DATA RECOVERY AT SIX PREHISTORIC SITES, UINTA BASIN REPLACEMENT PROJECT BONNEVILLE UNIT, CENTRAL UTAH PROJECT, DUCHESNE COUNTY, UTAH

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SFS Special Use Permit DCN993904
Cultural Resource Report No. 1588

March 02, 2009

ABSTRACT

In Fall 2006, the Utah Reclamation Mitigation and Conservation Commission (URMCC) requested that Sagebrush Consultants, L.L.C. (Sagebrush), as a partner company with TEC, Inc., of Charlottesville, Virginia, conduct data recovery at six prehistoric sites. This work is part of ongoing mitigation efforts associated with completion of the High Mountain Lakes Stabilization Project, an element of the Uinta Basin Replacement Project (UBRP) of the Central Utah Project (CUP), located in northwestern Duchesne County, Utah. This stabilization project is associated with the transfer of water storage rights from 13 high mountain lakes to a downstream reservoir that was enlarged as part of the UBRP. The purpose of the Section 203 High Mountain Lakes Cultural Resources Site Mitigation Project is to conduct cultural resource data recovery at six prehistoric sites near Island, Kidney, and East Timothy Lakes to partially mitigate the effects of stabilization efforts at the 13 lakes on recommended eligible sites prior to proposed construction.

This report presents the results of cultural resource mitigation efforts undertaken at six prehistoric sites (42DC1340, 42DC1341, 42DC1342, 42DC1344, 42DC1411, and 42DC1412) recommended eligible to the National Register of Historic Places during the inventory phase of the Section 203 Project. Sites involved in the High Mountain Lakes Mitigation Project are located at three lakes on the Lake Fork and Swift Creek Drainages. Sites 42DC1340, 42DC1341, 42DC1342, and Site 42DC1344 are located at Island and Kidney Lakes in Brown Duck Basin on the Lake Fork drainage. Sites 42DC1411 and 42DC1412 are located at East Timothy Lake in Swift Creek Basin on the Swift Creek Drainage.

Data recovery indicated that all sites in Brown Duck and Swift Creek basins are in highly disturbed reservoir settings, which have detrimental effects on archaeological deposits. Due to the cycle of inundation and draining of these reservoirs, erosion and redeposition of cultural materials has altered site integrity. However, temporal data recovered at sites 42DC1340, 42Dc1341, 42DC1344, and 42DC1412 strongly indicates a mid-to-late Archaic pattern in Swift Creek and Brown Duck basins and also a Late Prehistoric/Formative and possible Numic presence at Brown Duck Basin. Combined with data from the lithic analysis, these sites show a mid- to late-Archaic hunting pattern followed by what appears to be a Late Prehistoric logistical hunting and foraging pattern.

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INTRODUCTION

In Fall 2006, the Utah Reclamation Mitigation and Conservation Commission (URMCC) requested that Sagebrush Consultants, L.L.C. (Sagebrush), as a partner company with TEC, Inc., of Charlottesville, Virginia, conduct data recovery at six prehistoric sites. This work is part of ongoing mitigation efforts associated with completion of the High Mountain Lakes Stabilization Project, an element of the Uinta Basin Replacement Project (UBRP) of the Central Utah Project (CUP), located in northwestern Duchesne County, Utah. The purpose of the Section 203 High Mountain Lakes Cultural Resources Site Mitigation Project is to conduct cultural resource data recovery at six prehistoric sites near Island, Kidney, and East Timothy Lakes to partially mitigate the effects of stabilization efforts at the 13 lakes on recommended eligible sites prior to proposed construction.

The UBRP project includes the stabilization of 13 high mountain lakes on the Lake Fork, Swift Creek, and Yellowstone Drainages on the Ashley National Forest (ANF) (Figure 1). Dams/structures were constructed at each of these lakes in the historic period in order to impound additional water from spring runoff for subsequent release during the summer irrigation season. The UBRP project included the enlargement of Big Sand Wash Reservoir, in part to provide capacity to store and deliver water rights formerly held in the 13 upstream reservoirs. Once the upstream lakes are stabilized, irrigation water will be delivered from the UBRP project as replacement water. Stabilizing the lakes will create constant lake water levels. The resulting lake levels will be more consistent with the natural state of each lake prior to dam construction. As a result, stream flows originating in the upper watershed will be unregulated and follow natural run-off patterns. The goals of stabilization are to eliminate dam safety hazards from the High Uintas Wilderness Area (HUWA), restore natural hydrologic patterns, enhance recreational values within the HUWA, improve water quality and fish habitat, and to eliminate impacts to the wilderness area associated with dam maintenance operations (Central Utah Water Conservancy District 1996:S-3).

The URMCC has determined the 13 lakes to be eligible to the National Register of Historic Places in accordance with Section 106 of the National Historic Preservation Act, as amended (16 USC 470). The URMCC has further determined stabilization of the 13 lakes to be an adverse effect on the associated dams and on six eligible prehistoric archaeological sites nearby. Stabilization of the lakes will create an adverse effect on the six eligible sites, which are below the present high water line of the reservoirs, by exposing them to visibility and therefore potential vandalism during peak summer use season. The Utah State Historic Preservation Office (SHPO) has concurred with these findings. The URMCC, SHPO, Ashley National Forest, and the Department of the Interior entered into a Memorandum of Agreement for mitigation of the adverse effects. One component of the agreed mitigation was to conduct cultural resource data recovery at Island, Kidney, and East Timothy Lakes in order to mitigate the effects of stabilization efforts at these lakes on recommended eligible prehistoric sites.

This report presents the results of cultural resource mitigation efforts undertaken at six prehistoric sites (42Dc1340, 42Dc1341, 42Dc1342, 42Dc1344, 42Dc1411, and 42Dc1412).

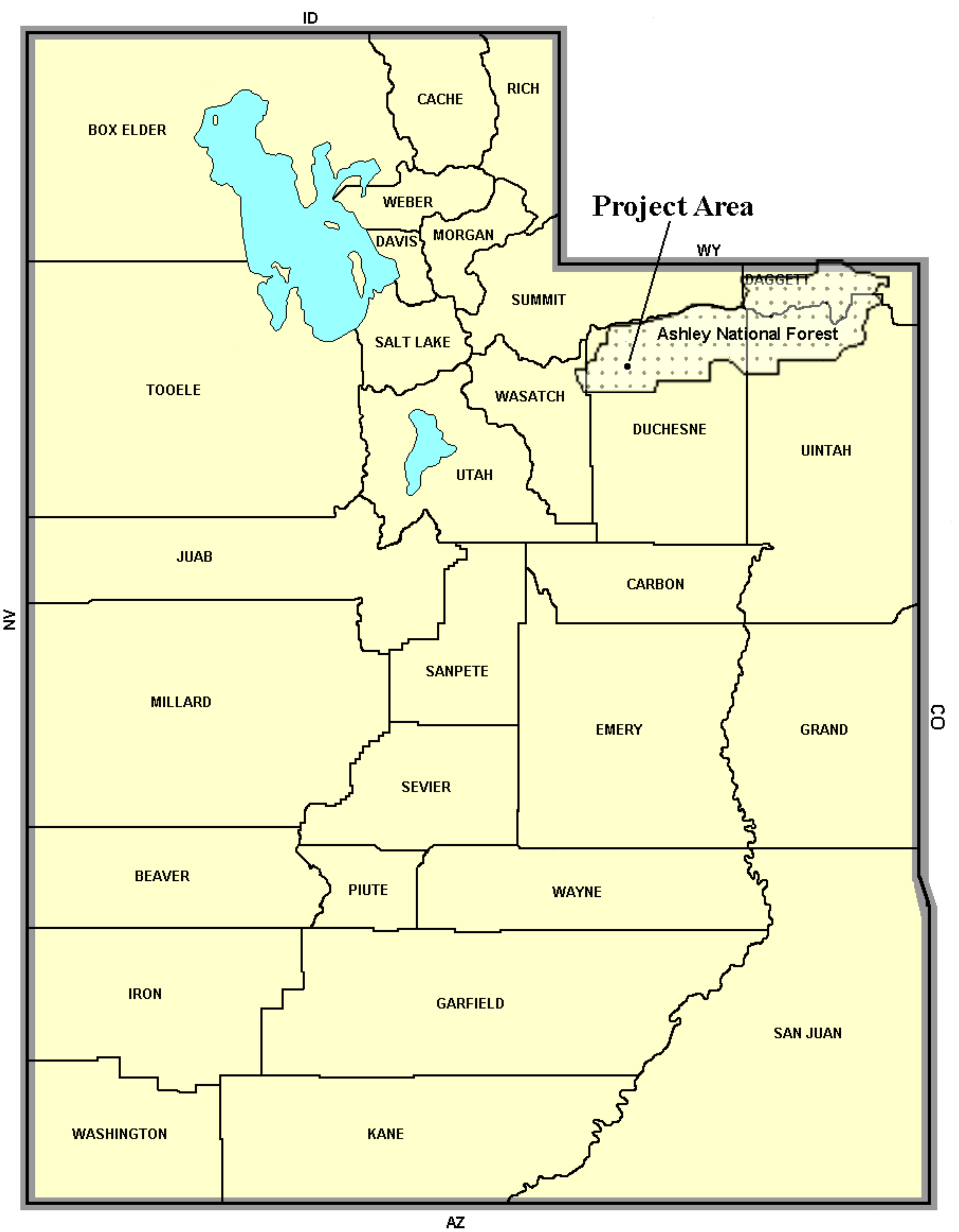

Figure 1. General Location of the Section 203 High Mountain Lakes Site Mitigation Project in Brown Duck Lake and Swift Creek Basins Within Duchesne County.

A total of six prehistoric cultural resource sites (42DC1340, 42DC1341, 42DC1342, 42DC1344, 42DC1411, and 42DC1412) were excavated to determine the extent and significance of the subsurface component at each site. Specialized samples (pollen, charcoal, flotation, etc.) were collected, where present, and sent out for laboratory analysis. Data recovery efforts included recordation and collection of surface artifacts, excavation of test units, and collection of subsurface artifacts at each site.

The current project areas are located in northwestern Duchesne County, Utah, [redacted]. These areas lie on lands administered by the Ashley National Forest located within the High Uintas Wilderness Area. Fieldwork for the project was carried out in Swift Creek Basin by Heather M. Weymouth, John D. Baker, and Michael Terlep between August 24 and 29, 2007. Additional fieldwork was completed in Brown Duck Basin (Lake Fork) between September 27 and October 10, 2007. All fieldwork was conducted under authority of United States Forest Service Special-Use Permit (Authorization ID DCN993904).

PREVIOUS RESEARCH

Previous Research in the Brown Duck and Swift Creek Basins

Prior to conducting fieldwork, a file search for previously recorded cultural resource sites near the current project area was conducted by Heather M. Weymouth on July 19, 2007, at the offices of the Ashley National Forest, Vernal, Utah. Five cultural resource projects have been conducted within a one-mile radius of the current project area. These projects are briefly described below:

In 2004, the Ashley National Forest conducted the Swift Creek Passport in Time Project (Jebb and Loosle 2004). Six new sites were documented during this inventory and two of these sites (42DC1835 and 42DC1839) were recommended eligible to the NRHP.

In 2001, Sagebrush completed cultural resource surveys of lake margins and documentation of historic dams associated with Farmers, East Timothy, White Miller, and Deer Lakes on the Swift Creek Drainage (Weymouth and Chynoweth Pagano 2002). Five prehistoric sites were documented during this project and two of these sites (42DC1411 and 42DC1412) were recommended eligible to the NRHP.

In 2000, Robyn Watkins and five volunteers conducted an intensive survey of randomly selected areas within the Swift Creek Basin as part of a Passport in Time Project (Loosle and Watkins 2001). The results of the work carried out are presented in her Master's Thesis presenting predictive GIS Models (Watkins 2000). A total of 1,046 acres were surveyed resulting in the identification of 15 archaeological sites, 10 of which are recommended eligible to the NRHP (42DC1359-42DC1361, 42DC1364-42DC1367, 42DC1370, 42DC1372, and 42DC1373).

Figure 2. Location of sites at Brown Duck Basin for the Section 203 High Mountain Lakes Sites Mitigation Project. Taken from USGS 7.5' Quadrangle Kidney Lake, Utah (1996).

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Figure 3. Location of sites at Swfit Creek Basin for the Section 203 High Mountain Lakes Sites Mitigation Project. Taken from USGS 7.5' Quadrangle Mount Emmons, Utah (1996).

In 2000, the Ashley National Forest conducted the High Uintas Passport in Time Project on the Swift Creek Drainage (Loosle and Watkins 2001). Fifteen new sites were documented during this inventory and ten of these sites (42DC1359-42DC1361, 42DC1364-42DC1367, 42DC1370, and 42DC1372-42DC1373) were recommended eligible to the NRHP.

In 2000, Sagebrush completed cultural resource surveys of lake margins and documentation of historic dams associated with Brown Duck, Island, Kidney, and Clements Lakes in Brown Duck Basin on the Lake Fork Drainage (Weymouth and Christensen 2001). Eight prehistoric sites were documented during this project and four of these sites (42DC1340, 42DC1341, 42DC1342, and Site 42DC1344) were recommended eligible to the NRHP.

In 1985, Fraser Design of Loveland, Colorado, completed Historic American Engineering Record (HAER) documentation of 14 dams and 1 tunnel within the Upalco Unit of the Uinta Basin Replacement Project (Fraser 1986; Fraser and Jurale 1985a; 1985b; 1985c; 1985d; 1985e; 1985f; 1985g; 1985h; 1985i). This documentation included the dams at Five Point (HAER UT-42-H), Superior (HAER UT-42-L), Drift (HAER UT-42-E), Bluebell (HAER UT-42-A), East Timothy (HAER UT-42-F), White Miller (HAER UT-42-O), Deer (HAER UT-42-D), and Water Lily (HAER UT-42-N) Lakes, and the Farmers Lake Tunnel (HAER UT-42-G). This documentation provided a brief regional irrigation context, short historic overviews, and brief dimensional descriptions of each dam. At that time Five Point, Superior, Drift, Bluebell, East Timothy, White Miller, and Deer Lake Dams were recommended NOT eligible to the NRHP. The Farmers Lake Tunnel and Water Lily Lake Dam were recommended ELIGIBLE to the NRHP.

No additional cultural resource sites have been recorded in the vicinity of the project area. The National Register of Historic Places (NRHP) was consulted prior to the initiation of the current inventory. No NRHP listed sites were found to be located near the project area.

Previous Research in the Uinta Mountains

Various investigations in the upper elevations on ANF have identified sites within all life zones (108 within the Alpine Life Zone, 128 in the Hudsonian, 246 in the Canadian, and 79 in the Transitional Life Zones). Survey coverage has been somewhat biased with most coverage in the Canadian Life Zone. Combined, these data indicate Uinta Mountain occupation from Paleoindian to historic times (Johnson and Loosle 2002; Knoll 2003).

Significant research of prehistoric occupations has been conducted on ANF including cultural chronology, settlement patterns, Fremont use of high elevations, ceramics, textiles, and raw material use. Of particular note, is the extensive work conducted by Byron Loosle and Clay Johnson from 2000 to 2002 at all elevations in the Uinta Mountains, particularly in the eastern Uintas. Both the Dutch John (Loosle and Johnson 2000) and Prehistoric Uinta Mountain occupations (Johnson and Loosle 2002) publications provide climatic, cultural and conceptual frameworks for the Uintas. This report draws heavily from the data presented in these two publications.

Research conducted in the Henry's Fork, Fox Lake, and Garfield Basin study areas by Madsen et al. (2000) provides a theoretical approach to high-altitude prehistoric settlement patterns and occupation in the Uinta Mountains. Madsen et al.(2000) make a compelling case for logistical hunting-patterns on the north slope versus the south slope of the Uintas using differential transport cost models and energy return rates. Michelle Knoll (2003) also used maximum distance transport cost models to determine residential base and logistical foray hunting patterns at six sites at Deadman Lake in the eastern High Uintas. Occupation at these sites range from the Fremont Period to the Post-contact era.

ENVIRONMENTAL SETTING

The project areas lie on the Lake Fork and Swift Creek Drainages of the High Uintas Wilderness Area in the Ashley National Forest in northwestern Duchesne County, Utah. The Uinta Mountains form a distinct east-west trending topographic unit situated in northeastern Utah. They extend more than 150 miles from east to west and over 40 miles wide from north to south, with the lower portions of the north and east slopes extending into Wyoming and Colorado. The headwaters of the Bear, Duchesne, Provo, Weber, and Unita Rivers originate in the High Unitas. Major drainage systems in the east and south flow into the Green River, eventually draining into the Colorado River. Systems in the northwest drain into the Bear River, ultimately flowing into the Great Salt Lake. Elevations range from 5600 feet (1700 meters) above mean sea level (amsl) to as high as 13,528 feet amsl (4115 meters).

Geology

The Uintas form a distinct, steep, flat-topped anticline or central plateau flanked to the north and south by extensive marginal benches (Fenneman 1931; Stokes 1986) rather than foothills typical of other mountain ranges. The High Uintas comprise the higher elevations of the central plateau. The crest of the Uintas has been sculpted by extensive glaciation, leaving behind features such as deep cirques, gentle sloping, flat-bottomed cirque valleys, moraine deposits and lakes in rock basins and behind moraine dams. These semi-circular, flat-bottomed valleys are separated from one another by steep ridges, which act to divide the area into individual basins (Fenneman 1931; Stokes 1986). The marginal benches, between 7,500 and 8,500 feet in elevation, are eroded remnants of older surfaces (Stokes 1986). Numerous rivers and streams transect these marginal benches, exposing underlying formations of the Uintas.

Pre-Cambrian Uinta quartzite and sandstone make up the core of the Uintas. These pre-Cambrian quartzites make up the central plateau, which have been exposed by continuing erosional episodes (Fenneman 1931; Stokes 1986; Johnson and Loosle 2002). Further north and south from the crest, progressively younger sedimentary strata are exposed (Johnson and Loosle 2002).

Climate

Physiographically, the Uintas are located in the Middle Rocky Mountain province, with the Great Basin province to the west and southwest, and the Colorado Plateau province to the south. The complex topography of the east-west trending Uinta Mountains has led to a wide array of seasonal climates and biotic zones and somewhat serves as a climate boundary. For example, north of the Uintas wet winters and dry summers with short growing seasons prevail. To the southwest, the Great Basin experiences both dry summers and winters. Whereas, the Colorado Plateau to the south and east experiences dry winters and monsoon flows from the south that create wet summer conditions. While differences in topography and elevation contribute significantly to variability in storm patterns, precipitation, temperatures, and growing season across the Uintas, the present day climate of the Uintas is, overall, generally cool and relatively dry.

Paleoclimate data for the Uintas is somewhat less understood; however, bog studies in the Uintas (Carrara et al. 1985) and excavations at the Dutch John site provide a tentative reconstruction of paleoclimatic data (Johnson and Loosle 2002). Johnson and Loosle (2002) suggest that due to high elevations in the Uintas and its location at the junction of three different climatic regions, the Uintas may have been shielded from such warming and cooling extremes experienced during the Middle Holocene and Neoglacial periods (Johnson and Loosle 2002). As such, the warming trend experienced during the Altithermal (Middle Holocene) was slightly delayed and less severe in the Uintas. Cooler conditions than today prevailed in the Uintas between 8000-6600 cal BP, then shifted towards dryer and warmer conditions than today, which peaked between 4700-3400 cal BP. During the mid-Neoglacial (around 3300 cal BP), conditions returned to cool in the Uintas, although with an increase in effective moisture. Effective moisture levels more or less persisted until about 1700 cal BP, then declined as a result of a warming trend occurring around 2000 cal BP. Climates in the Uintas became warmer and dryer, punctuated by periodic droughts around 1500 cal BP. Finally, cooler conditions and effective moisture returned to the Uintas around 550 cal BP (Johnson and Loosle 2002).

Uinta Mountain Locales

The Uinta Mountains are comprised of five different locales based on elevation, topography, climate and flora and fauna. Such locals include: canyons (4500-6000 ft), low benches (6000-6600 ft), intermediate benches (6600-7200 ft), mountain benches (7900-8900 ft), and the high lakes/Uintas divide (9500-12000 ft). The following discussion is specific to the high lakes/Uintas divide locale and draws heavily from Johnson and Loosle (2002). For a complete description of the various locales of the Uinta Mountains, see Johnson and Loosle (2002).

The high lakes/Uintas divide (9500-12000 ft) locale is just below the crest on both the north and south slopes of the Uintas. This locale encompasses basins with glaciated cirques, flat-bottomed cirque valleys, moraine deposits, and lakes. Steep talus slopes and ridges separate each basin from one another. Snow accumulations can begin as early as October, limiting access to these areas from June through late September. However, even in the summer months day temperatures at these elevations are cool and nights are cold. Generally, weather patterns can be quite unstable, with severe thunder and lightening storms occurring often.

Both the Hudsonian and Alpine Life Zones are in the high lakes/Uintas divide (9500-12,000 ft) locale. Hudsonian zone vegetation is dominated by spruce, with lesser quantities of sub-alpine fir and a variety of shrubs such as serviceberry, Oregon grape, Canadian thistle, smooth scouring rush, and raspberry. Assorted grasses and forbes include arnica, bluegrass, tufted hairgrass (*Deschampsia caespitosa*), oatgrass (*Danthonia*), american bistort (*Polygonum bistortoides*), and elephant head (*Pedicularis groenlandica*). The Alpine Life Zones consist of low forbes, grasses, and herbs including tufted hairgrass (*Deschampsia caespitosa*), needlegrass (*Stipa comata*), alpine avens (*Guem rossii*), single-spike sedge (*Carex scirpoidea*), alpine sagebrush (*Artemesia scopulorum*), alpine bistort (*Polygonum vivparum*), and indian paintbrush (*Castilleja pulchetta*). Important roots and tubers found in both the Hudsonian and Alpine zones include springbeauty (*Claytonia megarrhiza*), bistort (*Polygonum vivparum*), bitterroot (*Lewisia*), dogtooth violet (*Erythronium violet*), Rocky Mountain cow lily (*Nuphar ploysepalum*), and valerian (*Valeriana acutiloba*). Combined, this locale provides rich meadows, riparian corridors, and timber edges, which support an abundance of mountain sheep, possibly both Rocky Mountain bighorn (*Ovis candensis canadensis*) and the desert bighorn (*Ovis candensis nelsonii*) prehistorically, elk (*Cervus canadensis*), and mule deer (*Odocoileus hemionus*). Bighorn sheep, deer, and elk are all relatively abundant in this locale during the summer months. Interestingly, Johnson and Loosle (2002) indicated a single bison skull was identified at this locale. Historically, bison were prevalent in the Uinta Basin as well as north of the Uinta Mountains and in the Colorado Rockies. However, there is no evidence at this time to support the assertion that bison herds were using this locale, historically.

Brown Duck Basin/Lake Fork Drainage

Brown Duck Basin is a north-south trending basin in the high lakes/Uintas divide locale containing over 40 lakes just west of the Lake Fork River Drainage. Brown Duck Basin is in the Hudsonian Life Zone, with basin elevations ranging from 10,000 to 10,600 feet amsl. Peaks in the area are as high as 11,866 feet amsl (Brown Duck Mountain). The basin is bordered by Brown Duck Mountain in the north, Lake Fork Drainage in the northeast, Round Mountain to the southeast, and various mountain peaks to the south and west. Tworoose Pass links Brown Duck Basin to Squaw Basin in the northwest and East Basin Pass to East Basin in the north. Brown Duck Basin is approximately 11 miles south of the crest of the Uinta Mountains.

The location of the basin, just over two miles northwest from Moon Lake Reservoir (the largest lake in the Uintas and a popular destination for recreationists), allows for a high number of visitors to the area. The basin is laced with numerous hiking and fishing trails as it is extensively used for recreation in the summer and early fall months.

Lakes in the Brown Duck Basin such as Brown Duck, Island, Kidney, and Clements were selected for storage of irrigation water for the Uinta Basin. More specific to the project area are Island and Kidney Lakes. Once natural glacial lakes, these lakes were impounded by the 1920s (see Development of Irrigation Storage section below). Island Lake is at 10,250 feet amsl and occupies some 66 acres between Brown Duck Lake and Kidney Lake. The reservoir is just under 50 feet at its deepest, with an average depth of 12 feet. Seasonal reservoir levels fluctuate roughly 15 feet (Vincent et al.1964; Donaldson et al. 1983). Kidney Lake is directly west of Island Lake at an elevation of 10,267 feet amsl. The reservoir spans a minimum of 190 acres and is 112 feet at its deepest, with an average depth of 48 feet. Seasonal reservoir levels fluctuate roughly 20 feet (Vincent et al.1964; Donaldson et al. 1983). Vegetation is very dense in areas not affected by seasonal reservoir fluctuation. In those areas that have been subjected to inundation and drawdown, vegetation is limited to sparse patches of grasses and eroded rocky shorelines.

Natural disturbance at these reservoirs consists of wind and water erosion and frost heaving. Cultural disturbances include recreational impacts, trail construction/maintenance, dam construction/maintenance, and the seasonal inundation of reservoir shore margins.

Swift Creek Basin/Swift Creek Drainage

Swift Creek Basin is also a north-south trending basin in the high lakes/Uintas divide locale. The basin is 16 miles northeast of Brown Duck Basin; however, there is no direct route as the two basins are separated by two major drainages (Lake Fork and Yellowstone) punctuated by steep ridge systems. The Swift Creek Basin contains well over 40 lakes. Drainages converge into Swift Creek and eventually drain into the Yellowstone River drainage system. Swift Creek Basin lies within the upper elevations of the Hudsonian Life Zone (10,800 to 11,000 feet amsl) and the Alpine Life Zone (11,000 feet amsl and above). Basin elevations range from 10,800 to 11,200 feet amsl, with peaks in the area as high as 13,440 feet amsl (Mount Emmons). The northern portion of the basin, where East Timothy Lake is located, is nearly 10 miles in from the main Swift Creek Campground trail head. Despite this distance, the area is still quite popular for hiking and fishing in the summer and early fall months. Extensive camping has been noted, especially at East Timothy Lake (Donaldson et al. 1983).

The basin is bordered by steep and high ridge systems to the north, east (Mount Emmons), and west and the narrow Swift Creek drainage system to the south. A northwest/southeast trending ridge system at the north end of the basin leads to Kings Peak, some 4 miles northwest along this ridge line, with Mount Emmons at its southeastern most end. Kings Peak is the highest peak in Utah at 13,528 feet amsl, and is just south of the crest of the Uintas. While Swift Creek basin is close to the crest of the Uintas, this ridge system is high and would take considerable effort to reach the north flank of the Uinta Mountains, making travel back and forth from the south to the north flank via the Swift Creek Basin unlikely. There is, however, Bluebell Pass, which is the only pass out of the basin to an adjacent basin. The pass leads to the Yellowstone River drainage, where there is currently a trail (TR 057) leading to the crest of the Uintas via the Yellowstone drainage. Prehistorically, this may have been a route to access the north flank of the Uintas.

East Timothy Lake is at 11,000 feet elevation. Once a natural glacial lake, East Timothy was impounded in the 1920s (see Development of Irrigation Storage section below). The reservoir covers 40 acres and has a maximum depth of 35 feet. Seasonal water levels fluctuate as much as 30 feet (Donaldson et al. 1983). Vegetation is virtually nonexistent or limited to sparse patches of grasses and eroded rocky shorelines along the reservoir fluctuation zones. Natural disturbance in the area consists of wind and water erosion and frost heaving. Cultural disturbances include recreational impacts, trail construction/maintenance, dam construction/maintenance, and the seasonal inundation of reservoir shore margins.

METHODOLOGY

The six sites (42DC1340, 42DC1341, 42DC1342, 42DC1344, 42DC1411, and 42DC1412) identified for mitigation through data recovery as part of the High Mountain Lakes Mitigation Project are at Island and Kidney Lakes on the upper Lake Fork Drainage within Brown Duck Basin, and East Timothy Lake on the upper Swift Creek Drainage in the Swift Creek Basin, within the boundaries of the High Uintas Wilderness Area. Data recovery was conducted as late in the season as feasible in order to completely expose the sites, as previously recorded, during the late season low lake levels. This strategy made it possible to access those areas, which are generally inundated during the high seasonal lake level. The excavations were completed on two separate field rotations, as the sites are located in two completely different drainage basins. A total of 12 days were spent at Island and Kidney Lakes and 4 days at East Timothy Lake. Environmental elements, remote setting, and the high altitude of these locations made completion of data recovery at these sites difficult and labor intensive. Although standard data recovery methods were employed, environmental conditions and the geological setting provided an exceptional challenge in completion of the excavations. Adaptation of strategy was often necessary in order to compensate for difficult weather conditions resulting from snow and freezing temperatures. The field methodology employed at these sites is detailed below.

