MACROBOTANICAL ANALYSIS OF ARCHAEOLOGICAL MATERIALS RECOVERED FROM SITE 5GN1.2, GUNNISON COUNTY, COLORADO

By

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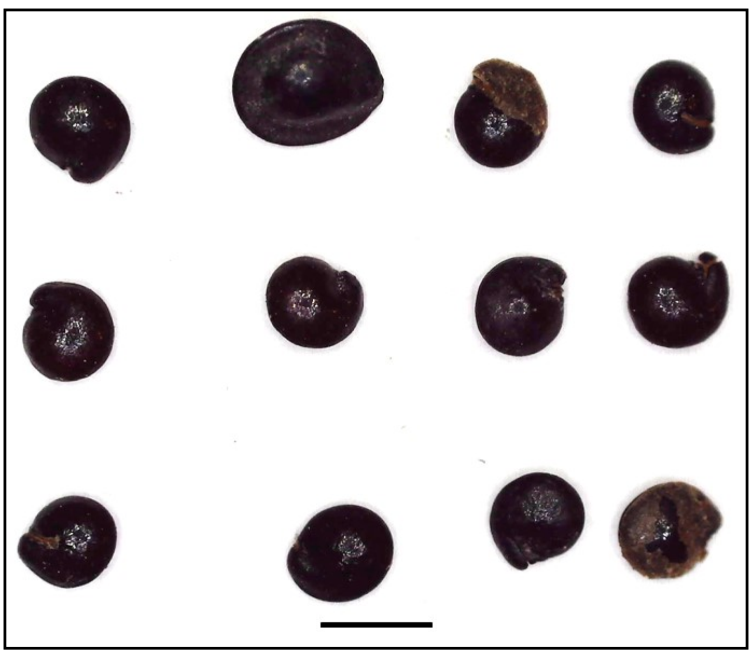

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Acknowledgments

I wish to express my appreciation to the many people and organizations that contributed to the success of this project over the years. The following people were instrumental to the success of the 2010 test excavation including Dr. Bonnie Pitblado, Dr. Molly Boeka Cannon, Jason Patten, Carl Haberland, Barbara Haberland and Forest Frost. Furthermore, the test excavation would never have occurred without the financial assistance provided by the Curecanti National Recreation Area and the Rocky Mountain Cooperative Ecosystems Study Unit (RM-CESU Cooperative Agreement Number H1200090004). I am also very appreciative of the flotation processing and debitage analysis help provided by USU graduate students Ryan Breslawski, Jessica Dougherty, Benjamin Fowler, Tod Hildebrandt, Ashley Losey, Britt McNamara, Elizabeth Seymour and Dayna Reale.

Countless hours went into writing the test excavation report, analyzing the lithic assemblage, cleaning the artifacts, sorting through the light fraction, preparing for curation and writing a thesis. As a result, I was unable to complete a full analysis of the macrobotanical assemblage while in graduate school. Ever since then I have had this nagging feeling that I really should finish that analysis someday when I have the time. As it happens, in the fall of 2018 I found the time and contacted Forest Frost. Forest patiently guided me through the NPS research permit application and artifact loan process. His help was vital in the success of this follow up project. I also would like to thank Dr. Shanti Morell-Hart and the McMaster Paleoethnobotanical Research Laboratory for graciously allowing me to use their research facility, resources and equipment. Thanks everyone for helping me finish this project and check another task off my bucket list!

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CHAPTER 1

PROJECT INTRODUCTION

This technical report presents the research methods and analysis results of the "Macrobotanical Analysis of Archaeological Materials Recovered from Site 5GN1.2, Gunnison County, Colorado" project under National Park Service (NPS) Study Number CURE-0007 and NPS Permit Number CURE-2019-SC1-0001. For this macrobotanical analysis and research project, Jonathan M. Peart (Principal Investigator and report author) completed a pro bono analysis of the macrobotanical materials recovered from 5GN1.2. I am a visiting researcher at McMaster Paleoethnobotanical Research Facility (MPERF) in Ontario, Canada and am working in collaboration with Dr. Shanti Morell-Hart (MPERF Director). Nonetheless, I am responsible for the analysis and conclusions presented in this technical report.

Site Setting

Site 5GN1.2 is located within the Upper Gunnison Basin (UGB) of southcentral Colorado (Figure 1-1). The UGB is within the southern Rocky Mountains and includes over 11,000 km^2 (2.5 million acres) of land, including most of Gunnison County and portions of Hinsdale and Saguache Counties. Elevation in the UGB ranges from about 2300 m (7500 ft) on the west side of the basin along the Gunnison River up to several mountain peaks soaring over 4250 m (14,000 ft) along the basin rim. The UGB is surrounded by high elevation (at least 3050 m or 10,000 ft) mountainous terrain, except for a narrow corridor entering the basin from the west through the Black Canyon of the Gunnison. The enclosed nature of the UGB limits lower elevation adapted vegetation and animal species, culminating in unique biotic diversity (Armstrong 1972; Emslie 1986), as well as distinctive human adaptations and culture history (e.g. Black 1991; Stiger 2001). For example, species such as piñon *(Pinus edulis)* and ash (*Fraxinus* spp.) are rare in the UGB, yet these species frequently occur in the surrounding region within similar elevation zones, climates and habitats (Johnston et al. 2001; Stiger 2001).

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Figure 1-1. 5GN1.2 site location map.

Site 5GN1.2 is located at 2,341 m (7,680 ft) ASL within few hundred meters of the historic channel of the Gunnison River. The Gunnison River drains the UGB through the Black Canyon. During the 1960s and 1970s, the Bureau of Reclamation constructed three major dams (Blue Mesa, Morrow and Crystal dams) on the Gunnison River as part of the Wayne N. Aspinall Unit of the Colorado River Storage Project. These dams backed up nearly 65 km (40 miles) of the river, mainly within the UGB. The Blue Mesa Reservoir measures over 32 km (20 miles) long with 154.5 km (96 miles) of shoreline and when full contains over 1.16 km^3 (940,000-acre ft) of water (Zaenger 2009). By filling in deep canyons and lower parkland areas along the Gunnison River these reservoirs give a false impression of the landscape (Stiger 1980; Woodbury et al. 1962). The site is located within CURE between the Blue Mesa Reservoir and US Highway 50 about 22 km west of Gunnison, Colorado.

Environmental Background

Several published paleoenvironmental data sources are available for the UGB and the surrounding region, including glacial sequences in the San Juan Mountains (Pierce 2003), pollen and macrobotanical columns from the UGB and San Juan Mountains (Briles et al. 2012; Carrara et al. 1991; Fall 1997; Marksgraf and Scott 1981; Petersen 1988), tree ring studies (Woodhouse 2003) and pack-rat midden macrobotanical studies (Emslie et al. 2005, 2015). Pollen core and plant macrofossil sequences documented by Fall (1997) provide the highest resolution published source of Holocene-aged past environmental data for the UGB (Reed and Metcalf 1999). Fall (1997) compiled pollen and plant macrofossil data from eight sedimentary basins on the west slope of the southern Rocky Mountains in Colorado. By tracking the extent of the largely moisture-controlled lower-timberline and temperature-controlled upper-timberline, Fall (1997) identified broad-scale past climatic patterns for the region beginning with the terminal Pleistocene.

Topographic variability, as well as other factors, including prevailing wind direction and especially overlapping rain shadows produces highly variable localized diachronic weather patterns throughout the UGB (Reed and Metcalf 1999). Accordingly, the results from one location or paleoenvironmental data source may not seamlessly correlate with data collected in other areas. For the purposes of this introduction chapter, this section discusses a generalized paleoclimatic model for the study area focused on the last 3000 BP (Late Prehistoric). This discussion focuses on the fine-grained pollen study results reported by Fall (1997) and pack-rat midden research conducted by Emslie et al. (2005). These two sources of environmental data provide the most applicable data available in the UGB as sample locations are nearest site 5GN1.2 and span the Late Prehistoric. Pollen and packrat paleoenvironmental studies provide fundamentally different sources of data. Pollen studies recover and interpret a near continuous record of pollen rain representing surface vegetation within both the local and regional environment (Kneller 2009). Conversely, pack-rat middens provide an episodic record of localized vegetation (Wells 1976).

Of the eight sample locations described by Fall (1997), the Alkali Basin I and II samples were collected at the lowest elevation (2750 m [9000 ft]) within the UGB and about 50 km from site 5GN1.2. Several of the pack-rat middens sampled by Emslie et al. (2005) are located within about 10 km of site 5GN1.2. The findings of these two studies (Emslie et al. 2005; Fall 1997) are summarized in Table 1-1 and provide a general broad-scale model for the past environment and climate of the UGB.

Table 1-1. Past environment and climate summary table. Adapted from Reed and Metcalf (1999).

kBP	Vegetation (Fall 1997)	Climate (Fall 1997)	kBP	Pack-rat data (Emslie et al. 2005, 2015)
1			0.5	---170--- Cooling period ---660---
2	*Artemisia* steppe	Modern conditions ------	1	------ Warming period
3		Cooler, slightly moister	1.5	------
4	--------	------	2	
5	*Artemisia* steppe with *Pinus* on slopes	Warmer (~1°C) 6 cm more moisture	2.5	Vegetation stabilizes near modern limits
6			3	Piñon becomes extinct
7		Warmer (~2°C) 8-11 cm more moisture	3.5	Cooler and wetter with *Pinus* in lower elevations
8	*Pinus* forest			
9				
10	------			
11	*Picea-Abies-Pinus* Forest	------ Maximum winter moisture		
12	------	Cooler (2-5°C) 7-16 cm more moisture		
13	*Picea* parkland			

Spruce (*Picea*) parkland dominated UGB vegetation during the colder and wetter terminal Pleistocene (pre-12 kBP). As temperatures became slightly warmer and drier after 12 kBP, spruce parklands transitioned into mixed spruce, fir (*Abies* spp.) and pine (*Pinus* spp.) forests. As cooling and drying continued in the early Holocene, the mixed forests gave way to pine dominated forests. Pollen data reported by Fall (1997) indicates that between 6000 and 4000 BP the lower limit of the subalpine forests retreated upslope, probably in response to drier conditions during the middle Holocene and roughly contemporaneous with Antev's (1948, 1955) Altithermal (ca. 7000 to 4500 BP). The upper timberline descended after 4000 BP, suggesting temperatures cooled to about 1°C warmer than modern climate averages (Fall 1997). At the same time, the lower timberline retreated upslope. Fall (1997) suggested that modern climatic conditions were established by about 2000 BP (Fall 1997).

Paleoenvironmental reconstructions provided by Emslie et al. (2005) and Fall (1997) suggest that vegetation stabilized near modern distributions between 4000 and 2000 BP across much of the UGB. Both also argued that climatic conditions became slightly warmer and drier akin to modern averages during that time period. Even though the paleoenvironmental record is incomplete and fragmentary, existing research does not provide evidence of abrupt climatic shifts within the last 3000 BP. Rather the existing research suggests a gradual pattern of moderately decreasing average temperatures and decreasing precipitation through the Holocene (Emslie et al. 2005; Fall 1997). As such, modern distributions of the biotic communities provide a reasonable analog in understanding the resources available to hunter-gatherers during the occupation of site 5GN1.2.

