Cultural Inclusion in the Cowling Arboretum Restoration: Evaluating Ethnobotanical Connections and Assessing the Educational Value of Ethnobotanical Resources

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ABSTRACT

Environmental scholarship is increasingly calling for more culturally inclusive approaches to ecological restoration as a way to capture human narratives associated with the land. Integrating Native American history and knowledge specifically into restorations can both strengthen marginalized indigenous communities and bring to light alternative traditional ecological knowledge. This paper explores how ethnobotany, the study of human relationships with plants, can be used to both address the absence of human narratives from ecological restorations and serve as a solution to declining student interest in the natural sciences. With Carleton College's Cowling Arboretum as our study site, we pursue two related goals: (1) to thoroughly research ethnobotanical connections to plants in the Arboretum, and (2) to evaluate the potential for this kind of ethnobotanical information to increase student engagement with the Arboretum. We first investigate the history and contemporary presence of indigenous communities in southwest Minnesota, and explore local Native ethnobotanical knowledge. We then explore current Carleton student and faculty engagement with the Arboretum. Finally, we assess the capacity of this ethnobotanical information to heighten student engagement with the Arboretum in a series of botany tours, surveys, and interviews. Although we find no significant quantitative evidence that ethnobotanical guides can enhance students engagement, we conclude from our qualitative analysis that there is abundant and largely untapped student interest in learning more about human connections to Arboretum flora. This project succeeded in raising interest and awareness among members of the Carleton community about the various types of ethnobotanical relationships that can be found in the Cowling Arboretum, and laying groundwork for the integration of culturally inclusive ethnobotanical study into ecological restorations.

INTRODUCTION

Scholars in the field of ecological restoration are calling for a broader, more integrative approach to restoration that respects different forms of knowledge apart from Western science, such as the traditional ecological knowledge held by indigenous communities (Higgs, 2005; Kimmerer, 2002; Hourdequin, 2013). Culturally inclusive restorations provide an important arena for a two-way exchange between indigenous communities and environmental educators through which dislocated Native communities can revitalize traditional knowledge and environmental educators can learn from bodies of traditional knowledge beyond Western science. Integrating ethnobotany, the study of human relationships with plants, into restoration resources can turn ecological restorations into culturally inclusive and diversely valuable resources for local communities (Hamilton et al., 2003; Salick et al., 2003).

Ethnobotany has additionally been identified as an area of study that can be useful for introducing students to more interdisciplinary perspectives regarding cultural and environmental systems. Ethnobotanical education can also serve as a tool to generate student interest in the natural sciences (Brandt, 2010). Educational researchers have recently highlighted the need for higher education institutions to ground scientific learning in a "place-based" pedagogy involving engagement not only with the local physical environment, but also with local culture and history (Levine, 2011; Bowler, 1999; Brandt, 2010; Gruenewald, 2003; Yore, 1997). Ethnobotany exemplifies this integrated place-based approach and can benefit both the students it targets and the surrounding communities it looks to for its curriculum.

Our study focuses on Carleton College's Cowling Arboretum, an ecological restoration that began in the 1920s. We make use of the Cowling Arboretum to explore how ethnobotanical resources can help achieve more culturally inclusive restorations and management practices. As an additional focus, we apply our research on the ethnobotany of the Cowling Arboretum to test whether ethnobotanical information can be used to foster meaningful, place-based environmental education for Carleton students.

LITERATURE REVIEW

Ethical debates in restoration: Integrating human narratives into the landscape

"Knowing" a landscape or ecosystem is not only a matter of collecting supposedly objective information about the ecology and the array of flora and fauna within it. Rather, landscapes embody an intersection between many social and scientific disciplines, including human history, cultural tradition, religion, ethics, economics, geology, geography, politics, industry, technology, nutrition, medicine, taxonomy and linguistics (Hamilton et al., 2003). The strength of ethnobotanical study is that it, by definition, takes into account these many layers of meaning that can be attached to a landscape (Hamilton et al., 2003; Salick et al., 2003).

When the field of restoration ecology began to take shape in the 1980s, the stated definition of restoration was "the process of intentionally altering a site to establish a defined, indigenous, historic ecosystem" (Hourdequin, 2013). These early restorations took pre-settlement conditions as their standard and aimed to erase the effects of European settlement in order to appreciate nature "for its own sake" (Jordan, 2010). More recent definitions of restoration have moved away from this emphasis on historical fidelity and looked instead to recovering ecosystem

function without having to adhere to exact historical species compositions (Hourdequin, 2013). But in determining the ecosystem function, opinions differ on how much historical human interaction should be considered part of the "natural" state of the land.

The environmental philosopher Marion Hourdequin proposes using "narrative restoration" in order to acknowledge "the relational ties that exist in a place among people, and between people, animals, plants and natural systems." She emphasizes the fact that human ties to the land extend and accumulate through time. To erase and deny this cumulative history in the land is not only infeasible due to the impossibility of tracing back the landscape to pre-human conditions, but also socially unethical. Rather, restorationists should ask how both the natural and human history of the land can be respected in efforts to restore the ecosystem (Hourdequin, 2013). Biologist Young Choi (2007) echoes these ideas, writing that efforts to preserve an environment of the past without social values "would probably lead to ossification within the field, a decline in scientific credibility, and a loss of public support."

Inclusive narrative approaches to restoration are not only about respecting human histories, but also about respecting and sustaining present-day local cultures and communities. Many environmental scholars have promoted a localized and participatory approach to restoration, in order to empower local communities and increase their sense of investment in the health of their natural environments (Light and Higgs, 1996; Davis and Slobodkin, 2004; Higgs, 2005; Naveh, 2005; McManus, 2006). In other words, a restoration should look to the needs of its surrounding human communities in order to make the restoration a more highly valued and charismatic piece of its local infrastructure. To achieve this kind of long-term sustainability, restorations must engage with human culture, looking beyond an exclusively scientific perspective. Restorations must be viewed as a tool to sustain and promote the growth of local culture and local knowledge.

Indigenous communities in ecological restoration

In order to be fully inclusive of human stories in a post-colonial landscape, we must engage with the knowledge and practices of indigenous communities. To simply acknowledge the views of a dominant culture already exercising agency over the land would be insufficient. Our project is grounded in the idea that restorations can provide a critical platform for the preservation and proliferation of Native culture and traditional uses of the land. Moreover, ecological restorations must not only be a site of preservation of local culture and knowledge, but must include local communities in management decision-making. We must look to the perspectives of indigenous cultures who have largely been forced off the land, and reinvigorate the presence of their voices in restoration management. Ethical debates in restoration emphasize the importance of integrating indigenous knowledge, history, and perspectives into land management.

For dislocated Native communities with traditions rooted in specific landscapes, ecological restoration can provide important opportunities for cultural restoration. Higgs (2005) describes such an instance in British Columbia, Canada, involving a community of Lekwungen indigenous peoples. The Lekwungen were removed from what is now the city of Victoria during British colonization, but a few hundred members of the Nation have remained on a small reservation nearby. In 2000 a group of ethnobotanists and members of the Lekwungen Nation collaborated to restore local meadows of Blue Camas that had been neglected since the relocations. Blue camas had historically been an important food source and trade item for the Lekwungen, who intensively managed the plant through weeding, prescribed burning, and

specific harvesting methods. The restoration project enabled the first camas harvest in over a century to take place, an event that carried huge importance for the Lekwungen who saw their culture and traditions revived through this "cultural keystone species" (Garibaldi and Turner, 2004).

Not only can including indigenous cultures in restoration projects help Native communities preserve and revitalize traditional knowledge; culturally inclusive restoration also opens up vast bodies of information beyond what Western science has discovered. A 1988 study estimated that modern science had examined the chemical composition of less than one percent of flowering plants (Farnsworth, 1988, as cited by Sheldon and Balick, 1995). Authors Jennie W. Sheldon and Michael J. Balick explain that the ecological and botanical knowledge that indigenous cultures have accumulated is formidable by comparison: "Thousands of years of direct dependence on plants has required the revision and perpetuation of a significant body of information regarding the value of individual species and their habitats" (Sheldon and Balick, 1995).

While both sides of this two-way exchange between restoration science and indigenous culture are important in establishing culturally inclusive restorations, our project will focus on the latter part of the exchange and on how indigenous ways of knowing the local landscape can contribute to the fulfilment of Carleton's stated mission "to be welcoming and hospitable to its neighbors, guests, and the public, and a responsible steward of its resources." In this study, we take an ethnobotanical approach to engaging culturally inclusive, indigenous-based knowledge surrounding the Cowling Arboretum. An in-depth look at indigenous history in Minnesota, specifically Dakota history, illustrates the breadth of local Native ethnobotanical connections in the Arboretum.

Local indigenous history and land use in Minnesota

Before the arrival of Europeans in the late 1600's, Minnesota was occupied by various indigenous tribes. The presence of these tribes is difficult to trace back since early exposure to European diseases destroyed many indigenous populations. European presence was established in the land in the 16th and 17th centuries. The three tribes that remained in Minnesota after its organization as a territory in 1849 were the Dakota (part of the Oceti Šakowiŋ, or 7 council fires, also called the Sioux nation by Western colonizers)[1,2], Ojibwes (or Chippewas), and Hotchungraws (or Winnebagoes) (Berg, 1959). Minnesota was, however, primarily Dakota territory, and received its name, 'Mni Sota Makoce,' from the Dakota (Westerman and White, 2012). Therefore, we focus the indigenous knowledge portion of our study on the Dakota. Given the fluidity of tribal movement at the time of colonization, however, we remain open in our study to information concerning the Ojibwe[3], as well as the larger Oceti Šakowiŋ, including the Lakota and Nakota.

Beginning with the Pike Treaty of 1805, Colonization of Dakota land 'Mni Sota Makoce' consisted of a series of treaties in which the Dakota ceded land in exchange for promised

[1] All bands in this political-social organization, including Dakota, Nakota, and Lakota spoke closely related dialects of the same language (St. Clair, USDakotaWar.org).

[2] The Oceti Šakowiŋ peoples, the Dakota, Nakota, and Lakota, were deemed the Sioux Nation by French traders, however, many Dakota do not support this terminology.

[3] The Ojibwe tribe is oriented in the more forested areas north of us and the Lakota (Tituŋwan or Teton, Dwellers of the Plains) are another band of the Seven Council Fires located to our West in South Dakota.

government annuity payments, which often did not come to fruition. The starving Dakota led a rebellion that escalated into the U.S.-Dakota war. The mass execution that followed the short-lived Dakota war in 1862 represents the largest organized execution in American history. During the winter of 1862 to 1863, the Dakotas who surrendered--mostly non-combatants--were incarcerated in a concentration camp at the foot of Fort Snelling where they suffered sickness and assault, resulting in high mortality rates. The following spring, most Dakotas were exiled from the state and sent to reservations in the West (M. Flynn, personal communication, Jan. 10, 2017; Minnesota Historical Society). This event is emblematic of the disregard for Native lives that accompanied European colonization.

The colonists' destructive behavior toward the landscapes and ecosystems that these Native cultures depended on was a major factor that contributed to the weakening and removal of the Dakota. As Melvin Gilmore, an ethnobotanist from the Bureau of Indian Ethnology, wrote:

> The people of the European race in coming into the New World have not really sought to make friends of the Native population, or to make adequate use of the plants or the animals indigenous to this continent, but rather to exterminate everything found here and to supplant it with the plants and animals to which they were accustomed at home. (1919)

Prior to colonization, the Dakota sustained a culture and a livelihood both vitally tied to their detailed understanding of Native plants and ecologies and honed over many generations. The Dakota "followed a seasonal way of life, hunting game in the woods and in the wetlands, fishing in the rivers and lakes, ricing and growing gardens on the lakeshores and riverbanks" (Westerman and White, 2012). The disruption of Native ecologies and disregard for centuries of accumulated Native knowledge accelerated the impacts of European colonization by compromising the tribes' sources of sustenance and objects of tradition.

While it is true that Dakota lifeways have been profoundly disrupted throughout centuries of colonization, it is important to recognize that the Dakota Nations and the Oceti Šakowiŋ live on today, and are facing continued displacement and erasure in the face of intensifying ecological degradation. The tendency of historians to focus on the tumultuous period surrounding 1862 has come at the cost of better understanding the intact relationship of the Dakota people to the land before their exile, as well as the elements of that relationship which remain intact today. Many Dakota people have now returned to their native land. There are four Dakota communities near Carleton College: Shakopee Mdewakaton (located just south of the twin cities), Prairie Island (near Red Wing), Lower Sioux (near Redwood Falls), and Upper Sioux (near Granite Falls). There are also Dakota and Ojibwe communities in the Twin Cities.

Indigenous presence and ethnobotanical review in the Cowling Arboretum

Before colonization, the Cowling Arboretum was part of the Oceti Šakowiŋ, or the Seven Council Fires, territory. The two bands that lived in the Northfield area for thousands of years prior to colonization spoke Dakota: the Bdewakaŋtoŋwaŋ (Mdewakanton, The Spirit Lake People) and the the Waȟpekute (Wahpekute, The Shooters Among the Leaves People). Although there are few pre-colonial written records left by the indigenous peoples in and around what is now the Cowling Arboretum, we know from written accounts following the arrival of Europeans that Native tribes lived in the area. "The Indian Pathway Through the Cowling Arboretum," written in 1985 by Paul Jensen and Charles Umbanhowar and available through the Cowling Arboretum Online Archives, compiles historical accounts and maps of pre-settlement era trails in

the Arboretum and surrounding land. The authors concluded that indigenous people were indeed present in what is now the Arboretum. They write: "that the Indians traversed the arboretum land is well attested by numerous reminiscences about Indians holding dances north of the city and by stories of Indians going down Division Street on their way to the Wahpekute village at Cannon Lake [and no doubt much further]" (Jensen and Umbanhowar, 1998). In his "Memoirs of Northfield Minnesota," Charles Taylor also writes that up until 1862, "there were still a considerable number of Indians (both Chippewa [Ojibwe] and Sioux) living nearby" (1950). After 1862, Taylor testifies, "most of the Sioux were consigned to Northwestern Minnesota and the Dakotas" (1950). Lillie Clara Berg also writes in her history of Rice County that "the east side of the Cannon River is fairly lined with mounds from Northfield to within a few miles of Faribault," in reference to mounds built by Dakota people (1959). It is clear from these accounts that indigenous people made connections to the local ecology that should be included in a review of local ethnobotanical knowledge.

Many plants of historical and modern significance to the Dakota are present in the Arboretum. Twelve in particular, some of which we used in our guides, are White Sage (*Artemisia ludoviciana*), Prairie Rose (*Rosa spp.*), Black Raspberry (*Rubus occidentalis*), Eastern Cottonwood (*Populus deltoides*), Boxelder (*Acer negundo*), Redosier Dogwood (*Cornus sericea*), Chokecherry *(Prunus virginiana)*, Black Willow (*Salix nigra*), Hackberry (*Celtis occidentalis*), White Cedar (*Thuja occidentalis*), Yarrow (*Achillea millefolium*), and Pasque Flower (*Anemone pulsatilla*). Black Raspberry, White Cedar, Hackberry, Chokecherry, and Boxelder have culinary uses for the Dakota either for nutrition or seasoning. Black Willow has medicinal value to the Dakota as a treatment for fever and pain. Eastern cottonwood is used ceremonially in the Dakota Sundance ritual. The prairie rose is the subject of stories passed down in Dakota tradition.

White sage and Redosier Dogwood are two of the most important Dakota spiritual plants. The burning of white sage, and of "smudge sticks" (wrapped sage bundles) promotes ceremonial cleansing and purification (Kindscher, 1992). Additionally, sage tea is used to cure stomach ailments (USDA Plants Database). White sage is common throughout the Arboretum's prairies, and is easily identifiable by its white color and strong smell. Redosier dogwood, commonly called Red Willow by the Dakota, is connected with the "departure of the spirit from the body, the change we all call death" and used in funeral ceremonies (Gilmore, 1929). The inner bark of the tree is mixed also with tobacco and smoked in sacred pipe ceremonies (USDA Plants Database). Yarrow has both medicinal and culinary purposes. Used as a wound medicine (Munson, 1981) the entire plant is dried and then chewed and used as a poultice. With a sweet and potent scent, yarrow is also used to flavor food (Sherman, 2017).

Dakotas often associate Native species, including Pasque flowers, with a practical use as well as with a story. In terms of practical usage, Pasque flowers were used as a counter-irritant for rheumatism. Additionally, the leaves were crushed into a paste to soothe blisters (Gilmore, 1919). Ethnobotanist Melvin Gilmore transcribes a story of the Pasque flower told from a Dakota elder in his book *Prairie Smoke*:

> Whenever any of the people happened to pass by where these flowers were blooming, the flowers tried to show the friendliness which they felt for human beings by nodding their heads in the chilly spring wind, showing their smiling faces and saying, "Good morning! Good morning!" But the people passed them unheeding. The flowers became abashed at this indifference, and so nowadays, still feeling friendly towards the people in spite of their rebuffs, they bashfully turn their heads to one side as they nod and call their kindly greetings in their sweet low voice. (1929)

Gilmore transcribed many traditional stories regarding indigenous plants in his book *Prairie Smoke*. These orally-transmitted stories ground Dakota tradition in the land.

The ecological degradation that began with European arrival and continues today has contributed to the displacement of Dakota people in the Twin Cities area and to the erasure of their culture, knowledge and traditions. Incorporating indigenous ethnobotany into the Cowling Arboretum and other restorations can help to undo this erasure and prevent further cultural loss. Case studies around the country speak to the centrality of traditional food sources and botanical practices to the cultures of today's Native communities (Nelson, 1983; Coté, 2010). For these populations whose knowledge of native plants is the manifestation of thousands of years of heritage rooted in specific ecological settings, the opportunity to engage in traditional land use practices represents a crucial tie between the past and the present (Sheldon and Balick, 1995).