Field Methods

Prior to beginning data recovery efforts, each site was relocated and site boundaries reestablished. Next, an intensive level pedestrian survey was conducted within the site boundaries. Additional cultural materials exposed since initial recordation (2000-2001) were then mapped and recorded followed by surface collection of all diagnostic artifacts. Where present, obsidian samples identified on the site surface were collected for specialized analysis. As mentioned above, inclement weather posed significant challenges during excavations. As a result, time constraints limited the number of excavation units opened at a given site. Following the surface collection, two 1x1 m units were placed in areas thought to most likely contain undisturbed deposits as well as contain the densest artifact concentration. An exception to this is site 42Dc1344 where only one 1x1 m unit was excavated. The nature of the soils and small amount of material recovered from Unit 1 at 42Dc1344 indicated the site was in a highly disturbed context; therefore, it was decided that no additional units would be excavated at this site.

Proposed units were covered with tarps for protection from inclement weather. Units were uncovered during excavation and re-covered, if not completed, by the end of the day. When possible, a 3x3 m (10x10 ft) floorless tent was erected over units during excavation to provide some cover and protection from the elements; however, due to strong winds it was not possible to leave the structure up over night. As a result, in the evenings and during windy periods, the tent was dropped and used as a tarp over night.

Units were excavated in 5 cm levels until a sterile level was reached. All sediments removed were sifted through ⅛-inch mesh screen and examined for cultural materials. Specialized samples (charcoal, pollen, flotation) were collected where applicable and all subsurface artifacts collected. All botanical and radiocarbon samples were carefully extracted using a clean trowel and enclosed in foil in order to minimize contamination. The samples were then placed in plastic bags and appropriately labeled with the site number, description of the sample, unit number, provenience, and date the sample was collected. Prior to the excavation of each new level, plan drawings were completed and photographs were taken of all unit surfaces. Stratigraphic profiles were drawn and photographs taken once a sterile level was reached. A level was determined sterile if no artifacts were found within the level and there was a significant decline (typically over 50%) in artifact amounts in the previous level.

A Trimble GeoExplorer III Global Positioning System (GPS) was used to collect locational data for all excavation units and artifacts collected during this project. All artifacts collected were brought back to the Sagebrush laboratory for processing (see laboratory methods below).

Laboratory Methods

All artifacts recovered were processed at the Sagebrush laboratory in Ogden, Utah. Processing procedures followed a standardized format consistent with the repository policy and procedures of the Utah Museum of Natural History. Materials were cleaned to the degree necessary for identification and analysis and sorted in sequential order by site, unit, and level from top to bottom. Debitage was grouped and assigned a catalog number by basic raw material type (e.g. cryptocrystalline silicate, quartzite and obsidian) and each tool assigned an individual catalog number. All materials were placed in 4-mil plastic bags accompanied with an acid-free specimen tag, and labeled with indelible ink. Appendix A provides a master artifact catalog.

Raw material assignments include cryptocrystalline silicates (CCS), quartzite, and obsidian. Previous research of raw material types in the Uinta Mountains has identified the Bridger Formation (Tiger Chert) and Dutch John cherts, and the Red Creek quartzite and Uinta quartzite. Raw material assignments to these specific types were not made in an effort to avoid erroneous classifications. The nature of the debitage recovered from these sites was small and largely fragmented, preventing raw material identifications to specific material types. As such, debitage was assigned very general raw material groups. The cryptocrystalline group subsumes various cherts, including possible chalcedony and jasper. Similarly, there were differences in the types of quartzite identified, which were subsumed under the general quartzite raw material type. Material types of larger tools, such as scrapers, edge-modified flakes, and projectile points, were easier to identify (i.e., chert, chalcedony), although these are still subsumed under the general raw material categories outlined above. However, specific descriptions of each individual tool material type are presented in the Data Recovery Results section.

In all, the cryptocrystalline silicates are fine grained with over 60% containing 1 to 2 mm inclusions. Less than 8% of cryptocrystalline silicates collected retained some level of banding. Colors range from white, yellow, buff, light to dark tan, light to dark brown, "root beer" and "beer bottle" brown, light to dark pink, and reddish-orange. Quartzite materials vary from fine-grained homogenous materials with very few inclusions to medium-grained with inclusions ranging in size from 1 to 4 mm. Colors vary and include cream, tan, buff, brownish gray, gray, light pink, and dark pinkish-purple. Some specimens had a pearlescent sheen on the surface of the artifact.

Analytical Methods

The type and extent of analytical methods conducted of the High Mountain Lakes assemblages was determined by the nature and size of the materials collected. Special studies undertaken include pollen and phytolith identification, radiometric dating, obsidian hydration rim measurement, X-ray fluorescence sourcing, and debitage analysis. Results of these special studies are presented within the appropriate sections in the report and appendices.

Debitage Analysis

With the exception of a small sample of projectile points, flaked-stone tools, and three small groundstone fragments, debitage is the only direct evidence of cultural occupation at these sites. Therefore, focusing on debitage analysis was an important aspect in efforts to gain a broader understanding of how these sites fit in with prehistoric use of the High Uinta Wilderness landscape.

Two methods of debitage analysis were undertaken for each of the six sites: technological typologies analysis and aggregate analysis using size sorting. Combined, these two methods highlighted the basic reduction strategies occurring at these sites and the relation of these strategies to high altitude settlement patterns. Due to the relatively small amounts of debitage recovered from each of the six sites, all material was analyzed (Appendix B).

Technological typology analysis includes separating flake types into diagnostic and non-diagnostic categories based on the stage of reduction employed. Five diagnostic flakes types were identified: cortical (primary and secondary decortication flakes), simple interior, complex interior, biface-thinning, and pressure flakes. Non-diagnostic flakes types include shatter and indeterminate flakes. The purpose of this type of analysis was to identify and compare two types of technologies: that of core reduction and biface manufacture/retouch strategies. The following table (Table 1) provides distinguishing characteristics of these flake types.

Table 1. Distinguishing Characteristics of Flake Types and Inferred Behavior		
Flake Type	**Distinguishing Characteristics**	**Inferred Behavior**
Cortical (Primary and Secondary decortication)	*Primary Decortication*: any piece of debitage with more than 70% of its dorsal surface covered by cortex. *Secondary Decortication*: any piece of debitage with less than 70% of its dorsal surface covered by cortex.	Early stage core reduction
Simple Interior	A non-cortical flake with two or less negative flake scars on its dorsal surface, excluding platform preparation scars. Pronounced ventral curvature. Platforms are typically flat to concave.	Early stage core OR biface reduction
Complex Interior	A non-cortical flake with three or more negative flake scars on its dorsal surface, excluding platform preparation scars. Negative flake scars typically emanating in various directions. Less pronounced ventral curvature than simple interior flakes. Platforms may have multiple facets and flat to concave.	Late stage core reduction
Biface Thinning	A slightly curved or flat flake with a bifacial, often beveled, platform. Flake shape is typically symmetrical in outline. Multiple dorsal flake scars are present, possibly revealing a pattern of previous flake removals.	Biface manufacture
Pressure	Small flakes, usually 5 mm or less, with uniform thickness and a pronounced bulb of percussion. Often, crushing or grinding at point of percussion is present. Shapes may vary from wide and short to long and narrow.	Formed tool manufacture and retouch
Shatter	Angular fragments or debris of flake stone with no visible flakes attributes.	Reduction by-product
Indeterminate	Flake fragments with no visible flake attributes.	-

Size sorting techniques included placing debitage over different diameter circles. These incremental diameter circles measured 0-5 mm, 5.1-10 mm, 10.1-20 mm, 20.1-30 mm, 30.1-40 mm and 40.1-50 mm. Note that this size sorting technique used diagnostic debitage only and excluded non-diagnostic debitage (i.e., indeterminate fragments and shatter).

Pollen/Phytolith and Macrofloral Analysis

Selected soil samples from 42DC1340 - Unit 1 and 42DC1412 - Unit 1 were sent to Paleo Research Institute in Golden, Colorado for pollen/phytolith, and macrofloral identification using standard pollen concentration, phytolith separation and floatation techniques (see Appendix C).

Organic Residue Analysis

Three pieces of groundstone recovered from 42DC1412 - Unit 1 were sent to Paleo Research Institute in Golden, Colorado, for organic residue analysis using standard Fourier Transform Infrared Spectroscopy (FTIR) techniques (see Appendix C).

AMS Radiocarbon Dating

Selected soils samples from 42DC1340 - Unit 1 and 42DC1412 - Unit 1 were sent to the Paleo Research Institute in Golden, Colorado for pollen, phytolith, and macrofloral identification. Charcoal samples were separated from these soils samples and were prepared and analyzed using standard AMS radiocarbon dating methods. An additional sample extracted directly underneath a Humboldt Concave Base projectile point from 42DC1412 - Unit 1was also analyzed (see Appendix C).

Obsidian Sourcing and Hydration

A total of nine obsidian specimens were sent to the Northwest Research Obsidian Laboratories in Corvallis, Oregon, for XRF trace element analysis, source identification, and hydration measurements. Two specimens were selected from 42Dc1341 and the remaining seven specimens from 42DC1344 (see Appendix D).

PREHISTORIC OVERVIEW

The prehistory of the current project area is complex and not well understood. This is due, in part, to the area's remote location, but largely because of its location near the contact zone between the Great Basin, Colorado Plateau, and Northern Plains cultures. The prehistory of the Uinta Basin is a meld of these traditions that has resulted in the identification of many enigmatic archaeological sites. Because of this mix of archaeological traits, the authors have provided both the general model of prehistory for the eastern Great Basin and northern Colorado Plateau found most prominent in the Uinta Basin as well as a generalized culture chronology established for the Uinta Mountains (Johnson and Loosle 2002). The Uinta Basin model is classified into the following four general chronological periods: Paleo-Indian, Desert Archaic, Formative, and Post-Formative (Jennings 1986).

However, the second generalized culture chronology established for the eastern Uinta Mountains is focused on the eastern Uinta Mountain area and is considered an essential jumping off point to understanding broader prehistoric patterns in the Uintas. The chronology is divided into three broad eras (Paleoindian, Archaic, and Late prehistoric) based on Reed and Metcalf (1999), and augmented with published data from the northeastern Uintas and surrounding areas. Where supported by data from the Uintas, these eras are sub-divided into shorter time periods (Johnson and Loosle 2002). The eastern Uinta Mountain chronology is presented along side that of the Uinta Basin chronology (Table 2).

Table 2. Cultural and Climatic Sequences of the Uinta Basin and Eastern Uinta Mountains

Date BP	Calendric Date	Uinta Basin Periods	Uinta Basin Sequence	Eastern Uinta Mountains Eras*	Eastern Uinta Mountains Sequence*	Climatic Periods	
	A.D. 1776	Historic	Historic	Historic	Historic	MedIthermal	Little Ice Age
		Post-Formative Period	Numic Expansion		Protohistoric		
650	AD 1300						
	AD 1200						Medieval Climatic Anomaly
				Late Prehistoric Era			
	AD 1000	Formative/ Fremont Period			Late prehistoric/ Formative		
1000	AD 950						
1100	AD 800		Whiterocks Phase				
	AD 650		Cub Creek Phase				
	AD 500						
	AD 400						
	AD						
	BC						
2000	1000 BC						Neo-glacial
3000	2000 BC		Black Rock Phase		Late Archaic		
4000	3000 BC	Desert Archaic Period		Archaic era			
5000	4000 BC					Middle Holocene (Altithermal)	
6000	5000 BC				Early Archaic		
7000	6000 BC		Wendover Phase				
8000						Early Holocene (Anathermal)	
	7500 BC						
	9000 BC		Bonneville Phase	Paleoindian Era	Paleoindian Era		
	12000 BC	Paleoindian Period	Paleoindian				

* **(Johnson and Loosle 2002)**

Uinta Basin Culture Chronology

Paleo-Indian Period: ca. 12000 B.C. to 9000 B.C.

Also known as the Clovis Period, the Paleo-Indian Period is poorly understood in the eastern Great Basin and northwestern Colorado Plateau. What little is known about this period comes from a limited number of surface sites and isolated finds of Clovis, Folsom, and Lake Mojave projectile points (Zier 1984).

Associations of large faunal remains, such as those of extinct bison, camel, mammoth, ground sloth, and other large fauna, with Paleo-Indian artifacts like those commonly found in the Great Plains are absent in the eastern Great Basin. Sites and isolates attributed to Paleo-Indian occupation of the area are typically found along the edges of extinct Pleistocene or early Holocene beaches, suggesting a possible lake edge-marsh adaptation (Madsen 1982; Heizer and Baumhoff 1970).

Desert Archaic Period: ca. 9000 B.C. to A.D. 500

This period, which is also poorly represented in the project area, is marked by broad range movement and diminishing hunting of big game by the native peoples. It also includes a time of climatic change associated with the end of the Pleistocene Epoch and with the subsequent cultural adaptations. The Desert Archaic is divided into three phases: the Bonneville Phase, the Wendover Phase, and the Black Rock Phase. Important sites associated with these periods that are located in the basin area east of Duchesne include Swelter Shelter and Thorne Cave (Jones and MacKay 1980).

Bonneville Phase: ca. 9000 B.C. to 7500 B.C.

The terminal Pleistocene, called the Bonneville Phase in the Great Basin by Aikens and Madsen (1986), represents the time of diminishing reliance on big game hunting and an increased use of a broader range of natural resources. Though evidence of this phase of human activity has been found in other parts of the western United States, its presence in Utah is largely limited to surface finds of large lanceolate-shaped projectile points along lakeshores in the western part of the state (Aikens and Madsen 1986). In north-central Utah, known evidence of this phase is limited. In addition to two fluted projectile points, one found near Duchesne in the 1950s (Schroedl 1976) and the other (a point fragment) found near Cedarview, 10 miles northwest of Roosevelt (Lindsay 1976), a small number of Plano points have been found in the area (Loosle 1995). These Plano points suggest the influence of the Plains Cultures on the inhabitants of the general project area.

Wendover Phase: ca. 7500 B.C. to 4000 B.C.

This phase encompasses the time when Pleistocene lakes in the Great Basin greatly receded. The change in environment gave way to a more diversified hunting and gathering subsistence strategy for prehistoric inhabitants because of a wider availability of game and plant foods. Technological changes that occurred along with these environmental shifts included the appearance of an increasing number of grinding implements for wild plant processing and of atlatls or spear-throwers. Other artifacts known from this occupation include thin slab millstones, manos, L-shaped scapula and splinter awls, antler flaking tools, basketry, and flaked stone tools (Jennings 1978).

Black Rock Phase: ca. 4000 B.C. to A.D. 500

The Black Rock Phase (Aikens and Madsen 1986) is characterized by a movement toward the occupation of sites within a broader range of ecozones and a further diversification of resource exploitation to include a large proportion of upland resources. The technology of the phase was largely similar to that of the Wendover Phase. The greatest change in technology occurred near the close of the phase when smaller projectile points were introduced, indicating a shift to the use of the bow and arrow.

Formative Period: ca. A.D. 400 to 1300

This period is characterized by a shift from a hunting and gathering lifeway to a more sedentary one based on horticulture. The growing of maize increased during this period throughout much of the Great Basin; however, it was less intensive in the Uinta Basin than in areas to the south. The native peoples associated with this period, the Fremont, were roughly contemporaneous with the Anasazi of southern Utah and the Four-Corners region. A number of important sites attributable to this period are located In the Uinta Basin. These sites, primarily represented by small hamlets or rancherias, include Caldwell Village, Flattop Butte, Felter Hill, the Goodrich Site, and the Gilbert Site (Marwitt 1986). The Formative Period is composed of a single phase known loosely as the Fremont Culture Phase. The broader Fremont Culture Phase in the Uinta Basin has been divided into two subphases, known as the Cub Creek Phase and the Whiterocks Phase (Marwitt 1986).

Fremont Culture Phase: ca. A.D. 400 to 1300

Near the end of the Black Rock Phase of the Desert Archaic Period, many elements of a settled horticultural lifestyle were introduced into the Archaic lifeway of Utah from the Southwest, including the manufacture of pottery and the development of horticultural practices. The Fremont Culture is a label applied to groups exhibiting this different lifestyle who occupied the Utah area from ca. A.D. 400 to 1300 (Marwitt 1986). Five geographic variants of the Fremont Culture are generally recognized today.

The Uinta Basin Fremont had a relatively short period of occupation compared to other Fremont variants throughout the state of Utah (Marwitt 1986). Until a short time ago, archaeological evidence suggested an occupation period from A.D. 650 to 1175 for this group. However, a recently excavated Uinta Basin Fremont site in western Colorado yielded a date of post-A.D. 1500. This new evidence suggests a later Fremont occupation of the Uinta Basin than was previously believed (Loosle 1995).

The occupation of the Uinta Basin Fremont is enigmatic in other ways as well. Most archaeological sites attributable to this group indicate a less intensive (population) use of the area than has been evidenced for other Fremont groups in other areas of the state. These sites often consist of only a small number of shallow, circular pit houses and no surface storage structures.

Coupled with the high average elevation of the area and the short growing season, the small "village" size and lack of storage structures suggest limited use of the area by the Fremont. However, other Uinta Basin Fremont sites indicate a different scenario. Several large Fremont archaeological sites, such as those in Dry Fork Canyon and within Dinosaur National Monument, have also been documented. At least one of these sites is over 10 acres in size (Loosle 1995). Sites such as these suggest a much more intensive use of the area by the Fremont.

The material remains of the Uinta Basin Fremont are somewhat unique compared to those of other Fremont variants. For example, the "Utah type" metate, although found in the Uinta Basin, is far less common than in other areas of the state. In addition, it does not appear that the Uinta Basin Fremont created the clay figurines that are the hallmarks of Fremont cultures elsewhere in the region (Marwitt 1986). The Uinta Basin Fremont also restricted their use and creation of pottery to a limited stylistic assemblage dominated by undecorated, limestone or calcite tempered grayware, known as Uinta Gray pottery. A small proportion of decorated and incised tradewares appear to have been acquired by the Uinta Basin Fremont from other Fremont and Anasazi groups (Marwitt 1986).

Cub Creek (Sub)Phase: ca. A.D. 650 to 800

The Cub Creek (Sub) Phase of the Fremont Culture Period is known from sites such as Boundary Village, Goodrich, Felter Hill, and Flattop Butte. These sites are unique because they contain no surface structures. The only pottery found at Cub Creek sites thus far has been undecorated utilitarian Uinta Grayware with a notable absence of bowl forms. No tradewares have been found at sites attributable to this subphase.

Whiterocks (Sub)Phase: ca. A.D. 800 to 950

The Whiterocks (Sub) Phase was named after the archaeological site of Whiterocks Village. This phase is also known from excavations at the Caldwell Village site (Marwitt 1986). Unlike those of the Cub Creek Phase, Whiterocks Phase archaeological sites contain substantial surface structures of masonry and coursed adobe. They have also yielded surface-decorated Uinta Grayware and tradewares from other Fremont variants and from Anasazi groups (Marwitt 1986).

Post-Formative Period: ca. A.D. 1200 to 1776

The Post-Formative Period is marked by the apparent replacement of the Fremont peoples by a migratory group of Shoshonean/Numic-speaking people from the Southwest. This period also includes the arrival of the direct ancestors of modern-day Ute Indians and their use of the Uinta Basin's resources. Archaeological sites from this period are numerous.

The Numic Expansion: ca. A.D. 1200 to 1776

The final archaeologically identifiable phase of occupation prior to the historic-ethnographic period is that of the Numic Expansion. This occupation apparently began as Numic/Shoshonean speaking peoples migrated into the northern Utah area and replaced the Fremont Culture. It is not yet clear whether the Fremont abandoned the area prior to the arrival of the Shoshoneans or whether resource competition between the two groups forced the Fremont from the region (Marwitt 1986:171-172). The Uinta Basin is an exception to this problem in that it is known that the Fremont left this portion of Utah roughly 200 years prior to the arrival of the Numic population. The Uinta Basin was occupied by the Ute ancestral group of Numic speakers, who arrived about A.D. 1200 to 1300 and continued to reside in the Basin into the historic period (Callaway et al. 1986).

Little is known about the Shoshonean groups archaeologically, other than the presence of Shoshone pottery and Desert Side-Notched projectile points at Shoshonean identified sites. Ethnographically, subsistence activities of Shoshonean groups (bands) involved seasonal movements to specific geographic localities as particular food resources became available throughout the year (Steward 1938). The size and structure of a band fluctuated with changes in the types and availability of resources, but generally included small, family-sized bands through the spring and summer and large, multi-family groups during the fall and winter months.

Eastern Uinta Mountain Cultural Chronology

Minimal evidence of a Paleoindian Era (?-8500 cal BP) occupation is found on ANF, represented by sparse surface artifacts. Paleoindian point fragments were identified at eight sites relatively close to the Green River. These sites cluster between 6070 and 6300 ft in elevation, with only two found between 6300 and 8720 feet. Points found include a possible Agate Basin point, one Folsom, Medicine Lodge Creek and Midland. Others include untyped lanceolate and stemmed points. The earliest dates produced by sites in the Uintas (42Da599 and 42Da690) point to Archaic occupations around 8000 cal BP. In light of this limited evidence, the Paleoindian Era in this area is thought to have ended before 8000 cal BP (Johnson and Loosle 2002:13).

Archaic occupations represented in the data from the Dutch John excavations on ANF more closely align with archaic chronologies from northwestern Colorado and southwestern Wyoming. Such early archaic expressions include activity areas with brush structures containing internal hearths and pits, large side-notched points, and groundstone. These activity areas and brush structures (8005 and 6605 cal BP) may represent central place foraging strategies (Johnson and Loosle 2002:14). Late Archaic components include slab lined storage basins (4610 and 3290 cal BP) (Loosle and Johnson 2000:235-24,255) indicative of high mobility and rockshelter hearth and roasting pits (1-sigma range 2784-1880 cal BP). This later date corresponds to the mid-Neoglacial cool-wet conditions (Loosle and Johnson 2000; Johnson and Loosle 2002:14). Based on these changes in feature type and suggested mobility, the Archaic Era was subdivided in to the Early Archaic (8000-5000 cal BP) and the Late Archaic (5000-2000 cal. BP) (Loosle and Johnson 2000:253-254; Johnson and Loosle 2002:14).

The Late Prehistoric Era is subdivided into the Formative, Fremont, and Protohistoric periods. Currently, there is no evidence of the Protohistoric period on High Uinta portion of the ANF. However, there is evidence on ANF to support the Formative and Fremont periods. This chronology identifies the Formative and Fremont periods in northeastern Utah as synonymous. Most evidence of the Uinta Fremont variant is found in lowland occupations along the south slope of the Uintas. Evidence from Dutch John on ANF suggest short duration camps in the form of Fremont brush structures and campsites with hearths and roasting pits providing dates with a 1-sigma range of 1705-925 cal BP (Loosle and Johnson 2000:257-259; Johnson and Loosle 2002:14-15).

Ethnographic Overview: Prehistoric Times to Early European Contact

What is known of aboriginal occupation of the region before Escalante's expedition through the Uinta Basin in 1776 is based on the oral tradition of the Utes, ethnographic accounts, and archaeological evidence. Although there is some debate about details, it is generally agreed among scholars that the scattered bands of Numic speakers, now collectively identified as Utes, occupied the area that is now central Utah and most of Colorado. More specifically, this area extends from the western high plains in the east to the Oquirrh Mountains of Utah in the west, and from the Uinta Mountains and Yampa River in northern Utah and Colorado to the southern margins of Colorado and the canyonlands of southwestern Utah (Stewart 1966a). This area of occupation was later established by various treaties between the Utes and the United States and reaffirmed by the U.S. Indian Claims Commission (Stewart 1966b).

The question of which protohistoric group(s) used and occupied the Uinta Basin and whether the occupation was permanent or seasonal is more controversial. However, scholars generally agree that the people who occupied the Basin before contact were a portion of the Western Ute, which were bands that habitually used the area between the high country of the Uinta Basin and the areas between the Wasatch Mountains and the Great Salt and Utah Lakes and south to the Tavaputs Plateau. Some authors believe the Uintah and the Timpanogots of Utah Lake constituted a single band, while others conclude these were separate bands (O'Neil 1973; Stewart 1966b; Janetski 1991).

Julian Steward described the Uintah Ute as the three or more bands who occupied the Green and Uinta Valleys, with the mouth of the Uinta River as a central point. These collectively numbered between 1,000 and 3,000 people (Steward 1938). Fowler and Fowler (1971) derive the name Uinta from the Ute name for the Uinta River, which is given as *U-int-a-nu-kwints*.

The Western Ute, like other Numic speakers, were scattered in small family groups, each of which used the resources of a specific territory. Other families who were related by the in-law relationships that flowed from an exogamous marriage custom also occupied the territories. The territories were flexible in boundary and resource use prerogatives, but typically included a variety of resources because the territories of bands incorporated the ecological diversity that resulted from altitude and local water drainage features. Thus, during the summer and fall, Western Ute Bands would occupy higher elevations to hunt larger game and collect high-desert and alpine resources. As the season shortened, Ute families moved to lower elevations, pausing to harvest pinyon pine nuts, a major food source. During the winter, the Western Ute Bands spread out in the Great Basin proper where they hunted small game, principally jack-rabbits, and collected a wide variety of plant foods, reptiles, and insects. When possible, they used the resources of lakes and streams, including fish, migratory waterfowl, and aquatic plants.

Period of Contact

Contact with Europeans and European-Americans produced a remarkable transformation in Ute culture. Although the change was neither universally rapid nor uniform, both direct and indirect external influences transformed Ute culture by the mid-nineteenth century. During this period, the Utes acquired horses and took on many aspects of Plains Indian Equestrian culture. The result was rapid change toward larger group sizes, alteration of the economy and seasonal movement, and material culture (Steward 1970).

Utes living as neighbors of the eastern Pueblos and Comanche first acquired horses in the middle part of the seventeenth century (Secoy 1992). As they acquired horses they ventured more and more to the High Plains where they hunted bison and, through contact with other plains tribes, acquired the horn back bow, skin clothing, the tipi, and other paraphernalia of Plains Indian culture (Rockwell 1956). They also resided in larger groups appropriate to increased food supply, mobility, and the aggressive nature of intertribal relations. These patterns intensified with the introduction of firearms. By 1700, mounted Utes occupied and dominated all of mountainous Colorado.

The Western Ute did not acquire horses as early or in as large numbers as their eastern relatives. When the first Spanish explorers of the Dominquez-Escalante Expedition reached the Uinta Basin in August of 1776, they encountered no Indians at all, but traveling west they met unmounted Utes in the vicinity of Utah Lake. About 50 years later, in 1824, William Ashley met mounted and armed Utes in the Uinta Basin who were well integrated into plains culture. Presumably the Eastern Ute had acquired guns and horses by about 1750 (Secoy 1992). Janetski (1991) suggests that the reason Escalante did not encounter Utes was because mounted Shoshone from the north and east, which had acquired horses by 1700, had driven them from the Basin. Other explanations are also credible.

By at least 1800, the Western Ute had acquired horses in considerable numbers from the south and east, and by mid-century were well into the process of equestrian transformation (Janetski 1991). In fact, by this time they were slave raiding among their Southern Paiute neighbors and had expanded eastward, regaining the Uinta Basin. By the time of Ashley's visit in 1825, they may have been living year-round in the Basin (Lyman and Driver 1970).

It is also during this period that the Utes of the Uinta Basin came into sustained contact with European and American fur trappers who established semi-permanent trading facilities in the Basin.

In the following years, a number of fur trappers made their way into the area. Some, such as French-Canadian trapper Baptiste Brown, set up trading posts in the Basin to trade with both the Ute Indians and the travelers along the Spanish Trail (Jones and MacKay 1980:108). The beaver-rich rivers and streams of the Uinta Basin and mountains became host to a suite of trappers from Taos, New Mexico known as the Taos trappers. Such trappers included Christopher "Kit" Carson and Antoine Robidoux. In 1833, Carson, who had been trapping in the Basin since the late-1820s, established a trading post at the confluence of the Green and White Rivers. Four years later, in 1937, Antoine Robidoux erected his own trading post on the west fork of the Uinta River. This trading post, which was built from adobe, was known variously as

Fort Uintah, Fort Wintey, and Fort Robidoux (Jones and MacKay 1980:66). Shortly after, a second trade center was established by a French trapper known only as Du Chasne at the future site of Fort Duchesne (Van Cott 1990:143).

HISTORIC IRRIGATION STORAGE DEVELOPMENT IN THE PROJECT AREA

Historic development in the project area began during the early 20th Century with the exploration of glacial lakes on the southern slopes of the Uinta Mountains. This exploration focused on acquiring data regarding potential lake capacities for storing water in order to enhance late summer irrigation flow within the Uinta Basin. Expanding settlement and the developing agricultural economy within the Uinta Basin made the acquisition and transportation of water very important to the regional economy. The dams that were constructed in the Uinta Mountains were an essential component within the irrigation networks, which supplied flow to the agricultural fields of the Uinta Basin. The following provides a brief historic overview of development specific to the high mountain lakes region addressed during the Section 203 Project. For a more thorough treatment of settlement, irrigation development, and the battle for water rights in the Uinta Basin see Fraser (1986) and Fraser et al.(1989).