The modern climate of the UGB generally represents a relatively cold and dry mid-latitude continental-interior, high-elevation basin. The Blue Mesa Lake, Colorado (No. 050797) weather station is nearest to the site at about 3.5 km to the west and at about the same elevation (2307 m ASL). Weather data spanning nearly 50 years, from 1967 to 2016, documents an average of 24.1 cm of yearly precipitation and a yearly average of 138.2 cm of snow (WRCC 2019). January is the coldest month with an average daily low temperature of -18.3°C (maximum of -2.6°C) and July is the warmest month with an average daily high temperature of 28.6°C (minimum of 8.4°C).

In the UGB, average daily July temperatures decrease about 6.9°C, mean daily recorded maximum temperature decreases 6.0°C, and mean annual precipitation increases at a rate of about 22.5 cm per 1000 m of elevation gain (Fall 1997). However, localized factors produce widely different conditions within a few kilometers even at the same elevation (Reed and Metcalf 1999). Much of this variation arises from location-specific topography, aspect, and the combined effects of prevailing wind direction and rain shadows. Rain shadows formed behind the San Juan and West Elk Mountains are particularly prominent in the valleys of Cebolla Creek, middle Tomichi Creek, and along the upper Cochetopa Creek watersheds (Johnston et al. 2001). Topographic variability afforded inhabitants of site 5GN1.2 the ability to reach areas with differing levels of precipitation and temperatures within relatively short distances. The variability of local climate vertically stratifies biotic communities which can be exploited at different times of the year depending on the availability of resources.

Fauna and Flora

Animal species found in the UGB include large mammals such as mule deer (*Odocoileus hemionus*), elk (*Cervus canadensis*), pronghorn antelope (*Antilocapra americana*), bighorn sheep (*Ovis Canadensis*) and bison (*Bison* spp. [now extirpated in the UGB]). Other mammals include coyote (*Canis latrans*), gray wolf (*Canis lupus*), marten (*Martes americana*), lagomorphs (*Lepus* spp. and *Sylvilagus* spp.), and chipmunks/squirrels (e.g. *Eutamias* spp. and *Spermorphilus* spp.) among other species (Armstrong 1972; Johnston et al. 2001). Other potential aboriginal prey species found in the basin include sage grouse, various migratory waterfowl, fish, reptiles, and insects (Johnston et al. 2001).

Mark Stiger (2001) wrote the most often cited cultural history model of the UGB. His model postulates that big-game, particularly bison, dominated the diet during the Late Prehistoric (2001). Bison are primarily grazers that feed on a diet rich in grasses and sedges (McDonald 1981; Meagher 1986). Bison habitat includes sagebrush steppe, piñon-juniper woodlands, and oak brush at lower elevations and aspen/spruce forests and subalpine meadows at higher elevations (Armstrong 1972). Modern and prehistoric bison populations lived in high elevation (above 3000 m) settings within the region indicating that altitude does not represent a significant limiting factor for bison foraging (Beidelman 1955; Cannon 2004; Fryxell 1926, 1928).

Johnston et al. (2001) published the results from a twenty-year cooperative ecological management study of the UGB conducted by the US Forest Service (Grand Mesa, Uncompahgre, and Gunnison National Forests), Bureau of Land Management (Gunnison Field Office), and the Colorado Division of Wildlife (Habitat Partnership Program). The study collected data on vegetation, soils and landform distribution at over 1500 points across the UGB. The study resulted in the classification of 97 Ecological Types grouped into the 33 Ecological Series. This complex and detailed classification system developed by Johnson and colleagues (2001) highlights the ecological variability within the UGB. For simplicity, the basic vegetation zones defined by Johnston et al. (2001) include the Alpine, Subalpine, Montane, Mountain Shrub and the Foothills-Semidesert Shrub zones. Elevation ranges and dominant vegetation of each zone are provided in Table 1-2. The southern Rocky Mountains typically contains Piñon-Juniper Woodlands however in the UGB only small stands of recently established piñon occur in the Gunnison Uplift Area (Arnette 2002; Taylor 2000). Based on packrat paleoenvironmental data (Emslie et al. 2005, 2015) piñon became exceedingly rare if not completely extinct in the UGB around 3000 BP.

Table 1-2. Upper Gunnison Basin vegetation zones (adapted from Johnston et al. 2001:6).

Zone	Dominant Plant Species	Elevation Range (m)	
		North and east slopes	South and west slopes
Alpine	Curly sedge, alpine avens and tufted hairgrass	> 3600	> 3718
Subalpine	Subalpine fir, Engelman spruce, aspen, lodgepole pine, Douglas fir, bristlecone pine and plane leaf / wolf willows	2956-3600	3078-3749
Montane	Douglas fir, ponderosa pine, lodgepole pine, aspen, Arizona fescue, Saskatoon serviceberry, gambel oak and yellow-Geyer-Bebb willows	2774-3261	2865-3382
Mountain Shrub	Douglas fir, big sagebrush, muttongrass, gambel oak and yellow-Geyer-Bebb willows	2316-3078	2316-3078
Foothills-Semidesert Shrub	Big sagebrush, Indian ricegrass and Rocky Mountain juniper	< 2560	< 2560

Site 5GN1.2 occurs within a typical section of the UGB Foothills Semi-desert Shrub vegetation zone and contains a diverse suite of plant species despite its rough, arid and sparse surface appearance (Figure 1-2). In 2010, Jason Patten (USU undergraduate student) conducted an informal vegetation survey in the vicinity of 5GN1.2. Mr. Patten identified a large variety of plant species including bitterbrush, buckwheat, cottonwood, cyptantha, fescue, gilia skyrocket, globe marrow, granite gilia, hedgehog cactus, paintbrush, pricklypear cactus, rabbitbrush, Indian ricegrass, Russian thistle (introduced modern species), big sagebrush, sandwort, snakeweed, stonecrop, thistle, Rocky Mountain juniper, locoweed, yampa and yarrow.

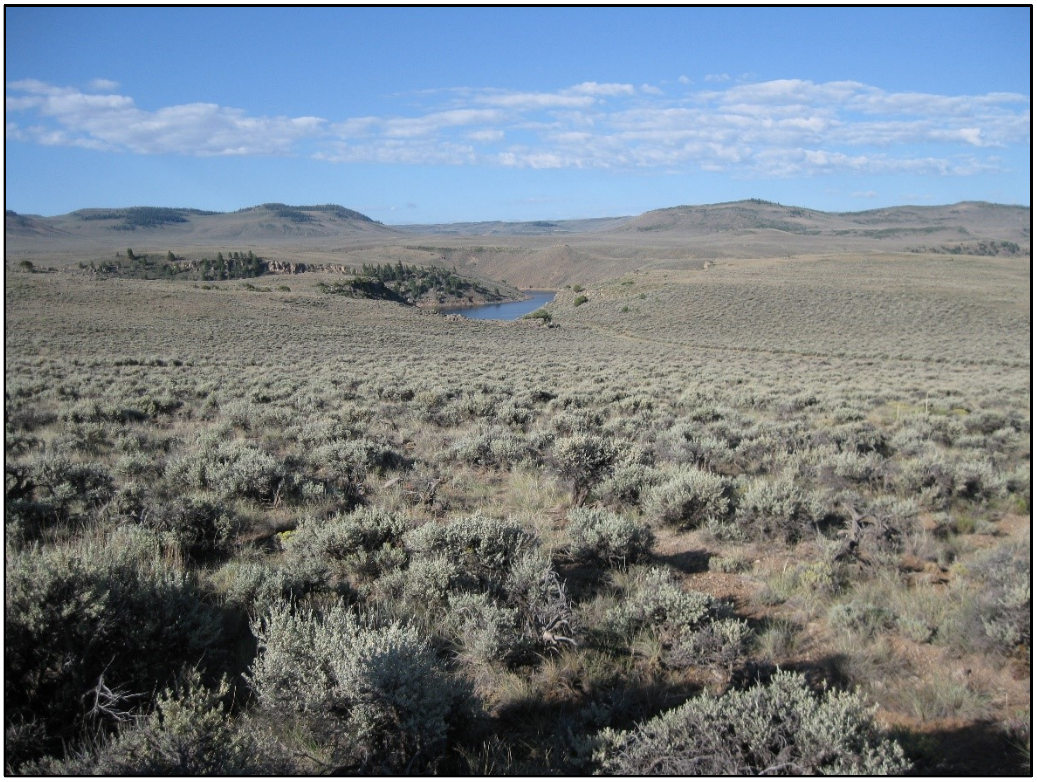

Figure 1-2. Overview of 5GN1 vegetation. Photo taken above (north) of the rockshelter outcrop and facing south with the Blue Mesa Reservoir in center of background.

Previous Research Summary

William G. Buckles, working at the University of Colorado, originally recorded 5GN1 (Big Game Hill Site) in 1962 during an inventory of the Blue Mesa Reservoir (Buckles 1962; Lister 1962). He described the site as a large multi-component quartzite procurement site containing scattered quartzite reduction workshop locations and thousands of surface lithic artifacts. Later, Liestman (1985) identified several bedrock exposures of Junction Creek quartzite along Big Game Hill (within 5GN1) all associated with areas of geologic faulting or volcanic venting. Stiger (2001) and Andrews (2010) further investigated these fine-grained quartzite outcrops. On several of these outcrops they identified large percussion flake scars and observed a high degree of color variability (white, gray, red, and brown combinations) among the bedrock exposures. These flake scars provide direct evidence of prehistoric bedrock lithic reduction and quartzite procurement at site 5GN1.

In 2009, Utah State University (USU) archaeological field school, under the direction of Dr. Bonnie Pitblado, conducted archaeological and geological surface surveys at site 5GN1. Pitblado's students found seven small rockshelters along the southern edge of the site. The rockshelters are located along outcrops of the Junction Creek Formation with a commanding viewshed overlooking the former Gunnison River and valley. 5GN1.2 is the most prominent of the rockshelters recorded in 2009 and USU students named it Picasso's Den in reference to the shelter's petroglyphs. 5GN1.2 is located under a sandstone overhang extending over a roughly crescent-shaped area measuring approximately 20 m long (east-to-west) by 4.5 m wide (north-to-south; Figure 1-3). The rockshelter is located about 182 m to the north and 115 m above the historic channel of the Gunnison River.

USU conducted additional fieldwork at site 5GN1.2 under the direction of Jonathan M. Peart (Field Director and graduate student) and Dr. Bonnie Pitblado (Principal Investigator and graduate advisor). The additional fieldwork included an intensive surface inventory from the rockshelter to the shoreline of the Blue Mesa Reservoir and controlled test excavations in 2010. The surface inventory identified a complete quartzite corner-notched projectile point, five quartzite bifaces, eight sandstone manos and a non-diagnostic ground stone fragment. Additionally, the field crew estimated that the surface assemblage includes more than 450 flakes (>95% quartzite), about 64 scattered fire-cracked rock fragments (FCR) and six surface charcoal stains interpreted as possible features (Peart 2011).

Figure 1-3. Overview of 5GN1.2 rockshelter, facing northeast with the Blue Mesa Reservoir in the background.

The 2010 test excavations at 5GN1.2 unearthed a total of only about .6 m^3 of site matrix yet documented a dense accumulation of cultural material including four features, debitage, chipped-stone tools, ground stone, ecofacts and FCR. The four features include an undated, surface-exposed, half-circle of FCR measuring about 75 cm in diameter (Feature 1), a subsurface scatter of FCR fragments also measuring about 75 cm in diameter (Feature 2) and two features constructed with heavily burnt and stacked large (10 to 20 cm maximum dimension) FCR (Features 3 and 4). Radiocarbon dates from the four subsurface hearth features ranged from about 3000 to 1330 ^{14}C yr BP suggesting site occupation during the Late Prehistoric prior to Ute occupations (Reed and Metcalf 1999). The excavation recovered a diverse collection of chipped-stone and ground stone tools, including five manos, one slab metate, seven quartzite bifaces or biface fragments, four non-diagnostic projectile point fragments, a well-worn scraper, a tested cobble or hammerstone, an amorphous core, 19 utilized flakes and 3565 flakes.

