically focused on age groups from youth through university students (Perez et al., 2010, Kirchoff et al., 2014, Bartoszeck et al., 2015, Merenlender et al., 2016, Levy et al., 2018; Comeau et al., 2019). Some research measuring adult experiences with plants shows that more women than men have positive attitudes toward the environment, volunteer more in citizen science projects, and have a better understanding of the human impact on the environment (Perez, 2010; Turreira-Garcia et al., 2015; Merenlender et al., 2016; Levy, 2018).

The current study sought to assess the citizens of Rolette County, North Dakota, including the Turtle Mountain Band of Chippewa Indians (TMBCI), a group with a rich cultural plant-affiliated history. Determining how citizens within the study area are gaining their plant knowledge, ability to identify and correctly name plants, and comparing plant knowledge across demographics. Specific objectives of the study include: (1) assessing where and how people learn their plant knowledge; (2) assessing plant knowledge and experiences across demographics; and (3) evaluating which plant features citizens use to identify plants.

Method

The study area for this project was Rolette County, North Dakota, USA (Figure 3.1). The county population was 12,187, according to the U.S. Census Bureau (USCB 2021). The county has six rural communities and one tribal reservation, TMBCI. The county's population is 79.7% American Indian/Alaska Native, 16.6% white, and 2.3% Hispanic or Latino (USCB, 2021). Females to males percentage is 50.2% to 49.8% (USCB, 2021).

Figure 3.1. Rolette County, ND (USDA, 2017).



Land use is predominantly cropland with interspersed pastureland and woodland (USDA, 2017). The land base is 2, 340 km^2, and the percentage of land in farms is 88.5%, with 73% held in cropland, 12% in pastureland, 8% woodland, and the remaining 7% listed as other (USDA, 2017; USCB, 2019). The areas elevation will change from 475 m above mean sea level (AMSL) in the prairie upwards to 735 m AMSL at the highest point within the forested hills of the Turtle Mountain region (Google Earth, 2021).

This study was encouraged by local Anishinaabe elders concerned about the number of tribal citizens with plant knowledge. The study sought to understand local citizen knowledge of native plants, the features they use to identify plants, and how they gained their plant knowledge. This area has been the land that the Anishinaabe have known and have a recorded presence on since before 1738 (Disrud, 1968). The U.S. Government moved the Anishinaabe people to North Dakota. They became known as Plains Ojibwe people, who became known as the TMBCI by the federal government. The Ojibwe name for their homeland is Mikinock Wajiw or Turtle Mountain.

The original intent was to talk to citizens face-to-face; however, due to the Coronavirus 2019 pandemic, the survey was redesigned and offered online through Qualtrics (Qualtrics XM, Provo, Utah). The online survey appeared to be a viable option because 79.3% of households within the study area report they own a computer, and 69.5% have broadband internet subscriptions, as reported in the 2020 census (USCB, 2021). The survey format was available to be viewed on a computer or mobile phone. Through Qualtrics, a link was created that could be shared through email and social media.

The survey consisted a variety of questions; demographic, multiple-choice, fill-in-the-blank, and questions placed within a five-point Likert scale (Appendix D). In addition, the survey was reviewed by two focus groups. The initial focus group consisted of six natural resource and plant professionals. This focus group reviewed and provided feedback on the goals of the research and the accuracy and effectiveness of the questions in achieving these goals. The second focus group comprised three Anishinaabe tribal citizens who reviewed the survey to approve any tribal knowledge that may be shared within the survey.

Authors sought and received approval from the North Dakota State University (NDSU) Institutional Review Board (IRB) (institution conducting the research), the Turtle Mountain Community College (TMCC) Research Committee (an author's place of employment), and the Tribal Nations Research Group who functions as the TMBCI IRB. The survey questions did not request names or identifying information from individuals, though demographic information was gathered to be used to sort the results of questions based on demographic data. At the end of the survey, participants could choose to provide contact information to be included in a drawing for a blanket purchased by an author. The identifying contact information was separated from the survey results.

The TMCC research committee approved the use of the college listserv to reach potential participants. This TMCC listserv provided access to 700 email accounts of students, faculty, and staff. A post was also created through the author's personal Facebook account to distribute the survey link. The survey link was shared 50 times on social media by a diverse group of citizens, including individuals, local groups, and area politicians.

The survey started with demographic questions which asked participants to self-identify age, gender, and ethnicity (Appendix D). A multiple choice question was used to determine where survey participants spend their time outdoors, as this would influence their interaction with outdoor plants. The next question sought to understand where people are learning their plant knowledge and are they learning it from one source or a diversity of resources. Then, five-point Likert scale questions were used to assess people's opinions of plants and their usefulness. The next section of the survey sought to understand how people identify plants. A plant characteristic list was created for participants to choose from when explaining which characteristics help them to identify a plant. Participants were asked to review three images, one of a grassland plant, one wetland plant, and one forest, the three dominant land types in the study area. Authors took all of the images presented and all were taken within the study area.

Results and Discussion

The original goal of the project was to survey citizens attending community events throughout the study area. The numerous community events within the study area would have allowed for interactions with a larger number of people, potentially increasing the number of participants within the different age categories. Due to coronavirus (COVID-19), the online survey provided the best opportunity to reach citizens. Additionally, the use of an online survey allowed participants to complete the survey at their convenience and pace (Herrick et al., 2019).

Conducting the survey online may have missed individuals that would have participated face-to-face or by mail (Daikeler et al., 2022). There were more females that participated in the study than men. Based on survey design, we are not able to decipher if men were less likely to participate in the survey due to lack of interest in plants, lack of plant knowledge, or lack of awareness and interest in the survey itself. Similar to results in this study, Fischer et al. (2014), found the majority of public participation in the survey was females in the 31 to 60 years of age category.

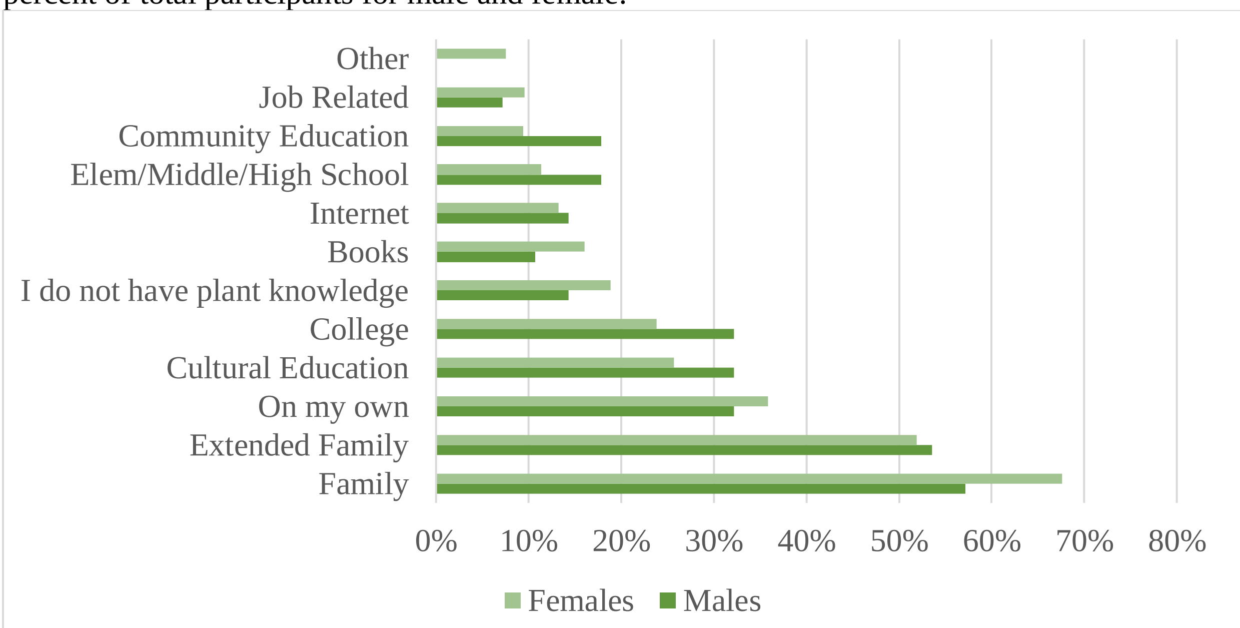
A total of 212 individuals who currently or previously lived within the study area participated in the survey. The survey was taken by 172 females and 40 males, of which 91%

identified as Native American or Alaska Native, 8% as White or Caucasian, and 1% as Hispanic or Latino. The USCB reports that 78% of the population in this area is American Indian and Alaska Native, 18.4% White or Caucasian, and 2.1% Hispanic or Latino (USCB, 2020). Indicating that the results don't match perfectly with the USCB, but are close and would be considered representative of the study area population. The age group with the most participants was the 37 to 46 age group (n=56); followed by 47 to 56 age group (n=47); 57 to 66 age group (n=39); 27 to 36 age group (n=37); 18 to 26 age group (n=23), the least participants in the 67 to 76 age group (n=10).

The first survey question asked participants to identify where they learned their plant knowledge, participants could select all categories that applied (Figure 3.2). The question was completed by 134 survey participants, with 105 females and 28 males completing it. Over 50% of participants, both male (n=31) and female (n=126), indicated that they gained their plant knowledge from family and extended family. Almost 19% of females (n=20) and 14% of males (n=4) indicated that they don't have any plant knowledge. Between 10% and 16% of participants learned plant knowledge from books (males n=3, females n=17) or the internet (males n=4, females n=14).

Numerous studies have discussed the need to increase teaching of plant knowledge in K-12 education as well as college (Wandersee & Schussler, 1999; Wals et al., 2014; Krosnick et al., 2018; Jose et al., 2019; Knapp, 2019; Amprazis & Papadopoulou, 2020; Pedrera et al., 2021). Interestingly, results of this study show that 11% of females (n=12) and 17% of males (n=5) learned about plants in their K-12 years. While, 23% of females (n=25) and 32% of males (n=9) learned about plants in college. Beyond family and extended family, learning about plants on their own was the most common way to learn about plants, followed by cultural education and then college. This study demonstrates that simply focusing on school education may not be enough. Additionally, it shows the significant role that family and culture can take in plant education. Turreira-Garcia et al. (2015) provide evidence showing individuals who learned plant knowledge from their relatives in the local environment had better plant recognition skills than individuals who learned about plants in school or on their own. Overall, there weren't large differences between male and female responses. However, males tended to feel that they had learned more in formal education settings such as college, K-12 schooling, and community education. While females felt they learned more than males from their family, on their own, and from books.

Figure 3.2. Responses for where participants gained their plant knowledge. Represented as percent of total participants for male and female.

