

**Paleoethnobotany at Wanuskewin Heritage Park: Plant Use at the Red Tail (FbNp-10) and
Wolf Willow (FbNp-26) Sites and An Evaluation of Macrobotanical Flotation Techniques**

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By
Eryn L. Coward

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Head of the Department of Archaeology and Anthropology

55 Campus Drive

University of Saskatchewan

Saskatoon, Saskatchewan S7N 1H1 Canada

OR

Dean

College of Graduate and Postdoctoral Studies

University of Saskatchewan

116 Thorvaldson Building, 110 Science Place

Saskatoon, Saskatchewan S7N 5C9 Canada

Abstract

Plant use of mobile hunter-gatherers of the Northern Plains has been vastly understudied. The analysis of macrobotanical (seeds and charcoal) remains from archaeological sites, if they are conducted, are often an addendum to general site reports and subsistence research rather than being an integral part of the research design. Using Wanuskewin Heritage Park (Saskatoon, Saskatchewan) as a case study, forty-one feature and non-feature sediment samples were collected from the Red Tail (FbNp-10) and Wolf Willow (FbNp-26) sites. The intent of this research is two-fold. First, to determine which method for extracting macrobotanicals from archaeological sediments produces the highest recovery rate. Second, to determine the nature and extent of plant use at these two sites, with a particular focus on the McKean complex (ca. 4750-3150 cal BP). For part one, 19 samples were subjected to a recovery rate test by adding known quantities of both buoyant and non-buoyant seeds prior to processing using Flote-Tech[®], IDOT, and wet-screening methods. The results indicated that the IDOT was the preferred method for this sample-set, while issues of contamination were discovered using the Flote-Tech[®], and issues of organic fragmentation were identified with the wet-screen method. For part two, the feature samples from the Red Tail and Wolf Willow sites indicated that plants were being used for food, medicines, and other uses such as fuel. The analysis of the non-feature results provided greater interpretative value regarding the nature and extent of plant use at the sites. Further, as the organics recovered from these samples evidenced food and medicinal plant use outside of known features and plant processing areas, they clearly document the need to sample all contexts and not just the more typical practice of just sampling feature contexts. This research denoted that the feature and non-feature results indicate that plant use was important to the different mobile hunter-gatherer groups that inhabited both the Red Tail and Wolf Willow sites. It also emphasised that it is important to have established research questions and an understanding of sediment matrix as the method chosen for extracting macrobotanicals is dependent on both.

Plain Language Summary

Plant remains from archaeological sites in the Canadian Prairies have been vastly understudied for several decades, even though plants can provide valuable information to archaeologists. Plant remains like seeds and charcoal can tell us what time of year people were at the site, what types of plants were used for food and medicines, and how plants were generally used in everyday life. This study focuses on the charred seed and charcoal pieces found in 41 archaeological sediment samples from the Red Tail and Wolf Willow archaeological sites in Wanuskewin Heritage Park. Wanuskewin is located approximately 3 kilometers north of the city of Saskatoon, Saskatchewan.

Paleoethnobotanists, specialists who study the people-plant relationship, often use a process called flotation to recover seeds and charcoal from sediment samples. Flotation uses moving water in a large tub or machine to loosen the sediment from the seed and charcoal fragments, allowing the organics to float to the water's surface. There are several flotation techniques commonly used by paleoethnobotanists; part of my research entailed testing two flotation techniques as well as wet-screening to investigate botanical recovery rates. The Flote-Tech is a machine-assisted flotation device that has a pump that circulates water within the machine, creating water movement and allowing organic material to float into a large catchment tray. The IDOT is a manual flotation device that is shifted back and forth in a large tub filled with water, causing the organic material to float to the surface of the IDOT. The wet-screening method uses several different sized nesting screens, with the largest screen size at the top and the smallest screen size at the bottom. The sediment sample was washed through these screens with a gentle stream of water until there was no sediment left in the screens. To test the recovery rate of the different methods, three different types of seeds were added to 19 of the sediment samples. The IDOT method was the preferred method for this research as it recovered the highest amount of the added seeds. The other methods had some recovery issues. The Flote-Tech method had problems with contamination, presumably related to reusing the water for several samples though exactly how contamination was occurring was not identified. Wet-screening caused several of the recovery seeds to break apart as the water, even in the form of a gently spray, forced the seeds through the screen. The results of these recovery rate tests highlight the

importance of choosing a method that is best suited for the samples in hand and the nature of the research questions asked.

I identified the seeds and charcoal from all 41 Wolf Willow and Red Tail samples to try to understand how the people at these sites used plants in the past. The seeds and charcoal that were recovered indicate that plants were an important part of everyday life. They used these plants as food, as medicines to heal their sick, in ceremonies and for fuel in their fires. The seeds and charcoal also indicated that the Red Tail site was occupied during the spring, summer, and fall, whereas the Wolf Willow site was most likely occupied in the late summer into the fall.

Research on plant remains in archaeological sites adds a great deal of information to help archaeologists understand the full picture as to what kinds of activities are occurring within a site. Further, my research explored different extraction techniques which can help archaeologists and paleoethnobotanists make informed decisions on what flotation method is best suited for their research and how it will affect plant recovery.

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Chapter 1 - Introduction

1.1 Research Background

Paleoethnobotany and archaeobotany can add a wealth of knowledge to the archaeological record by providing further explanations on multifaceted subsistence strategies of mobile hunter-gatherer groups, identification of plant medicines, identification of plant processing areas, site seasonality, provide explanations for repeated site-use, provide data pertinent to paleovegetation and paleoenvironmental reconstruction, and much more. The study of paleoethnobotany can be defined as “...the study of behavioral and ecological interactions between past peoples and plants...” (Stuart 2018:5755). With its origins in ethnobotany, the human-plant interaction can be documented through the analysis of phytoliths, residues, starch grains, pollen grains, and charred seeds and wood (Stuart 2018). The study of archaeobotany is “...the study of botanical remains from archaeological sites regardless of their purpose for which they are studied...” (Stuart and Coward 2020:20).

This research examines the paleoethnobotanical record for two sites located in Wanuskewin Heritage Park: Red Tail (FbNp-10) and Wolf Willow (FbNp-26). Wanuskewin is located approximately 3 kilometers north of the city of Saskatoon, Saskatchewan and is home to 19 multicomponent archaeological sites within the Opimihaw Valley, which forms the centre of the Park (Walker 2016). This approximately 40-hectare valley, as calculated by mapping the park extent in Google Earth, is situated on the northern edge of the Great Plains. The Great Plains contains five major subareas (Wood 1998). 1) The Southern Plains consisting of areas south of the Arkansas River, including parts of New Mexico, Texas, Oklahoma, and Kansas; 2) The Central Plains consisting of eastern Nebraska, and parts of Kansas, Missouri, Iowa, and South Dakota; 3) The Middle Missouri consisting of the Missouri River and its major tributaries, extending to the mouth of the Yellowstone River on the Montana-North Dakota state-line as well as into south-central South Dakota at the mouth of the White River; 4) Northeastern Plains encompasses the eastern halves of North and South Dakota, as well as the southeastern corner of Manitoba, and the south-central region of Saskatchewan; 5) Northwestern Plains consists of Montana, Wyoming, Colorado (north of Colorado Springs), and the southern half of Alberta, excluding the Rocky Mountains (Wood 1998). For the purpose of this research, the Northeastern and Northwestern Plains have been grouped together as the “Northern Plains”.

The Red Tail site was excavated during the summers of 1988 and 1989 by students in the University of Saskatchewan archaeological field school, cultural resource management crews, and volunteers from the Saskatchewan Archaeological Society (Williams 2015). This multicomponent site is deeply stratified with some of the 44 1m x 1m units excavated at the site reaching a depth of 2.3 meters below surface. Several feature (such as hearths, charcoal scatters, and cairns) and non-feature samples were collected by then Department of Archaeology and Anthropology graduate student Charles Ramsay who helped direct the excavations. Thanks to the foresight of Dr. Walker in storing this material, some of the samples he obtained were analyzed as part of the current research.

The Wolf Willow site was excavated during the summers of 2010 to 2019 by University of Saskatchewan archaeological field school students as well as Saskatchewan Archaeological Society volunteers in 2010 and 2011. A total of 139 square meters were excavated at this multicomponent site, reaching a maximum depth of 0.9 meters below surface (Bailey Pelletier, personal communication 2022). Paleoethnobotanical samples analyzed as part of the current research were predominately derived from the 2019 excavations, following a comprehensive sampling strategy developed by the author (Chapter 3.2.2) to incorporate collection of non-feature samples into the previously established practice of emphasizing only feature samples.

1.2 Research Objectives

(1) What method produces the highest recovery rate for extracting macrobotanicals from archaeological sediments?

A comparative investigation of various flotation methods was used to answer this question. Forty-one sediment samples from feature and non-feature contexts, including four clay-rich, sterile control samples from non-cultural levels, were processed using an assisted flotation machine (Model A Flote-Tech®), manual flotation system (IDOT), and nesting geological screens as a wet-screening method. To test the recovery rates non-native charred seeds were added to nineteen samples, including the four control samples. Results of this analysis are presented in chapter 3.4.

(2) Can paleoethnobotanical analysis of non-feature sediment samples aid interpretation of the nature and extent of plant use at the Wolf Willow and Red Tail sites?

To answer this question, sediment samples from both feature and non-feature contexts were analyzed from both the Wolf Willow and Red Tail sites (Chapter 3.1 and 3.2.2). Greater focus was placed on McKean complex samples to explore Keyser's (1986) claim of increased plant use during this time (Chapter 2.2). Non-feature sample results were then compared with the results of the feature samples to identify similarities and differences (Chapters 4 and 5).

(3) What plant taxa are represented in the archaeological record at the Wolf Willow and Red Tail sites? What is the nature and extent of plant use at these sites?

To answer these questions, 41 sediment samples were hand-sorted and macrobotanicals were identified from the multi-component Wolf Willow and Red Tail sites. To determine nature and extent of plant use, the sample context, chronological sequence, and quantities of organics recovered were analyzed for interpretations and comparisons at each site. Secondary sources were then used to determine plant use in this region and final interpretations and comparisons on intersite and intrasite variations were made (Chapter 4).

The results of these investigations provide researchers with 1) a guide for choosing macrobotanical processing methods to suit their research questions; 2) additional data and interpretation to explore some of Keyser's (1986) mostly uninvestigated claims of increased plant utilization in the McKean complex and 3) broadly explore the nature and extent of plant utilization at the Red Tail and Wolf Willow sites to better document past plant use; and 4) to discuss the implications of these results for plant use at Wanuskewin and on the Northern Plains.

1.3 Thesis Organization

This thesis contains 5 chapters including this introductory chapter. Chapter 2 presents the archaeobotany and paleoethnobotany that has previously been conducted on the Northern Plains. This chapter also provides comparative horticultural and plant tending examples from elsewhere on the Great Plains. It then outlines previous archaeobotanical work that has been conducted at Wanuskewin. Finally, Chapter 2 provides a cultural history and summary of the stratigraphic sequence for both the Red Tail and Wolf Willow sites.

Chapter 3 is written as a stand-alone chapter intended for publication. It describes all field and laboratory methods used for collecting, processing, and identifying macrobotanicals from both the Red Tail and Wolf Willow sites. It also documents recovery rate tests conducted

on the Model A Flote-Tech[®], IDOT, and wet-screening methods. A version of this chapter will be submitted to the *Journal of Archaeological Science*.

Chapter 4 presents the results of the investigations of organics recovered from both feature and non-feature contexts at both Wolf Willow and Red Tail. Intersite and intrasite comparisons to documenting the nature and extent of plant use at these sites is presented, as is a brief summary of the recovery rate results discussed in Chapter 3.

The final chapter, Chapter 5, presents conclusions reached as well as a discussion of limitations this research encountered, future research directions, and a review of the answers to the research objectives presented above.

1.4 Limitations

This research faced several limitations throughout the course of sample selection, sample processing, and interpretation. The records from the Red Tail site have been stored at the University of Saskatchewan since these excavations occurred. The records have also been used by three other graduate students prior to the use in this research. Additionally, during excavation, students, volunteers, and professional archaeologists all assisted in the excavation and record keeping. Unfortunately, whether as a result of being misplaced or through oversight in completion, information on several of the collected sediment samples and other excavation documentation is missing. This includes all the level record forms from the 1988 excavations, though the plan views are available. For the 1989 excavations, all the student excavated units are missing plan views, though most of the level records are available. The lack of documentation creates a huge problem when selecting samples, feature samples were documented on a “Flotation Sample Collection Form” which provided some context for the features that were missing level record or plan view maps. However, it seems that all the non-feature samples from the Red Tail site were recorded and documented on level records rather than a “Flotation Sample Collection Form”, and consequently, in the absence of level forms, no documentation for these samples is available; nor is there a master sample list available.

Previous graduate student Charles Ramsey had flotation samples processed from the Red Tail site by a third party. This flotation report would have included details on the methods used for processing and analysis, further explanations on fungal sclerotia found in the Red Tail samples (Chapter 4.5), as well as documentation on plant remains recovered from the samples

and interpretations on those organics in relation to the features from which they were obtained. Though this flotation report was mentioned in Ramsay's (1993) thesis, a physical copy of the flotation report could not be located. Ramsay's (1993) thesis detailed the organics that were recovered and general macrobotanical interpretations such as growing season, and general subsistence uses but unfortunately does not include important details about the flotation processing method and more in-depth interpretations that could have aided in the current interpretations of the Red Tail site macrobotanical record.

Finally, a very significant constraint that affected the current research as well as many other researchers has been the COVID-19 pandemic. Hand-sorting and identification were conducted in my home office rather than in a lab. This situation was not ideal and slowed the hand-sorting procedures. In terms of seed and charcoal identification, my personal reference collection is quite small and seed identification could not always be identified to species level due to not having the variety of seeds that a larger, more established, collection has. Arrangements had been made to use the extensive collection at the Royal Alberta Museum, but due to the pandemic, I was not able to access this collection. Additionally, it is very important to me to incorporate Indigenous Traditional Knowledge in discussions of plant use. Due to both direct and indirect effects of the pandemic, discussions and fostering relationships with Indigenous Knowledge Keepers was not able to be pursued.

Chapter 2 - Northern Plains Archaeobotany

2.1 Introduction

The Ancestral Indigenous Peoples of the Northern Plains (as defined in Chapter 1.1) utilized plants for many purposes including food, medicines, and utilitarian purposes (such as baskets, structures, and shafts for hunting implements). However, the paleoethnobotanical and archaeobotanical (as defined in Chapter 1.1) records of these mobile hunter-gatherer groups are vastly understudied (Keyser 1986). More often than not, if they occur, seed and charcoal analyses are an addendum to subsistence studies or general site reports (Ramsay 1993; Smith 2012; Webster 1999). Though Indigenous Peoples on the Northern Plains are typically classified as hunters and gatherers (Kornfeld et al. 2010), there is, nevertheless, evidence for plant tending and purposeful planting (Lightfoot et al. 2013; Oetelaar & Oetelaar 2007; Smith 2011). As with the rest of the Northern Plains, few dedicated paleoethnobotanical studies have been conducted at Wanuskewin Heritage Park (WHP), with those that have been done focusing on subsistence strategies and environmental reconstruction (Burdeyney 2019; Pletz 2010; Ramsay 1993; Smith 2012; Stuart and Walker 2018; Webster 1999). To set the stage for the current archaeobotanical work, it is important to understand the history of archaeobotanical research within WHP and the Northern Plains more broadly, and to review the different cultural complexes represented at the Wolf Willow (FbNp-26) and Red Tail (FbNp-10) sites.

2.2 History and Theoretical Foci of Northern Plains Archaeobotany

The analysis of plant remains from archaeological sites can provide great insight into past environments, specific cultural activities, use of medicinal plants, food preferences, season of occupation, amongst various other topics (see Stuart 2018). It can also reveal the nature and form of interaction between Ancestral Indigenous Peoples and the plant community (Stuart and Coward 2020). Although paleoethnobotany can provide a wealth of knowledge, such previous research within the Northern Plains has been limited, with much of the research predominantly oriented toward paleoenvironmental reconstruction (Aaberg et al. 2003; Cummings 1995, 1996; Cyr et al. 2011; Fredlund and Tieszen 1994; Klassen 2004).

Paleoethnobotanical research on the Great Plains tends to focus on groups that rely more extensively on horticulture (Boyd et al. 2006; Cutler and Agogino 1960; Drass 1993, 2008; Schneider 2002). Boyd and colleagues (2006), for example, studied phytolith, starch granules,

and macrofossils from six Plains Woodland tradition archaeological sites within southern Manitoba on the Northeastern Plains. This is one of the first studies on paleodiet, trade, and local horticulture within southern Manitoba. Cutler and Agogino (1960) studied the different variations of *Zea mays* (maize) that were cultivated at three Arikara village sites in the Middle Missouri area of the Northeastern Plains in South Dakota. Drass (1993) analyzed macrobotanicals from trash-filled pits at two prehistoric village sites in south-central Oklahoma, part of the Southern Great Plains, documenting food use of both *Z. mays* and native plants. Elsewhere on the Southern Great Plains, Drass (2008) discusses several Plains Village period (1050-200 BP) sites in Oklahoma and Texas. He discusses the diversity of plant use within this region as it relates to both horticulture and the gathering of wild plants. Schneider (2002) also looks at the Plains Village Period, however he focuses on the Middle Missouri River Valley of North and South Dakota in the Northeastern Plains. In his discussion of the importance of horticulture in this region and period, Schneider (2002) addresses issues and provides suggestions as to how to better recognize horticulture in the archaeological record.

While there is very little evidence for horticulture on the Northern Plains, that does not indicate that people were simply living off the land as passive foragers (Lightfoot et al. 2013), nor does it limit the applicability of paleoethnobotanical research. People were active agents affecting the abundance and distribution of different plants and animals through landscape management, plant tending, and purposeful planting (Lightfoot et al. 2013, Oetelaar and Oetelaar 2007, Smith 2011). However, identifying landscape management practices in the archaeological record is difficult (Lightfoot et al. 2013).

Lightfoot and colleagues (2013) argue that hunter-gatherers practiced landscape management (e.g., systematic burning) for centuries or longer and that archaeologists need to be more adaptive in considering the different ways landscapes could be managed. The authors also provide suggestions about how to better identify systematic burning in the archaeological record (Lightfoot et al. 2013).

Oetelaar and Oetelaar (2007) incorporate 'new ecology' into their research, highlighting the importance of disturbances that occur at different spatial and temporal scales on ecosystems. The authors use the annual subsistence round of the Nitsitapii of the Northern Plains to explain their approach. As argued by Oetelaar and Oetelaar (2007), the Nitsitapii not only retrace their steps every year but they also stop in the same areas of importance. Using landscape

management practices such as purposeful planting and controlled burning, the Nitsitapii increase productivity and predictability of desired resources (Oetelaar and Oetelaar 2007).

Similarly, Smith (2011) argues that, in general, hunter-gatherer environmental manipulation was intended to enhance floral and faunal diversity. He discusses the concept of niche construction: the process of organisms (in this case humans) modifying their environments both deliberately and inadvertently. According to Smith (2011:187), there are six general categories of human niche construction evidenced by hunter-gatherer behaviour: 1) general modification of flora communities, 2) purposeful planting of annuals, 3) transplanting of fruit-bearing perennials, 4) in-place plant tending, 5) transplanting and in-place plant tending of root crops, and 6) landscape management to increase faunal presence in specific places. Paleoethnobotanical research is a prime means by which the topics and issues raised by Lightfoot and colleagues, the Oetelaars, and Smith could be investigated. To date, such research is limited, but not absent.

At the Forks-North Point site, located at the junction of the Red and Assiniboine rivers in Manitoba, Shay and colleagues (1991) analyzed 35 flotation samples spanning four different cultural periods (Historic III 140-124 BP, Late Prehistoric 500 BP, Blackduck I-II 1250-1220 BP, and Blackduck III-V 1560-1290 BP). They (Shay et al. 1991) determined that the plant types represented in their samples reflected food use, but also that the distribution of the seeds and charcoal was affected by the feature type and chronological period, indicating that paleoethnobotanical study could document not only plant use, but variation through time. Further, the authors were able to offer insight into past flora, based on the charcoal recovered. The presence of *Acer* sp. (maple), *Populus deltoides* (cottonwood), *Salix* sp. (willow), *Fraxinus* sp. (ash), and *Ulmus* sp. (elm), was argued to reflect the composition of past woodlands or forests in this now deforested area. Thus evidencing the presence of wooded environments similar to those typically found along river bottoms within the Winnipeg area today (Shay et al. 1991).

Keyser (1986) points out that the McKean complex offers a particularly interesting period for paleoethnobotanical study on the Northwestern Plains, which he defines as Wyoming, Colorado, Montana, and South Dakota. His (Keyser 1986) investigations of the McKean complex provided direct evidence for an increase in plant utilization, as reflected in the increase in stone milling technology and roasting pits. His paleoethnobotanical research included both

feature and non-feature sediment samples, a practice that is not commonly followed in Northern Plain's archaeology. As a result, Keyser (1986) was able to document important characteristics of plant utilization in the McKean complex, including the wide range of plant foods used by these groups, season of site use, and even the possible origin of the McKean complex itself. Unfortunately, research building upon these pioneering efforts has not occurred, leaving several of his hypotheses and conclusions untested and unexplored. It is imperative to the field of paleoethnobotany to answer questions regarding context and subsistence for these mobile hunter-gatherer groups.

Illustrating the range of research avenues open to paleoethnobotany, Zarrillo and Kooyman (2006) analyzed starch grains recovered from pre-contact grinding stones from a Northwestern Plains site near Calgary. They (Zarrillo & Kooyman 2006) highlight that formal grinding stones or pounding stones are uncommon in the Canadian Plains and that pounding and grinding implements are likely to be unmodified stones and consequently may often have been missed during archaeological excavation. However, the authors indicate that when recognized, paleoethnobotanical analysis can be used to help confirm use as a tool. In this particular case, the authors (Zarrillo and Kooyman 2006) found evidence for processing of *Amelanchier alnifolia* (saskatoon berry or serviceberry), *Prunus virginiana* (chokecherries), *Z. mays* (maize), and possibly *Pedimelum esculentum* (prairie turnip). Grinding of *P. virginiana* is consistent with an ethnographic account provided by Peacock (1992), thus further substantiating the importance of assessing these grinding tools to produce a more holistic interpretation of the archaeological record. The information gained from paleoethnobotanical analysis of possible processing tools is very likely to increase our understanding of subsistence strategies, plant processing, and medicinal plant uses by mobile hunter-gatherer groups on the Plains.