Dakota and Ojibwe communities continue to rely on local ecological staples, many of which are foraged, for medicinal, spiritual, and culinary purposes. Native activist Winona LaDuke stresses the importance of indigenous food in Ojibwe culture: "Food for us comes from our relatives whether they have wings or fins or roots. That is how we consider food. Food has a culture. It has a history. It has a story. It has relationships" (LaDuke, 2012). According to Oglala Lakota chef Sean Sherman, indigenous food is not only part of Dakota and Lakota culture, it defines it (2016). Sherman recognizes the importance of eating, growing, and foraging traditionally as ways to preserve and strengthen Dakota culture (2016). Native American Studies Professor Darlene St. Clair explained to us:

> As much as colonization has disrupted our tradition and land, and our access to plants has been lost to agriculture, there is still a thirst to know more. We [Dakota in the Twin Cities area] often have to go to South Dakota, however, to gain access to these plants… Colonization disrupted our land, our knowledge pathways, our ability to grow, and our ceremonies. But Natives are still very interested in the power and benefits of traditional healing… western medicine does not always cure what ails you. (personal communication, January 27, 2017)

Professor St. Clair then added that Carleton's Arboretum could expand from acting simply as a "museum of plants", to taking measures to incorporate Native rights history as a step towards decolonizing the area. She asked us to consider, "if the goal is to decolonize the area, then how is Carleton as an institution undoing the harm that has been done to Natives?" She explained the complexity of this task and the deep cultural awareness that must accompany any attempt at it. Allowing Native peoples to harvest from the area, for instance, would mean "more than just putting the seed of a plant into the ground, much, much more." For the Dakota, harvesting has very specific requirements in order to ensure the health of the plant source and of those using it (D. St. Clair, personal communication, January 27, 2017). In the quest to make a restoration like the Arboretum culturally useful, the first crucial piece of groundwork is to deepen our understanding of indigenous traditions and to spread that awareness in our educational community.

The value of ethnobotany in undergraduate and university environmental education

Alongside physical displacement, cultural negation, and ecological destruction, another force in the erasure of indigenous people in the United States is an educational system that

neglects indigenous knowledge. As of now, ethnobotany and other forms of traditional ecological knowledge are a vast and valuable body of information largely absent from undergraduate science curriculums. As a consequence, students rarely get to engage with local and traditional knowledge in an academic context, if at all. When science curriculums operate under a decontextualized and placeless framework, not only are local cultures neglected, but students are also deprived of valuable opportunities to connect their classroom learning to the world around them and to other academic disciplines. As education professor Carol Brandt writes:

> In much of university learning, science is decontextualized and ahistorical. In a sense, one could say that a normative approach to science is "anti-place," connected only to the mastery of objective knowledge and universal theories, disconnected from the lives of students and their families (2004)

Brandt calls for recognition of the ways that our educational system indoctrinates students into a Western and Eurocentric scientific worldview. She looks to ethnobotany as "an ideal subject to carry students into cross-disciplinary discussions and investigations into the epistemology of science" (Brant, 2004). Ethnobotany fosters an approach to science as a cultural process and reveals the situational nature of knowledge through the ways that humans come to understand a place (Brant, 2004).

Some researchers have identified the deficit of place-based learning in university-level science education as a reason for recent declines in student interest in ecology, botany, and other natural sciences (Vougioukalou et al., 2014; Hall and Sawey, 2014). As an inherently place-based field, ethnobotany can offer a remedy to declining interest in ecology and to a general deepening disconnect between human communities and their natural surroundings. The field of ethnobotany takes as its foundation the fact that human and ecological communities are inextricably bound and in constant dynamic dialogue (Vougioukalou et al., 2014). Ethnobotanical study opens up the network of interdisciplinary connections in which natural science is embedded, looking to the myriad uses and meanings--medicinal, edible, spiritual, traditional--that plants and ecosystems have acquired throughout history. Robin W. Kimmerer, a plant ecology professor and Potawatomi tribal member, explains that incorporating traditional ecological stories into biology lectures "helps students retain information and integrate it with their own experiences" (2002). The National Science Foundation (1997) found that students involved in cultural and localized science research projects have shown greater retention of knowledge, techniques, and quantitative skills (NSF, 1997). Not only can ethnobotanical study serve as useful pedagogical tool, it can also demonstrate the usefulness and importance of local flora, and topple the notion that human systems and biological systems are dichotomously opposed and even harmful to each other (Stewart, 2008; Vougioukalou et al., 2014). In university classrooms, embracing ethnobotanical perspectives can make plants and landscapes seem more approachable and relevant to students, improve student retention of botanical knowledge, and increase students' perceived value of a natural setting (Brosi and Huish, 2014; Bowler et al., 1999).

In addition to its educational benefits, the incorporation of ethnobotanical information into undergraduate science education prepares graduates to solve complex environmental issues in the workforce. As Native American land holdings in North America contain more wildlands than all the National Parks and Nature Conservancy Areas in the U.S. combined (Nabhan, 1997), Native Americans are stakeholders in issues of sustainable development, natural resource management, and ecological restoration (Kimmerer, 2002). College graduates, particularly in the fields of biology, geology, environmental science, engineering, and economics have a high probability of

encountering issues involving indigenous cultures and traditional ecological knowledge. Without exposure to traditional ecological knowledge, undergraduates may have a difficult time navigating issues involving Native stakeholders. The Coldwater Spring study from a 2015 Environmental Studies class exemplified the issues that can unfold in the field of ecological restoration when players lack an understanding of traditional ecological knowledge (Bloom et al., 2015). The project concluded that the National Park Service responsible for this restoration intentionally privileged the values of public recreation over the cultural needs of the Dakota, who tried to make their voices heard in the restoration process so that they could continue to use the site for religious practices built on thousands of years of local tradition (Bloom et al., 2015). More specifically, miscommunication of the importance of individual plant species, such as willow, to the Dakota has tainted the relationship between the National Park Service and local Dakota people (Darlene St. Clair, personal communication, January 25, 2017; Sorem, 2011).

What students are learning in undergraduate science curriculums will shape the future of environmental action. Robin Wall Kimmerer stresses the importance of teaching traditional ecological knowledge as a way to support diverse modes of environmental thinking and problem-solving that, in the long run, will benefit us all:

> A basic tenet of biology is that diversity is the raw material of evolution. Without adequate diversity, adaptation to changing environments is not possible, and extinction ensues. Similarly, intellectual diversity fuels the evolution of cultures and their ability to adapt to a changing world. The adoption of a single mode of thinking based on a materialistic view of nature has contributed to serious environmental degradation. The complex issues of environmental sustainability require a diversity of intellectual approaches and can benefit from a thoughtful consideration and incorporation of traditional ecological knowledge. (2002)

Kimmerer emphasizes the need to incorporate traditional ecological knowledge into dominant modes of thinking about nature in order to ensure that we do not rely on the ecological values of one culture and limit our ability to adapt to change.

The Cowling Arboretum: Education, restoration, and recreation

Carleton College, home to a diversity of intellects and cultures, offers an ideal setting in which to investigate the incorporation of traditional ethnobotanical knowledge into an educational setting. Carol Brandt highlights many universities' focus on "Big Science," and their drive to earn large grants and publish research, as the greatest barrier to institutionalizing a place-based approach (2010). As a small liberal arts institution without a focus on research overshadowing its educational goals, Carleton College is a perfect place to introduce this type of challenge to some of the problematic structures and status quos of Western science. Moreover, using the Arboretum to promote culturally conscious learning fits well with Carleton's holistic mission to be "a responsible steward of its resources." While there are many means by which to implement ethnobotanical learning around ecological restoration at Carleton, we have chosen to explore how ethnobotany can be applied to the informational resources and guides offered to public and student visitors to the Arboretum.

The Arboretum, with ecosystems connected to indigenous cultures through a rich local history, presents an opportunity to focus attention on traditional ecological knowledge and to implement this kind of ethnobotanical learning approach. Ethical literature suggests that restorations like the Cowling Arboretum are important platforms for preserving ethnobotanical

knowledge sustaining the livelihood and culture of many marginalized Native groups. The Dakota community, with historical roots in this area and a continued presence today, represents one such marginalized group that could benefit from more culturally inclusive approaches to restoration, and could also provide others with a rich store of ethnobotanical information pertaining to the local ecology.

Indigenous communities, however, are just one source of ethnobotanical information, and over the course of this project we realized that it is critical to acknowledge that human connections to ecology are generated in all cultural and societal contexts. We broadened our thinking about cultural inclusivity in the Arboretum to include the culture that exists among Carleton students and faculty, who are the primary users of the space. We hoped to counter the tendency to view dominant groups in society as "acultural" wherein one looks for "real culture" only outside of one's own context, among, for instance, exoticized Native communities. The human-environment connections among Carleton students are indeed rich and worthy of ethnobotanical study. The Cowling Arboretum has long served as a diverse resource for students, faculty, and local community. The Arboretum is, according to its website, "foremost an outdoor classroom for students of Carleton College [...] used by all disciplines and majors" from Biology, to English, to Studio Art. In addition to serving as an academic resource and a site for faculty-led research, the Arboretum facilitates a variety of other educational and community outreach programs including nature walks, field trips, a *Student Naturalist* program immersing participants in "natural history and nature interpretation", *Master Naturalist* courses dealing in both "natural and cultural history", one-time workshops instructing volunteers in land management techniques, and a YMCA summer camp. With robust goals and initiatives to educate students and the public on issues ranging from land stewardship and conservation to cultural history to basic plant recognition and ecological understanding, the Arboretum is likely to find educational value in the kind of ethnobotanical knowledge that can be located not only among Dakota people, but also among Carleton's own diverse population.

Research Objectives

Our study had a twofold objective: (1) to thoroughly research Dakota and Carleton ethnobotanical connections to plants in the Arboretum, and (2) to evaluate the potential for this ethnobotanical information to increase student engagement with the Arboretum when incorporated into interpretive guides. Our research question asks: *What ethnobotanical information is available about the flora of the Cowling Arboretum and how can this ethnobotanical knowledge be used to produce culturally inclusive user resources for restorations like the Cowling Arboretum?* And secondarily: *Can engaging ethnobotanical knowledge in the Cowling Arboretum foster greater student knowledge, appreciation, and utilization of the Arboretum?* This project represents the first effort to formally compile ethnobotanical information about Carleton's Arboretum, and to our knowledge, the first analysis of how ethnobotanical education can impact students at Carleton.

METHODOLOGY

Ethnobotanical research and the creation of the botany guides

We began by exploring the historical and current significance of Arboretum plants to Dakota culture, and then moved into examining connections within the Carleton community. We explored both Dakota and Carleton ethnobotanical knowledge. After an extensive phase of ethnobotanical research pulling from local sources, we created three botanical guides to the Arboretum: one with a natural science focus, one with a focus on Dakota ethnobotany, and one with a focus on Carleton ethnobotany.

Each stage of research required a somewhat different approach. For the natural science guide, we pulled as much information as we could from the existing Arboretum interpretive guide, eliminating whatever we considered to be ethnobotanical information, and added supplemental information from online plant databases. This natural science guide served as our control treatment for the participant experiment, representing the established and dominant approach to presenting botanical information to general audiences.

In conducting research for the Dakota ethnobotanical guide, we first met with anthropology professor Constanza Ocampo-Reider who informed us of anthropological research methods and encouraged us to maintain an awareness of our own positionality with respect to indigenous culture as we conducted our study. We then spoke with Don Hazlett, an ethnobotanist at the Denver Botanical Garden who has developed an informal ethnobotanical guide of the area. Hazlett informed us of ethnobotanical research methods. Since we had access to information about Ojibwe and Lakota ecological knowledge, we expanded our research to include information from these tribes, as prior to colonization these tribes neighbored Dakota land.

We then consulted published compilations of Dakota and Lakota ethnobotany (Munson, 1981; Gilmore, 1919; Gilmore, 1929; Moerman, 1998) and conducted a series of interviews with Dakota, Lakota, and Ojibwe sources from within Minnesota. One of our contacts was Sean Sherman, Oglala Lakota food educator and CEO/founder of The Sioux Chef in the Twin Cities, a modern indigenous catering company which features pre-contact foods of the Dakota and Minnesota territories. We also spoke to Native American Studies Professor and Dakota Scholar Darlene St. Clair and to local ethnobotanists and scholars such as Julia Uleberg-Swanson and Mike Flynn.

In grappling with how to conduct this research respectfully, we looked to indigenous scholar Linda Tuhiwai Smith who wrote that “research is not an innocent or distant academic exercise but an activity that has something at stake and that occurs in a set of political and social conditions” (Smith, 1999). Smith’s critique of research made us aware that in trying to publicize indigenous perspectives on Native plants in the Cowling Arboretum, we ran the risk of exploiting the cultures who produced and own this knowledge. Smith cautioned that “research is one of the ways in which the underlying code of imperialism and colonialism is both regulated and realized” (1999). We strove to avoid imposing colonialist modes of thinking by allowing the project and our mindsets flexibility as we learned from Native sources. All tribal members and Native people who we interviewed were aware of how the information they shared with us would be used, and had the opportunity to fact check our write-ups before they were printed.

Finally, in researching for the Carleton ethnobotanical guide, we drew primarily from interviews with current Carleton faculty and students about their involvement with the Arboretum. We defined “involvement” broadly, and questioned our sources both about their use

of specific plants, and about any associations, memories, and personal significance attached to the general setting. In order to determine how Carleton students have made use of the Arboretum's various plants, we met and interviewed Carleton students who have experience foraging, including members of Farm Club, the Mycology Club, the Holistic Medicine Club, the Firebellies culinary club, and the Arb Naturalists. We also spoke to several Carleton professors, including art professors Stephen Mohring and Rebecca Hutchinson and English professor and Northfield resident Peter Balaam.

After completing our research, we wrote the three alternative guides, maintaining as much formal and stylistic consistency as possible (see Appendix 7). The *Cowling Arboretum Interpretive Guide* (Luterra, 2007), provided the basic template for the guides. We included ten plants in each guide, with some overlap of species across the three versions, and wrote a few paragraphs of text for each.

Applying our research: Testing educational benefits of local ethnobotany

We then set out to test whether the ethnobotanical guides might be more likely to foster student engagement with the Arboretum. For our experiment we brought students on short botanical walks through the Arboretum in three treatment groups aligning with the three alternative guides. Students took online surveys two days after the walks, and several students were randomly selected to participate in in-person interviews. This aspect of our methodology builds on a previous Environmental Studies comprehensive project, "Seeing Biodiversity: Exploring the factors that influence perception" (Harrison et al., 2015), in which participants took a guided nature walk and then evaluated their perceptions of biodiversity.

In operationalizing our dependent variable of student "engagement" with the Arboretum, we referenced a study by Bowler et al. (1999) on the role of ecological restoration work in university environmental education. The authors compared an entirely classroom-based ecology course with a version of the same course that incorporated actual ecological restoration fieldwork, assessing the variables of 'environmental knowledge,' 'environmental values,' and 'ecological behavior intention.' Our experimental framework also referenced research by Hinds and Sparks (2007) who studied how engaging with the natural environment affects environmental connection and identity using the variables 'environmental attitudes,' 'behavioral intentions,' and 'environmental identity.' They concluded that an "affective" or "emotional connection" toward a natural setting is a strong predictor of one's intentions to engage with that setting.

Pulling from these published studies, we defined student "engagement" according to three measureable variables:

1. Retention of Information: Recognition of survey information pertaining to plants in the Arboretum
2. Ecological Appreciation: Stated sense of interest, relevance, and usefulness of plants in the Arboretum
3. Ecological Behavior: Stated intention to make use of the Arboretum and its resources

We interpreted these variables as representing sequential stages or levels of impact according to the following model:

Knowledge retention → Sense of interest and connection → Changes to behavior and action

Our hypothesis was that exposure to ethnobotanical information, as opposed to purely natural science information, would enhance students' reported engagement with the Arboretum for all three variables. We also expected, more specifically, that of the two ethnobotanical guides the one focused on Carleton culture would have a greater magnitude of effect. Given that the Carleton ethnobotanical guide presented information grounded specifically in student culture, we predicted that this treatment would go the furthest in fostering student connections to the Arboretum, and would significantly increase all three dependent variables. We predicted that students would take interest in the Dakota ethnobotanical guide, though to a lesser extent than the Carleton guide. We made this prediction recognizing that indigenous botanical knowledge cannot simply be isolated and transplanted into other cultural contexts; indigenous uses for plants are embedded in broader spiritual, economic, and traditional systems unique to each particular community. We expected that students might take somewhat of an interest in the Dakota ethnobotanical guide simply due to the emphasis on human connections, but that, as outsiders to indigenous culture, they would not necessarily find this guide as relevant to their lives.

We led three treatment groups on short, guided walks of about a half hour each through the Arboretum. Each participant was given a printed guide, led to a living specimen of each plant on their guide, and given time to read the description corresponding to that species. The walks were scheduled and given over the course of two weeks and contained anywhere from 1 to 12 participants at a time.

We recruited 78 students in total but due to problems we encountered with some of the surveys, we only used the data for 71 of the participants: 26 for the natural science treatment, 22 for the Dakota ethnobotany treatment, and 23 for the Carleton ethnobotany treatment. Our participant pool drew from across class years and academic backgrounds.[4] Before participating in the walk, each student took a preliminary survey through the YouCanBook.me online booking service. The survey collected information regarding participants' previous engagement with the Arboretum and botanical knowledge (see Appendix 1).