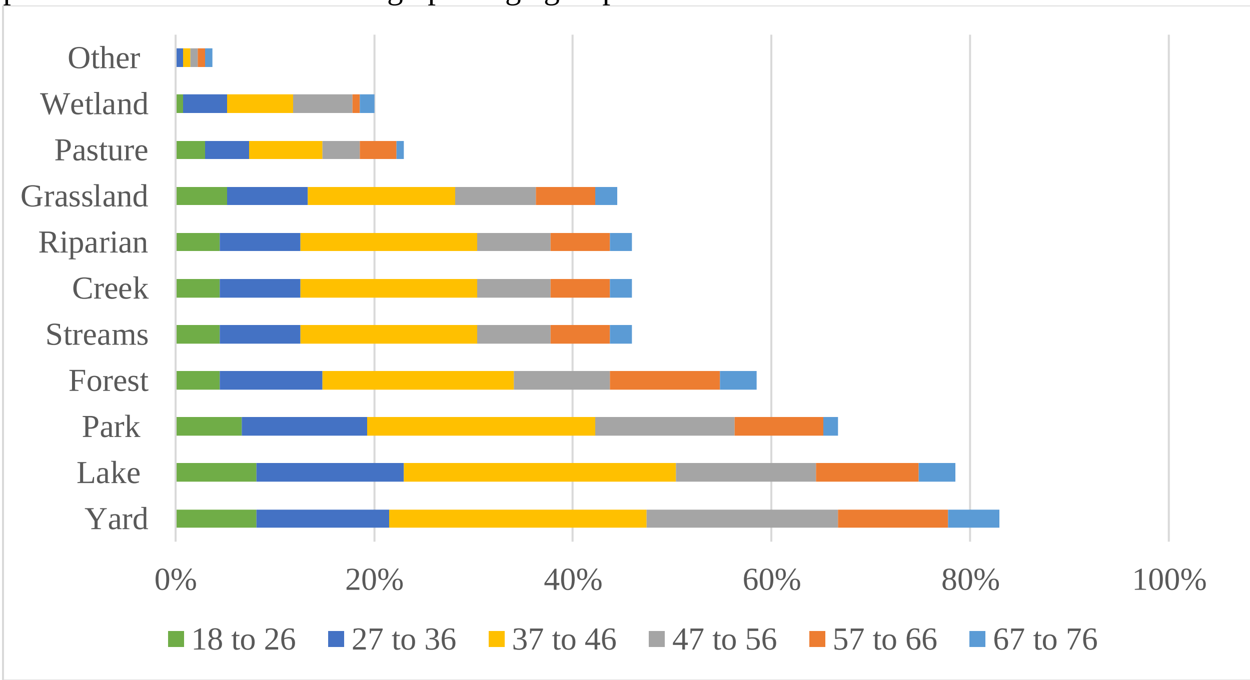


Teaching plant knowledge in many cultures is passed from parents and siblings, in addition to lessons from extended family members such as grandparents, aunts, and uncles (Pesek et al., 2009; Bartoszeck, 2015; Terrera-Garcia, 2015; Balding & Williams, 2016; Barreau et al., 2016; Bear Don't Walk, 2019). Higher education and courses taken while in college are personal choices. Results from this study show that in general citizens are not learning plant knowledge from educational institutions. Literature has encouraged educational institutions to be a part of the answer in teaching people about plants and their local environments (Hungerford and Volk, 1990; Wandersee & Schussler, 1999; Balding and Williams, 2016; Krosnick et al., 2018; Jose et al., 2019; Knapp, 2019, Amprazis & Papadopoulou, 2020; Pedrera et al., 2021; Stagg, 2021; Uno, 2021), while this is important, this research demonstrates the importance of involving family and culture in the process.

When individuals do not understand the cause of environmental problems, it is easy to believe misinformation or misdirection (Robelia & Murphy, 2011). Cruz et al. (2018) encourage a connection between scientific concepts, lived social experiences, and cultural knowledge to create a meaningful environmental education experience. In a study by Lindemann-Matthies (2011) of 4,000 Swiss children and their attraction to plants and animals, most children found plants that they viewed daily such as decorative or garden plants, to be attractive. At the same time, children who were taught and interacted with wild plants daily expressed appreciation for the inconspicuous wild plants (Lindemann-Matthies, 2011). Bartoszeck et al. (2015) also encouraged educators to learn where children are at in their understanding of local plants and continue to enhance their experiences through growing gardens, having snacks from local food, and creating opportunities for positive experiences with local plants (Bartoszeck et al., 2015). As educational institutions move forward with environmental education, the integration of social and cultural experiences can benefit students and enhance their understanding of the information taught (Kimmerer, 2013; Cajete, 2020; Ribeiro & Orion, 2021).

Survey participants were next asked where they spend their time outdoors, selecting as many options as applicable (Figure 3.3). The most selected category was yard (outdoor area surrounding a home), followed by lake and park. While grassland, pasture, and wetland were chosen the least often. Participants that selected ‘other’ were asked to explain and included options such as traditional areas for ceremonies, golf courses, and mountains. Within the study area, ‘mountains’ is a nickname for the geology of the Turtle Mountain region. The Turtle Mountains are an area of rolling hills created by glacial dead-ice (Potter & Moir, 1961; Iannicelli, 2003) and covered by deciduous forest with areas of wetlands, lakes, streams, and open land for crops and livestock (Disrud, 1968). The Turtle Mountains encompass most of the study area for this project.

Figure 3.3. Participant responses to where they enjoy spending time outdoors. Represented as a percent of total for each demographic age group.

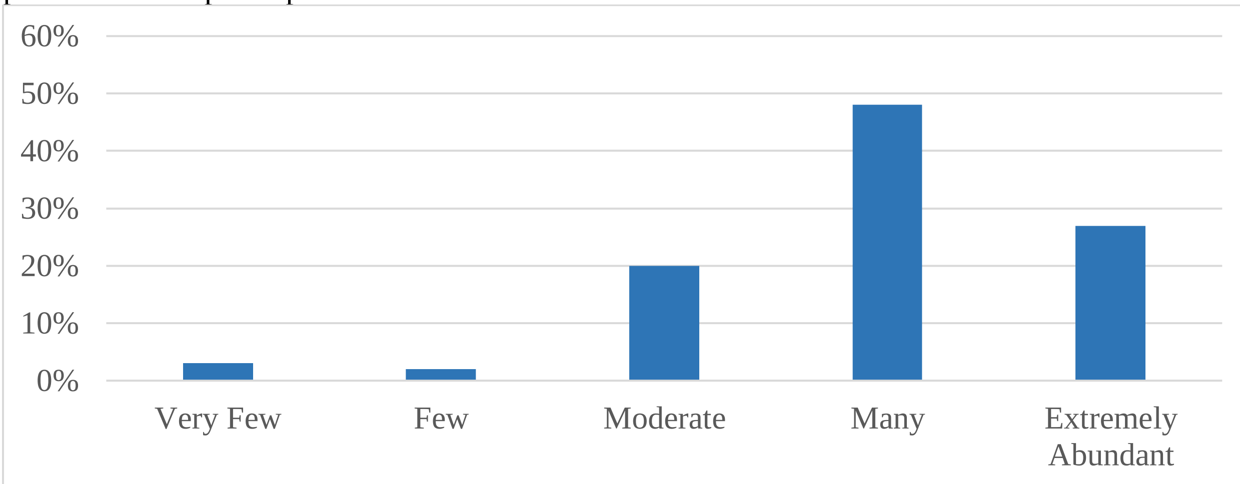


In general, the results of where participants like to spend time outdoors indicates that they prefer areas that are maintained by humans for enjoyment (yard or park) or recreation (lakes) as opposed to wild areas (Frumkin & Louv, 2007; Milligan & Bingley, 2007) . The study area is a rural area, when citizens refer to their “yard”, the size of the yard could vary from multiple hectares to spaces equal to the size of their home. The landscape of the study area includes an island of forested hills with several small water bodies, surrounded by a prairie of agriculture and rangelands (Henderson et al., 2002). The lakes in the area are often used for recreation including fishing, canoeing, and birding (ND Parks and Recreation, 2022).

The greatest density of Native American population (TMBCI) within this area is found within the forested hills, while the prairie has a greater density of Caucasians. The tribal population has used the plants from the forests, lakes, and grasslands for shelter, tools, medicine, nutrition, heat, and artwork for many years (Richotte, 2009). The history of the TMBCI people includes a time when tribal citizens were limited to being only within the reservation boundaries, which is predominantly forested. Therefore, it is understandable that forests are in the top four places where people enjoy being (Disrud, 1968; Richotte, 2009) and the wildest habitat selected for places people enjoy to spend time.

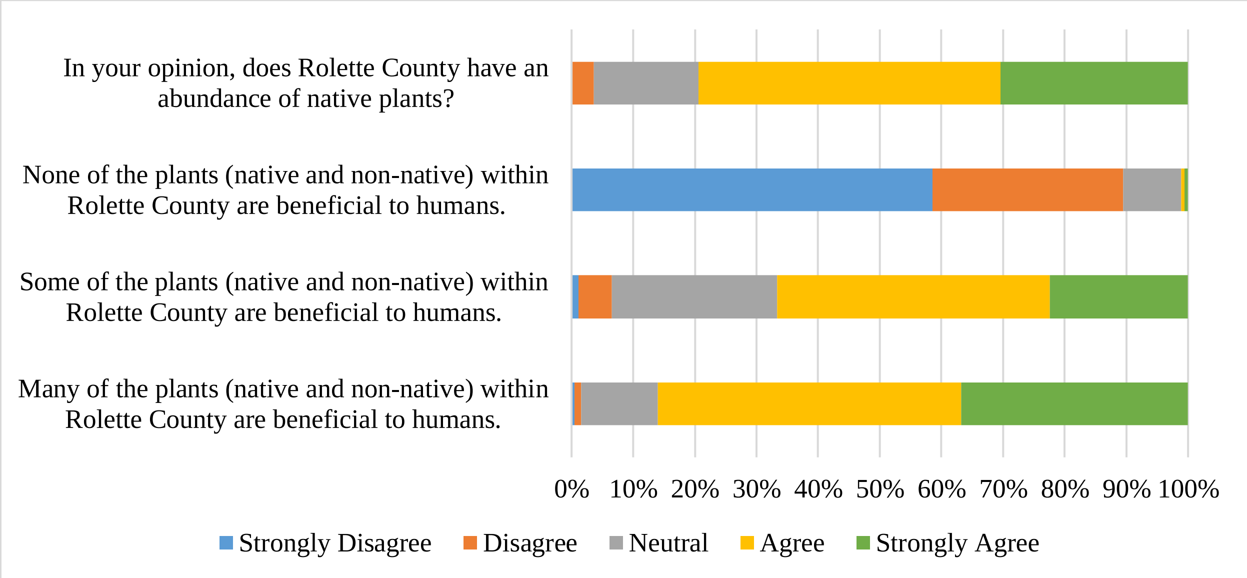
After considering where participants learned their plant knowledge, they were asked from their perspective how many native plants exist within the study area. The predominant choice was many (48%, n=93), with the second most popular choice being extremely abundant (27%, n=53). Together these options make up 75% of participant responses (n=193), indicating that people believe native plants are abundant as opposed to less abundant in the study area.

Figure 3.4. Responses for how many native plants exist within the study area. Represented as percent of total participants.