Also within Alberta, Leyden (2011) analyzed sediment obtained from a protohistoric hearth feature as well as stone tools from within a stone circle. They found residue of local plant species such as *Pinus* sp. (pine), *Rosa* sp. (rose), *Allium* sp. (prairie onion), and *Achillea* sp. (yarrow) and surprisingly exotic species like *Cucurbita* sp. (squash), *Z. mays* (maize), and *Phaseolus* sp. (bean). It is important to note how unusual it is to find the North American Triad (maize, beans, and squash) in Alberta; indeed, I am unaware of any other instance where all three of these plants have been found, though *Z. mays* has been identified. Fedyniak and Giering (2016) in their residue analysis of mauls identified *Z. mays* and indicate that it has been found on

stone tools, pottery, and in features within Alberta. They also discuss that potential trade for this plant is not otherwise represented within the archaeological record, as there has not been *Z. mays* cobs or seeds found in Alberta, or Saskatchewan, for that matter. Fedyniak and Giering (2016) suggest that *Z. mays* could be traded in small amounts or that trade centred on ground maize (maize flour). *Cucurbita* sp. and *Phaseolus* sp. were also distributed throughout the eastern woodlands and southern North America prior to European contact (Leyden 2011). Thus, suggesting that the identification of *Cucurbita* sp. and *Phaseolus* sp. in Alberta also reflected trade for these plants, but similarly to *Z. mays*, trade of these plants is not represented in the archaeological record save for detailed paleoethnobotanical analysis.

Another aspect of paleoethnobotanical research can be developed through community-based research. Stuart and Coward (2020) outline the importance and benefits of community-based scholarship in relation to medicinal plant uses and paleoethnobotany. The authors suggest, based on previous community-based research, that collaborative research on medicinal plants could help preserve traditional knowledge, and aid in protecting plant-collecting areas; ultimately, lending this research to directly contribute to the community's wellbeing.

From an ethnobotanical perspective, perhaps one of the more insightful contributions into the use of plants by Northern Plains people is that of Peacock (1992), who conducted research into traditional ethnobotanical knowledge of the Piikáni. Her research provides details on the use, collection, processing, and preservation of each plant resource presented. Though other ethnographic accounts of plant use occur (Hellson 1974; Johnston 1987; Moerman 2009), they tend to lack the anthropological context of Peacock's (1992) research but can still be informative by providing evidence for potential plant use (see Stuart and Coward 2020).

2.3 Previous Archaeobotanical Research at Wanuskewin Heritage Park

Previous archaeobotanical research with WHP has focused predominantly on environmental reconstruction but with some preliminary research on subsistence strategies as reflected in hearth samples. Ramsay (1993) analyzed seven flotation samples from the Red Tail site (FbNp-10), recovering charred seeds of *Chenopodium* (goosefoot), *Prunus* (cherry), *Rosa* (rose), *Symphoricarpos* (honeysuckle), cf. Labiate (mint family), cf. Asteraceae (aster family), and charcoal identified as *Populus* (which could derive from poplar, aspen, or cottonwood). Ramsay (1993) highlights the potential for paleoethnobotanical research to be conducted at the

Red Tail site, and his results further substantiate Keyser's (1986) long-standing, yet mostly uninvestigated, claim of the McKean occupations placing a greater reliance on plant foods than did earlier cultural groups. Ramsay (1993) suggested that the seeds found could indicate a summer and early fall site occupation, though noting that the plants could have been collected and then used later.

Smith's (2012) research at the Cut Arm site (FbNp-22) resulted in some seeds and charcoal being found, but extensive charring precluded taxonomic identification. Pletz (2010) also found charred seeds within a hearth feature at the Dog Child site (FbNp-24), but here documentation was possible with *Chenopodium* sp., *Crataegus* sp. (hawthorn), *Prunus virginiana* (chokecherry), *Purshia tridentata* (antelope bitterbrush), *Rosa* (rose), and *Iberis amara* (wild candytruff) identified. Pletz (2010) did not provide much discussion on the botanical remains recovered, though does mention the season that *Chenopodium* sp. sets seed as well as the unusual presence of *P. tridentata* outside its normal intermontane range, but nothing on the potential significance of this latter result.

Perhaps the most detailed subsistence strategy study conducted at Wanuskewin was that by Webster (1999) at the Thundercloud site (FbNp-25), through analysis of faunal and seed remains. Sediment samples collected from features were processed using a bucket flotation method with a less than 1mm mesh size. Seed specimens were then identified at the University of Saskatchewan by Dr. John Hudson from the Department of Agriculture. Some of the species identified were *Carex* sp. (sedge), *Polygonum ramosissimum* (bushy knotweed), *P. aviculare* (doorweed), *Chenopodium* (goosefoot), *Amaranthus* (amaranth), *Amelanchier alnifolia* (saskatoon), *Prunus pensylvanica* (pin cherry), *P. virginiana* (chokecherry), *P. americana* (plum), *Rubus idaeus* (wild red raspberry), *Elaeagnus commutata* (silverberry), *Vaccinium* sp. (high bush-cranberry), *Suaeda calceoliformis* (western sea-blite), *Astragalus* sp. (vetch), and *Cornus sericea* (red-osier dogwood) (Webster 1999: 53, 82, 109). Although there were several seed-types recovered, the focus of this work was predominantly on the faunal assemblage and there is only a limited discussion on the floral remains. This discussion included the completeness of the seeds, but there was no interpretive discussion on the botanical specimens.

These previous subsistence works also did not discuss how macrobotanical depositional processes, such as seed rain, can affect their analysis. Seed rain occurs when the seeds of a plant are blown off the original plant, and in this case, into archaeological sites and sediments (Minnis

1981). Modern seeds can also become deeply buried if carried downward by burrowing animals, root movement from plants, and bugs (Pearsall 2015). Luckily, it is relatively easy to ascertain if a modern seed rain has contaminated archaeological sediments as modern seeds are easily identifiable when compared to charred ancient seeds and the modern vegetation within the area. Plants such as *Chenopodium* sp. (goosefoot species), Asteraceae (aster family), and Poaceae (grass family) are common plant types to contribute to seed rain (Minnis 1981).

Additional archaeobotanical research conducted at Wanuskewin was oriented primarily toward environmental reconstruction. Stead (2013) contributed to the paleoenvironmental record for WHP by analysing phytoliths from five Red Tail (FbNp-10) cores. Stead's (2013) research at the Red Tail site indicated that the Hypsithermal, a period of generally warmer and drier climate, may not have affected Wanuskewin as drastically as other areas on the Great Plains. Her research found a higher percentage of C₃ plants which thrive in cooler, wetter conditions, than the expected C₄ plants which were prominent elsewhere during the Hypsithermal. C₄ plants were still reflected in the phytolith record, but they were not as abundant as expected (Stead 2013). As a result, Stead (2013) concluded that the continued high presence of C₃ plants and the environment they evidence could have been a factor in drawing Indigenous Peoples to Wanuskewin.

Burdeyney (2019) provided a broader analysis than Stead (2013) by incorporating more archaeological sites into her research by analyzing grass short-cell phytoliths from Dog Child (FbNp-24), Thundercloud (FbNp-25), Wolf Willow (FbNp-26), Amisk (FbNp-17), Cut Arm (FbNp-22), and Tipperary Creek (FbNp-1). Burdeyney (2019) also indicated that the 5000 yearlong WHP record she analyzed reflected a dominance of C₃ plants. However, she also found that the environment was not static. The grass short-celled phytoliths indicated that Hypsithermal conditions improved prior to 4860±30BP and that peak warming from this period occurred between 8000-6000BP which is consistent with climate data from elsewhere in Saskatchewan.

Stuart and Walker (2018) analyzed botanical remains (pollen and charcoal) at the Wolf Willow site. The pollen data allowed for environmental reconstruction while charcoal analysis documented differences in fuel uses through time and location within the site. Charred seeds, however, were not analyzed as part of this research. Stuart and Walker (2018) also indicated similar results as Burdeyney (2019) with their pollen analysis at the Wolf Willow site. Thus, it would appear that not surprisingly the Hypsithermal did affect WHP, but that the characteristics

of the valley may have ameliorated this impact (see Mampe 2015). Future research may help clarify the specifics of the environmental conditions in Wanuskewin during the Hypsithermal.

2.4 Cultural Stratigraphy of the Wolf Willow (FbNp-26) and Red Tail (FbNp-10) Sites

2.4.1 Wolf Willow

As outlined by Stuart and Walker (2018), the Wolf Willow site has seven cultural levels. However, since publication of their article an additional cultural level has been identified (Bailey Pelletier, personal communication 2021). The level is situated between the already determined cultural level 6 and non-cultural level 7. The majority of these cultural layers are represented in Figure 2.1, a stratigraphic profile of the Wolf Willow site. A stratigraphic profile that documented all of the culture levels from the Wolf Willow site is not available.

Cultural level 1 is part of the Old Women's phase, more specifically Plains side-notched. This period dates to ca. 600-200 ¹⁴C years BP (before the present date defined as 1950) or ca. 650-200 calibrated BP. Cultural level 2, which is also part of the Old Women's phase, is known as Prairie side-notched and is dated to ca. 1100-600 ¹⁴C years BP or 1050-650 cal BP. The Plains and Prairie side-notched points are triangular points with V-shaped and broad notches (Bubel et al. 2012). The Prairie side-notched points are notched close to or touching the base whereas the Plains side-notched are notched higher up with its base being the widest point. These points are part of the Late Precontact Period (1350-250 BP). The beginning of this period was marked by the shift from atlatl darts to the use of the bow and arrow. The shift in technology is seen as beneficial as arrows have a longer range, a greater velocity and higher accuracy than do atlatl darts (Williams 2015). Also during this period, the use of pottery becomes more common and more refined in construction and decoration (Meyer and Walde 2009). Thus the bow and arrow and increased use of pottery are seen as the defining characteristics of the Late Precontact Period (Walker 1999).

The third "level" is a depositional hiatus resulting from flood-associated erosion along Opimihaw Creek (Stumborg 2016) and dates to ca. 2500-1200 ¹⁴C years BP or ca. 2650-1150 cal BP. The fourth level, whose presence is intermittent at the site, is known as cultural level 3a and is associated with the Pelican Lake complex. This level dates to ca. 3300-1800 ¹⁴C years BP or ca. 3550-1700 cal BP. These "Christmas tree" looking atlatl dart points are long and symmetrical with deep corner-notching, creating a narrow base and neck (Bubel et al. 2012). Bubel and

colleagues (2012) suggest that earlier Pelican Lake sites tend to be smaller camp sites that focus on animal stalking, but that around 2800 BP there is a shift to repeated use of bison jumps in the Northern Plains.

The fifth level is cultural level 3, the McKean complex. The McKean complex dates to ca. 4200-3000 ¹⁴C years BP or ca. 4750-3150 cal BP. This complex includes three different atlatl dart point forms known as McKean, Duncan and Hanna. These points differ from the more recent points in that they lack side-notches, but do have a distinctive shape (Bubel et al. 2012). There is some argument as to whether these point styles follow a chronological sequence to a degree (i.e. McKean 4200-3500 BP, Duncan 3900-3500 BP, and Hanna 3900-3500 BP), but all three types have been found together indicating simultaneous use (Bubel et al. 2012; Peck 2011). As with other Plains cultures, people who produced these points focused on big game subsistence, but as noted above Keyser (1986) argued that the McKean complex also reflects an increase in plant utilization over what was seen in earlier cultures.

The sixth level, cultural level 4, is part of the Oxbow complex dating to ca. 4800-4100 ¹⁴C years BP or ca. 5500-4550 cal BP. The Oxbow atlatl dart points are very easily identifiable due to the ear-shaped basal edges (Bubel et al. 2012). Once again, bison played the prominent role in the subsistence strategy for the Indigenous people of the Oxbow complex.

The newest identified level at the Wolf Willow site is the Gowen cultural level (Bailey Pelletier, personal communication 2021). This level has no associated radiocarbon dates as no bone or other dateable materials have been recovered. Gowen atlatl points are part of the Mummy Cave Series which elsewhere dates between 7500-5000 BP (Walker 1992), therefore making it the oldest occupation identified at Wanuskewin. Artifacts from the Mummy Cave Series have also been found at the Dog Child site (Cyr 2006; Pletz 2010) and the Cut Arm site (Smith 2012). Gowen points are notched closer to the base than other Mummy Cave points. This time period has been argued to reflect adoption of the atlatl (Bubel et al. 2012; Walker 1992). Pelican lake, McKean, Oxbow and Gowen are all part of the Middle Precontact Period (7500-1350 BP). This period is at least in part associated with the Hypsithermal and a shift to warmer and dryer conditions with an increase of drought tolerant C₄ plants (Kay 1998).

The seventh and final level has non-cultural skeletal elements of bison and lacks associated artifacts. This level dates to ca. 4900-4800 ¹⁴C years BP or ca. 5650-5500 cal BP (Stuart and Walker 2018). The Gowen atlatl point was found directly on top of this level, which

could indicate a general age of the Gowen point, however, a radiocarbon date that is associated with the Gowen point should be done to confirm the implications of this current date range.

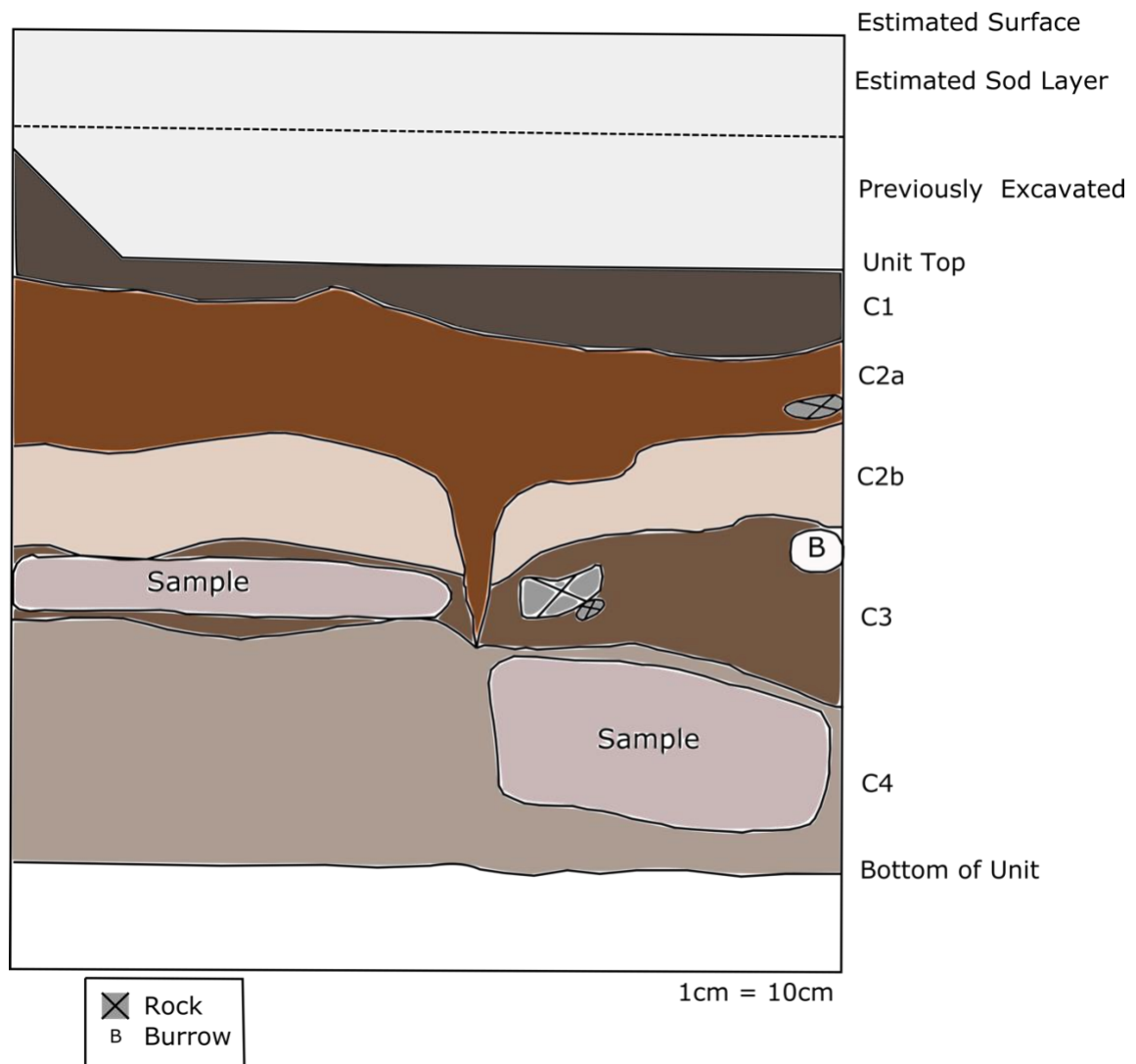


Figure 2.1-West Wall of Unit 2S 17E, Wolf Willow site. Sediment colours chosen for image are not accurate representations of sediment colour, rather they were used to highlight the different strata. Cultural levels are identified on the right side.

2.4.1 Red Tail

The cultural stratigraphic layers at the Red Tail site include 15 different cultural levels (Ramsay 1993; Williams 2015). Williams (2015) provides nine radiocarbon dates for six different cultural levels; these dates derive from her and Ramsay's (1993) research at the Red Tail site. Several of the following cultural layers were analyzed together as they contained the same projectile point types. However, the cultural layers were separated due to differences

within the matrix in which the cultural materials were found. That the same point type occurs across multiple discrete strata suggests re-occupation of the site by members of the same culture over an unknown period of time. Ramsay (1993:56-59, 79) describes the sediment types in relation to the cultural layers. The cultural layers can be seen in Figure 2.2, a stratigraphic profile of the Red Tail site.

Cultural layers 1 and 2 were analyzed together as these levels provide both Avonlea and Besant projectile point types; this aligns with the calibrated radiocarbon date of 1340 BP from level 2 (Williams 2015). Although these two projectile point types are very different, these two levels were analysed as a single level because separation between these two levels was only possible in 6 of the 44 units excavated at the Red Tail site (Williams 2015). Avonlea arrow points are from the Late Precontact Period when large-scale communal bison hunting is prominent on the Great Plains (Bubel et al. 2012). Avonlea points mark the beginning of the Late Precontact Period within Alberta and Saskatchewan. These triangular arrow points are easily identifiable as they are very well made, thin, small and have shallow side-notching (Bubel et al. 2012). Similar to Old Women's, pottery is also commonly associated with Avonlea. Besant atlatl dart points are from the Middle Precontact Period. These points are broad points with shallow side notches and concave bases (Bubel et al. 2012). It is important to note that these two cultural levels are from two different time periods with different technologies (bow and arrow versus atlatl) and not being able to separate these layers affects the interpretation. Thus, determining cultural use in association with Avonlea and Besant in these levels becomes difficult to interpret as there is no clear correlation with artifacts in levels 1 and 2.

Cultural levels 3 and 4 were also analyzed together as projectile points from the Sandy Creek complex were found within both these levels. Williams (2015) does not provide a radiocarbon date for cultural levels 3 and 4. Sandy Creek points are part of the Besant Phase, and they are often attributed to be transitional points between Besant and Oxbow atlatl points (Bubel et al. 2012). Sandy Creek points are often short and thick with an asymmetrical shape and shallow side notches.

Cultural level 5 was identified as a sparse or ephemeral by both Ramsay (1993) and Williams (2015). There were no diagnostic artifacts found in this level, nor was there a radiocarbon date provided, resulting in an unclear identification of cultural complex affiliation. It was separated from cultural levels above and below it as it was stratigraphically different.

Cultural levels 6 and 7 also had no clear cultural complex affiliation, but there was a stratigraphic change. Williams (2015) discusses the possibility of these two levels experience some mixing due to the thinness of level 7. Cultural level 8 did not produce diagnostic artifacts, but the calibrated radiocarbon date of 3300-3440 BP that Williams (2015) acquired places this level within the late McKean complex. Ramsay (1993) indicated that cultural level 9 experienced heavy disturbance in the form of erosion; therefore, it is unclear as to which cultural complex level 9 belongs to, but it was stratigraphically different than cultural levels 8 and 10. Cultural level 10 contains Hanna projectile points placing this level within the McKean complex (Ramsay 1993). Cultural level 11 also contains Hanna projectile point types in association with a calibrated radiocarbon date of approximately 3480 BP, once again associating this level with the McKean complex (Ramsay 1993; Williams 2015). Cultural level 12 has a calibrated radiocarbon date of 3470-3660 BP, and this level, like the two levels above it, contains Hanna materials. Cultural level 13 has a calibrated radiocarbon date of 3860-4280 BP, and it also has materials from the McKean complex. Finally, stratum levels 14 and 15 do not have a clear cultural complex association; however, level 15 does have a radiocarbon date of 5010 BP (Ramsay 1993; Williams 2015). Although Ramsay (1993) and Williams (2015) do not offer a cultural affiliation due to having no projectile points or other diagnostic artifacts, the radiocarbon date indicates that any cultural material from level 15 would likely be associated with the Mummy Cave Series.