Individual flake attribute analysis of the entire 3565 flake assemblage provides evidence that at 5GN1.2 Late Prehistoric lithic reduction activities were dominated by bifacial tool production of mostly locally procured quartzite but also of a small amount of non-local chert materials (Peart 2013). Additionally, the quartzite debitage nearly represents the entire bifacial reduction sequence, minus initial edging and cortex removal that probably occurred nearer the quartzite outcrops. Non-quartzite flakes are dominated by late-stage bifacial reduction, probably representing tool maintenance debitage. Dense accumulations of quartzite debitage and the proximity of quartzite raw material sources indicate an emphasis on lithic procurement and bifacial tool production. The preponderance of bifacial technology at 5GN1.2 suggests Late Prehistoric site occupants may have geared up on bifaces in anticipation of an extended stay, perhaps seasonal, in the mountainous environments of the UGB (Thomas 2012).

Site 5GN1.2 contains all the hallmarks of a residential site, including constructed hearths, rock art, evidence of plant processing, small-game procurement, high tool diversity, high proportion of locally available lithic raw materials, late-stage tool manufacture and tool maintenance debitage. These data support the view that site 5GN1.2 served as a residential site, possibly a short-term base camp, during the Late Prehistoric.

Study Limitations

A myriad of site formation processes can bring plant remains into rock shelter deposits. However, charred plant remains, especially within thermal features, are assumed to represent ecofacts associated with the cultural use of the site. Though uncharred materials found in features may be associated with past human activities, their association is viewed with much less confidence. Nevertheless, uncharred materials still reveal important data about the area surrounding the site (Kennedy and Smith 2016).

The test excavation of 5GN1.2 and surface inventory identified some potential sources of non-cultural botanical materials. The excavation noted krotovina in most of the units as well as modern roots and rootlets. Additionally, packrat middens occur in the rock outcrop and the rockshelter surface contains concentrations of artiodactyl droppings (Figures 1-4 and 1-5). It is also important to note that many of the plant species that are associated with human subsistence, for instance Indian rice grass and saltbush, are popular targets for rodent seed caching (Kennedy and Smith 2016). These potential sources of botanical materials further reduce confidence that the uncharred materials are cultural.

Figure 1-4. Close-up of a possible packrat midden found in the rockshelter outcrop.

Figure 1-5. Close-up of the rockshelter surface showing artiodactyl scat.

Project Goals and Research Questions

Paleoethnobotany (also called Archaeobotany) encompasses the analysis and interpretation of archaeologically derived plant remains. Understanding how ancient peoples collected, produced, processed, prepared, stored and used plants is central to understanding small-sale site-specific events and large-scale broad archaeological patterns (Pennington and Weber 2004; VanDerwarker et al. 2015; Wright 2010). Through a multidisciplinary approach, Paleoethnobotanists synthesize data from several fields and sources including microbotanical (e.g. starch, phytoliths, pollen), macrobotanical (e.g. stems, charcoal, seeds), paleoenvironmental, ethnographic and various proxies to produce a more complete understanding of the roles that plants played in the everyday lives of ancient peoples (Pennington and Weber 2004). Particularly useful archaeological proxies that provide evidence of plant use include lithic tools (e.g. ground stone and chipped-stone use-wear), features (e.g. types, sizes and construction methods), seasonality and site landscape position.

Previous archaeological research in the UGB has generally underemphasized the role of plants in favor of land-use models focusing on bison hunting during the Late Prehistoric (see Reed and Metcalf 1999; Stiger 2001). This potential bias is driven largely by the overwhelming dominance of shallow open lithic scatters and the paucity of sites containing preserved botanical remains (Peart 2013; Stiger 2001). Site 5GN1.2 is the only excavated Late Prehistoric occupied rock shelter within the basin and is the only known site with such a well-preserved botanical assemblage. The archaeologically derived botanical materials recovered from site 5GN1.2 provides a unique and important opportunity to understand the role that plants played in UGB prehistory.

Based on the results of the 2010 test excavation and subsequent lithic analysis, site 5GN1.2 likely served as a short-term habitation site for small groups, probably nuclear families, of hunter-gatherers during the Late Prehistoric (Peart 2011, 2013). Therefore, the preserved macrobotanical remains found in the hearths are directly relevant in understanding the subsistence practices of the people who lived there. Additionally, macrobotanical remains found in hearth features can provide data regarding the plants collected by site occupants for a variety of other purposes. These diverse purposes include fuel, tool production (e.g. arrows, scrapers, knife handles, pigments), shelter, clothing, medicine and ceremonies (Pennington and Weber 2004). The following list of ambitious research questions guided this macrobotanical analysis project.

Research Questions

1) What plant resources were used by the occupants of the site? Of these resources, what purpose did they serve (e.g. food, fuel, medicine, tools)?
2) Where were these plant resources collected? Were they local, within a typical daily foraging radius, or nonlocal?
3) Can the identified plant remains provide evidence of site occupation seasonality or duration?
4) Can the identified plant remains provide information of relevant in understanding prehistoric feature design, construction and use? How does these results compare with other regional Paleoethnobotany studies on feature use at high elevation (see Troyer 2014)?
5) Are there any temporal patterns evident in the use of plants at site 5GN1.2? Can these patterns relate to paleoenvironmental conditions, regional demographics or changing land-use or mobility strategies?

CHAPTER 2
RESEARCH METHODS

In July 2010, USU archaeologists collected sediment samples for flotation from 5GN1.2. These samples included five from 100N 100E (Feature 1), one from 100N 101E (Feature 3), 13 from 101N 102E (Feature 2) and six samples from Unit A (Feature 4). Each sample included about 1-1.5 liters of sediment. Flotation processing of the collected samples occurred at USU in September and October 2010 using the standard barrel "Flotation Device" manufactured by William Sandy. Following flotation, I sorted the light and heavy fraction. The heavy fraction included flakes, ground stone fragments, FCR, bone, some botanical specimens and other materials. Under low magnification (5-20x) the entire light fraction was painstakingly separated into categories including wood charcoal, seeds, insect parts and other (includes twigs, bark, feathers, uncharred wood).

During the spring of 2011, I attempted to identify the recovered seeds using published reference materials (e.g. Davis 1993; Delorit 1970; Martin and Barkley 2000). This preliminary analysis identified a diverse suite of charred seeds but left most of the botanical assemblage unidentified. Additionally, twelve charcoal specimens were submitted to Alden Identification Services (AIS) for identification and three charcoal samples (one from Features 2, 3 and 4) were submitted to Beta Analytic Inc. for radiocarbon dating. The results of the charcoal identification and radiocarbon dating are presented in the test excavation report (Peart 2011 Appendices A and B). At that point, I prepared the assemblage from 5GN1.2 for curation and submitted the materials to CURE in 2011.

Nearly a decade later, I initiated this current project entitled, "Macrobotanical Analysis of Archaeological Materials Recovered from Site 5GN1.2, Gunnison County, Colorado." I am the Principal Investigator for this project and analyzed the archaeological botanical materials from site 5GN1.2 at MPERF in Hamilton, Ontario. I am a visiting researcher at the MPERF and am working in collaboration with Dr. Shanti Morell-Hart (MPERF Director). The research was conducted at MPERF in order to follow high research standards and to ensure assemblage security. The botanical specimens from site 5GN1.2 were sorted and analyzed using standard archaeological procedures employed in the field of macrofossil analysis (Pearsal 2016). Specimens were categorized, photographed, described and measured using Amscope zoom stereo microscopes and USB cameras (5x-50x reflected light magnification). Ecofacts were identified to the most specific taxonomic level possible through comparisons with published relevant literature (e.g. Cappers and Bekker 2013; Davis 1993; Delorit 1970; Martin and Barkley 2000) and comparative macrobotanical collections at MPERF and my personal reference collection. In addition to the macrobotanical analysis, I submitted one sample of charcoal from Feature 1 to André E. Lalonde AMS Laboratory for radiocarbon dating. Plant nomenclature in this report follows that of the PLANTS Database (USDA NRCS 2020).

CHAPTER 3

ANALYSIS RESULTS

The 2010 test excavation collected a total of 25 flotation samples (about 32 liters)[1] from the four excavation units (Table 3-1). Following flotation processing the light fraction (including point-plotted and screened charcoal) totaled 106.31 g[2]. The largest component of the light fraction were charcoal fragments (66.52 g; 62.6%). Across the four units, the percentage (by mass) of charcoal as a component of the light fraction varied from 54.5% (Feature 4) to 64.3% (Feature 2). Additionally, the number of recovered seeds per flotation sample ranged from 6 to 13 (Feature 3 and Feature 4 respectively). Considering the differences in radiocarbon dates and feature construction, these consistent data (charcoal percentage and seed counts) are noteworthy and suggest that the features remained relatively undisturbed.

Table 3-1. Macrobotanical analysis summary.

Provenience	Feature	Flotation samples	Charcoal (g)	Seeds	Charred lumps
100N 100E	Feature 1	5	1.75	48	4
101N 102E	Feature 2	13	45.25	110	18
100N 101E	Feature 3	1	12.27	6	3
Unit A	Feature 4	6	7.25	80	33
Totals		**25**	**66.52**	**244**	**58**

In 2011, I submitted three samples of charcoal from each feature to AIS for taxonomic identification (Peart 2011 Appendix B). AIS identified four samples as sagebrush (*Artemisia* cf. A. *tridentata*) and eight as White Pine Group (*Pinus* cf. P. *flexilis*) charcoal (Table 3-2). Feature 1 contained a mix of sagebrush and *Pinus* spp. charcoal. Features 2 and 4 contained *Pinus* spp. and Feature 3 contained sagebrush charcoal. Additionally, fragments of sagebrush bark and sticks were found in the light fraction recovered from all four features. Burnt and unburnt juniper sticks also occur within Features 2 and 4. Fuel burnt in the fires consisted of a mix of locally available sagebrush, juniper and pine. Pine trees presently do not occur within site 5GN1, however paleoenvironmental reconstructions provide evidence that pine forests prehistorically extended to lower elevations in the UGB (Emslie et al. 2005, 2015). Increasing the sample of identified charcoal specimens may shed more light on paleoenvironmental conditions and provide a clearer picture on the fuels used in the prehistoric features.

Table 3-2. Charcoal identification.

Provenience	Sagebrush	White pine group *Pinus* cf P. *flexilis*
Feature 1	1	2
Feature 2	0	3
Feature 3	3	0
Feature 4	0	3
Totals	**4**	**8**

[1] I was unable to locate the flotation processing notes from 2010. Consequently, this volume calculation represents an educated estimate based on the number and volume of the sample collection bags.

[2] Total light fraction weight is based on the final artifact catalog since the original flotation processing notes from 2010 were lost.