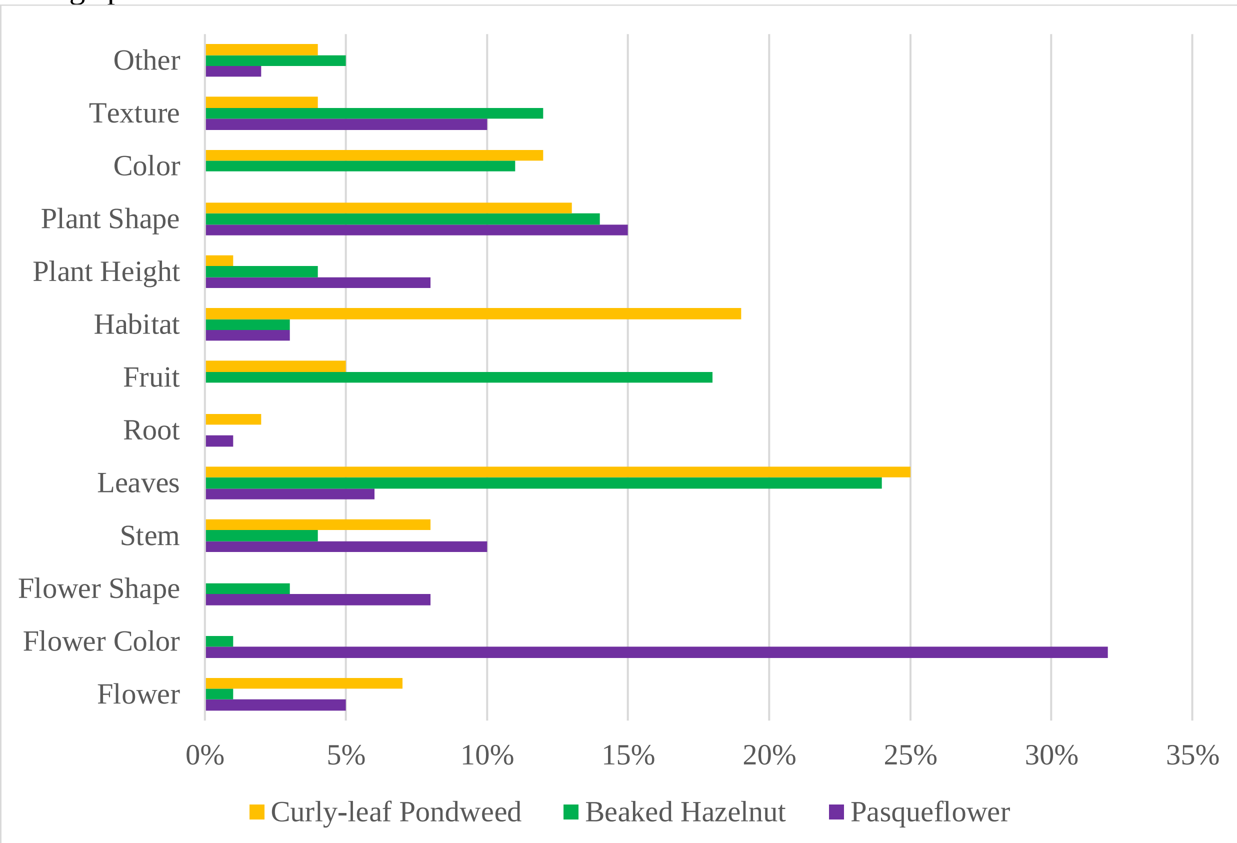
The next question asked if participants felt the study area has an abundance of native plants. Participants (n=194), mostly agreed or strongly agree with this statement (79%, n=154). Next, they were asked Likert scale questions to measure participants' perspectives on the presence of beneficial plants within the study area. Most participants (n=181) selected strongly disagree to none of the plants in the study area being beneficial to humans. While most participants agreed (49% , n=95) or strongly agreed (37%, n=71) that many of the plants are beneficial to humans. This showed consistency in opinions regarding the benefits of plants, showing citizens in this area generally feel more plants, both native and non-native, are beneficial.

Figure 3.5. Likert scale assessment of participant view on abundance and beneficial plants in the study area, represented as percent of total.



People typically use specific features to identify and recall plants. Therefore, participants were provided with one plant from each of three different habitats (forest, grassland, and wetland). To determine if participants use the same features to identify plants, they were asked to provide their top three identifying features for each plant. The plant features list included: flower; flower color; flower shape; stem; leaves; root; fruit; habitat; plant height; plant shape; color; texture; and other. The first plant they were shown a picture of was Beaked hazelnut (*Corylus cornuta*) and participants were asked if they needed to memorize the plant and find it again in nature, what features would they notice most that would help them identify it later. The participants that answered the question (n=126) identified leaves (n=81), fruit (n=60), plant shape (n=48), and texture (n=40) as the most common features (Figure 3.5). When asked the same question referring to Pasqueflower (Pulsatilla vulgaris), participants (n=129) selected the following features: flower color (n=117); plant shape (n=54); stem (n=37); and texture (n=35) most often (Figure 3.5). Lastly, the Curly-leaf pondweed (Potamogeton crispus) features most chosen by participants (n=119), included: leaves (n=79); habitat (n=59); plant shape (n=40); and color (n=37) (Figure 3.6).

Figure 3.6. Plant characteristics participants would use to identify species. Represented as average percent.

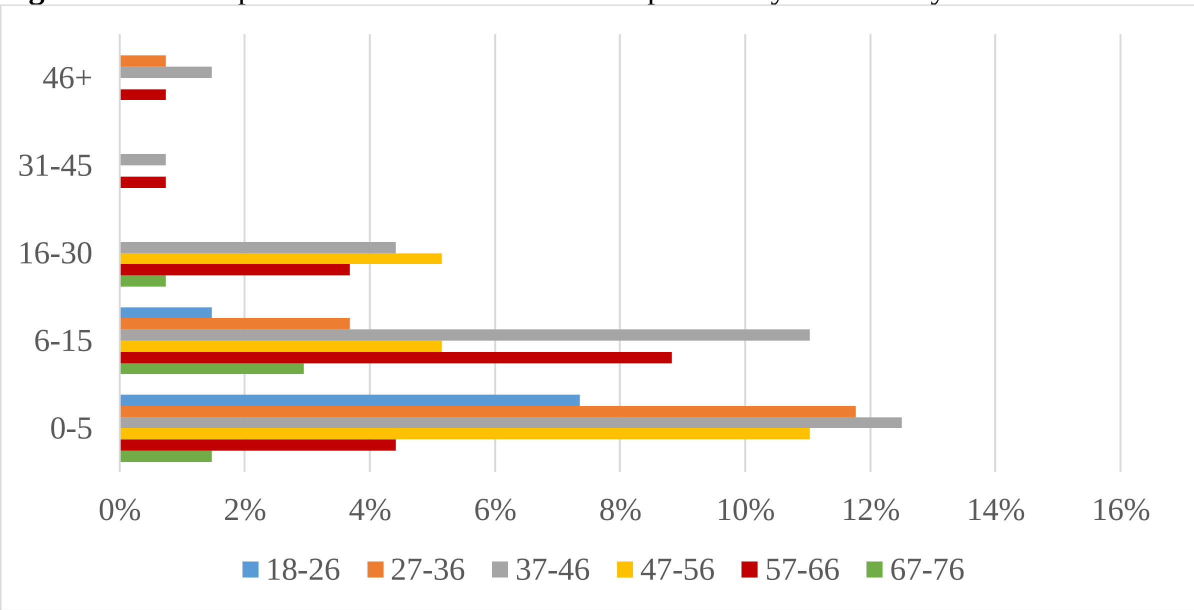


The three plants provided for participants to select identifying features from are common plants in the study area with distinct features. Pasqueflowers are the first spring flowers in grassland areas, while beaked hazelnut trees are found throughout area forests and have a unique husk over the nut, and curly-leaf pondweed is found in many of the area lakes and wetlands. The features participants chose to help identify and recall plants most often were: flower color; leaves; habitat; fruit; and plant shape (Figure 3.6). A few survey participants chose to include additional features they use to identify plants, for example, one repeatedly identified for pasqueflower (*Pulsatilla patens ssp. multifida*) was fuzzy stem. As for Curly-leaf pondweed

(*Potamogeton crispus*) the stem and flower are the next features to be used to identify the wetland plant, in addition to a few generalizations of 'icky' as a feature. Beaked hazelnut (*Corylus cornuta*) leaves and fruit are numerous and distinct in the Turtle Mountain Forest. The Anishinaabe have named plants according to characteristics, place, timing of flower or fruit, dreams, or use, for example within the Turtle Mountains, beaked hazelnut is more commonly known as pucon. (Meeker, et.al., 1993). Pucon is derived from the Anishinaabe word 'bagaan' and the Cree word 'pakan' which both mean nut (Dictionary of the Cree Language, 1865; Ojibwe People's Dictionary, 2022).

Knowledge of the existence of plants and the ability to identify and name plants are different concepts. The next section of questions asked participants to self-identify how many plants they believed they could identify and name within the study area (Figure 3.7). Although a majority of the participants selected that many native plants exist within the study area, and many of the plants are beneficial, 49% (n=66) of participants said they could only name 0-5 plants, and 33% (n=45) said 6-15 plants; leaving only 18% of participants that can identify over 15 plants (16-30 plants n=19, 31-45 plants n=2, and 46+ plants n=4). This means of all the plants in the study area 82% of participants could identify 15 or less plants, which shows a limited botanical knowledge, indicating plant blindness is likely present in this population.

Figure 3.7. Participants' self-identified number of plants they can identify and name.



All the plant images from the survey were taken within the study area. Participants were asked how many of the plants they recognized (Figure 3.8), and results were graphed by age (Figure 3.8) and gender (Figure 3.9). Only four individuals selected that they recognized 0% of the plant images. In contrast, most participants (n=62) said they recognized 25% of the plants. With the second highest selection being 50% of plants (n=37), followed by 75% (n=18), and 100% (n=2). There was not a discernable pattern between age and plant recognition. For example, the majority of 18-26 year old's identified that they recognized 50% of the plants, but recognizing more plants didn't necessarily equate to being able to name the plants (Figure 3.7). When breaking the results down by gender (Figure 3.9), males selected they recognized between 25% to 75% of plants, and females were able to recognize anywhere from 0% to 100% of plants. The majority of participants for both males and females was 25% (n=14 and n=48 respectively).

Figure 3.8. Recognition of images of plants found within the study area by age represented as percent of total.

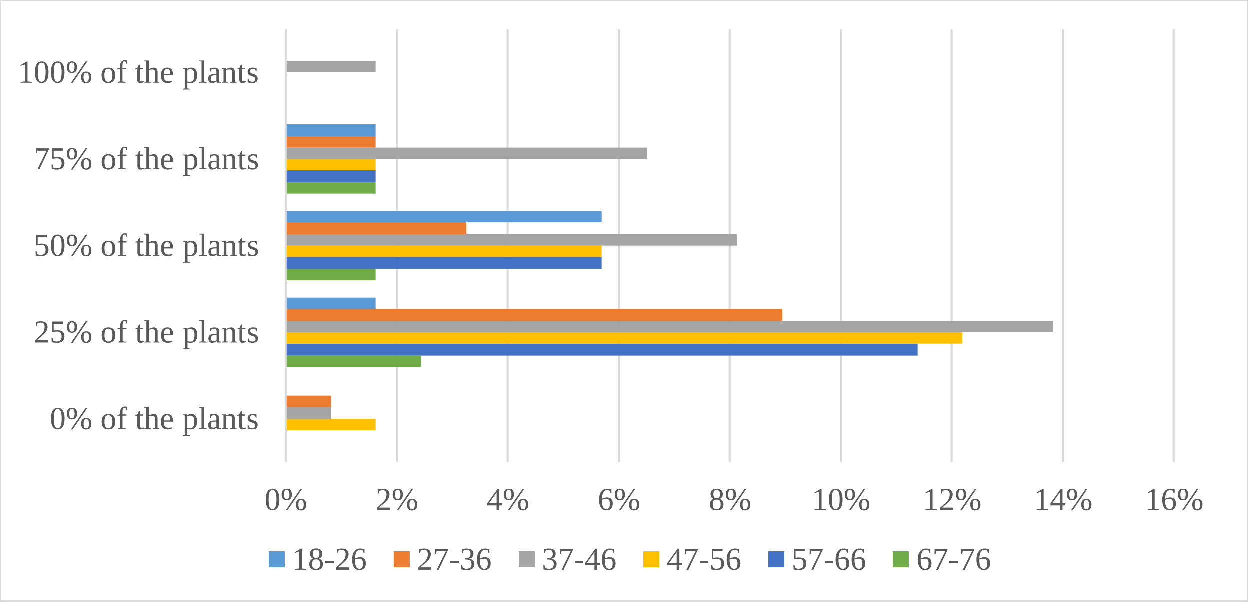
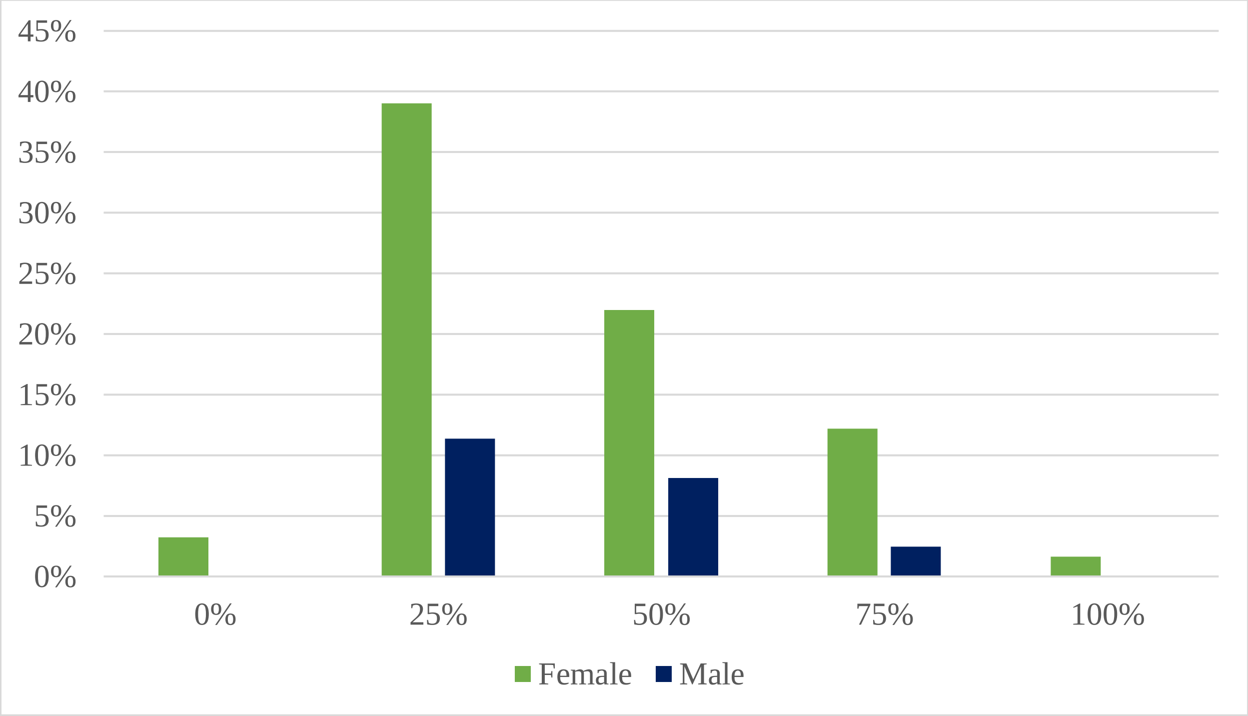