Several prominent irrigation companies developed in the Uinta Basin during this period of settlement and agricultural development. These companies, whose sole purpose was to provide irrigation to the Uinta Basin, developed into corporations or cooperatives that traded stocks for labor. The companies included the Dry Gulch Irrigation Company (Dry Gulch) and the Farnsworth Canal and Reservoir Company (Farnsworth). Smaller companies in the region included the Farmers Irrigation Company (Farmers), the Swift Creek Reservoir Company, and the Lake Fork Irrigation Company. Several of the companies that played central roles in the historic development of these early irrigation systems are still in operation today. The longevity of these companies emphasizes their importance throughout the economic history of the region.

Dry Gulch and Farnsworth in the lakes of the Lake Fork Drainage and by Farmers and the later Moon Lake Water Users Association (Moon Lake) on the Swift Creek and Yellowstone Drainages most prominently influenced development of irrigation storage in the lakes of the High Uintas. For the purposes of the following discussion the historical development of these two areas is separated by drainage basin.

Development of Irrigation Storage within the Lake Fork Drainage

In 1905, Dry Gulch was granted rights to water storage in several of the remote lakes of the Uinta Mountains (Fraser et al. 1989:62). Among these was Clements Lake, a remote body of water pooled behind a terminal moraine on the Lake Fork drainage. Although Dry Gulch was granted the first rights to storage within the Lake Fork Drainage, it was not until more than a decade later that Dry Gulch began to actually develop its claims. In 1915, Farnsworth began to demonstrate interest in the area, initiating the first wave of development at the lakes.

Farnsworth Canal, incorporated in 1908, is one of the oldest extant irrigation companies in the Uinta Basin (Fraser et al. 1989:62). Farnsworth, following the lead of the larger Dry Gulch, petitioned the Utah State Engineer's Office for irrigation water storage rights on the Lake Fork Drainage in 1915 (Fraser et al. 1989:62, 63). The company proposed building dams at Brown Duck, Kidney, and Island lakes. As a competitor, Farnsworth's claim had potential to infringe upon Dry Gulch's claims at Clements Lake. By April 1916, Farnsworth was granted rights to store 324, 435, and 851.2 acre-feet of water at the three lakes with the understanding that all construction be completed by November 1, 1918 (Fraser et al. 1989:62). Upon demonstrating that Kidney Lake could provide more water than anticipated, Farnsworth resubmitted the proposal in January 1917 requesting an additional 1500 acre-feet of storage. The following year, Farnsworth again re-filed for an additional 1700 acre-feet of water, pleading for an extension past the November 1, 1918 deadline (Fraser et al. 1989:63)

In 1916, the Farnsworth crew began horse packing construction supplies up freshly blazed trails to the three lakes (Fraser et al. 1989:65). Actual construction was initiated in 1917 (Fraser et al. 1989:66, 68). Blasting of the rocky moraine deposits required many caps and sticks of dynamite. Barrow pits were excavated, and linear trenches were dug approximately 10 ft below the natural lake levels for the placement of the clay foundations at each dam. Concrete mix, corrugated metal pipe, canal gates, excavation equipment, tools, rebar, food, and supplies all had to be brought in by pack horses and men. Steep terrain complicated the transport of heavy, bulky, and explosive materials. The bulk of heavy building materials was transported to the dam sites during winter months when sturdy sleds or sleighs could be used (Fraser et al. 1989:67, 71).

By November 1919, small earthen dams were in place at the outlets of Brown Duck, Kidney, and Island Lakes. The dams were completed at the tail end of a two-year drought that threatened losses on over 50,000 acres of agricultural fields (Fraser et al. 1989:62). Although the dams contributed to the irrigation requirements of the region, the capacity of the Lake Fork Drainage was viewed as insufficient for the growing number of acres cultivated in the valleys below. The call for more water was met by further irrigation water storage projects along adjacent drainage systems. Nevertheless, Farnsworth's achievements were pioneering efforts in the development of irrigation in Northeastern Utah.

In 1919, Dry Gulch initiated efforts to prove its claim at Clements Lake. The proposed dam was to be the largest on the Lake Fork Drainage, enhancing the storage capacity of the existing system by nearly 650 acre-feet at maximum capacity (Fraser et al. 1989:72). In 1921, the United States Forest Service granted Dry Gulch a special use permit for the development of a dam for the storage of irrigation water at Clements Lake. This permit authorized Dry Gulch to utilize up to 81 acres of Clements Lake surface (Fraser et al. 1989:71).

In order to prove their claim, Dry Gulch built a small log dam across the natural outlet on the east end of Clements Lake (Fraser et al. 1989:71, 72). With the proof of claim, Dry Gulch introduced the highest reservoired lake to the existing Lake Fork Drainage water storage system. The small dam proved sufficient only to secure Dry Gulch's interests in the drainage. A larger, formal dam would have to be built in order to utilize Clements Lake to its fullest storage potential.

In 1926, Dry Gulch contracted engineer Louis Galloway to survey the proposed Clements Dam location and plan a pack trail from the Moon Lake trailhead to the dam site (Fraser et al. 1989:71). Galloway's assistant, Pete Wall, received the contract to construct the dam at Clements Lake. Dry Gulch faced the same challenges met by the Farnsworth crews in undertaking a large-scale construction project in the high Uintas. Like the Farnsworth crews, prior to snowfall, Wall used packhorses to bring equipment and supplies to the lake. After snow-pack was established, sleds were the preferred method of transporting goods and equipment (Fraser et al. 1989:67, 71). The Clements Lake Dam built by Dry Gulch is very similar to those built by Farnsworth at Brown Duck, Kidney, and Island Lakes. Dry Gulch followed the same strategy for blasting, excavation, foundation placement, and gathering of barrow materials. As a result, the Clements Lake Dam appears very similar in form to the other clay core, earth, and stone dams of the region. Improvements made to the Farnsworth design include the patterned placement of tabular stone facing as armorization to the upstream face of the dam, and construction of an overflow spillway directing overflow well away from the main dam structure.

In 1967, the dam at Brown Duck Lake was partially breached (Fraser and Jurale 1985a). Its function as an agricultural water retention feature was suspended until approximately 1977. In this year, improvements to the dam outlets of the Lake Fork system were made to upgrade the existing facilities. These improvements and repairs returned Brown Duck Lake Dam to operational status.

Development of Irrigation Storage within the Swift Creek and Yellowstone Drainages

Farmers petitioned the Utah State Engineer's Office for irrigation water storage rights to natural lakes in Garfield and Swift Creek Basins of the Yellowstone Drainage of the High Uintas during the 1910s and 1920s. Farmers was a small company, primarily concerned with providing irrigation to a relatively minor amount of Uinta Basin farm acreage (Fraser et al. 1989:76-77). The company proposed building dams to increase water storage on the Swift Creek Drainage in Water Lily, Deer, Farmers, and White Miller Lakes, and in the Garfield Basin of the Yellowstone Drainage in Bluebell, Drift, Five Point, and Superior Lakes.

By April 1918, Farmers was granted rights to store 723 acre-feet of water at Water Lily Lake, its first reservoir (Fraser et al. 1989:77). Between 1919 and 1926, permits were granted for 803 acre-feet of storage at Farmers Lake (1919), 249 acre-feet at Deer Lake (1925), and 77 acre-feet at White Miller Lake (1926). In 1926, Farmers was granted permits for 258 acre-feet of storage at Bluebell Lake and 197 acre-feet at Drift Lake. In 1927, Farmers obtained permits for 607 acre-feet of storage at Five Point Lake and 359 acre-feet at Superior Lake (Fraser et al.1989:76-80).

Actual construction at Water Lily and Farmers Lakes was initiated in 1919 (Fraser et al.1989:66-68). Barrow pits were excavated, and linear trenches were dug approximately 10 ft below the natural lake levels for the placement of the clay foundations at each dam. Concrete mix, corrugated metal pipe, canal gates, excavation equipment, tools, rebar, food, and supplies all had to be brought in by pack horses. Steep terrain complicated the transport of heavy, bulky, or explosive materials. Much of the transportation of supplies to the dam sites was conducted during the winter when sturdy sleds or sleighs could be used (Fraser et al. 1989:67-71).

By 1920, a small earthen dam was in place at the outlet of Water Lily Lake and a tunnel had been blasted at Farmers Lake. The Farmers Lake Tunnel provided for the release of naturally stored water into White Miller Lake. Work at Water Lily and Farmers Lakes was quickly followed by the construction of dams at Deer Lake in 1925, White Miller Lake in 1926, Drift Lake in 1928, Five Point Lake in 1929, and Bluebell and Superior Lakes in 1930 (Fraser et al. 1989:77-80).

The dams constructed by the Farmers Irrigation Company were small-scale in comparison to the high mountain dams built by the larger irrigation companies such as Dry Gulch and Farnsworth. Although the dams constructed by the Farmers Irrigation Company were small, their contribution was nevertheless significant. The Farmers Irrigation Company ceased operation as an individual entity when it was incorporated into the newly formed Moon Lake Water Users Association. Moon Lake was organized by joining several irrigation companies, including Farnsworth, Dry Gulch, Lake Fork, Swift Creek, and Farmers in the 1930s (Fraser et al. 1989:86-87, 90).

Uinta Basin farmer, Brigham Timothy, initially constructed the dam at East Timothy Lake circa 1920. This original structure measured 12 by 18 ft and consisted of stacked blocks of sod with a wood outlet gate across the lakes natural outlet channel (Fraser et al. 1989:69). Timothy's water rights were eventually transferred to the Swift Creek Reservoir Company, which later became part of Moon Lake (Fraser et al. 1989:86-87, 90).

In 1951, Moon Lake cut a primitive road from Jackson Park up to East Timothy Lake and began construction of the present East Timothy Dam utilizing heavy earth-moving equipment. Construction workers placed stone riprap on the face of the dam, which was an elongated S-shaped structure built across the natural outlet on the southeast corner of the lake. "Despite the fact that construction of the dam was carried out using motorized heavy equipment, the East Timothy Dam resembles the other dams built in the 1920s and 1930s, illustrating the relatively unsophisticated nature of earth-fill technology" (Fraser et al. 1989:88). East Timothy Lake Dam is the largest dam in the Swift Creek Drainage.

In the 1960s, concerns stemming from the Wilderness Act of 1964 prompted the Bureau of Reclamation to adopt a policy, which called for the stabilization of the high mountain lakes dammed during the first half of the 20th Century. This policy, combined with safety concerns regarding the condition of the dams, made the dam at East Timothy Lake a major concern. The natural seal of the ground at East Timothy had been disturbed by the borrowing of earth from the upstream and downstream toes of the dam. This disturbance eventually led to a seepage problem (Fraser et al. 1989:88-89) that if left unchecked could ultimately lead to structural failure. In order to prevent structural failure, a series of breather/seep pipes were added to the downstream toe of the dam. These pipes provide an outlet for seepage in an effort to prevent structural failure of the vulnerable portion of the dam.

The dams of the Lake Fork and Swift Creek Drainage systems were relatively well maintained throughout their history. Modern outlet works replaced historic log crib structures, spillways were improved, and debris was cleared from the upstream faces of the dams. Repairs were completed as required to maintain the operation of each dam.

Development of more efficient methods of irrigation, including pressurized systems, has reduced regional dependence upon water storage in the lakes of the High Uintas for irrigation use. As a result, proposals have been made to stabilize lakes previously used for irrigation storage purposes. Through stabilization, efforts would be made to return water levels within these lakes to natural levels. It is proposed that stabilization will enhance recreational values within the High Uintas Wilderness Area, improve water quality and fish habitat, and eliminate impacts to the wilderness area associated with maintenance operations at the dam sites (Central Utah Water Conservancy District 1996:S-3). Today, construction efforts have been completed at most of the original 13 high mountain lakes proposed for stabilization as part of the Section 203 Project.

THE EFFECTS OF RESERVOIRS ON ARCHAEOLOGICAL SITES

The increasing number of studies undertaken on the effects of reservoirs on archaeological sites (Morgan 2000; Morgan 2005; Will and Clark 1996; Lenihan et al. 1981) is a result of the continuing construction, maintenance, decommissioning, and dismantling of dams and reservoirs. Numerous dams/reservoir systems are also under relicensing by federal agencies, necessitating compliance with federal resource preservation laws. This body of work has highlighted the need for archaeologists, particularly those working within cultural resource management, to scrutinize the integrity of sites found within reservoir settings when making important management decisions.

The following discussion of reservoir effects is an important aspect of this study, as all six sites excavated for the High Mountain Lakes Stabilization Project are in reservoir drawdown areas. The discussion highlights important hydrologic and geomorphic processes inherent to reservoir settings and their effects on the integrity of archaeological sites. These processes are relevant in their application to the data recovered at all six sites, allowing for a deeper understanding of site formation processes and site integrity.

Will and Clark (1996) describe the tendency to erroneously view environments of contemporary impoundments as similar to those that may have existed in the natural body of water prior to its being dammed. In fact, the impoundment of these natural bodies of water creates new shorelines and environmental conditions that native populations never encountered. Moreover, the creation of new shorelines has significant implications for existing archaeological sites. The authors suggest two explanations for the presence of archaeological sites within reservoir settings: (1) archaeological sites recovered on modern reservoir shorelines may represent the "last remnants of fully eroded" archaeological sites; and (2) the plausibility that these "sites" are *created* by the process of materials being transported by erosional and depositional processes endemic to reservoir settings (Will and Clark 1996:502).

A brief discussion of several geomorphic environments found in reservoir settings is important to understanding the nature of geomorphic processes present in most reservoirs. The discussion does not comprehensively explore all geomorphic environments, nor does it attempt to take into account overall environmental setting, reservoir size, geographic location, or climate. The three geomorphic environments that are most applicable to the project area include: lakeshore and nearshore fluctuation zones, stream inflows, and reservoir basins. Refer to Table 3 below for a summary of processes and predicted effects on cultural deposits.

Table 3. Summary of Geomorphic Settings, Processes, and Predicted Effects on Cultural Deposits in Reservoir Settings

Geomorphic Setting/Landform	Principal Geomorphic Processes	Predicted Effects on Cultural Deposits
Lakeshore/Nearshore (*Exposed Shoreline, Peninsula, Inlet*)	Wave cut erosion, longshore drift, wave refraction	Erosion, deflation, relocation of materials, and redepostion of site deposits. Creation of new sites consisting of secondary deposits is possible.
Stream Inflow	Alluvial deposition and erosion	Erosion, deflation, relocation of materials, and redepostion of site deposits. Creation of new sites consisting of secondary deposits is possible.
Reservoir Basin	Settling out of clays/silts and deposition	Partial to complete burial of deposit; preservation of cultural deposit integrity; minimal effects from lake drawdown and inundation.

Lakeshore/Nearshore Fluctuation Zones

Areas subject to constant wave action and exposure during reservoir drawdown are referred to as lakeshore and nearshore fluctuation zones (Morris and Fan 1998). Three identified landforms found within this zone include exposed shorelines, peninsulas, and inlets. The effects of wind, wave action, and longshore drift on these differing landform settings almost always negatively impact the integrity of archeological sites (Morgan 2000; Morgan 2005; Will and Clark1996; Lenihan et al. 1981).

Exposed Shorelines

Exposed shorelines comprise long linear expanses of shoreline encircling the reservoir and lacking topographic features such as peninsulas, inlets, embayments, and knolls. These areas are vulnerable to the effects of wind and wave energy. Wave action, which is driven by wind, erodes reservoir shores, with the exception of shores with exposed resistant bedrock. When water levels repeatedly fluctuate within the shoreline zone, sediments are redistributed within the zone prohibiting the stabilization of shoreline, impacting slope stability, and reducing vegetation that helps bind sediments in the shore zone. As such, most archaeological sites found within the fluctuation zone are subject to near complete destruction as archaeological materials are part of the shoreline system and are subject to the impacts from that system such as erosion, transport, and redeposition (Morgan 2000; Morgan 2005; Will and Clark1996; Lenihan et al. 1981). However, not all exposed shorelines are subject to such vigorous erosional processes. For example, shoreline deposits composed of glacial till, particularly clay-rich till, are less likely to erode as easily as eolian or alluvial sediments. Furthermore, larger, coarser materials including cobbles and boulders also act to stabilize exposed shorelines, perhaps having less of an impact on archaeological materials (Will and Clark 1996).

Peninsulas

Any projection of land into a reservoir, which is surrounded by water on all three sides is considered a peninsula. The nature of sediment erosion, transport, and redeposition is different in peninsulas in that they are particularly affected by longshore drift. In brief, longshore drift wave energy, which can move large quantities of sediment laterally along the shore long distances from its original location, approaches peninsula shores and is refracted towards the outermost tip of the peninsula. The effect of this is the deposition of suspended sediments just below the water levels (nearshore), along the lateral margins of the peninsula and continuous erosion of the tip of the peninsula. Thus, wave action in these environments has the effect of not only eroding archaeological deposits, but redepositing archaeological material carried long distances through the process of longshore drift (Morgan 2000; Morgan 2005; Will and Clark1996; Camfield and Briggs 1993).

Inlets

Inlets, for the purposes of this discussion, are smaller bodies of water enclosed to some degree by land on all three sides. While physiographically opposite of peninsulas, inlets experience the same hydrologic and geomorphic processes. For example, incoming waves carrying sediment lodes are refracted away from the highest point of the inlet towards its lateral margins, resulting in the erosion of these shores and subsequent deposition of both eroded material and longshore transport sediment just below the water along the lateral margins of the inlet (Morgan 2000; Morgan 2005; Will and Clark1996; Camfield and Briggs).

Stream Inflows

Typically located farthest from the dam or impoundment body, stream inflows are the principle water source feeding the reservoir. In brief, the transition zone between the inundated alluvial/lacustrine and riverine systems are punctuated by repeated transgression and regression cycles associated with seasonal reservoir drawdown and inundation. As a result, the dominant geomorphic processes alternate between those found in both lacustrine and alluvial settings, including erosion and sediment transportation and deposition, all of which is dependant upon reservoir pool elevations. To illustrate this point, if pool elevations at a given location are high, lacustrine sedimentation will occur; at intermediate pool elevations, shore erosion and transportation of sediments occur; and at low pool elevations, both erosion and deposition of sediments occur. Evidence for these types of geomorphic settings can be seen in sediment profiles as alternating between fine-grained lacustrine sediments and coarse-grained alluvial deposits associated with periodic cut/fill sequences characteristic of reservoir transgression/ regression cycles (Morgan 2000; Morgan 2005; Morris and Fan 1998). That said, archaeological deposits situated near stream inflow geomorphic settings, are particularly vulnerable to damage.

Reservoir Basins

In the deeper areas within the reservoir, reservoir basins are the areas below the shoreline fluctuation zone. There is considerable variability in basin dimensions based on the configuration, depth, and topography of a given reservoir, although they typically tend to become deepest nearest the impoundment. Of particular note, reservoir basins, much like natural lakes, are the focus of deposition and accumulation of sediments. These depositional processes happen in two ways: (1) the settling out of clays and silts in suspension; and (2) through both alluvial and colluvial deposition. As such, reservoirs tend to silt up in the upstream or inflow areas first due to alluvial sedimentation with downstream areas (i.e., those near the impoundment location) remaining relatively sediment free and maintaining depth.

The importance of such reservoir basin geomorphic processes with respect to archaeological deposits lies in the possibility of the preservation of such sites. In short, archaeological sites situated in upstream settings experience the deposition of significant amounts of sediment load, therefore potentially burying archaeological deposits and minimizing the effects of erosive episodes from post reservoir drawdown.

In all, the above analysis suggests that though geomorphic processes associated with different shoreline settings are different, the impacts, such as erosion and redeposition of cultural materials, are invariably the same. All sites within reservoir settings are subject to varying redepositional processes, one of which is the cycle of filling in and draining of the reservoirs themselves. However, sites within reservoir drawdown and fluctuation zones appear to be the most impacted. Data recovery results at six sites from the High Mountain Lakes Stabilization Project indicate generally poor and sometimes fair site integrity (see Data Recovery Results below and Table 15 in the Synthesis section).

DATA RECOVERY RESULTS

A total of six prehistoric cultural resource sites were excavated within the High Uintas Wilderness Area of the ANF as part of the Section 203 EA for the High Mountain Lakes Stabilization Project. These sites include four on the Lake Fork Drainage in Brown Duck Basin (42DC1340, 42DC1341, 42DC1342, and 42DC1344) and two in Swift Creek Basin on the Swift Creek Drainage (42DC1411 and 42DC1412). Data recovery excavations were undertaken in an effort to mitigate the effect of the stabilization processes at these lakes. Such effects include impacts from the process of deconstructing the dams and sustained site exposure from lowered lake levels. Excavations were also carried out in order to determine the extent and significance of the subsurface component at each eligible site. Below are the results of the data recovery effort at each of these sites. This discussion presents results by drainage basin separately. The purpose of the Section 203 High Mountain Lakes Site Mitigation Project is to conduct cultural resource

Brown Duck Basin

Data recovery excavations were carried out at three prehistoric sites, 42DC1340, 42DC1341, and 42DC1342 on [redacted] half of Island Lake and at prehistoric site 42DC1344 on [redacted] Kidney Lake within the Lake Fork Drainage in Brown Duck Basin. During excavations at Island Lake, one new isolated find (IF-A) was identified (Figure 2).

Isolated Find (IF-A)

One isolated find (IF-A) was identified at Island Lake during data recovery efforts. The isolated find was identified on [redacted] Island Lake [redacted] It is a complete Gatecliff Split Stem projectile point of cream and orange-tan mottled, opaque chert with gray and brown speckles or inclusions less than 1 mm in size. The material appears to be heat treated, indicated by a slight dull luster. The point's maximum length measures 51.2 mm, with a maximum width of 23.4 mm and a maximum thickness of 4.8 mm.

The point type was assigned using the Monitor Valley Typology of projectile points established by Thomas (1981). Thomas establishes a sequence for the Gatecliff Series extending from 3,000 to 1,300 B.C. although he argues that the use of Gatecliff Split Stem points might extend later in time in the eastern Great Basin (Thomas 1981:33-34).

Site 42DC1340

Site 42DC1340 is on [redacted] Island Lake at an elevation of 10,250 feet amsl. The site is a small, low to moderate density lithic scatter [redacted]. The original site recording (Weymouth and Christensen 2001) identified over 450 flakes. Secondary decortication flakes dominate the assemblage at 65% followed by tertiary (20%), primary (10%), and much less frequent shatter debris (5%). Materials are present in a wide array of cryptocrystaline silicates and quartzite in a variety of colors. Two bifaces, one core, and one projectile point were also identified. The projectile point was noted as most closely resembling those identified as an Elko Side-notched type affiliated with the Terminal Paleo-Indian/Archaic (10,000 to 500 B.P.) of the Great Basin. However, no well-defined concentrations of lithic materials and no features were identified. Weymouth and Christensen (2001) indicate that the site was in good condition, but noted impacts such as heavy erosion as a result of seasonal lake inundation, drawdown, and wave action.

Excavation Results

Three units (Units 1, 2, and 3) were excavated at 42DC1340 producing 232 artifacts (Figure 4). Each unit was excavated to sterile soils, which was typically no more than 10 cm below the modern surface. The exception to this is Unit 3, which reached sterile soils at the 5 to 10 cm level. Special studies undertaken include pollen/phytolith and macrofloral analysis and AMS radiocarbon analysis of a single soil sample of charcoal stained extracted from Unit 1, possibly representing a remnant hearth.

Stratigraphy

Soils are weakly developed and shallow, with cultural deposits reaching a maximum depth of 10 cm below the modern ground surface. Surface soils are characterized as somewhat mottled light-brown to reddish-brown silt containing moderate to high amounts of rounded pebbles and gravels to angular cobbles and slabs of quartzite scattered throughout.

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Figure 4. 42DC1340 Site map and unit locations

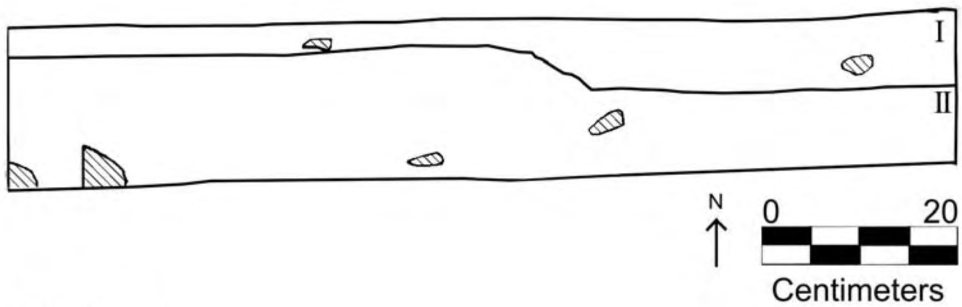
In general, site soils appear to have a thin layer, ranging from 0 to 5 cm, of very fine-grained, pinkish-brown lacustrine sediments consisting of site constituents such as artifacts and flecks of charcoal. These cap an eroded forest subsoil, possibly representing A/B or B Horizon soils, of fine-grained reddish-brown clayey-silts. There is an overall decrease in charcoal, an increase in gravels, and a roughly 50% or more increase in angular cobbles from the 0-5 cm and 5-10 cm levels. The contact between these two strata is an unconformity representing one or more erosional episodes resulting from reservoir drawdown and inundation. Below this is a sterile medium to coarse-grained reddish-pink sandy substrate likely derived from the pre-Cambrian Uinta quartzite formation (Figure 5).

Unit 1 contained higher amounts of charcoal than Units 2 and 3. An area of charcoal stained soils in the NW 1/4 of Unit 1 was encountered at the bottom of the 0-5 cm level. Soils around the charcoal concentration appeared very red, possibly indicating burnt soils. A 25 x 25 cm sample was taken of these charcoal-stained soils from 5 to 9 cm in depth, which were sent to Paleo Research Institute for Pollen/phytolith and organic residue analysis (see results in the pollen/phytolith section below). A similar charcoal stain with areas of red soils was identified in the westernmost portion of the north wall of Unit 2, which only minimally extended south into the unit. Due to time and weather constraints, it was not possible to extend Unit 2 to the north to follow the stain.

Cultural Materials

A total of 232 artifacts were recovered from 42DC1340. Debitage comprises the majority of these, with 222 flakes recovered accounting for 96% of the assemblage. Other artifacts include three formal flake tools (two scrapers and one uniface); three simple flake tools (edge-modified flakes); and four projectile points (one indeterminate, a non diagnostic concave or possible Split Stem base fragment, one Pinto Square-shoulder, and a heavily reworked Elko Corner-notched). Interestingly, all projectile points and flake tools were located on the site's surface, with the exception of one edge-modified flake found in the 0-5 cm level of Unit 3. Cryptocrystalline silicate (CCS) and quartzite dominate the assemblage with CCS comprising 69% of the assemblage and quartzite the remaining 31%, with only one obsidian flake recovered. No features were identified.

Unit 1 yielded 26 pieces of debitage, Unit 2 yielded 152 pieces, and Unit 3 produced 43 pieces. Debitage counts from the 0-5 to 5-10 cm levels in both Unit 1 and Unit 2 increase 68% and 88%, respectively, with debitage counts dropping off completely between these two levels in Unit 3. Debitage counts drop dramatically in Units 1 and 2 as sterile soils were reached at the 10-15 cm level (Table 4).



Stratigraphy

I Mottled pinkish-brown, fine grained, silty lacustrine sediments with subrounded to angular gravels and cobbles. Soils contain charcoal flecks and redeposited site constituents.

II Reddish-brown, fine grained, clayey-silt with increased amounts of gravels and angular cobbles. Soils contain charcoal flecks and stains with site constituents. From 8-10 cm, small patches of a medium to coarse-grained reddish-pink sandy substrate are present. Rodent disturbance is visible.

Rock

Figure 5. 42DC1340 Unit 1 north wall stratigraphic profile

Table 4. 42DC1340 Artifact Summary per Unit and Level						
Unit Number	**Level (cmbd-SW corner of unit)**	**Debitage Count**	**Flake Tool Count**	**Biface Count**	**Projectile Point Count**	**Total Artifact Count**
Site Surface	Surface	1	-	-	3	4
1	Surface	1	3	-	1	5
1	0-5 cmbd	19	-	-		19
1	5-10 cmbd	6	-	-		6
1	10- 15 cmbd	0	-	-		0 (Sterile)
2	Surface	13	2	-		15
2	0-5 cmbd	124	-	-		124
2	5-10 cmbd	15	-	-		15
2	10-15 cmbd	0	0	0	0	0 (Sterile)
3	Surface	25	-	-		25
3	0-5 cmbd	18	1	-		19
3	5-10 cmbd	0	0	0	0	0 (Sterile)
Total Artifact Count		**222**	**6**	**0**	**4**	**232**

Flake types include one (<1%) primary decortication flake, 12 (5%) secondary decortication flakes, 12 (5%) simple interior flakes, 19 (9%) complex interior flakes, 25 (11%) biface thinning flakes, 7 (3%) pressure flakes, and 141 (64%) indeterminate flakes. Aside from non-diagnostic indeterminate flakes dominating the assemblage at 64%, biface thinning flakes are the next most frequent flake type (n=25/11%). However, when viewed in terms of core reduction and biface manufacture technologies, these data indicate that core reduction strategies dominate the assemblage at 58%, versus biface manufacture/retouch at 42% (Figure 6).