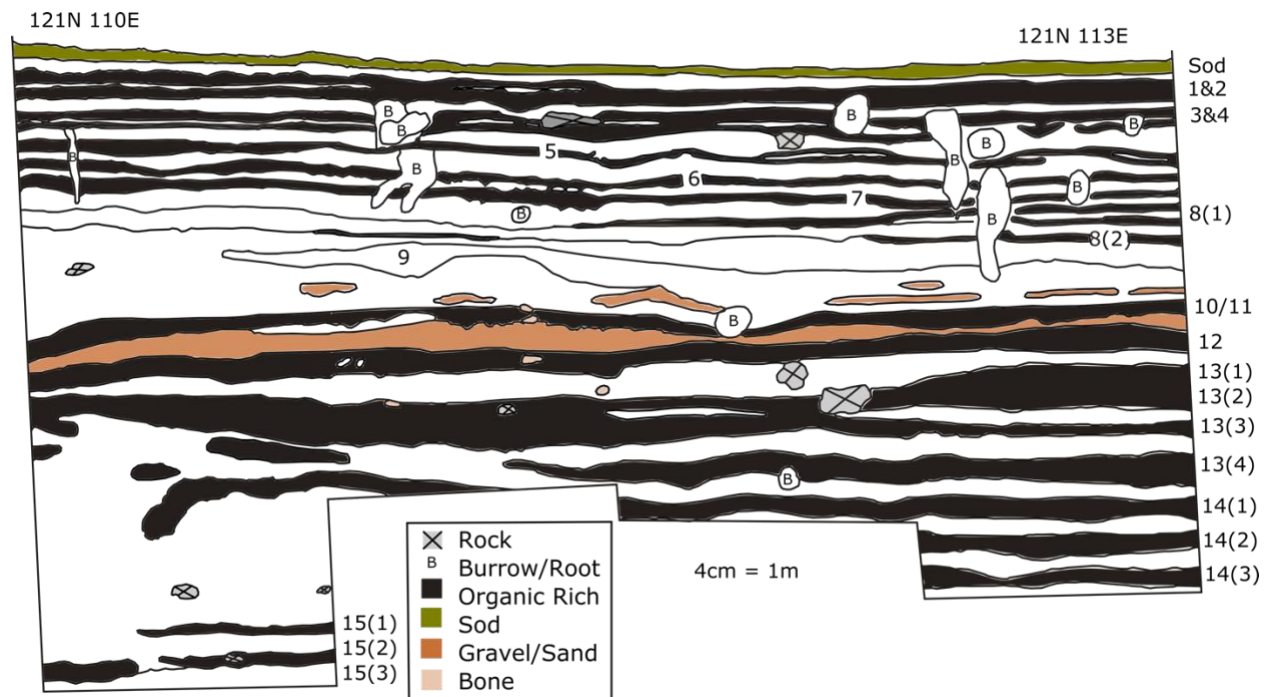


Figure 2.2- Red Tail profile from units 121N 110E to 121N 113E, adapted from Ramsey (1993). Sediment colours chosen for image are not accurate representations of sediment colour, rather they were used to highlight the different stratum levels. Cultural levels are identified by numbers throughout profile and on the right side.

2.5 Conclusions

Notwithstanding the examples provided above, Northern Plains paleoethnobotany is vastly under-studied. Ancestral Indigenous Peoples of the Northern Plains were not just hunters, they also gathered. There is often a focus in research of big game subsistence strategies of these mobile hunter-gatherer groups. The gathering of plants was not just for subsistence, but also for medicines and other utilitarian purposes. It is important to broaden our understanding of these mobile hunter-gatherers through the field of paleoethnobotany and archaeobotany as it can aid archaeologists in answering questions regarding context, subsistence, seasonality, and repeated site use. Additionally, increased research in the fields of archaeobotany and paleoethnobotany can aid in better identifying areas of floral significance, ecological niches, and plant food preferences in archaeological settings. Identifying these areas can then lead to better identifying landscape management practices and purposeful planting in the archaeological record. As an example, by evaluating environmental changes or identifying areas that were subjected to controlled burning, which increases floral and faunal biodiversity, archaeobotany and

paleoethnobotany could explain why the presence of a particular animal is found a site when it is not its native habitat. By performing archaeobotany and paleoethnobotany research, the plant practices of mobile hunter-gatherers can be better identified, and these practices can aid in the broader site interpretations that otherwise would not be included.

Chapter 3 - Plains Macrobotanicals: Evaluating Flotation Methods and Comprehensive Sampling at Wanuskewin Heritage Park

Abstract

Procedures employed in extracting and sampling macrobotanicals within archaeological sediments can vary depending upon research goals as well as budget constraints. Using Wanuskewin Heritage Park (Saskatoon, Canada) as a case study, this paper reviews recovery rates for three different macrobotanical extraction techniques. Forty-one feature and non-feature samples were collected and selected from the Red Tail (FbNp-10) and Wolf Willow (FbNp-26) sites. Recovery rates for nineteen samples were calculated by adding known quantities of both buoyant and non-buoyant seeds prior to processing using the Flote-Tech[®], IDOT, and wet-screening methods. Issues of contamination were discovered using the Flote-Tech[®] as well as issues with organic fragmentation with the wet-screen method. Results indicate that the IDOT was the best overall method for extracting macrobotanicals from this sample set.

3.1 Introduction

Wanuskewin Heritage Park (WHP), located approximately 3 kilometres north of the city of Saskatoon, Canada, contains a highly unusual archaeological record as the Opimihaw Valley, which runs through the centre of the park, is home to 19 multicomponent archaeological sites within an approximately 40 hectare area (Stead 2013; Google Earth n.d). The current analysis reports results of macrobotanical analysis on feature and non-feature sediments from both the Red Tail (FbNp-10) and Wolf Willow (FbNp-26) sites.

A comprehensive sampling strategy was created and implemented at the Wolf Willow site. Samples were collected by WHP field school students under the guidance of the author, this provided upcoming archaeologists with an opportunity to be trained and exposed in comprehensive sampling techniques as well as proper sampling procedures. Sediments from the Red Tail site had been collected in previous excavations using judgemental sampling techniques. As a result, most of the Red Tail samples were from features.

Flotation is a water recovery method that disaggregates sediments from organic material through the aeration or agitation of water, thus allowing the organic material to float to the surface of the water. A total of forty-one samples were processed, including four clay-rich, sterile control samples from non-cultural levels (see Tables 3.1-3.2, Section 3.3). Twenty-seven were processed using an assisted flotation machine, a Model A Flote-Tech[®], eight were

processed using a manual flotation system, an IDOT, and six were processed through nesting geological screens as a wet-screening method. To test the recovery rates, *Papaver somniferum* (poppy) seeds and non-buoyant *Nepeta cataria* (catnip) and *Brassica oleracea* var. *italica* (broccoli) seeds were added to nineteen samples, including the four control samples.

Results from the current analysis are compared to those of Wagner (1982) who tested several flotation techniques, employing both manual flotation and machine-assisted flotation methods. The recovery rates of the Flote-Tech® were also previously assessed by Hunter and Gassner (1998). However, flotation recovery rates have not been addressed since 1998, nor have these three flotation methods been evaluated side-by-side.

3.2 Field Methods

From May 8 to June 22, 2019, the University of Saskatchewan field school students executed a comprehensive or blanket (*sensu* Lennstrom and Hastorf 1995) sediment sampling program to obtain samples appropriate for the analysis of macrobotanicals, phytoliths, pollen, and starch from archaeological contexts within the Wolf Willow (FbNp-26) site. The sampling protocol was designed to produce a representative sample set from all archaeological contexts, rather than the previous emphasis on judgmental sampling used at both the Red Tail and Wolf Willow sites. It also provided the opportunity to train archaeology students in sediment sampling techniques and the importance of a comprehensive sampling strategy.

3.2.1 Archaeobotanical sampling strategies

There are six broad categories of sediment sampling strategies within archaeobotany (Jones 1991; Lennstrom and Hastorf 1995; Pearsall 2015). The first is not to sample at all, thereby precluding archaeobotanical research. The second strategy is haphazard sampling; a passive form of sampling lacking a defined strategy (Jones 1991). An example of this could be taking a single feature sample without concern for identifying possible stratification within the feature. Neither of these two methods provides a representative sample, yet both are common (Jones 1991; Pearsall 2015).

The third sampling strategy is judgmental sampling. Judgemental sampling is based on choice informed by previous knowledge (Jones 1991). If the assumptions of where the botanical remains are located are well-founded, this is considered to be the most effective and economical

form of sampling. Ford (1979) suggests having a botanical specialist on-site to recognize features or other contexts as botanically important for sampling. However, having a botanical specialist or archaeobotanist on-site at all times is often unrealistic. Most excavations on Northern Great Plains, for example, do not have the funds to hire a specialist. Quite often, these excavations do not see the need for an archaeobotanist as they can sample thermal features on their own, though such a practice often leads to missing other important sampling opportunities. Although Ford (1979) specifically indicates having a botanical specialist on site, this is not the best course of action. It would be uncommon for a botanist to be trained to recognize the specific contexts in which archaeological plant material may be found. This role is better suited for an archaeobotanist who has undergone training in both botany and archaeology and therefore has the expertise to identify botanically rich archaeological contexts. At the time of Ford's writing, however, archaeobotanists were rare. Consequently I think that if written today Ford likely would specify archaeobotanists, and further that it would be reasonable for *botanical specialists* to be read as archaeobotanists as much of his paper discusses archaeobotany.

The fourth type of sampling is when samples are taken evenly across the site, known as interval samplings (Jones 1991). Sampling using this strategy can be problematic when the sample interval is placed too close together over top an excavation; meaning, sampling could result in a high rate of sample redundancy. Alternatively, if too far apart, then some depositional contexts could be missed. These problems are sometimes addressed through probabilistic sampling.

Probabilistic sampling, typically stratified random sampling, is the fifth type of sampling. This type of sampling divides the site into areas of interest, often based on depositional contexts, that are thought to provide different propensities for deposition and preservation of plant remains. Samples are then proportionally allocated to each of these contexts (Jones 1991). Jones (1991) advocates for this type of sampling as he suggests that samples should be collected so that data sets can be statistically assessed, while simultaneously reducing the issue of redundant samples while avoiding sample clustering.

The final sampling strategy favoured by Lennstrom and Hastorf (1995) and Pearsall (2015) is called blanket sampling as it involves a specific emphasis on ensuring the collection of sediment from all excavated contexts (Pearsall 2015). It also tends to specify rules for sample collection from feature contexts and adjacent areas to ensure that botanical remains from the

feature reflect feature use rather than being incidental inclusions. A blanket sampling strategy presents six advantages: 1) strengthens conclusions concerning plant deposition, 2) allows botanical records obtained from features to be compared to records obtained from surrounding non-feature deposits so that unique characteristics of the feature assemblage can be recognized, 3) may prevent false interpretations about the interpretive significance of the botanical contents of the feature; 4) offers a means of solving issues regarding chronology and stratigraphy; 5) allows evaluation of the conventional wisdom that artifacts and plant remains usually co-vary; and 6) it addresses archaeologists' preconceived notions about botanical remains and their association with features (Lennstrom and Hastorf 1995:716-717).

3.2.2 Wolf Willow (*FbNp-26*) sampling

The comprehensive sample strategy implemented at the Wolf Willow site was based on Pearsall's (2015) blanket sampling method. However, to avoid obtaining more samples than can be comfortably processed and analyzed or stored for future research, if a stratum continues through multiple excavation units a sample need not be obtained from every unit, rather it would be taken from a limited number of units. For example, at Wolf Willow a series of 1 x 1m units were placed to form a trench. If the same depositional context was present in all units, then a sample was taken from each end of the trench (see Figure 3.1: cultural and paleosol layer). Occasionally, a sample from the middle unit was also taken to assess the stratum's botanical consistency. If the depositional context did not continue through the entire trench, a sample would be taken towards the termination of the stratum. Thus, if the stratum starts in unit 1 and continues to unit 3 but does not continue to unit 4, a sample will be taken from unit 1 and unit 3 (See figure 3.1: Sand / Silt layer). Each of these two samples was collected as a pinch sample to help ensure that all the taxa within the area (i.e., each 1 x 1m unit) were collected. The excavation was also quite small, a 2m x 6m trench, limiting substantive stratigraphic differences across space. Thus, it was deemed appropriate to take samples at each end of the excavation while observing the middle units and sampling if/when the stratum changed or if there was a concentration of organics observed. The sample size for all samples was approximately 2.5L of sediment. This allowed 2L of sediment for flotation and 0.5L of sediment for pollen, phytoliths, and starch extraction.

Unit 1	Unit 2	Unit 3	Unit 4	Unit 5	Unit 6	Unit 7	Unit 8	
Sample		Sample	Sample	H.S			Sample	Sand/Silt
Sample			H.S	Hearth	H.S		Sample	Cultural
Sample				H.S			Sample	Paleosol
								Sterile

Figure 3.1 - Simplified stratigraphy to outline sampling method. H.S (Hearth samples) are the samples located near the feature (hearth). Colour changes reflect different depositional contexts.

Banket sampling features entails obtaining samples from within, beside, above, and below the feature (see figure 3.1: unit 5). These samples will help the archaeobotanist determine the extent to which plant remains from inside the feature differ from the surrounding contexts and thus aid in determining if there is a direct cultural relationship between the feature and its floral content (Lennstrom and Hastorf 1995). Sampling around the feature helps determine issues such as contamination and disturbance. Samples from within the feature would be taken as point samples. Samples above, around, and below the feature will be taken as separate pinch samples. Sampling above a feature can sometimes be difficult as it is not always clear when an excavator is coming down onto a feature. To address this problem, it may be possible to collect a sample from above the feature within an adjacent unit that has not yet reached the feature depth. By exposing the feature in the wall between the two units, the feature depth can be determined in the adjacent unit and the sample that should be taken above the feature can be taken at the appropriate position. Changes in the stratigraphy need be noted, such as the start and termination of the feature. This will help determine if the feature presents itself in a different level within an adjacent unit, whereas, simply recording the depth where it was originally located may result in missing the opportunity to take samples. In cases where the feature is located against a baulk, then a sample can be taken from the baulk above the feature.

Sample collection followed Bryant and Holloway's (1983) guidelines. All sampling tools were cleaned prior to sampling. The sampling surface will be cleaned immediately prior to sampling by gently scraping the surface; this must be done with care as the thickness of stratum layers are hard to predict, and it is important not to contaminate the sample with sediment from

an adjacent stratum. The sample was then placed into a sterile paper bag in which all seams were taped to ensure integrity, and then the bag containing the sediment was placed inside a second sterile paper bag to reduce the chance of the bag ripping. Finally, the bag and the associated tag were labelled with the appropriate information discussed below. The sample was then placed in a designated area, so they were not lost or accidentally crushed. At the end of the day, all samples were taken to the University of Saskatchewan.

The samples were recorded through three main methods: sampling paperwork, sample bags and tags, and a photo logbook. The sampling paperwork was filled out by the student taking the sample; this included: the date, site, unit, the name of the excavator, sample provenience, type of sample, size of the sample, associated photo numbers, and the assigned sample number (see Appendix A). I provided the student with the photo numbers and the assigned sample number. On the back of the sample paperwork, there was a grid representing the unit; this enabled the student to draw the exact location of where the samples were taken from in a topographic orientation.

The next method of recording is the bags and tags for the sample. Tags were placed inside the second bag, not the bag containing the sediment sample, and the bag was labelled with a permanent marker. Information on the tag included date, site, unit, provenience, and assigned sample number. Due to the size of the samples, it is possible that not all of the sample would fit within one bag; there was space on the tag to put “bag _ of _”.

The final method of recording samples was the archaeobotanist’s photo logbook. Within this logbook, there are two lists. The first list was a master list of all the samples taken within the site. Beside the assigned sample number, there is a brief description of the sample. This description included the unit number, the context from which the sample was taken, and the Munsell sediment colour. The second list within the photo log was a list of the photos taken at the site. All photos were taken on one camera to ensure there are no duplicate photo numbers. Each photo number was written in the book with a short description about what the photo is; sample number, the direction the photo was taken in, unit number, depth, and the context the photo is taken. Each sample photo should have marked nails to showcase where the sample was taken from as well as a photo board, scale bar, and north arrow (or trowel pointing north). This information was input into an excel document every evening after excavation to act as a back-up for the information. All photographs were also uploaded onto a computer at the end of each day.

Samples were stored in paper bags to allow the sediment to air dry while they awaited flotation. This is important for a couple of reasons, the first being microbial degradation, and the second is mould growth. If a sample is stored wet, it can increase microbial degradation leading to the botanical remains being destroyed. Mould also likes damp environments, if mould starts to grow on the sample, it compromises researcher safety and can negatively affect the botanical remains. Samples were processed during the course of the field school to help with issues such as storage and to also show the field school students the flotation process.

Cultural and stratigraphic layers were identified at Wolf Willow based on prior experience derived from Dr. Ernest Walker's several years of excavation at the site, as well as by the recovery of culturally diagnostic artifacts. To help ensure that sediment samples could be directly related to cultural levels, samples were taken close to locations from which diagnostic artifacts, particularly projectile point types, were observed. In the absence of such artifacts, sediment samples were obtained from strata whose physical characteristics and depth have been previously associated with specific cultural layers.

3.2.3 Techniques for Collecting Sediment Samples

Regardless of sampling strategy employed, there are three commonly used sample collection techniques: point sampling, pinch sampling, and column sampling (Pearsall 2015). A point sample, called a bulk sampling by Lennstrom and Hastorf (1992), is a sample that is taken from a small, discrete area (Pearsall 2015). Lennstrom and Hastorf (1992) describe point sampling as being the best for recovering precise information on particular activities. Point sampling can be useful when the cultural context has already been defined or in small features where the boundaries of the feature are well defined. Examples of this could be thermal features or small midden pits.

Pinch sampling is when sediment is gathered from several locations within a defined context, with all these sediment pinches combined into one sample (Lennstrom and Hastorf 1992). For example, if there was one cultural activity across an entire 3 x 3m area, small samples would be taken across the area's surface and placed in one bag. Pinch sampling is appropriate for many situations, such as large features, arbitrary fill levels, floors, trash mounds, and pits (Lennstrom and Hastorf 1992), as it represents a context or stratigraphic layer as a whole rather than separate activities within one area (Pearsall 2015).

A column sample consists of a sequence of sediment layers, midden material, or floors within an excavation unit (Pearsall 2015). A column sample is typically taken from a profiled wall. The benefit of this sampling technique is that the samples do not need to be taken until after the unit is completed and each stratigraphic level has been defined. One problem with column sampling is that the samples only contain botanical remains from one small area of the excavation.

3.3 Laboratory Methods

Forty-one feature and non-feature sediment samples were processed for macrobotanicals remains using three different flotation methods (Tables 3.1-3.2). Sixteen of the samples were from the Red Tail site (14 feature and 2 non-feature) and 25 samples were from the Wolf Willow site (3 feature and 22 non-feature). Nineteen of these samples were subjected to recovery rate tests through addition of buoyant and non-buoyant seeds prior to processing. The author was not made aware of which samples these tests seeds were added to until after hand-sorting had been completed. Samples were floated at the University of Saskatchewan, but hand-sorting and analysis took place in the authors home office due to campus restrictions caused by the COVID-19 pandemic.

Site	Sample Number	Unit Number	Context	Processing Method	<i>Papaver somniferum</i> (Poppy)	<i>Nepeta cataria</i> (Catnip)	<i>Brassica oleracea</i> var. <i>italica</i> (Broccoli)
FbNp-10	9	123N 108E	Feature	Flote-Tech			
FbNp-10	10	123N 108E	Feature	Flote-Tech	x		
FbNp-10	14	124N 109E	Feature	Flote-Tech			
FbNp-10	17	120N 107E	Feature	Flote-Tech	x		
FbNp-10	19	123N 110E	Feature	Flote-Tech			
FbNp-10	20	123N 109E	Feature	Flote-Tech			
FbNp-10	21	124N 109E	Feature	Flote-Tech			
FbNp-10	22	124N 109E	Feature	Flote-Tech			
FbNp-10	23	123N 109E	Non-Feature	Flote-Tech			
FbNp-10	24	123N 109E	Non-Feature	Flote-Tech			
FbNp-10	12	120N 107E	Feature	I-DOT	x		x
FbNp-10	13	122N 113E	Feature	I-DOT	x		
FbNp-10	15	124N 111E	Feature	I-DOT	x		x
FbNp-10	11	123N 108E	Feature	Wet-Screening	x		
FbNp-10	16	124N 111E	Feature	Wet-Screening			
FbNp-10	18	124N 111E	Feature	Wet-Screening	x		

Table 3.1 - Red Tail sample table. "X" indicates seed type was added to sample to test recovery rates.

Site	Sample Number	Unit Number	Context	Processing Method	<i>Papaver somniferum</i> (Poppy)	<i>Nepeta cataria</i> (Catnip)	<i>Brassica oleracea</i> var. <i>italica</i> (Broccoli)
FbNp-26	8	20S 12E	Feature	Flote-Tech	x	x	
FbNp-26	2	9S 16E	Non-Feature	Flote-Tech			
FbNp-26	5	2S 17E	Non-Feature	Flote-Tech	x		
FbNp-26	25	12S 15E	Non-Feature	Flote-Tech			
FbNp-26	26	8S 16E	Non-Feature	Flote-Tech			
FbNp-26	27	9S 15E	Non-Feature	Flote-Tech			
FbNp-26	28	13S 16E	Non-Feature	Flote-Tech			
FbNp-26	29	10S 16E	Non-Feature	Flote-Tech			
FbNp-26	30	8S 15E	Non-Feature	Flote-Tech			
FbNp-26	31	12S 16E	Non-Feature	Flote-Tech			
FbNp-26	32	11S 16E	Non-Feature	Flote-Tech			
FbNp-26	33	12S 15E	Non-Feature	Flote-Tech			
FbNp-26	34	13S 16E	Non-Feature	Flote-Tech			
FbNp-26	35	13S 15E	Non-Feature	Flote-Tech			
FbNp-26	36	10S 15E	Non-Feature	Flote-Tech			
FbNp-26	37	12S 15E	Non-Feature	Flote-Tech			
FbNp-26	Control 4	3S 18E	Non-Feature	Flote-Tech	x		
FbNp-26	7	26S 11E	Feature	I-DOT	x		x
FbNp-26	3	2S 17E	Non-Feature	I-DOT	x		
FbNp-26	4	11S 15E	Non-Feature	I-DOT	x	x	
FbNp-26	Control 1	3S 18E	Non-Feature	I-DOT	x		
FbNp-26	Control 2	3S 18E	Non-Feature	I-DOT	x		
FbNp-26	6	50S 10E	Feature	Wet-Screen			
FbNp-26	1	8S 16E	Non-Feature	Wet-Screen	x		
FbNp-26	Control 3	3S 18E	Non-Feature	Wet-Screen	x		

Table 3.2 - Wolf Willow sample table. “X” indicates seed type was added to sample to test recovery rates.

3.3.1 Flotation

Background on Flotation Methods

Since flotation was introduced to New World archaeology in the 1960s (Pearsall 2015), many different separation systems and techniques have been developed, including manual flotation, machine-assisted flotation, water separators, and froth flotation. These various methods were developed to suit different purposes and different archaeological field and laboratory conditions (Pearsall 2015). Flotation methods are often chosen based on research questions, budget, and facilities available.

The Model A Flote-Tech[®], designed and manufactured by R.J. Dausman Technical Services Inc., is similar to the Ankara water separator machine developed and used in Turkey in 1971 (Pearsall 2015). These machines were created 1) to efficiently recover macroscopic materials in an unbiased manner, 2) to create a mechanical method that could be standardized and repeatable, 3) to combine the process of separation and recovery of buoyant and non-buoyant remains, and 4) to allow for large quantities of sediment sieving (Pearsall 2015). The

Flote-Tech® uses the floatation box and reservoir box to separate congealed sediment, clean non-buoyant remains, and float off organic or buoyant materials (Pearsall 2015).