Figure 3.9. Recognition of images of plants found within the study area by gender represented as percent of total.



Conclusion

This project was able to obtain a reasonable number of participants even though it had to be online due to Covid-19. The majority of participants identified as Native American. This is the first project to investigate plant knowledge of a large Native American population, a group that plant blindness research has hypothesized may have increased plant knowledge due to the cultural value of plants. This is also the first study to assess Native American plant knowledge, understand where it is gained, and how it changes across demographics.

A large amount of literature on plant blindness implies that gains can be made through formal education avenues such as K-12 classrooms and college settings. However, results showed that these were some of the avenues least identified as places where participants gained plant knowledge. Most knowledge was gained through family and extended family interactions. Therefore, while formal education likely could show gains in plant knowledge, this research emphasizes the importance of utilizing family ties and the passing down of plant knowledge through lived experiences. Experiences such as gathering mint from wetlands, eating snacks of berries, and learning about food through gardening all have the potential to inspire students to be mindful citizens who value plants. Within indigenous communities, plant knowledge is generational knowledge. People who are part of plant affiliated cultures, such as the Anishinaabe, experience a way of life that involves plants in everyday life. Immediate and extended family members were shown to provide the most memorable experiences when teaching about plants. Creating opportunities for people to interact with plant species while their unique characteristics (i.e. fruits, flowers, aroma) are evident is a first step in helping people to recall and identify plants. Then engaging people on how to identify the plants when those characteristics are not obvious through repeated experiences will help them to learn about the habitats and other plants within the area.

Participants in this study demonstrated a preference for natural areas maintained for humans for recreation purposes. Although more wild habitats may not be the in top three choices for the average citizen to spend time in, forest did have the fourth highest selection. Building on the knowledge that can be learned in familiar and comfortable environments as well as moving into new and wild areas will be important to helping citizens understand the value of biodiversity and conservation in the future.

Participants identified plant features such as flower color, leaves, habitat, fruit, and plant shape to be the most useful features in recognizing plants. Utilizing plants with distinct characteristics or uses would be a good way to get people interested in plants and plant identification. However, efforts should be made to help recognize these plants when they are not in peak season when fruits or flowers are not present. Results showed that people could recognize more plants than they felt they could identify and name. Efforts to teach the average person about plants in the local environment through things like signage at parks and other recreation areas may prove useful at reaching increasing plant interest of citizens.

Even though participants had some plant knowledge, the amount of plants they were able to identify was small, indicating the presence of plant blindness even within a plant affiliated culture. Additionally, younger people, even though they were adults, could name and identify less plants than the older generations. Results of this study show it is important to continue with plant education at any age and to make sure educational experiences with plants don't solely focus on formal education settings, but instead include family, culture, and areas where an average citizen can learn about plants. This information is useful to educators working to improve citizen plant knowledge; as well as, researchers seeking to understand the causes of plant blindness and ways to combat plant blindness in the future.

References

Amprazis, A., Papadopoulou, P., & Malandrakis, G. (2021). Plant blindness and children's recognition of plants as living things: a research in the primary schools context. *Journal of Biological Education*, 55(2), 139-154. https://doi.org/10.1080/00219266.2019.1667406

Balding, M., & Williams, K.J.H. (2016) Plant Blindness and the implications for plant conservation. *Conservation Biology*, 30(6), 1192-1199. https://doi.org/10.1111/cobi.12738

Barreau, A., Ibarra, J.T., Wyndham, F.S., Rojas, A., & Kozak, R.A. (2016) How can we teach our children if we cannot access the forest? Generational change in Mapuche knowledge of wild edible plants in Andean temperate ecosystem of Chile. *Journal of Ethnobiology*, 36(2), 412-432. https://doi.org/10.2993/0278-0771-36.2.412

Bartoszeck, A.B., Cosmo, C.R., Silva, B.R. da, & Tunnicliffe, S.D. (2015). Concepts of Plants Held by Young Brazilian Children: An Exploratory Study. *European Journal of Educational Research*, 4(3), 105-117.

Bear Don't Walk, M.R. (2019) Recovering our Roots: The Importance of Salish Ethnobotanical Knowledge and Traditional Food Systems to Community Wellbeing on the Flathead Indian Reservation in Montana. Graduate Student Theses, Dissertations, & Professional Papers. 11494. https://scholarworks.umt.edu/etd/11494

Becerra, T.A., Engle, D.M., Elmore, R.D., & Fuhlendorf, S.D. (2013). Contrasting Preference for Grassland Landscapes Among Population Groups in the Central and Southern Great Plains. *Rangeland Ecology & Management*, 66(5), 529–538. https://doi.org/10.2111/REM-D-12-00174.1

Cajete, G. A. (2020). Indigenous Science, Climate Change, and Indigenous Community Building: A Framework of Foundational Perspectives for Indigenous Community Resilience and Revitalization. *Sustainability*,12(22), 9569. https://doi.org/10.3390/su12229569

Comeau, P., Hargiss, C. L. M., Norland, J., Wallace, A., & Bormann, A. (2019) Analysis of Children's Drawings to Gain Insight into Plant Blindness. *Natural Sciences Education*, 48:1, https://doi.org/10.4195/nse2019.05.0009

Cordeiro, B., Marchante, H., Castro, P., & Marchante, E. (2020) Does public awareness about invasive plants pays off? An analysis of knowledge and perceptions of environmentally aware citizens in Portugal. *Biological Invasions*, 22(7), 2267-2281. https://doi.org/10.1007/s10530-020-02247-z

Cruz. A.R., Selby, S.T., & William H. Durham (2018) Place-based education for environmental behavior: a 'funds of knowledge' and social capital approach. *Environmental Education Research*, 24:5, 627-647, https://doi.org/10.1080/13504622.2017.1311842

Daikeler, J., Silber, H., & Bosnjak, M.(2022) A Meta-Analysis of How Country-Level Factors Affect Web Survey Response Rates. *International Journal of Market Research*, 64(3), 306-333. https://doi.org/10.1177/14707853211050916

Dictionary of the Cree Language (1865). Cree word for Nut. *A Dictionary of the Cree Language, As Spoken by the Indians of the Hudson's Bay Company's Territories.* Society for Promoting Christian Knowledge, London.

Disrud, D.T. (1968). Wetland Vegetation of The Turtle Mountains of North Dakota. (Doctoral dissertation, North Dakota State University). University Microfilms, Inc., Ann Arbor, Michigan.

Elliot, L.H., Igl, L.D., & Johnson, D.H. (2020) The relative importance of wetland area versus habitat heterogeneity for promoting species richness and abundance of wetland birds in the Prairie Pothole Region, USA. *The Condor*, 122, 1-21, https://doi.org/10.1093/condor/duz060

Fischer, A., Selge, S., van der Wal, R., & Larson, B.M.H.(2014) The Public and Professionals Reason Similarly about the Management of Non-Native Invasive Species: A Quantitative Investigation of the Relationship between Beliefs and Attitudes. *PLoS ONE*, 9(8): e105495. https://doi.org/10.1371/journal.pone.0105495

Frumkin, H., & Louv, R. (2007). Conserving land; Preserving human health. The Future of Land Conservation in America.

Herrick, R., Mendez Morehouse, J., Pryor, B., & Davis, J.A.(2019) Surveying American Indians with Opt-In Internet Surveys. *American Indian Quarterly*, 43(3), 281-305. https://doi.org/10.5250/amerindiquar.43.3.0281

Henderson, N., Hogg, E., Barrow, E., & Dolter, B. (2002). Climate Change Impacts on the Island Forests of the Great Plains and the Implications for Nature Conservation Policy: The Outlook for Sweet Grass Hills (Montana), Cypress Hills (Alberta-Saskatchewan), Moose Mountain (Saskatchewan), Spruce Woods (Manitoba), and Turtle Mountain (Manitoba-North Dakota). Government of Canada's Climate Change Action Fund, Prairie Adaptation Research Collaborative (PARC).www.parc.ca

Hungerford H.R., & Volk T.L. (1990) Changing learner behavior through environmental education. *The Journal of Environmental Education*, 21(3), 8-23.

Iannicelli, M. (2003) Reinterpretation of the Original Dekalb Mounds in Illinois. *Physical Geography*, 24:2, 170-182, https://doi.org/10.2747/0272-3646.24.2.170

Jose, S.B., Wu, C-H., & Kamoun S. (2019). Overcoming plant blindness in science, education, and society. *Plants, People, Planet*, 1, 169-172. https://doi.org/10.1002/ppp3.51

Kahneman, D (2011) *Thinking, Fast and Slow*. Farrar, Straus and Giroux, New York.