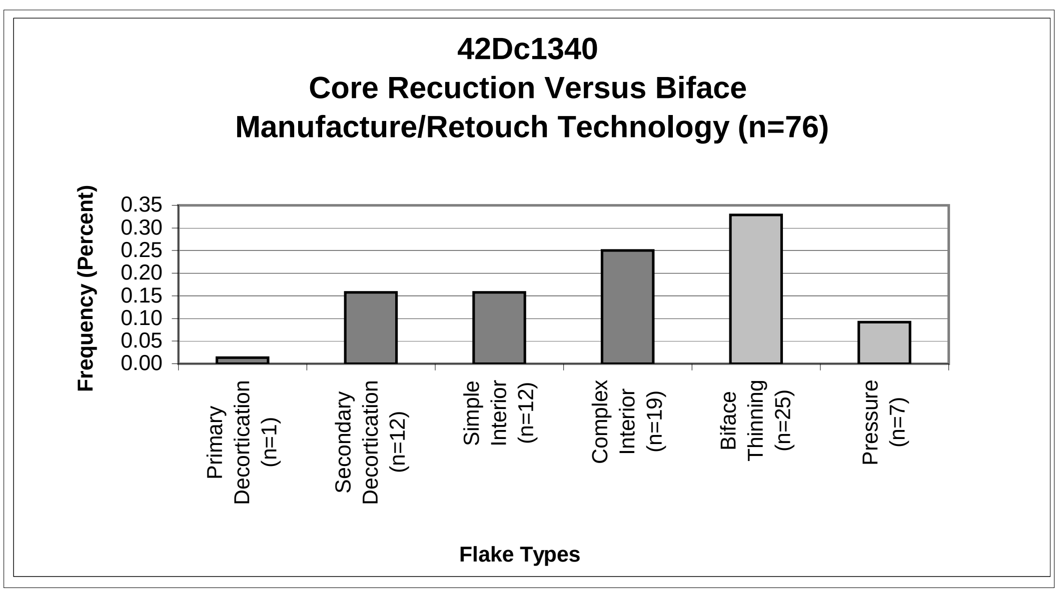


Figure 6. Core Reduction versus Biface Manufacture/Retouch at 42DC1340.

Size sorting analysis show the most frequently occurring flake size at 42DC1340 is between 10.1 and 20 mm (n=36; 45%), followed by the 5.1-10 mm size category (n=20; 25%); 0-5.0 mm (n=9; 11%), 20.1-30 mm (n=6; 8%), and the 30.1-40 mm and 40.1-50 mm size categories with two flakes each (3% each) Figure 7). These data reflect the results of the debitage morphological analysis with small flakes dominating the assemblage. These are mostly the numbers of biface tool manufacture and retouch, with smaller quantities of very late stage core reduction.

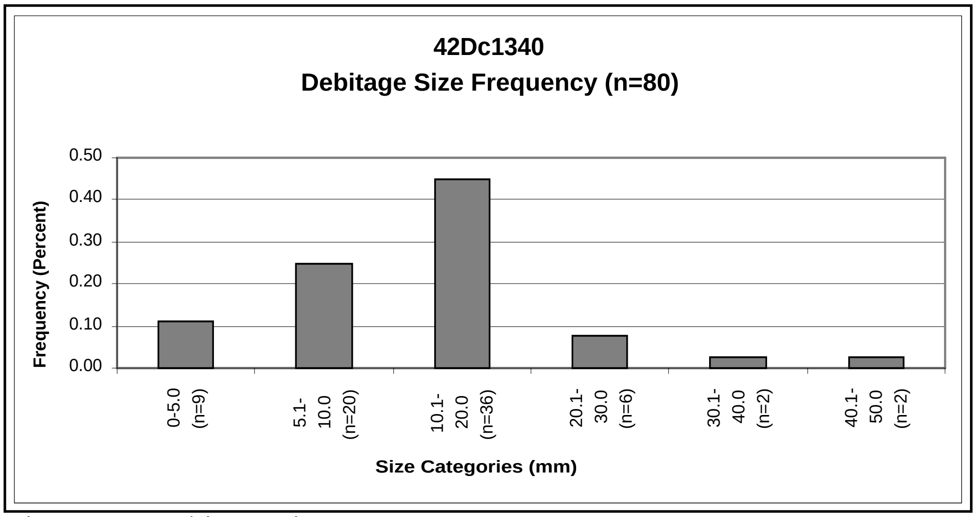


Figure 7. Debitage Size Frequency at 42DC1340.

Two scrapers, an edge-modified flake, and a uniface were all found on the surface of the site, and one edge-modified flake was found in the 0-5 cm level in Unit 3. One of the scrapers (Catalog No. 1340-04) is a fine-grained, tan, mottled chert, partially translucent with dark brown and black inclusions less than 1 mm in size. The other scraper (Catalog No. 1340-15) is an opaque gray chert, dull in luster, with larger black inclusions up to 2 mm in size. The edge-modified flake (Catalog No. 1340-08) found on the site's surface is a medium-grained, pinkish-buff colored quartzite with a pearlescent sheen on its surface. The material has characteristics of the Red Creek quartzite found on the eastern portion of the ANF. The other edge-modified flake (Catalog No. 1340-25) is a partially translucent, pink and orange mottled fine-grained chert with cream banding and brown to dark brown inclusions up to 1 mm in size. The uniface (Catalog No. 1340-06) is opaque, white and pink-banded chert, dull in luster, with tan inclusions up to 3 mm in size.

Of the four projectile points found, two were assigned definitive Great Basin typologies including one Pinto Square-shoulder (Catalog No. 1340-01) and a highly reworked Elko Corner-notched (Catalog No. 1340-03). The Pinto Square-shoulder point is fine-grained, dark brown chert with "beer bottle' brown banding, has three or more spall scars, and is somewhat translucent along the edges of the point. The material may possibly be of the Bridger Formation (Tiger Chert) due to its color, banding, and partial translucency. The reworked Elko Corner-notched is a medium to course-grained gray quartzite with black and tan inclusions less than 1 mm in size. The Drager and Ireland's (1986) Great Basin typology places the Pinto Square-shoulder within the Pinto Basin Series from 6,000 to 3,000 B.P. The Elko Corner-notched appears to be affiliated with the Terminal Paleo-Indian/Archaic (10,000 to 500 B.P.) of the Great Basin (Drager and Ireland 1986; Thomas 1981). However, the remaining two are small indeterminate point fragments lacking diagnostic attributes.

Pollen/Phytolith Analysis

A sample (Sample 5) of charcoal-rich sediment in the northwest quadrant of Unit 1 between 5-9 cm below the modern surface was sent to the Paleo Research Institute for analysis. Charcoal from this sample was extracted and processed for FTIR analysis of organic residues trapped and preserved within this charcoal sample. Analysis resulted in two distinct signatures referred to as Lower B and Lower A. Matches for both Lower B and Lower A signatures include acorns, lanolin, buffalo gourd, yucca pods, and hazelnut, all of which represent fats, oils lipids, and waxes. With respect to protein, Lower A found matches with acorn and lanolin. These data suggest the processing of nuts and possibly yucca pods at the site, while matches to lanolin also might indicate the processing of sheep at this site (Cummings et al. 2008) (See Appendix C).

Macrofloral Analysis/AMS Radiocarbon Analysis

Macrofloral remains identified from Sample 5 contained burned root/tuber remains, a charred, unidentified seed remain lacking its diagnostic outer seed coat, and *Pinus* species**.** Combined, these remains may reflect plant/seed-processing activities. AMS radiocarbon analysis on the single pine charcoal fragment provided a radiocarbon date of 1595 $\pm$ 15 RCYBP with a two-sigma calibrated age range 1530-1410 CAL BP (Cummings et al. 2008).

Site Summary

Site 42DC1340 is a small, low-density lithic scatter with debitage comprising 96% of the assemblage. Lithic analysis results indicate core reduction comprises slightly more of the assemblage at 58% with biface manufacture/retouch at 42%. These data are consistent with assemblage constituents, such as projectile points and both formal (two scrapers and a single uniface) and expedient flake tools (three edge-modified flakes) and is suggestive of a hunting-related pattern. Indeterminate flakes comprise the bulk of debitage (64%), and roughly 31percent of diagnostic flakes are broken illustrating the poor and damaged condition of the site due to its location on a reservoir peninsula. CCS comprises the majority of the raw material (69%) with quartzite at 31%.

All projectile points were recovered from the surface of the site. Only two were assigned typologies including a CCS Pinto Square-shoulder (6,000 to 3,000 BP) and a heavily re-worked quartzite Elko Corner-notched (10,000 to 500 BP). These dates point to at least an Archaic occupation. However, the AMS radiocarbon date (1530 –1410 CAL yr. BP) from charcoal recovered between 5 and 9 cm below the surface suggests a Late Prehistoric component. As such, it is evident the site lacks temporal control and further illustrates the disturbed nature of the deposit.

Site soils appear eroded and deflated due to lake drawdown, inundation and, most likely, longshore drift. The site's location [redacted] in the reservoir lakeshore fluctuation zone combined with the presence of very shallow cultural deposits, points to, at best, a highly disturbed and truncated cultural deposit with intact soils unlikely.

Site 42Dc1341

This site is a low to moderate density lithic scatter near [redacted] Island Lake at an elevation of 10,900 feet amsl. [redacted] Originally recorded in 2001, Weymouth and Christensen (2001) indicate the presence of roughly 500 flakes representing all stages of lithic reduction including primary (20%), secondary (30%), and tertiary (45%), and shatter (<5%). Materials noted include reddish-purple quartzite, obsidian and chert in a variety of colors including white, pink/white, grey, olive-tan, and red. One core and four projectile points were also documented. Three of these points were identified with the Elko Side-notched subtype affiliated with the Terminal Paleo-Indian/Archaic Period (10,000 to 500 B.P.) of the Great Basin. Weymouth and Christensen (2001) indicated the site is in good condition although they cite impacts such as wind and water erosion from lake inundation and drawdown.

Excavation Results

Units 1, 2 and 3 were excavated at 42DC1341 recovering a total of 109 artifacts (Figure 8). Each unit was excavated to sterile soils, which were encountered at the 10 to 15 cm level. Unit 1 is the exception to this, where sterile soils were reached at both the 0 to 5 and 5 to 10 cm levels. Obsidian studies were conducted on selected pieces of obsidian, although no other special studies were undertaken for this site.

Stratigraphy

Soils are weakly developed and shallow. Cultural deposits extend to a maximum depth of 10 cm below the modern ground surface. General site surface soils are characterized as somewhat mottled light-brown to pinkish-brown silts containing moderate amounts of rounded to angular pebbles and gravels, angular cobbles and larger, blocky slabs of quartzite scattered throughout the site and shoreline. Small bunch grasses dot the shoreline along with lake debris including whole and partial trees.

In general, soils are similar to those encountered at 42DC1340. While stratigraphy varies somewhat for each of the units excavated, site soils ranging from 0 to 5 cm below the modern ground surface are characterized as a thin layer of very fine-grained, pinkish-brown, silty lacustrine sediments containing angular gravels and site constituents such as pockets of small flecks and stains of charcoal. These overlie a truncated forest subsoil of reddish-brown fine-grained clayey-silts, possibly representing A/B or B Horizon soils. There is a decrease in charcoal and a slight increase in gravels and small angular cobbles from the 0-5 cm and 5-10 cm levels. Rodent disturbance, represented by significant mottling of soils, is present. The contact between these two strata is an unconformity representing multiple erosional episodes resulting from reservoir drawdown and inundation. Below this is a sterile, sandy substrate likely derived from the pre-Cambrian Uinta quartzite formation. This substrate is medium to coarse-grained reddish-pink sand (Figure 9).

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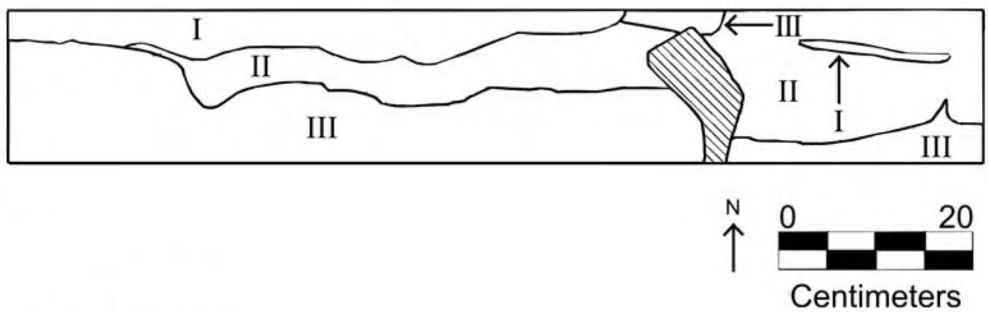
Figure 8. 42DC1341 Site map and unit locations.



Stratigraphy

I Mottled pinkish-brown, fine-grained, silty lacustrine sediments with subrounded to angular gravels and cobbles. Soils contain charcoal flecks and site constituents.

II Fine-grained, reddish-brown clayey-silt with decreased charcoal flecks and increased small angular gravels and cobbles. Substantial rodent disturbance is present, marked by extensive mottling of the soils.

III Medium to coarse-grained reddish-pink sandy substrate.

▨ Rock

Figure 9. 42DC1341 Unit 3 north wall stratigraphic profile

Unit 1 contains the shallowest deposit with evidence of mixing with pockets of sands and silts though out the unit. Unit 3 depicts a slightly less disturbed soil profile with forest subsoils of reddish- brown clayey silts comprising most of the soils from the 0 to 10 cm.

However, Unit 2 is particularly complex with a mix of reddish-pink sands from 5 to 15 cm interspersed with reddish-brown silts. This is likely a function of cutting and infilling of small channels specific to lake drawdown and inundation.

Four charcoal/ash stains were encountered at the 5 cm level. Each stain is 12 cm in diameter, spaced roughly 18 cm apart, and aligned in a rough semicircle. The stains are shallow and appear between 5 and 10 cm below ground surface (Figure 10). Initial exposure of the ash stains looked like potential features such as post holes to a brush structure, but further excavation revealed that these stains became very ephemeral and did not retain their shape. These stains were determined most likely not to be cultural features but may have been rodent burrows with accumulated ash stains or remnants of past forest fires. Therefore, no samples were taken of the ash stains and adjacent units were not opened up to follow the extent of these stains.

Cultural Materials

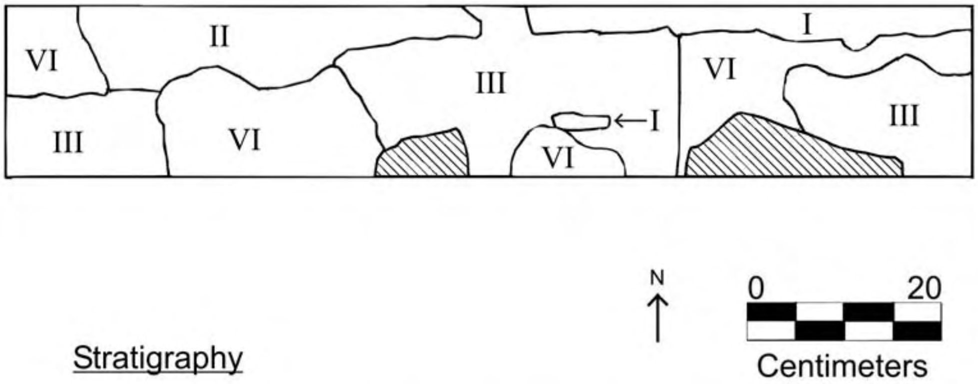
Artifacts recovered from 42Dc1341 (n=109) include debitage (n=102), comprising the majority of the assemblage (94%), one flake tool (edge-modified flake), two biface fragments of CCS, and four projectile points (one Desert Side-notched, an Elko Side-notched, one Humboldt Concave Base, and a large corner-notched fragment). All formal tools were collected on the surface of the site and are made of CCS. CCS materials dominate the assemblage at 60%, followed by obsidian (25%), and quartzite at 15%.

A single flaked tool of CCS was collected from the surface of Unit 1. No other materials were noted from the 0 to 5 cm and 5 to 10 cm levels. However, Unit 2 was the most productive with 73 artifacts recovered, the majority of which were found within the 0 to 5 cm level. Artifact counts decrease significantly from the 0-5 to 5-10 cm levels by 73%, with sterile soils encountered at the 10 to 15 cm level. Unit 3 produced only 27 artifacts, with the majority of materials found in the 5 to 10 cm level, showing a slight increase (23%) from the 0 to 5 cm level, then drop off completely with sterile soils encountered at the 10 to 15 cm level.

Table 5 indicates that non-diagnostic flakes comprise more than half of the assemblage (62%) with the majority of these being indeterminate flakes. Three diagnostic flakes types are represented in the assemblage, with biface thinning flakes occurring most frequently. No primary and secondary decortication flakes were identified. A total of 25 (25%) diagnostic flake types were broken, but exhibit distinct flake attributes, which allowed for classification. When comparing core reduction, versus biface manufacture/retouch, which excludes all non-diagnostic flake specimens, biface thinning and pressure flake types are at 62%, while the remaining 38% are core reduction flake types (Figure 11).

Table 5. Summary of Flake Types at 42DC1341

Primary Decortication	Secondary Decortication	Simple Interior	Complex Interior	Biface Thinning	Pressure	Shatter	Indeterminate
-	-	N=5; 5%	N=10; 10%	N=17; 17%	N=7; 7%	N=3; 3%	N=60; 59%



Stratigraphy

I Mottled pinkish-brown, fine-grained, silty lasustrine sediments with subrounded to angular gravels and cobbles. Soils contain charcoal flecks, and small roots.

II Fine-grained, reddish-brown clayey silt with decreased charcoal flecks, increased small angular gravels and cobbles, and site constituents.

III Fine-grained, red clay with decreased charcoal flecks and increased small angular gravels and cobbles.

IV Medium to coarse reddish-pink sandy substrate.

▧ Rock

Figure 10. 42DC1341 Unit 2 north wall stratigraphic profile

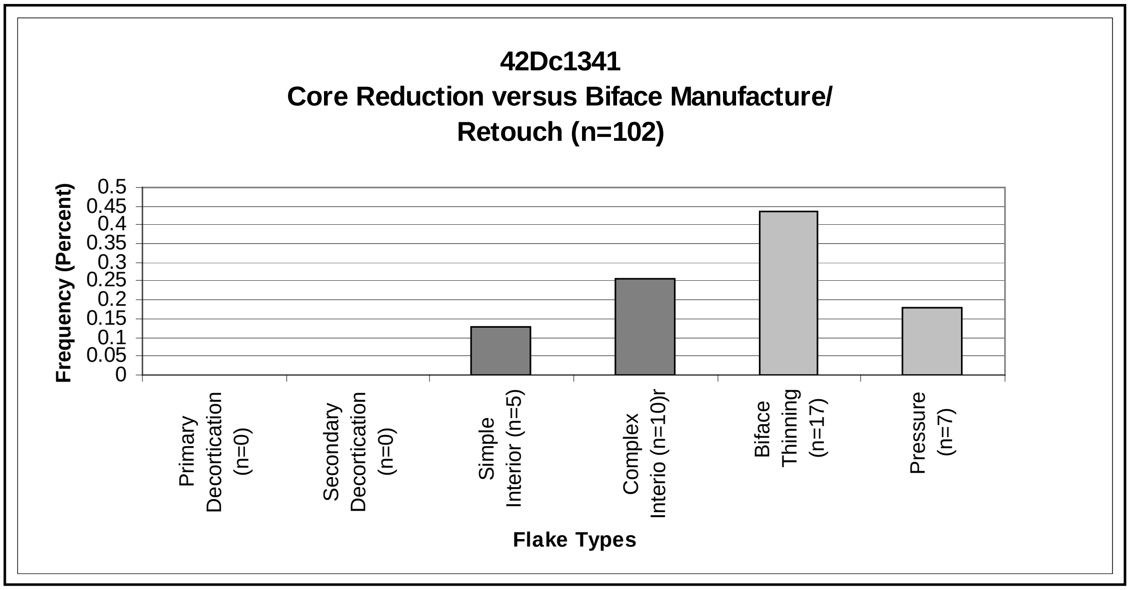


Figure 11. Core Reduction versus Biface Manufacture/Retouch at 42DC1341

Size sorting analysis data indicate the most frequently occurring flake size at 42DC1340 is between 5.1 and 10 mm (n=23; 51%), followed by the 10.1 and 20 mm size category (n=17; 38%); 0-5.0 mm (n=3; 7%); 20.1-30 mm (n=2; 4%); with no flakes measuring between 30.1-40 mm and 40.1-50 mm (Figure 12). As such, these numbers correspond to and support the above data suggesting that biface manufacture/retouch technology was the dominant type of lithic reduction activity at this site. These data reflect the results of the debitage morphological analysis with small flakes dominating the assemblage. These are mostly biface tool manufacture and retouch flakes, with smaller quantities of very late stage core reduction.

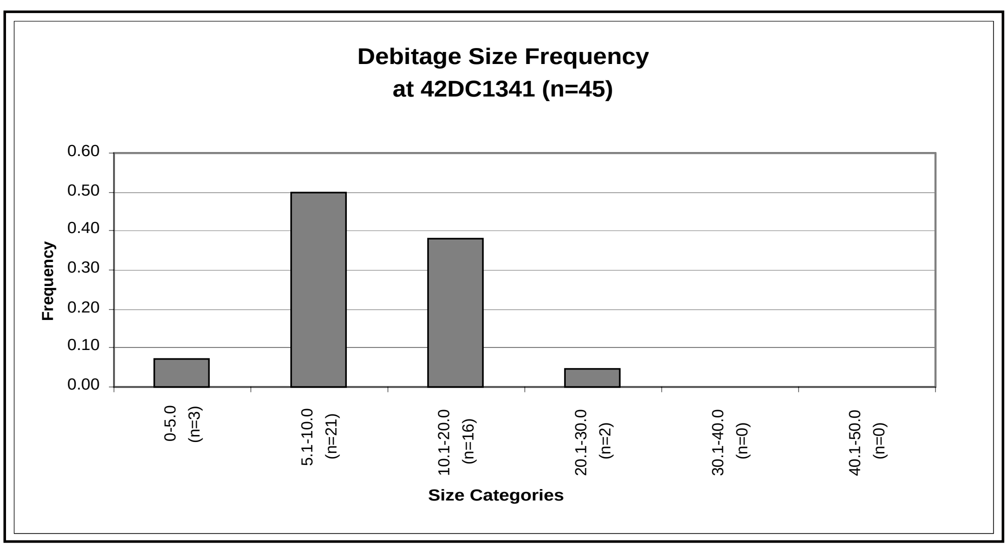


Figure 12. Debitage Size Frequency at 42DC1341.

The single edge-modified flake from Unit 3 (Catalog No1341-24) is a fine-grained chert, tan in color, with dark tan and orange banding. The material is partially translucent with small dark brown and gray inclusions less than 1 mm in size. Two biface fragments were collected on the surface of the site. One (Catalog No.1341-02) is a fine-grained, opaque, grayish-tan chert with cream and orange-pink mottling. The biface has a dull luster and appears to have been heat-treated with slight potlidding on its dorsal surface. The other (Catalog No. 1341-08) is an opaque, tan chert with light banding of a coarser-grained, dark tan material. The chert appears to be heat treated due to its very dull luster.

Of the four projectile points found, three were confidently assigned Great Basin chronological types including an Elko Side-notched (Catalog No. 1341-04), a Humboldt Concave Base (Catalog No. 1341-05), and a single Desert Side-notched point (Catalog No. 1341-03). The Elko Side-notched point is a fine-grained, opaque, pink chert with chocolate colored banding and small dark brown inclusions up to 2 mm in size. The point appears to be affiliated with the Terminal Paleo-Indian/Archaic (10,000 to 500 B.P.) (Drager and Ireland 1986; Thomas 1981). The Humboldt Concave Base is a fine-grained, homogenous cream and tan quartzite. There is a small trace of a pearlescent sheen. The point is placed within Drager and Ireland's (1986) Humboldt Series spanning a time frame of 5,000 to 3,000 B.P., while Thomas (1981) suggests the Humboldt Series extends as late as 1250 B.P. The Desert Side-notched point is a translucent, partially cloudy, white and cream siliceous material resembling that of chalcedony. Drager and Ireland (1986) depict the Desert Side-notched point within the Desert Complex ranging from 4,000 to 250 B.P., although Thomas (1981) assigns this type to post 650 B.P.

The proximal end of an unusually large corner-notched fragment (Catalog No. 1341-01) exhibits uniformly serrated edges and a random flaking pattern. The material is a fine-grained, pinkish-tan, cloudy, mottled chert that is partially translucent, particularly along its edges. The material has tan to dark brown inclusions from 2 to 4 mm in size. Its form most closely resembles that of an Elko Corner-notched point as it has a straight base with a basal width greater than 10 mm (15.4 mm); however, it's large size and lack of complete dimensions prevents a type assignment.

Obsidian Studies

Two obsidian flake samples were sent to the Northwest Research Obsidian Laboratory in Corvallis, Oregon for XRF trace element analysis, source identification and hydration measurements. Specimen number 5 is a complex interior flake (Catalog No. 1341-06) collected on the site's surface; the other, Specimen number 6, is a biface thinning flake (Catalog No.1341-11) from the surface of Unit 2. Both were sourced to Wild Horse Canyon in southwestern Utah in the Mineral Mountain Range, some 215 miles southwest of the project area. Wild Horse Canyon is one of the more common obsidian sources accessed prehistorically in Utah (Craig E. Skinner 2008, pers. comm.). However, it is interesting that obsidian from such a southern source is found in the Uinta Mountains. Obsidian sourced from 42DC1344 at Kidney Lake also contained obsidian from southwestern, Utah, but from the Pumice Hole Mine source that is also in the Mineral Mountain Range.

Both specimens yielded hydration measurements of 3.3 microns. Data published from the Kern River 2003 Expansion Project (SWCA 2005) provides a refined hydration chronology for obsidian from Wild Horse Canyon, Black Rock Area, and Panaca Summit/Modena sources in Utah. Roughly 2,000 obsidian projectile points and debitage from site surfaces and those excavated from well-dated contexts were used for the Kern River study. The refined chronology for the Wild Horse Canyon obsidian source was applied to the two Wild Horse Canyon obsidian specimens recovered from 42Dc1341 (Table 6) with measurements corresponding to the Late Prehistoric/Formative period.

Table 6. Summary of Obsidian Studies at 42DC1341

Specimen Number (Accession Number)	Catalog Number	Source	Hydration Rim Measurements	Defined Period
5 (2008-101)	1341-06	Wild Horse Canyon	3.3 $\pm$ 0.1	Late Prehistoric/Formative (SWCA 2005)
6 (2008-101)	1341-11	Wild Horse Canyon	3.3 $\pm$ 0.1	Late Prehistoric/Formative (SWCA 2005)

Site Summary

Site 42Dc1341 is a small low-to-moderate density lithic scatter. Debitage makes up the bulk of the assemblage (94%), with indeterminate flakes comprising over half (59%) of the debitage. A total of 25% of diagnostic flakes were broken. Biface manufacture/ retouch dominates the debitage assemblage at 62% with core reduction at 38%. These data support the assemblage constituents including three projectile points and a point fragment, two bifaces, and a single flake tool (edge-modified), which implies a hunting-related pattern. CCS dominates the assemblage at 60% followed by obsidian and quartzite, respectively.

Two samples of obsidian collected from the site's surface have rim measurements of 3.3 microns, which implies a Late Prehistoric/Formative presence. Also collected from the site's surface are an Elko Side-notched (10,000 to 500 BP), a Humboldt Concave Base (6,000 to 3,000 BP), and a Desert Side-notched (Post- A.D. 1300). These data suggest the site is somewhat deflated and in poor to fair condition, lacking any reliable control for time as multiple components, including an Archaic component and a Late Prehistoric component (possibly containing both a Formative and Numic presence), are located on the sites surface.

However, it should also be argued that the site contains some level of integrity due to the presence of substantial rodent disturbance, which indicates some level of soil stability and possible intact cultural deposits.

Site 42DC1342

Site 42DC1342 is a small low-density lithic scatter on [redacted] Island Lake at 10,250 feet amsl. [redacted] The original site record (Weymouth and Christensen 2001), indicate approximately 100 to 150 flakes were found. All stages of reduction were identified including secondary (80%), primary (15%), and tertiary flakes (5%). Cryptocrystaline silicates dominate the assemblage including chalcedony; white chert/chalcedony; and grey, yellow, and pink/white chert. Grey quartzite and olive-tan mudstone was also noted, but in lesser quantities. Two bifaces, two cores, a unifacial tool, and a single projectile point fragment were also

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Figure 13. 42DC1342 Site map with unit locations

identified. None of these tools were found to be diagnostic of any particular period or tool type (Weymouth and Christensen 2001). The previous recorders indicated the site to be in good condition, but evidenced impacts from exposure to winds, lake inundation and drawdown, and wave action.