Two days after completing the botanical walk, participants were sent a short online survey, through SurveyMonkey, with a combination of free response, multiple choice, and ranked response questions (see Appendix 2).[5] We measured our first variable, *information retention*, via free response questions asking participants to identify the plants they visited based on provided photos, and then to recall as much information as they could about each plant. We targeted our other two variables, *ecological appreciation* and *ecological behavior*, with a series of Likert scale ranked response questions asking students to rate their level of agreement with statements such as "Participating in the botany walk was refreshing," and "I am likely to take advantage of published guides like the one I used to learn more about plants in the Arboretum." The scales provided for these questions were out of seven. Two additional multiple choice questions asked participants about what different kinds of events might draw them to the Arboretum in the future, and what aspects of the Arboretum they were most interested in learning more about. In addition to the online survey, we conducted semi-structured in-person interviews with a random sampling of ten students, asking questions similar to those from the online survey.

We conducted quantitative analysis on all of our survey responses using R Studio (Version 0.99.441). For the photo identification section under the information retention portion of

[4] We recruited by visiting introductory Chemistry, Economics, Statistics, Linguistics, and Computer Science Classes, putting recruitment slips into mailboxes, and sending emails to various student group listservs.

[5] All participants were compensated with a $3 giftcard for their participation (partial funding was provided by the Carleton ENTS Department)

the survey, each response was awarded a point for every plant correctly named, half a point for a partially correct answer, and no points for an incorrect answer. We ran an ANOVA test comparing the mean identification scores across the three treatment groups.

In order to quantitatively analyze the free response answers asking respondents to recall details about specific plants, we devised a scoring system that rewarded answers based on accuracy, specificity, and overall amount of information recall. We evaluated each discrete fact in a given response on a scale from 0 to 3 (see Appendix 3) and then tallied up a total score for each individual response. Each of the three of us conducted this scoring process independently and then took the average of our three scores for each response. In carrying out this "triangulation" approach we hoped to reduce any bias that might result from just one person scoring the answers. Using our averaged triangulated scores for each response, we then ran one-way ANOVA tests comparing the mean information retention scores across our three treatment groups.

In order to evaluate our *ecological appreciation* and *ecological behaviour* variables, we likewise used one-way ANOVA tests to evaluate if there was a significant difference in means between responses. We ran ANOVA tests on each Likert scale question independently, and on the grouped variables (*ecological appreciation* and *ecological behavior*) as a whole. Questions were grouped separately for *ecological appreciation* and for *ecological behaviour* and averages by grouping were calculated and compared using a one-way ANOVA to test for differences according to which guide was used.

In order to evaluate Questions 19 and 20, which attempted to gauge what activities would draw students in the Arboretum and what types of knowledge related to the Arboretum they are most interested in acquiring, we used Chi-square tests to evaluate if there was a significant difference in activity preference and learning preference depending on the guide the respondent used for the botany walk. We also looked at the proportions directly to get a general idea of student interest in Arboretum activities and knowledge.

After all the surveys were completed, we interviewed 10 participants in one-on-one interview sessions. Three participants were randomly selected from the group who used the Natural Science guide, three randomly selected from the group who used the Carleton Ethnobotany guide, and four randomly selected from the group who used the Dakota Ethnobotany guide. The interview questions were aimed at getting a more in-depth understanding of participants' levels of engagement with the Arboretum, their perceived value of it, their reaction to the guides, and their educational interest in the Arboretum. We used a triangulation method of evaluating responses from the interviews, whereby we each separately picked out themes from the interviews and then drew from those themes in our analysis of the interviews.

RESULTS

Results from ethnobotanical research and guide creation

In creating the three Arboretum guides, our research took us in surprising directions and led us to make unexpected connections, yielding fruitful results. Using a snowball method, we found ourselves engaging with previously untapped informational Dakota sources affiliated with Carleton, as well as delving into Carleton's own rich ethnobotanical culture (see Appendix 6 for a chart summarizing each of these sources). We started by interviewing Connor Rohwer of the Carleton Farm Club, who we heard through word-of-mouth had foraging experience. In his

interview, Rohwer recommended we get in touch with Adam Rutkowski of the Carleton Mycology Club, Cameron Shorb who is a former Carleton Naturalist, and Peter Balaam who is an English professor. We heard from classmates about Rebecca Hutchinson and Stephen Mohring, two art professors who harvest plants from the Arboretum for their classes.

For information about Dakota history and plant-uses in the Arboretum, we gathered preliminary information from sources recommended by linguistics professor Mike Flynn and religion professor Michael McNally. McNally also put us in touch with Darlene St. Clair, Professor of American Indian Studies at the University of Minnesota at St. Cloud. We got in touch with Sean Sherman, Oglala Lakota food educator and CEO/founder of The Sioux Chef, when he came to speak at Carleton as part of a weekly convocation series. Daniel Hernandez, professor of biology, recommended that we contact Don Hazlett who is the father of a professor at Carleton and an ethnobotanist for the Denver Botanical Garden. Rinya Kamber of the Carleton Holistic Medicine club recommended we talk to Julia Uleberg-Swanson, Dacie Moses manager and adopted member of an Ojibwe family. Uleberg-Swanson put us in touch with her adoptive Ojibwe sister, Dorene Day, who is a midwife who uses traditional Ojibwe practices.

Baseline pre-survey data

From our preliminary survey, we gathered data on how often and through what activities, our participants engage with the Arboretum. 53% of respondents reported that they utilize the arb at least once a month (see Figure 1). The majority of respondents use the Arboretum for personal recreation (87.69%), followed by socializing (33.85%), classes or labs (26.15%) job related activities (13.85%), CCCE or CANOE programming (9.23%), and Arboretum Programming (9.23%). Only 3.08% of respondents had not utilized the Arboretum (see Figure 2).

The pre-walk surveys also allowed us to get an understanding of what knowledge our participants had in regards to Arboretum plants and ethnobotany in general. We found that 43% of our participants could not name a single plant species located in the Arboretum (see Figure 3). In terms of avenues through which participants "have come to know the plants or ecosystems in the Arb," 29% of participants reported they had been exposed to information in classes or labs, 12% through a job, 11% through personal research and exploration, 6% through guided walks through the Arboretum, 3% through informal information sharing, and 2% through volunteer opportunities (see Figure 4).

We also used a free-listing question asking respondents to name plants that are used for medicinal purposes (recommended by Don Hazlett) in order to get a cursory estimate of our respondents general ethnobotanical knowledge. We found that 42% of participants were unable to list even one plant that can be used medicinally.

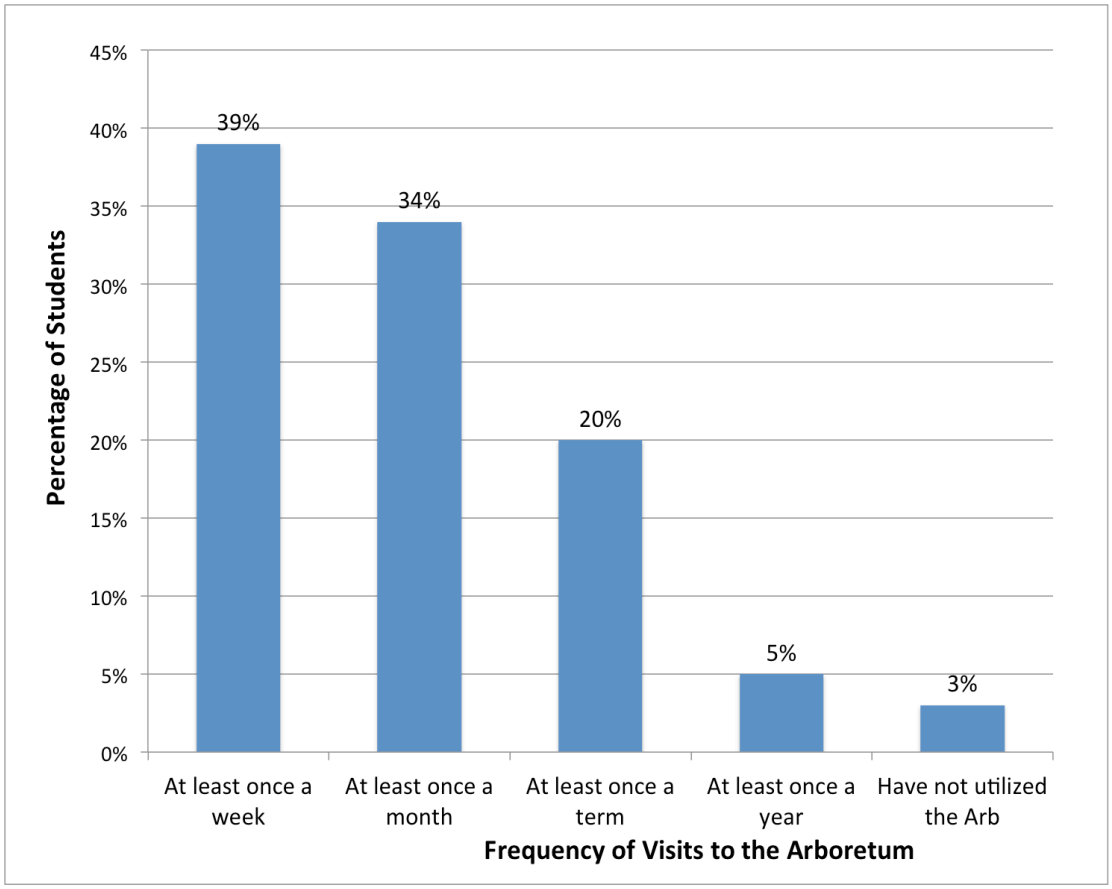

Figure 1: *Frequency of student visitation to the Arboretum. Data is compiled from the pre-walk survey.*

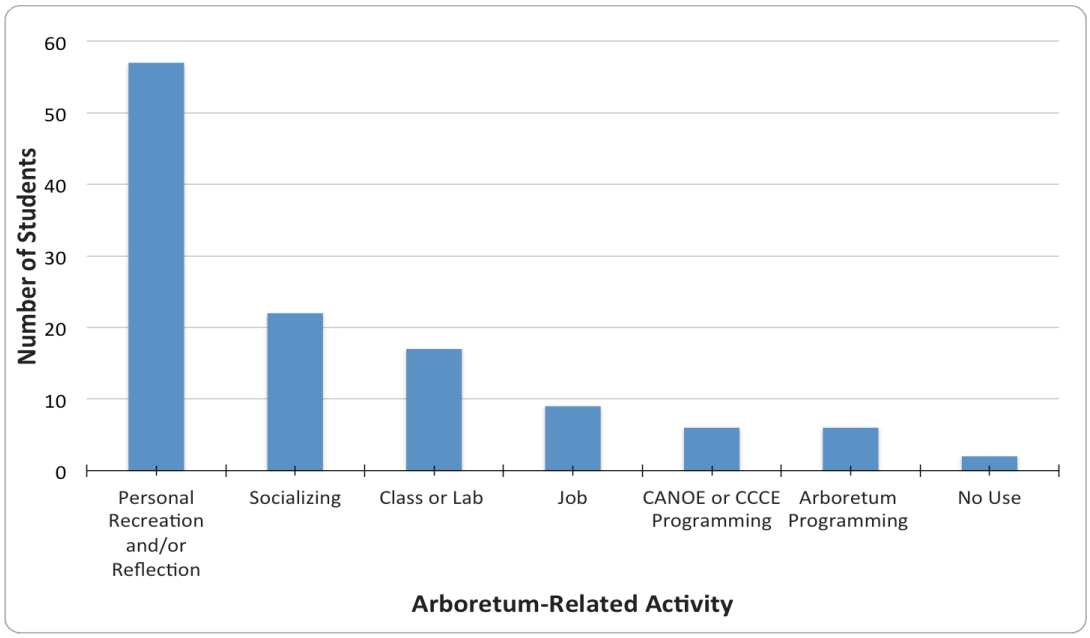

Figure 2: *Level of student engagement across various activities in the Arboreum. Data is compiled from the pre-walk survey.*

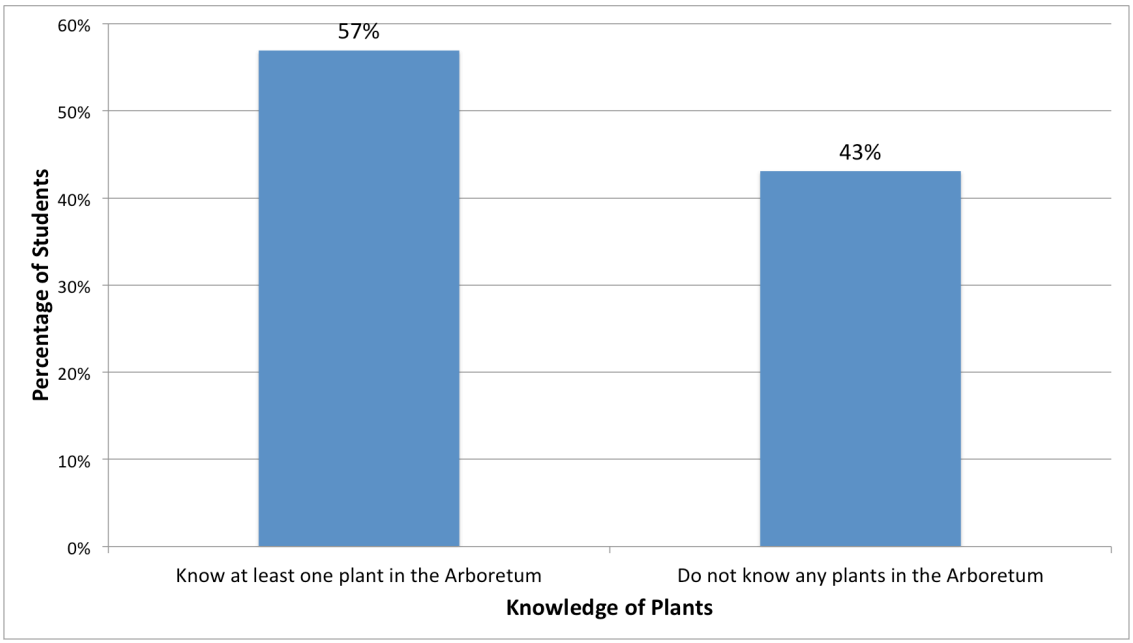

***Figure 3**: Students' baseline knowledge of Arboretum plants. Data is compiled from the pre-walk survey. Prior to the botany walk students were asked to list up to five plants that they were aware of in the Arboretum.*

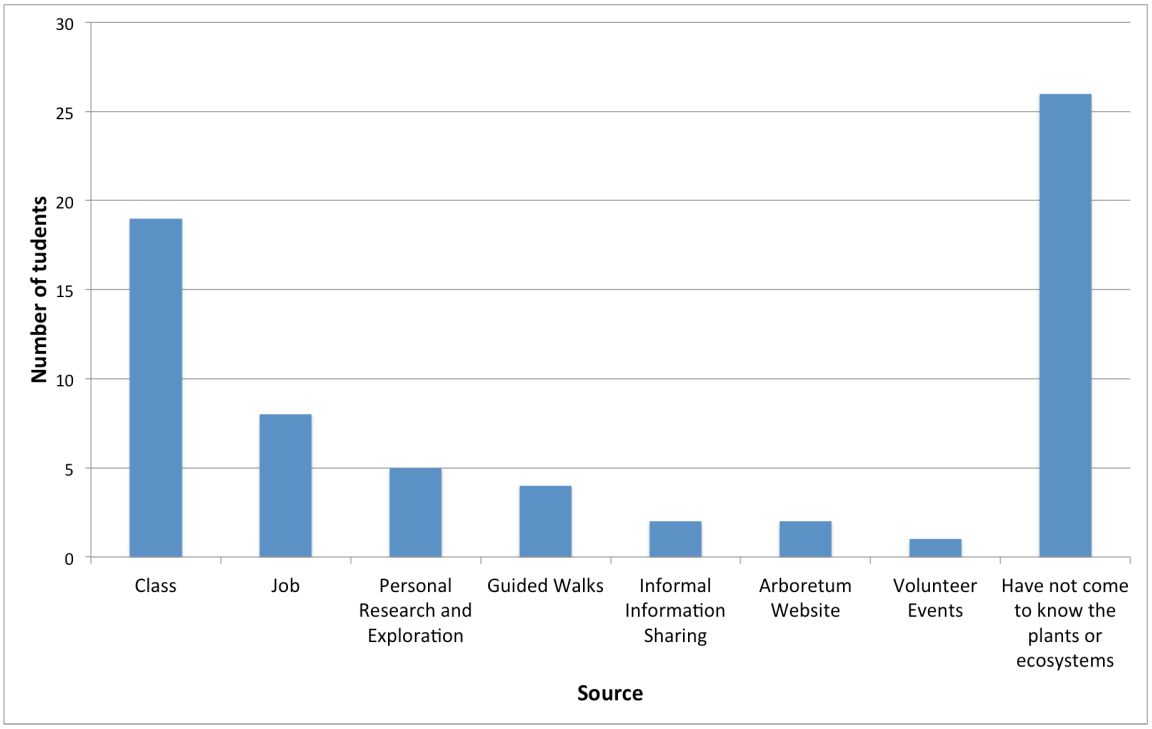

***Figure 4**: Sources of student knowledge about Arboretum plants. Data is compiled from the pre-walk survey.*

Information retention

There was no significant difference in information retention across the three treatment groups. The mean scores for the photo identification section were 3.86 out of 10 for the natural science group, 3.95 for the Dakota ethnobotany group, and 3.31 for the Carleton ethnobotany group. The mean scores for the free response recall of information about each plant were 1.87 for the natural science group, 1.75 for the Dakota ethnobotany group, and 2.20 for the Carleton ethnobotany group.