The IDOT was developed by Gail E. Wagner for the Illinois Department of Transportation (IDOT) and the Dayton Museum of Natural History (Pearsall 2015; Wagner 1976, 1977). This allows floatation to occur on-site as in some cases it is easier to bring water to the sample rather than the samples to the floatation system, though the IDOT system does require an abundant water supply. Wagner (1982) experimented with several different screen sizes for the IDOT device to determine the best recovery rates, ultimately concluding that having 0.59mm mesh resulted in the best recovery, reaching 87.5%. The screen mesh subsequently changed on the sides of the device to 0.42mm while the bottom stayed at 0.59mm resulting in an (interpretable equal) 87% recovery rate.

Hunter and Gassner (1998) compared recovery rates for the Flote-Tech® and IDOT devices. They used two different screen sizes on the Flote-Tech® but did not process their own samples with an IDOT device, instead relying on published accounts comparing the recovery rates of several different screen variations and sediment types, including Wagner's (1982) research presented above. For the Flote-Tech® they processed samples using 1mm and 0.5mm mesh (Hunter and Gassner 1998). The best recovery rate of 98% derived from processing loamy fine sand in an IDOT with 0.5mm mesh on all sides (Hunter and Gassner 1998; Hunter and Umlauf 1989).

Wet-screening or wet-sieving is commonly used on waterlogged sediments in Central Europe (Pearsall 2015; see also Badham and Jones 1985; Tolar et al. 2010), and has been implemented in the New World as well (Dye and Moore 1978; Wagner 1988). Dye and Moore (1978) used a single screen with 1/8-inch mesh, and they pushed sediment through the screen with trowels. Wagner (1988) discussed the use of geological nesting screens and a very fine water stream to gently spray materials through the various screens. Wagner (1988) does not recommend any type of wet sieving for botanical remains as the fragility of organics results in fragmentated organic remains. Rather, she suggests wet sieving is better suited for recovering ceramics, lithics and bone (Wagner 1988). Nevertheless, wet-screening is still often used for the processing of botanical remains (see Hosch and Jacomet 2001; Hosch and Zibulski 2003). To assess this technique, I used geological nesting sieves and did not force the material through the screens.

Assisted Flotation with the Model A Flote-Tech[®]

The Flote-Tech[®] is made up of two main sections (see Figure 3.2 for diagram). The flotation side has a basket with 0.5mm mesh fastened to its bottom to allow water to flow freely through the device. There are also small aeration pipes underneath the flotation basket to aid in breaking up the sediment. A metal baffle can be attached to the inside of the basket to increase and decrease the water flow and therefore the rate at which water carrying floating organics flows into the second section. The second section is the reservoir side. The catchment tray, to which a fine mesh cloth is attached, catches the small organics that float over from the flotation side. Water is pumped from the reservoir side to the bottom of the flotation side, where it rises through the basket, completing the loop.



Figure 3.2 - Flote-Tech[®] diagram. A: flotation basket where sample is added, B: reservoir side, and C: catchment tray with fine mesh attached. Photo by E.Coward.

To use the Flote-Tech[®], it must be filled from the flotation side (see Figure 3.2). The Flote-Tech[®] is full when the water level reaches 1 inch below the top of the catchment tray after

which the pump is primed. The Flote-Tech[®] is then turned off and is ready for use. A fine mesh cloth (90 µm) is clipped onto the catchment screen to receive specimens released during the flotation process. Sediment is added to the flotation side and the pump is turned on. As the water level rises the metal baffle is slowly removed from the basket to facilitate the flow of water into the reservoir side and to allow the floating organics to flow over onto the light fraction mesh (Figure 3.2).

The sediment sample is measured in a large measuring cup, and all the sample information is recorded on the flotation sheet (Appendix B). The index card that came out of the original sample is placed inside a plastic bag and placed on the drying trays to await the heavy and light fraction of the processed sample.

Aeration and manual manipulation help break up the sediment, releasing organic remains. When there are no longer any organics floating over to the fine fraction screen, the aerator is turned off, followed by the pump. The mesh containing the floated material is tied shut and placed on a drying tray with its identification card.

To obtain the heavy fraction of the sample, the large metal tray is taken off from the side of the Flote-Tech[®] and attached to the edge of the reservoir side to create a work surface (Figure 3.3). The 90µm mesh is then replaced onto the screen in the reservoir side. The flotation basket was then removed and placed on the tray. At this point, some of the heavy fraction in the bottom of the basket starts to come out when the screen on the bottom of the flotation basket was gently tapped. To recover the remaining heavy fraction, the Flote-Tech[®] was turned on to get the water hose to work. The basket is then washed out with the spray nozzle to remove any non-buoyant botanicals as well as any artifacts that may have made it into the sediment sample. Once the basket is cleaned out, it is placed in the sink to be wash and to await the next sample. The tray attached to the reservoir is then tipped up and sprayed off. The mesh was then removed the same way as the light fraction, and it is also placed on the drying tray.



Figure 3.3 - Flote-Tech® with extended workspace; used for recovering heavy fraction from bottom of flotation basket. Photo by E.Coward.

As the Flote-Tech® is designed to reuse the water several times, multiple samples were processed before replacing the dirty water with clean water. This is one of the advantages to the Flote-Tech® as it considerably reduced the amount of water required. However, sediment that has a larger clay content or that is a darker colour due to higher organic content, caused the water to become dirty quite quickly. On average, these types of samples only allowed 4 or 5 samples to be processed before having to change the water within the Flote-Tech®. If the sediment is a light silty or sandy matrix, the water would stay “cleaner” for longer, and roughly 8 to 10 samples could be processed before changing the water. Water was always changed when organics, which are typically black because of charring, became difficult to see during flotation.

To removed soiled water from the Flote-Tech®, the machine needs to sit idle for approximately five days or longer to allow suspended fine sediment to settle out. The sump-pump on the side of the Flote-Tech® is used to remove most of the water from the unit; the remaining sediment and small amount of water left in the Flote-Tech® can then be vacuumed up using a shop vacuum meant for wet or dry conditions. Finally, the inside of the Flote-Tech® was

rinsed with a spray nozzle to remove any remaining sediment, and it was then vacuumed once again.

Once the samples were dried, they were sieved through geological nesting screens to create size classes of 2mm, 1mm, and 0.5mm. Each size class was then hand sorted.

Manual Flotation with the IDOT Device

The IDOT style flotation device was fabricated by the University of Saskatchewan Engineering Shops, following instructions provided by the author. The IDOT device has 0.2mm mesh and was built from stainless steel so it could be used in saltwater environments. The 0.2mm mesh was selected to capture smaller seeds such as *Nicotiana tabacum* (tobacco). However, it quickly became apparent that a two-step process employing an IDOT device with 0.5mm mesh followed by the 0.2mm device would facilitate both processing and sorting.

The IDOT device was placed on two wooden boards inside a filled water tank. Once all the appropriate sample information is recorded the IDOT device is placed halfway into the water and manually moved from side-to-side to agitate the water (Pearsall 2015). Sediment is slowly poured into the device, and the device is again moved in a side-to-side motion. If processing was conducted by one person, the device was then placed on two wooden boards resting a few inches from the top of the water. This helps the botanicals float to the top (Pearsall 2015). If two people were processing, the device would continue to be gently agitated by the second person (Figure 3.4). The floating botanicals are then scooped out with a fat skimmer in an S motion with the scoop tilted upward slightly. The skimmer is then emptied onto a fine-mesh (90µm; the same mesh using in the Flote-Tech[®]) which was attached to the top of a bucket. The skimmer was then rinsed off with a gentle spray nozzle over the bucket with the 90µm mesh, catching any remaining botanicals that were on the skimmer. If this step is skipped, organics would go back into the IDOT. Once there are no more botanicals floating on the water surface, the IDOT device is agitated again, and newly released botanicals are skimmed off the top. Agitating and skimming are repeated until no floating botanicals are observed. On average, four rounds of agitation and skimming, taking about half an hour, were required to remove all organics. The device is then moved in an up and down motion to force semi-buoyant materials to rise off the screen, followed by a deeper pass with the skimmer to collect the semi-buoyant materials. The process is the same for two people except the two wooden boards are removed, and the person agitating the water

remains holding the device in the water. When all the organics were captured, the light fraction mesh was bundled up, tied with string and placed on the drying trays with the sample information.



Figure 3.4 – (A) IDOT flotation with one person using wooden boards. Photo by E. Coward. (B) IDOT flotation with two people, one person agitates device and other person skims off organic material. Photo by B. Halyk.

To clean out the heavy fraction from the IDOT, the IDOT was removed from the water and placed upside down on a tray that was lined with 90µm mesh fabric. The IDOT was then rinsed out with a gentle spray nozzle. Once the heavy fraction was captured in the mesh, it was bundled and tied with string at the top. It was then placed on the paper towel lined drying trays with the sample information. As with the Flote-Tech® samples, once the samples dried, they were bagged for storage and then sifted through geological nesting screens into size classes of 2mm, 1mm, and 0.5mm for hand-sorting. On average, two to three samples could be processed in the large tub before changing the water.

Deflocculation

One of the clay control samples was deflocculated using baking soda (see Pearsall 2015:89). To make a 10% baking soda solution, 100g of baking soda was needed for every

1000mL of warm water (Pearsall 2015). It is used at a 1:1 ratio of solution to sediment (i.e., 1000g of sediment needs 1000mL of solution). Sediment soaks in the solution for half an hour. This period was chosen as prolonged soaking waterlogs charcoal and seeds, decreasing their ability to float, and may also increase the speed of microbial degradation (Pearsall 2015). After deflocculation, the sample was processed as above. Although deflocculation made it easier for the clay-rich sediment to separate, the organics did not float as well, presumably from some degree of waterlogging, remaining suspended about 3cm under the surface. This increased the difficulty to capture all the floating organics as one could not see them as easily.

Deflocculation only occurred with the IDOT device as deflocculation is not necessary in the Flote-Tech® as it is equipped with aeration vents to assist in sediment disaggregation; deflocculation is not relevant to wet-screening. Pearsall (2015:89) discusses the problems of flotation after deflocculation as the slurry of soil and water may have waterlogged organic materials. She found that the organic material remained in the heavy fraction after deflocculation with the use of a manual flotation system. Pearsall (2015:90) suggested using an IDOT device with a fine-mesh screen on deflocculated sediments to combat the loss of organic materials. Thus, the 0.2mm mesh screen on the IDOT device was a logical choice.

Wet-screening

This method is loosely based on the method documented in the Macrofossil Processing Laboratory Manual (MPLM) prepared by the Quaternary Environments Laboratory (QEL) at the Royal Alberta Museum (RAM) (QEL 2018). The method was adapted to better suit the archaeological samples from WHP, and the research questions posed.

Rather than soaking the sample overnight in distilled water like the QEL does, samples were worked while dry. This was due to the lack of storage available at the University of Saskatchewan for the now waterlogged organic materials, as these organics need be stored in a cool, moist environment to preserve seed and charcoal integrity (QEL 2018).

Sediment samples were measured using a large measuring cup, and all the sample information was recorded. Drying trays were lined with paper towels, and size classes were labelled on the paper towel with a permanent marker. Geological nesting sieves of 90µm (bottom), 125µm, 250µm, 500µm, 1mm, and 2mm (top) were placed on two wooden boards overtop a bucket (QEL 2018) (Figure 3.5). The dry sample was then poured into the nesting

sieves in 250mL increments. These smaller volumes facilitated processing by not clogging the screens as quickly as each nesting sieve was rinsed clean over the appropriate assigned bucket (see below) after each 250mL increment. The sample was washed gently through each sieve with a spray nozzle (Figure 3.5). After the water passing through the sediment sample ran clear, indicating that all material smaller than the screen mesh had been removed, each screen was tipped upside down onto 90µm mesh attached to a bucket by four clothespins. This allowed the screens to be gently rinsed out. The mesh had to be pulled tight to place the sieve on top, otherwise the sieve would collapse the mesh into the bucket. These steps were repeated for each 250mL of sediment until the sample was complete. Once the entire sample was processed, the mesh on the buckets was removed, and the size classes were tied at the top with a string and placed on the drying trays next to the appropriate size class label. Once dried they were hand-sorted.



Figure 3.5 - Wet-screening using a gentle spray nozzle and geological nesting screens. Photo by B. Halyk.

However, because the sample could not be processed all at once, this method requires a constant stream of fresh water, making this method more wasteful of water than the other

methods. A 2L sediment sample using the nesting sieves would fill as many buckets of water as emptying the Flote-Tech[®], which processed approximately seven samples before the water needed to be changed.

Departures from Standard Practice

As sample processing was conducted there was one small issue with the IDOT system. Initially, IDOT flotation was conducted by one person, as Pearsall (2015:61) outlines. However, after processing one sample alone, it became abundantly clear that it was easier to conduct this flotation style with two people, one person would agitate the IDOT device and hold it within the water while the other person skimmed out the floating organics.

Another departure from the standard practice was for wet-screening. After the first sample was processed, it became clear that the 90 μ m nesting sieve was not appropriate for these samples. Sediment clogged this screen size. Further, when the sieve was emptied onto the mesh material to collect remaining sediment and organics, the material recovered in the nesting sieve would flow through the fine mesh. The QEL, MPLM (2018) indicates that the 90 μ m nesting sieve was used primarily as an extra precaution to catch any macrobotanicals that may have gone through the 125 μ m sieve. However, Birks (2017) identifies that only a 125 μ m sieve is required to catch the smallest of seeds. In terms of this project, the smallest seed that was expected to be captured was a *Nicotiana tabacum* (tobacco) seed, which is approximately 0.25mm (250 μ m) in size (Montgomery 1977). Thus, if the *N. tabacum* was able to pass through the 250 μ m sieve it would indeed be captured by the 125 μ m sieve. As a result, the stack to nesting sieves then became 125 μ m (bottom), 250 μ m, 500 μ m, 1mm, and 2mm (top) for the remainder of wet-screening.

Other problems with the wet-screening method were that because the samples were not water-logged, this method was quite time-consuming as the water does not easily pass through the finer mesh because the screens are full of sediment. As a result, there was lots of waiting for the water to drip through the sediment to ensure the screens would not overflow and risk losing organic remains. This is also why samples were processed in 250mL increments, these smaller sub-samples made the sample processing more manageable, and it also sped up the processing as the screens did not become overloaded with sediment.

3.3.2 Recovery Rate Test

To test recovery rates of these three methods, a Poppy Seed Test was conducted (Pearsall 2015; Wagner 1982). *Papaver somniferum* seeds were chosen as they are not native to the area, they are easy (and inexpensive) to purchase from the local grocery store, morphologically they are quite distinctive, and consequently are unlikely to be confused with other seeds. Further, the size of the seed, at 0.7 - 1.4mm, is similar to many of those found in archaeological contexts (Wagner 1982). *Nepeta cataria* and *Brassica olerancea* var. *italica* seeds are also not native and morphologically distinct but are also non-buoyant thereby providing a good baseline for other non-buoyant high-density seeds.

P. somniferum seeds were counted into lots of 100, and the *N. cataria* and *B. olerancea* var. *italica* seeds were counted into lots of 50. According to Wagner (1982), control seed recovery tests do not represent a recovery rate exactly comparable to archaeological seeds as the charred control seeds are not necessarily charred to the same degree as archaeological specimens, nor are they thoroughly mixed or coated in the matrix. Therefore, recovery rates may not precisely reflect recovery rates of all archaeological macrobotanicals, but it does indicate if there are potential concerns that might be affecting recovery of archaeological materials. It is also a useful tool to determine recovery effectiveness and consistency between the various flotation systems, methods employed, and personnel (Wagner 1982).

Experimentation with different methods of charring *P. somniferum* seeds allowed determination of the most appropriate charring method for the laboratory equipment available. This same method was then used to char the *B. olerancea* var. *italica* and *N. cataria* seeds. The first method as described by Pearsall (2015) involves baking the seeds at 400-500°C for 5-15 minutes depending on seed sizes. *P. somniferum* seeds were placed in tinfoil, and the muffle furnace vent was closed to create a reducing atmosphere, mimicking an archaeological hearth (Pearsall 2015). Five-minute increments at 400°C all failed to produce viable results as the *P. somniferum* seeds stuck to the tinfoil and were unable to be removed without suffering damage.

The second method as described by Hather (1991) involved charring specimens in a wood ash or sand matrix at 250-500°C for 2.5-4 hours. These matrices also create a reducing environment (Hather 1991; Pearsall 2015). Sand was selected as it was more readily available than wood ash. It was found that charring specimens at lower temperatures for longer periods of time reduced the number of specimens that ruptured or burnt to ash. Interestingly, this was not

dependent on whether the seeds were placed in empty tinfoil crucibles or in sand. Both methods reduced the number of ruptured specimens, however, there were a higher number of complete seeds produced with the sand method as they were subject to a greater reducing environment, similar to that of a hearth. Given these results, Hather's (1991) method was chosen.

P. somniferum seeds were placed in sand, and then they were put in the muffle furnace at 250°C for 2.5 hours. Unfortunately, larger sand granules and smaller pebbles made *P. somniferum* seed retrieval almost impossible as screening could not easily separate the seeds from these larger grains. The seeds then became difficult to spot within the matrix of sand and pebbles left in the screen. Consequently, the sand was pre-screened through a 500µm sieve to remove large granules and only the <500µm sand was used in charring. After baking and cooling, the sand and *P. somniferum* seeds were sieved through the 500µm sieve allowing the *P. somniferum* seeds to be readily separated from most of the sand as the seeds remained in the sieve. It is important to only use the sand for one charring process as the sand particles would readily stick to the seeds when the sand was reheated. The *P. somniferum* seeds had few issues with sand adhering to them, but the *N. cataria* and *B. oleracea* var. *italica* almost always had sand grains stuck to them. It was time-consuming and difficult to chip sand off the seeds without damaging them.

Once seeds were counted into lots, they were added by a third party to samples they randomly selected to ensure that the researcher was unaware of which samples contained the *P. somniferum* and other added seeds, thereby preventing the researcher from treating these samples differently, intentionally, or not, then the rest of the sediment samples. Only after all samples were floated was the researcher notified as to which samples contained the added seeds.

3.3.3 Hand-Sorting and Identification

According to Siegfried (2002), hand-sorting is a process that is very subjective. Each person develops their own way of hand-sorting that best suits them. For a specific example, see Siegfried (2002:62-64).

New sample cards were made with site, unit, depth, size class, laboratory sample number, method of processing, and light or heavy fraction information; this allowed the original cards to stay with the sorted sediment while the new cards provided information relevant to the organic materials removed from the sediment. A hand-sorting form listing seed or charcoal identification,

catalogue numbers, count, fragment (or weight) and any comments was completed for each sample (Appendix C). A small foam board tray with horizontal reference lines drawn across it at 2.5cm increments was used for sorting (Bohrer and Adams 1977). Volume for each size class was recorded then evenly distributed across the tray. As observed, seeds and charcoal were placed in labelled glass half dram vials. Using glass vials for storage reduces static and makes it easier to remove specimens for future analysis (Pearsall 2015). Seed coats were counted as a single seed if there was 75% or more of the seed coat present. On occasion, it was even possible to find seed coats that could be refitted, refitted specimens were also counted as a single seed.

After each size class was sorted, vials were sealed and placed in an artifact bag with an index card repeating provenience information. This bag was then placed in a larger bag with another index card indicating all the site and sample information. This larger bag would hold all the seeds and charcoal collected from all the size classes and fractions of one sediment sample. After the tray was sorted, the remaining sediment was placed back into its bag, and the bag was then put into artifact boxes for any possible future processing or identification, such as forensic entomology as deceased bugs were found in several samples.

The 0.5mm mesh attached to the bottom of the flotation basket on the Flote-Tech[®] allowed sand to pass through the mesh more readily than the 0.2mm mesh on the IDOT, resulting in more gravel materials in the heavy fraction of the Flote-Tech[®] rather than larger sand granules like the IDOT heavy fraction. Due to the large number of samples as well as the difference in heavy fraction materials of the Flote-Tech[®], only 30% of the Flote-Tech[®] heavy fraction samples were hand-sorted. These samples were randomly selected, other than the control sample and two other samples that indicated errors when processing (see Section 3.5). The samples selected for heavy fraction hand-sorting were control 4, samples 5, 8, 10, 22, 29, 34, and 37. All Flote-Tech[®] light fractions were hand-sorted. All the light and heavy fractions for the IDOT were hand-sorted, as the heavy fraction for the IDOT samples were quite large. The wet-screening samples did not have heavy and light fractions, so all size classes were hand-sorted.

3.3.4 Analysis

Once all samples were hand-sorted, materials were identified and photographed using a Zeiss 305 stereoscope with an Axiocam 103 colour camera attached, using ZEN software.

A small reference collection of seeds acquired from the Germplasm Resources Information Network (GRIN) at no cost, other than customs brokerage fees, was created to facilitate identification. Published sources such as Martin and Barkley (2000) and Montgomery (1977) were also consulted. During the identification process, previously collected and hand-sorted seeds were further investigated, revealing that some of the seeds that were originally identified as two different species, were actually the same species, while other ‘seeds’, when viewed under the microscope, proved to be deceased insects or clumps of sediment.

Charcoal identification involved snapping the piece of charcoal to obtain a fresh face. It was identified by placing it upright, with the cross-section presented, in a Petri dish full of sand. Identification was facilitated by comparison with a small charcoal reference collection of woody materials previously collected from WHP (Furlotte 2020) and by comparison to images in Hoadley (1990). While identifying woody taxa, the *Salix/Populus* type was identified as type 1, meaning the charcoal had fewer and smaller pores, and type 2, which had more and larger pores (Stuart and Walker 2018). Identifiable pieces of charcoal were placed into new vials with new catalogue numbers, and the identifiable pieces were added to the hand-sorting forms. The number of identifiable pieces was then subtracted from the unidentifiable count, in which all charcoal pieces were originally included. Once identification was complete, each vial of identified and unidentifiable charcoal was weighed.

3.4 Recovery Rate Results

Recovery rate results are summarized in tables 3.3 – 3.8. Cross-sample contamination is apparent with the Flote-Tech[®] as neither sample 9 nor 14 had *P. somniferum* seeds added (Table 3.3). For those samples in which seeds were added, control sample 4 had a significantly lower recovery rate than the other samples while sample 17 had roughly a 10% lower recovery rate. Samples 5, 8, and 10 had similarly high recovery rates.