In 2011, I submitted three charcoal samples to Beta Analytic for radiocarbon dating (Peart 2011). These three point-plotted charcoal specimens were selected from Features 2, 3 and 4. In 2019, I submitted charcoal from a Feature 1 flotation sample to the André E. Lalonde AMS Laboratory for radiocarbon dating (Appendix A). The radiocarbon results are summarized in Table 3-3 and Figure 3-1. Although Features 1, 2 and 3 produced conventional radiocarbon dates within a relatively narrow numerical range, the dates do not statistically overlap within the 2σ calibrated date range ($p<0.05$). If the variation in radiocarbon dates is not the result of the old wood problem, then these data suggest four distinct prehistoric occupations. Since old sagebrush can last over a hundred years and old pine can last a few hundred years on the landscape, these radiocarbon dates can plausibly represent as few as two periods of occupation (Baker et al. 2008; Geib 2008; Schiffer 1986).

Table 3-3. AMS radiocarbon dating results for the four charcoal samples. Calibrated date ranges were calculated from OxCal Version 4.3.2, using the IntCal13 Calibration dataset (Reimer et al. 2013).

Feature	**Lab No.**	**Material**	**Conventional (^{14}C yr BP)**	**2σ Calibrated Date Range (cal BP)**
1	UOC-11322	Unidentified charcoal	1698 ± 24	1694-1652 (p=0.178) and 1631-1547 (p=0.778)
2	Beta-293435	Sagebrush charcoal	1520 ± 30	1523-1452 (p=0.299) and 1445-1341 (p=0.655)
3	Beta-293434	Sagebrush charcoal	1330 ± 30	1302-1232 (p=0.785) and 1208-1184 (p=0.169)
4	Beta-293436	*Pinus* cf. P. *flexilis* charcoal	3000 ± 40	3326-3297 (p=0.060) and 3253-3075 (p=0.894)

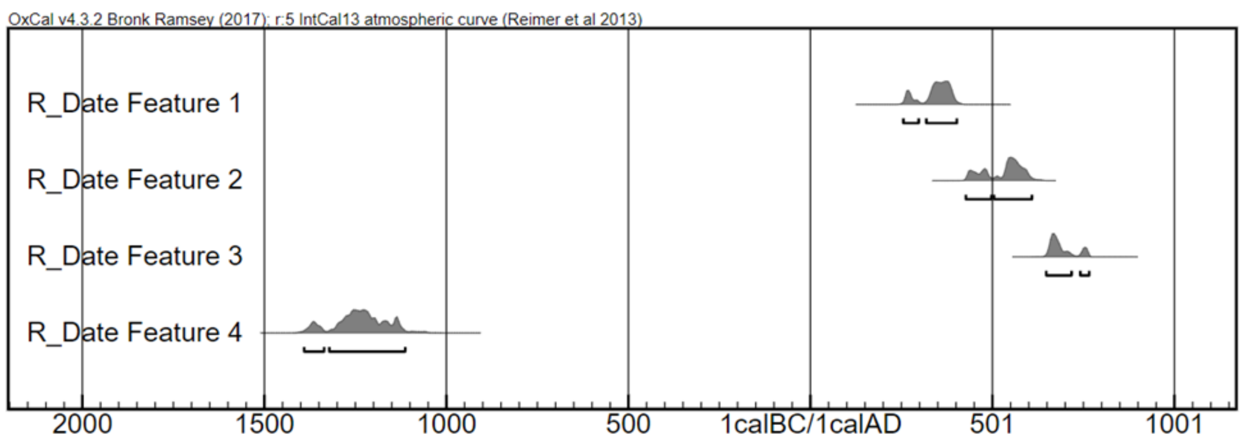

Figure 3-1. Calibrated radiocarbon date ranges (calBC / calAD).

All four units contained charred lumps (Figure 3-2). Charred lumps are also called parenchymous or processed edible tissue (PET) in paleoethnobotanical literature (see Hather 1991; Hoag 2007). The presence of charred lumps suggests that plants, not just wood, were processed, cooked and deposited in the features. Feature 4 contained significantly more charred lumps per sample (5.5 lumps per sample) than the other units which implies more processing/cooking of varied plant tissues. Other than seeds, the rest of the light fraction included a mix of burnt/unburnt unidentified sticks, bark fragments, florets, grass stalks, roots/rootlets, insect parts and a feather (Figures 3-3 and 3-4).

Figure 3-2. Sample of charred lumps from Feature 2. Scale bar is 1 mm.

Figure 3-3. Close-up of a feather (possible singed) found in Feature 3. Scale bar is 1 mm.

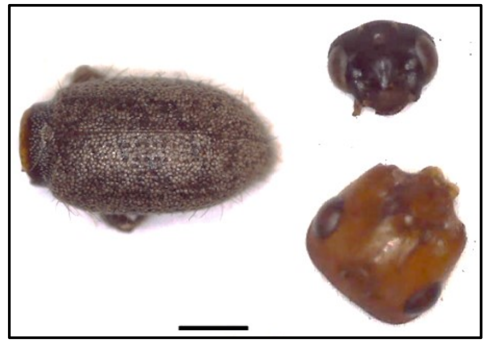

Figure 3-4. Close-up of a sample of insect parts found in the flotation samples. Scale bar is 1 mm.

Seeds

The macrobotanical analysis identified a total of 244 seeds[3] (Table 3-4). Appendix B contains an excel file detailing the raw macrobotanical analysis data and Appendix C contains a collection of digital seed photographs. Of the identified seeds, 164 seeds (67.2%) display evidence of charring or carbonizing consistent with exposure to fire and are likely archaeological. Feature 1 contained a total of 48 seeds of which 36 (75.0%) seeds appeared charred. The single flotation sample taken from Feature 3[4] contained six total seeds of which four (66.7%) seeds were charred. Feature 2 contained the most seeds at 110 in total, of which 61 (55.5%) seeds were charred. The lower frequency of charred seeds found in Feature 2 is likely due the unstructured nature of the feature and the presence of krotovina. Feature 2 also contained the fewest FCR fragments suggesting lower temperatures and less time invested in feature construction. The last feature, Feature 4 contained 80 seeds of which 63 (78.8%) appear charred. As opposed to Feature 3, Feature 4 exhibits an elevated proportion of charred seeds and charred lumps. The higher proportion of charred seeds is almost certainly related to the constructed nature of the feature and possibly to greater depositional integrity. Feature 4 consists of heavily burnt and stacked FCR encased with blackened, charcoal-rich sediments suggesting both intense heat and time-investment in feature construction.

Three identified taxa are only represented by uncharred seed specimens. These include *Heterotheca villosa* (hairy golden aster; n=1), *Pinus* spp. (pine; n=2) and *Bromopsis* or *Ceratochloa* (brome; n=7). Since these seeds and seed fragments appear uncharred, they are presumed to be non-cultural. Based on vegetation surveys reported by Johnston et al. (2001) hairy golden aster is rare in the UGB but does occur at the same elevation as 5GN1.2. The two identified *Pinus* spp. specimens consist of small uncharred seed shell fragments that probably are limber pine but are too small for definitive identification (Figure 3-5). The seven brome seeds all represent modern grass seeds with no evidence of charring. Various *Bromosis spp. and Ceratochloa* spp. occur within the immediate vicinity of the site and are the likely source of these uncharred specimens.

Figure 3-5. Pinus spp. shell fragment from Unit 4. Scale bar is 1 mm.

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[3] The preliminary analysis (Peart 2011 and 2013) estimated a total of 321 seeds. Many of the "unidentified" seeds noted in the preliminary analysis were found to be small charred lumps when viewed under higher magnification.

[4] According to the 2010 test excavation field notes, the flotation sample collected from Unit 100N 101E came from a portion of Feature 3 that partially overlaps Feature 1. Therefore, it is possible (albeit unlikely) that the sample contains material from both features.

Cheno-am seeds represent by far the most common seed taxon (Figure 3-6). In total, 168 cheno-am seeds were identified which comprises 68.9% of the seed assemblage. Cheno-am seeds were divided into three categories based on seed morphology; cheno-am indeterminate (n=35), cf. *Amaranthus* spp. (n=14) and cf. *Atriplex* spp. or *Chenopodium* spp. (n=119). Indian ricegrass (*Achnatherum hymenoides*) is the second most common taxon comprising 33 seeds or 13.5% of the assemblage. The remaining taxa contributed between one to eight seeds each.

Despite a thorough search of available literature and after combing through type collections, two of the seeds, representing two different species, were unidentified even to the family level (Figure 3-7). Since these unidentified seeds are charred, they are presumed to be archaeological but represent only 0.8% of the assemblage. Unidentified Type 1 consists of a charred globose seed (about 1 mm diameter) with a finely textured surface and unidentified Type 2 consists of a charred and open four-segment seed coat (aff. Poaceae family) that overall measures less than 2 mm long.

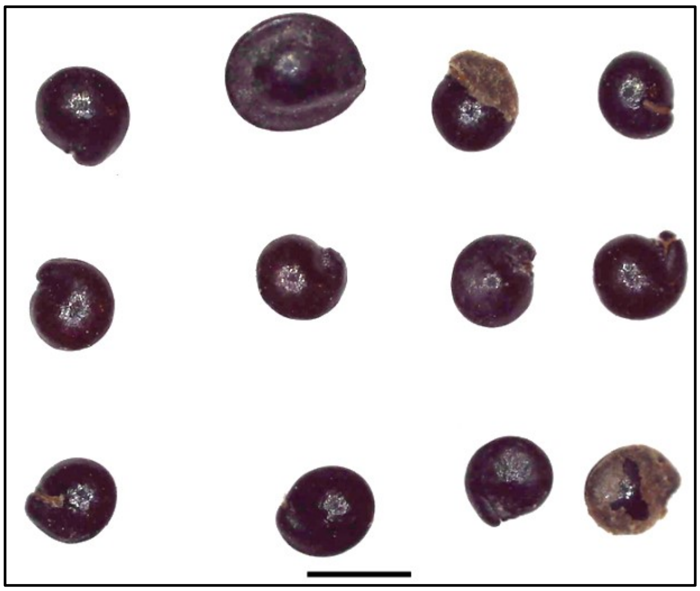

Figure 3-6. Sample of cheno-am seeds from Feature 2. Scale bar is 1 mm.

Figure 3-7. Unidentified Type 1 (left) found in Feature 2 and Unidentified Type 2 (right) found in Feature 4. Scale bar is 1 mm.

Table 3-4. Identified charred and uncharred seed taxa by feature. Asterisks indicates taxa with only uncharred specimens.