Excavation Results

A total of 59 artifacts were recovered from the three units (Units 1, 2, and 3). Each unit was excavated to sterile soils, typically between the 5 to 10 cm levels. The exception to this is Unit 2, where sterile soils were encountered at the 10 to 15 cm level. No features were encountered and no special studies were undertaken for this site, except for the botanical identification of a single seed recovered from Unit 2.

Stratigraphy

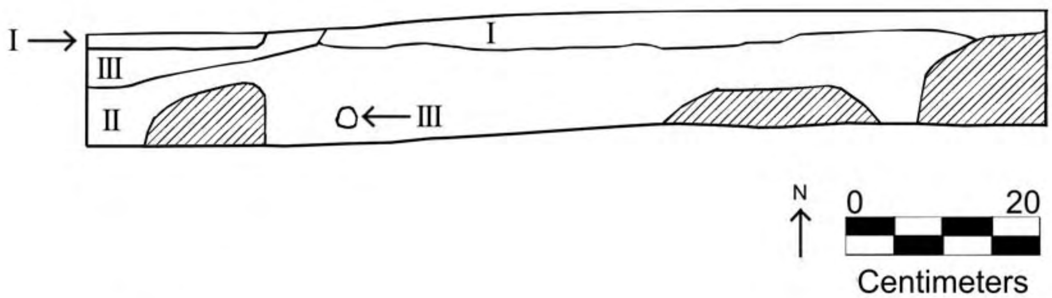
Cultural deposits at site 42DC1342 are shallow, extending down to a maximum depth of 10 cm below the modern ground surface. General site surface soils are characterized as somewhat mottled light brown to pinkish-brown silts containing moderate amounts of rounded to angular gravels and small to large angular cobbles of quartzite. Small bunch grasses are noted along the shoreline along with substantial lake debris.

In general, soils are consistent with those of 42DC1340 and 42Dc1341. Site soils ranging from 0 to 3 cm below the modern ground surface comprise a layer of very fine-grained pinkish-brown silty lacustrine sediments containing site constituents, pockets of small flecks and stains of charcoal, angular gravels, and small roots. Below this stratum, from roughly the 5 to 10 cm levels is an eroded forest subsoil of fine-grained reddish-brown silts, possibly representing A/B or B Horizon soils. This stratum reflects a slight decrease in charcoal and a 50% or more increase in gravels and large, angular cobbles. Rodent disturbance is also present, evidenced by significant mottling of soils. The unconformity between these two strata likely represents multiple erosional episodes resulting from reservoir drawdown and inundation. Below this is a medium to coarse-grained reddish-pink sandy substrate likely derived from the pre-Cambrian Uinta quartzite formation (Figure 14).

Unit 1 soils appear to be slightly more complex than those of Unit 2 and 3, with pockets of the reddish-pink sandy substrate from 3 to 8 cm. Soils from Units 2 and 3 are similar in profile, with the reddish-pink sandy substrate below the eroded forest subsoils. Substrate soils begin at 10 cm below the surface in Unit 2 and at 8 cm below the surface in Unit 3. However, unlike Units 1 and 3, Unit 2 is without large angular cobbles from the 5 to 15 cm level.

Cultural Materials

A total of 59 artifacts were recovered from 42DC1342 including debitage (n=56), which comprises 95% of the assemblage, a single CCS biface fragment, and two indeterminate projectile point fragments made of quartzite. Cryptocrystalline silicate is the preferred raw material type (n=40; 68%), followed by quartzite (n=18; 31%), and obsidian comprising only 2% (n=1) of the assemblage.



Stratigraphy

I Very fine-grained, pinkish-brown, silty lacustrine sediments containing roots and pockets of small flecks and stains of charcoal and redeposited site constituents. Angular gravels are throughout the matrix.

II Fine-grained reddish-brown clayey-silts. Soils depict a slight decrease in charcoal and 50% increase in angular gravels and cobbles. Rodent disturbance is evident by mottling of soils.

III Medium to coarse-grained reddish-pink sandy substrate.

▧ Rock

Figure 14. 42DC1342 Unit 1 north wall stratigraphic profile

Unit 1 yielded 15 artifacts including one indeterminate projectile point fragment and two pieces of debitage on the surface of the site, with the remaining debitage and indeterminate projectile point fragment from the 0 to 5 cm level. Sterile soils were encountered from 5 to 10 cm. Unit 2 was the most productive with 24 flakes recovered, the majority of which were found within the 0 to 5 cm level. Artifact counts decrease 57% from the 5 to 10 cm level to the 10 to 15 cm level where sterile soils were encountered. Twenty artifacts were produced from Unit 3, with most of these found in the 0 to 5 cm level including a biface fragment. Sterile soils were reached at the 5 to 10 cm level.

The data in Table 7 indicate non-diagnostic flakes comprise more than half of the assemblage (58%) with most of these being indeterminate flakes. In terms of diagnostic flake types, biface thinning flakes occur most frequently (32%) with primary and secondary decortication flakes occurring the least. A total of 9 (16%) diagnostic flake types were broken, but exhibit distinct flake attributes, which allowed for classification. When comparing core reduction and biface manufacture/retouch, these data suggest biface thinning and pressure flake types make up over half of the assemblage at 55%, while the remaining 45% are core reduction (Figure 15).

Table 7. Summary of Flake Types at 42DC1342

Primary Decortication	Secondary Decortication	Simple Interior	Complex Interior	Biface Thinning	Pressure	Shatter	Indeterminate
N=2; 4%	N=1; 2%	N=4; 7%	N=3; 5%	N=7; 13%	N=5; 9%	N=3; 5%	N=31; 55%

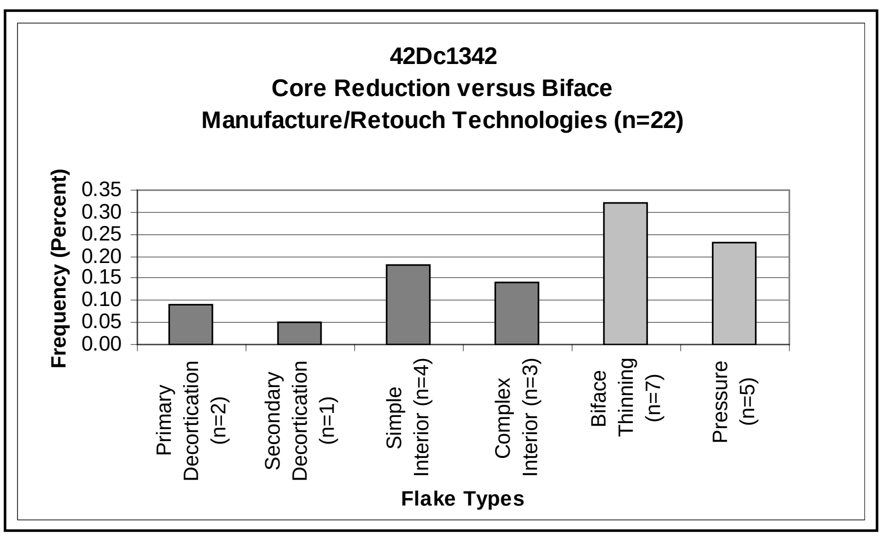


Figure 15. Core Reduction versus Biface Manufacture/Retouch at 42DC1342.

Data from the size sorting analysis indicate flakes within the 5.1 and 10 mm category (n=10; 43%) are most abundant, followed by the 10.1 and 20 mm size category (n=10; 17%); 30.1-40 mm (n=3; 13%); 0-5.0 mm (n=2; 9%); 20.1-30 mm (n=2; 9%); and 40.1-50 mm (n=2; 9%) (Figure 16). These data reflect the results of the debitage morphological analysis with small flakes dominating the assemblage. These numbers represent biface tool manufacture and retouch flakes with smaller quantities of very late stage core reduction.

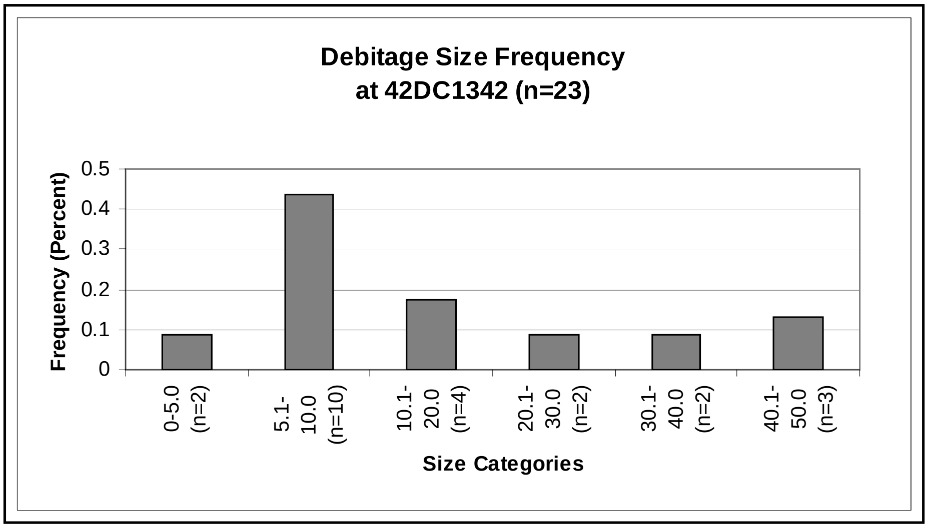


Figure 16. Debitage Size Frequency at 42DC1342.

The single biface fragment (Catalog No. 1342-13) recovered from Unit 3 in the 0-5 cm level, is a fine-grained cream, opaque chert, with pink to orange colored banding. Numerous small gray and tan inclusions range in size from 1 to 4 mm. Both indeterminate projectile point fragments are of quartzite and are less than 2 cm in length and width. One (Catalog No. 1342-01) is a tip fragment of light pinkish-buff to reddish-pink, fine-grained quartzite. The material has a slight pearlescent sheen on its surface. The other is a projectile point mid-section (Catalog No. 1342-03). The material is a fine-grained gray to tan quartzite, with a single, slightly more crystalline, dark gray band running through it. Small gray and brown inclusions range in size from less than 1 to 4 mm.

Botanical Identification

A single seed (Sample 4) from site 42DC1342 was submitted to the Paleo Research Institute for analysis. The seed was extracted from the 5 to 10 cm level of Unit 2, which was noted to have upwards of 22 seed casings. The seed is unburned and was positively identified as *Pseudotsuga*, or Douglas fir (Cummings et al. 2008) (see Appendix C).

Site Summary

Site 42DC1342 is a small low-density lithic scatter with debitage comprising 95% of the assemblage. Indeterminate flakes comprise the bulk of debitage (55%) and roughly 16% of diagnostic flakes are broken. While all flake types are present at the site, data indicate biface manufacture/retouch slightly dominates the assemblage at 55% with core reduction at 45%. These data are somewhat consistent with assemblage constituents, which include projectile points and a single biface fragment. However, utilized flakes or expedient flake tools are absent from the assemblage. Overall, these data are suggestive of a hunting-related pattern. CCS comprises the majority of the raw material (68%) with quartzite at 31% and a small amount of obsidian. The site lacks chronological data to place the site within a particular time period. Both projectile points were too fragmented to assign typologies.

In sum, site soils appear disturbed by erosion due to lake drawdown, inundation, and longshore drift. This fact, combined with the small amount of materials recovered and the presence of very shallow cultural deposits, suggests that the site is highly disturbed with soils minimally intact. Because of its geomorphic location, it is likely that materials from elsewhere along the lakeshore have been redeposited at this site.

Site 42DC1344

A small densely concentrated obsidian lithic scatter, site 42DC1344, lies on [redacted] Kidney Lake at an elevation of 10,270 feet amsl. [redacted] Site documentation in 2001 (Weymouth and Christensen 2001) noted approximately 200 to 250 black translucent and semi-transparent obsidian flakes. Most stages of lithic reduction were identified including tertiary flakes (65%), secondary (25%), and shatter debris (10%). Primary decortication represent less than one percent of the assemblage. Weymouth and Christensen (2001) suggest secondary retouch and bifacial thinning with sizes averaging less than 0.5 cm in length and ranging between 0.02 and 0.08 cm in thickness generated most of the tertiary flakes. No diagnostic artifacts or features were identified, although one secondary obsidian flake was collected for sourcing and hydration analysis. Weymouth and Christensen (2001) reported the site to be in good condition, although they list ongoing impacts from exposure to winds, lake inundation, drawdown, and wave action.

<u>Excavation Results</u>

A single unit (Unit 1) was excavated in an area containing the densest artifact concentration, which produced 21 artifacts (Figure 17). The unit was excavated to sterile soils encountered at the 5 to 10 cm level. A total of seven obsidian samples were selected for obsidian studies. No features were encountered during excavations.

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Figure 17. 42DC1344 Site map with unit location

Stratigraphy

Unit 1 soils are poorly developed and exceedingly shallow. Cultural deposits extend to a maximum depth of 5 cm. Soils appear homogenous through out the unit and are light-brown to pinkish-brown sandy silts containing obsidian debitage, large numbers of rounded to angular pebbles and gravels, and small to large angular cobbles of quartzite. The picture below (Figure 18) is an overview of the site that illustrates the extent of erosion at the site along the exposed, rocky truncated shoreline. Such truncated and deflated shorelines are typical in reservoir settings.

Figure 18. 42DC1344 Site Overview with Truncated Shoreline.

Cultural Materials

Twenty-one artifacts were recovered from 42DC1344, all of which are debitage. The most abundant raw material at this site is obsidian (n=19; 90%), with only 2 quartzite flakes identified (10%). Two obsidian flakes were collected from the general site surface. A total of nine flakes were collected on the surface of Unit 1, one of which was quartzite. The remaining artifacts (n=9) were recovered from the 0 to 5 cm level. Sterile soils were reached at the 5 to 10 cm level.

The data below (Table 8) show that non-diagnostic indeterminate flakes comprise only 33% of the assemblage. Four diagnostic flake types are represented, with biface thinning flakes comprising more than half (79%) of these. Cortication flakes and shatter are absent from the assemblage. A total of four (19%) diagnostic flakes were broken. Comparing core reduction versus biface manufacture/retouch, biface thinning/retouch flakes comprise 86%, while core reduction accounts for 14% of the sample (Figure 19).

Table 8. Summary of Flakes Types at 42DC1344.							
Primary Decortication	**Secondary Decortication**	**Simple Interior**	**Complex Interior**	**Biface Thinning**	**Pressure**	**Shatter**	**Indeterminate**
-	-	N=1; 5%	N=1; 5%	N=11; 52%	N=1; 5%	-	N=31;33%

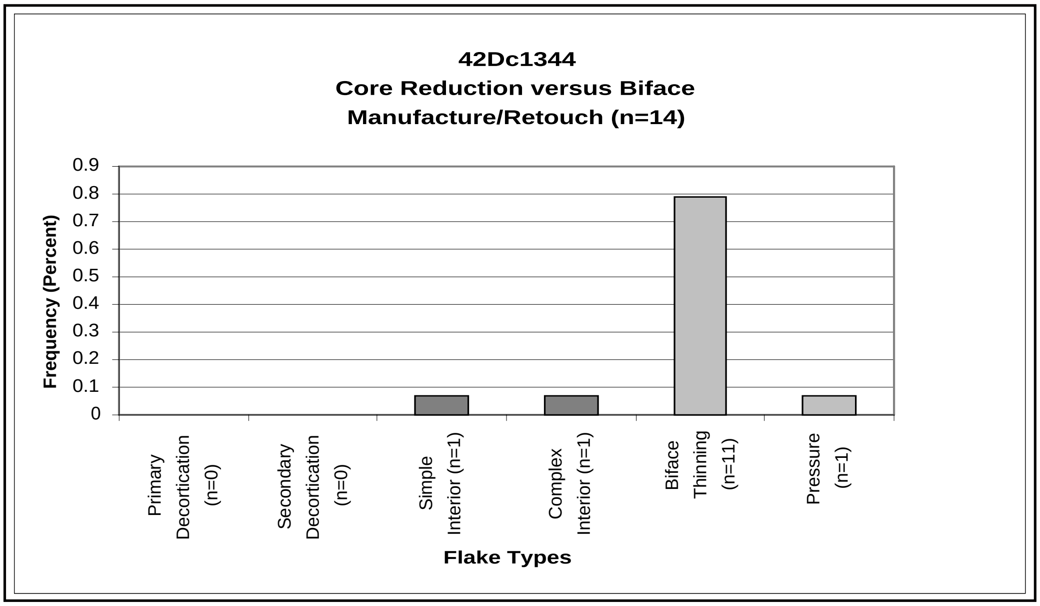

Figure 19. Core Reduction versus Biface Thinning/Retouch at 42DC1344.

Size sorting analysis indicates the most prominent flake size is the 10.1 and 20 mm category (n=8; 57%), followed by the 20.1 and 30 mm size category (n=4; 29%), 0 to5 mm (n=1; 7%), and 5.1 to 10 mm (n=1; 7%). No flakes measured within the 30.1-40 mm and 40.1-50 mm categories (Figure 20). Size sorting analysis clearly supports the results of the debitage morphological analysis with small flakes (biface thinning and pressure) dominating the assemblage. These numbers represent biface tool manufacture and retouch, with smaller quantities of very late stage core reduction.

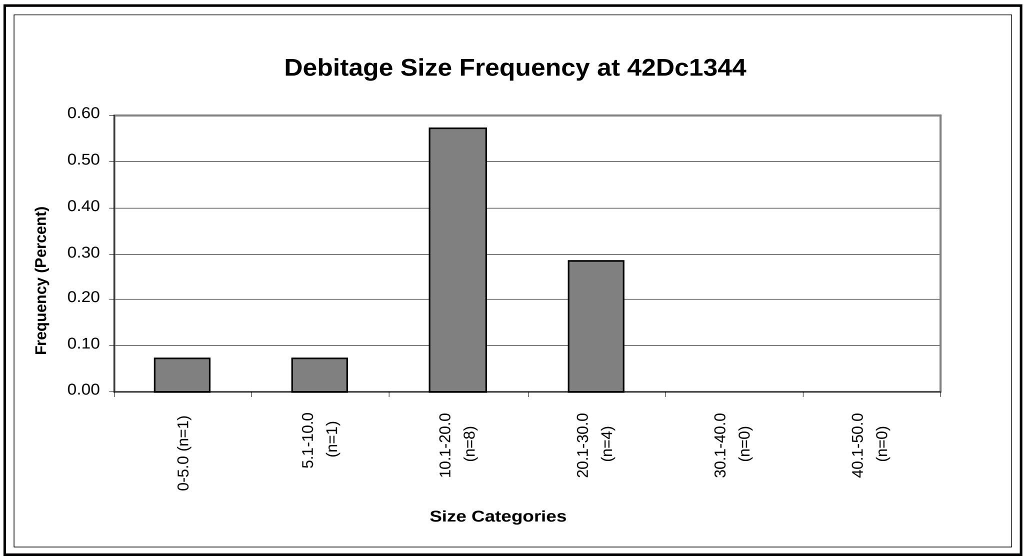

Figure 20. Debitage Size Frequency at 42DC1344.

Obsidian Studies

Seven obsidian flake specimens were sent to the Northwest Research Obsidian Laboratory for XRF trace element analysis, source identification, and hydration measurements (see Appendix D). Three samples were assigned specimen numbers *Sample #1, 2,* and *3* and four flakes were assigned specimen numbers 1-4 (Table 9). The samples and flakes were prepared and analyzed under accession number 2008-101 (Skinner and Thatcher 2008).

Table 9. Summary of Obsidian Studies at 42DC1344

Specimen Number	Catalog Number	Source	Hydration Rim Measurements	Defined Period
1	1344-02	Pumice Hole Mine	1.5 ± 0.1 microns	Confidently Late Prehistoric
2	1344-02	Pumice Hole Mine	1.3 ± 0.0 microns	Confidently Late Prehistoric
3	1344-03	Pumice Hole Mine	1.5 ± 0.1 microns	Confidently Late Prehistoric
4	1344-03	Pumice Hole Mine	1.3 ± 0.0 microns	Confidently Late Prehistoric
Sample #1	1344-05	Pumice Hole Mine	1.5 ± 0.1 microns	Confidently Late Prehistoric
Sample #2	1344-06	Pumice Hole Mine	1.8 ± 0.1 microns	Confidently Late Prehistoric Late Prehistoric/Formative
Sample #3	1344-07	Pumice Hole Mine	1.9 ± 0.1 microns	Confidently Late Prehistoric Late Prehistoric/Formative

All specimens were sourced to Pumice Hole Mine, a smaller obsidian source found in the Mineral Mountain Range in southwestern Utah some 215 miles southwest of the project area. Of particular note, is the location of Pumice Hole Mine roughly 3 miles northwest of the larger, more commonly accessed Wild Horse Canyon source (Craig E. Skinner 2008, pers. comm.).

Unfortunately, a refined obsidian chronology for Pumice Hole Mine has not been established. However, by using refined temporal sequences of other obsidian sources in the area as proxies for the Pumice Hole Mine source, the two samples with measurements of 1.3 microns and the three samples with measurements of 1.5 microns can be confidently placed within the Late Prehistoric period. At the very least, the single sample of 1.8 and one sample of 1.9 microns corresponds to the Late Prehistoric period; however, it is possible that these two specimens may be from the Late Prehistoric/Formative period.

Site Summary

Site 42DC1344 is a small moderate-density debitage scatter comprised primarily of obsidian flakes (90%). Indeterminate flakes comprise 33% of the assemblage. Roughly 19% of diagnostic flakes are broken. Debitage analysis results indicate biface manufacture/retouch strongly dominates the assemblage at 86% with core reduction at 14%. Most of the material was collected from the surface with only nine flakes found from the 0 to 5 cm level. Seven obsidian samples, all from the site's surface, had hydration rim measurements that fell within the Late Prehistoric period. In all, these data imply a Late Prehistoric hunting-related pattern.

[redacted]
Soils are disturbed by erosion due to lake drawdown, inundation and longshore drift. The presence of very shallow cultural deposits, combined with a paucity of materials recovered and the site's location [redacted] suggests the site is in a highly disturbed context with intact soils unlikely. Numerous cobbles embedded along the shoreline act to trap materials that are transported through longshore drift. That said, it is probable that materials from this site have been redeposited, possibly comprised entirely of secondary deposits.

Swift Creek Basin

Data recovery excavations were conducted at two sites, 42DC1411 and 42DC1412, located along [redacted] East Timothy Lake within the Swift Creek Basin of the Yellowstone River Drainage. The following describes the results of data recovery efforts (Figure 3).

Site 42DC1411

Site 42DC1411 is a medium-density prehistoric lithic scatter situated on [redacted] East Timothy Lake. [redacted] Weymouth and Chynoweth Pagano (2002) originally recorded the site as containing one unifacial tool and lithics representing all three stages of manufacturing. The majority of the flakes represent tertiary stage production at 90% with some shatter present. Chert, chalcedony, ignimbrite, quartzite, and other cryptocrystalline silicate material types were noted. Weymouth and Chynoweth Pagano (2002) also indicated the site to be in good condition, although they list a number of ongoing impacts including heavy wave erosion with cultural constituents spread downslope from their original location, considerable size sorting of material, such as the larger flakes being limited to the upslope areas on the site and smaller, lighter flakes being distributed outward.

Excavation Results

Two units (Unit 1 and 2) were excavated producing 25 artifacts (Figure 21). The units were placed in areas containing the highest density of artifacts. Both units encountered sterile soils at the 5 to 10 cm level. No features were found during excavations.

Stratigraphy

Cultural deposits at site 42DC1411 are very shallow, extending down to a maximum depth of 5 cm below the modern ground surface. General site surface soils are characterized as slightly mottled light-brown to pinkish-brown silty sands containing large amounts of sub-rounded to angular pebbles, gravels and cobbles of quartzite. Large slabs and boulders of quartzite are scattered through out the shoreline. Some lake debris (downed trees) and small amounts of bunch grass are noted along the shoreline.

In general, site soils ranging from 0 to 2 cm below the modern ground surface comprise a very thin layer of fine-grained light pinkish-brown sandy-silt lacustrine sediments containing redeposited site constituents, small flecks of charcoal, and angular gravels. Below this stratum, from roughly 2 to 5 cm is an eroded forest subsoil of pinkish-brown fine to medium-grained clayey-sandy silts possibly representing A/B or B Horizon soils. This stratum also contains flecks and chunks of charcoal with increased amounts of gravels and large angular cobbles. Rodent disturbance is also present, evidenced by significant mottling of soils. The contact between the two strata is an unconformity, which likely represents multiple erosional episodes resulting from reservoir drawdown and inundation. Below this is a sterile medium to coarse-grained pink to reddish-brown sandy substrate likely derived from the pre-Cambrian Uinta quartzite formation (Figure 22). This layer is mottled with pockets of dark brownish-gray sandy-silt.

Cultural Materials

Of the total number of artifacts (n=25) recovered from the site, most were debitage (n=23) comprising 92% of the assemblage. The remaining artifacts include a single biface fragment, which was collected from the general site surface, and one flake tool (edge-modified flake) recovered from the 0 to 5 cm level of Unit 1. Unit 1 was the most productive unit yielding 17 of the 23 total artifacts recovered at the site, with most artifacts found within the 0 to 5 cm level (n=13) and dropping off completely by the sterile 5 to 10 cm level. Unit 2 produced 7 flakes, two of which were collected from the surface and the rest from the 0 to 5 cm level. Unit 2 also encountered sterile soils from the 5 to 10 cm level. The majority of the assemblage is of CCS (78%) with quartzite (22%) comprising the rest.

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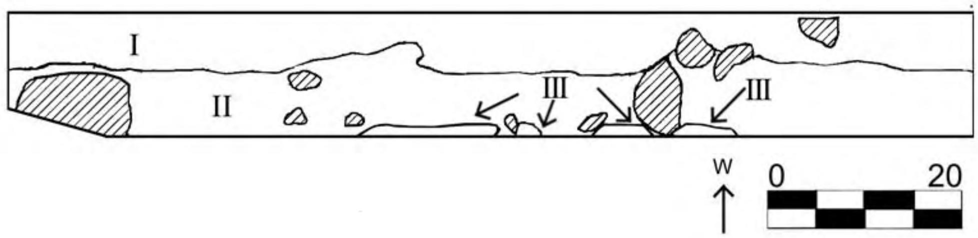
Figure 21. 42DC1411 Site map with unit locations.



Stratigraphy

I Fine-grained, light pinkish-brown sandy-silt lacustrine sediments containing redeposited site constituents, small flecks of charcoal, and angular gravels.

II Fine to medium-grained pinkish-brown clayey sandy-silt containing flecks and small chunks of charcoal and increased amounts of angular gravels and cobbles.

III Medium to coarse-grained pink to reddish-brown sandy substrate mottled with pockets of dark, brownish-gray sandy silt.

Figure 22. 42DC1411 Unit 2 north wall stratigraphic profile

Data represented in Table 10 show non-diagnostic flakes make up over half of the debitage assemblage (52%), most of which are indeterminate flakes (48%). Four diagnostic flakes types are represented, with both primary decortication and pressure flakes absent from the assemblage. Biface thinning flakes comprise 30% of the entire assemblage and more than half of the diagnostic flake types (64%). A total of three (13%) diagnostic flakes were broken. When comparing biface manufacture/retouch with core reduction, biface thinning flakes dominate (n=7; 64%) with core reduction accounting for 36% (Figure 23).

Table. 10. Summary of Flake Types at 42DC1411

Primary Decortication	Secondary Decortication	Simple Interior	Complex Interior	Biface Thinning	Pressure	Shatter	Indeterminate
-	N=1; 4%	N=2; 9%	N=1; 4%	N=7; 30%	-	N=1; 4%	N=11;48%

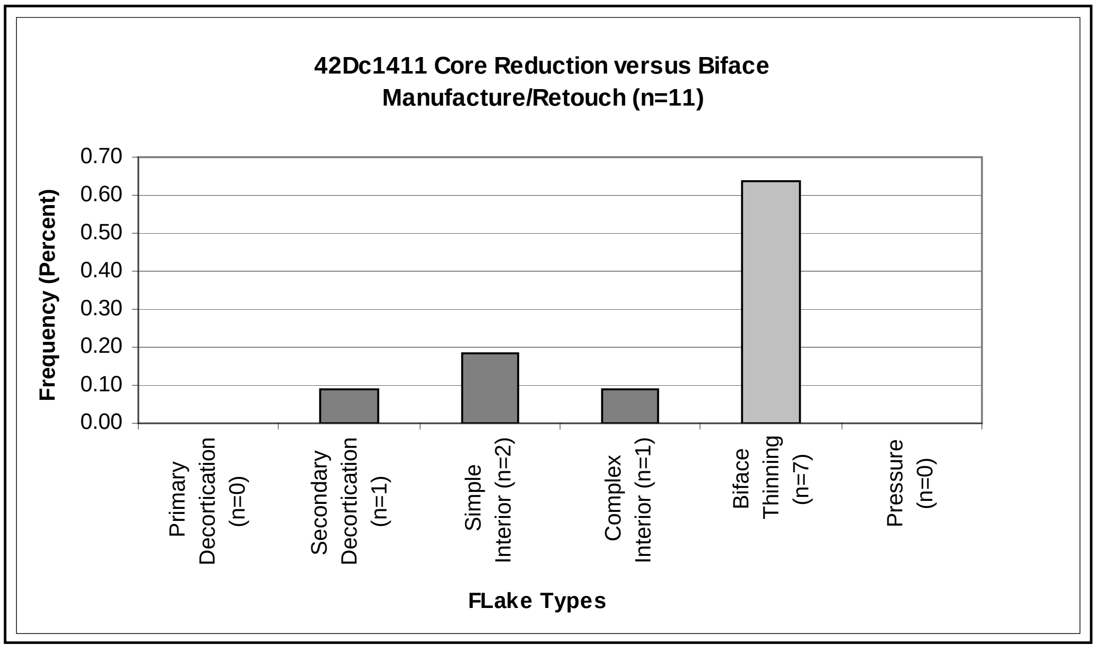


Figure 23. Core Reduction versus Biface Manufacture/Retouch at 42Dc1411.