Ecological appreciation

There was no significant difference in reported ecological appreciation across the three treatment groups, although the data exhibited a slight overall trend in favor of the two ethnobotanical guides ($p = 0.29$). Breaking this survey section down by individual question, the strongest trends manifested in the questions asking participants to rank their agreement with the following statements: "Participating in the botany walk was refreshing" ($p = 0.21$); "Participating in the botany walk was relaxing" ($p = 0.22$); "Participating in the botany walk made me feel happy" ($p = 0.15$); and "The botany walk made me aware of new uses for the Arboretum and its plants" ($p = 0.35$). For all of these questions, the two ethnobotanical guides yielded slightly more positive results (see Appendix 4).

Ecological behavior

The different guides had no significant impact on the ecological behavior of respondents either. Although not showing a significant trend, respondents who used the Carleton ethnobotany guide reported the highest mean responses for feeling inclined to visit the Arboretum more frequently, being likely to share some of the information that they learned from their Arboretum guide, and feeling that some of the information that they learned from their Arboretum guide is relevant to their life. Also insignificantly, those who used the Dakota guide had the highest mean response for being more likely, after having taken the walk, to engage in Arboretum restoration projects (see Appendix 5).

Education and programming interests surrounding the Arboretum

Finally, the different guides also did not significantly impact what type of Arboretum-themed activity respondents were most attracted to or what aspects of the Arboretum respondents were most interested in learning more about. However, the activity that drew the most interest across the treatment groups was a "plant-use workshop," which was chosen by 34% of respondents (Appendix 4) potentially highlighting a trend towards plant-use interest. After "plant-use workshop" the next highest level of interest was in a "volunteer tree-planting workshop" (22%), followed by a "field research project involving various ecosystems of the Arboretum" (19%), and finally "a guided tour about the history of the Arboretum" (18%). In the "other" response option, students also said they were interested in "more guided, interactive tours of the Arboretum's botanical resources" and the opportunity to learn more about "edible plants and foraging" in the Arboretum (see Figure 5).

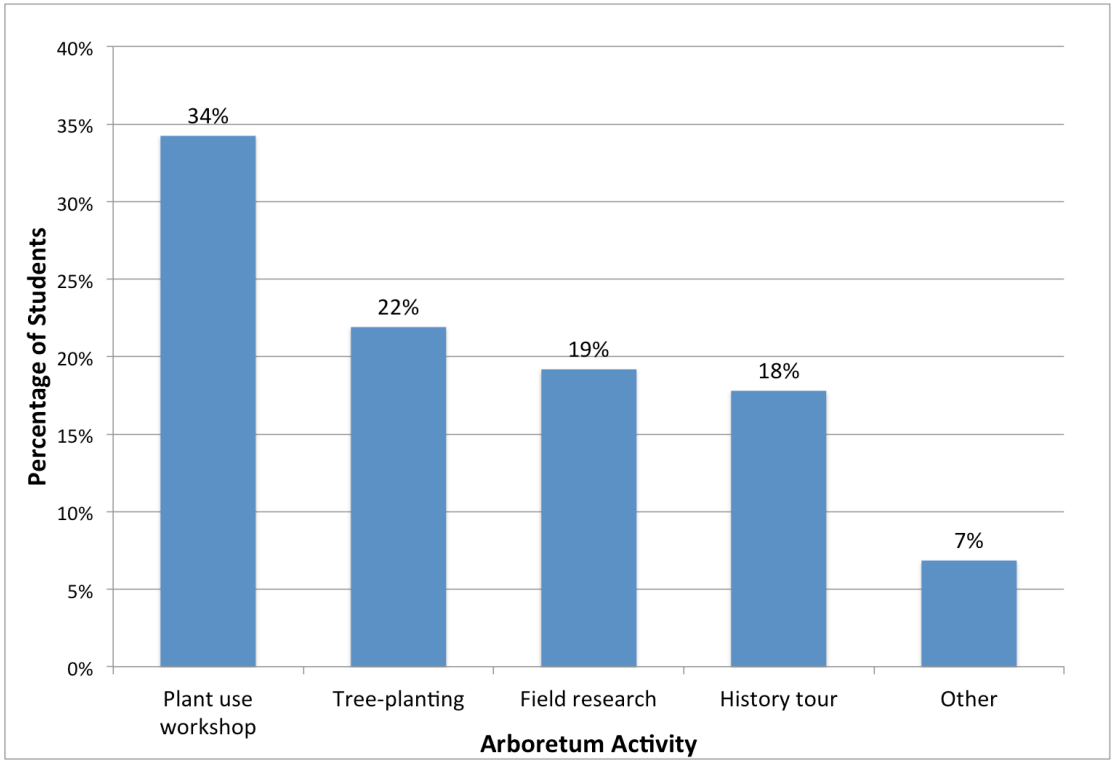

Figure 5: Students' post-walk interest in various activities in the Arboretum*. Data is compiled from the post-walk survey question, "What type of activity is most likely to attract you to the Arb?"*

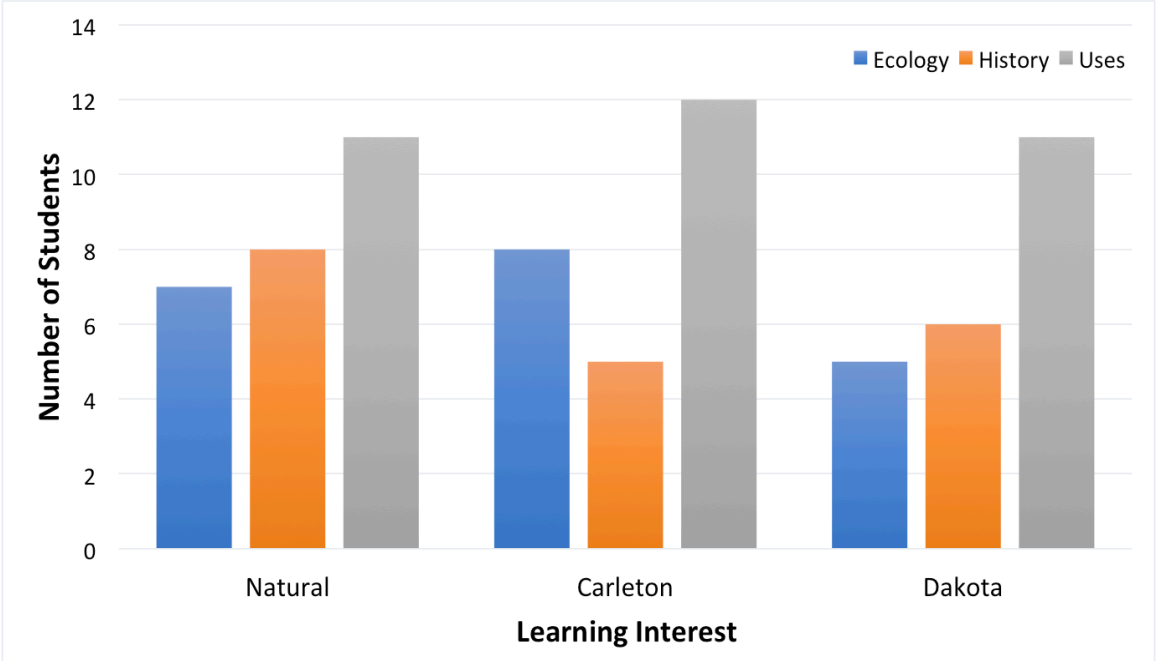

Figure 6: Students' post-walk learning interests relating to the Arboretum. *Data is compiled from the post-walk survey.*

When participants were asked "What aspects of the Arboretum are you most interested in learning about further?" the most popular choice across treatment groups was "uses of plants and plants in culture," with 46% of participants ranking it as their first choice, followed by "ecology and other scientific research" with 27% of participants ranking it as their first choice, and "history (natural or other)" with 26% of participants ranking this as their first choice (see Figure 6 and Appendix 5).

Findings from interviews

We gathered information from 10 interviewees (3 from the natural science botany walk, 3 from the Carleton botany walk, and 4 from the Dakota botany walk) asking questions that we grouped under the four categories of Personal engagement with the Arboretum, Importance and value of the Arboretum, Reactions to Arboretum guides, and Educational interests related to the Arboretum.

Personal engagement with the Arboretum

In order to measure personal engagement with the Arboretum, we asked interviewees how often and for what reasons they enter the Arboretum, what they value about it, and why they do not spend more time in it. Respondents tend to spend time in the Arboretum mostly for recreation and occasionally for classes or for volunteer or paid work. Several respondents said the Arboretum was a factor in their decision to come to Carleton. Respondents cited lack of time as the primary factor limiting their time spent in the Arboretum, along with the distance they have to walk to get there, fear of getting lost on the trails, and weather conditions. Several respondents said that spending time in the Arboretum feels too calm or purposeless and that they would be more inclined to enter the Arboretum with an activity in mind. Even though many interviewees did not use the Arboretum as much as they would like for these various reasons, respondents echoed that "it's [just] a great place to know is there." One respondent mentioned that the guided walk provided them with a compelling purpose for entering the Arboretum.

Importance and value of the Arboretum

In order to assess the importance and value of the Arboretum to students, we asked students what they believe are the main benefits of the Arboretum for Carleton students, for the surrounding community, and in general, as well as whether the Arboretum was a valuable part of their Carleton experience. Students replied that they valued the Arboretum for three main reasons: 1) recreation and an opportunity to go into a "natural open space" where they go to feel happier, 2) a public space in which to "escape" from the stress, "get away," and relax, and 3) a resource to "apply learning in classes in a meaningful way." The majority of respondents highlighted that they were drawn to the Arboretum for recreation and relaxation. Comments in this vein included: "It gives me time away from campus, which is rejuvenating;" "it makes you step back and slow down, which is really important especially for students," "it feels like there's plenty to explore." Participants also highlighted the Arboretum as an asset for classes: "I had an archaeology class where most of the labs were in the Arb and it made it a totally different experience than what it would have been if we didn't have somewhere to do hands on archaeological stuff." Students also noted that they appreciate that the Arboretum is open to the larger community. One student said:

"I think it's cool how the high school skiers and St. Olaf skiers come here. I think it's a benefit to have an accessible natural area for everyone to use." Another student commented that it is good to be reminded "that there are people beyond the student body."

We then asked our participants if the Arboretum has contributed to them learning more about their local surroundings here in Minnesota. Most students replied yes, if they had participated in some form of guided learning activity (such as a guided walk, work on the Arb Crew, or a class). Participants who had only used the Arboretum recreationally were less confident that the Arboretum has helped them to learn more about their natural surroundings. This is exemplified by one participant's answer: "Definitely after taking the [botany] walk, yes; prior to that [the Arboretum] was just nature/outside; but after learning about all the different plants, now I can spot them around campus which is cool." Another participant who works on the Arb Crew and is native to Chicago answered: "One hundred percent, definitely, before coming here I never considered the prairie as an ecosystem that would be desirable." Many participants explained that it is difficult to do more than observational learning independently, but emphasized that they "definitely want to learn more." Thus, there seems to be a genuine interest among students for more organized, guided learning opportunities.

Reactions to Arboretum guides

In this section of the interview, we started by asking students to reflect on what stood out to them from their guide and whether anything they learned changed their understanding of the Arboretum. The overwhelming focus of the responses was on plants that could be eaten or used in some other way; this theme came up for almost all responses. One student exclaimed that she was "surprised by the breadth of plant uses," as well as "the breadth of plant life in general." Another student echoed this sentiment: "I didn't realize there were so many different plants that could be used, especially in ways other than food." A student who used the Dakota guide explained: "I realized better that obviously everything, things that we don't think of as food or medicine, everything was food or medicine before colonialism…There are uses and value in traditional medicine that we don't think about today." Some students appreciated that learning about these specific uses made the plants in the Arboretum seem more approachable and less "nondescript," and a few students mentioned that they hoped to return in the spring or summer to find some of the edible plants that were not accessible to us on our winter walks. Many respondents talked more generally about how human connections surrounding plants were most memorable, for instance how people introduced various invasive plants and used the Arboretum for a mill site. One student voiced his appreciation of how the Carleton ethnobotany guide "added a human presence" and integrated "modern humans using the Arb" in the broader landscape history, in a sense, "finishing this human story." He followed up: "If you look at something that doesn't include you it's less important... But if you look at nature including humans you care more about those systems and take care of them better." One student added that she thinks "Place-based learning is really cool,"and appreciated the focus on "TEK (Traditional Ecological Knowledge)" presented in the guides. In addition to discussing how human connections to plants stood out, a few students mentioned that they found the ecological function of certain plants interesting, for instance how certain trees helped with erosion. Some students also noted that their prior personal experience with certain plants also played a big role in what they remembered.

Following up on this question, we also asked our participants if they could foresee themselves pursuing more information about any of the plants in their guide, whether they

thought their guide could increase student interest in the Arboretum, and what other kinds of resources and programming might prompt them to engage more with the Arboretum. In response to the first question, most students said that they were interested in the material from their guide but that they likely would not seek out more information on their own. Some students said they might enjoy more formal plant science classes. Others noted if there were just more convenient, low-effort ways to access more information in the Arboretum they would take advantage of them. Several students, for example, independently came up with the idea of informational signs around the Arboretum. In response to the second question, our respondents all agreed that the guides could help make students more interested in the Arboretum, but many again emphasized issues of time and convenience, as well as general unfamiliarity with the navigation of the Arboretum and its online resources. (For instance, a couple students noted that they did not even know the Arb office existed prior to the walk or where to find Arb guides.) Some students remarked that "college students are lazy," and "you'd have to make sure it [the guide] gets distributed and that people know about it." Despite these barriers, our participants were enthusiastic about how their guides made them "feel more connected" to the Arboretum and gave them new reasons to visit the Arboretum (i.e. "for the sake of plants and not just walking around"). One student explained that he likes that "the guides were something concrete you could get from the Arb, rather than just spending time there."

Finally, asked about what kinds of resources and events would be most likely to draw them to the Arboretum, our respondents almost all called for more interactive, guided walks, with some proposing walks geared toward specific interests and topics (i.e. snowshoeing or foraging). Respondents also also asked for better publicity surrounding the walks. A few students also expressed interest in planting events, classes that engage heavily with the Arboretum, and more illustrated and visual guides.

Educational interests related to the Arboretum

In this portion of the interview, students were asked whether they were interested in learning more about the Native American history related to the Arboretum, the ecology of the Arboretum, and student and faculty uses of the Arboretum. All respondents stated that they were interested in the Arboretum's Native American history. Many remarked that there is a general lack of knowledge and discussion about the topic on campus and a few students emphasized the importance of using human stories to build people's connections to their physical place. A participant noted that Native American History is "not something I think about on a regular basis, that this land was taken from the people who lived here before. And it's not just the Arb, but Carleton in general. So if the Arb is way to access that consciousness then that'd be great." One student additionally explained: "I think [human history] would increase people's level of involvement with the Arb; people care more when a story is involved." All interview respondents also expressed interest in learning more about student and faculty interaction with the Arboretum, some mentioning that they feel there is a lot that goes on that they do not know about, and that hearing how other people use the Arboretum might give them more ideas for their own involvement.

Meanwhile, students' level of interest in the ecology of the Arboretum was more varied. Most respondents said they were interested to learn more but qualified that they would not pursue it on their own; they might enjoy it in an academic context or as part of an activity that was organized for them. Additionally, some students brought up their lack of academic background in

science as a potential barrier to fully appreciating the Arboretum's ecology. Still, a couple of respondents described how, as with local human history, local ecology is an important subject to tap into and "vital for getting more people involved in and caring for an environment." One student observed that, in general, she enjoys her time outdoors more when she can identify species, and said she "could appreciate the Arb more by learning more about the ecology of the area."

Interview participants were also asked whether there were any other specific educational dimensions of the Arboretum they were interested in, apart from the three already mentioned. The major themes that emerged were conservation and land management techniques (historic, current, and future), the human history surrounding the land especially after the Arboretum's establishment, and the evolving purposes and goals of the Arboretum through time. One student explained: "I'd like to learn more about land management techniques, the interesting history of farmland being restored to Native prairie, and the complex ecosystems they're trying to maintain and balance. I'd also like to learn more about how they're doing that and why." Additionally, a couple of participants also mentioned that they would like to become more familiar with the trails and navigational resources.

DISCUSSION

We set out to understand the role that a culturally inclusive ethnobotanical investigation of the Cowling Arboretum can play in improving educational efforts and in increasing student engagement. Our study expanded to become a multidimensional project with the aims of collecting and compiling Dakota and Carleton ethnobotanical knowledge specific to the plant composition of the Cowling Arboretum and investigating the impacts this ethnobotanical information could have on students' ecological education. As this topic has gone unexplored at Carleton, we did not expect to yield conclusive and stand alone results. Rather, we hoped to lay the groundwork for an important educational blueprint for the "narrative restoration" of the Arboretum. Our project, and future studies building on it, will provide useful information for the college on how to promote culturally inclusive perspectives surrounding the Arboretum and how these new perspectives might enhance students' involvement with the Arb.

Our first goal was to get an understanding of what an ethnobotanical study of the Cowling Arboretum might entail. What does the matrix of human connections surrounding the Arboretum look like? What are the relevant groups and communities that might have a stake in this particular natural restoration, taking into account a broader regional history as well as looking at the present? Who in the immediate area has connections to the Arboretum and how does the ecology of the Arboretum connect it to communities who may not necessarily inhabit this exact space? Whose perspectives have been privileged in our current understanding of the Arboretum and how can we promote a more inclusive understanding of the Arboretum ecology? In answering these questions and conducting our ethnobotanical research, we homed in on the current Carleton communities and local Dakota communities indigenous to this area. Within these two groups, we found robust knowledge bases pertaining to the plants in the Arboretum and ample channels of information to explore. We recognize, however, that the Arboretum may have importance for other communities as well, such as the early homesteaders. There is a broad range of community connections to the Arboretum still yet to be explored beyond this project.