Kimmerer, R.W. (2012) Searching for synergy: integrating traditional and scientific ecological knowledge in environmental science education. *Journal of Environmental Studies and Sciences*, 2(4), 317-323, https://doi.org/10.1007/s13412-012-0091-y

Kimmerer, R.W. (2013) *Braiding Sweetgrass*. Milkweed Editions

Kirchoff, B.K., Delaney, P.F., Horton, M., & Dellinger-Johnston, R. (2014) Optimizing Learning of Scientific Category Knowledge in the Classroom: The Case of Plant Identification. *Life Sciences Education*, 13, 425-436. https://doi.org/10.1187/cbe.13-11-0224

Krosnick, S.E., Baker, J.C., & Moore, K.R.(2021) The Pet Plant Project: Treating plant blindness by making plants personal. *The American Biology Teacher*, 80(5), 339-345. https://doi.org/10.1525/abt.2018.80.5.339

Knapp, S. (2019) Are humans really blind to plants? *Plants, People, Planet*, 1, 164-168. https://doi.org/10.1002/ppp3.36

Levy, A., Orion, N., & Lesham, Y. (2018) Variables that influence the environmental behavior of adults. *Environmental Education Research*, 24(3), 307-325. https://doi.org/10.1080/13504622.2016.1271865

Lindemann-Matthies, P.(2011) ‘Loveable’ mammals and ‘lifeless’ plants: how children’s interest in common local organisms can be enhanced through observation of nature. *International Journal of Science Education*, 27(6), 655-677. https://doi.org/10.1080/09500690500038116

Map showing the Turtle Mountains of Rolette County, North Dakota, Google Earth. earth.google.com/web/. Accessed December, 29, 2021.

Marguiles, J.D., Bullough, L-A., Hinsley, A., Ingram, D.J., Cowell, C., Goettsch, B., Klitgard, B.B., Lavorgna, A., Sinovas, P., & Phelps, J. (2019) Illegal wildlife trade and the persistence of “plant blindness”. *Plants, People, Planet*, 1: 173-182. https://doi.org/10.1002/ppp3.10053

Mbah, M. (2019) Can local knowledge make the difference? Rethinking universities’ community engagement and prospect for sustainable community development. *The Journal of Environmental Education*, 50(1), 11–22. https://doi.org/10.1080/00958964.2018.1462136

Meeker, J.E., Elias, J.E., & Heim, J.A. (1993). *Plants Used by the Great Lakes Ojibwa*. United States: Great Lakes Indian Fish and Wildlife Commission.

Merenlender, A.M., Crall, A.W., Drill, S., Prysby, & M., Ballard. (2016) Evaluating environmental education, citizen science, and stewardship through naturalist programs. *Society for Conservation Biology*, 30(6), 1255-1265. https://doi.org/10.1111/cobi.12737

Milligan, C., & Bingley, A. (2007). Restorative places or scary spaces? The impact of woodland on the mental well-being of young adults. *Health & Place*, 13(4).

North Dakota Parks and Recreation (n.d.) Lake Metigoshe State Park, ND Parks and Recreation. Retrieved October, 10th, 2022, from https://www.parkrec.nd.gov/lake-metigoshe-state-park

Ojibwe People's Dictionary (n.d.). Definition of Bagaan. https://ojibwe.lib.umn.edu/main-entry/bagaan-na, Retrieved January, 2022.

Pedrera, O., Ortega, U., Ruiz-Gonzalez, A., Diez, J.R., & Barrutia, O.(2021) Branches of plant blindness and their relationship with biodiversity conceptualization among secondary students. *Journal of Biological Education*, 1-26. https://doi.org/10.1080/00219266.2021.1933133

Pearce, T., Ford, J., Willox, A., Ashlee, C., & Smit, B.(2015) Inuit Traditional Ecological Knowledge (TEK), Subsistence Hunting and Adaptation to Climate Change in the Canadian Arctic. *Arctic*, 68(2), 233-245. https://doi.org/10.14430/arctic4475

Perez, H.E., Adams, C.R., Kane, M.E., Norcini, J.G., Acomb, G., & Larsen, C. (2010) Awareness of and Interest in Native Wildflowers among College Students in Plant-related Disciplines: A Case Study from Florida. *HortTechnology*, 20(2), 368-376, https://doi.org/10.21273/HORTTECH.20.2.368

Pesek, T., Abramiuk, M., Garagic, D., Fini, N., Meerman, J., & Cal, V. (2009). Sustaining Plants and People: Traditional Q`eqchi' Maya Botanical Knowledge and Interactive Spatial Modeling in Prioritizing Conservation of Medicinal Plants for Culturally Relative Holistic Health Promotion. *EcoHealth*, 6, 79-90, https://doi.org/10.1007/s10393-009-0224-2

Potter, L.D., & Moir, R.D. (1961) Phytosociological Study of Burned Deciduous Woods, Turtle Mountains North Dakota. *Ecology*, 42 (3), 468-480. www.jstor.org/stable/1932232

Qualtrics XM. (2005). Copyright Year 2020. Version 7.2020. Qualtrics, Provo, UT, USA.

Ribeiro, T., & Orion, N. (2021) Educating for a Holistic View of the Earth System: A Review. *Geosciences*, 11, 485. https://doi.org/10.3390/geosciences11120485

Richotte, K. (2009). We the Indians of the Turtle Mountain Reservation…" Rethinking tribal constitutionalism beyond the colonialist/revolutionary dialectic. (Doctoral dissertation). The University of Minnesota.

Robelia, B., & Murphy, T. (2012) What do people know about key environmental issues? A review of environmental knowledge surveys. *Environmental Education Research*, 18(3), 299-321. https://doi.org/10.1080/13504622.2011.618288

Sanders, D., Eriksen, B., MacHale Gunnarsson, C., & Emanuelsson, J. (2021) Seeing the green cucumber: Reflections on variation theory and teaching plant identification. *Plants, People, Planet*, 1-11. https://doi.org/10.1002/ppp3.10248

Sharrock, S., & Jackson, P.W. (2017) Plant Conservation and the Sustainable Development Goals: A Policy Prepared for the Global Partnership for Plant Conservation. *Missouri Botanical Garden Press*, 102(2), 290-302.

Smith, H.H. (1932) *Ethnobotany of the Ojibwe Indians*. Bulletin of the Public Museum of the City of Milwaukee. 4(3), 327-525.

Srinivasan, P., Subramaniyan, V., Gk, T., Krishnasamy, K., Jeyalachagan, S., & Palani, M.(2022) A Survey on Medicinal Plant Knowledge among the Indigenous Communities (Tamilians) in the Delta Regions of Tamil Nadu, India. *Journal of Herbs, Spices, & Medicinal Plants*, 28(1), 36-72, https://doi.org/10.1080/10496475.2021.1962474

Stagg, B.C., & Donkin, M (2013) Teaching botanical identification to adults: experiences of the UK participatory science project 'Open Air Laboratories'. *Journal of Biological Education*, 47:2, 104-110, https://doi.org/10.1080/00219266.2013.764341

Thorpert, P., & Nielsen, A.B.(2014) Experience of vegetation–borne colours, *Journal of Landscape Architecture*, 9:1, 60-69, https://doi.org/10.1080/18626033.2014.898834

Turreira-Garcia, N., Theilade, I., Meilby, H., & Sorensen, M. (2015) Wild edible plant knowledge, distribution and transmission: a case study of the Achi Mayans of Guatemala. *Journal of Ethnobiology and Ethnomedicine*, 11(52), 1-17, https://doi.org/10.1186/s13002-015-0024-4

U.S. Census Bureau (2021) QuickFacts Rolette County, North Dakota. Retrieved from https://www.census.gov/quickfacts/fact/table/rolettecountynorthdakota/PST045221

U.S. Department of Agriculture. (2017). Census of Agriculture, County Profile, Rolette County, North Dakota.

Uno, G.E. (2021) Plant blindness, science illiteracy, and the future of botany. *South African Journal of Botany*, pp277. https://doi.org/10.1016/j.sajb.2018.02.011

Wals, A.E.J., Brody, M., Dillon, J., & Stevenson, R.B. (2014) Convergence between science and environmental education. *Science*, 344(9), 583-584

Wandersee, J.H, & Schussler, E.E. (1999) Preventing Plant Blindness. *The American Biology Teacher*, 61(2), 82-86, https://doi.org/10.2307/445062

CHAPTER 4. REDUCING PLANT BLINDNESS PROJECT

Abstract

The Reducing Plant Blindness (RPB) Project is in response to the summary of the Request for Applications (RFA) for Funding Opportunity USDA-NIFA-TCRGP-009143. The United States Department of Agriculture (USDA), National Institute of Food and Agriculture (NIFA), Tribal Colleges Research Grants Program (TCRGP) released a Request for Applications (RFA) for 2022. The NIFA is committed to enhancing diversity, equity, inclusion, and accessibility of programs and encourages individuals, institutions, and organizations from underserved communities to apply for funding opportunities as lead, co-lead, or subaward recipient(s), and to engage as leaders in the peer panel review process to support the development of strong networks and collaborations.

An Applied Faculty/Community project, the **Reducing Plant Blindness (RPB) Project**, will successfully enhance the quality of education at TMCC by developing a pathway of innovative, hands-on learning, and research experiences that implement an enhanced integration of Science, Technology, Engineering, Art, and Mathematical (STEAM) resources. The RPB project will advance knowledge and scientific research in diverse fields. It will demonstrate how and why innovations that integrate STEAM and traditional indigenous knowledge throughout place-based research projects will increase plant knowledge and reduce plant blindness within Rolette County, North Dakota. The RPB project will be an interdisciplinary project including TMCC faculty, staff, and college students to research scenarios that will increase the plant knowledge of local citizens in addition to local plant experiences.

Introduction

Turtle Mountain Community College (TMCC) submits this USDA NIFA proposal for a TCRGP project to strengthen TMCC's capacity as an education and research resource for the Turtle Mountain Band of Chippewa Indians and surrounding communities. An Applied Faculty/Community project, the **Reducing Plant Blindness (RPB) Project**, will successfully enhance the quality of education at TMCC by developing a pathway of innovative, hands-on learning and research experiences that implement an enhanced integration of Science, Technology, Engineering, Art, and Mathematical (STEAM) resources. The Anishinaabe traditional knowledge will be the base of all the research and educational components supported through this project.

The RPB project will advance knowledge and scientific research in diverse fields. It will demonstrate how and why innovations that integrate STEAM and traditional indigenous knowledge throughout place-based research projects will increase plant knowledge and reduce plant blindness within Rolette County, North Dakota. The RPB project will be an interdisciplinary project including TMCC faculty, staff, and college students to research scenarios that will increase the plant knowledge of local citizens. TMCC will also collaborate with Dr. Christina Hargiss from NDSU College of Agriculture, Food Systems, and Natural Resources, and she will advise on; curriculum design for plant knowledge workshops, the design of scenario workshops, and assessment tools for evaluation of the RPB project. The RPB project will produce educational material to be shared with citizens of the Turtle Mountain Region, in addition to the design of evaluation tools to create publishable data. The project will also broaden access to and engagement in STEAM education and research for underrepresented populations, including; rural, Native Americans, females, individuals with disabilities, and veterans.

The Turtle Mountain region is one of the most interesting and unique areas in north-central North Dakota for its physiography and vegetation (Potter and Moir, 1961). The Turtle Mountains are separated by the 49th parallel, with the northern portion of the Turtle Mountains in Manitoba, Canada, and the southern portion in North Dakota, United States of America. Native American tribes have moved through this land for thousands of years prior to the arrival of the fur trade and colonized settlements (Law, 1953; Molberg et al., 1959 as cited in Disrud, 1968). Once settlements were developed after 1882, land-use development caused changes to the flora of the Turtle Mountains (Stevens, 1920). Following settlement, extensive timber harvesting and land clearing for agriculture contributed to the forest's demise (Disrud, 1968). Disrud (1968) states that in addition to reducing the forested area, draining of wetlands was also a land-use problem, reducing habitat and plant communities within the Turtle Mountains. Citizens of the Turtle Mountain Band of Chippewa Indians (TMBCI) have spoken about the vast distribution of plants pre-settlement (Disrud, 1968). The Turtle Mountains are an island forest that may not be as ecologically diverse or resilient as larger forest ecosystems. Still, they are essential environmental outliers as they contain species and ecosystems believed to be on the edge of their natural range (Henderson et al., 2002). Island forests are sensitive to relatively small changes in environmental conditions, making conservation of these areas important (Henderson et al., 2002).