Size sorting analysis of the debitage assemblage depicts most flakes are within the 5.1 and 10 mm category (n=6; 50%), followed by the 10.1 and 20 mm size category (n=3; 25%), 20.1 to30 mm (n=2; 17%), and 0 to 5 mm (n=1; 8%). No flakes measured within the 30.1-40 mm and 40.1-50 mm categories (Figure 24). These data clearly support the debitage morphological analysis results with small flakes (biface thinning and complex interior) dominating the assemblage. These numbers represent biface tool manufacture and retouch, with smaller quantities of very late stage core reduction.

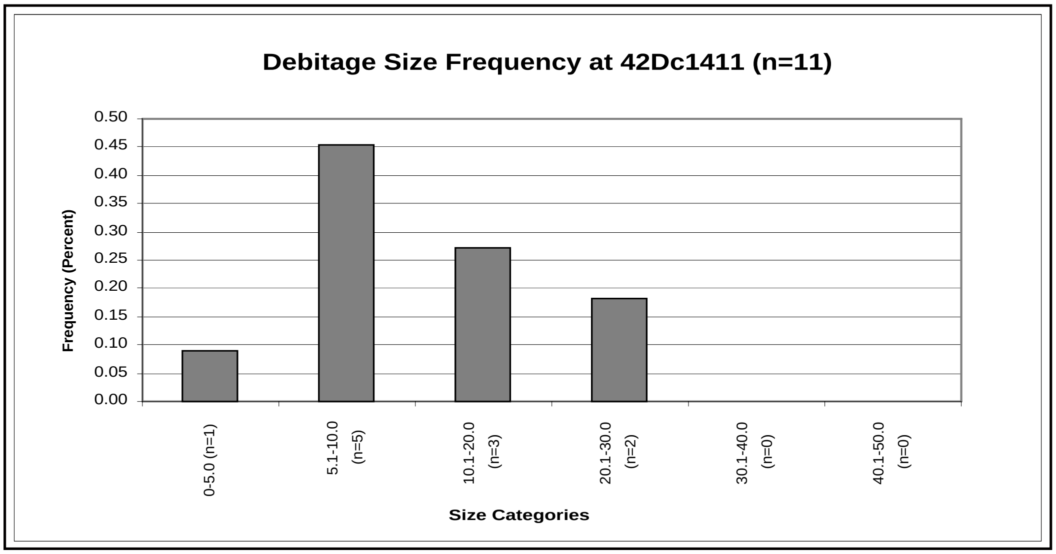


Figure 24. Debitage Size Frequency at 42DC1411.

The edge-modified flake (Catalog No. 1411-03) recovered from 0-5 cm level in Unit 1 is a fine- to medium-grained opaque cream chert, with tan and gray inclusions measuring 1 to 6 mm in size. The material has a dull luster and appears to have been heat-treated, although no potlidding, discoloration, or crazing is visible. The single, early stage, biface fragment (Catalog No. 1411-01) recovered from the site's surface is a fine to medium-rained, light to dark gray quartzite.

<u>Site Summary</u>

Site 42DC1411 is a small moderate-density lithic scatter. Debitage comprises 92% of the assemblage. A total of 48% of debitage are indeterminate, and roughly 13% of diagnostic flakes are broken. While the sample is small (n=11), debitage analysis data indicate biface manufacture/retouch dominates the assemblage at 64% and core reduction at 36%. Other assemblage constituents include a single biface fragment and one expedient flake tool (edge-modified). Taken together, these data imply a hunting-related pattern. No diagnostic artifacts or features were recovered; therefore no temporal distinctions can be made.

While the site is comprised of dense, clayey, sandy silts, which are less likely to erode as fast as other, less cohesive soils, the site soils are highly disturbed by erosion due to lake drawdown, inundation, and longshore drift. The presence of very shallow cultural deposits, combined with small amounts of materials recovered (n= 25) and the site's location [redacted] suggests it is highly disturbed with intact soils unlikely. The numerous cobbles embedded along the shoreline also act to trap materials that are transported from elsewhere along the shore through wave energy, adding to an already mixed deposit.

Site 42DC1412

Site 42DC1412 is a moderate-to-high density lithic scatter at 11,000 feet amsl on the [redacted] shore of East Timothy Lake. The site, [redacted] is on

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Figure 25. 42DC1412 Site map with unit locations.

a beach filled with large cobbles and gravels forming natural eddies in which flakes are gathered below the high water mark. [redacted] The original site recorders (Weymouth and Chynoweth Pagano 2002) estimated roughly 100 flakes in a centralized concentration. The assemblage is noted to be limited to secondary (10%) and tertiary flakes (90%). Three projectile point fragments were identified, two of which are considered to be diagnostic and closely related in form to projectile points identified with the Black Rock-Humboldt Series (5000 to 3000 B.P.) as defined for the Great Basin Culture Area (Drager and Ireland 1983:593). Weymouth and Chynoweth Pagano (2002) note that impacts to the site, such as size sorting of flakes, are a result of erosion from seasonal lake inundation, drawdown, and wave action.

Excavation Results

A total of 360 artifacts were recovered from two units (Units 1and 2) (Figure 25). Unit 1 was excavated in the densest artifact concentration, and in the area thought to most likely contain undisturbed deposits. In Unit 1, Level 1 consists of loose soils from 0 to 4 centimeters below datum (cmbd). Level 2 extends from 4 to 8 cmbd and sterile soils were encountered in level 3 from 8 to 14 cmbd. In Unit 2, loose soils from 0 to 4 cmbd comprise Level 1. Level 2 contains sterile soils from 4 to 10 cmbd. No features were encountered. Special studies were undertaken for three samples taken from Unit 1 including two samples for pollen/phytolith analysis, macrofloral, and organic residue of a charcoal stained soil sample taken directly beneath a Humboldt Concave Base projectile point. Organic residue analysis was also conducted for three groundstone fragments collected from the surface of Unit 1.

Stratigraphy

Cultural deposits at site 42DC1412 are shallow, extending down to a maximum depth of 8 cm below the modern ground surface. General site surface soils are characterized as slightly light-brown to pinkish-brown sandy silts containing large amounts of sub-rounded to angular pebbles, gravels, and cobbles of medium to course-grained quartzite. Large slabs and boulders of quartzite are scattered through out the shoreline. Some lake debris (downed trees and limbs) and small amounts of bunch grass are noted along the shoreline.

Site soils ranging from 0 to 4 cm below the modern ground surface are loose fine-grained sandy-silt lacustrine sediments, which are mottled tan to pinkish- brown sandy silts containing redeposited site constituents. These soils are comprised of small sub-rounded to angular gravels and cobbles. Cobbles range from fist-sized to larger rocks up to 25 cm in diameter. Soils from 4 to 10 cm are characterized as more compact, reddish-brown, slightly more clayey, sandy silts, with charcoal flecks and larger charcoal inclusions. These soils are mottled with pockets of dark brownish-gray sandy-silts and pink sands and contain high amounts of sub-rounded to angular gravels and cobbles. Cobbles range from fist-sized to larger rocks up to 35 cm in diameter.

These cap a sterile, reddish-pink sandy substrate likely derived from the pre-Cambrian Uinta quartzite formation (Figure 26).

Unit 1 has a slightly different soil column than that of Unit 2. In Unit 1, between 4 and 8 cm, is a darker reddish- brown clayey sandy silt layer containing site constituents with charcoal flecks and larger charcoal inclusions. Whereas, in Unit 2 sterile soils were encountered at the 4 to 10 cm level and appeared much more red in color than those in Unit 1 at that level, which encountered sterile soils from 8 to 14 cm.

Cultural Materials

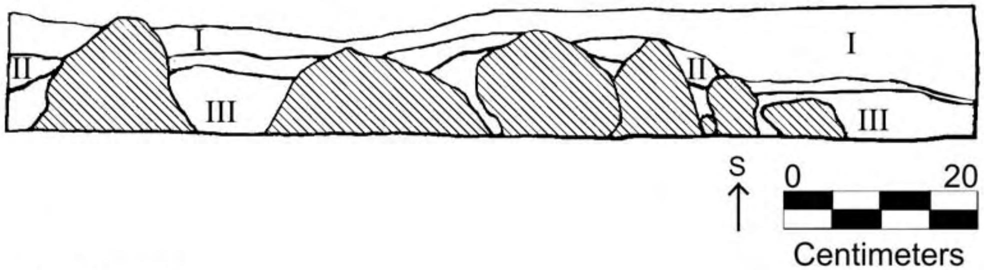
Artifacts recovered include 350 flakes, 5 projectile points (two Humboldt Concave Base, one Humboldt Series and two indeterminate fragments), a single CCS biface fragment, a quartzite flake tool (Edge-modified flake), and 3 groundstone fragments. Interestingly, all formed tools were collected from the site's surface, with the exception of the two articulating pieces forming a Humboldt Concave Base projectile points recovered at 4 cmbd from Unit 1 (Table 11). Cryptocrystalline silicate is clearly the preferred material type at this site as it comprises 94% of the assemblage with quartzite accounting for only 6%.

Table 11. 42DC1412 Artifact Summary Per Unit and Level

Unit Number	Level (cmbd-SW corner of unit)	Debitage Count	Flake Tool Count	Biface Count	Projectile Point Count	Groundstone Count	Total Artifact Count
1	Surface	10	-	-	2 (Indeter-minate fragments)	3 (slab fragments)	15
1	0-4 cmbd	214	-	-	2 (Humboldt Concave Base)	-	216
1	4-8 cmbd	53	-	-	-	-	53
1	8-14 cmbd	-	-	-	-	-	0 (Sterile)
2	Surface	9	-	1 (fragment)	1 (Humboldt Series)	-	11
2	0-4 cmbd	64	1 (Edge-modified)	-	-	-	65
2	4-10 cmbd	-	-	-	-	-	0 (Sterile)
Total Artifact Count		**350**	**1**	**1**	**5**	**3**	**360**

The data in Table 11 show Unit 1 contained the highest number of artifacts (n=284), but also the most artifact diversity. The 0 to 4 cm level yielded 216 artifacts, the majority of which was debitage (n=214). Artifact counts decrease significantly (75%) from the 0 to 4 cm and 4 to 8 cm levels. Unit 2 produced 76 artifacts with the majority (n=65) in the 0 to 4 cm level. Sterile soils were reached at the 4 to 10 cm level.

Debitage (n=350) is by far the most abundant artifact type comprising 97% of the assemblage. Data represented in Table 12 depict non-diagnostic flakes accounting for well over half of the debitage assemblage (78%) with indeterminate flakes comprising the majority at 75%. Biface thinning flakes are the second highest occurring flake type (n=32; 9%). Most diagnostic flake types are represented, with the exception of primary decortication flakes. Broken



Stratigraphy

I Loose, fine-grained mottled pinkish-brown sandy-silts. This stratum contains large amounts of sub-rounded to angular gravels and cobbles. Cobbles range in size from 10 to 25 cm in diameter.

II Slightly more compact, reddish-brown clayey, sandy silts with charcoal flecks and larger charcoal inclussions. These soils are mottled with pockets of dark brownish-gray sandy silts and pink sands.

III Medium to coarse reddish-pink sandy substrate.

Figure 26. 42DC1412 Unit 1 south wall stratigraphic profile.

diagnostic flakes account for 7% (n=24) and 12% (n=41) exhibit signs of heat treatment. In terms of diagnostic flakes, nearly half are biface thinning (44%). When combined with pressure flakes (n=15; 21%), biface manufacture tool/retouch comprises 64% of flakes recovered and 36% represent core reduction (Figure 27).

Table 12. Summary of Flake Types at 42DC1412

Primary Decortication	Secondary Decortication	Simple Interior	Complex Interior	Biface Thinning	Pressure	Shatter	Indeterminate
-	N=2; 1%	N=13; 4%	N=11; 3%	N=32; 9%	N=15; 4%	N=10; 3%	N=261; 75%

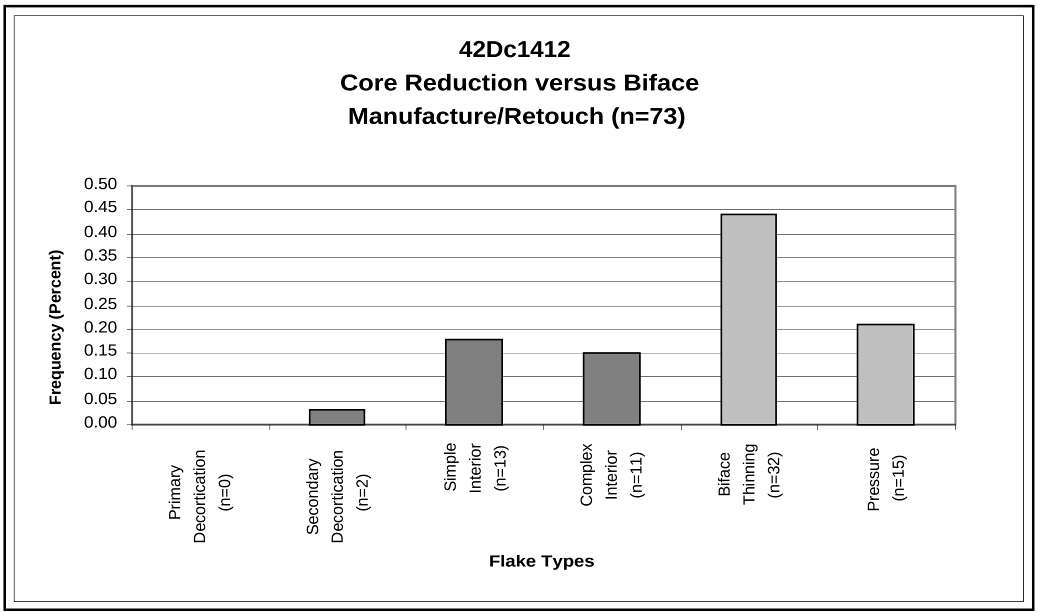


Figure 27. Core Reduction versus Biface Manufacture/Retouch at 42DC1412.

Data from the size sorting analysis of the debitage show the number of flakes within the 10.1 and 20 mm (n=31; 43%) and 5.1 and 10 mm (n=30; 41%) size categories as nearly the same, followed by the 0 to 5 mm (n=10; 14%) size category; 20.1 to30 mm (n=1; 1%); and 30.1 to 40 mm (n=1; 1%). No flakes measured within the 40.1 to 50 mm categories (Figure 28). These results support the debitage morphological analysis results with small flakes (biface thinning, pressure, and complex interior) dominating the assemblage. These numbers represent biface tool manufacture and retouch with smaller quantities of very late stage core reduction.

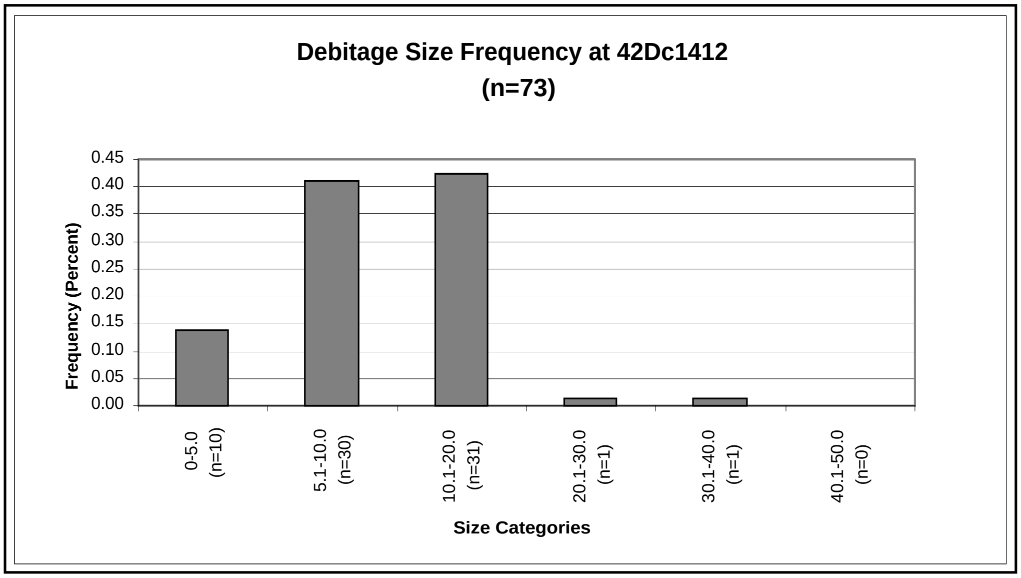


Figure 28. Debitage Size Frequency at 42 Dc1412.

A single large, edge-modified flake (Catalog No. 1412-16) recovered from the site's surface is a large interior flake just under 5 cm long and 5 cm wide. This expedient tool is a dark pinkish-purple, fine to medium-grained quartzite. The material has a slight pearlescent sheen. The small biface fragment (Catalog No. 1412-12) is less than 1.5 cm long and under 1 cm wide. The material is an opaque gray and tan chert, has a dull, waxy luster, and appears to be heat-treated.

Of the five projectile points found, three were confidently assigned Great Basin chronological types including two Humboldt Concave Base points, both of quartzite, and a Humboldt Series point of CCS material. One Humboldt Concave Base (Catalog No. 1412-05) is a fine- to medium-grained, dark pinkish-purple quartzite. The material has a pearlescent sheen on the surface and may be of the Red Creek quartzite. The other Humboldt Concave Base (Catalog No. 1412-06) is a fine-grained, banded, grayish-tan quartzite. The material has cream and brown colored inclusions up to 3 mm in size. The Humboldt Series point (Catalog No. 1412-11) is tan in color, slightly waxy in appearance, and large, dark tan inclusions. Both Humboldt Concave Base points and the Humboldt Series point are subsumed under Drager and Ireland's (1986) Humboldt Series spanning a time frame of 5,000 to 3,000 B.P., while Thomas (1981) suggests the Humboldt Series extends as late as 1250 B.P. The remaining two point fragments (Catalog No. 1412-01 and 1412-02) are indeterminate end fragments, both of fine-grained opaque, dark gray/black chert mottled with light gray inclusions. These point fragments lack diagnostic attributes prohibiting definitive point type assignments.

Pollen/Phytolith Analysis

Pollen/phytolith analysis was conducted on two soil samples from site 42DC1412. Sample 1 is an off-unit controlled surface sample indicative of a non-cultural pollen signature for the area. Sample 2 was taken from the 0 to 5 cm level in the southeast quadrant of Unit 1 (Appendix C).

Paleo Research indicates that Samples 1 and 2 depict very different pollen signatures from one another. Sample 1 is dominated by pine (*Pinus*) pollen, while Sample 2 is dominated by *Artemisia* pollen, the majority of which is sagebrush with smaller amounts of willow. Both samples produced microscopic fragments of charcoal. Paleo Research indicates Sample 2 is much larger than that of Sample 1 and suggests that this may indicate the sample has been impacted by introduction of relatively recent pollen. Other pollen matches found are presented in Table 13, roughly in order of frequency noted (Cummings et al. 2008).

Table 13. Summary of Pollen from Sample 1 and Sample 2 from Unit 1 at 42DC1412

Sample 1 (Off-unit controlled surface sample)	**Sample 2 (Fill from 0-5 cm in the southeast quadrant)**
ARBOREAL: **pine (*Pinus*); juniper(*Juniperus*); fir(*Abies*); spruce (*Picea*); Douglas fir (*Pseudotsuga*)**	***ASTERACEAE:*** ***sagebrush; low-spine Asteraceae (ragweed, sumpweed, cocklebur); high-spine Asteraceae (aster, rabbitbrush, sunflower, snakeweed)***
ASTERACEAE: ***sagebrush; low-spine Asteraceae (ragweed, sumpweed,cocklebur); high-spine Asteraceae (aster, rabbitbrush, sunflower, snakeweed)***	***ARBOREAL:*** ***juniper (Juniperus)*; fir (*Abies*); spruce (*Picea*); pine (*Pinus*); Douglas fir (*Pseudotsuga*)**
BRASSICACEAE: *Mustard family, cabbage family*	***SALIX:*** *willow*
CARYOPHYLLACEAE: *pink family*	***BRACSSICACEAE:*** *mustard family, cabbage family*
CHENO-AM: *Goosefoot and amaranth*	***CARYOPHYLLACEAE:*** *pink family*
SARCOBATUS: *Greasewood*	***CHENO-AM:*** *goosefoot and amaranth*
EPHEDRA: *ephedra, Jointfir, Mormon tea*	***SARCOBATUS:*** *Greasewood*
MAHONIA: *Oregon grape*	***EPHEDRA:*** *ephedra, Jointfir, Mormon tea*
POACEAE: *grass family*	***POACEAE:*** *grass family*
BISTORTA: *Bistort*	***BISTORTA:*** *Bistort*
ROSACEAE: *rose family*	***ROSACEAE:*** *rose family*

In contrast to the different signatures noted in the pollen record for Samples 1 and 2, the phytolith record indicates very similar assemblages. Cool season grasses dominate both samples, which Paleo Research suggests are likely wetland species from the subfamily Pooideae. They further argue that because of the similarities in assemblages between the surface sample (Sample 1) and the cultural level sample (Sample 2), cool season riparian grasses appear to have been the dominant vegetation type surrounding East Timothy Lake since the mid-Holocene (Cummings et al. 2008). Such cool season riparian grasses include: fescue, reed canary grass, wheatgrass, sweetgrass, needlegrass, ricegrass, and *Muhlenbergia* types (Cummings et al. 2008). (See Appendix C). These data are in contrast to the pollen signatures noted above, which are dominated by sagebrush indicating a dryer and more arid climate. This contrast further supports the probability of contaminated pollen samples as a result of reservoir fluctuations.

Organic Residue/Macrofloral Analysis

Both organic residue and macrofloral analysis was conducted on a sample of charcoal-rich sediment (Sample 3) taken from Unit 1 from 4 to 5 cm below the modern ground surface, just below a Humboldt Concave Base projectile point. Three samples of groundstone (Samples 6, 7, and 8) collected from the surface of Unit 1 in the southeast quadrant were also submitted for FTIR organic residue analysis. See Appendix C for a complete listing of remains identified.

Organic residue analysis of charcoal pieces from Sample 3 provided signatures matching a variety of plants and animal remains. Such plant signatures include yucca, prickly pear (*Opuntia*), snowberry (*Symphoricarpos*), and blueberries (*Vaccinium*). Interestingly, both bison fat and Big Horn sheep blood were identified. Both the yucca and bison fat have strong signatures and Cummings et al (2008) suggests a high probability that these were processed on site (Cummings et al. 2008).

Macrofloral analysis of Sample 3 identified four charred parenchymous tissue fragments, several charred *Picea* needles (see AMS radiocarbon results below), and sclerotia. Sclerotia are found in abundance with coniferous and deciduous trees as their function is to help deliver minerals to tree roots. More importantly, is the presence of parenchyma fragments, which are indicative of roots and/or tubers. This data suggest the processing of root and tubers may have also occurred at the site (Cummings et al. 2008).

Organic residue analysis from three groundstone fragments (Samples 6, 7, and 8) indicated a large presence of oils, lipids, fats and plant waxes. Matches for all three samples were primarily of nuts. However, Cummings et al. (2008) suggests many nuts have oils with similar properties, and therefore warn against making specific interpretations that the nuts listed were processed at the site. Sample 6 found matches with hazelnut (*Corylus*), acorn (*Quercus*), pecan (*Carya*), walnut, hickory, and pinon nuts. Other matches include yucca, buffalo gourd, and fish oils. These data suggest that not only were nuts, or oil seeds processed, but yucca and possibly fish as well. Samples 7 and 8 had similar signatures including hazelnut, acorn, pecan, yucca, and buffalo gourd in Sample 7. Sample 8 contained hazelnut, walnut, hickory, pinon nuts and, interestingly, pumpkin seeds (Cummings et al. 2008).

AMS Radiocarbon Analysis

The *Picea* needles extracted from Sample 3 were submitted for AMS radiocarbon dating. These needles produced a date of 2925 $\pm$ 15 RCYBP with a two-sigma calibrated age range 3210-3190 and 3170-3000 CAL BP. These dates are consistent with the later date range assigned to the Humboldt Concave Base projectile point (5,000 to 3,000 B.P.) found directly above Sample 3 (Cummings et al. 2008) (see Appendix D).

Site Summary

Site 42DC1412 is a small moderate to high-density lithic scatter. While debitage comprises 97% of the assemblage, the site is somewhat more diverse with the presence of projectile points, a biface, an edge-modified flake, and groundstone. Debitage analysis data indicate biface manufacture/retouch dominates the assemblage at 64% with core reduction at 36%. These data are consistent with the stone tool assemblage. Indeterminate flakes comprise the bulk of debitage (75%) and roughly 7% of diagnostic flakes are broken, emphasizing the damaged condition of the site. CCS overwhelmingly dominates the assemblage at 94%, with quartzite at 6%.

Most projectile points were recovered from the surface of the site, with the exception of a Humboldt Concave Base found at 4 cm below the surface. Three of the five projectile points were assigned typologies including two quartzite Humboldt Concave Base points and a single CCS Humboldt Series (6,000 to 3,000 BP). The AMS radiocarbon date obtained from charcoal recovered from just beneath the Humboldt Concave Base (4-5 cm below the surface) produced a 2-sigma range radiocarbon date of 3210-3190 and 3170-3000 CAL yrs. BP. These dates correspond to the later end of the Humboldt Series chronology suggesting a Late Archaic occupation.

While the debitage and stone tool assemblage implies a hunting-related pattern, the presence of groundstone is interesting. Traditionally, groundstone has been associated with women. It is possible that women may have been present at this site, which may have implications in terms of site type (i.e., residential or logistical).

[redacted] Site soils appear highly disturbed by erosion due to lake drawdown and inundation. However, soils at 4 cm below the modern ground surface are comprised of dense clayey sandy silts, which are less likely to erode as fast as other, less cohesive soils. While cultural deposits are very shallow, a large amount of materials were recovered (n= 360). Soils in Unit 1 were more complex than those of Unit 2 and produced the highest artifact counts, which might imply a slightly more intact remnant of cultural deposit amid highly disturbed and eroded soils. The numerous small to large cobbles stabilize the soils but also act to trap materials that are transported through longshore drift.

Data Recovery Results Summary

The summary table below (Table 14) provides a brief overview of the results from the data recovery effort at six sites in the Brown Duck and Swift Creek Basins.