Family	Taxa Genus/Species	Common Name(s)	100N 100E Feature 1		100N 101E Feature 3		101N 102E Feature 2		Unit A Feature 4		Notes
			Charred	Un-charred	Charred	Un-charred	Charred	Un-charred	Charred	Un-charred	
Amaranthaceae	Cheno-am indeterminate	Goosefoot or pigweed	11	-	-	-	9	-	15	-	
Amaranthaceae	cf. *Amaranthus* spp.	Pigweed	3	3	-	-	2	3	2	1	Ovoid with a narrow/thin rounded rim (aff. A. *albus*)
Amaranthaceae	cf. *Atriplex* spp. or *Chenopodium* spp.	Goosefoot or saltbush	9	8	-	1	32	44	15	10	Ovoid with a radial furrow that forms a small notch (aff. C. *praticola*)
Asteraceae	*Heterotheca villosa**	Hairy golden aster	-	-	-	-	-	-	-	1	Modern uncharred seed
Cactaceae	*Opuntia polyacantha*	Prickly pear cactus	1	-	1	-	-	-	1	-	
Capparaceae	*Cleome* cf. C. *serrulata*	Rocky Mountain bee plant	1	-	1	-	1	-	-	-	Heavy charring affecting identification
Cupressaceae	*Juniperus scopulorum*	Rocky Mountain juniper	3	-	1	-	2	-	1	-	
Ericaceae	*Arctostaphylos* cf. A. *uva-ursi*	Kinnikinnick (bearberry)	1	-	-	-	-	-	-	-	
Pinaceae	*Pinus spp.**	Pine	-	-	-	1	-	1	-	-	Small uncharred shell fragments
Poaceae	cf. *Bromopsis or Ceratochloa* spp.*	Brome grass	-	1	-	-	-	1	-	5	Modern uncharred grass seeds
Poaceae	*Achnatherum hymenoides*	Indian ricegrass	-	-	-	-	9	-	22	-	Most specimens consist of partially or fully open seed coats
Poaceae	*Achnatherum* cf. A. *hymenoides*	Indian ricegrass	1	-	-	-	-	-	1	-	Heavily charred; seed coat dimensions and shape consistent with A. *hymenoides*
Polygonaceae	*Polygonum* spp. (Type 1)	Knotgrasses or buckwheat	2	-	-	-	1	-	-	-	Ovate/broadly elliptical outline with blunt base and small acute tip (aff. P. *lapathifolium*)

Family	Taxa Genus/Species	Common Name(s)	100N 100E Feature 1		100N 101E Feature 3		101N 102E Feature 2		Unit A Feature 4		Notes
			Charred	Un-charred	Charred	Un-charred	Charred	Un-charred	Charred	Un-charred	
Polygonaceae	cf. *Polygonum* spp. or cf. *Rumex* spp. (Type 2)	Knotgrasses, buckwheat or dock	1	-	-	-	-	-	-	-	Three-sided ellipsoid, broadest at about the middle with a blunt end and a narrow apex (aff. P. *ramosissimum*)
Ranunculaceae	*Actaea* cf. A. *rubra*	Red baneberry	-	-	-	-	-	-	1	-	
Rosaceae	*Potentilla* spp.	Cinquefoil	1	-	-	-	1	-	1	-	
Solanaceae	*Physalis* spp.	Ground cherry	2	-	1	-	3	-	2	-	
Solanaceae	cf. *Physalis* sp. or *cf. Solanum* sp.	Ground cherry or nightshade	-	-	-	-	-	-	1	-	Heavy charring affecting identification
Unidentified	Type 1	Unknown	-	-	-	-	1	-	-	-	Charred globose seed (~1 mm diameter) with a finely textured surface and a slightly raised band around the circumference
Unidentified	Type 2	Unknown	-	-	-	-	-	-	1	-	Charred open seed coat with four sectors (<2 mm long); aff. Poaceae family
	Totals		**36**	**12**	**4**	**2**	**61**	**49**	**63**	**17**	Total Seeds = **244** Total Charred = **164 (67.2%)**

CHAPTER 4
DISCUSSION AND SUMMARY

The macrobotanical analysis identified a wide range of charred plant specimens (seeds and charcoal) from at least 12 plant families. These families include Amaranthaceae (amaranth), Asteraceae (aster/sunflower), Cactaceae (cactus), Capparaceae (capers), Cupressaceae (cypress), Ericaceae (heath), Pinaceae (pine), Poaceae (grass), Polygonaceae (polygonum), Ranunculaceae (buttercup), Rosaceae (rose) and Solanaceae (nightshade) families. The following taxa description section is organized by plant family.

Taxa Descriptions

Amaranthaceae Family

The Amaranthaceae Family, named after the *Amaranthus* genus, includes numerous species with common names such as amaranth, goosefoot, pigweed, saltbush and others. Recent taxonomic research has subsumed the genus *Chenopodium* (goosefoot) under the Amaranthaceae family. In general, these plants are annual herbs with an erect or spreading stem that ranges between 30 to 120 cm tall. Often these species have small green or brown flowers united with fruits in tight clusters distributed over the length of the stem or at the end of the stem (Cappers and Bekker 2013).

In total, 168 Amaranthaceae seeds were identified which comprises 68.9% of the total seed assemblage. Due to very similar morphological attributes, seeds of the Amaranthaceae family are typically not defined below the genus level (Cappers and Bekker 2013). In relation to this project, the seeds of genera *Amaranthus*, *Atriplex* and *Chenopodium* appear morphologically very similar and are difficult to confidently discern species particularly when charred. As such, the category of cheno-am broadly encompasses these genera. Based on vegetation survey data in the UGB, at least two species of *Amaranthus* (A. *albus* and A. *retroflexus*), two species of *Atriplex* (A. *confertifolia* and A. *corrugata*) and seven of *Chenopodium* (C. *album*, C. *atrovirens*, C. *foliosum*, C. *fremontii*, C. *leptophyllum*, C. *overi* and C. *rubrum*) occur in the UGB (Arnette 2002; Taylor 2000). Most of the above listed UGB cheno-am species bloom in the summer and produce fruit in the late summer to early fall (USDA NRCS 2019).

Ethnobotanical sources from across western North America cite abundant uses of plants from the Amaranthaceae family and more specially from *Amaranthus*, *Atriplex* and *Chenopodium* genera. The Acoma ate saltbush fruits, Hopi boiled and ate saltbush leaves as greens, and the Paiute as well as the Gosiute ate saltbush seeds either raw or roasted and mashed (Castetter 1935; Chamberlin 1911; Fewkes 1896; Fowler 1989). Additionally, the Navajo used saltbush in medicines as an analgesic and to treat dermatological conditions as well as used the leaves/twigs to make dyes (Elmore 1944). Ethnographic uses of genera *Chenopodium* and *Amaranthus* are just as varied and common. Apache, Gosiute, Hopi, Navajo and Paiute are all known to have consumed *Chenopodium* spp. seeds (raw, ground or mashed) or leaves (Castetter 1935; Chamberlin 1911; Elmore 1944; Fowler 1989; Vestal 1940). Similarly, the Acoma, Apache, Gosiute, Hopi and Navajo are all known to have consumed ground *Amaranthus* spp. seeds made into a porridge or ate the leaves as greens (Chamberlin 1911; Elmore 1944; Reagan 1929; Vestal 1952; Whiting 1939).

A total of 98 charred cheno-am seeds were found in Features 1, 2 and 4. These charred seeds were separated into three categories based on seed morphology; cheno-am indeterminate (n=35), cf. *Amaranthus* spp. (n=7) and cf. *Atriplex* spp. or cf. *Chenopodium* spp. (n=56; Figure 3-8). In general, cf.

Amaranthus seeds are ovoid with narrow/thin rounded rim (aff. A. *albus*) and cf. *Atriplex* and cf. *Chenopodium* seeds are ovoid with a radial furrow that forms a small notch (aff. C. *pratericola*). The presence of these charred specimens provides evidence of late summer to early fall harvesting and consumption of cheno-am seeds/fruits.

Figure 3-8. a. Representative cf. Amaranthus spp. seed from Feature 1. b. Four representative cf. Atriplex and cf. Chenopodium seeds from Feature 2. Scale bars are 1 mm.

Asteraceae Family

The macrobotanical analysis identified both burnt and unburnt sagebrush (*Artemisia* spp.) sticks and bark fragments in the four features at 5GN1.2. Additionally, AIS identified big sagebrush (*Artemisia tridentata* Nutt.) charcoal in Features 1 and 3. *Artemisia tridentata Nutt.* are members of the Asteraceae family also known as the aster/sunflower family and are a dominate plant species in the Foothills-Semidesert Shrub vegetation zone in the UGB (Johnston et al. 2001). Big sagebrush have evergreen leaves and are tall, rounded, native shrubs with branched, woody trunks. Shrub height varies among the six subspecies, but overall ranges from .6 m in arid settings to as tall as 4.5 m in favorable habitats (USDA NRCS 2008). In general, big sagebrush are well-adapted to arid plains, valleys, foothills and mountains and are found on moderately shallow to deep, well-drained, sandy to silt loam soils throughout the intermountain west.

Ethnographic data sources document a wide variety of uses of sagebrush plants among many indigenous groups. For example, sagebrush wood was commonly used as a fuel in cooking fires and used to make friction fire starters among the Navajo and Gosiute (Chamberlin 1911; Elmore 1944; Mahar 1953). Several groups, including Paiute and Shoshone, used sagebrush bark to construct sandals, cordage and living structures (Mahar 1953; Steward 1933; Train et al. 1941). Sagebrush served many religious ceremonial and medicinal functions including as incense in purification rituals, as a remedy for colds, fevers, aches, gastrointestinal problems and for many other medical issues (e.g. Chamberlin 1911; Elmore 1944; Mahar 1953; Reagan 1929; Steward 1933). Some sources also indicate that sagebrush seeds were mixed with other seeds and consumed in times of food shortages in the Great Basin (Steward 1933).

The macrobotanical data suggests that prehistoric occupants of the site used big sagebrush as fuel in the features. Other roles (e.g. tools or medicine) are possible based on known ethnographic uses but no specific indications of these activities were identified at the site.

Cactaceae Family

The analysis identified three charred prickly pear cactus (*Opuntia polyacantha*) seeds. Features 1, 3 and 4 contained one charred seed each. Prickly pear cactus is a member of the Cactaceae family and is a native perennial shrub with enlarged photosynthetic stem joints (cladophylls) which function as leaves. The shrub averages between 30 to 60 cm tall and has flattened stem joints that are about 5 to 15 cm long that notably include patches of long spines. Flowers have yellow-pink or violet pedals and the fruit consists of a barrel-to-pear-shaped fleshy berry measuring 2.5 to 5 cm long. The plant blooms from April to July and bears fruit beginning in the late spring through summer. Prickly pear cactus species are found across western North America. In the intermountain west and northern Great Plains, prickly pear cactus plants can be found growing in cold desert shrublands in association with sagebrush, rabbitbrush, horsebrush, western wheatgrass, blue bunch wheatgrass and Idaho fescue (USDA NRCS 2014).

Prickly pear cactus is a well-known aboriginal food source in the intermountain west. For example, the Cheyenne, Gosiute and Flathead ate the fruit (either raw or dried) and roasted joints (Chamberlin 1911; Elmore 1944; Hart 1992). Additionally, the Navajo made a dye out of the flowers as well as used the plant to produce a hunting poison (Elmore 1944). The Flathead also made antidiarrheal and analgesic medicines from the plant (Hart 1992).

Prickly pear cactus occurs within site 5GN1.2. The presence of charred prickly pear cactus seeds suggests the consumption of locally available fruit and probably pads during the late spring through summer.

Capparaceae Family

Three heavily charred probable Rocky Mountain bee plant (*Cleome* cf. C. *serrulata*) seeds were identified. Features 1, 2 and 3 each contained one charred seed. Rocky Mountain bee plant has traditionally been considered part of the Capparaceae (capers) family (USDA NRCS 2019); but genetic studies suggest it may be part of the Brassicaceae (mustard) family or part of a newly defined Cleomaceae family (USDA NRCS 2019; USDA USFS 2019). The plant is an annual herb known for its distinctive pink-flowers and nectar-filled blossoms. Rocky Mountain bee plant grows up to 120 cm tall and blooms from May to September. The plant yields distinctive pod-like capsule fruits that are up to 10 cm long during the summer to early fall (USDA USFS 2019).