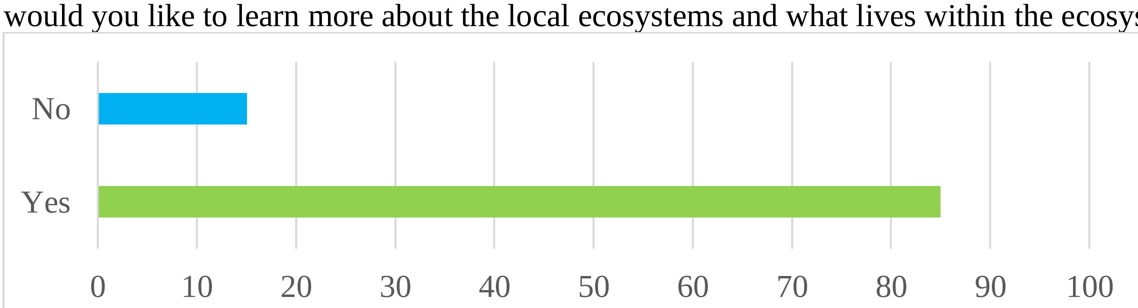
Biodiversity loss is a major environmental concern, and it is crucial for people to understand the role biodiversity plays within trophic chains and ecosystems (Knapp, 2019; Amprazis & Papadopoulou, 2020; Pedrera et al., 2021). Wandersee and Schussler (1999) coined the term plant blindness and described it as a person’s inability to: “see the diversity of plants in their environment, understand the importance of plants to the biosphere, and view plants as not inferior to animals". Balding and Williams (2016) state that even though evidence exists on plant blindness having a foundation in biological patterns, cultural factors play a significant role in determining whether a given individual notices and values plants. Indigenous knowledge, local knowledge, and the sciences approach an understanding of the natural environment and management practices in different ways (Wheeler and Root-Bernstein, 2020). Wheeler and Root-Bernstein (2020) state that the challenge for scientists is understanding their role in any collaborative process. They recommend that scientists understand and treat the research and decision-making by indigenous and local knowledge equitably and respectfully. Educators and industry are encouraged to combine their abilities to provide experiences for plant education and hands-on experiences in natural landscapes and a diversity of courses (Becerra et al., 2013; Comeau et al., 2019; Perez et al., 2020). Engagement in traditional ecological knowledge can aid in the process of being open to alternative sociocultural systems and developing frameworks based upon respect for and responsibility to more than just humans (Kimmerer, 2012). Those who can bridge the knowledge systems can enrich the knowledge base and contribute to the communities' goals (Wheeler and Root-Bernstein, 2020).

People who have relied on plants for their source of livelihood, health, and staple food source have been shown to pass plant knowledge down among the generations, with women and men being responsible for their understanding of similar and diverse plants (Turreira-Garcia et al., 2015; Poncet et al., 2021). In a study by Turreira-Garcia et al. (2015), they found that the older women in the community could identify more plants and explain their practical uses. In addition, their community research showed that survey participants who acquired plant knowledge from their families recognized more plants than others. Specifically, when individuals who were identified as "knowledge transmitted from relatives" were compared to "knowledge transmitted from other sources" (school, books, individually), their average plant identification scores were higher (Turreira-Garcia et al., 2015).

Colonialism has been detrimental to indigenous people via extermination, forced assimilation, laws against practicing culture, and boarding schools that brutally reprimanded children who spoke their language and observed their culture. This history has severely disrupted tribal communities. Thankfully TMCC is leading the community to revitalize language, culture, and traditions. The RPB project, with the integration of traditional knowledge, multi-generational community members, staff, and students will aid in revitalizing plant knowledge throughout the area and among other Anishinaabe communities.

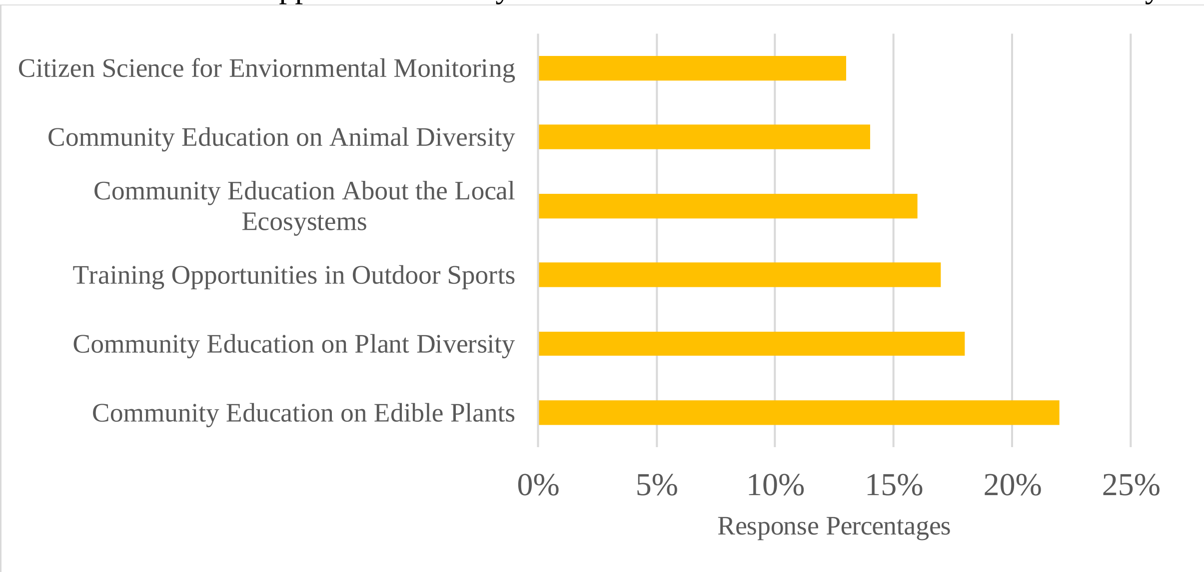
In a recent online survey by Project Director, Stacie Blue, Measuring Rolette County Citizen Knowledge of Plants, citizens were asked about their interest in learning more about the local ecosystems and what lives within the ecosystems. Of the 212 survey participants, n=133 participants completed the question, of those, 85% of the citizens selected 'yes' that they would like to learn more about the local ecosystems and what lives within the ecosystems (Figure 4.1), while in comparison, 15% of participants selected 'no.'

Figure 4.1. Survey Question from Citizen Knowledge of Plants: As a citizen of Rolette County, would you like to learn more about the local ecosystems and what lives within the ecosystems?



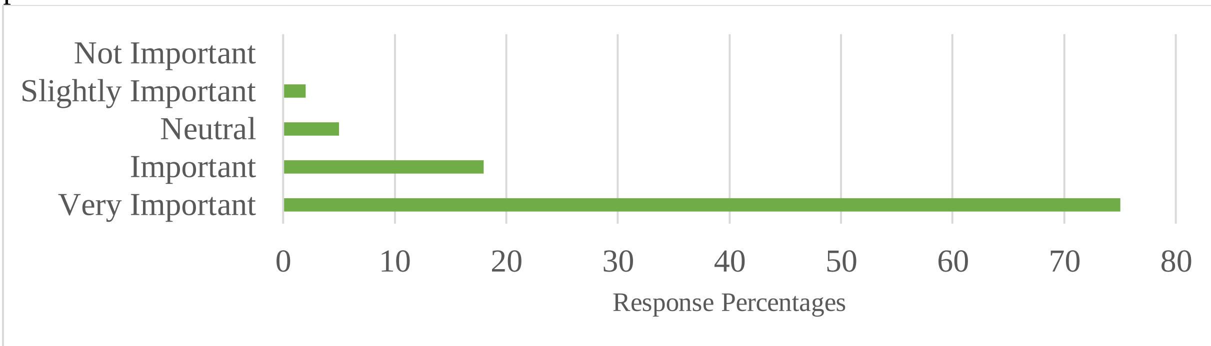
Survey participants were asked to select all the options among a list of nature-focused educational opportunities they would like to see offered within Rolette County, n=131 (Figure 4.2). Community education on edible plants was selected at 22%, and the other five options were close in selection, with the percentages of chosen options varying from 13% to 18%. Community education on plant diversity was the next highest selection, with citizen science for environmental monitoring having the lowest selection percentage.

Figure 4.2. Survey Question from Citizen Knowledge of Plants: Please select all the nature-focused educational opportunities that you would like to see offered within Rolette County.



The last question within the survey was designed to measure participants' interest in the importance of developing conservation areas (Figure 4.3). "Conservation areas help to; restore habitats, promote plant and animal diversity, and aid in the development of healthy soils, water, and air quality. These areas also provide community education opportunities and a place for all outdoor enthusiasts to enjoy the environment. How important do you believe it is to develop a conservation area within Rolette County that includes forest, wetland, and prairie habitat?" The most significant selection percentage at 75% was for "Very Important."

Figure 4.3. Survey Question from Citizen Knowledge of Plants: How important do you believe it is to develop a conservation area within Rolette County that includes forest, wetland, and prairie habitats?



Objectives

The survey results spurred the development of a program that will decrease plant blindness within the local area while developing student research skills, integrating diverse faculty in plant-based research, and promoting the integration of traditional ecological and scientific ecological knowledge (Table 4.1).

Table 4.1. Reducing Plant Blindness Objectives, Priorities, and Merit

TCRGP Faculty/Community	Objectives	Priority	Merit
Address practical tribal community needs and opportunities in collaboration with the 1862 Land-Grant institution.	Reduce Plant Blindness, Provide hands-on experiences with plants. Integration of Traditional Ecological and Scientific Ecological knowledge.	Improve traditional plant knowledge among TMCC students, faculty, staff, and the local community through hands-on experiences.	Demonstrate the impact of plant experiences on increasing traditional plant knowledge.
Skillful adaptations of existing knowledge to address unique community needs requiring a culturally sensitive approach.	Developing scenarios of what a future would be like with a community knowledgeable of plants, plant uses, and benefits to diversity	Scenario Team will guide faculty/staff/student teams through developing scenarios and implementing research projects.	Demonstrate the positive impact on students' education and research experience.

Goal: The goal of the Reducing Plant Blindness (RPB) project is to improve the quality of education and research on local plants (native and non-native species) by strengthening learning experiences and integrating the traditional knowledge of the Anishinaabe in a way that weaves together the Anishinaabe traditional knowledge with engaging, innovative discovery.

Objective 1. Reduce Plant Blindness. Improve traditional plant knowledge among TMCC students, faculty, staff, and the local community through hands-on experiences. TMCC, in collaboration with NDSU College of Agriculture, Food Systems, and Natural Resources, will serve college students, staff, faculty, and the community with a pathway of learning activities that will integrate traditional indigenous knowledge with STEAM through (a) a series of 14 Plant Blindness Workshops, (b) community education materials, and (c) sharing of content and images on social media pages.

Objective 2. Developing scenarios of what a future would be like with a community knowledgeable of plants, plant uses, and benefits of diversity. Scenario-based planning aims to help teams explore possible futures, encouraging motivation to attain or prevent possible outcomes. Scenario projects will be made up of faculty/staff/student teams who will develop scenarios that; envision possible and plausible futures for the flora within the diverse ecosystems of the Turtle Mountains, develop long-range plans and contingency plans for the conservation of habitats, and envision a future without plants that have been traditionally used. The scenarios will then develop into research projects where a faculty member from a STEAM subject will work with students to plan, facilitate, and disseminate their project: (a) two, two-day scenario projects, (b) two, one-day monitoring progress workshops, (c) two presentation events of scenario projects and findings, and (d) creation of articles to be shared within local newspapers, Tribal College Journal, and NDSU and USDA Extension publications for county residents.