Sample Number	Sediment in Liters	<i>P. somniferum</i> Recovery in Light Fraction (%)	<i>P. somniferum</i> Recovery in Heavy Fraction (%)	Total <i>P. somniferum</i> Recovery (%)
Control 4	3L	14%	1%	15%
Sample 5	2L	88%	1%	89%
Sample 8	1L	87%	1%	88%
Sample 9	1.5L	1%	0%	1% (Contamination)
Sample 10	1.5L	86%	3%	89%
Sample 14	2L	1%	0%	1% (Contamination)
Sample 17	1L	79%	0%	79%

Table 3.3 - Flote-Tech® recovery rates of *P. somniferum* and sample size in litres.

Like *P. somniferum*, contamination is also present in sample 5 as no *N. cataria* (non-buoyant) seeds were added to this sample but were recovered (Table 3.4). Sample 8 also had a disappointing recovery rate of 44%. Aside from the discrepancies caused by cross-sample contamination, an average of 71% of the *P. somniferum* seeds and 44% of the *N. cataria* seeds were recovered, though the *P. somniferum* average is heavily affected by one sample with unusually low seed recovery and only one sample had *N. cataria* added.

Sample Number	Sediment in Liters	<i>N. cataria</i> Recovery in Light Fraction (%)	<i>N. cataria</i> Recovery in Heavy Fraction (%)	Total <i>N. cataria</i> Recovery (%)
Control 4	3L	N/A	N/A	N/A
Sample 5	2L	2%	2%	4% (Contamination)
Sample 8	1L	40%	4%	44%
Sample 9	1.5L	N/A	N/A	N/A
Sample 10	1.5L	N/A	N/A	N/A
Sample 14	2L	N/A	N/A	N/A
Sample 17	1L	N/A	N/A	N/A

Table 3.4 - Flote-Tech® recovery rates of *N. cataria* and sample size in litres.

The IDOT method produced consistent recovery rates of *P. somniferum* with returns averaging 94%. However, ‘only’ 78% of the seeds were recovered from sample 7 (Table 3.5).

Sample Number	Sediment in Liters	<i>P. somniferum</i> Recovery in Light Fraction (%)	<i>P. somniferum</i> Recovery in Heavy Fraction (%)	Total <i>P. somniferum</i> Recovery (%)
Control 1 (baking soda)	3L	59%	30%	89%
Control 2	3L	54%	41%	95%
Sample 3	2.5L	94%	4%	98%
Sample 4	3L	91%	5%	96%
Sample 7	0.8L	73%	5%	78%
Sample 12	2L	94%	2%	96%
Sample 13	2.25L	100%	0%	100%
Sample 15	2.5L	96%	3%	99%

Table 3.5 - IDOT recovery rates of *P. somniferum* and sample size in litres.

Recovery of the *N. cataria* seeds from the IDOT method are quite interesting. Although there is a relatively good recovery rate of 86%, unsurprisingly, due to the non-buoyant nature of

the seed, 36% of the seeds were recovered from the heavy fraction while 50% was recovered in the light fraction (Table 3.6). The recovery of the non-buoyant seeds in the IDOT method produced relatively consistent results with about a 10% difference in recovery rates between the two seed types. Samples processed with the IDOT resulted in recovering an average of 97% of the *B. oleracea* var. *italica* and 86% of the *N. cataria* seeds (Table 3.7 and 3.6).

Sample Number	Sediment in Liters	<i>N. cataria</i> Recovery in Light Fraction (%)	<i>N. cataria</i> Recovery in Heavy Fraction (%)	Total <i>N. cataria</i> Recovery (%)
Control 1 (baking soda)	3L	N/A	N/A	N/A
Control 2	3L	N/A	N/A	N/A
Sample 3	2.5L	N/A	N/A	N/A
Sample 4	3L	50%	36%	86%
Sample 7	0.8L	N/A	N/A	N/A
Sample 12	2L	N/A	N/A	N/A
Sample 13	2.25L	N/A	N/A	N/A
Sample 15	2.5L	N/A	N/A	N/A

Table 3.6 - IDOT recovery rates of *N. cataria* and sample size in litres.

Sample Number	Sediment in Liters	<i>B. oleracea</i> var. <i>italica</i> Recovery in Light Fraction (%)	<i>B. oleracea</i> var. <i>italica</i> Recovery in Heavy Fraction (%)	Total <i>B. oleracea</i> var. <i>italica</i> Recovery (%)
Control 1 (baking soda)	3L	N/A	N/A	N/A
Control 2	3L	N/A	N/A	N/A
Sample 3	2.5L	N/A	N/A	N/A
Sample 4	3L	N/A	N/A	N/A
Sample 7	0.8L	96%	2%	98%
Sample 12	2L	90%	7%	97%
Sample 13	2.25L	N/A	N/A	N/A
Sample 15	2.5L	90%	9%	99%

Table 3.7 - IDOT recovery rates of *B. oleracea* var. *italica* and sample size in litres.

The wet-screen samples produced a recovery rate of 86% of the *P. somniferum* seeds. Sample 11 produced the lowest recovery rate of 75% whereas the control sample 3 produced the highest recovery of 96% (Table 3.8).

Sample Number	Sediment in Liters	Total <i>P. somniferum</i> Recovery (%)
Control 3	2.5L	96%
Sample 1	4L	82%
Sample 11	2L	75%
Sample 18	1.5L	90%

Table 3.8 - Wet-screen recovery rate and sample size in litres.

3.5 Recovery Rate Discussion

While discussing recovery rates it is important to understand the difference between a good and poor recovery rate. A literature review did not provide a standardized means for identifying a poor versus good recovery rate, therefore for the purpose of this project, anything above 80% was classified as a good or high recovery rate. A recovery rate between 50-80% was a moderate recovery rate and anything below 50% was considered a poor recovery rate. These values are not based on objective criteria, but rather the author's subjective opinion based on how variation in seed recovery rates seems likely to affect interpretation.

Hunter and Gassner (1998) indicated that the mean recovery rate for the IDOT device was 90% with a 0.5mm screen size. The smaller 0.2mm mesh used in the IDOT device for this research may result in the slightly higher 94% recovery rate. Their (1998) research also indicated that with a 0.5mm screen size, the Flote-Tech[®] produced the best results with a 96% average recovery rate. Thus, it was a bit surprising that the Flote-Tech[®] had the lowest recovery rate in the current analysis.

Although the Flote-Tech[®] average recovery rate is disappointing, it is important to note that the control sample greatly affected the overall average recovery. If this sample is removed, the average becomes 89%, which is a good recovery rate. The control sample results cannot be disregarded, however, as it adds valuable information. This sample showcases the potential

importance of sample matrix (sediment) in relation to seed recovery. Most of the samples collected from the Red Tail and Wolf Willow sites had high concentrations of sand or silt making flotation quite easy. The control sample was a clay rich sample, indicating that this type of sample may not be best suited for flotation in an assisted flotation device, but rather a manual flotation device. When comparing the results of the control samples between the Flote-Tech® and the IDOT, it can be noted that the IDOT recovery rates were significantly higher at 89% with the deflocculated sediment and 95% when the sample was not deflocculated whereas the Flote-Tech® returned only 15%. These staggering differences could indicate the importance of method or even screen size.

Similarly, sample 7, which was processed in the IDOT had a lower recovery rate of 78% while other samples processed with this device ranged in recovery from 89-100%. Sample 7 contained sediments consistent with other sediments found at the Wolf Willow site, rather the volume of the sample was significantly smaller at 800mL. Other samples collected from Wolf Willow averaged between 1.5-2.5L. Indicating, that sample volume may somehow affect the recovery rate. Although, this outcome could be coincidental, it is still intriguing that the recovery rate is lower with the smaller volume of sediment.

Not only did the Flote-Tech® exhibit issues of contamination in samples 9 and 14; after processing sample 8 and 10, the author observed a small number of organics float onto the catchment tray while preparing the Flote-Tech® for the next sample. This occurred during the period where the Flote-Tech® was turned on to allow the tanks to equalize before adding the next sample. This again indicates the potential for contamination with the Flote-Tech®. There is no indication as to how the organics remained within the machine; nor did the operator conduct the processing differently for these two samples. The flotation basket and the tray to catch the light and heavy fraction were cleaned in a clean laboratory sink using fresh water from a spray nozzle between each sample, ruling out that the organics were coming from either of those items. It is unclear how the organics remained in the water, but it could be possible for a small clump of sediment to have gotten stuck on the underside of the flotation basket as the water was flowing into the catchment tray. Another possibility is that the materials somehow got trapped at the bottom of the flotation basket and they were able to pass through the mesh on the bottom. Then the organics ultimately came back up the surface once they became dislodged when the flotation basket was removed or replaced into the tank. Hunter and Gassner (1998:153) also discussed that

cross-contamination could be a possibility as the Flote-Tech[®] has a closed water system, but they did not note cross-contamination within their samples.

The Flote-Tech[®] did recover more charcoal from samples than any other method. Arguably, these samples could have contained more charcoal than other samples. However, samples with similar contexts or located in the same stratum did not return as much charcoal under other processing methods. This raises the question of where the charcoal went in the other methods. The wet-screening method has proven to have issues with fragmentation, and it is entirely possible that the charcoal became more fragmented in this method. Meaning the charcoal could still be present in the sample, but it was too small or fragmented to count while hand-sorting was being conducted. The IDOT method is a little bit harder to conceptualize as to what happened to the charcoal. The manual aggregation is a gentle process, fragmentation was not noted with this method. The scoop used to skim the surface of the water to capture the organics collected seeds smaller than the charcoal fragments that were being collected. Theoretically, the charcoal should have been in the heavy fraction if it was not in the light fraction, but that was not the case. It is possible that the samples selected for the IDOT could have less charcoal in them compared to the Flote-Tech[®] samples as the samples being compared were not from the exact same location. To have a fair comparison, a sample should be subdivided in a riffle box and one sub-sample processed in the IDOT and the other in the Flote-Tech[®].

It could be argued that the Flote-Tech[®] method is better suited for charcoal analysis; however, with the noted issues of contamination, this method could prove to be unreliable as it could become difficult to identify materials travelling between archaeological contexts if charcoal is also somehow becoming trapped within the Flote-Tech[®]. Analysis of samples with known amounts of charcoal of from different taxa and of different sizes would be required to determine the validity for successful charcoal analysis.

The IDOT method had the highest recovery rate for both the non-buoyant and buoyant seed types. However approximately half of the non-buoyant *N. cataria* seeds were recovered within the heavy fraction. Although, it came as no surprise as the method for suspending semi-buoyant remains in the IDOT device required quick, yet efficient, scooping as the organic materials would not stay suspended for long (see Section 3.3.1). Given that the seeds chosen for analysis were non-buoyant, it is an important reminder that both the light and the heavy fractions should be analysed as these results indicated that approximately half of the seeds were found in

the heavy fraction. It is also possible that not all the non-buoyant materials could become suspended within the IDOT device as the size of the heavy fractions were quite large. Given that the screen size (0.2mm) on the device did not allow large sand particles to be emitted from the device, it is possible that organics were trapped under the large amount of sand retained at the bottom of the IDOT. It would be interesting to compare the recovery of non-buoyant organics within the IDOT method using a large screen size (0.5mm) on the device.

Another observation with the IDOT method was the lower recovery rate of *P. somniferum* in control sample 1. Although the recovery rate was still high with 89% of the *P. somniferum* seeds recovered, it did produce a lower recovery rate than control sample 2 with 95% recovery. This discrepancy could be indicative of the deflocculation method used with control sample 1. The baking soda deflocculation used on control sample 1 required the sediment sample to soak for a short period of time (see Section 3.3.1). Soaking the sample could have contributed to the change in recovery via waterlogging.

The wet-screen method produced acceptable recovery rates with 86%. However, it is very important to note that organic remains were more heavily damaged by this method than by the others. Most likely this is due to the water forcing organic materials and sediment through the screen (see also Hosch and Zibulski 2003). It was observed that this method did present more seed coats of *P. somniferum* than other processing techniques.

Each of these methods has advantages and disadvantages to processing archaeological sediments. For example, the Flote-Tech® allows for large volumes of sediment to be processed quite quickly and it only requires one person for processing. This method also uses less water as the water within the device can be used on several samples and the organic remains that are recovered from this method are not as fragmented as the wet-screening method. However, contamination was an issue within this sample set, and it should be kept in mind while processing. The Flote-Tech® also had lower recovery rates than any of the other methods used, especially in terms of non-buoyant materials. There is also a larger upfront cost to purchase this device which can have a large impact on a research budget.

In terms of the IDOT device some of the advantages are the higher recovery rates and the portability making field flotation a possibility wherever there is access to clean water. This device is also less costly. However, the IDOT does take significantly longer than the Flote-Tech® to process a sample, and it cannot process as much sediment at a time. It also produces a larger

heavy fraction, at least if using a 0.2mm screen, resulting in longer hand sorting times in the laboratory. Finally, this method can be done by one person, but it is far easier to have 2 people for processing.

The wet-screen method is probably the most cost efficient out of all the methods as many archaeological laboratories already have geological nesting sieves. This method can be done by one person, and it still produces a high recovery rate. However, the wet-screen method does require a constant stream of clean water and it takes a very long time to process one sample. Perhaps of greatest concern is that this method produces more fragmented organic remains (i.e., does more damage to organic materials) which can ultimately alter the results of the analysis especially when the organic materials are extremely fragile (see also: Marekovic and Sostaric 2016).

3.6 Conclusions

Based on the recovery rates of sediment samples from both the Red Tail and Wolf Willow sites, the preferred processing method for this sample set was with the IDOT device. The IDOT device produced the highest recovery rate of both the buoyant and non-buoyant seed types. It would be incorrect to say the IDOT method is the best, as it may not suit every context or research goal. Although there are a few problems to this method, such as needing a second person assist in flotation, the longer time it took to process the sample, as well as the longer time spend hand-sorting the heavy fractions due to the 0.2mm mesh size selected for this project, this method was still better suited for this sample set. Future research with the IDOT method should explore recovery rates between the 0.2mm screen size used for this project and a large screen size such as a 0.5mm screen. Other types of deflocculants should also be tested when performing flotation on clay rich sediments to determine the reason for the loss of organics expressed in this project.

Although the other methods had lower recovery rates and other disadvantages that made them less suitable for flotation analysis of the samples in this project, they still have other important purposes. The Flote-Tech[®] recovers significantly more charcoal, suitable for topics surrounding fuel use. However, it is important to determine how contamination is occurring in this device. It is possible that contamination just occurs in this particular Flote-Tech[®] machine. The wet-screen method is most appropriately used when processing water-logged sediments as

organic materials will no longer float. Ultimately, when choosing a method, it is important to keep research goals in mind.

Chapter 4 - Feature and Non-feature Results, Discussions, and Summary of Recovery Rates

4.1 Introduction

This chapter presents the results of the analysis of flotation and wet-screen samples and the organic material recovered from sediment samples taken at both the Wolf Willow and Red Tail sites. As discussed previously (Chapter 3.3.1), samples were separated into size classes using geological nesting screens. Charcoal from the 2mm and 1mm pan were the only size classes processed for charcoal identification. Charcoal found in these screens had a greater possibility of being identified as pieces could be broken in half to produce a clean cross-section without crushing them; and these sized items also had the greatest potential for observing diagnostic features during microscopy.

The results from both feature and non-feature samples are provided as well as both intersite and intrasite interpretations for the Wolf Willow and Red Tail sites. The different cultural levels from the Wolf Willow and Red Tail sites were discussed in chapter 2.4. These levels are referenced throughout this chapter in relation to the location of sediment samples as well as interpretation of the organic material recovered in the samples. Finally, there is a short summary of the previously discussed (Chapter 3.4) recovery rates for each flotation method (Flote-Tech[®], IDOT, and wet-screen).

4.2 Non-feature Results

Samples were taken from all archaeologically identified periods and stratigraphic contexts. More McKean complex samples were analyzed as there was a larger number of McKean samples available than there were for other cultural periods. However, this does provide a benefit in that it allows some of the questions raised by Keyser (1986) to be evaluated (Chapter 2.2). Samples from other periods, especially those earlier than McKean needed to be analysed as well, however, to ascertain if there is an increase in plant utilization during the McKean period. Unfortunately, samples from other periods were not as plentiful in non-feature contexts at the Red Tail site (Section 4.3) or feature contexts at the Wolf Willow site (Section 4.5).

Four samples, numbers 25, 26, 27, and 28, were obtained from sediments associated with the Plains side-notched complex (cultural layer 1) at Wolf Willow (Figure 4.1 and 4.2). These samples were taken from directly under the sod, have a high silt and organic content, and a

Munsell colour of 7.5YR 2.5/1 black (Tables 4.1 and 4.2). Samples 29, 30, and 31 were obtained from sediments associated with the Prairie side-notched complex (cultural layer 2). Cultural layer 2 samples were very similar in matrix to cultural layer 1 samples with high silt and organic content, however, the Munsell colour is 5YR 3/1 very dark gray. Samples 1, 33, and 34 were obtained from sediments associated with the Pelican Lake cultural layer (cultural layer 3a). These sediments are a mottled silty clay with Munsell colours of 2.5YR 3/2 dusky red and 7.5YR 3/2 dark brown. From sediments associated with the McKean complex (cultural layer 3), samples 5, 32, 35, 36, and 37 were taken. The cultural layer 3 sediments are a silty clay with a Munsell colour of 5YR 3/2 dark reddish brown. From sediments associated with the Oxbow period (cultural layer 4), samples 2 and 3 were taken. The cultural layer 4 sediments are clay rich with a Munsell colour of 10YR 6/3 pale brown. Finally, level 5, from which only bison bone had previously been recovered, was not considered a cultural layer and consequently was where excavation typically ended. However, during the 2019 excavation, a complete Gowen point was found in unit 11S 15E within level 5 indicating there is a cultural association to this level. Therefore, a sediment sample, sample number 4, was taken near where the point was found. Sample number 4 is clay rich with a Munsell colour of 2.5YR 5/2 weak red.

Almost all the Red Tail samples, including feature samples, are from the McKean complex, typically in association with Hanna dart points (Figure 4.3). The Red Tail non-feature samples, numbers 23 and 24, are both associated with the McKean complex (cultural layer 11). Additional previously collected Red Tail samples were to be analyzed, but a combination of missing sample paperwork and limited collection of non-feature samples precluded additional analysis (Chapter 1.4). Sediment samples collected from the Red Tail site were previously identified as having high organic content (Ramsay 1993), which was also observed in the flotation samples selected for this research. The sediment types and colours observed during analysis were consistent with the sediment types and colours previously identified by Ramsay (1993). Sediment descriptions for the Red Tail samples are found below (Section 4.4).

4.2.1 Wolf Willow

While the non-feature Plains side-notched complex samples from the Wolf Willow site have a limited amount of charcoal, they have the highest number of charred seeds (n=163) from of any non-feature samples (Tables 4.1 and 4.2). Sample 25 produced a cf. *Juniperus* (probable

juniper species) charcoal fragment and 12 other unidentifiable charcoal fragments; no seeds or seed fragments were found in sample 25. Sample 26 produced 12 complete *Chenopodium* sp. (goosefoot species, Figure 4.4) seeds as well as 8 unidentifiable charcoal fragments. Seeds identified as *Chenopodium* sp. compared favourably to this *Chenopodium* cf. *leptophyllum* (narrow-leaved goosefoot) species, however other *Chenopodium* species were not available in the reference collection used for identification and therefore the species cannot be confirmed. Sample 27 had the largest number of *Chenopodium* sp. seeds (151) of all processed samples, which is intriguing given the non-feature context. There was also one type 1 *Populus/Salix* (poplar sp./willow sp.) fragment retrieved and one unidentifiable piece of charcoal. As discussed in Section 3.3.4, type 1 refers to fewer and smaller pores, while type 2 refers to more and larger pores. No seeds were recovered from sample 28, but this sample did produce the largest amount of charcoal in comparison to the other samples from cultural level 1, with one identifiable piece of *Fraxinus/Ulmus* (ash sp./elm sp., Figure 4.5) charcoal and 30 unidentifiable charcoal fragments (see Tables 4.1 and 4.2).

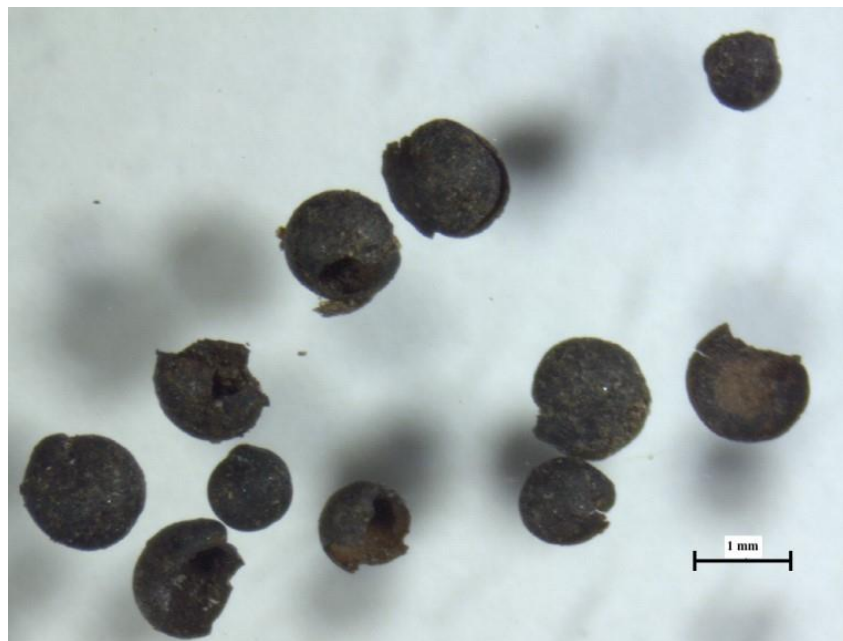


Figure 4.4 – *Chenopodium* sp. Photo by E. Coward.