Sites at Island and Kidney Lakes (42DC1340, 42Dc1341, 42DC1342, and 42DC1344) within the Brown Duck Basin are typically small, low to moderate density lithic scatters. The two sites at East Timothy (42DC1411 and 42DC1412) are small, moderate to high-density lithic scatters. Most artifacts recovered from the sites in these two basins were between the 0 to 5 cm levels and the majority of tools were noted on the surface, with few in the 0 to 5 cm level. At all sites, debitage is the most abundant artifact type comprising 94% or more of each of the

Table 14. Summary of Results from the High Mountain Lakes Data Recovery Project							
Site Number	**Description**	**Artifacts (Count)**	**Total Artifacts**	**Obsidian Studies**	**Other Analytical Studies**	**Projectile Point Typology**	**Other Dates**
BROWN DUCK BASIN							
IF-A	Isolate Find	Projectile Point	1	-	-	Gate Cliff Split Stem (1) (4950 -2250 BP)	-
42DC1340	Small, low-density lithic scatter	Debitage (222) Flake tools (6) Projectile points (2) Point fragments (2)	232	-	Pollen/Phytolith analysis. AMS radiocarbon dating	Elko Corner-notched (1) (10,000- 500 BP) Pinto Square-shoulder (1) (6,000 to 3,000 BP)	AMS radiocarbon date 2-sigma range 1530-1410 CAL BP
42Dc1341	Low to moderate-density lithic scatter	Debitage (102) Projectile points (3) Point fragments (1) Biface (2) Flake tool (1)	109	Two (2) samples sourced to Wild Horse Canyon	-	Elko (10,000- 500 BP) (1) Humboldt Concave Base (1) (5,000 to 3,000 BP) DSN (post A.D 1300) (1)	<u>Hydration microns:</u> 3.3 ± 0.1 Late Prehistoric/ Formative
42DC1342	Small, low-density lithic scatter	Debitage (56) Projectile point fragments (2) biface (1)	59	-	Botanical identification	Indeterminate	-
42DC1344	Small, moderate-density lithic scatter	Debitage (19)	21	Seven (7) samples all sourced to Pumice Hole Mine	-	-	<u>Hydration microns</u> (1.3 ± 0.1 to 1.9 ± 0.1) Confidently Late Prehistoric/Late Prehistoric/ Formative
SWIFT CREEK BASIN							
42DC1411	Small, moderate-density lithic scatter	Debitage (23) Flake tools (1) Biface (1)	25	-	-	-	-
42DC1412	Small, moderate to high-density lithic scatter	Debitage (350) Projectile points (3) Point fragments (2) Flake tool (1) Biface (1)	360	-	Pollen/Phytolith, organic residue, macrofloral. AMS radiocarbon dating.	Humboldt Series (1) Humboldt Concave Base (2) (5,000 to 3,000 BP)	<u>AMS radiocarbon date : 2-sigma range</u> 3210-3190 and 3170-3000 CAL BP
Totals	**6**	**30**	**802**	**2**	**3**	**-**	**-**

assemblages. Debitage size analysis at all sites show small flake sizes dominant between 10.1 to 20 mm and 5.1 to 10 mm, respectively. Cultural deposits extend no deeper than 10 cm below the modern ground surface.

Soils appear to be consistent at all sites and are weakly developed, exhibiting an eroded forest sub-soil above a sterile, sandy substrate. The one exception to this is at site 42DC1344, where soils are homogenous throughout and are uniformly very poorly developed and lack distinct forest sub-soils, which cap a sandy substrate. In all, sites exhibit significant and ongoing erosion and deflation of soils typical of reservoir settings as is evidenced by the mixed soils down to at least 10 to 15 cm below the surface.

While the sites are in highly disturbed contexts, the data indicate all sites exhibit a hunting-related pattern. It can be said with slightly more confidence, however, that prehistoric use of both basins occurred during the mid-to-late Archaic with evidence of Late Prehistoric use in the Duck Brown Basin.

SYNTHESIS

Data recovery at six prehistoric lithic scatters in the High Uinta Mountains indicates that these sites are largely in highly disturbed geomorphic contexts. As such, interpretations made here are somewhat tentative. While all sites are extensively eroded and have mixed deposits, all are contained within two separate basins. Though conclusions from the sites themselves can be used to make limited inferences about broader prehistoric patterns, the combined data from within these individual basins speak to a number of germane research topics. The following discussion focuses on these topics: site formation processes, culture chronology, settlement patterns, subsistence and exchange at Brown Duck and Swift Creek basins.

Site Formation Processes

All of the sites are within reservoir drawdown and fluctuation zones and reiterate the fact that reservoirs have detrimental effects on archaeological deposits (Morgan 2005; Morgan 2000; Will and Clark 1996; Lenihan et al. 1981). Analysis suggests that though geomorphic processes associated with different shoreline settings are different, the impacts are invariably the same: erosion and redeposition of cultural materials. All sites are subject to varying redepositional processes, one of which is the cycle of filling in and draining of the reservoirs themselves. This process removes cultural materials from their original locations and redeposits them elsewhere on or off site, significantly altering site integrity. The results are generally poor and sometimes fair for site integrity (Table 15).

Table 15. Summary of Geomorphic Settings and Their Effects on High Mountain Lakes Sites.					
Reservoir/ Basin	**Site**	**Predominate Geomorphic Setting**	**Principle Geomorphic Processes**	**Site Condition**	**Depositional Integrity**
Island Lake/ Brown Duck	42DC1340	Peninsula	Wave cut erosion, longshore drift, wave refraction	Site is mostly eroded and redeposited	Poor-Fair
Island Lake/ Brown Duck	42Dc1341	Exposed Shoreline	Wave cut erosion, longshore drift	Site is mostly eroded and redeposited, small portion possibly intact	Poor-Fair
Island Lake/ Brown Duck	42DC1342	Peninsula	Wave cut erosion, longshore drift, wave refraction	Site is eroded and redeposited	Poor
Island Lake/ Brown Duck	42Dc1343	Exposed Shoreline	Wave cut erosion, longshore drift	Site is mostly eroded and redeposited	Poor
Kidney Lake/ Brown Duck	42DC1344	Exposed Shoreline	Wave cut erosion, longshore drift	Site is mostly eroded and possibly a secondary redeposit	Poor
East Timothy/Swift Creek Basin	42DC1411	Exposed Shoreline	Wave cut erosion, longshore drift	Site is mostly eroded and redeposited	Poor
East Timothy/Swift Creek Basin	42DC1412	Exposed Shoreline	Wave cut erosion, longshore drift	Site is mostly eroded and redeposited, small portion possibly intact	Poor-Fair

However, at each site, with the exception 42DC1344, there is evidence of an eroded forest sub-soil representing the remnants of possible intact cultural deposit. Darker, organic matter containing cultural constituents and charcoal fragments characterizes this deposit. These soils show significant bioturbation, further indicating mixing of soils. These soils extend no deeper than 5 to 10 cm below the surface and are capped by mixed and redeposited lacustrine sediments containing redeposited cultural material.

Small pockets of intact deposit may be present at sites 42DC1341 and 42DC1412, which are essentially the remnants of what was once a more intact cultural deposit that has now been significantly eroded. Site 42DC1344 lacks this forest sub-soil and is likely a secondary deposit resulting from longshore drift.

Culture Chronology

Data collected from projectile point types, AMS radiocarbon dates, and obsidian hydration measurements indicate prehistoric use of both basins occurred mainly during the Archaic, with evidence of Late Prehistoric use in the Duck Brown Basin. It should be noted that projectile points and obsidian from these sites were largely recovered from site surfaces, and AMS radiocarbon samples were taken from shallow soils in disturbed reservoir settings. The need to be conservative with chronological assignments of these sites cannot be understated. However, these data can be generally applied to prehistoric use of the individual basins.

Three sites in the Brown Duck Basin (42DC1340, 42DC1341 and 42DC1344) and an isolated find (IF-A) provided chronological data. A Pinto Square-shoulder point found on the surface of 42DC1340 (6000 and 3000 BP) and an AMS radiocarbon date of 1530-1410 CAL BP suggests mid-Archaic and Late Prehistoric use. A Humboldt Concave Base, Desert Side-notched projectile point and obsidian hydration data at site 42DC1341 also indicates mid-Archaic and Late Prehistoric occupation. Hydration data from 42DC1344 indicates a Late Prehistoric component. Finally, an isolated Gatecliff Split-stem point found at Island Lake's north end indicates mid-Archaic occupation. Combined, these data strongly point to mid- to-late Archaic use of the area as well as a Late Prehistoric component.

Temporal data recovered from East Timothy Lake in the Swift Creek basin is from site 42DC1412. The site contained three Humboldt Series points (two are Humboldt Concave Base) dating between 6000 to 3000 BP. An AMS radiocarbon date from charcoal rich soils underneath where a Humboldt Concave Base was recovered provided a 2-sigma range of 3210-3190 and 3170-3000 CAL BP. These data strongly point to mid- to late-Archaic use of the area.

Chronological data recovered indicates a lack of Paleoindian and Early Archaic occupation in these basins. The data strongly reflects a mid-to-late Archaic pattern in Swift Creek and Brown Duck basin. A Late Prehistoric/Formative and possible Numic presence is also represented at Brown Duck Basin. These results are not surprising and are consistent with other high elevation settings in the Uintas and other Rocky Mountain patterns showing a mid- to late-Archaic hunting pattern followed by what appears to be a Late Prehistoric logistical hunting and foraging pattern (Loosle and Johnson 2000; Madsen et al. 2000; Johnson and Loosle 2002; Knoll 2003).

Settlement Patterns

The lithic assemblages analyzed for this report represent small, geographically constrained samples, which precludes large-scale landscape settlement pattern analysis. Stone tool and debitage analysis, however, can be used as proxies for mobility and settlement patterns (Andrevsky 2001; Madsen et al. 2000; Cowen 1999; Kelly 1988; Parry and Kelly 1987). A discussion of these proxies follow.

Artifact assemblages at sites 42DC1340, 42DC1341, 42DC1342, and 42DC1412 are small and are comprised entirely of flaked stone debris and small amounts of formal and informal tools, with site 42DC1412 also containing three groundstone fragments. Sites 42DC1344 and 42DC1411 contain debitage only (Appendix A and B). Morphological debitage analysis indicates biface manufacture/retouch accounts for over half of the assemblages at each site, particularly at sites 42DC1341, 42DC1411, and 42DC1412 (between 62 and 64% of the assemblages). These data are also supported by the presence of projectile points and bifaces. The exception is site 42DC1342 where core reduction slightly dominates the assemblage at 58%. The presence of projectile points, bifaces, scrapers, and expedient flake tools noted at these sites indicate hunting-related patterns.

The abundance of small flakes at each site correlates with biface manufacturing debris and retouch (Odell 2003; Andrevsky 2001). The presence of bifacial tools and biface manufacture/retouch debris implies higher mobility due, in part, by the portable, light weight nature of bifacial tools, and the fact that they can be used as cores and as resharpenable, longer use tools (Andrevsky 2001; Madsen et al. 2000; Cowen 1999; Kelly 1988; Parry and Kelly 1987). Theoretically, an assemblage dominated by bifacial tools and their by-products indicate residential mobility as foragers move across the landscape mapping on to resources as they encounter them (Cowen 1999; Kelly 1988; Parry and Kelly 1987). As noted above, five out of six sites at Brown Duck and Swift Creek basins show biface manufacture/retouch as slightly dominating the assemblages.

However, each site and basin also contains fairly high percentages of core reduction debris and expedient tools. Core reduction and expedient core technology is typically associated with greater sedentism supported by logistical forays (Cowen 1999; Parry and Kelly 1987). In the High Uintas, however, Madsen et al. (2000) argue that logistical hunting forays on the south slope are not cost effective due to travel distances into and out of the basins to lower settlements in woodland communities. They suggest that transport costs would far outweigh the energetic return rate for such resources as deer or sheep procured at high elevations on the south slope. Therefore, hunting-related sites should be more prevalent on the north slope of the Uintas (Madsen et al. 2000).

The dichotomy between biface and core technology presents a complex problem in this part of the Uintas. Are people hunting and highly mobile in a residential sense or are they living in lower elevations supported by logistical forays to the high country? The question may be a temporal one. In the Archaic, residential mobility and intensive biface manufacture is prevalent. In the Formative, the situation might be reversed, with logistical groups exploiting the high country. Because of the poor depositional integrity and small sample size, the nature of these patterns is impossible to determine here.

Taken together, the lithic assemblages at all six sites in both the Brown Duck and Swift Creek Basins imply a hunting-related pattern. Clearly there is a mix of residential and logistical strategies represented in the lithic data. This can be said with some certainty based on the relative lack of diverse artifact assemblages and structures that might suggest longer-term occupations.

Subsistence

Subsistence data is evidenced solely by botanical and organic residue analysis conducted at sites 42DC1340, 42DC1342, and 42DC1412 and pollen and phytolith analysis conducted at 42DC1412. No additional organic materials such as faunal remains were identified during excavations. Interpretations regarding local vegetation and resource exploitation are tentative as the samples analyzed were small and taken from highly disturbed contexts. Moreover, off site samples representing natural pollen/phytolith levels in the area are lacking for comparative analysis. However, results from these analyses are somewhat compelling and have allowed for the identification of locally occurring resources likely exploited in the area prehistorically and those that appear to have been brought in to the Brown Duck and Swift Creek basins. Data from organic residue analysis provide more reliable subsistence data since fat, lipid, and oil residues from plants and animals processed at these sites are less likely to be contaminated or break down.

Macrofloral remains analyzed at 42DC1340 identified three parenchymous tissue fragments (roots/ tubers) and a single charred seed lacking its diagnostic outer seed coat. These data indicate possible seed and fleshy root processing at the site although specific plant identification was not possible. FTIR analysis on charcoal from the sample identified *Pinus* or a local pine species. A single seed from 42DC1340 was recovered and submitted for botanical identification. Results suggest the growth of *Pseudotsuga* or Douglas fir in the area.

The majority of plant species identifications came from pollen, phytolith, botanical, and organic residue analysis from 42DC1412 in the Swift Creek Basin (see Table 2-5 in Cummings et al 2008). Pollen samples 1 and 2 are dominated by pine (off unit Sample 1) and sagebrush (Sample 2) and additional species, including numerous cool season grasses naturally occurring in Swift Creek Basin, indicating the area was once a meadow environment bordered by Hudsonian zone tree margins. Of particular interest is the presence of willow, which ethnographic accounts indicate had many uses including medicinal ceremonial uses; ephedra and Mormon tea (*Ephedra* sp)., which is reported to have medicinal properties; Bistort (*Bistorta),* springbeauty (indian potato), and Oregon grape (*Mahonia),* which were prized roots and tubers exploited for their nutritional value; and the rose family (*Rosaceae*), which had medicinal purposes as well as used in burial practices ethnographically (Albers and Lowry 1995).

Organic residue analysis was conducted on charcoal from site sediments and groundstone at 42DC1412. FTIR analysis on the charcoal samples identified locally occurring blueberries and snowberry and the presence of Bighorn sheep blood. Resources not locally occurring and likely brought up to the area include yucca, prickly pear. Yucca is found on dry slopes and foothills about 4,000 to 6,000 feet lower than these sites. Prehistorically, the fiber of yucca plants was used for cordage and sandals. However, yucca signatures are close to that of Camus bulbs, although the data was not specific enough to make a distinction. Prickly pear is found in dry areas in sagegrass and juniper communities. Ethnographic evidence implies the cactus flowers were eaten and the cactus was also used as a cure for infections from insect bites.

Interestingly, the organic residue analysis also identified the presence of bison fat. Historically, bison was prevalent (and regularly hunted) in the Uinta Basin, north of the Uinta Mountains. Studies of bison distribution have indicated that small herds were also known to extend up into the higher elevations (7,000 to 10,000 ft amsl) in Hayden, Pelican and Lammar Valleys on the Yellowstone Plateau, and on the grasslands and meadows up to 10,000 to 11,000 feet in the Colorado Rockies (Sloane 1950; Stewart 1966b; Roe 1972; Meagher 1973; Janetski 1983; Callaway et al. 1986; Albers and Lowry 1995). It is interesting to note that Johnson and Loosle (2002) noted a single bison skull was identified within the high lakes/Uintas divide (9500-12000 ft) locale. In light of this, it is possible that small herds of buffalo did in fact use the high lakes/Uintas divide locale; however, there is minimal evidence to support this statement. It is likely that the bison was brought up as dried meat as it was a large source of protein for native groups in the area.

FTIR analysis on three groundstone fragments indicates a large presence of lipids, plant waxes, oils, and fats from a variety of nuts and seeds such as hazelnut, acorn, pecan, hickory, pinon, and pumpkin seed. Cummings et al. (2008) warn that many nuts have oils with similar properties; therefore limited interpretations should be made as to specific kinds of nuts that may have been processed at the site. If acorns were being processed, these would have been transported to the area, as would have piñon nut. However, there is no evidence to date of any storage or processing of piñon on the Uinta Mountains (Knoll 2003). Of particular interest is the presence of pumpkin seed, which is a cultivated food source that would have had to be brought up to the area. Interestingly, this data implies a Late Prehistoric/Formative occupation of the Swift Creek Basin.

The geomorphic processes associated with reservoir settings may, in part, explain the lack of faunal material at any of the sites at Brown Duck and Swift Creek Basin. Sites along exposed shorelines and peninsulas are subject to ongoing reservoir drawdown and inundation, which, as discussed earlier, has the effect of removing cultural materials from their original location and redepositing them elsewhere. Another factor to consider is the lack of preservation of faunal remains within reservoir settings as a result of exposure and complete inundation due to fluctuating reservoir levels. This, combined with continued exposure to extreme mountain elements, may explain the complete absence of faunal materials.

Ethnographic evidence indicates that berries, starchy roots, and seeds were a nutritionally important aspect of subsistence for the Utes in historic times (Albers and Lowry 1995:35). Fleshy roots were prized because they store important vitamins, minerals, fiber, and most importantly, carbohydrates, which offset the negative effects of high protein diets based on lean animal meat. In addition to berries, roots, and seeds, Bighorn, and undoubtedly other ungulates such as deer and elk, were hunted during the summer and fall months in the study areas. Due to these numerous and rich resources, the Uinta Mountains were regularly used for resource intensification during the mid-to late-Archaic and Late Prehistoric/Formative periods.

Exchange

Exchange and external relationships at these sites are indicated solely by XRF data. Obsidian analysis of nine specimens from two sites in Brown Duck Basin, two from 42DC1341 (Island Lake) and seven from 42DC1344 (Kidney Lake), indicate that the obsidian found at these sites are from two different sources from southwestern Utah. While the sample size is too small to make reliable interpretations, these data are important because of the significant distance of the two sources from these two high elevation sites.

Two obsidian samples from 42DC1341 were sourced to Wild Horse Canyon in the Mineral Mountain Range in southwestern Utah. Seven samples from site 42DC1344 at Kidney Lake were all sourced to Pumice Hole Mine, also in the Mineral Mountain Range in southwestern Utah. It is interesting to note that the Pumice Hole Mine source is roughly 3 miles northwest of the larger, more commonly accessed Wild Horse Canyon source (Craig E. Skinner 2008, pers. comm.). The fact that obsidian from these two sites was obtained from sources some

215 miles southwest of the project area implies that obsidian was either procured directly from the source or obtained by down-the-line exchange.

Procurement brings up two issues each relating to culture chronology. Hydration data from 42DC1341 at Island Lake in Brown Duck Basin indicates a Late Prehistoric/Formative occupation. Hydration data from 42DC1344 at Kidney Lake, also in Brown Duck Basin, points to a Formative and Post Formative occupation. The first issue is if long distance forays were employed to directly procure obsidian, individuals on these forays would likely have had to cross multiple cultural boundaries to gain access to these obsidian sources. Second, depending on the period in prehistory, limited access to these sources due to source ownership may have played a role in limiting direct procurement. During the Formative period, for example, Fremont trade interactions increased substantially with groups from the Great Basin and major political centers in the southwest between A.D. 1100 and A.D. 1300 (Simm 2008). It is plausible that Fremont groups controlled quarry access during this time in southern Utah. In this instance, we might expect more formal trade relationships and/or down the line exchange to explain the obsidian in Brown Duck Basin.

During the Late Prehistoric, however, Numic speaking groups were highly mobile and regularly moved long distances. They also would likely have had less restricted access to these obsidian sources. In this period, it is certainly plausible obsidian found in the Uintas may have been procured directly.

A more extensive, regional study of obsidian found at sites in the Uintas and beyond might shed some light on regional systems of obsidian procurement and exchange and major shifts in these systems over time.

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Appendix A:

Master Artifact Catalog

HIGH MOUNTAIN LAKES MASTER CATALOG KEY

The Sagebrush master catalog is comprised of 18 fields. The following provides a key to codes and abbreviations used in the printed catalog as well as those found in the Microsoft Access 2000 electronic version.

Site NO: Site number (Smithsonian Institution system)

Specimen: Assigned catalog number

Unit Type: Type of unit excavated. Note: SCA is Surface Collected Artifact on general site surface unless followed by Unit Designation.

SCA:	Surface Collected Artifact
EU (Microsoft Access):	Excavation Unit
Unit (Printed catalog):	Excavation Unit

Unit Designation: Number assigned to excavation unit.

Unit Size: Unit Size in meters: North-South size first followed by East-West size.

High Depth: Beginning unit level depth

Low Depth: Ending unit level depth

Group: General grouping of similar artifacts

FLS:	Flaked Stone
GDS:	Groundstone

Class: Specific classification of artifacts within their particular Group

BIF:	Biface
DEB:	Debitage
FLT:	Flake tool
PPT:	Projectile point
SLB:	Slab

Type: Description of artifact.

COR:	Corner-notched	HUM:	Humboldt Series
DEB:	Debitage	HCB:	Humboldt Concave Base
DSN:	Desert Side-notched	SCR:	Scraper
ECN:	Elko Corner-notched	SID:	Elko Side-notched
EMF:	Edge-modified flake	SQS:	Pinto Square-shoulder
FRG:	Indeterminate fragment	UNI:	Uniface
GSS:	Gatecliff Split-stem		

HIGH MOUNTAIN LAKES MASTER CATALOG KEY

Material: Material type

- CCS: Cryptocrystalline silicate
- OBS: Obsidian
- QZT: Quartzite

Count: Total number of specimens

Weight: Weight in grams

Length: Length in millimeters (proximal to distal; maximum dimensions on whole or fragmentary artifacts that cannot be oriented)

Width: Width in millimeters (perpendicular to length)

Thickness: Maximum thickness in millimeters

Comments: Any distinguishing characteristics (i.e. heat treatment, cortex, material color or texture)

HIGH MOUNTAIN LAKES
MASTER ARTIFACT CATALOG

Site Number	Specimen	Unit Type	Unit	Unit Size	Screen	Highdepth	Lowdepth	Group	Class	Type	Material	Count	Weight	Length	Width	Thickness	Comment
42DC1340	1340-01	SCA				0	0	FLS	PPT	SQS	CCS	2	2.3	31	16.4	4.7	Two conjoining pieces. Dark brown. Heat treatment.
42DC1340	1340-02	SCA				0	0	FLS	PPT	FRG	CCS	1	0.6	11.2	13.5	4.2	PPT-Stem. Gray w/white bands
42DC1340	1340-03	SCA				0	0	FLS	PPT	ECN	QZT	1	2.7	25.3	21.9	5	Medium- to course-grained gray. Heavily reworked Elko
42DC1340	1340-04	SCA	1	1x1	1/8	0	0	FLS	FLT	SCR	CCS	1	1	21.5	14.6	3.1	Dark brown. Heat treatment.
42DC1340	1340-05	SCA	1	1x1	1/8	0	0	FLS	PPT	FRG	CCS	1	1.1	19.4	14.9	5.3	Tip. Tan w/blk banding. Heat treatment.
42DC1340	1340-06	SCA	1	1x1	1/8	0	0	FLS	FLT	UNI	CCS	1	5.4	29.1	22.4	10.6	
42DC1340	1340-07	SCA	1	1x1	1/8	0	0	FLS	DEB	DEB	CCS	1	6.9	0	0	0	White/tan mottled
42DC1340	1340-08	SCA	1	1x1	1/8	0	0	FLS	FLT	EMF	QZT	1	3.2	29	19.6	5.1	Pink. Possible Red Creek quartzite.
42DC1340	1340-09	EU	1	1x1	1/8	0	5	FLS	DEB	DEB	CCS	18	7	0	0	0	White/tan/grey/brown. Signs of heat treatment.
42DC1340	1340-10	EU	1	1x1	1/8	0	5	FLS	DEB	DEB	QZT	1	0.4	0	0	0	Medium-grained, buff.
42DC1340	1340-11	EU	1	1x1	1/8	5	10	FLS	DEB	DEB	CCS	6	0.9	0	0	0	White/tan/gray. Signs of pot-lidding.
42DC1340	1340-12	SCA	2	1x1	1/8	0	0	FLS	FLT	EMF	QZT	1	3.5	30.9	24.4	5.2	Pink- Possible Red Creek Quartzite
42DC1340	1340-13	SCA	2	1x1	1/8	0	0	FLS	DEB	DEB	CCS	6	2	0	0	0	Tan/white
42DC1340	1340-14	SCA	2	1x1	1/8	0	0	FLS	DEB	DEB	QZT	7	5.3	0	0	0	Buff/ Pink (possible Red Creek Quartzite).
42DC1340	1340-15	SCA	2	1x1	1/8	0	0	FLS	FLT	SCR	CCS	1	6.2	30.8	18.3	18.1	Steep sided. Gray with black inclusions.
42DC1340	1340-16	EU	2	1x1	1/8	0	5	FLS	DEB	DEB	CCS	75	9.3	0	0	0	White/tan.gray/white w/peppering/brwn.
42DC1340	1340-17	EU	2	1x1	1/8	0	5	FLS	DEB	DEB	QZT	48	13.4	0	0	0	Fine-grained;gray/pink/buff.
42DC1340	1340-18	EU	2	1x1	1/8	0	5	FLS	DEB	DEB	OBS	1	0.1	0	0	0	Source unidentified
42DC1340	1340-20	EU	2	1x1	1/8	5	10	FLS	DEB	DEB	CCS	4	0.5	0	0	0	White/ tan/ gray
42DC1340	1340-21	EU	2	1x1	1/8	5	10	FLS	DEB	DEB	QZT	12	9.2	0	0	0	Fine-grained; poss. Red Creek pink
42DC1340	1340-22	SCA	3	1x1	1/8	0	0	FLS	DEB	DEB	CCS	24	19.5	0	0	0	White/gray/reddish-brown.
42DC1340	1340-23	SCA	3	1x1	1/8	0	0	FLS	DEB	DEB	QZT	1	0.1	0	0	0	Fine-grained; buff.
42DC1340	1340-24	EU	3	1x1	1/8	0	5	FLS	DEB	DEB	CCS	18	16	0	0	0	Redish-brown/tan/white/brown/ poss. Chalcedony
42DC1340	1340-25	EU	3	1x1	1/8	0	5	FLS	FLT	EMF	CCS	1	1.8	32.4	16.1	6.1	

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Site Number	Specimen	Unit Type	Unit	Unit Size	Screen	Highdepth	Lowdepth	Group	Class	Type	Material	Count	Weight	Length	Width	Thickness	Comment
42DC1340	1340-26	EU	1	1x1		5	9	SMP	CHR	-	CHR	1	5.2	0	0	0	Charcoal from bulk soil sample (Sample #5)
42DC1340	1340-27	EU	1	1x1		5	9	SMP	SOL	-	SOL	1	21.7	0	0	0	Heavy fraction from bulk soil sample (Sample # 5)
42DC1340	1340-28	EU	1	1x1		5	9	SMP	FLO	BOT	UNI	1	8.2	0	0	0	Light fraction from bulk soil sample (Sample #5)
42DC1340	1340-29	EU	1	1x1		5	9	SMP	FLO	SEED	OTH	2	0.1	0	0	0	Lewisia seeds from bulk soil sample (Sample #5)
42DC1340	1340-30	EU	1	1x1		5	9	SMP	FLO	BOT	CHR	1	0.1	0	0	0	Paranchyma tissue from bulk soil sample (Sample #5)
42DC1341	1341-01	SCA				0	0	FLS	PPT	COR	CCS	1	8	38.6	29.3	5.9	Possible Elko Series- pronounced serration along margins
42DC1341	1341-02	SCA				0	0	FLS	BIF	FRG	CCS	1	6.1	35.6	21.3	7	Midsection and tip. Exhibits potlidding
42DC1341	1341-03	SCA				0	0	FLS	PPT	DSN	CCS	1	0.6	21.6	12.4	2.7	Missing left basil ear.
42DC1341	1341-04	SCA				0	0	FLS	PPT	SID	CCS	1	3.2	28.08	21.15	5.2	Proximal end missing base.
42DC1341	1341-05	SCA				0	0	FLS	PPT	HCB	QZT	1	2.8	32.3	14.8	5.2	Cream/tan
42DC1341	1341-06	SCA				0	0	FLS	DEB	DEB	OBS	1	0.5	0	0	0	XRF- Wild Horse Canyon
42DC1341	1341-07	SCA	1	1x1	1/8	0	0	FLS	DEB	DEB	CCS	1	0.5	0	0	0	
42DC1341	1341-08	SCA	1	1x1	1/8	0	0	FLS	BIF	FRG	CCS	1	3.5	25.1	22	8.8	
42DC1341	1341-09	SCA	2	1x1	1/8	0	0	FLS	DEB	DEB	CCS	4	2.4	0	0	0	Blk/White/Orange
42DC1341	1341-10	SCA	2	1x1	1/8	0	0	FLS	DEB	DEB	QZT	1	4.9	0	0	0	Fine-grained. Tan w/pink bands
42DC1341	1341-11	SCA	2	1x1	1/8	0	0	FLS	DEB	DEB	OBS	5	0.5	0	0	0	XRF- Wild Horse Canyon
42DC1341	1341-12	EU	2	1x1	1/8	0	5	FLS	DEB	DEB	CCS	26	1	0	0	0	
42DC1341	1341-13	EU	2	1x1	1/8	0	5	FLS	DEB	DEB	QZT	5	4.4	0	0	0	Gray and buff
42DC1341	1341-14	EU	2	1x1	1/8	0	5	FLS	DEB	DEB	OBS	18	0.7	0	0	0	Source unidentified
42DC1341	1341-15	EU	2	1x1	1/8	5	10	FLS	DEB	DEB	CCS	12	0.7	0	0	0	White/blck/tan/gray
42DC1341	1341-16	EU	2	1x1	1/8	5	10	FLS	DEB	DEB	QZT	2	0.1	0	0	0	Tan and buff
42DC1341	1341-17	EU	2	1x1	1/8	5	10	FLS	DEB	DEB	OBS	1	0.1	0	0	0	Source unidentified.
42DC1341	1341-18	SCA	3	1x1	1/8	0	0	FLS	DEB	DEB	CCS	4	0.7	0	0	0	Blk/white/tan
42DC1341	1341-19	EU	3	1x1	1/8	0	5	FLS	DEB	DEB	CCS	6	1.5	0	0	0	Gray/tan/white/blk