Methods

The RPB project will advance knowledge and scientific research. Experiencing plants through the diversity of STEAM categories allows people to understand and explore plants and their habitats in additional artistic and creative ways. The RPB project will model how and why innovations integrating STEAM and traditional ecological knowledge throughout education and place-based research will contribute to understanding, retention, and applied research involvement for underrepresented students.

This project is based on a growing body of research that connects science learning, ecological stewardship, tribal history, and culture during a time of climate change. It builds on prior research conducted with support from the NSF-TCUP, NASA, USDA NRCS, and EPSCOR projects at TMCC over the last ten years. Students involved in exciting research tend to remain engaged in the educational process through completion. In addition, the research project often serves as a tool to keep students engaged in STEAM fields leading to eventual workforce placement. Experiences will provide active engagement in learning best practices in conducting research and academic year and summer opportunities to participate in active real-world research leading to presentations and publications.

Pre and post-assessment tools will be used to collect information to measure the project's impact on participants' understanding of plants. The mixed-methods assessment will include: content analysis to examine understanding and concerns through multiple choice questions, participation measures to understand the relationship of the level of participation and ability to recall plants and teachings through descriptive responses, and interviews (Dennon, 2008). Multiple data sources will be used to cross-validate participant experience and understanding. This mixed-method evaluation will include findings from qualitative (e.g., surveys, interviews, stakeholder feedback, strategy evaluations, observations, and case study analysis) and quantitative (e.g., demographics of participants, attendance, and engagement) data sources, providing a more comprehensive understanding of implementation and outcomes. Surveys will be delivered online through Google Survey.

The information gained through performance measures attained from participant pre/post surveys and interviews will include: evidence of change in plant awareness and knowledge, STEAM knowledge, quantitative and qualitative indicators of progress in improvement in organizational culture (faculty preparation, use of modified educational practices incorporated into the curriculum, innovative use of RPB project into STEAM subject curriculum) and participant engagement/perceptions (measurable student-based outcomes pre-/post RPB learning and research activities, number of STEAM activities started and completed, and number of research workshops completed) as reported by project records, monthly/annual reports, and research outcomes.

The detailed information and stories shared by participants will be presented through articles, publications, social media posts, and presentations. Presenting the information to the community will be designed to ignite plant interest of local citizens. The RPB project will advance STEAM experiences with Traditional Ecological Knowledge and Scientific Ecological Knowledge. The project will increase mutualistic relationships between traditional indigenous knowledge holders, diverse educators, area citizens, and academic institutions.

Table 4.2. Key Personnel

Personnel	Responsibilities
Dr. Donna Brown President and PI	Oversight of academic unit, fiscal responsibility, supervision of faculty and staff.
Stacie Blue Natural Resource Instructor Project Director	Collaborate with staff, faculty, students, and community in developing and implementing the RPB. Recruit, mentor, and advise students on research, STEAM integration, ensure Anishinaabe culture and language integration throughout the RPB project, incorporating it into the curriculum, student research, scenario projects, and social media posts.
Traditional Knowledge Expert	Turtle Mountain Elder, knowledgeable about tribal values and traditions.
Dr. Christina Hargiss NDSU Representative	Will contribute to curriculum design for plant knowledge workshops and the design of scenario workshops. Will review the plan of assessment of the RPB project and the development of publishable articles.
TMCC Student Intern	In addition to participating in projects, the student intern will assist in advertisement, recruitment, scheduling, social media, and workshop management tasks. The student will also apprentice in grant management.

Challenges that will be monitored for and addressed will include the dynamics in teams of faculty, staff, and students. Ensuring students have an active role in scenario building, encouraging them to share their views and values, and keeping them engaged throughout the project. Other challenges to consider are creating an opportunity for all ages to learn about the project's outcomes and the sustainability of the movement from integrating SEK and STEAM into TEK. Once we are educated and aware, our responsibility will be to carry and pass on the plant knowledge to the next generations.

Table 4.3. Reducing Plant Blindness Project Timeline

Project Timeline	**2023**				**2024**			
Quarters	1	2	3	4	1	2	3	4
USDA NIFA TCRGP Grant Awarded to TMCC, January 1st, 2023 start date.								
Part-time staff/faculty are hired for the project								
Develop surveys and assessment tools for project actions								
Develop curriculum for RPB and Scenarios workshops. Reserve venues and set dates for workshops								
RPB Workshops								
TEK/SEK with STEAM Workshops								
Scenario Workshops								
PD works with student researchers to develop projects								
Scenario Mid-Way Workshops, Monitor Development of Community Education Material								
Presentation of Research Projects and Scenario Projects								
Dissemination of Community Education Material								
Analyze survey and assessment tool results								
Publication of Results								

Table 4.4. Budget

Personnel	Year 2023	Year 2024	Totals
Project Director			$17,944.74
Director: Stacie Blue is currently serving under a nine month contract. Support for summer project activities calculated at 270 hours across 2.5 person months (30 hours per week x 9 weeks) @ $30/hour	$8,100.00	$8,100.00	$16,200.00
Fringe Benefit 10.77%	$872.37	$872.37	$1,744.74
Student Assistant			$9,480.00
TMCC Assistant will be a Junior at TMCC. During Fall/Spring up to 10hrs/week x 26 weeks; During Summer up to 15hrs/week x 9weeks at $12/hr.	$4,740.00	$4,740.00	$9,480.00
Travel			$1,170.00
Local mileage reimbursement for staff, faculty, and students traveling to conduct project activities @ 1000miles/summer @ $.585/mile (current GSA)	$585.00	$585.00	$1,170.00
Participant Support			$43,500.00
Workshops (Plant Blindness, TEK/SEK in STEAM) stipends for faculty, staff, and students (15) @ $75/session x 14 sessions	$15,750.00	$15,750.00	$31,500.00
Scenario Workshops for Faculty, Staff, and Students (12) @ $125/session x 4/year	$6,000.00	$6,000.00	$12,000.00
Materials and Supplies			$3,950.00
Digital technology to support research and project: digital camera, video camera, tripods, peripherals	$1,200.00	$0.00	$1,200.00
Office supplies (paper, pens, staplers, folders, printing)	$750.00	$250.00	$1,000.00
Supplies, including first aid kit for field work, binoculars, chemical supplies, safety gear, as required for understanding plants, TEK, SEK, and STEAM.	$1,000.00	$0.00	$1,000.00
Publication of Results		$750.00	$750.00
Professional and Consultant Services			$3,000.00
Anishinaabe consultant will review and assess TEK integration in workshops, presentations, and publications.	$1,500.00	$1,500.00	$3,000.00
Direct Costs	$40,497.37	$38,547.37	$79,044.74
Indirect Cost (TMCC Rate at 20%)	$8,099.47	$7,709.47	$15,808.95
TOTAL	**$48,596.84**	**$46,256.84**	**$94,853.69**

References

Amprazis, A., Papadopoulou, P. (2020) Plant blindness: a faddish research interest or a substantive impediment to achieve sustainable development goals? *Environmental Education Research*, 26(8), 1065-1087. https://doi.org/10.1080/13504622.2020.1768225

Balding, M., Williams, K.J.H. (2016) Plant Blindness and the implications for plant conservation. *Conservation Biology*, 30(6), 1192-1199. https://doi.org/10.1111/cobi.12738

Becerra, T.A., Engle, D.M., Elmore, R.D., Fuhlendorf, S.D. (2013) Contrasting Preference for Grassland Landscapes Among Population Groups in the Central and Southern Great Plains. *Rangeland Ecology & Management*, 66(5). https://doi.org/10.2111/REM-D-12-00174.1

Comeau, P., Hargiss, C.L.H., Norland, J.E., Wallace, A., Bormann, A. (2019) Analysis of Children's Drawings to Gain Insight into Plant Blindness. *Natural Sciences Education*, 48:190009. https://doi.org/10.4195/nse2019.05.0009

Dennen, V.P. (2008) Looking for evidence of learning: Assessment and analysis methods for online discourse. *Computers in Human Behavior*, 24, 205-219. https://doi.org/10.1016/j.chb.2007.01.010

Disrud, D.T. (1968) Wetland Vegetation of The Turtle Mountains of North Dakota. (Doctoral dissertation, North Dakota State University). University Microfilms, Inc., Ann Arbor, Michigan.

Henderson, N., Hogg, E., Barrow, E., Dolter, B. (2002) Climate Change Impacts on the Island Forests of the Great Plains and the Implications for Nature Conservation Policy: The Outlook for Sweet Grass Hills (Montana), Cypress Hills (Alberta-Saskatchewan), Moose Mountain (Saskatchewan), Spruce Woods (Manitoba) and Turtle Mountain (Manitoba-North Dakota). Government of Canada's Climate Change Action Fund, Prairie Adaptation Research Collaborative (PARC).www.parc.ca

Kimmerer, R.W. (2012) Searching for synergy: integrating traditional and scientific ecological knowledge in environmental science education. *Journal of Environmental Studies and Sciences*, 2(4), 317-323. https://doi.org/10.1007/s13412-012-0091-y

Knapp, S. (2019) Are humans really blind to plants? *Plants, People, Planet*, 1:164-168. https://doi.org/10.1002/ppp3.36

Law, L.T. (1953) History of Rolette County, North Dakota and yarns of the pioneers. Lund Press Inc., Minneapolis. P276

Molberg, J.M., Vinje, M.E., Benson, O.B., Milligan, E.A, Lindberg, J.O. (1959) Bottineau County Diamond Jubilee: a brief history of the County of Bottineau, North Dakota. Bottineau Courant. P52.

Pedrera, O., Ortega, U., Ruiz-Gonzalez, A., Diez, J.R., Barrutia, O. (2021) Branches of plant blindness and their relationship with biodiversity conceptualization among secondary students. *Journal of Biological Education*, 1-26. https://doi.org/10.1080/00219266.2021.1933133

Perez, H.E., Adams, C.R., Kane, M.E., Norcini, J.G., Acomb, G., and Larsen, C. (2010) Awareness of and Interest in Native Wildflowers among College Students in Plant-related Disciplines: A Case Study from Florida. *HortTechnology*, 20(2): 368-376.

Poncet, A., Schunko, C., Vogl, C.R., Weckerle, C.S. (2021) Local plant knowledge and its variation among farmer's families in the Napf region, Switzerland. *Journal of Ethnobiology and Ethnomedicine*, 17(53), https://doi.org/10.1186/s13002-021-00478-5

Potter, L.D., Moir, D.R. (1961) Phytosociological Study of Burned Deciduous Woods, Turtle Mountains North Dakota. *Ecological Society of America*, 42(3), 468-480.

Stevens, O.A. (1920) Uses of Plants by the Indians. *Science*, 52(1335), 99-101.

Turreira-Garcia, N., Theilade, I., Meilby, H., Sorensen, M. (2015) Wild edible plant knowledge, distribution and transmission: a case study of the Achi Mayans of Guatemala. *Journal of Ethnobiology and Ethnomedicine*, 11(52), 1-17, https://doi.org/10.1186/s13002-015-0024-4

Wandersee, J.H, Schussler, E.E. (1999). Preventing Plant Blindness. *The American Biology Teacher*. 61(2), 82-86. www.jstor.org/stable/4450624

Wheeler, H.C., Root-Bernstein, M. (2020) Informing decision-making with Indigenous and local knowledge and science. *Journal of Applied Ecology*, 57:1634-1643. https://doi.org/10.1111/1365-2664.13734

APPENDIX A. ABILITY TO IDENTIFY AND NAME LOCAL PLANTS SURVEY

Survey:

1. **You must be at minimum 18 years of age to participate in this survey. Which age group category are you in?**
   - o 18 to 26
   - o 27 to 36
   - o 37 to 46
   - o 47 to 56
   - o 57 to 66
   - o 67 to 76
   - o 77+
2. **Please enter your gender.**

   ____

3. **Which of the following best describes your race?**
   - o Native American or Alaska Native
   - o White or Caucasian
   - o Black or African-American
   - o Hispanic or Latino
   - o Asian
   - o Native Hawaiian/Other Pacific Islander
4. **Do you currently reside within Rolette County?**
   - o Yes
   - o No
5. **If you are not a current resident, have you previously resided in Rolette County?**
   - o Yes
   - o No

6. Please select the following plants that are typically found in grasslands (not forest or water plants) of Rolette County?