Many ethnographic sources list Rocky Mountain bee plant as an important food source. For instance, the Apache, Hopi and Navajo are known to eat the leaves raw or boiled as greens (Buskirk 1986; Castetter 1935; Elmore 1944; Vestal 1952). The Navajo also ate the seeds/fruits and used the plant as a spice (Elmore 1944). Furthermore, the Gosiute and Navajo used Rocky Mountain bee plant in ceremonies and in several traditional medicines (Chamberlin 1911; Vestal 1952).

Rocky Mountain bee plants occur within the UGB (Taylor 2000), though no plants were identified within the vicinity of 5GN1.2 during the 2010 test excavation. The presence of charred Rocky Mountain bee plant seeds suggests the consumption of locally available fruit during the summer through early fall.

Cupressaceae Family

Rocky Mountain juniper (*Juniperus scopulorum*) is a member of the Cupressaceae (cypress) family. The plant is a medium-sized dioecious or rarely monoecious evergreen tree. Rocky Mountain juniper ranges from 10 to 20 m tall and is scraggy with a rounded-to-pyramidal shaped crown. The tree produces ovulate cones at the tip of branchlets that appear dark-blue or bluish purple with a waxy and berry-like appearance (0.4 to 0.7 cm long). These berry-like structures mature in the second season and fully ripen from September to October. Trees grow in rocky, sandy or clay soils on prairie hillsides, pastures and occasionally in woodlands (USDA NRCS 2003).

Ethnographic information suggests many indigenous groups used parts of the Rocky Mountain juniper tree in traditional medicines and ceremonies including the Apache, Cheyenne, Crow, Flathead, Navajo, Shoshoni, Sioux and others (Hart 1981, 1992; Elmore 1844; Train et al. 1941; Vestal 1952). A few groups ate the berries, particularly during times of resource stress, such as the Apache and Shoshoni (Castetter and Opler 1936; Train et al., 1941). Additionally, the Cheyenne found many uses for Rocky Mountain juniper wood such as for bows, bowls, flutes and various other implements (Hart 1981).

Charred Rocky Mountain juniper seeds were found in all four features. Additionally, charred/uncharred juniper sticks occur within Features 2 and 4. The macrobotanical evidence suggests that Rocky Mountain juniper wood served as a fuel and the berries as a possible food source. The berries fully ripen from September to October, however unripe berries are avaliable year-round.

Ericaceae

The macrobotanical analysis identified one charred possible Kinnikinnick (*Arctostaphylos uva-ursa*) seed in a flotation sample from Feature 1. Kinnikinnick (also known as bearberry) is a member of the Ericaceae family. The plant is a prostrate, mat-forming, evergreen shrub that often forms dense stands of up to 4 m diameter but rarely more than 15 cm tall. Kinnikinnick prefers coarse, well to excessively drained soils of forests, sand dunes or barren areas. White to pink flowers bloom from March to June and bear smooth, glossy skinned fruits ranging from 0.5 to 2 cm diameter. Fruits persist on the plant until early winter (USDA NRCS 2006). This plant commonly occurs in the UGB within forested environments ranging in elevation from about 2380 to 3243 m ASL (Johnston et al. 2001).

Ethnographic sources indicate that many indigenous groups across western North America ate Kinnikinnick berries either raw, dried or added to pemmican (Hamel and Chiltoskey 1975; Hellston 1974; Johnston 1987). However, Kinnikinnick is best known for its leaves which were commonly added to smoking mixtures by the Cheyenne, Paiute, various Great Basin groups and many others (Hart 1981; Nickerson 1966; Mahar 1953; Vestal 1952). The Cheyenne, Navajo, Paiute and other groups used Kinnikinnick in traditional medicine to cure a host of ailments and in ceremonies (Hart 1992; Mahar 1953; Vestal 1952). The presence of a charred seed in Feature 1 suggests harvesting and consumption of Kinnikinnick berries in the late summer to early winter. Speculatively, Kinnikinnick leaves might have been gathered with the fruits and smoked or used in traditional medicine.

Pinaceae Family

The *Pinus* genus are members of the Pinaceae (pine) family. AIS identified *Pinus* spp. (probably P. *flexilis*) charcoal in Features 1, 2 and 4 indicating that pine was used a fuel. The UGB prehistorically likely contained at least five *Pinus* genus species including bristlecone pine (P. *aristata*), lodgepole pine (P. *contorta*), limber pine (P. *flexilis*), ponderosa pine (P. *ponderosa*) and piñon (P. *edulis or* P. *monophylla*). Most substantial valleys and foothill regions in the southern Rocky Mountains contain Piñon-Juniper Woodlands however in the UGB only small stands of recently established piñon occur in the Gunnison Uplift Area (Arnette 2002; Taylor 2000). Based on packrat paleoenvironmental data (Emslie et al. 2005, 2015) piñon probably became effectively extinct in the UGB around 3000 BP.

The Native American Ethnobotany Database (NAEB; http://naeb.brit.org/) contains hundreds of entries listing uses of *Pinus* spp. among intermountain west indigenous groups. Of these species, piñon can probably be considered the most significant and economically important. Piñon produces large, nutritious and storable seeds known as a staple among many groups including the Apache, Gosiute, Paiute, Shoshoni and others (Buskirk 1986; Castetter and Opler 1936; Chamberlin 1911; Elmore 1944; Train et al., 1941; Steward 1933, 1936). Several groups also used piñon in ceremonies and in traditional medicines. For example, the Paiute and Navajo used piñon-based medicines to treat muscle soreness, diarrhea, nausea, rheumatism, cold, fevers and a host of other ailments (Elmore 1944; Train et al. 1941). The NAEB lists numerous other diverse uses of piñon. For instance, the Navajo used piñon to make inks/dyes, used resin for waterproofing baskets, built wooden structures, used the wood as fuel as well as made chewing gum (Elmore 1944). Although not as important as piñon, several groups used limber pine for food, medicine and tools. Limber pine nuts were roasted and ground by the Apache and groups in Montana (Blankenship 1905: Castetter and Opler 1936). The Navajo used limber pine in ceremonies and in traditional medicines for coughs, fevers and as an emetic (Vestal 1952).

Poaceae Family

Older literature identifies *Achnatherum hymenoides* (Indian ricegrass) as *Oryzopsis hymenoides* or *Stipa hymenoides*. Indian ricegrass is a member of the Poaceae (grasses) family and is a well-known indigenous food staple in the intermountain west. The Apache, Gosiute, Havasupai, Hopi, Navajo, Paiute and others ate Indian ricegrass seeds raw, ground and made into porridge/mush or cooked as bread (Blankenship 1905; Chamberlin 1911; Murphey 1990; Reagan 1929; Vestal 1940). The plant is a bunchgrass with a wiry appearance and averages between 20 to 76 cm tall. Indian ricegrass is very hardy and known for growing within broad climatic ranges from plains, foothills, mountains and intermountain basins. The plant blooms from May to June. Nutritious and abundant Indian ricegrass seeds are usually harvested from July to August (USDA NRCS 2000). Indian ricegrass is very common in the UGB, particularly within the Foothills Semi-desert Shrub vegetation zone in the vicinity of 5GN1.2 (Johnston et al. 2001).

The macrobotanical analysis identified charred Indian ricegrass seeds in Feature 1 (n=1), Feature 2 (n=9) and Feature 4 (n=23). The presence of these seeds provides evidence of Indian ricegrass harvesting and consumption during the mid-summer through early fall.

Polygonaceae

Two charred *Polygonum* sp. seeds and one charred cf. *Polygonum* or cf. *Rumex* seed were identified in Feature 1. Additionally, Feature 2 contains one charred *Polygonum* spp. seed. Genera *Polygonum* and *Rumex* are members of the Polygonaceae (buckwheat) family. Generally, the *Polygonum* genus (also known as knotweed or knotgrass) consists of annual or perennial herbaceous plants that have many branched stems. According to vegetation survey data, at least five *Polygonum* species occur in the UGB including water knotweed (P. *amphibium)*, prostrate knotweed (P. *aviculare)*, meadow bistort (P. *bistortoides)*, American bistort (P. *douglasii)* and alpine bistort (P. *viviparum* [Johnston et al. 2001; Taylor 2000]). Three of these species (water knotweed, meadow bistort and alpine knotweed) produce fruits/seeds in the late summer.

Rumex genus (also called docks and sorrels) generally consist of perennial forbs that are usually erect with long taproots. These plants usually have clusters of small green or sometimes red flowers carried above the leaves. According to vegetation survey data, at least five *Rumex* genus species occur in the UGB including common sheep sorrel (R. *acetosella)*, western dock (R. *aquaticus)*, curly dock (R. *crispus)*, denseflowered dock (R. *densiflorus)* and canaigre dock (R. *hymenosepalus [Johnston et al. 2001; Taylor 2000])*. Seeds and fruits of these species typically ripen in the late summer through fall (USDA NRCS 2019).

Ethnographic literature cites many uses of knotweed and dock species in the intermountain west (NAEB; http://naeb.brit.org/). Several groups used knotweed for food. For example, the Sioux ate young shoots as a relish, Cheyenne ate roots and some Montana groups ate parched and ground seeds as a staple (Blankenship 1905; Grinnel 1972; Hart 1981). Knotweed also figured prominently in traditional medicines among the Apache, Cherokee and Navajo (Hamel and Chiltoskey 1975; Reagan 1929; Vestal 1952). The Cherokee used the plant for several medicinal purposes including as an analgesic, an antidiarrheal, as an anti-inflammatory and others (Hamel and Chiltoskey 1975). Similarly, multiple dock species were known food sources. Leaves and stems of the plant were eaten by the Apache, Cheyenne and Navajo (Blankenship 1905; Castetter and Opler 1936; Hart 1981; Lynch 1986). Additionally, ground dock seeds were eaten the Paiute, Navajo and the indigenous peoples in Montana (Blankenship 1905; Elmore 1944; Fowler 1986; Lynch 1986; Mahar 1953). The Cheyenne, Hopi and Navajo made dyes from the plant (Hart 1981; Elmore 1944 and Whiting 1939). Just like knotweed, dock figured prominently in traditional medicines among the Arapaho, Cherokee, Hopi, Navajo, Paiute and Shoshoni (Hamel and Chiltoskey 1975; Murphey 1990; Train et al. 1941; Steward 1933; Vestal 1952; Whiting 1939).

Based on the archaeological evidence in Features 1 and 2 as well as ethnographic data, the inhabitants of 5GN1.2 likely gathered and consumed *Polygonum* spp. and possibly *Rumex* spp. plants during the late summer through fall.

Ranunculaceae Family

A single charred possible red baneberry (*Actaea rubra*) seed was identified in a flotation sample from Feature 4. Red baneberry is a member of the Ranunculaceae (buttercup) family. The plant mostly occurs in deciduous or mixed conifer forests. Red baneberry blooms from the spring to early summer and produces toxic inedible white berries that ripen from July to August. Vegetation surveys reported by Johnston et al. (2001) identified red baneberry plants in the UGB ranging in elevation from 2642 to 3070 m ASL. Although red baneberry is toxic to humans, many aboriginal groups utilized the plant in traditional medicines or in ceremonies. For example, the Blackfoot used the roots to make a remedy for colds and coughs (Johnston 1987) and the Cheyenne used the roots to make medicines for sores (Hart 1981). Interestingly, sources also indicate that the Cheyenne and Blackfoot used an infusion of roots/stems to increase milk flow among nursing women (Hart 1981, 1992; Grinnel 1905). The presence of a charred seed in Feature 4 may indicate the production of traditional medicines made from the plant probably during the summer.