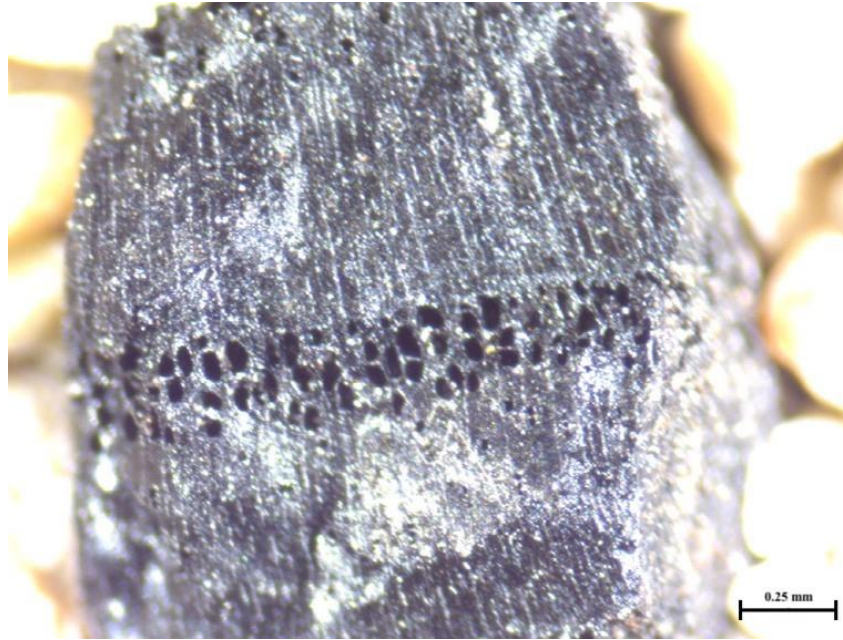


Figure 4.5 – *Fraxinus/Ulmus* sp. Photo by E. Coward.

Site	Sample number	Cultural Level	Depth (cm below surface)	Sample Volume (Liters)	<i>Chenopodium</i> sp.	Unidentifiable	Seed Fragments
Red Tail	23	11 - McKean (Hanna)	16.5-11	3L	0	0	2
Red Tail	24	11 - McKean (Hanna)	120-124	2.8L	0	1	0
Wolf Willow	25	1 - Plains side-notched	9-10	1.2L	0	0	0
Wolf Willow	26	1 - Plains side-notched	8-10	1.2L	12	0	0
Wolf Willow	27	1 - Plains side-notched	13-14	1.7L	151	0	0
Wolf Willow	28	1 - Plains side-notched	13-14	1.8L	0	0	0
Wolf Willow	29	2 - Prairie side-notched	22-23	1L	0	0	0
Wolf Willow	30	2 - Prairie side-notched	26-27	1.8L	1	0	0
Wolf Willow	31	2 - Prairie side-notched	23-24	1.5L	1	0	0
Wolf Willow	1	3a - Pelican Lake	31-33	4L	2	0	1
Wolf Willow	33	3a - Pelican Lake	30-32	1.7L	0	0	0
Wolf Willow	34	3a - Pelican Lake	36-38	2.5L	0	0	0
Wolf Willow	5	3 - McKean	53-58	2L	0	0	0
Wolf Willow	32	3 - McKean	53-54	2.2L	0	0	0
Wolf Willow	35	3 - McKean	39-40	2.2L	0	0	0
Wolf Willow	36	3 - McKean	48-49	2.1L	0	0	0
Wolf Willow	37	3 - McKean	51-54	2.5L	0	0	0
Wolf Willow	2	4 - Oxbow	63-65	2L	0	0	0
Wolf Willow	3	4 - Oxbow	63-74	2.5L	0	0	9
Wolf Willow	4	5 - Gowen	61-65	3L	1	0	0

Table 4.1 – Non-feature seed results and counts.

Site	Sample number	Cultural Level	Depth (cm below surface)	Sample Volume (Liters)	<i>Populus/Salix</i> Type 1	<i>Populus/Salix</i> Type 2	cf. <i>Juniperus</i> sp.	<i>Fraxinus/Ulmus</i>	Charcoal Fragments
Red Tail	23	11 - McKean (Hanna)	116.5-119	3L	0	0	0	0	49
Red Tail	24	11 - McKean (Hanna)	120-124	2.8L	1	0	0	0	31
Wolf Willow	25	1 - Plains side-notched	9-10	1.2L	0	0	1	0	12
Wolf Willow	26	1 - Plains side-notched	8-10	1.2L	0	0	0	0	8
Wolf Willow	27	1 - Plains side-notched	13-14	1.7L	1	0	0	0	1
Wolf Willow	28	1 - Plains side-notched	13-14	1.8L	0	0	0	1	30
Wolf Willow	29	2 - Prairie side-notched	22-23	1L	1	5	3	0	280
Wolf Willow	30	2 - Prairie side-notched	26-27	1.8L	2	0	0	0	107
Wolf Willow	31	2 - Prairie side-notched	23-24	1.5L	0	0	0	0	22
Wolf Willow	1	3a - Pelican Lake	31-33	4L	0	0	0	0	13
Wolf Willow	33	3a - Pelican Lake	30-32	1.7L	0	0	0	0	0
Wolf Willow	34	3a - Pelican Lake	36-38	2.5L	0	0	0	0	0
Wolf Willow	5	3 - McKean	53-58	2L	0	0	0	0	observed, not collected
Wolf Willow	32	3 - McKean	53-54	2.2L	0	0	1	0	3
Wolf Willow	35	3 - McKean	39-40	2.2L	0	0	0	0	0
Wolf Willow	36	3 - McKean	48-49	2.1L	0	0	0	0	0
Wolf Willow	37	3 - McKean	51-54	2.5L	0	0	0	0	5
Wolf Willow	2	4 - Oxbow	63-65	2L	0	0	0	0	0
Wolf Willow	3	4 - Oxbow	63-74	2.5L	0	0	0	0	282
Wolf Willow	4	5 - Gowen	61-65	3L	0	0	0	0	49

Table 4.2 – Non-feature charcoal results and counts.

Samples from the Prairie side-notched complex at Wolf Willow produced a large amount of charcoal. While sample 29 does not provide any evidence for seeds, it provides the highest number of charcoal fragments of all the non-feature samples, though much of the charcoal, totalling 280 fragments, is unidentifiable. However, there are 5 pieces of *Populus/Salix* type 2, charcoal, and this is the only non-feature sample to contain this charcoal. There is also 1 piece of *Populus/Salix* type 1 and 3 pieces of cf. *Juniperus* charcoal. Sample 30 also had a large amount of charcoal, including 2 pieces of *Populus/Salix* type 1 and 107 unidentifiable fragments. *Chenopodium* sp. is represented by a single seed in this sample as well as in sample 31. Sample 31 also had almost 22 unidentifiable charcoal fragments.

Samples associated with the Pelican Lake complex at the Wolf Willow site had a very low return rate for organic materials. There were no seeds or charcoal recovered in samples 33 and 34. Sample 1, however, did provide 2 *Chenopodium* sp. seeds, 1 seed fragment, and 13 unidentifiable charcoal fragments.

Wolf Willow McKean complex samples produced rather disappointing results. Sample 5 did not produce any seeds, though it did produce charcoal; however, the charcoal was observed in the smaller size classes, and it was unanalyzable as it was highly fragmented. Sample 32 provided 1 cf. *Juniperus* charcoal fragment and 3 unidentifiable charcoal fragments. Sample 35 and 36 did not produce any organics. Sample 37 only had 5 unidentifiable charcoal fragments recovered.

Similarly, samples from the Oxbow period at the Wolf Willow site did not provide many organics. Sample 2 had no seeds or charcoal, whereas sample 3 had no identifiable seed or charcoal fragments, but it does provide the highest number of seed fragments (9) and charcoal fragments (282) out of all the non-feature samples.

Sample 4 was taken from the Mummy Cave series or Gowen level at the Wolf Willow site. This sample had 1 *Chenopodium* sp. seed and 49 unidentifiable charcoal fragments.

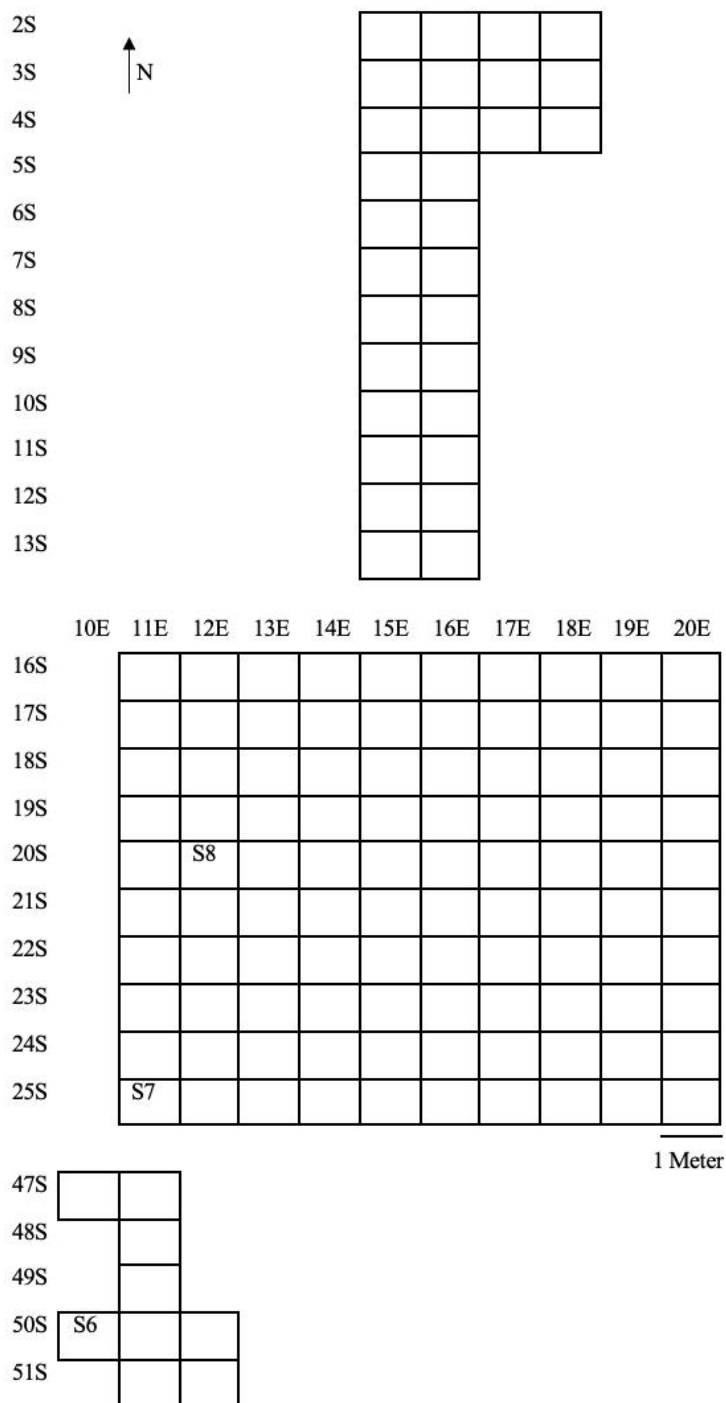


Figure 4.1 - Wolf Willow Unit map indicating feature sample (S6, S7, and S8) location. Adapted from Katie Willie (in preparation). *Note the distance between units 25S 11E and 47S 11E is not accurately reflected on this map

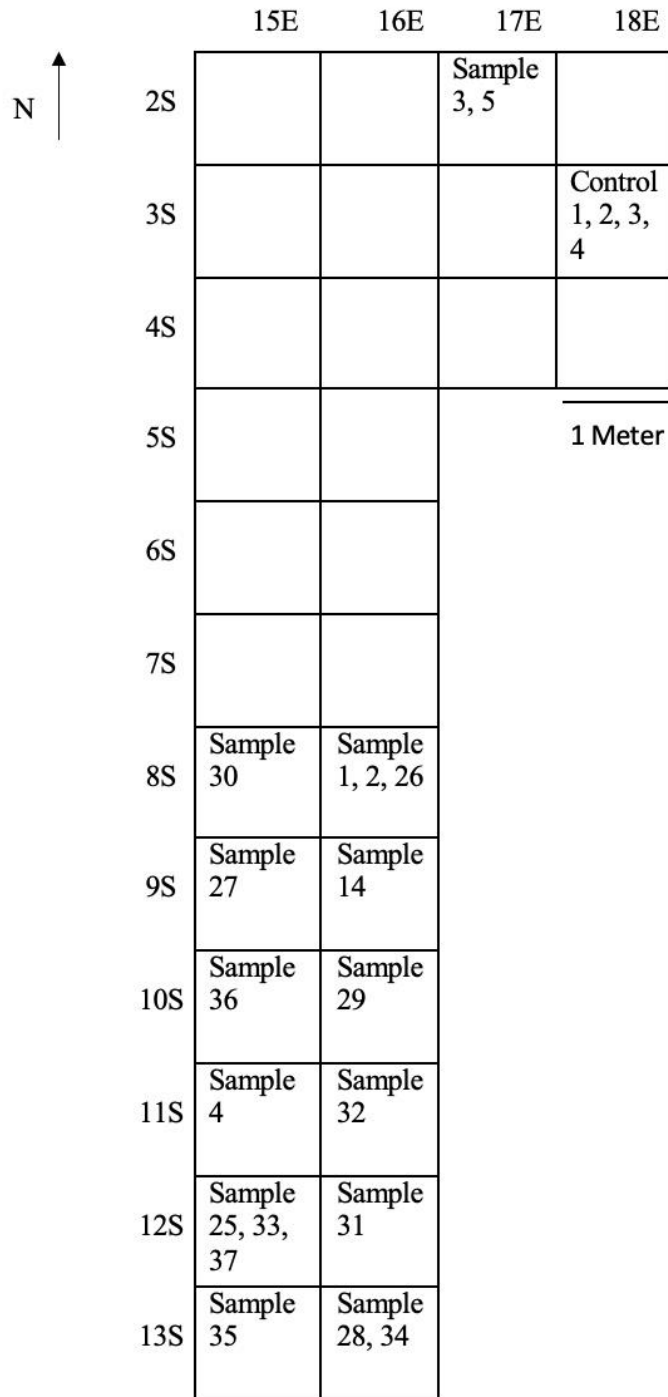


Figure 4.2 – Wolf Willow Unit map indicating non-feature samples. Indicates 2017-2020 excavation units. Adapted from Katie Willie (in preparation).

4.2.2 Red Tail

As mentioned above Red Tail samples 23 and 24 are associated with Hanna projectile points from cultural level 11. Sample 23 had 2 seed fragments and 49 unidentifiable charcoal fragments. Sample 24 had 1 unidentifiable seed, 1 *Populus/Salix* type 1 charcoal fragment, and 31 unidentifiable charcoal fragments (see Tables 4.1 and 4.2).

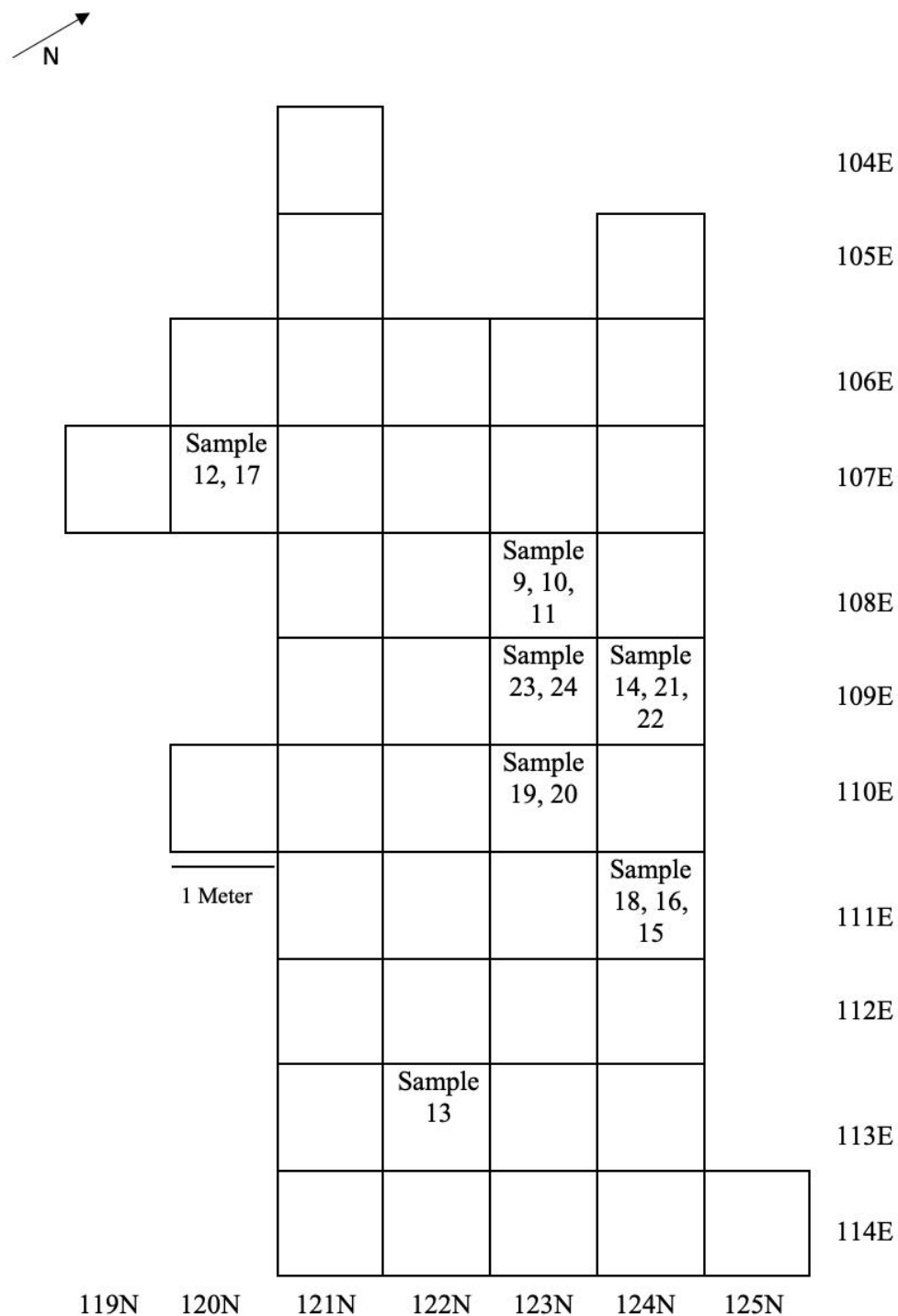


Figure 4.3 – Red Tail unit map indicating sample locations for both feature and non-feature samples. Adapted from Ramsey (1993).

4.3 Non-Feature Intersite and Intrasite Comparisons and Discussions

There appears to be a pattern of the more northern Wolf Willow units providing both higher amounts and greater variation within the organic material than other samples with similar volumes of sediment (Figure 4.1 and 4.2). This can be seen in samples 29, 30, and 3. When compared to other samples with similar or larger sample volumes there is an obvious increase in charcoal. Sample 29 has 3 types of charcoal to 1 liter of sediment while other samples, such as sample 25, only have one type of charcoal and only 25 fragments to 1 liter of sediment. This variation in organic material in these more northern units is not specific to one cultural complex, but rather it is constant in a few cultural levels (Prairie side-notched level 2 and Oxbow level 4). The relative dearth of organic materials in the more southern units may reflect less cultural activity associated with the use of organic materials within this area of the site, though preservation and other post-depositional processes may be a factor. Regardless, these results suggest that future investigations of non-feature samples may well yield data pertinent to identifying spatial patterning in plant remains.

Similarly, the two Red Tail samples are distinctly different. Thus, although the results are limited, they nevertheless indicate that if future excavation occurs within the Red Tail site, there is good potential for obtaining viable samples allowing for more detailed comparisons of non-feature contexts. Further, the organic remains recovered from these samples are also from the McKean complex, meaning there is added potential to explore Keyser's (1986) hypothesis of this time period reflecting increased plant utilization. However, evaluation of this hypothesis also requires comparison to non-McKean materials, thus requiring future excavations at the Red Tail site to also include collection of non-McKean samples.

Before addressing plant utilization by Ancestral Indigenous Peoples at the Wolf Willow and Red Tail sites, it is important to note that the information on plant use described within this chapter derives from secondary sources. Ideally, Indigenous Knowledge Keepers would have been consulted for information regarding plant use, but due to the COVID-19 pandemic consultation was not able to be conducted (Chapter 1.4).

Chenopodium sp. was only recovered in the Wolf Willow samples, and it was not recovered in cultural level 3 or 4. This could indicate that cultural levels 1 (Plains side-notched), 2 (Prairie side-notched), 3a (Pelican Lake), and 5 (Gowan) were occupied during late summer or into the fall (Shay 1980), faunal analyses currently underway will allow evaluation of these

results. *Chenopodium* sp. was typically used as food (Shay 1980), and, indeed, is one of the most commonly used food plants around the world (Asch and Asch 1977; Bruno and Whitehead 2003; Faulkner 1991; Mueller-Bieniek et al. 2019; Huckell and Toll 2004), so it is not surprising to find the occasional seed mixed into archaeological sediment. Sample 27, however, provides a large amount of charred *Chenopodium* sp. The high concentration of *Chenopodium* sp. within this unit could indicate an accidental anthropological deposition as the charcoal record from this sample does not indicate a natural or cultural burning such as a *Chenopodium* bush being burnt, and there is no evidence for a storage pit. There was also no indication for processing to take place nearby, meaning no grinding stones, hearths, or other methods of plant processing were found in adjacent units during this excavation. However, other expedient ground stone tools have been recovered at the Wolf Willow site, but they have not been systematically analyzed. Overall, these data are consistent with an anthropogenic deposit quite likely associated with the use of chenopods as food.

The charcoal types identified in these samples most likely reflect fuel use. However, it is still important to discuss the plant use beyond fuel for each of these plant types. The presence of charcoal could indicate that other parts of the plant, such as the berries, bark, and roots were taken and used for food, medicine or other purposes (Hellsen 1974), while the remaining wood was used for fuel. For example, *Juniperus* sp. berries were commonly used as a food source as was the inner bark of *Populus/Salix* (Peacock 1992). These two plant types also used had medicinal and ritual purposes, such as *Salix* roots being brewed for medicinal teas to cure colds, as well as cleaning wounds and as an eyewash. *Populus* bark is used for teas in women's medicines; and *Juniperus* roots are brewed as a tonic and for liniment for muscular aches, whereas the berries are brewed for medicinal teas to help with upset stomach and digestive problems (Peacock 1992).

The Red Tail non-feature results are more difficult to evaluate from a perspective of intersite variation than are those from the Wolf Willow site where the larger number of samples result in greater observable variation within the organic remains. From a broader perspective, based on the organic remains recovered from the Wolf Willow non-feature samples, the nature of the plant use indicates food and fuel use. Although it is difficult to determine the extent of the plant use at the Wolf Willow site, based on these limited results, it can be hypothesised that

plants were part of everyday practice at the Wolf Willow site as there are organic materials, in particular *Chenopodium* seeds, represented in several non-feature samples.

4.4 Feature Results

All feature samples from both the Wolf Willow and Red Tail sites (Tables 4.3 and 4.4) were previously collected as the 2019 Wolf Willow excavation did not encounter any features.