7. Please write the name you know (common name, scientific name, local name) for each of the following plants.

____

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8. Please select the following plants that are typically found in wetlands (not grassland or forest plants) of Rolette County?

9. Please write the name you know (common name, scientific name, local name) for each of the following plants.

____

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10. Please select the following plants that are typically found in forests (not grasslands or water plants) of Rolette County?

11. Please write the name you know (common name, scientific name, local name) for each of the following plants.

____

____

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APPENDIX B. ATTEMPS FOR IDENTIFYING PLANTS TO HABITAT

Table B.1. Attempts for Identifying Plants in Forest Habitat

Plants to identify for Forest Habitat	**Choice Count**	**Habitat**
Baneberry-*Actaea rubra*	48	Forest
Wood Violet-*Viola canadensis*	64	Forest
Chokecherry-*Prunus virginiana*	62	Forest
Upright Carrionflower-*Smilax ecirrhata*	28	Forest
Pink Shinleaf-*Pyrola asarifolia*	93	Forest
Columbine- *Aquilegia canadensis*	48	Forest
Wild Rose-*Rosa woodsii*	70	Forest
Cow Parsnip- *Heracleum lanatum*	83	Forest
Wild Strawberry- *Fragaria virginiana*	77	Forest
Gooseberry-*Ribes oxyacanthoides*	66	Forest
Juneberry- *Amelanchier alnifolia*	39	Forest
Beaked Hazelnut- *Corylus cornuta*	87	Forest
Red Osier Dogwood- *Cornus sericea*	74	Forest
Starry False Solomon Seal- *Maianthemum stellatum*	16	Forest
Spotted Coral Root-*Corallorhiza maculata*	42	Forest
Wild Bergamot- *Monarda fistulosa*	15	Grassland
Narrow-leaf blue-eyed-grass, *Sisyrinchium angustifolium*	32	Grassland
White penstemon-*Penstemon albidus*	20	Grassland
Water Smartweed-*Persicaria amphibia*	31	Wetland
Hybrid Cattail- *Typha xglauca*	13	Wetland
Marsh Skullcap- *Scutellaria galericulata*	26	Wetland

Table B.2. Attempts for Identifying Plants in Wetland Habitat

Plants to Identify for Wetland Habitat	Choice Count	Habitat
Arrowhead- *Sagittaria cuneata*	91	Wetland
Bulrush-*Scirpus microcarpus*	61	Wetland
Colts foot- *Petasites sagittatus*	24	Wetland
Soft stem bulrush- *Schoenoplectus tabernaemontani*	117	Wetland
Chara-*Chara vulgaris*	118	Wetland
Jewelweed - *Impatiens capensis*	23	Wetland
Wild Mint- *Mentha arvensis*	42	Wetland
Water milfoil- *Myriophyllum sibiricum*	130	Wetland
Marsh Skullcap- *Scutellaria galericulata*	29	Wetland
Curly leaf pondweed-*Potamogeton crispus*	122	Wetland
Hybrid Cattail-*Typha x glauca*	134	Wetland
Water Smartweed-*Persicaria amphibia*	35	Wetland
Stinging Nettle- *Urtica dioica*	42	Wetland
Prairie Smoke- *Geum triflorum*	25	Grassland
Pasqueflower-*Pulsatilla patens ssp. multifida*	12	Grassland
Golden Alexanders- *Zizia aurea*	52	Forest
Spreading Dogbane- *Apocynum androsaemifolium*	30	Forest
Limber Honeysuckle- *Lonicera dioica*	9	Forest

Table B.3. Attempts for Identifying Plants in Grassland Habitat

Plants to Identify for Grassland Habitat	Choice Count	Habitat
Narrow-leaf blue-eyed-grass, *Sisyrinchium angustifolium*	109	Grassland
Yellow Lady's Slipper, *Cypripedium parviflorum*	68	Grassland
Blanketflower, *Gaillardia aristata*	67	Grassland
Upright prairie coneflower, *Ratibida columnifera*	72	Grassland
Maximillian sunflower, *Helianthus maximiliani*	147	Grassland
Wild prairie rose-*Rosa arkansana*	124	Grassland
White penstemon-*Penstemon albidus*	70	Grassland
Pasqueflower-*Pulsatilla patens ssp. multifida*	78	Grassland
Wild bergamot-*Monarda fistulosa*	92	Grassland
White prairie clover-*Dalea candida*	97	Grassland
Heath aster-*Symphyotrichum ericoides*	89	Grassland
Prairie Lily-*Lilium philadelphicum*	67	Grassland
Yarrow- *Achillea millefolium*	62	Grassland
Prairie Smoke- *Geum triflorum*	78	Grassland
Green Bog Orchid- *Platanthera aquilonis*	43	Grassland
Arrowhead- *Sagittaria cuneata*	30	Wetland
Jewelweed - *Impatiens capensis*	62	Wetland
Hybrid Cattail-*Typha x glauca*	44	Wetland
Bunchberry dogwood, *Cornus canadensis*	64	Forest
Wild sarsaparilla, *Aralia nudicaulis*	91	Forest
Cutleaf coneflower- *Rudbeckia laciniata*	79	Forest

APPENDIX C. ATTEMPTS TO NAME LOCAL PLANTS

Table C.1. Attempts to Provide Names for the Forest Plants

Forest	
<u>**Chokecherry-*Prunus virginiana***</u>	
Attempts	103
Common Name	81
Tribal/Local	0
Unknown/Incorrect	21
Scientific	1
<u>**Beaked Hazelnut-*Corylus cornuta***</u>	
Attempts	80
Common Name	9
Tribal/Local	60
Unknown/Incorrect	10
Scientific	1
<u>**Columbine- *Aquilegia canadensis***</u>	
Attempts 42	42
Common Name	10
Tribal/Local	14
Unknown/Incorrect	17
Scientific	1
<u>**Highbush Cranberry-*Viburnum opulus***</u>	
Attempts 69	69
Common Name	19
Tribal/Local	5
Unknown/Incorrect	45
Scientific	0
<u>**Poison Ivy-*Toxicodendron radicans***</u>	
Attempts	20
Common Name	13
Tribal/Local	0
Unknown/Incorrect	7
Scientific	0
Total Attempts	**314**
Common Name	**132**
Tribal/Local	**79**
Unknown/Incorrect	**100**
Scientific	**3**

Table C.2. Attempts to Provide Names for the Wetland Plants

Wetland	
Water milfoil- *Myriophyllum sibiricum*	
Attempts	34
Common Name	0
Tribal/Local	0
Unknown/Incorrect	34
Scientific	0
Arrowhead- *Sagittaria cuneata*	
Attempts	23
Common Name	5
Tribal/Local	0
Unknown/Incorrect	18
Scientific	0
Soft stem bulrush- *Schoenoplectus tabernaemontani*	
Attempts	25
Common Name 5	5
Tribal/Local	0
Unknown/Incorrect	20
Scientific	0
Wild Mint- *Mentha arvensis*	
Attempts 25	25
Common Name	12
Tribal/Local	1
Unknown/Incorrect	12
Scientific	0
Stinging Nettle- *Urtica dioica*	
Attempts	23
Common Name	6
Tribal/Local	0
Unknown/Incorrect	17
Scientific	0
Total Attempts	**130**
Common Name	**28**
Tribal/Local	**21**
Unknown/Incorrect	**81**
Scientific	**0**

Table C.3. Attempts to Provide Names for the Grassland Plants

Grassland	
Wild bergamot-*Monarda fistulosa*	
Attempts	30
Common Name	4
Tribal/Local	8
Unknown/Incorrect	17
Scientific	1
Maximillian sunflower, *Helianthus maximiliani*	
Attempts	69
Common Name	1
Tribal/Local	0
Unknown/Incorrect	67
Scientific	1
Purple coneflower-*Echinacea purpurea*	
Attempts	45
Common Name	28
Tribal/Local	2
Unknown/Incorrect	11
Scientific	4
Wild prairie rose-*Rosa arkansana*	
Attempts	83
Common Name	24
Tribal/Local	39
Unknown/Incorrect	19
Scientific	1
Pasqueflower-*Pulsatilla patens ssp. Multifida*	
Attempts	50
Common Name	2
Tribal/Local	35
Unknown/Incorrect	12
Scientific	1
Total Attempts	**277**
Common Name	**59**
Tribal/Local	**84**
Unknown/Incorrect	**126**
Scientific	**8**

APPENDIX D. PLANT AWARENESS SURVEY

1. Please enter your gender.

2. Which of the following best describes your race?
   - Native American or Alaska Native
   - White or Caucasian
   - Black or African-American
   - Hispanic or Latino
   - Asian
   - Native Hawaiian/Other Pacific Islander

3. Do you currently reside within Rolette County?
   - Yes
   - No

4. If you are not a current resident, have you previously resided in Rolette County?
   - Yes
   - No

5. Which type of natural environment do you enjoy spending time in? Please select all that apply.
   - Forest
   - Grassland
   - Wetland (ponds/sloughs)
   - Lake
   - Stream, Creek, Riparian (area adjacent to water)
   - Yard (personal/family)
   - Pasture
   - Park (Tribal, City, State, or Federal land)
   - Other:

6. Where did you learn your plant knowledge (check all that apply):
   - I don't have any plant knowledge
   - On my own
   - Family
   - Extended family (grandparents, aunts, and uncles, elders)
   - Cultural education (outside of school)
   - Job-related
   - Elementary/High school
   - College
   - Community education
   - Books
   - Internet
   - Other:
   -

7. Likert Scale

	Little to None	Few	Moderate	Many	Extremely Abundant
How many native plants do you think Rolette County has?					
	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
In your opinion does Rolette County have an abundance of native plants?					
	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
Many of the plants (native and non-native) within Rolette County are beneficial to humans?					
Some of the plants (native and non-native) within Rolette County are beneficial to humans?					
None of the plants (native and non-native) within Rolette County are beneficial to humans?					
	0-5	6-15	16-30	31-45	46+
If you were in a natural area how many local plants (native and non-native) can you identify and name?					

Here is a list of common identifying characteristics for plants:
Flower: Color variation in flower, Flower shape,
Stem: Color variation on stem, Stem shape, Stem number;
Leaves: Number of leaves, Leaf shape, Leaf serration, Leaf symmetry, Leaf color, Size of leaf, Leaf veins, Root structure, Plant height, and Fruit,

8. If I asked you to memorize this grassland plant, Crocus also known as Pasqueflower, and find it again in nature, what would you most notice about the plant that would help you identify it later? List 3 characteristics, in order of importance, you would use to identify the plant.
    - 

9. If I asked you to memorize this forest plant, Pucons also known as Beaked Hazlenut, and find it again in nature, what would you most notice about the plant that would help you identify it later? List 3 characteristics, in order of importance, you would use to identify the plant.
    - 

10. If I asked you to memorize this wetland plant, Curly-leaf pondweed, and find it again in nature, what would you most notice about the plant that would help you identify it later? List 3 characteristics, in order of importance, you would use to identify the plant.