Carleton ethnobotany in the Arboretum

Our Carleton-centered ethnobotanical research revealed that the Arboretum and its plants have diverse connections throughout campus among both students and faculty and across academic departments and personal pursuits. We spoke to two studio art professors who source their materials from the Arboretum and place a high educational value on having students interact with their materials as local and living resources. We spoke to an English professor who likes to take advantage of the fact that so many students come into his class with the common experience of dissecting Goldenrod galls for introductory biology; he uses this point of reference as a handy springboard for getting students to think creatively about notions of homes, nests, and habitation in the Arboretum. We spoke to students who have found handy rope-making and fire-starting material in the Arboretum, as well as various plants to eat and cook with--black raspberries as a snack during fieldwork, sumac berries to make a festive drink at a club cooking event, and nettles as a staple part of the Farm House diet.

Our research was by no means a comprehensive survey of ethnobotanical connections and uses on campus. Given our time constraints, we talked to a limited number of students and faculty members, selecting these sources based on our own knowledge of who uses the Arboretum and based on referrals from various people we contacted along the way. As we very intentionally sought out these sources, we cannot say that this kind of ethnobotanical knowledge is pervasive across campus, nor can we say that the particular information and connections that we dug up are representative of the general ethnobotanical knowledge base of Carleton. A future study would benefit from exploring the larger web of ethnobotanical connections do the Arboretum.

Even so, the fraction of knowledge that we encountered alludes to the breadth of significance that the Arboretum has for the college, demonstrates the campus culture that has grown up around the Arboretum and specific plants within it, and lays open ethnobotanical avenues across campus life that can be further explored. We think these are important findings to emphasize because, at least for some students, the Arboretum can often feel remote, irrelevant to life at Carleton, and somewhat of an exclusive domain belonging to ecologists, nature enthusiasts, and recreationists. Interviewed respondents also indicated that they consider the Arboretum to be an escape from campus life; this is no doubt an important and beneficial quality, but it also plays into the idea that, as a natural setting, the Arboretum exists separate and apart from the real heart of student life and the functioning of Carleton as an institution. Our ethnobotanical research counters these claims and demonstrates that the Arboretum is very much an integrated piece of campus culture, and has the potential to become even more integrated if its diverse offerings are more intentionally promoted through interactive student outreach.

Dakota ethnobotany in the Arboretum

Alongside our Carleton-centric ethnobotanical study, our indigenous ethnobotanical research also revealed a rich breadth and depth of connections to the Arboretum and its flora. Although the Arboretum is not, as a specific location, prevalent in the lives of Dakota and other indigenous communities in the way that it is for Carleton students who live and work in its immediate vicinity, it is important for the Carleton community to understand the extent of Dakota connections to the land. The Arboretum is connected to the Dakota and their culture through their historical presence in the area, through their contemporary presence in enclaves nearby, and as an extension of a particular ecology that remains critical to their traditions and lifeways.

The indigenous ethnobotanical uses we encountered spanned a range of culinary, spiritual, storytelling, and medicinal significance. We interviewed an Oglala Lakota Twin Cities-based chef who forages a host of native plants for his cooking and sees his work as a cook and restaurant owner as critical to showing people that indigenous uses of plants that are applicable in today's world. Many of his staple ingredients can be found in the Arboretum. We spoke to an Anishinabe Ojibwe traditional birthing practitioner who lives in Minneapolis and travels to reservations to offer training in women's health grounded in indigenous practice. Some of the plants most prominent in her practice are common in the Arboretum. We also spoke to her adopted sister who works at Carleton, is involved in traditional birthing and is knowledgeable of other holistic and traditional forms of medicine relevant to Arboretum plants. As a co-sponsor of the Carleton Holistic Medicine Club, she is aware of how students at Carleton have benefited from holistic medicine. This was one of the few areas of overlap we found between Carleton and indigenous ethnobotanical practices.

In this research phase of our project, we found that the Arboretum is indeed embedded in a dense web of ethnobotanical knowledge and associations, among Carleton students and also in the context of indigenous culture. Our next goal was to gauge student interest in this kind of ethnobotanical perspective and to find out whether educational resources that espouse it could be a greater draw for Carleton students than conventional resources that focus strictly on a natural science perspective.

Educational value of ethnobotanical guides: quantitative analysis

Our post-walk surveys and quantitative analysis ultimately did not provide conclusive evidence that ethnobotanical information can impact students' retention of information about plants and ecosystems, appreciation of natural settings, or ecological behavior toward these natural settings. We did observe some slight trends pertaining to the ecological appreciation section of our study, with more students in the ethnobotanical treatment groups reporting that participating in the botany walk was refreshing, relaxing, made them feel happy, and made them aware of new uses for the Arboretum and its plants. Without any statistical significance below the threshold of $P = 0.1$, we cannot draw any conclusions, however, these results might suggest that the incorporation of ethnobotanical information did contribute to more positive experiences on the actual walks themselves, and that limitations in our study's methodology may have prevented us from observing these trends in our quantitative data.

It is critical to note that many comparable published studies on the benefits of ethnobotanical and place-based learning have taken place over a much longer time-span and have centered around actual semester-length classes. Our study stands apart from this body of work because, with our guides and brief botanical walks, we were testing a much more abridged type of education. The results that can be expected from ethnobotanical learning in classroom contexts are sure to be different from the results that can be expected from ethnobotanical learning in the context of one-time public education events. Though inconclusive, our study may suggest that the latter is not necessarily an effective means of reaping the benefits that can come with more immersive ethnobotanical study, or at least may be only partially effective.

We did find, however, that the walks as a whole improved overall participant knowledge of plants in the Arboretum. Before taking the guided walk, 56% of participants knew the name of at least one plant in the Arboretum, whereas after taking the guided walk, 92% of participants could visually identify at least one plant in the Arboretum. This indicates that the act of going out

in the Arboretum and learning directly from the natural landscape through a guided walk may have a positive influence on students capacity to absorb botanical knowledge. From our post-walk interviews, it seems that students are also very interested in more opportunities to learn about Arboretum botany, and the Arboretum in general, through organized activities such as interpretive walks, restoration workshops, volunteer activities, or other interactive events.

Educational value of ethnobotanical guides: qualitative analysis

Even while the quantitative results from our experiment were not significant, we learned a lot from the qualitative components of our study. To begin with, simply leading the botany walks was informative. We could not have predicted the level of interest that students would show in signing up for the walks; our final sample size far exceeded our expectations, demonstrating that there is certainly interest in educational events surrounding the Arboretum. As we led participants through the Arboretum, it seemed that the interactive walks in and of themselves were an effective way of generating student interest in native plants, regardless of which guide was used. One student made an unsolicited comment after participating in a walk with the Carleton ethnobotany guide that they found the information about human connections to plants very interesting and that they wanted access to more information in that vein. Regardless of which guide they had, students appreciated how the walks made them aware of specific plants in the Arboretum, whether associated with edible and medicinal uses, explanations of ecological role and function, or broader human histories. All of our respondents said that they valued the interactive learning experience that the walks offered, and expressed that the walks deepened their understanding of the Arboretum and piqued their interest in learning more about it.

The most enthusiastic responses during our post-walk interviews, however, came from the students who used either one of the ethnobotanical guides, perhaps telling of a trend that we failed to capture statistically in our experiment. Interviewees from both of these groups expressed their excitement at learning about the many edible plants in the Arboretum, as well as medicinal and other uses for plants. These interviewees tended to emphasize how the discussion of human connections and stories (Carleton or indigenous) changed their view of the Arboretum, and also stated most frequently that the guides made them feel more connected to the Arboretum. Though we are limited in our ability to compare interview responses across treatment groups due to our small sample size, it seems that those who had the ethnobotanical guides enjoyed and appreciated the emphasis on human connections to the natural environment, and that this kind of information both made the walks more engaging and made the Arboretum seem more important and relevant.

At the same time, though, most students who used the natural science and the ethnobotanical guides alike stated that for one reason or another they would not be likely to pursue more knowledge about Arboretum plants on their own. They suggested that the interactivity of guided walks or the convenience of informational signs might encourage them to learn more about the Arboretum.

Our interview results suggest that interest in botanical and ethnobotanical learning is prevalent among students, but that issues of convenience, time, and accessibility are critical barriers. We conclude that if there were an increased offering of guided walks and educational events, students would be eager to participate, and that these events should incorporate ethnobotanical information and inclusive human histories alongside ecological details. The walks should be geared toward specific and varied interest groups and should be actively publicized. There may also be interest in printed guides that students could use on their own, but these too

would need better publicity to reach more of the student body and overcome many students' unfamiliarity with the Arboretum as a resource. Given the results from our quantitative survey analysis, we cannot definitively say that more ethnobotanically-focused informational resources in these educational events would directly impact student engagement with the Arboretum. However we predict that including ethnobotanical perspectives would make the resources themselves more attractive to students, and in turn make the Arboretum a more visited and integrated part of campus life.

Our project provides the groundwork for expanded conversations about the role of culturally focused botanical knowledge at Carleton and in ecological restorations generally. Future researchers can look to this study for suggestions about where to locate ethnobotanical information related to the Arboretum, and for gaps in students' learning interests surrounding the Arboretum that have yet to be filled. The results of our study can be used to inform Arboretum management and publicity techniques and serve as a justification for greater incorporation of culturally inclusive ethnobotanical knowledge into science curriculums.

Study limitations

Despite our best efforts to normalize all aspects of this study, we faced many limitations in designing and conducting this experiment regarding participant recruitment, experimental treatment (walks and guides), and survey completion. Perhaps our biggest limitation is the short time frame of this study. We realize that a thirty minute walk through the Arboretum using a 10 page guide may be unlikely to override or change anyone's feelings about or knowledge of plants or natural landscapes that they have accumulated over their entire lifetime (of about 20 years in the case of this study). Additionally, although we tried to use unbiased recruiting methods, our participants likely represented somewhat of a self-selecting sample of students who were already inclined to take interest in the Arboretum and willing to visit the Arboretum in the winter.

We tried to standardize the guides as much as possible but, facing limits from our ethnobotanical sources, we ended up with a fair amount of variation in plants between the guides. Plants in the Carleton and Natural Guide largely overlapped, but there was not nearly as much overlap in the Dakota guide. Additionally, our guides included different proportions of different types of plants. For example, the Dakota Guide contained 6 trees, the Carleton guide contained 3 trees, and the natural science guide contained 2. This could be problematic considering how when one student was asked which plants stood out to her from the botany walk, she reported that "trees were not of so much interest." If other participants also had a bias against trees, or any other category of plant, this could have contributed to skewing our results in favor of one guide or another and confounded the effects of ethnobotanical variation. Additionally, some species were not visible in the winter so we put out images of the plant in the Arboretum. The low visibility and difficulty in distinguishing between plants in the winter in general also likely affected participants ability to recognize plants in the post-walk survey. Differences in timing and weather across the walks may also have also affected our experimental results. When conducting the walks, the length of the stop at each plant was not standardized within walks or between walks, with one participant commenting that her walk felt "rushed." There were also different numbers of people in each group and varied levels of conversation.

There were also some flaws in our post-walk survey that may have influenced our results. To begin with, not all participants completed the survey within the two-day time frame that we requested. We also think it is possible that simply going into the Arboretum had an effect on

people's happiness, regardless of the ethnobotanical variable, making likert-style Questions 5 through 11 ineffective as assessments of the effect of the guides. Another limitation is that the experience of looking at a plant in person is a lot different than looking at a photo on a webpage. This may have affected students' success at the photo identification portion of the survey.

Along these lines, we have some suggestions for future studies which attempt to gauge the educational benefits of ethnobotanical knowledge. We suggest a longer timeline, for example a series of walks that take place over a multiple week period or a workshop that takes place over the course of a term. We also suggest that this study be carried out in a season where more foliage is visible, in order for the plants to be more identifiable. It would also be beneficial to carry out this survey using guides that contained identical plants and in which group size for walks as well as extent of time of walks is standardized.

CONCLUSION

This study delved into the ethnobotanical connections to the Cowling Arboretum, unearthing both historical and current knowledge, and ultimately yielding some of Carleton's first ethnobotanical guides. By bringing to light a new realm of knowledge through guided botany walks, this project succeeded in raising interest and awareness among members of the Carleton community about the indigenous history of the Arboretum and its value as an ethnobotanical resource. We also found unexpected and previously unexplored faculty and student connections to the Arboretum and to indigenous communities. Our research found no statistically significant evidence that the integration of ethnobotanical information into higher education can impact student connection to the local landscape, retention of botanical information, or ecological behavior. Various limitations of our experimental design, including the short time frame of our study and lack of standardization amongst guides, likely contributed to our lack of significant results. Our interviews suggested, however, that students are eager to explore the Arboretum's ethnobotanical connections, as well as other topics such as its managment history, through additional opportunities for guided walks, organized events, and trail signage. We suggest refining and expanding on our methodology in order to further explore the importance of human connections to the Cowling Arboretum and continue Arboretum ethnobotanical studies.

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APPENDIX

Appendix 1:

Pre-participation questions:

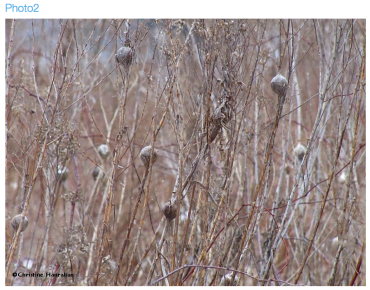
1. Engaging with the natural environment is the act of being in and actively participating in areas and settings produced by nature, such as woodland, hills, lakes, valleys, coastal area, mountains, rivers and forests. How, if ever, have you previously engaged with the Arboretum prior to this botany walk (for example through personal recreation, academics, social leisure, etc.)?
2. Generally throughout the year how often do you utilize the Arb?
    - At least once a week
    - At least once a month
    - At least once a term
    - At least once a year
    - Have not utilized the Arb
3. How, if ever, have you come to know the plants or ecosystems in the Arb? (ex. class, personal research, guided walks, etc.)
4. List up to five plants which are located in the Arboretum. If you cannot name any, simply leave this blank.
5. List up to five plants, not necessarily from this area, that can be used medicinally? If you cannot name any, simply leave this question blank.

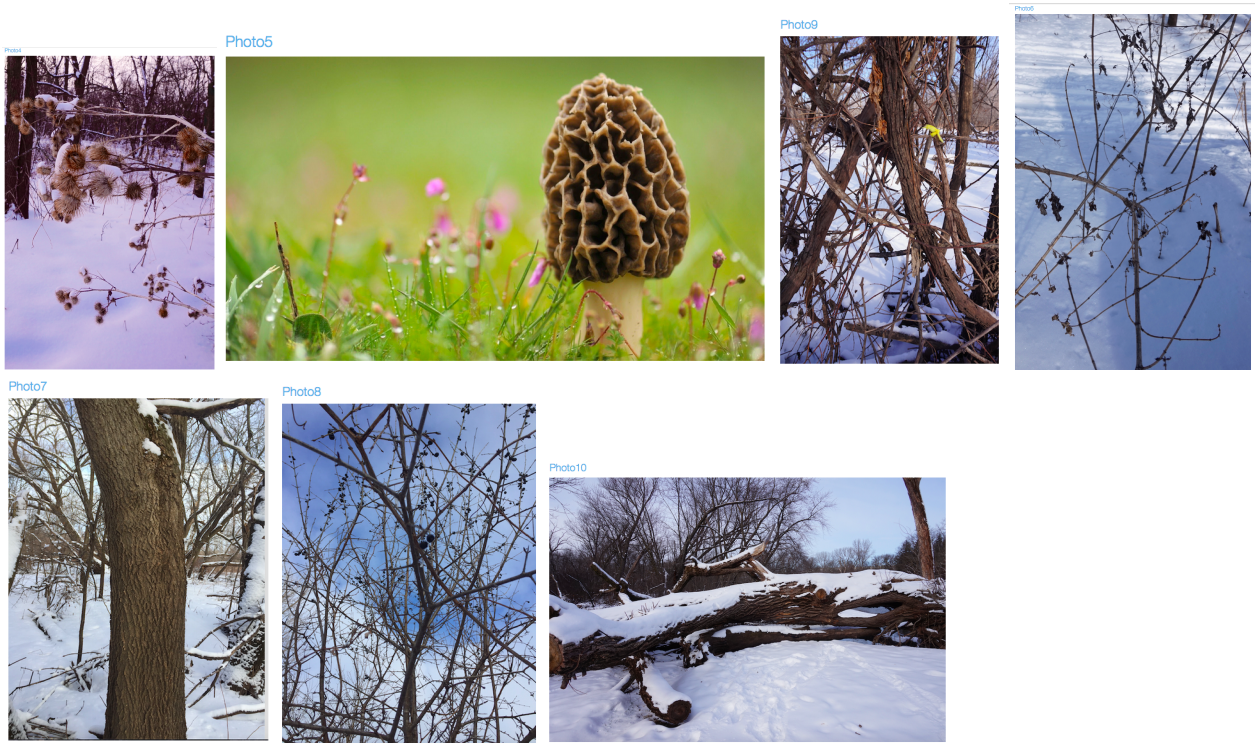
Appendix 2:

Post-walk survey:

1. What is your major (or prospective major)?
2. What is your ethnicity?
3. Using the following ten photos, please identify the corresponding plant species that you saw on the Arb walk (the common name is fine) based on the photo given. Fill in however many names you can remember, leaving the rest blank. Please do not change or go back to the questions in this section after continuing with the survey.