4.4.1 Wolf Willow

The 3 feature samples from Wolf Willow derive from a Plains side-notched (cultural level 1) hearth (sample 6), a McKean complex (cultural level 3) cairn (sample 7), and a Prairie side-notched (cultural level 2) hearth (sample 8). Thirteen of the 14 Red Tail hearth feature samples are from the McKean complex, with 7 being associated specifically with Hanna points. A non-McKean sample, sample 17 is from the Besant or Avonlea phase (cultural level 2). These sediments are a greyish brown, loamy silt (Ramsay 1993). Samples 12, 14, 15, 16 and 18 are from cultural level 8 and the most recent McKean occupation at the Red Tail site. Cultural level 8 sediments are grey, loamy sand (Ramsay 1993). Samples 13 and 20 are from cultural level 11; this level is associated with Hanna dart points. Sediment matrix of cultural level 11 is a very dark grey, fine sandy loam (Ramsay 1993). Samples 10, 11, 19, 21, and 22 are also associated with Hanna dart points, but they are from cultural level 12. Cultural level 12 sediment is very dark grey, sandy loam (Ramsay 1993). The cultural level 12 samples from the Red Tail site yielded the greatest variety of organic remains of all the samples taken from both the Wolf Willow and Red Tail sites (Tables 4.3 and 4.4). Finally, sample 9 is from cultural level 13, which also has a McKean complex affiliation. The sediment from this level is gray, loamy sand (Ramsay 1993).

Site	Sample number	Cultural Level	Depth (cm below surface)	Sample Volume (Liters)	Feature Type	<i>Chenopodium</i> sp.	<i>cf. Schoenoplectus tabernaemontani</i>	<i>cf. Sinapis arvensis</i>	<i>cf. Cirsium</i> sp.	<i>cf. Cyperus</i> sp.	<i>cf. Lamiaceae</i>	<i>Sisyrinchium</i> cf. <i>mucronatum</i>	<i>cf. Prunus virginiana</i>	<i>cf. Comandra</i>	<i>cf. Urtica dioica</i>	Unidentifiable	Seed Fragments
Wolf Willow	6	1 - Plains side-notched	22-33	2.25L	Hearth	87	1	1	0	0	0	0	0	0	0	0	3
Wolf Willow	8	2 - Prairie side-notched	15-20	1L	Hearth	0	0	0	1	0	0	0	0	0	0	0	0
Wolf Willow	7	3 - McKean	50-56	0.8L	Calm	0	0	0	0	0	0	0	0	0	0	0	4
Red Tail	17	2 - Besant or Avonlea	21.5-23	1L	Feature	1	0	0	0	0	0	0	0	0	0	0	0
Red Tail	12	8 - McKean	91-97	2L	Charcoal	3	0	0	0	0	2	0	0	0	0	0	38
Red Tail	14	8 - McKean	70.5-79.5	2L	Scatter	1	0	0	0	0	0	0	0	0	0	0	0
Red Tail	15	8 - McKean	41-47	2.5L	Hearth	1	0	0	0	0	0	0	0	0	0	0	45
Red Tail	16	8 - McKean	47-50.5	2.25L	Hearth	0	0	0	0	0	0	0	0	0	0	0	0
Red Tail	18	8 - McKean	39-41.5	1.5L	Hearth	0	0	0	0	0	0	0	0	0	0	0	0
Red Tail	13	11 - McKean (Hanna)	100-103.5	2.25L	Charcoal	1	0	0	0	0	0	1	0	0	0	0	0
Red Tail	20	11 - McKean (Hanna)	117-118	0.5L	Scatter	0	0	0	0	0	0	0	0	0	0	0	0
Red Tail	10	12 - McKean (Hanna)	120.5-129	1.5L	Hearth	1	0	0	0	0	0	0	0	0	0	1	4
Red Tail	11	12 - McKean (Hanna)	127.5-132	2L	Hearth	2	0	0	0	1	0	0	0	0	0	0	1
Red Tail	19	12 - McKean (Hanna)	110-125	2.6L	Hearth	0	0	0	0	0	0	0	1	0	0	0	1
Red Tail	21	12 - McKean (Hanna)	120-129	3.5L	Hearth	0	0	0	0	0	0	0	0	0	0	1	2
Red Tail	22	12 - McKean (Hanna)	121.5-129.5	2.5L	Hearth	0	0	0	0	0	0	0	0	0	2	0	1
Red Tail	9	13 - McKean	130.5-140	1.5L	Hearth	2	0	0	0	0	0	0	0	2	0	0	0

Table 4.3 – Feature seed results and counts.

Site	Sample number	Cultural Level	Depth (cm below surface)	Sample Volume (Liters)	Feature Type	<i>Populus/Salix</i> Type 1	<i>Populus/Salix</i> Type 2	cf. <i>Populus/Salix</i>	cf. <i>Fraxinus</i>	Charcoal Fragments
Wolf Willow	6	1 - Plains side-notched	22-33	2.25L	Hearth	0	0	0	0	28
Wolf Willow	8	2 - Prairie side-notched	15-20	1L	Hearth	0	0	0	0	1412
Wolf Willow	7	3 - McKean	50-56	0.8L	Cairn Feature	0	0	0	0	275
Red Tail	17	2 - Besant or Avonlea	21.5-23	1L	Hearth	0	0	0	0	12
Red Tail	12	8 - McKean	91-97	2L	Charcoal Scatter	0	0	0	0	510
Red Tail	14	8 - McKean	70.5-79.5	2L	Hearth	0	1	0	0	197
Red Tail	15	8 - McKean	41-47	2.5L	Hearth	0	1	0	2	944
Red Tail	16	8 - McKean	47-50.5	2.25L	Hearth	0	0	0	0	162
Red Tail	18	8 - McKean	39-41.5	1.5L	Hearth	0	0	0	0	511
Red Tail	13	11 - McKean (Hanna)	100-103.5	2.25L	Charcoal Scatter	0	0	0	0	293
Red Tail	20	11 - McKean (Hanna)	117-118	0.5L	Hearth	0	0	0	0	Observed, not collected
Red Tail	10	12 - McKean (Hanna)	120.5-129	1.5L	Hearth	0	14	0	0	1303
Red Tail	11	12 - McKean (Hanna)	127.5-132	2L	Hearth	0	2	0	0	1146
Red Tail	19	12 - McKean (Hanna)	110-125	2.6L	Hearth	0	2	0	0	289
Red Tail	21	12 - McKean (Hanna)	120-129	3.5L	Hearth	0	1	0	0	122
Red Tail	22	12 - McKean (Hanna)	121.5-129.5	2.5L	Hearth	0	0	3	0	425
Red Tail	9	13 - McKean	130.5-140	1.5L	Hearth	3	0	0	0	202

Table 4.4 – Feature charcoal results and counts.

4.5 Feature Intersite and Intrasite Comparisons and Discussions

Sample 6 (Plains side-notched) and 8 (Prairie side-notched) of the feature samples from the Wolf Willow site provided interesting organic materials while the third, sample 7 from a suspected cairn feature from the McKean cultural level 3, did not provide identifiable materials. This is not overly surprising since the feature from which sample 7 was obtained did not have a thermal component; thermal activities char seeds and wood, therefore, preserving them in the archaeological record. Consequently, thermal features tend to be emphasized in collection of samples for archaeobotanical analysis, though the problems with such an approach are discussed elsewhere (Chapter 3.2). These results also indicate why, in ideal situations, a combination of archaeobotanical data sources are employed. In the case of this feature, pollen or phytolith analysis might offer further elucidation of this feature since there could have been uncharred organics placed intentionally inside or underneath the cairn.

The organics from Plains side-notched period hearth sample 6 present an interesting variety. The most common botanical remains in this sample are *Chenopodium* sp., consistent with their regular occurrence within the non-feature Wolf Willow samples. Cf. *Schoenoplectus tabernaemontani* (probable soft-stemmed bulrush, Figure 4.6) is quite common in marshy environments, such as those that might occur along the side of Opimihaw Creek, so the recovery of a single charred seed may not be particularly significant. Nevertheless, it is worth noting that the stem pith of *S. tabernaemontani* is used to create a poultice and stops bleeding when applied as a dressing (Moerman 2009), so the seed may indeed reflect resource use. Cf. *Sinapis arvensis* (probable wild mustard) is an invasive species to Saskatchewan (VASCAN 2020). Consequently, the recovery of a single seed from this plant likely reflects contamination from a post-European contact level as *S. arvensis* is a plant that originated from Europe, Asia, and North Africa. Therefore, indicating that the paleoethnobotanical analysis has potentially highlighted concerns regarding disturbance that was not previously recognized.



Figure 4.6 – *Cf. Schoenoplectus tabernaemontani* Photo by E. Coward.

Sample 8 from a Prairie side-notched period hearth at the Wolf Willow site had one interesting seed, which was cf. *Cirsium* sp. (probable thistle). *C. arvense* (Canada thistle) is an introduced plant and it is often thought to be invasive, though it was quite often used for medicinal purposes by groups in eastern Canada (Moerman 2009; Peacock 1992). *C. arvense* has not been identified to have ethnobotanical uses for Plains Cree or Blackfoot peoples, however *C. discolor* (field thistle), *drummondii* (Drummond's thistle), *flodmanii* (Flodman's thistle), *muticum* (swamp thistle) and *undulatum* (wavyleaf thistle) are native to Saskatchewan (VASCAN 2020) and *C. discolor* does have ethnobotanical uses for the Plains Cree (Moerman 2009). In these other areas *C. arvense* was often used for tuberculosis remedies (Moerman 2009). Sample 8 also had the largest amount of charcoal of all the samples based on volumes of sediment to charcoal fragments. This sample only had 1 liter of sediment while other hearth samples with a larger volume of sediment produced smaller numbers of charcoal fragments. This could indicate that the fire burned at a low intensity for a long period of time, increasing the fragmentation of the charcoal (Lancelotti et al. 2010). The heat and duration of the hearth could also explain why there was only one seed type found as other seeds may not have survived. As an alternative hypothesis, the hearth could have been stoked for a long period of time increasing the amount of wood put into the fire which increases the output of charcoal.

Additionally, sample 8 had issues with sample contamination while processing with the Flote-Tech®, as discussed in Chapter 3.5. The larger number of charcoal fragments could also be

due to charcoal being trapped inside the Flote-Tech® and then ultimately altering the final charcoal counts. The seeds found in this sample could also be a result of contamination and they could have originated from other samples. The charcoal and seed counts in samples 9, 14, and 10 could have also been affected by contamination as it was observed during processing, or it was discovered when performing the recovery rate analysis (Chapter 3.5). Ultimately, this creates a problem when trying to interpret all the samples that were processed in the Flote-Tech® as it can become difficult to say which organic remains belong to which sample. However, because this research predominantly focuses on the nature and extent plant use and not specific feature uses and the plant distribution across sites; the contamination that is exhibited does not greatly affect the overall results of this research, but rather it does create problems when comparing densities of seeds and charcoal between cultural levels.

The McKean period cultural level 8 samples from the Red Tail site present mostly fragmented organic remains. There are many seed fragments in sample 12, and the highest amount of fragmented charcoal was collected from sample 15, with 378.8 pieces of charcoal for 1 liter of sediment. As with many of the Wolf Willow samples, *Chenopodium* sp. was recovered from a few Red Tail samples. The high amount of fragmented remains could be due to the temperature and duration of use of the hearths from which these samples were collected. When seeds are heated too long or at too high of a temperature, they become quite fragile and explode (Pearsall 2015; Wagner 1982). The high fragmentation of the organics could also be from the processing method. As mentioned in the Chapter 3.5, the wet-screening method employed on samples 12 and 15 did fragment remains.

Sample 12 was labeled as deriving from a charcoal scatter which makes it difficult to determine the behavioural context behind this feature, based on the amount of charcoal it could be hypothesised that it is the removed contents of a hearth that was cleaned out in order for it to be reused. If this charcoal scatter is from a hearth being emptied for continued use, the *Chenopodium* sp. and the cf. Lamiaceae (probable mint family) seeds could be an indicator that the original hearth was used over several seasons as these plants set their seeds in different seasons. The Lamiaceae seeds suggest a spring and summer use, while *Chenopodium* sp. seeds suggest a late summer into fall use. It is important to note that the seeds could have been stored for later use, and that this charcoal scatter could represent a re-used dumping ground from several different hearths or features. This does not negate the fact that this charcoal scatter could

be representing several seasons of use and therefore occupation. Other botanical analysis such as pollen and phytoliths may help in identifying season of use. The presence of cf. Lamiaceae in sample 12 could be significant. Members of the Lamiaceae family have many uses for Indigenous Peoples, including medicinal, spiritual, and as food (Peacock 1992). The leaves of some members of the Lamiaceae family were brewed and used as tea for colds, general medicines, and diabetes, as well as in ceremonies (Moerman 2009; Peacock 1992). The leaves were also consumed as greens (Peacock 1992).

The McKean period samples have very few organics, especially sample 20, which had no seeds or charcoal. Sample 13, like many other samples, had 1 *Chenopodium* sp. seed, but it is the only sample with a *Sisyrinchium*. cf. *mucronatum* (blue-eyed-grass) seed. *S.* cf. *mucronatum* does not have any known food or medicinal purposes for the Plains Cree or Blackfoot peoples but, according to Moerman (2009), it was used for throat troubles amongst the Navajo of the American Southwest.

The Hanna or McKean period (cultural level 12) samples from the Red Tail site has the greatest taxonomic diversity of organic remains of all the cultural levels from both the Red Tail and Wolf Willow sites. It does not, however, have the greatest density of seeds with 1.2 seeds per liter of sediment and 273.3 charcoal fragments to 1 liter of sediment. The Wolf Willow Plains side-notched period sample has the greatest density of seeds with 40.9 seeds per liter of sediment and the Prairie side-notched period sample has 1412 charcoal fragments to 1 liter of sediment.

The McKean period (cultural level 12) samples from the Red Tail site recovered *Chenopodium* sp. seeds in several of the hearth samples from this level. In sample 11, cf. *Cyperus* sp. (probable flatsedge) was recovered; though used for cold remedies by other groups, there is no recorded medicinal association with people within the study region (Moerman 2009). A *Prunus virginiana* (chokecherry) seed was found in sample 19. Most predominantly, *P. virginiana* was used as a food source, but it also had medicinal and spiritual uses (Peacock 1992). The bark of *P. virginiana* is brewed as a tea and it used for colds and upset stomachs while the branches are used for constructing shelters (Peacock 1992). Cf. *Urtica* sp. (probable nettle species) was recovered in sample 22, its typical uses are medicinal, particularly as a tea to keep blood flowing after childbirth (Moerman 2009). Additionally, the fibre from *Urtica* sp. is quite strong and has been used to create string or cordage (MacKinnon et al. 2009). This cordage

is also used to make netting which can be used to create impressions on pottery (Jolie 2014). The charcoal found in all the cultural level 12 samples was type 2 *Populus/Salix* (Figure 4.7). This is probably indicative of fuel use, but it could also reflect food use, as discussed above (Section 4.3). The diversity of organic remains of these hearth samples, particularly sample 11, could indicate that these hearths were used for plant processing, possibly including the production of medicinal teas. Regardless, it is quite clear that this level's hearth features indicate greater diversity of plant use compared to cultural level 8 a level with similar sample sizes and sample numbers. The cultural level 12 samples have 3 different seed types and greater numbers of charcoal (273.3 fragments per liter of sediment) than the cultural level 8 samples which only have 1 identifiable seed type and 227.1 charcoal fragments per liter of sediment. Although the density of seeds in the cultural level 8 samples are greater with 8.8 seeds and seed fragments per 1 liter of sediment whereas the cultural level 12 samples have 1.2 seeds and seed fragments per liter of sediment, there is still more diversity in the type of seeds found in the cultural level 12 samples. This difference in diversity in cultural level 12 could be indicative of different uses for the features.

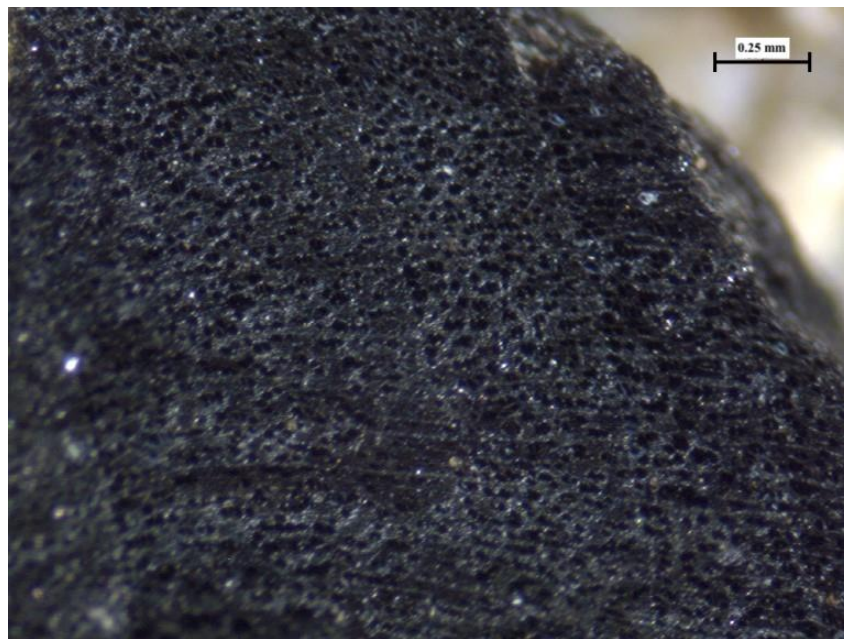


Figure 4.7 – *Populus/Salix* type 2 Photo by E. Coward.

The final cultural level processed from the Red Tail site was cultural level 13, also associated with the McKean complex. Only one sample was processed (sample 9), and it provided *Chenopodium* sp. seeds, like many of the other samples. Also recovered in this sample

were cf. *Comandra* seed (bastard toadflax); this was commonly used for medicines with other groups, but use of this plant has not been documented for people in this region (Moerman 2009). There was some identifiable *Populus/Salix* charcoal; however, it was of the type 1 variety, differing from the type recovered from cultural level 12.

One last thing to note is the presence of possible fungal sclerotia in cultural levels 8, 11, and 12 at the Red Tail site. Fungal sclerotia is a parasite found on local trees, shrubs, and herbs (Shay et al. 1991). Concentrations of fungal sclerotia can suggest a large amount of plant material accumulated in one place (Shay et al. 1991). These little black spheres are less than 0.5mm in diameter and can often be confused for seeds (Ramsay 1993; Shay et al. 1991) (Figure 4.8). Ramsay (1993) does mention that fungal sclerotia were discovered in his samples at the Red Tail site in levels 11, 12 and 13. This is consistent with the fungal sclerotia found in samples 10, 11, 16, 18, 21, 22, and 24.

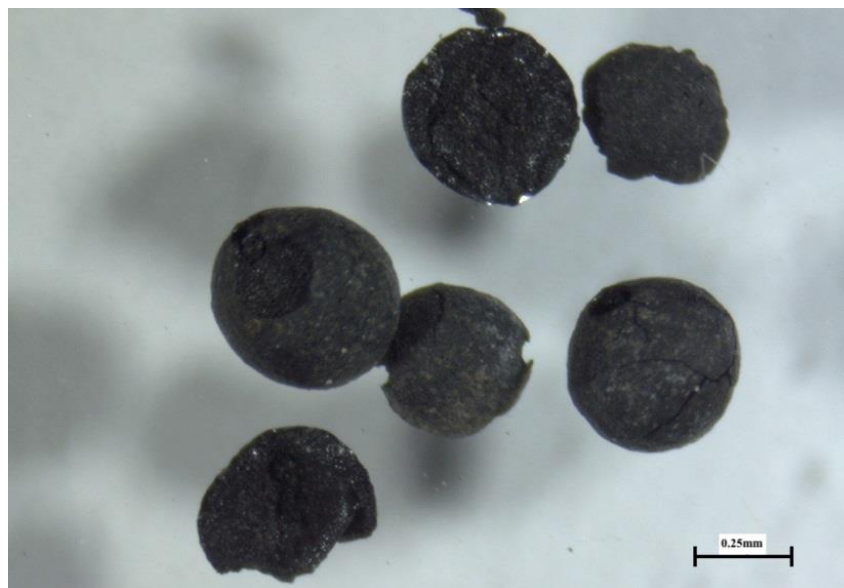


Figure 4.8 – *Fungal sclerotia* Photo by E. Coward.

The Red Tail feature samples provided more variety than the Wolf Willow samples. Cultural level 12 is arguably the most variable in terms of organic remains recovered, possibly indicative of increased plant utilization during the McKean complex. However, as discussed above (Section 4.3), other samples from various cultural levels, particularly cultural levels earlier than McKean need to be analysed to determine if the McKean complex represents an increase in plant utilization. This claim should be further explored at other sites within Wanuskewin

Heritage Park as there is a wealth of cultural material within the Opimihaw Creek Valley, and the information from the Red Tail site offers a good baseline for future research.

Comparing the Wolf Willow and Red Tail sites is difficult as the number of feature samples are not consistent between sites. There is also a difference in some of the feature types such as the cairn feature at the Wolf Willow site while the Red Tail site predominantly focuses on hearth samples. However, the Wolf Willow samples did showcase the greatest density of seeds and charcoal per liter of sediment in comparison to all the other feature samples. This can be observed in the Plains side-notched sample with 40.9 seeds and seed fragments per liter of sediment and the Prairie side-notched sample with 1412 charcoal fragments per liter of sediment, while the greatest seed density from the Red Tail site was observed in the McKean cultural level 8 samples with 8.8 seed and seed fragments per liter of sediment and the Hanna cultural level 12 samples with 273.3 charcoal fragments per liter of sediment. Sample 7 from the Wolf Willow site is from the McKean complex, but it did not produce anything identifiable. It would be valuable to compare more feature samples from the same cultural time periods to identify any similar patterning in plant utilization and further explain the nature and extent of plant use at Wanuskewin. It would also be beneficial to explore other cultural levels to determine plant utilization across multiple sites and time periods at Wanuskewin.

4.6 Recovery Rate Summary

The recovery rates of the Flote-Tech[®], IDOT, and wet-screening methods are discussed in Chapter 3, sections 4 and 5, a summary of those results is presented here (see Chapter 3.5 for a full discussion). Nineteen of the 41 samples had control seeds added to the sample to determine recovery rates and assess potential levels of contamination of three different macrobotanical extraction techniques: Flote-Tech[®], IDOT, and wet-screening. The control seeds that were added were *Papaver somniferum* (poppy), which are buoyant as well as *Nepeta cataria* (catnip) and *Brassica olerancea* var. *italica* (broccoli) which were non-buoyant.