Rosaceae Family

The macrobotanical analysis identified three charred *Potentilla* spp. seeds with one in Features 1, 2 and 4. Commonly known as cinquefoil, the genus *Potentilla* is a member of the Rosaceae (rose) family. Generally, cinquefoil species are perennial shrubs that resemble wild strawberry and are sometimes referred to as "barren strawberry". But unlike strawberry, cinquefoil generally produces dry and inedible fruit. Based on the vegetation surveys reported by Johnston et al. (2001), at least four cinquefoil species occur in the UGB including elegant cinquefoil (P. *concinna*), varileaf cinquefoil (P. *diversifolia*), horse cinquefoil (P. *hippiana*), Pennsylvania cinquefoil (P. *pensylvanica*) and beauty cinquefoil (P. *pulcherrima*). Cinquefoil species occur at nearly every elevation (ranging from about 1500 to 3800 m) within the UGB (Johnston et al. 2001). Generally, yellow flowers bloom from May to August and the plants produce fruits/seeds during the summer through the early fall.

Ethnographic sources provide evidence that various cinquefoil species served important roles in traditional medicines. For instance, the Navajo used cinquefoil as a "life medicine", as a burn lotion, as a poultice on injuries and as a medicine to reduce pain and speed up labor (Chamberlin 1911; Hamel and Chitoskey 1975; Vestal 1952; Wyman and Harris 1951). Additionally, the Cherokee used cinquefoil in medicines for dysentery, fevers and as a mouthwash for thrash (Hamel and Chitoskey 1975). The NAEB database does not list any entries where cinquefoil species were known as an indigenous food source. As such, the presence of charred cinquefoil seeds in Features 1, 2 and 4 suggest the production of traditional medicines during the summer through early fall.

Solanaceae Family

The Solanaceae family (nightshade) consists of flowering plants ranging from annual and perennial herbs to vines, shrubs and even some trees. The nightshade family includes several important agricultural crops, medicinal plants and spices such as tomatoes, potatoes, eggplant, bell peppers and chili peppers. Charred *Physalis* (ground cherry) seeds occurred in Feature 1 (n=2), Feature 2 (n=3), Feature 3 (n=1) and Feature 4 (n=2). Additionally, one possible charred *Physalis* or *Solanum* (nightshade) seed was identified in Feature 4. Generally, the *Physalis* genus consists of about 80 species of small herbaceous flowering plants noted for an inflated bag-like calyx (fused sepals) which encloses a fleshy berry. Berries from several species of the *Physalis* genus are edible and some are important new world commercial food crops such as cape gooseberry (P. *peruviana*), husk tomato (P. *pruinosa*) and tomatillo (P. *philadelphica [USDA NRCS 2019]*).

Several *Physalis* spp. occur in Colorado including small flower ground cherry (P. *cinerascens*), ivyleaf ground cherry (P. *hederifolia*), prairie ground cherry (P. *hispida*), longleaf ground cherry (P. *longifolia*), husk ground cherry (P. *pubescens*) and others. Fruits of ivyleaf ground cherry and clammy ground cherry ripen during the summer through fall (USDA NRCS 2020). Ground cherry fruit is a well-documented indigenous food source known to be consumed by the Apache, Cherokee, Navajo and others (Hamel and Chiltoskey 1975; Hart 1981; Reagan 1929).

Based on environmental conditions, ground cherry species should occur but are anomalously absent from the UGB (Emslie and Meltzer 2019). Still, *Physalis* spp. are not absent from the archaeological record. Stiger (2001: Appendix E) reports that a *Physalis* spp. seed was recovered from Feature 39 found at site 5GN1835 (Tenderfoot Site) dating to 7160 ± 90 BP. If ground cherry species were absent from the UGB prehistorically, then the charred ground cherry seeds found at 5GN1.2 provides evidence of subsistence resource transport from outside of the basin.

Summary and Conclusions

Using Stiger's (2001) feature typology, the four features identified at 5GN1.2 consist of two Small-shallow FCR (Features 1 and 2) and two Big-deep FCR features (Features 3 and 4). Due to the limited scope of the test excavation, only a section of each of the four identified features were excavated leaving a portion intact for future research. Since the features were not completely uncovered nor excavated it is impossible to determine their exact dimensions. Based on radiocarbon dated charcoal, Feature 1 dates to 1698 ± 24 ^{14}C yr BP, Feature 2 dates to 1520 ± 30 ^{14}C yr BP, Feature 3 dates to 1330 ± 30 ^{14}C yr BP and Feature 4 dates to 3000 ± 40 ^{14}C yr BP (Table 3-2). Although Features 1, 2 and 3 produced radiocarbon dates within a relatively narrow range (about 360 years), the dates do not statistically overlap within the 2σ calibrated date range ($p < 0.05$). Considering the old wood problem (Baker et al. 2008; Geib 2008; Schiffer 1986), these radiocarbon dates can plausibly represent as few as two temporally distinct prehistoric occupations.

Fuel used in the features consisted of sagebrush, juniper and pine. Based on the charcoal samples submitted to AIS, Feature 1 contained a mix of sagebrush and pine charcoal. Features 2 and 4 contained pine charcoal and Feature 3 contained sagebrush charcoal (Table 3-3). The flotation samples from all four features contained charred sagebrush sticks and bark. Additionally, burnt juniper sticks were observed in the flotation samples from Features 2 and 4. Sagebrush occurs within the site and juniper within a few hundred meters. Pine trees do not currently occur within the larger site 5GN1, but paleoenvironmental reconstructions (Emslie et al. 2005, 2015) provide evidence that pine forests prehistorically extended to lower elevations in the UGB and may have been locally available.

The macrobotanical analysis recovered a total of 244 seeds of which over 99% were identified to at least the genus taxonomic level (Table 3-4). After a thorough search of available literature and after combing through type collections, I was unable to confidently identify only two seeds representing two different species. The number of recovered seeds per feature is proportional to the number of processed flotation samples and averaged 9.8 seeds per 1-1.5-liter flotation sample. The five flotation samples from Feature 1 produced 48 seeds. The 13 flotation samples from Feature 2 produced 110 seeds. Only one flotation sample was collected from Feature 3 and it contained six seeds. The six flotation samples taken from Feature 4 yielded 80 seeds. Of the recovered seeds, 164 (67.2%) display evidence of charring or carbonizing consistent with exposure to fire and are likely archaeological. Three identified taxa are only represented by uncharred seed specimens. These include *Heterotheca villosa* (hairy golden aster; n=1), *Pinus* spp. (pine; n=2) and *Bromopsis* or *Ceratochloa* (brome; n=7). Since these seeds and seed fragments appear uncharred, they are presumed to be non-cultural.

The macrobotanical analysis identified a wide range of charred seeds from at least ten plant families. These families include Amaranthaceae (amaranth), Cactaceae (cactus), Capparaceae (capers), Cupressaceae (cypress), Ericaceae (heath), Poaceae (grass), Polygonaceae (polygonum), Ranunculaceae (buttercup), Rosaceae (rose) and Solanaceae (nightshade) families. Figure 3-9 is a pie chart that compares the ratios of the different identified charred seed taxa between Features 1, 2 and 4.

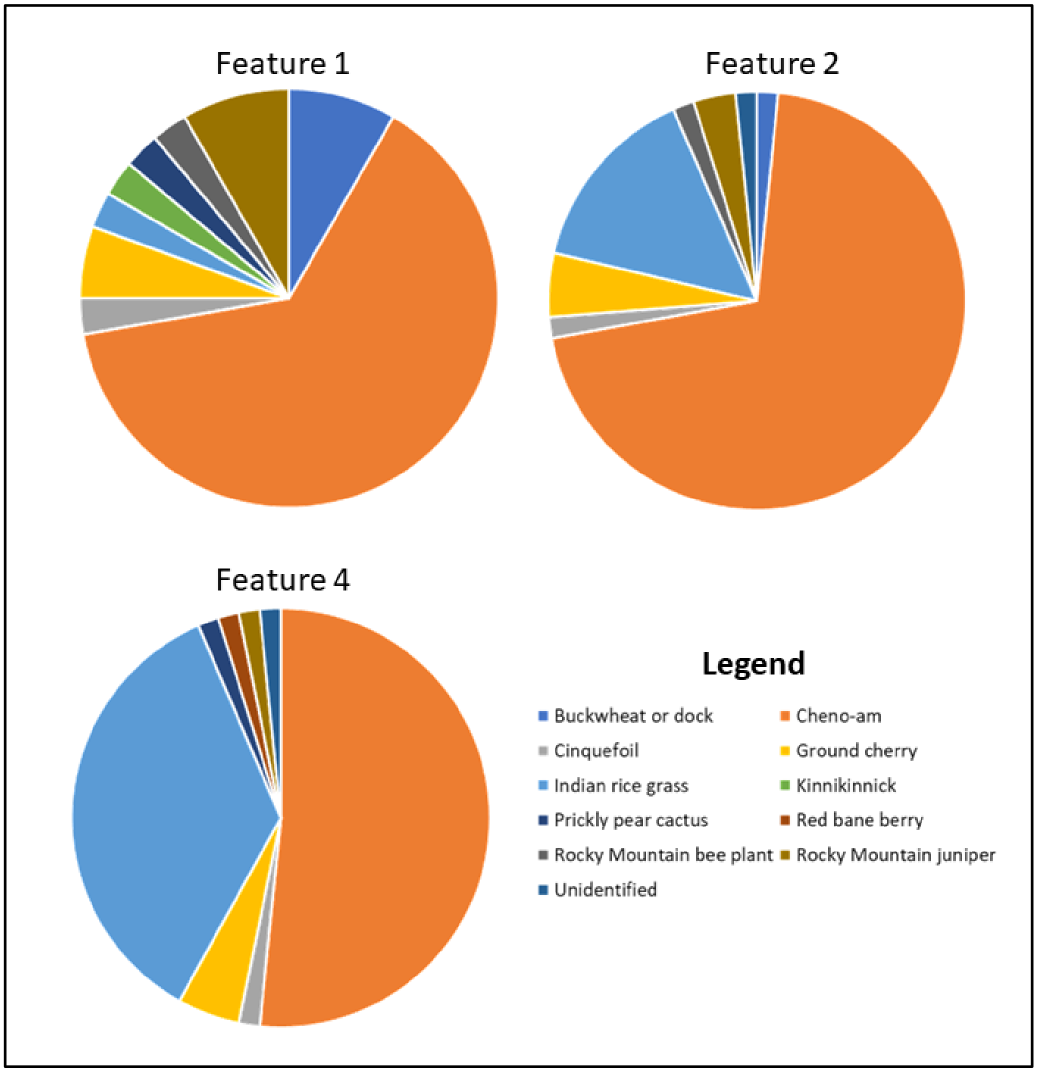

Figure 3-9. Pie charts showing the proportions of seed taxa identified from Features 1, 2 and 4.

Cheno-am seeds represent by far the most common seed taxon. In total, 168 cheno-am seeds were identified which comprises 68.9% of the seed assemblage. Cheno-am seeds were divided into three categories based on seed morphology; cheno-am indeterminate (n=35), cf. *Amaranthus* spp. (n=14) and cf. *Atriplex* spp. or *Chenopodium* spp. (n=119). Indian ricegrass (*Achnatherum hymenoides*) is the second most common taxon comprising 33 seeds or 13.5% of the assemblage. The remaining taxa contributed between one to eight seeds each. These other taxa include hairy golden aster (one seed), prickly pear cactus (three seeds), cf. Rocky Mountain bee plant (three seeds), Rocky Mountain juniper (seven seeds), Kinninnick (one seed), *Polygonum* (knotgrasses or buckwheat; three seeds), cf. *Polygonum* or *Rumex (*buckwheat or dock; one seed), cf. red bane berry (one seed), cinquefoil (three seeds), ground cherry (eight seeds) and cf. ground cherry or nightshade (one seed). A detailed summary of the identified charred seed remains by feature is include as Table 4-1.