    (Version 1: Survey for Natural Sciences Guide):





(Version 2: Survey for Carleton Connections Guide):

Photo7

Photo8

Photo9

Photo10

(Version 3: Survey for Dakota Connections Guide):

Photo1

Photo2

Photo3

Photo6

Photo4

Photo5

Photo7

Photo9

Photo8

Photo10

4. **Please enter as much information about the listed plant as you can remember from the botany walk.**

(Version 1: Survey for Natural Sciences Guide)

1. Goldenrod (*solidago spp.*)
2. Smooth Sumac (*Rhus glabra*)
3. Common Burdock (*Arctium minus*)
4. Stinging Nettle (*Urtico dioica*)
5. Wild Grape (*Vitis riparia*)
6. Common Morels (*Morchella esculenta*)
7. Common Buckthorn (*Rhamnus cathartica*)
8. Black Walnut (*Juglans nigra*)
9. Black Raspberry (*Rubus occidentalis*)
10. Black Willow (Salix nigra)

(Version 2: Survey for Carleton Connections Guide)

1. Goldenrod (*solidago spp.*)
2. Smooth Sumac (*Rhus glabra*)
3. Common Burdock (*Arctium minus*)
4. Stinging Nettle (*Urtico dioica*)
5. Wild Grape (*Vitis riparia*)
6. Common Morels (*Morchella esculenta*)
7. Common Buckthorn (*Rhamnus cathartica*)
8. Eastern Cottonwood (*Populus deltoids*)
9. Black Raspberry (*Rubus occidentalis*)
10. Black Walnut (*Juglans nigra*)

(Version 3: Survey for Dakota Connections Guide)

1. White Cedar (*Thuja occidentalis*)
2. White Sage (*Artemisia ludoviciana*)
3. Boxelder or Ash-leaved Maple or Manitoba Maple (*Acer negundo*)
4. Redosier Dogwood (*Cornus service*)
5. Chokecherry (*Prunus virginiana*)
6. Black Willow (*Salix nigra*)
7. Hackberry (*Celtis occidentalis*)
8. Eastern Cottonwood (*Populus deltoids*)
9. Black Raspberry (*Rubus occidentalis*)
10. Rose (*Rosa spp.*)

Assess the truthfulness of the following statements as they apply to you on a scale of 1 (strongly disagree) to 7 (strongly agree).

5. Participating in the botany walk was refreshing.
6. Participating in the botany walk was relaxing.
7. Participating in the botany walk made me feel happy.

8. The botany walk made me aware of new uses for the Arboretum and its plants.
9. Participating in the botany walk increased my feeling of connection to the Arboretum. (A connection with the natural environment is the subjective experience of any emotional attachment to the environment as a whole or to specific features within it.)
10. After participating in the botany walk, thinking of natural environments like the Arboretum being destroyed makes me more sad than it did before.
11. The Arboretum is a valuable resource at Carleton.

Assess the truthfulness of the following statements as they apply to you on a scale of 1 (strongly disagree) to 7 (strongly agree). After participating in this botany walk…

12. I feel inclined to visit the Arboretum more frequently.
13. I am likely to share some of the information that I learned from my Arboretum guide.
14. Some of the information that I learned from my Arboretum guide feels relevant to my life.
15. I am interested in learning more about plants in the Arboretum.
16. I am likely to take advantage of published guides like the one I used to learn more about plants in the Arboretum.
17. I believe that biodiversity should be maintained in the Arboretum. (Biodiversity is the variety of plant and animal species in an environment.)
18. I am more likely to engage in Arboretum restoration projects.
19. What type of activity is most likely to attract you to the Arb? *Options: A guided tour about the history of the Arboretum; A field research project involving various ecosystems of the Arboretum; A workshop regarding the uses of Arboretum plants; A volunteer tree-planting activity; Other (please specify)*
20. What aspects of the Arboretum are you most interested in learning about further? Rank the following options on a scale of 1-3. *Options: History (natural or other); Uses of Plants and Plants in Culture; Ecology and other Scientific Research*

Appendix 3:

Triangulated coding chart for post-walk survey free-response questions:

0	1	2	3
- No response if other plants have responses - Inaccurate and irrelevant to any plant in the guide - Fact that was not from our guides	- Fact is accurate but general and pertains to a different plant from the guide - Fact is only partially accurate - Fact is accurate but very general or obvious from simply looking at the plant	- Fact is accurate and precise but pertains to a different plant from the guide - Accurate, pertains to plant, gets at something specific, but is lacking vocab from the guide	- Accurate and specific to plant, pertains to the right plant, using vocab from the guide, could not be easily observed on the tour

Appendix 4:

Table showing mean likert-style rankings for post-walk survey questions assessing ecological appreciation. Bolded p-values suggest weak trends:

	Mean Likert scale ranking						
	Participating in the botany walk was refreshing.	Participating in the botany walk was relaxing.	Participating in the botany walk made me feel happy.	The botany walk made me aware of new uses for the Arboretum and its plants.	Participating in the botany walk increased my feeling of connection to the Arboretum.	After participating in the botany walk, thinking of natural environments like the Arboretum being destroyed makes me more sad than it did before.	The Arboretum is a valuable resource at Carleton.
Natural science guide	6.08	5.64	5.88	5.00	4.80	4.28	6.80
Carleton ethnobotany guide	6.36	6.24	6.32	6.36	5.16	4.16	6.88
Dakota ethnobotany guide	6.41	6.05	6.36	5.36	5.09	4.27	6.73
ANOVA p-value	**p = 0.21**	**p = 0.215**	**p = 0.146**	**p = 0.352**	p = 0.516	p = 0.984	p = 0.752

Appendix 5:

Table showing mean likert-style rankings for post-walk survey questions assessing ecological behavior. Bolded p-values suggest weak trends:

	Mean Likert scale ranking						
	I feel inclined to visit the Arboretum more frequently.	I am likely to share some of the information that I learned from my Arboretum guide.	Some of the information that I learned from my Arboretum guide feels relevant to my life.	I am interested in learning more about plants in the Arboretum.	I am likely to take advantage of published guides like the one I used to learn more about plants in the Arboretum.	I believe that biodiversity should be maintained in the Arboretum.	1. I am more likely to engage in Arboretum restoration projects.
Natural science guide	4.56	4.60	3.36	5.36	4.08	6.80	4.36
Carleton ethnobotany guide	4.80	5.00	4.56	5.36	4.16	6.60	4.92
Dakota ethnobotany guide	4.73	4.32	3.41	4.73	4.41	6.14	4.27
ANOVA p-value	p = 0.766	p = 0.633	p = 0.849	**p = 0.231**	p = 0.583	**Standard deviations not similar enough*	p = 0.916

Appendix 6:

Chart showing summaries of Pre-Survey Informational Interviews:

Source	Guide	Information
Sean Sherman, Oglala Lakota food educator and CEO/founder of The Sioux	Dakota	Provided information on current indigenous foraging practices, as well as modern-day and historical Dakota culinary uses of several plant

Chef		varieties which are found in the Arboretum.
Mike Flynn, Professor of Linguistics, Carleton College	Dakota	Informed us on the current linguistics department project which is working with a nearby Dakota community to create a pedagogical guide for the endangered Dakota language
Darlene St. Clair, Professor of American Indian Studies, University of Minnesota- St. Cloud	Dakota	Provided Dakota ethnobotanical resources, provided a current Dakota perspect, revised our final Dakota guide
Dorene Day, Traditional Birther	Dakota	Gave insight into current Ojibwe ethnobotanical practices, specifically medicinal and ceremonial.
Michael McNally, Professor of Religion, Carleton College	Dakota	Provided indigenous ethnobotanical resources and connections to Dakota scholars
Tim Kenny, Ethnobotanist, University of MN Extension	Dakota	Provided indigenous ethnobotanical resources.
Don Hazlett, Ethnobotanist for the Denver Botanical Garden	Dakota, Carleton	Provided indigenous ethnobotanical resources and knowledge, as well as expertise on ethnobotanical methodology.
Julia Uleberg-Swanson, Dacie Moses Manager and adopted member of an Ojibwe family	Dakota, Carleton	Provided indigenous ethnobotanical resources and knowledge, as well as expertise on how ethnobotanical knowledge and practices are being utilized at Carleton medicinally, ceremonially, and for culinary purposes.
Connor Rohwer, member of Carleton Farm Club	Carleton	Relayed how Farm Club and House utilize Arboretum resources, specifically for culinary purposes.
Adam Rutkowski, member of Carleton Mycology Club	Carleton	Relayed how the Mycology Club utilizes Arboretum resources, specifically for culinary purposes.
Rinya Kamber, member of Carleton Holistic Healing Club	Carleton	Relayed how the Holistic Healing Club utilize Arboretum resources, specifically for healing and ceremonial purposes.
Charlotte Mann, member of Firebellies culinary club	Carleton	Relayed how the Holistic Healing utilizes Arboretum resources, specifically for healing and ceremonial purposes.

Cameron Shorb, former Carleton Naturalist	Carleton	Relayed how the Carleton Naturalists, Ecology Lab students, and students in general utilize Arboretum resources, specifically for healing and ceremonial purposes.
Stephen Mohring, Professor of Studio Arts, Carleton College	Carleton	Provided information on the relationship the Studio Art Department maintains with Arboretum management in order to make use out of Arboretum timber. Also gave insight into how this timber is used in sculpture and table-making classes.
Rebecca Hutchinson, Professor of Studio Arts, Carleton College	Carleton	Provided information on which Arboretum species can be/are used in papermaking.
Peter Balaam, Professor of English, Carleton College	Carleton	Provided information on the relationship of the English Department to the Arboretum and t his efforts to integrate the Arboretum into his curriculum in English classes, encouraging students to think poetically and critically about the Arboretum.
Nancy Braker, Director of the Cowling Arboretum	Natural	Provided a Natural Science expertise on the Arboretum's botanical composition.

Appendix 7:

Full length guides: Natural Science, Carleton Ethnobotany, and Dakota Ethnobotany:

CARLETON COLLEGE COWLING ARBORETUM

An Interpretive Guide to the Flora of the Arboretum

The Arboretum was first established in the 1920s and has taken a long and winding road to its current form as an 800 acre ecological restoration. The Arboretum was first established in the 1920s under President Cowling and with the help of groundskeeper Blake Stewart ("Stewsie") and botany professor Dr. Harvey Stork, and since then has taken a long and winding road to its current form. In the recent history leading up to the college's purchase of the land, various parts of the Arb were put to use as agricultural land, as industrial sites, and even as city dumps. Today, the arb is made up of both remnant and restored prairie, forest, savannah, and wetland ecosystems. The land is actively managed to maintain the habitats and native plant communities that characterize our local ecosystem.

As many people will testify, however, the Arb is much more than an ecological artifact. Stork's original vision for a tree museum has evolved to embrace three key Arboretum goals: Conservation (a vision to protect and restores native ecosystems), Education, and Recreation. It has has an extensive history serving as a diverse resource for students, faculty, and the local community. It has become a vital part of a liberal arts institution with a diverse student body dedicated to fields of study ranging from biology to archeology to music and personal pursuits ranging from cross-country skiing to holistic medicine to sculpture. It is only fitting that these 800 acres of land should become so integrated into the life and culture of Carleton.

This interpretive guide presents a small sampling of some of the Arb's charismatic plants. It is intended to contribute to your appreciation of the Arb as a place and as whole, as well as to each individual species in this list. We hope that you, as the reader, take your time learning about each plant, observing its physical presence, and allowing each piece of new information to shape and expand your understanding of the Arb's significance.

(1) Goldenrod (*Solidago* spp.)

Six species of goldenrod grow throughout the Arboretum and are easily recognizable by their long wood-like stems, on average 1 meter tall, which harbor marble-sized swollen lumps called galls. The galls are formed on the stems of goldenrod when flies deposit their eggs, effectively parasitizing the plants and prompting them to grow hard round casings around the eggs as a defense mechanism. Gall-making insect larvae receive protection from most predators and sustenance from the inside of the gall. There is a small beetles that specializes in burrowing into the galls and eating the maggot that inhabits it.[1]

Goldenrod is a perennial plant that reproduces through its roots, bulbs, stems and by its seed. It tends to crossbreed with other plants, leading to the continual production of new varieties. Although in the winter the species of goldenrod are not easily

[1] "Goldenrod," Great Plains Nature Center, last modified November 22, 2016, http://www.gpnc.org/goldenro.htm.

distinguished, when they bloom, the differently shaped yellow flowers can be used to differentiate the species of goldenrod. Goldenrod, with its bright yellow flowers, tends to be a popular site for insect breeding.[2]

(2) Smooth Sumac (*Rhus glabra)*

Smooth Sumac is one of the more common native shrubs in Minnesota. Sumac is mostly found in open prairie and on roadsides, as it prefers full to partial sun, and seldom reaches over 10-15 feet tall. Sumac is rarely found growing under a closed canopy.[3] Plants that are 3-4 years old produce fruits.[4] Sumac is recognizable by its hairless twigs that are green the first year and turn reddish brown the second, with scattered light brown lenticels (pores) and slightly flattened, hairy, berry-like drupes which turn deep red and may persist through winter.[5] Sumac can spread aggressively and persists by the formation of clonal offsets from its rhizomes, which also enable it to recover from occasional wild fires.[6] Sumac provides emergency food during the winter for wildlife such as birds, who eat the sumac fruit, squirrels and rabbits which eat the bark, and white-tail deer which like the fruit and stems.[7] Sumac seeds sometimes have better germination after passing through the digestive system of wildlife, or after a fire.[8]

When flowering, sumac is often visited by many types of bees and flies, as well as occasional butterflies or beetles. Carpenter bees construct nest by tunneling into the inner bark of broken twigs. The larvae of some types of butterflies and moths feed destructively on the foliage, wood, sap, and flowers of sumac.

(3) Black Raspberry (*Rubus occidentalis*)

This native plant is most recognizable in the winter by its purplish arching stems which grow up to 12 feet long and are scattered with very sharp prickles. Black raspberry is common throughout much of southern Minnesota, frequently seen along roadsides and hiking trails. The nectar of the flowers attracts many types of bees, as well as the occasional small butterfly or skipper (a small insect closely related to the butterfly). There are several insects that chew on the foliage or suck sap, including the caterpillars of various moths, spider mites and flea beetles, and leafhoppers. Some caterpillars and grubs even bore through canes or roots. The fruit provides important nourishment for many gamebirds and songbirds. The fruit is also occasionally eaten by raccoons, squirrels, and chipmunks, while rabbits and deer chew on the foliage and stems.[9] Unlike the fruit of blackberry plants with their cylindrical white center, the fruit of the black raspberry has a hollow center, just like red raspberries.

[2] Great Plains Nature Center.
[3] "Smooth Sumac Plant Fact Sheet," USDA, https://plants.usda.gov/factsheet/pdf/fs_rhgl.pdf.
[4] "Smooth Sumac; Trees, Shrubs, and Woody Vines of Illinois," Illinois Wildflowers, last modified August 24, 2017, http://www.illinoiswildflowers.info/trees/plants/sm_sumac.htm.
[5] "Rhus glabra (Smooth Sumac)," Minnesota Wildflowers, last modified 2017, https://www.minnesotawildflowers.info/shrub/smooth-sumac.
[6] Illinois Wildflowers.
[7] USDA.
[8] USDA.
[9] "Black Raspberry (Rubus occidentalis), Wildflowers of Illinois in Savannas and Thickets," Illinois Wildflowers,

(4) Common Burdock (*Arctium minus*)

Identifiable by its thistle-like flower heads and rounded hairy leaves which grow up to 2 feet long and over a foot wide, common burdock is an invasive weed from Europe which is now likely in every Minnesota county.[10] Its massive taproot (deep straight root) does not respond well to herbicide control, and it has a persistent seed bank. Burdock may often be confused with rhubarb, which has similar leaves.

Common burdock is often found in full or partial sun on woodland edges, roadsides and other open areas.[11] The flowerheads, which are green with accented with pink or purple when they bloom in midsummer to early fall, turn brown in the fall, forming a burr. Humans and animals unwittingly disperse the seed far and wide, as the burrs cling readily to fur and clothing and are difficult to remove. The flowers are pollinated primarily by long-tongued bees. The bitter-tasting foliage is not generally eaten by mammalian herbivores, unless nothing else is available, and may even be poisonous to rabbits.

(5) Black Walnut (*Juglans nigra*)

Black walnut is a long-lived and fast growing tree that populates the early successional upland forests of the Arboretum and is also a common sight closer to campus. A black walnut tree typically takes about 150 years to mature. While it is highly shade intolerant when young, it can persist in dense forest as a mature tree. Black walnut produces a toxin known as juglone which inhibits the growth of other plants around it. Its naturally occurring range encompsses much of the midwest-eastern United States.

The trees have large compound leaves that emit an acrid "walnutty" smell when crushed, and crosshatch-patterned bark that changes to a knobby texture as it matures. The only walnut native to this area, black walnut produces edible hard-shelled nuts that are a favorite food of red and gray squirrels, and people with enough patience and strength to collect and crack the nuts. The nuts ripen between September and October at which point their yellow-green corrugated husks become a deep brown. This species relies on squirrels and other wildlife for seed dispersal; after being buried for winter storage in open areas, some nuts are forgotten and allowed to sprout the next spring or the spring after. [12]

(6) Stinging Nettle (*Urtica dioica)*

Stinging Nettle is a native understory plant and is dominant and widespread throughout much of the country. It can grow up to 6 feet tall and may be found in a variety of habitats: shaded or sunny, wet fields, ditches, or open woods. As the plant takes well to disturbed areas, it is liable to become weedy or invasive in many areas.[13] Nettle blooms from June through August, each plant with a mix of separate male and female flowers, cream colored and clustered densely along the length of the stems.[14] The leaves of the

[10] "Arctium minus (Common Burdock)" Minnesota Wildflowers, last modified 2017, https://www.minnesotawildflowers.info/flower/common-burdock.
[11] "Common Burdock, Weedy Wildflowers of Illinois," last modified 2016, http://www.illinoiswildflowers.info/weeds/plants/cm_burdock.htm.
[12] "Black Walnut Plant Fact Sheet," USDA, last modified February 5, 2002, https://plants.usda.gov/factsheet/pdf/fs_juni.pdf.
[13] "*Urtica dioica* L. stinging nettle," USDA, accessed January 2017, https://plants.usda.gov/core/profile?symbol=urdi.
[14] "Urtica dioica (Stinging Nettle)," Minnesota Wildflowers, last modified 2017, https://www.minnesotawildflowers.info/flower/stinging-nettle.

plant are heart-shaped and have toothed edges. The plant is perhaps most well-known for the stinging sensation it produces upon contact with bare skin; the bristly hairs covering its stalk and filled with formic acid cause an instant burning and often incite a mild rash which can last for a few hours.