The average recovery rate for the *P. somniferum* seeds for the Flote-Tech[®] samples was 78%. The clay rich sediment from the control sample for the Flote-Tech[®] greatly affected the recovery rate. If this control sample is removed the average recovery rate of *P. somniferum* rises to 89%. An average of 44% of the *N. cataria* seeds were recovered from the Flote-Tech[®]. *B. olerancea* var. *italica* seeds were not added to the Flote-Tech[®] samples. The average IDOT

recovery rate was 94% of *P. somniferum* seeds. Approximately 50% of the non-buoyant seeds in these samples were found in the heavy fraction. The recovery rate of *N. cataria* seeds in the IDOT samples was 86% while the *B. oleracea* var. *italica* seeds had a recovery rate of 97%. The average recovery rate for *P. somniferum* seeds in the wet-screening method was 96%. Non-buoyant seeds were not tested in this method as flotation was not a factor.

As detailed in Chapter 3.5, each of these methods has advantages and disadvantages. The Flote-Tech® provides a means for processing large volumes of sediment quickly, only requires one person, and uses less water as it is recycled within the system. However, contamination issues were observed, it produced lower recovery rates, and there is a large upfront cost for the device. The IDOT had higher recover rates and is less costly than the Flote-Tech® and the portability of the devices makes field flotation possible when there is clean water. However, processing takes significantly longer than the Flote-Tech® as it cannot process as much sediment at one time, and it is much easier to have two people processing samples with the IDOT. Finally, the wet-screening method is probably the most cost efficient as most archaeological laboratories have geological nesting screens. This method also has a high recovery rate and only needs one person. However, a constant stream of water is required, which not only results in high water use but this method produces more fragmented remains, which is highly problematic for archaeobotanical analysis.

4.7 Summary and Conclusions

The number of feature and non-feature samples available for analysis from the Red Tail and Wolf Willow sites were limited, though certainly sufficient to undertake this pioneering study. For Wolf Willow, part of the limitation arose from the fact that the 2019 excavations did not discover any features. Consequently, only samples collected from previously excavated features were available, and even then, samples of sufficient size for macrobotanical analysis were only collected from thermal features. A different problem was encountered at Red Tail. Though again all samples derived from previously excavated thermal features, aside from a couple of non-feature samples, paperwork for many of the samples was missing (Chapter 1.4). Thus, sample selection was limited to those samples with accompanying paperwork. Additionally, due to the sampling program employed at the Red Tail site and that there was a

larger number of McKean features found during excavation, it became difficult to identify patterning of plant use between different cultural time periods.

The choice of processing method for extracting macrobotanicals from archaeological sediments can affect the recovery rate. The preferred method for this sample set was the IDOT device. The IDOT method had the highest recover rate, but it may not suit every context or research goal. The Flote-Tech[®] recovers more charcoal, which would be more suitable for research on fuel uses. Nonetheless, issues of contamination with this method need to be addressed. The wet-screen method is more appropriate for water-logged samples as organic material will not float. It is important to have established research questions and an understanding of the sediment type to choose the appropriate method for extracting macrobotanicals. Ultimately, leading to the most prosperous organic returns from the sediment samples.

Previous research at Wanuskewin has focused on large game subsistence and while some prior paleoethnobotanical research has been conducted (Chapter 2.3) the current paleoethnobotanical research provides the most comprehensive investigation into the role that plants may have played in subsistence. However, this research is not limited to subsistence, but also incorporates the use of plants as both fuel and potentially in medicines. Further, analysis of non-feature samples provided additional knowledge regarding the nature and extent of plant use at the Wolf Willow and Red Tail sites. The non-feature samples provided seeds and charcoal remains of plants ethnobotanically known to have been used for food and in the preparation of medicines, reaffirming the importance of sampling all contexts, not just features and plant processing areas even if the heightened cultural association that feature samples offer showcases plants used for food, medicines, and other uses.

Additionally, when comparing the organics recovered in the current study with organics that have been recovered in previous research at Wanuskewin, it can be determined that *Chenopodium* sp., *Prunus virginiana*, and *Rosa* sp. were some of the most common seed types found across all previously studied sites. These three seed types were not limited to just one time period but rather, they are used by Ancestral Indigenous Peoples throughout the cultural history at Wanuskewin. Ramsay's (1993) research at the Red Tail site found *Chenopodium* sp., *P. virginiana*, and *Rosa* sp. during the McKean occupation. Pletz's (2010) research at the Dog Child site also recovered these three seed types, but during the Prairie side-notched period. Webster's

(1999) research at the Thundercloud site recovered *Chenopodium* sp. and *P. virginiana* during the Plains side-notched, Prairie side-notched, Avonlea, Besant, and McKean time periods. *Rosa* sp. was not found at the Thundercloud site. While Webster's (1999) research also found several other types of seeds (as discussed in Chapter 2.3), the Thundercloud site experienced a lot of mixing between cultural levels, and it becomes difficult to determine which seeds are associated with each cultural level. The current research did not recover any *Rosa* sp. at either the Wolf Willow or Red Tail site. At the Wolf Willow site *Chenopodium* sp. was found in the Plains side-notched, Prairie side-notched, Pelican Lake, and Gowen cultural levels. At the Red Tail site *Chenopodium* sp. was found during the Avonlea, Besant, and McKean cultural levels while *P. virginiana* was only found in the McKean cultural levels. These three seed types could indicate some contemporaneous plant use across the sites located within Wanuskewin.

Some of the plants that were identified for subsistence strategies include *Chenopodium* sp., *Prunus virginiana*, and Lamiaceae. Other plants identified with medicinal properties include Cf. *Urtica* sp., *Sisyrinchium. cf. mucronatum*, *P. virginiana*, and Lamiaceae. When combined, the recovery of plants of known ethnobotanical significance from both feature and non-feature contexts re-affirms the importance of plant resources at the Wolf Willow and Red Tail sites. These non-feature samples would have previously been overlooked or never collected as they are often deemed to not provided organic remains, as discussed in Chapter 3.2. However, the non-feature samples collected for this sample set indicate otherwise, and the information that is offered provided greater variation in fuel uses, such as *Juniperus* sp., which was not found in any of the feature samples for this research.

The analysis of both the feature and non-feature results also provided data regarding seasons of occupation at both the Red Tail and Wolf Willow sites. Ramsay (1993) hypothesised the Red Tail site had a spring, summer, and/or fall occupation, based on faunal, lithic reuse, and botanical analyses. Paleoethnobotanical analysis of Red Tail features and the recovery of Lamiaceae seeds indicates a spring and summer occupation, *P. virginiana* seeds suggests a summer occupation, while *Chenopodium* sp. seeds indicates a late summer into fall occupation. The Lamiaceae seeds and the *Chenopodium* sp. seeds are found in the same charcoal scatter, this could indicate re-used dumping ground from several different hearths or features used over several seasons. Non-feature samples analyzed from Wolf Willow in which *Chenopodium* sp. seeds were observed may indicate a late summer into fall occupation. Seasonality suggestions are

based off when the plant sets seeds and it is important to note that all these plants could have been dried, processed, and stored for later use and other analysis, such as faunal analysis needs to be done to provide comparative data on season of occupation.

Furthermore, the Red Tail site hearth samples provided a greater diversity in the organics represented in the McKean complex, particularly in cultural level 12, when compared to the Wolf Willow site. Thus, offering some support to Keyser's (1986) claim of the importance of plant use to the people of the McKean complex. However, because this sample set did not have many samples from earlier time periods, it is difficult to say if there was an increase of plant use during the McKean complex. Although limited to the Red Tail and Wolf Willow sites, the results of these investigations do suggest that additional paleoethnobotanical research at Wanuskewin Heritage Park would be highly worthwhile, should archaeological excavations resume.

Chapter 5 - Summary and Conclusion

This thesis evaluates recovery rates of three commonly used methods for extracting macrobotanicals from archaeological sediments, and it identifies organic remains from feature and non-feature sediment samples at the Wolf Willow and Red Tail sites at Wanuskewin Heritage Park in Saskatoon, Saskatchewan. The main aims of this thesis were to (1) identify which method produces the highest recovery rate of macrobotanicals from archaeological sediments, (2) identify if non-feature sediment samples can aid in interpretation of the nature and extent of plant use, and (3) identify plant taxa recovered from archaeological sediment samples to produce new and evaluate existing interpretations of the nature and extent of plant use at Wolf Willow and Red Tail sites.

5.1 Recovery Rate Evaluation

A total of 41 samples were processed including 4 clay-rich sterile control samples. Of the 41 samples, 27 were processed using an assisted flotation machine, a Model A Flote-Tech®, 8 were processed using a manual flotation system, an IDOT, and 6 were processed through nesting geological screens as a wet-screening method; all recovered organics were then hand-sorted and identified (Chapter 4). To test the recovery rates, *Papaver somniferum* (poppy) seeds and non-buoyant *Nepeta cataria* (catnip) and *Brassica oleracea* var. *italica* (broccoli) seeds were added to 19 samples, including the 4 control samples (Chapter 3).

The IDOT method was determined to be the preferred method for processing the Wanuskewin sample set as it produced the greatest recovery rate. The IDOT recovered an average of 94% of the *P. somniferum* seeds, 86% of the *N. cataria* seeds, and 97% of the *B. oleracea* var. *italica* (Chapter 3.4). Approximately 50% of the non-buoyant seeds were recovered in the heavy fraction, this was not surprising as the semi-buoyant seeds only remain suspended within the IDOT for a short period of time which requires quick and efficient scooping of the organic materials. The large size of the heavy fractions could have also inhibited the non-buoyant seeds from being suspended within the IDOT as it is possible that the seeds were trapped under large amounts of sand retained at the bottom of the device (Chapter 3.5).

Processing with the Flote-Tech® revealed contamination issues as well as disappointing recovery rate results with clay rich samples. The average recovery rate of the *P. somniferum* seeds was 71% and 44% of the *N. cataria* seeds. The average of the *P. somniferum* recovery rate

was heavily affected by the clay-rich sample that only recovered 15% of the added *P. somniferum* seeds (Chapter 3.4). This clay-rich sample showcases the importance of sediment in relation to seed recovery, as most of the other samples from the Red Tail and Wolf Willow sites are high in sand or silt making flotation quite easy. This result indicates that a clay-rich sample may not be best suited for assisted flotation devices, but rather a manual device such as the IDOT. When processing the clay-rich sediment sample in the IDOT it had a recovery of 95% (Chapter 3.5). There were also issues of contamination observed in Flote-Tech®. Two of the samples that did not have *P. somniferum* seeds added to them recovered small numbers of these seeds in the sample. It is unclear how the contamination occurred as proper cleaning procedures were implemented between each sample (Chapter 3.5).

The wet-screening method had a high recovery rate with 86% of *P. somniferum* seeds being recovered, but there were issues with fragmentation of organic remains due to the water forcing organic materials through the nesting screens (Chapter 3.4). When hand-sorting occurred, it was observed the seed coats of the *P. somniferum* experienced high fragmentation and separation from the seed. This was also seen in the organics recovered in the Red Tail McKean cultural level 8 samples (sample 12 and 15). These samples presented the highest amount of seed fragmentation as well as a large number of charcoal fragments. As discussed in Chapter 4.5, this could be due to the temperature of the hearth from which these organics derived, but it is important to note that the processing method itself may have caused this fragmentation.

Evaluation of recovery rates ultimately led to the conclusion that each method has advantages and disadvantages for processing archaeological sediments and that when choosing a method, it is important to keep research goals in mind. The IDOT is less costly than the Flote-Tech® and the portability of the IDOT device makes field flotation a possibility. However, the IDOT takes a longer period of time to process samples and it is better suited to be used by two people (Chapter 3.3.1). The Flote-Tech® may be best suited for research surrounding fuel uses as it recovered more charcoal than the two other methods (Chapter 3.5). However, this device is the most expensive to purchase, which requires budget constraints to be considered. Finally, the wet-screen method is best suited for waterlogged samples where the organics will no longer float, and it is the most cost effective of the methods as many archaeological laboratories already have a set of geological nesting sieves. However, this method requires a constant stream of water, and it takes a very long time to process one sample (Chapter 3.3.1). The greatest concern of this

method is the fragmentation or damage to organic remains, which can ultimately alter the results of the analysis especially when the organic materials are extremely fragile (Chapter 3.5).

5.2 Plant use at the Red Tail and Wolf Willow sites

As mentioned in Chapter 1.1, the Red Tail site was excavated in 1988 and 1989, all samples selected for this research were collected during those excavations. Sampling at Red Tail faced several constraints as there was a large amount of paperwork missing (Chapter 1.4) and samples were limited to those which had accompanying paperwork. The Red Tail samples are mostly from McKean features due to the large number of these features being found. The Wolf Willow feature samples were also collected from previous excavations as the 2019 excavations did not produce any features. Feature samples are important as they showcase a heightened cultural association to the plants used for food, medicine, and other uses. While feature samples provide the direct cultural link, sampling strategies that rely only on these thermal features miss out on information such as the spatial patterning of plant use across the site. By adding non-feature samples to a sampling strategy, questions regarding spatial patterning of plant use can be answered. Additionally, non-feature samples can provide more information on the nature and extent of plant use (Chapter 4). The 2019 Wolf Willow excavations yielded all the non-feature samples from this site as this was the first, and as it turned out, only year in which a comprehensive sampling strategy incorporating sampling from all depositional contexts was employed (Chapter 3.2.2).

The Red Tail non-feature samples were associated with Hanna projectile points from cultural level 11. These samples did not provide much information as the organics recovered were unidentifiable seed fragments and charcoal fragments with one *Populus/Salix* type 1 charcoal fragment. The Red Tail feature samples, on the other hand, provided a wealth of information on food, medicine, and other plant use, predominately from the McKean complex. The McKean cultural level 8 samples contained mostly fragmented organic remains with identifiable *Chenopodium* sp. (goosefoot species) seeds, a common food source, and cf. Lamiaceae (probable mint family) seeds, which are often used for medicinal purposes. The high fragmentation that these samples presented could have been due to processing method or a hearth burning at a relatively low temperature for an extended period. The greatest diversity of plant types was observed in the Hanna cultural level 12. This level recovered several food and

medicinal plant types *Chenopodium* sp., *Prunus virginiana* (chokecherry), cf. *Urtica* sp. (probable nettle species), and cf. *Cyperus* sp. (probable flatsedge) seeds (Chapter 4.5). From the Red Tail site, the cultural level 12 samples had the highest density of charcoal per 1 liter of sediment while the cultural level 8 samples had the highest density of seed and seed fragments per 1 liter of sediment. Also associated with the McKean complex was cultural level 13. There was only one sample processed from this level and it provided *Chenopodium* sp. seeds, like many of the other samples, and cf. *Comandra* seed, which was commonly used for medicines for Indigenous Peoples from other regions. Although a single *Comandra* seed is hardly conclusive, its presence could indicate similar medicinal uses for the McKean people that inhabited the Red Tail site.

Pervious research on plant use at the Red Tail site was quite broad with a larger focus on subsistence strategies. While fuel use was briefly mentioned, there was no confirmed charcoal identification but rather general descriptions such as hardwood, conifer, diffuse porous, semi-ring porous, etc. (Ramsay 1993:236). The current research identifies several charcoal types, indicative of fuel uses for hearths that were possibly used for processing food and medicinal plants. This research also identifies several seeds that have been previously described in ethnographies as having medicinal purposes to the peoples of the Northern Plains. However, this research is a stepping-stone in confirming how and what plants were used and processed at the Red Tail site. Although many of the Red Tail samples are from features, which provide a direct cultural use association, it is not necessarily enough to declare confidently that certain features were used just for processing plants. Rather, additional analysis on grinding stones as well as interviews with Indigenous Knowledge Keepers need to be conducted to provide additional data to help evaluate these hypothesized occurrences of past plant use (Chapter 2.2).

The Wolf Willow non-feature samples had high numbers of *Chenopodium* sp. seeds as well as some other identifiable charcoal types such as cf. *Juniperus* (probable juniper species), *Populus/Salix* (poplar sp./willow sp.), and *Fraxinus/Ulmus* (ash sp./elm sp.). The charcoal types identified were most likely to be associated with fuel uses, but the presence of these plant types could indicate food, medicinal, and ritual uses as the berries, roots, or bark could have been used for those purposes while the remainder of the plant was used for fuel. The three feature samples from the Wolf Willow site are a hearth from the Plains side-notched period, a cairn from the McKean complex, and a hearth from the Prairie side-notched period. The McKean associated

cairn did not produce any organics, which was not too surprising as it did not have a thermal component to preserve any seeds or wood that could have been used in this feature (Chapter 3.2). The Plains side-notched associated hearth had the greatest seed density of all the samples, and it exhibited several different seed types and fragments. This could indicate that the hearth had uses for both food and medicinal purposes. The Prairie side-notched associate hearth had the highest charcoal density. This could indicate that the hearth was burned at a lower temperature for an extended period of time. It could also indicate that this hearth had some of the longest use time when compared to other hearths in the current study (Chapter 4.5).

Previous archaeobotanical research at the Wolf Willow site was predominantly focused on environmental reconstruction with a dedicated charcoal analysis exhibiting fuel uses throughout different cultural periods (Chapter 2.3). Charcoal analysis was also done in the current research, but unlike previous research, the current study incorporated non-feature samples as well as seed analysis. Seed identification and analysis has not been conducted at the Wolf Willow site before and although it did not provide much information, it did suggest some food and possible medicinal uses. However, due to the nature of the samples being predominantly from non-feature contexts, it becomes more challenging to associate these plants to their cultural use. This research provided a broad idea of seed and charcoal types to be expected at the Wolf Willow site and further analysis is needed to understand how these plants are used at the site. More feature samples need to be processed to strengthen the cultural use association, grinding stones need to be analysed to more clearly relate feature use to plant use, distribution of grinding stones to features would also aid in determining the extent of plant use, and finally, consulting Indigenous Knowledge Keepers on traditional plant use is needed to explore medicinal and ritual plant use more thoroughly.

Comparing the Red Tail and Wolf Willow feature and non-feature samples reveals that the Wolf Willow site evidences a greater density in seed and charcoal numbers in both the feature and non-feature samples when compared to the Red Tail site. The non-feature samples indicate food and fuel uses for the different plant types and while the feature results showcase these, while simultaneously suggesting medicinal and ritual uses. However, additional analyses, akin to those mentioned above, are needed to help confirm the hypothesized medicinal and ritual plant uses at these archaeological sites. Combining the results of the feature and non-feature samples indicates that plant use at both the Wolf Willow and Red Tail sites was an important

part of life for these mobile hunter-gatherer groups. When compared to previous research conducted at Wanuskewin, which predominantly focused on large game subsistence, the current research provides greater insight into the role of plants, documenting and expanding upon existing knowledge regarding fuel, food, and even potential medicinal uses, while simultaneously providing hypotheses to explore through further research. Seed types such as *Chenopodium* sp. and *Prunus virginiana*, that were found at other sites previously studied at Wanuskewin were also found in the current research. This could indicate some contemporaneous plant use across the sites located in Wanuskewin.

5.3 Future Research

As discussed above (Chapter 1.4), an unexpected problem that substantially affected sample selection was missing paperwork. Thus, it is strongly recommended that all Wanuskewin Heritage Park archaeological records be digitized. Having two versions (digital and hard copy) of site records available for researchers should resolve issues of misplaced paperwork.

A mainstay of all archaeobotanical research is recourse to a comparative collection. Knowledge derived from experience, published keys, and online databases are all helpful, but access to comparative materials is paramount. COVID precluded access to the substantial RAM collection, limiting access to the small number of seeds available in the Department of Archaeology and Anthropology. Consequently, development of a larger reference collection housed in the Department of Archaeology and Anthropology is strongly recommended. This collection would be quite beneficial to future researchers studying macrobotanicals in Saskatchewan.

A version of the comprehensive sampling strategy used in this thesis could be used as a standard for sediment sampling in archaeological contexts for professional archaeologists, students, and volunteers. The recovery rate analysis could be further explored by adding a 0.5mm mesh to the IDOT device and comparing those results with 0.2mm mesh. Other methods for extracting macrobotanicals from sediments could also be subjected to a recovery rate test.

If and when archaeological instigations resume at Wanuskewin, non-feature samples should be collected and processed as an aid to better identifying the nature and extent of plant use within the park. For example, the current research may well have benefited from analyzing samples from around the sample 8 hearth feature at Wolf Willow as this feature could have been

used to produce medicines. As discussed in chapter 3.2.2, samples surrounding a feature can help determine the extent of the plant remains from inside the feature and how they differ from surrounding contexts. The analysis of sample 6 may have indicated disturbance, and if samples from around the feature had been collected, said samples could aid in the analysis of this feature to better ascertain the extent of this disturbance. Samples surrounding features would only be available if samples are routinely collected above, below, and beside features, rather than the previous practice of obtaining samples from just within a feature. However, the problem with a more substantive sampling method leads to issues of space for the samples to be stored and the funding capacity of having an archaeobotanist available to analyze the samples in a timely fashion (Chapter 3.2).

On a larger scale, several large paleoethnobotanical studies across the Northern Plains should be implemented, or at least paleoethnobotanical analysis should be incorporated as a standard analysis alongside faunal, lithic, and ceramic analyses typical of current archaeological research in the area. While the former would be preferred because it would be targeted specifically toward identifying and documenting multifaceted subsistent strategies, plant medicines, and other plant uses, the latter would still provide a much better understanding of regional and temporal plant use of these Indigenous, mobile hunter-gatherers.

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Appendix A - Wanuskewin Heritage Park Sampling Form

Date: _____

Site: _____

Unit: _____ N _____ E

Excavators: _____

CONTEXT

Provenience: _____ Depth Below Surface (DBS)

_____ S

_____ E

Context of Sample: Matrix / Profile (Circle one)

Feature Type: _____

Level: _____ Cultural Level: _____

Explain Sample Context: _____

Type of Sample: Flotation / Pollen / Phytolith / Other: _____

Other Information

Photo Number: _____

Size of Sample: _____ Number of Bags: _____

Assigned Sample Number: _____

Additional Comments: _____

Additional Comments (con't): _____

Appendix B - Flotation Recording Sheet

[illegible]

Appendix C - Laboratory Macrobotanical Hand-Sorting Form

Project: _____

Site: _____

Lab Sample no.: _____

Sample Type: LF or HF

Sieve Size: _____

Volume: _____

Analyst: _____

Date: _____

Seeds	Count	Fragment	Comments
Charcoal	Count	Weight	Comments