The various identified taxa may signify the exploitation of a wide range of ecological niches. However, the wide range of ecological conditions in which many of the recovered taxa survive makes this statement difficult to prove. All the identified charred taxa currently grow within the UGB, except for *Physalis* spp. (ground cherry). Based on environmental conditions, ground cherry species should occur but are anomalously absent from the UGB (Emslie and Meltzer 2019). If ground cherry species were absent from the UGB prehistorically, then the charred ground cherry seeds found at 5GN1.2 provides evidence of subsistence resource transport from areas outside of the basin. A few of the identified charred taxa occur within the UGB at higher elevation or in different vegetation zones but could be collected within a typical daily foraging radius of less than 10 km (Kelly 1995; Morgan 2008). These species include Rocky Mountain bee plant, Kinnikinnick and red bane berry. Several of the represented species could be gathered within a couple hundred meters of the rockshelter including sagebrush (wood), Rocky Mountain juniper (berries and wood), prickly pear cactus, Indian rice grass, cheno-am, buckwheat and cinquefoil.

The exact prehistoric use of specific taxa or specimens in most cases are very difficult to confidently ascertain. Based on macrobotanical and ethnographic data, prehistoric occupants of the site used sagebrush, pine and juniper as fuel in the hearths. Inhabitants appear to have consumed a diverse diet that included buckwheat/dock, cheno-am, ground cherry, Kinnikinnick, Indian rice grass, prickly pear cactus, Rocky Mountain bee plant and potentially Rocky Mountain juniper berries. Since red bane berry is inedible, it may have been used in the production of traditional medicines. Additionally, Kinnikinnick is a well-known plant used in smoking mixtures and cinquefoil is a common plant in traditional medicines.

The 2010 test excavation excavated only about .6 m^3 of site matrix and recovered a total of 25 flotation samples (about 32 liters) from the four excavation units. Despite the small size of the excavation, the research identified four features, thousands of flakes, dozens of lithic tools, hundreds of small faunal fragments and an impressive botanical assemblage (Peart 2011, 2013). This project effectively demonstrates that even small test excavations can produce impressive datasets and have significant archaeological impacts.

Table 4-1. Charred taxa potential uses and seasonality.

Feature and ^{14}C date	Taxa	Potential Use(s)	Seasonality*
Feature 1 1698 ± 24 (^{14}C yr BP)	Buckwheat or dock (three seeds)	Food	Blooms May to Sept.
	Cheno-am (23 seeds)	Food	Species vary; most bloom during the summer
	Cinquefoil (one seed)	Medicine	Blooms May to Aug.
	Ground cherry (two seeds)	Food	Blooms May to Oct.
	cf. Indian rice grass (one seed)	Food	Blooms May to June
	cf. Kinninnick (one seed)	Food / smoke?	Blooms March to June
	Pine (charcoal)	Fuel	Wood available year-round
	Prickly pear cactus (one seed)	Food	Blooms April to July
	cf. Rocky Mountain bee plant (one seed)	Food	Blooms May to Sept.
	Rocky Mountain juniper (three seeds)	Fuel / food	Berries ripen Sept. to Oct.
	Sagebrush (burnt sticks and bark)	Fuel	Wood available year-round
Feature 2 1520 ± 30 (^{14}C yr BP)	Buckwheat or dock (one seed)	Food	Blooms May to Sept.
	Cheno-am (43 seeds)	Food	Species vary; most bloom during the summer
	Cinquefoil (one seed)	Medicine	Blooms May to Aug.
	cf. Ground cherry (three seeds)	Food	Blooms May to Oct.
	Indian rice grass (nine seeds)	Food	Blooms May to June
	Pine (charcoal)	Fuel	Wood available year-round
	cf. Rocky Mountain bee plant (one seed)	Food	Blooms May to Sept.
	Rocky Mountain juniper (two seeds; burnt sticks)	Fuel / food	Berries ripen Sept. to Oct.
	Sagebrush (burnt sticks and bark)	Fuel	Wood available year-round
Feature 3 1330 ± 30 (^{14}C yr BP)	cf. Ground cherry (one seed)	Food	Blooms May to Oct.
	Prickly pear cactus (one seed)	Food	Blooms April to July.
	cf. Rocky Mountain bee plant (one seed)	Food	Blooms May to Sept.
	Rocky Mountain Juniper (one seed)	Fuel / food	Berries ripen Sept. to Oct.
	Sagebrush (burnt sticks and bark)	Fuel	Wood available year-round
Feature 4 3000 ± 40 (^{14}C yr BP)	Cheno-am (15 seeds)	Food	Species vary; most bloom during the summer
	Cinquefoil (one seed)	Medicine	Blooms May to Aug.
	Ground cherry or nightshade (three seeds)	Food	Blooms May to Oct.
	Indian rice grass (23 seeds)	Food	Blooms May to June
	Pine (charcoal)	Fuel	Wood available year-round
	Prickly pear cactus (one seed)	Food	Blooms April to July
	Red bane berry (one seed)	Medicine?	Blooms April to July
	Rocky Mountain juniper (one seed; burnt sticks)	Fuel / food	Berries ripen Sept. to Oct.
	Sagebrush (burnt sticks and bark)	Fuel	Wood available year-round

*The seasonality of specific plants varies by year and local environmental conditions (e.g. elevation, soil type, moisture, temperature). Flower blooming dates presented here are based on Alden and Grassy (1998) and Foster and Hobbs (2002).

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APPENDIX A

A.E. LaLonde AMS Laboratory Radiocarbon Analysis Report

November 27, 2019

Jonathan M. Peart
505-280 Montmorency Drive
Hamilton, ON
L8K5H1
Canada
jbpeart@yahoo.com
289.941.0174

RE: Radiocarbon analysis results, *Macrobotanical Analysis: Site 5GN1.2 Rockshelter*

Dear Mr. Peart,

We are pleased to provide radiocarbon analysis results for the charcoal sample received November 5, 2019. It was a very nice specimen and there were no issues during sample processing to report.

The preparators for your samples were Carley Crann and Carolyn Dziawa, and the AMS analysts were Dr. Xiao-Lei Zhao and Carley Crann. If you have specific questions about the analyses or calibration, please direct them to ccrann@uottawa.ca. If this data is used in publication or for a graduate thesis, we would appreciate a copy of the abstract for our records. In the interest of future researchers, we encourage you to take the time to submit your radiocarbon results to either the Canadian Archaeological Radiocarbon Database (CARD), or to the Neotoma Paleoecology Database.

Thank you for choosing the André E. Lalonde AMS Laboratory. We look forward to working with you again.

Sincerely,

Dr. W. E. Kieser
Director, A. E. Lalonde AMS Laboratory
Associate Professor, Department of Physics
25 Templeton St., Ottawa, ON, K1N 6N5, Canada
www.ams.uottawa.ca

Sample Processing

Sample pretreatment techniques, processing and definitions of media codes can be found in Crann et al. (2017) and Murseli et al. (2019). For more information about the equipment used for sample preparation, please see St-Jean et al. (2017). All manuscripts can be found at https://www.ams.uottawa.ca/research-publications/

Reporting of Data

In this analysis report, we have followed the conventions recommended by Millard (2014).

Radiocarbon Analysis

Radiocarbon analyses are performed on a 3MV tandem accelerator mass spectrometer built by High Voltage Engineering (HVE). $^{12,13,14}C^{+3}$ ions are measured at 2.5 MV terminal voltage with Ar stripping. The fraction modern carbon, $F^{14}C$, is calculated according to Reimer et al. (2004) as the ratio of the sample $^{14}C/^{12}C$ ratio to the standard $^{14}C/^{12}C$ ratio (in our case Ox-II) measured in the same data block. Both $^{14}C/^{12}C$ ratios are background-corrected and the result is corrected for spectrometer and preparation fractionation using the AMS measured $^{13}C/^{12}C$ ratio and is normalized to $\delta^{13}C$ (PDB). Radiocarbon ages are calculated as $-8033\ln(F^{14}C)$ and reported in ^{14}C yr BP (BP=AD 1950) as described by Stuiver and Polach (1977). The errors on 14C ages (1σ) are based on counting statistics and $^{14}C/^{12}C$ and $^{13}C/^{12}C$ variation between data blocks. We do not report $\delta^{13}C$ as it is measured on the AMS and contains machine fractionation.

Calibration

Calibration was performed using OxCal v4.3 (Bronk Ramsey, 2009). Calibrated results are given as a range (or ranges) with an associated probability as point estimates (mean, median) cannot represent the uncertainties involved (Millard, 2014). We acknowledge that point estimates are often desired and are thus included on the calibration plots in the Appendix, but we recommend that data tables used in publication maintain calibrated age ranges.

Where the $F^{14}C$ is less than 1, the IntCal13 calibration curve was used for Northern Hemisphere samples and ShCal13 for Southern Hemisphere samples (Reimer et al., 2013).

For samples with an $F^{14}C$ greater than 1, the post-bomb atmospheric curve was used (Hua et al., 2013). Post-bomb samples have two age ranges due to calibration on both sides of the bomb pulse. There are methods for deciding which side of the bomb pulse to select as the more appropriate date so feel free to contact us for further information.

Samples that calibrate between the 1700's and early 1950's will always result in a calibrated age range covering the majority of this period. This is due to the "Seuss Effect", which is a flat portion of the calibration curve caused by the burning of fossil fuels.

Rounding

Calibrated ages and ranges are rounded to the nearest year which may be too precise in many instances. Users are advised to round results to the nearest 10 yr for samples with standard deviation in the radiocarbon age greater than 50 yr, but rounding should only be done at the final reporting stage as intermediate rounding may introduce errors (Millard, 2014).

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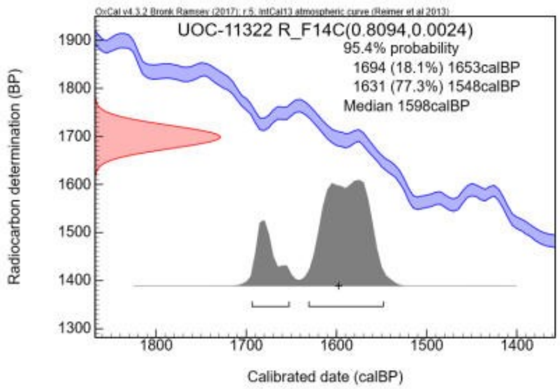
Table 1. Radiocarbon results. Calibration was performed using OxCal v4.3 (Bronk Ramsey, 2009) and the IntCal13 calibration curve (Reimer et al., 2013). Material codes are described in Crann et al. (2017).

Lab ID	Submitter ID	Material	Mat. Code	^{14}C yr BP	±	$F^{14}C$	±	cal BP
UOC-11322	SGn1.2_2-19b	charcoal	AAA	1698	24	0.8094	0.0024	1694-1653(18.1%) 1631-1548(77.3%)



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APPENDIX B

Raw Macrobotanical Data in MS Excel Electronic File Format.

APPENDIX C

Selected Macrobotanical Photographs in jpeg Electronic File Format.