(7) Wild Grape (*Vitis riparia*)

Wild grape grows as a woody perennial vine and can be found wrapping its curly tendrils around many trees and shrubs throughout the Arboretum. The forking tendrils coil themselves around anything they can get a hold of, allowing the vines to climb other plants and reach up to 50 feet in length.[15] While new growth on vines can be quite thin and fragile, the woody stems may be multiple inches thick and covered in shaggy bark.[16] If growth is not limited by the shade of old-growth forest, wild grape can spread out into dense thickets and shade out or smother other plants (and even small trees), often becoming a problematic invasive.[17] Also known as the riverbank grape, *Vitis riparia* grows extremely well in the elevated light of forest edges and in disturbed areas such as roadsides and trail edges.

The fruiting season of wild grape is a short one but the sour-sweet fruit of are a major source of both food and shady cover for birds, insects, and a number of mammals including skunks, opossum, and raccoons.[18] While they do not eat the grapes, white-tailed deer and cottontail rabbit will sometimes forage on the foliage and tender stems of the vines.[19]

(8) Common Morels (*Morchella esculenta*)

Morel mushrooms can be found popping up around the Arboretum during the spring, typically around dead elms and other deciduous trees and disturbed woodland areas. Their slender canopies have a honeycombed structure that, along with their hollow interiors, makes them easily identifiable. Like other mushrooms, morels have a mycorrhizal phase during which they exist underground as thin highways of sorts in symbiotic relationships with pine, spruce and other conifers.[20] Their fruiting season then is extremely short, typically just 2-3 weeks in the spring.

(9) Common Buckthorn (*Rhamnus cathartica*)

Buckthorn is not native to Minnesota but has nonetheless established a powerful presence in the Arboretum. First brought to Minnesota from Europe in the Nineteenth Century, Buckthorn has become rampantly invasive throughout much of the United States and Canada, growing in dense, monospecific thickets that easily crowd out other understory plants and can be self-perpetuating.[21][22]

[15] "Riverbank Grape; Trees, Shrubs, and Woody Vines of Illinois," Illinois Wildflowers, last modified August 24, 2017, http://www.illinoiswildflowers.info/trees/tree_index.htm#rb_grape.
[16] Illinois Wildflowers
[17] "Vitis riparia (Riverbank Grape)," Minnesota Wildflowers, last modified 2017, http://www.chicagomanualofstyle.org/tools_citationguide.html.
[18] Minnesota Wildflowers
[19] Illinois Wildflowers
[20] "Morchella esculenta (common morel), Discover Plants and Fungi," Kew Botanical Gardens, accessed January 2017, http://www.kew.org/science-conservation/plants-fungi/morchella-esculenta-common-morel.
[21] "Invasive terrestrial plants," Minnesota DNR, last modified 2017, http://dnr.state.mn.us/invasives/terrestrialplants/woody/buckthorn/index.html.

Though classified as a shrub, buckthorn can grow to be up to 20 feet tall and 10 inches in basal diameter, producing small dark berries that are then eaten and dispersed by birds. The laxative effect induced by the berries helps to make animal seed dispersal more efficient and effective. While buckthorn will invade young restorations and open forests, it is less able to invade mature, dense-canopied forests such as Best Woods. Despite ongoing removal efforts, many areas of the Arb remain covered by dense buckthorn. Complete removal of this species may be an eventual possibility but remains a very long-term goal at present.

(10) Black Willow (*Salix nigra*)

All willow species prefer wet soil, and the willows in the Arb are no exception. Large willows can be found immediately adjacent to the Cannon River and Spring Creek, often leaning out over the river. The estimated life span for black willow averages 65 years with a range of 40 to 100 years. Older trees tend to rot out inside, eventually toppling but remaining alive at the base. One such example is the toppled tree where the trail into the lower arb meets the canon river that marks a popular spot to start tubing during warm weather. Willows have deeply furrowed bark, short, stout trunks that often branch near the base, and narrow, serrate-margined, lance-shaped leaves.

One of the greatest conservation services of the willows is as a soil-binder. Growing along the banks of countless streams, their fibrous roots help to prevent the soil from being washed away. Willow has been planted frequently to help stabilize the banks of eroding streams, to hold the soil in road cuts and embankments, and to bind shifting sands. Black willow's dense root system is excellent for stabilizing eroding lands.

The willows are also important to some wildlife. They are among the first plants to provide honey bees, after long winters, with nectar and pollen. Domestic grazing animals browse in willow thickets. Elk and beaver browse on willow leaves in the summer and willow twigs in the winter. Willow shoots are common food of beaver, hares, and rabbits. Black willow and other willows are host plants for Viceroy and red -spotted purple butterflies.[23]

[22] "The Buckthorn Menace: The only tree without a reflection," Carleton College, last modified September 12, 2007, https://apps.carleton.edu/campus/gallery/buckthorn/what/.

[23] "Black Willow Plant Guide," USDA, last modified June 2010, https://plants.usda.gov/plantguide/pdf/pg_sani.pdf.

CARLETON COLLEGE COWLING ARBORETUM

An Interpretive Guide of Student and Faculty Connections to Arboretum Flora

The following descriptions represent the culmination of our efforts to dig deep into the dense web of human connections surrounding the Cowling Arboretum. The Arboretum was first established in the 1920s under President Cowling and with the help of groundskeeper Blake Stewart ("Stewsie") and botany professor Dr. Harvey Stork, and since then has taken a long and winding road to its current form. It has has an extensive history serving as a diverse resource for students, faculty, and the local community and is much more than an ecological restoration, as many will attest to. Stork's original vision for a tree museum has evolved to embrace three key Arboretum goals: Conservation (a vision to protect and restores native ecosystems), Education, and Recreation. The 'Arb' has become a vital part of Carleton with its diverse student body dedicated to fields of study ranging from biology to archeology to music and personal pursuits ranging from cross-country skiing to holistic medicine to sculpture. It is only fitting that these 800 acres of land should become layered with such a rich range of memories, creative uses, discoveries, artistic endeavors, and understandings, and that the Arb should become so integrated into the life and culture of Carleton.

Through a series of on-campus interviews, we have begun to catalogue the myriad connections students and faculty have made to specific plants within the Arboretum, some obvious and some surprising. These findings contribute to our appreciation of the Arb as a place and as whole, as well as to each individual species in this list. We hope that you, as the reader, take your time learning about each plant, observing its physical presence, and allowing each piece of new information to shape and expand your understanding of the Arb's significance.

(1) Goldenrod (*Solidago* spp.)

Six species of goldenrod grow throughout the Arboretum and are easily recognizable by the marble-sized galls prevalent on their stems. These galls are formed when gall flies deposit their eggs, effectively parasitizing the plants and prompting them to grow hard round casings around the eggs as a defense mechanism. Although in the winter the species are not easily distinguished, when they bloom in the spring the differently shaped yellow flowers can be used to differentiate the species of goldenrod.

Goldenrod has served as a regular subject of study for students in winter offerings of introductory biology. As part of the lab component, students collect the galls, extract the living larvae, homogenize them, and conduct a genetic analysis of the DNA! Because this recurring gall project has been a common experience for so many freshmen and sophomores cycling through Carleton, professors in other departments have found it to be a useful point of reference. In his English classes, for instance, Professor Peter Balaam often points to the goldenrod galls when trying to get his students to think poetically and imaginatively about the notion of homes, nests, and habitation in the Arboretum.

(2) Smooth Sumac (*Rhus glabra)*

Smooth Sumac is one of the more common native shrubs in Minnesota, mostly found in open prairie and on roadsides. It is

recognizable by its hairless twigs that are green the first year and turn reddish brown the second, and also by its slightly flattened and hairy berry-like drupes which turn deep red and may persist through winter.[1] The sumac berries are a nice seasonal indicator, as they are one of the first things to turn brilliant red as the summer ends and fall begins.

The berries of this particular sumac species are not poisonous, and are in fact very high in Vitamin C due to the high concentration of ascorbic acid in the red covering over the seed clusters.[2,8] When walking in the Arb, you might try grabbing some berries and sucking on them for a few seconds. Although the berries are somewhat fuzzy and tough, their citrusy, lemony taste can provide an enjoyable treat. Students conducting summer ecology research in the Arboretum have found their tanginess to be a great way to rejuvenate and refresh their senses while working in the heat.[3] If you get them at just the right time of summer before the first rain, you can crush them into water to make a sort of pink lemonade (or more accurately, pink sumac-ade). Firebellies club, for example, made a scrumptious sumac lemonade for their "Love at First Bite," set-up-your-roommate restaurant.[10,4,8]

(3) Black Raspberry (*Rubus occidentalis*)

This native plant is most recognizable in the winter by its purplish arching stems which grow up to 12 feet long and are scattered with very sharp prickles. Black raspberry is widespread throughout much of southern Minnesota, frequently seen along roadsides and hiking trails. Common in the Upper Arboretum, especially near Spring Creek they also thrive all along the black-topped road that leads through the Upper Arb from 2nd St to the Rec Center and downhill to the tunnel beneath Hwy 19.[5]

Many of Carleton's nature enthusiasts look for this plant when they are on walks through the Arb, eating the fruit whenever they see it (an activity called "black cap picking"). The fruit is tasty, turning a deep blue-black with only the faintest hints of red when ripe, but quite tart until then.[15] Children on family walks are encouraged to spot, pick and eat them--a good first lesson in dealing with thorny brambles, as the plant can certainly be prickly! Additionally, the summer farm interns have been known to procrastinate from doing their work by indulging in the berry-goodness of black raspberries.[6] These little forest treats have also often turned students in Dan Hernandez's lab groups into berry-obsessed squirrels, scurrying around hunting for berries amidst hoards of mosquitos.[15]

Their peak ripeness starts in late July, lasts through the later half of mid-summer, and is generally over in September. There is always an element of surprise to the taste as its unpredictable whether a berry will be tart, sweet, sickly sweet, or tangy from fermentation on the branch. This guess work in picking berries is all part of the fun though.[7]

To observant Arb walkers, black raspberries seem to tell the time of year: as black caps are done mid-summer is turning into late summer. They are just one more natural species to sound that note: school time! After leaves have fallen in the autumn and when slicked with rain, the leafless brambles of the black raspberry color

[1] Minnesota Wildflowers
[2] Uleberg-Swanson, Julia. Interview. 15 Jan. 2017.
[3] Shorb, Cameron. Interview. 12 Jan. 2017.
[4] Mann, Charlotte. Interview. 26 Jan. 2017.
[5] Balaam, Peter. Interview. 9 Jan. 2017.
[6] Rohwer, Connor. Interview. 3 Jan. 2017.
[7] Shorb, Cameron. Interview. 12 Jan. 2017.

the Arb understory with arcs of deep shiny maroon and, at times or in places, an exotic powdered blue that dazzles before the backdrop of buff colored leaf mould.[8]

(4) Common Burdock (*Arctium minus*)

Identifiable by its thistle-like flower heads (also called burrs) and its rounded hairy leaves which grow up to 2 feet long and over a foot wide, common burdock is an invasive weed from Europe which is now likely in every Minnesotan county.[9] Its massive taproot (a central, deep straight root) does not respond well to herbicide control, and it has a persistent seed bank. Common burdock is not to be confused with rhubarb, which has similar shaped leaves that lack the hairy underside of the common burdock.

Carleton students at Farm House have used common burdock for steam pit cooking, as burdock leaves are good for wrapping vegetables, fish, or meat to put in a fire pit.[10] Students have also used the large leaves as plates. The root of the plant can also be harvested and consumed. Once a common burdock is a year old, the massive taproot can be chopped up, roasted, and steeped to make tea that is similar in flavor to coffee.[13] The burrs, which attach to clothing, animal fur, and anything that passes by, can be thrown on people for a laugh, meanwhile spreading the seed of this invasive plant far and wide in an ignorant act of mirth. Be careful though, handling the burrs extensively can cause skin aggravation!

(5) Stinging Nettle (*Urtica dioica)*

Stinging Nettle is an understory plant and is dominant and widespread throughout much of the country. It can grow up to 6 feet tall and may be found in a variety of habitats: shaded or sunny, wet fields, ditches, or open woods. The plant is perhaps most well-known for the stinging sensation it produces upon contact with bare skin; the bristly hairs covering its stalk are filled with formic acid and cause an instant burning upon contact, leading to an irritating rash that can last up to a few hours.[11]

Despite this negative association from which its common name stems, when handled correctly stinging nettle has a variety of medicinal and culinary uses. Farm House students have used stinging nettle as a hearty vegetarian side dish high in protein. Once the stalk has been boiled long enough, the spines become limp and the stalk can be eaten as a filling vegetable with a beefy or umami quality to its taste, especially delicious when seasoned with soy sauce, ginger, and garlic.[12] It is also often baked into a hearty bread! Additionally, tea made from dried nettle leaves is known to be an excellent detoxifier and good for the liver.

(6) Black Walnut (*Juglans nigra*)

Black walnut is a long-lived and fast growing tree that populates the early successional upland forests of the Arboretum and is also a common sight closer to campus. It is the only walnut tree native to this area and is recognizable by the dark, hard-shelled nuts it produces.

Black walnut is a staple hardwood in Professor Stephen Mohring's sculpture classes. It is admired for the deep, dark color it takes on when oiled and is a favorite for table making. Walnut is

[8] Balaam, Peter. Interview. 9 Jan. 2017.
[9] Minnesota Wildflowers
[10] Shorb, Cameron. Interview. 12 Jan. 2017.
[11] Minnesota Wildflowers
[12] Shorb, Cameron. Interview. 12 Jan. 2017.

just one of many types of wood that sculpture students source from the Arboretum, however. Other trees that often make it into the faculty-operated and student-staffed sawmill of the sculpture studio include hardwoods such as Cherry, Maple, Oak, Elm, and Ash, as well as occasional softwoods such as Cedar and Spruce. Sourcing lumber from the Arboretum, though labor intensive, makes good use of trees that are already being removed as part of restoration efforts. Just as importantly, it gives sculpture students a chance to engage more fully with the harvesting process, and to interact with their materials as local and living resources rather than simply purchased commodities. The growing collaboration between the sculpture studio and the Arboretum is part of a larger effort to supplement sculpture classes with more information about the biology, growth, and harvesting factors that come before trees are processed. For example, did you know that for Maple and some other trees subjection to variable wind may affect the grain patterning of the wood?![13]

(7) Eastern Cottonwood (*Populus deltoids)*

In the winter, the thick, deeply furrowed brownish-gray bark is the most recognizable feature of eastern cottonwoods.[12] This fast-growing tree is native to Minnesota but has a wide range throughout the country. Out of the native trees in the Arb, cottonwoods are the largest, growing up to 100 feet in height and seven feet in diameter.

The highly fibrous inner bark of cottonwood has been used by Carleton students to make string, rope, and to start fires.[13] When you find a dead log, you can pull away the corky outer bark to reveal the dry stringy inner bark which you can then peel out in big strips. Rubbing these together will help to separate the fibers. If not being woven into string, the fibers can serve as a perfect little tinder bundle to start a fire. With extremely soft wood, eastern cottonwood is also good for making a fire-starting device called a bowdril: wrap a string around a wooden spindle, then use another stick to spin the spindle and superheat it.[13]

(8) Wild Grape (*Vitis riparia*)

Wild grape vines can be found wrapping their curly tendrils around many trees and shrubs throughout the Arboretum. There is a short window to pick wild grapes as they are often sour until after a frost and then quickly turn sweet-tart. However their culinary uses are numerous. In addition to simply being eaten right off the vine, students and staff have made them into jelly and wine. The fruit of wild grape plants are not to be confused with the fruit of moonseed which is similar, and poisonous. The leaves of moonseed are not toothed, like those of wild grape, and the fruit has a single seed inside, whereas wild grape has multiple seeds.[14]

A lesser known use for the highly fibrous grapevines around the Arboretum is papermaking. Students in a Winter 2017 offering of a Studio Art class on sustainable papermaking are using grapevines harvested from the Arboretum. To make paper, the vines are first boiled down in a caustic solution to remove everything but the most basic form of fiber in the plant, cellulose. What remains after hours of boiling is then beaten to a beige or brownish pulp at which point it can be not only made into paper, but also added to clay, or even used to paint with. While any fibrous plant or peeling bark can be converted to pulp (cattails, pine needles, horsetails to name a few in the Arboretum), grapevines have some of the highest fiber content and thus represent one of the toughest and most resilient plants to work with as a papermaker. The intensive labor

[13] Mohring, Stephen. Interview. 6 Jan. 2017

[14] Minnesota Wildflowers.

required to break down grapevines makes them an unpopular choice in commercial paper production. For papermaking students at Carleton, however, using wild grapes and other native plants offers an opportunity to take advantage of local materials and consider not only the final product of their artwork but also the ties they have made to local ecosystems.[15]

(9) Common Morels (*Morchella esculenta*)

Morel mushrooms can be found popping up around the Arboretum during the spring, typically around dead elms and other deciduous trees. Their slender yellowish brown canopies have a honeycombed structure that, along with their hollow interiors and whitish or pale tan stems, makes them easily identifiable.[16] Some have likened them to inverted pinecones.

Though they cannot be eaten raw due to the presence of a toxin, cooking Morels makes them safe to eat and brings out a strong and distinct savory flavor. They are one of the most valued mushrooms for cooking with, and are one of a number of edible fungi that grow around the Arboretum. Here at Carleton, Farm House residents and members of the Mycology Club frequently cook with morels. The fruitbodies are considered quite nutritious, containing high-quality protein, and being rich in minerals and low in calories.[17]

(10) Common Buckthorn (*Rhamnus cathartica*)

Buckthorn is not native to Minnesota but has nonetheless established a powerful presence in the Arboretum. First brought to Minnesota from Europe in the Nineteenth Century, it has become rampantly invasive throughout much of the United States and Canada, growing in dense thickets that easily crowd out other understory plants.[18] Though classified as a shrub, buckthorn can grow to be up to 20 feet, producing small dark berries that are then eaten and dispersed by birds (Arb guide). In the Arboretum, buckthorn has been the disproportionate focus of regular removal efforts, bringing together Carleton students as well as Northfield community members. Much of the student Arb crew's time is spent cutting down and uprooting--in other words "battling"--the shrub. Retired Arb Manager Myles Bakke has been spotted sporting a "Die Buckthorn Scum" t-shirt and once wrote that he considers buckthorn to be "the floral equivalent of the antichrist."

In 2007, Minneapolis artist and St. Olaf alum Jim Proctor directed the construction of an art installation in the Arb meant to raise community awareness around the ecological impacts of the invasive plant. The project, titled "The Buckthorn Menace," enlisted students and volunteers from around Northfield to pull and collect buckthorn around Carleton and St. Olaf and then assemble the dense webbing roots into giant structures imitating another, much more familiar invasive weed: dandelions. The installation stood in the upper Arb (near Bell Field) for a full year, alluding to how buckthorn is an invasive that is just as prevalent as dandelions, though simultaneously much less visible in the public eye and much more detrimental.[19]

[15] Hutchinson, Rebecca. Interview. 16 Jan. 2017.
[16] Kuo, M., & Methven, A. (1900). Mushrooms of the Midwest.
[17] Kew Botanical Gardens

[18] MN DNR; Myles Bakke piece
[19] Carleton Press Releases; The Buckthorn Menace

CARLETON COLLEGE COWLING ARBORETUM

An Interpretive Guide to Dakota Connections to Arboretum Flora

Prior to colonization, the Cowling Arboretum was part of the Oceti Šakowiŋ, or the Seven Council Fires, territory.[1] All bands in this political-social organization, including Dakota, Nakota, and Lakota spoke closely related dialects of the same language (St. Clair, USDakotaWar.org).[2][3] The two bands that lived in our area specifically for thousands of years prior to colonization spoke Dakota: the Bdewakaŋtoŋwaŋ (Mdewakanton, The Spirit Lake People) and the the Waȟpekute (Wahpekute, The Shooters Among the Leaves People).

Beginning with the Fort Laramie Treaty of 1851, Colonization of Dakota land 'Mni Sota Makoce' consisted of a series of treaties in which Dakota ceded land in exchange for promised government annuity payments, which often did not come to fruition. The starving Dakota led a rebellion that escalated into the Dakota war. The mass execution that followed the short-lived Dakota war in 1862 became the largest organized execution in American history. During the winter of 1862 to 1863, the Dakotas who surrendered--mostly women, children, and the elderly--were incarcerated in a concentration camp at the foot of Fort Snelling where they suffered sickness and assault, resulting in high mortality rates. The following spring, most Dakotas were exiled from the state and sent to reservations in the West.[4][5] This tragic event is emblematic of the disregard for native ecological values and landscapes that accompanied European colonization. While it is true that Dakota culture and lifestyles have been profoundly disrupted during the last centuries of colonization, it is important to recognize that the Dakota Nation lives on today.

The majority of our guide is based on ethnobotanical information derived from the Dakota, however, we have also drawn some information from tribes near our area. The Ojibwe tribe is oriented in the more forested areas north of us and the Lakota (Tituŋwan or Teton, Dwellers of the Plains) are another band of the Seven Council Fires located to our West in South Dakota.

(1) White Sage *(Artemisia ludoviciana)*

Artemisia ludoviciana, one of a couple sage species that can be found in the Arb, is a white-wooly herb with small tight greenish clusters of flowers near the ends of the stems. Sage, like cedar, belongs to the group of four sacred plants used by the Dakota and other Plains tribes for medicinal and ceremonial purposes, and is an important plant for cleansing and healing. There are both 'male' (A*rtemisia ludoviciana*) and 'female' sage (*Artemisia frigida)* varieties of sage[6]; the sage present in the Arboretum is the 'male'

[1] The Oceti Šakowiŋ peoples, the Dakota, Nakota, and Lakota, were deemed the Sioux Nation by French traders, however, many Dakota do not support this terminology.

[2] Darlene St. Clair. Interview. 26 Jan. 2017.

[3] "Oceti Šakowi?: The Seven Council Fires." *The US Dakota War of 1862*, Minnesota Historical Society, www.usdakotawar.org/history/dakota-homeland/oceti-%C5%A1akowi%C5%8B-seven-council-fires. Accessed 25 Jan. 2017.

[4] Mike Flynn, Interview, 10 Jan. 2017.

[5] "Historic Fort Snelling: U.S.-Dakota War of 1862." *Minnesota Historical Society*, www.historicfortsnelling.org/history/us-dakota-war.

[6] Don Hazlett, Interview, 3 Jan. 2017.

variety. White sage, or 'male' sage, is often burned in the form of a smudge stick, a tightly tied bundle of sage. This helps to clear any sadness or other negative energy from the general setting and anyone present. When smudging, a participant either uses their own hands or a feather to wash the sage smoke over themselves, making sure it reaches the body, heart, head, and hair.

Brewed into a tea, sage can aid as a decongestant or to remedy stomach trouble,[7] and the female variety (*Artemisia frigida)* in particular can help a woman's milk dry up after pregnancy and during the process of weaning or to regulate one's menstrual cycle.[8] [9] Due to its importance as a ceremonial and medicinal herb for Dakota and Ojibwe tribes, it has been over-harvested in areas close to the Twin Cities where it is an important resource for the Dakota communities who live there.[10]

(2) Rose (*Rosa spp*.)

Rose blooms from June through July in Minnesota, and can get grow to be 4 to 7 feet tall. Also known as prairie rose, the plant can be used to flavor foods and teas and is regarded as beneficial for the "emotional heart." The rose hips in particular are high in nutrients, especially vitamin C. The fruits have been used by some tribes to help tide people through a period of winter scarcity.[11]

Dakota, and other Native American tribes, think of various plants and animals as having their own songs or stories. The following is an English translation of a Dakota story about the prairie rose. It was taken from *Prairie Smoke*, published in 1929 by ethnobotanist Melvin Gilmore:

The prairie was gray and drab, no beautiful flowers brightened it, it had only dull greenish-grey herbs and grasses, and Mother Earth's heart was sad because her robe was lacking in beauty and brightness. Then the Holy Earth, our Mother, sighed and said: "Ah, my robe is not beautiful, it is somber and dull. I wish it might be bright and beautiful with flowers and splendid with color. I have many beautiful, sweet, and dainty flowers in my heart. I wish to have them upon my robe…."

...Then a sweet little pink flower said, "Do not grieve, mother. I will go upon your robe and beautify it." So the little pink flower came up from the heart of Mother Earth to be upon the said prairie of her mother's robe.

Now, when the Wind Demon saw the pink flower there, he said, "Indeed she is pretty, but I will not have her trespassing in my playground." So the Wind Demon rushed at her, shouting and roaring, and blew out her life, but her spirit returned to the heart of Mother Earth. And when the other flowers ventured, one after another, to come out upon the prairie, which was Mother Earth's robe, the Wind Demon destroyed them also...

At last Prairie Rose offered to go and brighten the appearance of Mother Earth's robe, the prairie. Mother Earth said fondly, "Yes, dear, sweet child, I will let you go… So Prairie Rose made the toilsome journey up through the dark ground and came out upon the sad gray prairie. …

Now, when the Wind Demon saw Prairie Rose, he rushed at her, shouting, and said, "Indeed, though she is pretty, I shall not

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[7] Julia Uleberg Swanson, Interview, 15 Jan. 2017.
[8] Dorene Day, Interview, 16 Jan. 2017.
[9] Melvin Rose Gilmore (1919). Uses of Plants by the Indians of the Missouri River Region. Bureau of American Ethnography, Annual Report 33, pp. 43-154. Washington, D.C.
[10] Swanson, Interview.
[11] Swanson, Interview.

allow her to be upon my ground. I will blow out her life." So he came on, roaring and drawing his breath in strong gusts. Just then he caught the fragrance of the breath of Prairie Rose. "Ah," he said, "how sweet her breath is! Why, I do not have it in my heart to blow out the life of such a beautiful little maiden whose breath is so sweet!... I must make my voice gentle and sing a melodious song, for I wish not to frighten her with my awful noise."

So he became quiet and breathed gentle breezes which passes over the prairie grasses whispering and humming little songs of gladness. Then the other flowers came up through the dark ground and out upon the dull gray prairie and made it bright and joyous with their presence. And the wind came to love all the flowers and all the grasses.

And so the robe of Mother Earth became beautiful because of the loveliness and sweet breath of Prairie Rose. Sometimes the Wind forgets his gentle songs and becomes loud and boisterous, but he does not harm a person whose robe is ornamented with the color of Prairie Rose.

(3) **Black Raspberry (*Rubus occidentalis*)**

This native plant is most recognizable in the winter by its purplish arching stems which grow up to 12 feet long and are scattered with very sharp prickles. Black raspberry is widespread throughout much of southern Minnesota, frequently seen along roadsides and hiking trails. Dakota, along with all plains tribes, ate, and continue to eat, raspberries fresh in season or dried them for the winter. Young leaves can also be steeped into a tea like beverage. Raspberry root is also chewed to treat coughs by other native american tribes.

(4) Eastern Cottonwood *(Populus deltoides)*

The eastern cottonwood is the largest tree native to this area, often achieving a trunk diameter of seven feet or greater and a height of 100 feet. For the Dakota, the eastern cottonwood is a symbol of fidelity and is used as the central object in the religious ritual of the sundance.[12] The sundance is one of the most traditionally important ceremonies practiced by the Dakota, allowing participants to achieve renewal and cleansing. It requires men to make a sacrifice by dancing for hours circling around the cottonwood, attached to the truck by a bone piercings with a leather extension. With the passing of the Native American Religious Freedom Act in 1978, the dance has been widely practiced in many forms.[13] Additionally, the inner bark of young sprouts has been eaten by the Dakota, prized for its sweet taste and high nutritional value. The value of young cottonwood branches for horse forage was also commonly known among the Dakota peoples, European trappers, and travelers alike, said to be "good for them as oats." [14]

(5) Boxelder or Ash-leaved Maple or Manitoba Maple (*Acer negundo*)

Identifiable by the blocky, vertical ridges and furrows in its bark, this large cold-hardy native tree has been tapped by the Dakota and its sap used to make a sweet syrup and sugar (Gilmore). As the sweeter sugar maples more commonly used for syrup do not

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[12] Gilmore, 1919.
[13] St. Clair, Darlene. Interview.
[14] P. Munson, (1981). Contributions to Osage and Lakota Ethnobotany. Plains Anthropologist, 26(93), 229-240.

grow in prairie regions, boxelders, which are prevalent in prairies, offered an important alternative sap source.[15] With sap that flows throughout the entire winter, boxelders have helped provide nourishment and tide people through the ends of winters when supplies ran low. The Ojibwe to the north knew when the maple sap would start freely flowing in the late winter and early spring when eagles and crows started to return to Minnesota from their winter grounds.[16] Additionally, the Dakota also have used the wood of the boxelder to make charcoal for ceremonial painting and for tattooing.[17]

(6) Redosier dogwood (*Cornus service*)

Commonly called red willow, redosier dogwood is recognizable in the winter by its rich red bark. The Dakota have historically prefered to smoke this species; the outer bark is removed and the inner bark is scraped and dried for smoking in the sacred pipe. Though it is called Cansasa specifically by the Dakota, it is also commonly called Kinnikinnick, the Algonquian word for mixture, and is often smoked in conjunction with tobacco or bearberry (though neither of these are native to MN) in a Kinnikinnick mixture. Silky dogwood (*Cornus amomun*), also located in the Cowling Arboretum, is also smoked and added to kinnikinnik mixtures. Though tart and bitter, the berries were also eaten.[18] [19] [20]

[15] Swanson, Interview
[16] DNR
[17] Daniel E. Moerman, *Native American Ethnobotany* (Timber Press, Inc., 1998).
[18] St. Clair, Interview.
[19] Michelle Stevens, "Redosier dogwood, Cornus service L." USDA Plants Database.
[20] Gilmore, 1919.

(7) Chokecherry (*Prunus virginiana*)

Chokecherry is a native thicket forming, shrubby tree with bark that starts as a smooth reddish-brown and becomes dark and furrowed with age. Though the chokecherry was a staple for many native tribes, it is particularly important to the Dakota tribes who used the stem of the plants to make arrows and gave the name to one of their calendar months, *Canpásapa Wi*, "the-month-when-cherries-are-ripe" or "black-cherry-month."[21] Chokecherry fruit is eaten fresh and also dried for winter use in various forms. *Wasna,* meaning "all mixed up" in Lakota, is a popular, traditional Dakota dish made of a mix of dried buffalo, dried cherry, and fat, and has been stored throughout the winter. Another chokecherry dish entails pounding the cherries into a pulp, straining out the peel and seeds, leaving the pulp to dry out in the sun, and then forming it into cakes and balls. The seeds when eaten fresh are poisonous and potentially fatal as they contains hydrocyanic acid. Boiling or drying the fruit, however, neutralizes the naturally occurring hydrocyanic acid.

(8) Black Willow (*Salix nigra*)

All willow species prefer wet soil, and the black willows in the Arb are no exception. Large willows can be found immediately adjacent to the Cannon River and Spring Creek, often leaning out over the river. Willow poles were traditionally used as a building material by the Dakota to sustain the thatch of earth lodges and to

[21] Gilmore, 1919.

form the frame of the bath lodges.[22] Tea made from willow bark can be used to treat fever and pain, and has served as a sort of precursor to aspirin.[23] In the 1840's, chemists isolated salicylic acid from willows and found that is has strong antipyretic (fever reducing) and analgesic (pain-killing) effects. Modern aspirin (acetylsalicylic acid), which contains synthetic salicylic acid, got its name from *Salix*.[24] Julia Uleberg Swanson, the manager of Dacie Moses, an adopted member of an Ojibwe family, and a registered nurse and holistic healer, shared an estimate that 75% of all pharmaceuticals are derived from native knowledge.

(9) Hackberry *(Celtis occidentalis)*

Hackberry is identifiable by its deeply furrowed bark, covered by corky warts and ridges. Each tree has the same number of ridges throughout its entire life, and the ridges grow deeper and more robust as the tree ages. One Dakota name for the tree is *Yamnumnugapi* from the word *yamnumnuga*, which means "to crunch" and refers to the manner in which animals crunch the berries.[25] Among the Dakota, the berries were traditionally dried and ground, seeds and all, and then used to season meat.[26] [27] When Dakota people were first exposed to black peppercorns as a ground seasoning, they likened it to *yamnumnugapi*, calling it "white man's *yamnumnugapi*." Other native tribes have used hackberry as a gynecological aid in order to induce abortion, regulate menstrual cycles, and treat venereal diseases. Finally, ground hackberry seeds have also been used to help sore throats, or mixed with fat and corn to form porridge.[28]

(10) White Cedar *(Thuja occidentalis)*

The Arboretum has a sparse population of white cedars, which have grey, reddish-brown bark. The cedar tree is highly sacred to the Dakota, who believe the mythical thunderbird lives in a cedar in the "western mountains." Given this spiritual significance, cedar boughs were often put on tipi poles to ward off lightning.

Cedar fruits, in Dakota, are known as *anti itika*, or "cedar eggs." Cedar needles have numerous culinary uses, fresh or dried and chopped up as an herbal seasoning, and are a common ingredient for some local Dakota cooks.[29] Tea made from cedar needles is also put to use as a powerful medicine to help coughs, regulate blood sugar, and prevent common colds, flus and infections. One story has it that when the Asiatic cholera epidemic struck the Oglala Lakota in 1849, chief Red Cloud tried various treatments for his people. It was a decoction of cedar leaves, used to drink and bathe in, that finally provided a cure (Gilmore).[30]

Cedar, along with sage, sweetgrass, and tobacco, is one of the four sacred plants, commonly used among the Plains tribes. Among the Anishinabe Ojibway, cedar needles are employed along

[22] Moerman, 1998.
[23] Swanson, interview.
[24] USDA.
[25] Gilmore, M.R. Uses of Plants by the Indians of the Missouri River Region.
[26] Munson, P. Contributions to Osage and Lakota Ethnobotany.
[27] Moermann
[28] Sarah Wennerberg, "Common Hackberry, Celtis occidentalis L." Edited by Mark Skinner. *USDA Plants Database*, USDA: Natural Resources Conservation Science, 5 June 2006, plants.usda.gov/plantguide/pdf/pg_ceoc.pdf. Accessed 25 Jan. 2017.
[29] Sean Sherman, interview. 5 Jan. 2017.
[30] Gilmore, 1919.