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Site Number	Specimen	Unit Type	Unit	Unit Size	Screen	Highdepth	Lowdepth	Group	Class	Type	Material	Count	Weight	Length	Width	Thickness	Comment
42DC1341	1341-20	EU	3	1x1	1/8	0	5	FLS	DEB	DEB	QZT	2	0.6	0	0	0	Fine-grained tan
42DC1341	1341-21	EU	3	1x1	1/8	0	5	FLS	DEB	DEB	OBS	2	0.1	0	0	0	Source unidentified.
42DC1341	1341-22	EU	3	1x1	1/8	5	10	FLS	DEB	DEB	CCS	8	0.8	0	0	0	White/tan/pinkish-orange
42DC1341	1341-23	EU	3	1x1	1/8	5	10	FLS	DEB	DEB	QZT	5	0.6	0	0	0	Fine to medium-grained. Tan/buff/gray
42DC1341	1341-24	EU	3	1x1	1/8	0	5	FLS	FLT	EMF	CCS	1	1.4	28.3	18.7	2.9	
42DC1342	1342-01	SCA				0	0	FLS	PPT	FRG	QZT	1	0.8	16.9	15.8	2.7	Reddish-pink. Tip only.
42DC1342	1342-02	SCA	1	1x1	1/8	0	0	FLS	DEB	DEB	CCS	2	3.7	0	0	0	Tan w/white motteling.
42DC1342	1342-03	EU	1	1x1	1/8	0	5	FLS	PPT	FRG	QZT	1	1	15.9	13.4	3.2	Mid-section. Tan w/gray bands.
42DC1342	1342-04	EU	1	1x1	1/8	0	5	FLS	DEB	DEB	CCS	8	2.7	0	0	0	Signs of heat treatment
42DC1342	1342-05	EU	1	1x1	1/8	0	5	FLS	DEB	DEB	QZT	3	0.7	0	0	0	White and orange
42DC1342	1342-06	SCA	2	1x1	1/8	0	0	FLS	DEB	DEB	CCS	1	7.7	0	0	0	Tan/pink/yellow
42DC1342	1342-07	EU	2	1x1	1/8	0	5	FLS	DEB	DEB	CCS	9	12.2	0	0	0	White/tan/gray/pink
42DC1342	1342-08	EU	2	1x1	1/8	0	5	FLS	DEB	DEB	QZT	6	3.2	0	0	0	Tan w/buff bands
42DC1342	1342-09	EU	2	1x1	1/8	0	5	FLS	DEB	DEB	OBS	1	0.1	0	0	0	Source unidentified.
42DC1342	1342-10	EU	2	1x1	1/8	5	10	FLS	DEB	DEB	CCS	3	0.5	0	0	0	Tan/brwn/white
42DC1342	1342-11	EU	2	1x1	1/8	5	10	FLS	DEB	DEB	QZT	4	0.3	0	0	0	Tan
42DC1342	1342-12	SCA	3	1x1	1/8	0	0	FLS	DEB	DEB	CCS	5	3.9	0	0	0	Tan/white
42DC1342	1342-13	EU	3	1x1	1/8	0	5	FLS	BIF	FRG	CCS	1	8.1	31.4	34.2	9.8	White/pink motteling
42DC1342	1342-14	EU	3	1x1	1/8	0	5	FLS	DEB	DEB	CCS	11	8.8	0	0	0	Tan/white/pink/gray
42DC1342	1342-15	EU	3	1x1	1/8	0	5	FLS	DEB	DEB	QZT	3	0.2	0	0	0	Tan/brown
42DC1342	1342-16	EU	2	1x1		5	5	SMP	BOT	SEED	OTH	1	0.1	0	0	0	Psuedotsuga seed. Botanical Sample #4)
42DC1344	1344-01	SCA	1	1x1	1/8	0	0	FLS	DEB	DEB	QZT	1	0.1	0	0	0	Tan
42DC1344	1344-02	SCA	1	1x1	1/8	0	0	FLS	DEB	DEB	OBS	8	1.4	0	0	0	XRF- Pumice Hole Mine (two samples: Sample 1 and Sample 2)
42DC1344	1344-03	EU	1	1x1	1/8	0	5	FLS	DEB	DEB	OBS	8	2.3	0	0	0	XRF- Pumice Hole Mine (two samples: Sample 3 and Sample 4)

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Site Number	Specimen	Unit Type	Unit	Unit Size	Screen	Highdepth	Lowdepth	Group	Class	Type	Material	Count	Weight	Length	Width	Thickness	Comment
42DC1344	1344-04	EU	1	1x1	1/8	0	5	FLS	DEB	DEB	QZT	1	0.2	0	0	0	Highly weathered, broke in two.
42DC1344	1344-05	SCA				0	0	FLS	DEB	DEB	OBS	1	3.5	27.4	22.4	8	XRF- Pumice Hole Mine
42DC1344	1344-06	SCA				0	0	FLS	DEB	DEB	OBS	1	1.5	23.4	18.1	5.7	XRF- Pumice Hole Mine
42DC1344	1344-07	SCA	1	1x1	1/8	0	0	FLS	DEB	DEB	OBS	1	3.9	18.4	19.6	3.9	XRF-Pumice Hole Mine
42DC1411	1411-01	SCA				0	0	FLS	BIF	FRG	QZT	1	13.6	42.6	30.9	9.8	Fine to medium-grained
42DC1411	1411-02	SCA	1	1x1	1/8	0	0	FLS	DEB	DEB	CCS	3	1	0	0	0	Dark brown and black
42DC1411	1411-03	EU	1	1x1	1/8	0	5	FLS	FLT	EMF	CCS	1	5.3	29.8	23.8	8	Light gray/white
42DC1411	1411-04	EU	1	1x1	1/8	0	5	FLS	DEB	DEB	CCS	10	2.6	0	0	0	Dark brown/blk/tan
42DC1411	1411-05	EU	1	1x1	1/8	0	5	FLS	DEB	DEB	QZT	3	0.4	0	0	0	Fine-grained pink
42DC1411	1411-06	SCA	2	1x1	1/8	0	0	FLS	DEB	DEB	CCS	1	0.8	0	0	0	Brown/tan
42DC1411	1411-07	SCA	2	1x1	1/8	0	0	FLS	DEB	DEB	QZT	1	3.7	0	0	0	Fine to medium-grained/ tan
42DC1411	1411-08	EU	2	1x1	1/8	0	5	FLS	DEB	DEB	CCS	4	1.3	0	0	0	Dark brown/gray
42DC1411	1411-09	EU	2	1x1	1/8	0	5	FLS	DEB	DEB	QZT	1	1.8	0	0	0	Fine to medium-grained. Reddish-brown.
42DC1412	1412-01	SCA	1	1x1	1/8	0	0	FLS	PPT	FRG	CCS	1	0.6	13.2	11.3	3.2	PPT tip- dark brown. Possible heat treatment
42DC1412	1412-02	SCA	1	1x1	1/8	0	0	FLS	PPT	FRG	CCS	1	0.4	14.1	11.08	2.8	Dark gray/ mottled
42DC1412	1412-03	SCA	1	1x1	1/8	0	0	FLS	DEB	DEB	CCS	7	2.1	0	0	0	Tan/gray/white
42DC1412	1412-04	SCA	1	1x1	1/8	0	0	FLS	DEB	DEB	QZT	3	0.3	0	0	0	Fine to medium-grained. Pink/tan
42DC1412	1412-05	EU	1	1x1	1/8	0	4	FLS	PPT	HCB	QZT	1	2	39.9	15.8	4	Tannish-gray possibly heat treated.
42DC1412	1412-06	EU	1	1x1	1/8	0	4	FLS	PPT	HCB	QZT	2	3.9	44.3	18.2	4.2	Two pieces conjoin. Slight basal notching. Dark pinkish-purple.
42DC1412	1412-07	EU	1	1x1	1/8	0	4	FLS	DEB	DEB	CCS	211	13.9	0	0	0	White/tan/gray/dark brown
42DC1412	1412-08	EU	1	1x1	1/8	0	4	FLS	DEB	DEB	QZT	3	1.7	0	0	0	Dark pinkish-purple/tan
42DC1412	1412-09	EU	1	1x1	1/8	4	8	FLS	DEB	DEB	CCS	51	3	0	0	0	White/buff/tan. Signs of heat treatment.
42DC1412	1412-10	EU	1	1x1	1/8	4	8	FLS	DEB	DEB	QZT	2	0.6	0	0	0	Gray and tan
42DC1412	1412-11	SCA	2	1x1	1/8	0	0	FLS	PPT	HUM	CCS	1	3.4	33.2	2	4.9	Tanish-white. Slight concave base

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Site Number	Specimen	Unit Type	Unit	Unit Size	Screen	Highdepth	Lowdepth	Group	Class	Type	Material	Count	Weight	Length	Width	Thickness	Comment
42DC1412	1412-12	SCA	2	1x1	1/8	0	0	FLS	BIF	FRG	CCS	1	0.5	15.6	6.7	2.3	Tan/gray
42DC1412	1412-13	SCA	2	1x1	1/8	0	0	FLS	DEB	DEB	CCS	9	1.5	0	0	0	White/gray/brown/poss. Chalcedony
42DC1412	1412-14	EU	2	1x1	1/8	0	4	FLS	DEB	DEB	CCS	54	3.8	0	0	0	Tan/reddish-brwn/gray/white/poss. Chalcedony
42DC1412	1412-15	EU	2	1x1	1/8	0	4	FLS	DEB	DEB	QZT	10	0.8	0	0	0	Fine to medium-grained. Tan/gray
42DC1412	1412-16	SCA	1	1x1	1/8	0	0	FLS	FLT	EMF	QZT	1	19.5	66.5	57.1	8.7	
42DC1412	1412-17	SCA	1	1x1	1/8	0	0	GDS	SLB	FRG	QZT	2	364	0	0	0	Residue Analysis Sample #6
42DC1412	1412-18	SCA	1	1x1	1/8	0	0	GDS	SLB	FRG	QZT	1	174.4	0	0	0	Residue Analysis Sample #7
42DC1412	1412-19	SCA	1	1x1	1/8	0	0	GDS	SLB	FRG	QTZ	2	130.6	0	0	0	Residue Analysis Sample #8
42DC1412	1412-20	EU	1	1x1		4	5	SMP	CHR	-	CHR	1	1.5	0	0	0	Charcoal from bulk soil sample (Sample #3)
42DC1412	1412-21	EU	1	1x1		4	5	SMP	SOL	-	SOL	1	21.1	0	0	0	Heavy fraction from bulk soil sample (Sample # 3)
42Dc1412	1412-22	EU	1	1x1		4	5	SMP	FLO	BOT	UNI	1	6.7	0	0	0	Light fraction from bulk soil sample (Sample #3)
42DC1412	1412-23	EU	1	1x1		4	5	SMP	FLO	BOT	CHR	1	0.1	0	0	0	Picea sp. From bulk soil sample (Sample #3)
42DC1412	1412-24	EU	1	1x1		4	5	SMP	FLO	BOT	CHR	1	0.1	0	0	0	Paranchyma tissue from bulk soil sample (Sample #3)
42Dc1412	1412-25	SC		1x1		0	0	SMP	SOL	-	SOL	1	8.8	0	0	0	Bulk Off-unit soil sample from site surface (Sample #1)
42DC1412	1412-26	SC	1	1x1		0	5	SMP	SOL	-	SOL	1	148.8	0	0	0	Bulk soil sample from Unit 1 SE Quad (Sample #2)
IF5-2000	IF5-01	SCA				0	0	FLS	PPT	FRG	OBS	1	2.1	21.7	19.7	5.4	XRF-Topaz Mountain
IF-A Island Lakes	IF-A-01	SCA				0	0	FLS	PPT	GSS	CCS	1	4.9	51.2	23.3	4.9	Tan w/gray spreckles

Appendix B:

Flaked Stone Analysis

HIGH MOUNTAIN LAKES DEBITAGE ANALYSIS KEY

The Sagebrush debitage catalog is comprised of 23 fields. The following provides a key to codes and abbreviations used in the catalog.

Site No: Site number

Unit/Level: Designated unit and level number. Level 1 is first level excavated (typically 0-5 centimeters below the surface); Level 2 is typically 5 to 10 centimeters below the surface, etc.

Description: Artifact classification

MTRL: Material type

CCS: Cryptocrystalline silicate   OBS: Obsidian   QZT: Quartzite

PD: *Primary Decortication*: any piece of debitage with more than 70% of its dorsal surface covered by cortex.

SD:: *Secondary Decortication*: any piece of debitage with less than 70% of its dorsal surface covered by cortex.

SI: *Simple Interior*: a non-cortical flake with two or less negative flake scars on its dorsal surface, excluding platform preparation scars.

CI: *Complex Interior*: a non-cortical flake with three or more negative flake scars on its dorsal surface, excluding platform preparation scars.

BT: *Biface Thinning*: any flake with a bifacial platform and multiple dorsal flake scars.

PR: *Pressure Flakes*

IND: *Indeterminate Flake Fragment*: any flake that is broken, retaining no defining flake attributes such as a platform and proximal or dorsal ends.

SHT: *Shatter*: any angular or blocky fragments of toolstone with no visible flake attributes.

BR: Any flake that is broken, but still retains diagnostic flake attributes.

#CTX: Number of flakes with cortext.

#HT: Number of heat-treated flakes including differential luster/color, spalling, and crazing.

0-5.0; 5.1-10.0, etc.: Size sorting categories in millimeters

SITE NO	UNIT/LEV	DESCRIF	MTRL	CATALO(	COUNT	PD	SD	SI	CI	BT	PR	IND	SHT	BR	#CTX	#HT	0-5.0	5.1-10.0	10.1-20.0	20.1-30.0	30.1-40.0	40.1-50.0
42DC1340	1/Surface	Debitage	CCS	1340-07	1							1			1	1					1	
42DC1340	1/Level 1	Debitage	CCS	1340-09	11							11				4		6	5			
42DC1340	1/Level 1	Debitage	CCS	1340-09	4		4							1	4				2	2		
42DC1340	1/Level 1	Debitage	CCS	1340-09	2			2						1					2			
42DC1340	1/Level 1	Debitage	CCS	1340-09	1				1					1					1			
42DC1340	1/Level 1	Debitage	QZT	1340-10	1	1								1					1			
42DC1340	1/Level 2	Debitage	CCS	1340-11	4							4				1			4			
42DC1340	1/Level 2	Debitage	CCS	1340-11	1				1					1					1			
42DC1340	1/Level 2	Debitage	CCS	1340-11	1					1				1				1				
42DC1340	2/Surface	Debitage	CCS	1340-13	2							2						1	1			
42DC1340	2/Surface	Debitage	CCS	1340-13	1			1						1					1			
42DC1340	2/Surface	Debitage	CCS	1340-13	2				2					1					2			
42DC1340	2/Surface	Debitage	CCS	1340-13	1					1								1				
42DC1340	2/Surface	Debitage	QZT	1340-14	5							5						2	2	1		
42DC1340	2/Surface	Debitage	QZT	1340-14	1				1											1		
42DC1340	2/Surface	Debitage	QZT	1340-14	1						1						1					
42DC1340	2/Level 1	Debitage	CCS	1340-16	52							52			1		2	35	15			
42DC1340	2/Level 1	Debitage	CCS	1340-16	4								4						4			
42DC1340	2/Level 1	Debitage	CCS	1340-16	2		2								2				2			
42DC1340	2/Level 1	Debitage	CCS	1340-16	1			1										1				
42DC1340	2/Level 1	Debitage	CCS	1340-16	2				2									1	1			
42DC1340	2/Level 1	Debitage	CCS	1340-16	10					10				6			1	6	3			
42DC1340	2/Level 1	Debitage	CCS	1340-16	4						4						3	1				
42DC1340	2/Level 1	Debitage	QZT	1340-17	35							35					1	12	22			
42DC1340	2/Level 1	Debitage	QZT	1340-17	6			6										2	4			
42DC1340	2/Level 1	Debitage	QZT	1340-17	4				4									2	2			
42DC1340	2/Level 1	Debitage	QZT	1340-17	3					3				2					3			
42DC1340	2/Level 1	Debitage	OBS	1340-18	1							1						1				
42DC1340	2/Level 2	Debitage	CCS	1340-20	2							2						2				
42DC1340	2/Level 2	Debitage	CCS	1340-20	1			1											1			
42DC1340	2/Level 2	Debitage	CCS	1340-20	1					1								1				
42DC1340	2/Level 2	Debitage	QZT	1340-21	5							5							5			
42DC1340	2/Level 2	Debitage	QZT	1340-21	1			1						1				1				
42DC1340	2/Level 2	Debitage	QZT	1340-21	2				2									1				1
42DC1340	2/Level 2	Debitage	QZT	1340-21	3					3							2	1				
42DC1340	2/Level 2	Debitage	QZT	1340-21	1						1						1					
42DC1340	3/Surface	Debitage	CCS	1340-22	12							12			2	4		2	8	2		
42DC1340	3/Surface	Debitage	CCS	1340-22	5		5								5				3	1	1	
42DC1340	3/Surface	Debitage	CCS	1340-22	2				2										1	1		
42DC1340	3/Surface	Debitage	CCS	1340-22	4					4				3					4			
42DC1340	3/Surface	Debitage	CCS	1340-22	1								1						1			
42DC1340	3/Surface	Debitage	QZT	1340-23	1							1						1				
42DC1340	3/Level 1	Debitage	CCS	1340-24	10							10				2		2	4	1		
42DC1340	3/Level 1	Debitage	CCS	1340-24	1		1								1							1
42DC1340	3/Level 1	Debitage	CCS	1340-24	4				4					2		2		1	1	1	1	

SITE NO	UNIT/LEV	DESCRIP	MTRL	CATALOG	COUNT	PD	SD	SI	CI	BT	PR	IND	SHT	BR	#CTX	#HT	0-5.0	5.1-10.0	10.1-20.0	20.1-30.0	30.1-40.0	40.1-50.0
42DC1340	3/Level 1	Debitage	CCS	1340-24	2					2				1		1		1	1			
42DC1340	3/Level 1	Debitage	CCS	1340-24	1						1						1					
42DC1341	Site Surfa	Debitage	OBS	1341-06	1				1					1					1			
42DC1341	1/Surface	Debitage	CCS	1341-07	1			1						1					1			
42DC1341	2/Surface	Debitage	CCS	1341-09	1							1							1			
42DC1341	2/Surface	Debitage	CCS	1341-09	3				3					1					2	1		
42DC1341	2/Surface	Debitage	QZT	1341-10	1				1					1						1		
42DC1341	2/Surface	Debitage	OBS	1341-11	1							1						1				
42DC1341	2/Surface	Debitage	OBS	1341-11	4					4				4				2	2			
42DC1341	2/Level 1	Debitage	CCS	1341-12	18							18				3	5	13				
42DC1341	2/Level 1	Debitage	CCS	1341-12	1				1							1			1			
42DC1341	2/Level 1	Debitage	CCS	1341-12	3					3				2			1	2				
42DC1341	2/Level 1	Debitage	CCS	1341-12	3						3							3				
42DC1341	2/Level 1	Debitage	CCS	1341-12	1								1					1				
42DC1341	2/Level 1	Debitage	QZT	1341-13	3							3					1	2				
42DC1341	2/Level 1	Debitage	QZT	1341-13	1			1						1				1				
42DC1341	2/Level 1	Debitage	QZT	1341-13	1					1				1				1				
42DC1341	2/Level 1	Debitage	OBS	1341-14	13							13					4	8	1			
42DC1341	2/Level 1	Debitage	OBS	1341-14	3					3				2					3			
42DC1341	2/Level 1	Debitage	OBS	1341-14	2						2						1	1				
42DC1341	2/Level 2	Debitage	CCS	1341-15	4							4						4				
42DC1341	2/Level 2	Debitage	CCS	1341-15	2			2						2				2				
42DC1341	2/Level 2	Debitage	CCS	1341-15	2				2					2				2				
42DC1341	2/Level 2	Debitage	CCS	1341-15	1					1								1				
42DC1341	2/Level 2	Debitage	CCS	1341-15	2								2			1		1	1			
42DC1341	2/Level 2	Debitage	QZT	1341-16	1							1						1				
42DC1341	2/Level 2	Debitage	QZT	1341-16	1						1							1				
42DC1341	2/Level 2	Debitage	OBS	1341-17	1							1						1				
42DC1341	3/Surface	Debitage	CCS	1341-18	3														3			
42DC1341	3/Surface	Debitage	CCS	1341-18	1					1				1				1				
42DC1341	3/Level 1	Debitage	CCS	1341-19	4							4				2			4			
42DC1341	3/Level 1	Debitage	CCS	1341-19	1				1					1				1				
42DC1341	3/Level 1	Debitage	CCS	1341-19	1					1				1				1				
42DC1341	3/Level 1	Debitage	QZT	1341-20	1							1							1			
42DC1341	3/Level 1	Debitage	QZT	1341-20	1					1				1					1			
42DC1341	3/Level 1	Debitage	OBS	1341-21	2							2						2				
42DC1341	3/Level 2	Debitage	CCS	1341-22	6							6						5	1			
42DC1341	3/Level 2	Debitage	CCS	1341-22	1				1										1			
42DC1341	3/Level 2	Debitage	CCS	1341-22	1					1				1				1				
42DC1341	3/Level 2	Debitage	QZT	1341-23	2							2							2			
42DC1341	3/Level 2	Debitage	QZT	1341-23	1			1						1				1				
42DC1341	3/Level 2	Debitage	QZT	1341-23	1					1				1					1			
42DC1341	3/Level 2	Debitage	QZT	1341-23	1						1						1					
42DC1342	1/Surface	Debitage	CCS	1342-02	1							1								1		
42DC1342	1/Surface	Debitage	CCS	1342-02	1	1								1							1	

DEBITAGE ANALYSIS CATALOG

SITE NO	UNIT/LEV	DESCRIF	MTRL	CATALO(	COUNT	PD	SD	SI	CI	BT	PR	IND	SHT	BR	#CTX	#HT	0-5.0	5.1-10.0	10.1-20.0	20.1-30.0	30.1-40.0	40.1-50.0
42DC1342	1/Level 1	Debitage	CCS	1342-04	6							6						4	2			
42DC1342	1/Level 1	Debitage	CCS	1342-04	1				1							1					1	
42DC1342	1/Level 1	Debitage	CCS	1342-04	1					1				1					1			
42DC1342	1/Level 1	Debitage	QZT	1342-05	2							2							2			
42DC1342	1/Level 1	Debitage	QZT	1342-05	1			1						1				1				
42DC1342	2/Surface	Debitage	CCS	1342-06	1							1										1
42DC1342	2/Level 1	Debitage	CCS	1341-07	7							7				3		7				
42DC1342	2/Level 1	Debitage	CCS	1341-07	1	1																1
42DC1342	2/Level 1	Debitage	CCS	1341-07	1				1					1				1				
42DC1342	2/Level 1	Debitage	QZT	1342-08	3							3					1	2				
42DC1342	2/Level 1	Debitage	QZT	1342-08	1			1												1		
42DC1342	2/Level 1	Debitage	QZT	1342-08	2						2							2				
42DC1342	2/Level 1	Debitage	OBS	1342-09	1					1								1				
42DC1342	2/Level 2	Debitage	CCS	1342-10	1							1						1				
42DC1342	2/Level 2	Debitage	CCS	1342-10	1			1											1			
42DC1342	2/Level 2	Debitage	CCS	1342-10	1						1						1					
42DC1342	2/Level 2	Debitage	QZT	1342-11	2							2						2				
42DC1342	2/Level 2	Debitage	QZT	1342-11	1					1								1				
42DC1342	2/Level 2	Debitage	QZT	1342-11	1						1							1				
42DC1342	3/Surface	Debitage	CCS	1342-12	3							3				1		1	2			
42DC1342	3/Surface	Debitage	CCS	1342-12	1				1					1						1		
42DC1342	3/Surface	Debitage	CCS	1342-12	1					1				1					1			
42DC1342	3/Level 1	Debitage	CCS	1342-14	5							5				2		3	2			
42DC1342	3/Level 1	Debitage	CCS	1342-14	1		1								1							1
42DC1342	3/Level 1	Debitage	CCS	1342-14	2					2				1				1	1			
42DC1342	3/Level 1	Debitage	CCS	1342-14	3								3			1			3			
42DC1342	3/Level 1	Debitage	QZT	1342-15	1			1						1				1				
42DC1342	3/Level 1	Debitage	QZT	1342-15	1					1				1				1				
42DC1342	3/Level 1	Debitage	QZT	1342-15	1						1						1					
42DC1344	Site Surfa(	Debitage	OBS	1344-05	1				1											1		
42DC1344	Site Surfa(	Debitage	OBS	1344-06	1					1										1		
42DC1344	1/Surface	Debitage	QZT	1344-01	1					1				1				1				
42DC1344	1/Surface	Debitage	OBS	1344-02	4							4						1	3			
42DC1344	1/Surface	Debitage	OBS	1344-02	1			1											1			
42DC1344	1/Surface	Debitage	OBS	1344-02	2					2									2			
42DC1344	1/Surface	Debitage	OBS	1344-02	1						1						1					
42DC1344	1/Surface	Debitage	OBS	1344-07	1					1									1			
42DC1344	1/Level 1	Debitage	OBS	1344-03	2							2						1	1			
42DC1344	1/Level 1	Debitage	OBS	1344-03	6					6				2					4	2		
42DC1344	1/Level 1	Debitage	QZT	1344-04	1							1		1				1				
42DC1411	1/Surface	Debitage	CCS	1411-02	2							2							2			
42DC1411	1/Surface	Debitage	CCS	1411-02	1					1									1			
42DC1411	1/Level 1	Debitage	CCS	1411-04	5							5				1		1	4			
42DC1411	1/Level 1	Debitage	CCS	1411-04	1		1								1				1			
42DC1411	1/Level 1	Debitage	CCS	1411-04	3					3				3			1	2				

DEBITAGE ANALYSIS CATALOG

SITE NO	UNIT/LEV	DESCRIP	MTRL	CATALOG	COUNT	PD	SD	SI	CI	BT	PR	IND	SHT	BR	#CTX	#HT	0-5.0	5.1-10.0	10.1-20.0	20.1-30.0	30.1-40.0	40.1-50.0
42DC1411	1/Level 1	Debitage	CCS	1411-04	1								1					1				
42DC1411	1/Level 1	Debitage	QZT	1411-05	1							1						1				
42DC1411	1/Level 1	Debitage	QZT	1411-05	1			1										1				
42DC1411	1/Level 1	Debitage	QZT	1411-05	1					1								1				
42DC1411	2/Surface	Debitage	CCS	1411-06	1							1							1			
42DC1411	2/Surface	Debitage	QZT	1411-07	1			1												1		
42DC1411	2/Level 1	Debitage	CCS	1411-08	2							2							1	1		
42DC1411	2/Level 1	Debitage	CCS	1411-08	2					2								1	1			
42DC1411	2/Level 1	Debitage	QZT	1411-09	1				1											1		
42DC1412	1/Surface	Debitage	CCS	1412-03	3							3							3			
42DC1412	1/Surface	Debitage	CCS	1412-03	1			1											1			
42DC1412	1/Surface	Debitage	CCS	1412-03	3					3				2		1		1	2			
42DC1412	1/Surface	Debitage	QZT	1412-04	2							2						1	1			
42DC1412	1/Surface	Debitage	QZT	1412-04	1					1				1				1				
42DC1412	1/Level 1	Debitage	CCS	1412-07	165							165			1	18	20	127	18			
42DC1412	1/Level 1	Debitage	CCS	1412-07	1		1								1				1			
42DC1412	1/Level 1	Debitage	CCS	1412-07	12			12										5	6		1	
42DC1412	1/Level 1	Debitage	CCS	1412-07	14					14				7		3		2	12			
42DC1412	1/Level 1	Debitage	CCS	1412-07	10						10					2	7	3				
42DC1412	1/Level 1	Debitage	CCS	1412-07	9								9				9					
42DC1412	1/Level 1	Debitage	QZT	1412-08	1							1						1				
42DC1412	1/Level 1	Debitage	QZT	1412-08	1		1							1	1					1		
42DC1412	1/Level 1	Debitage	QZT	1412-08	1				1									1				
42DC1412	1/Level 2	Debitage	CCS	1412-09	39							39				6		34	5			
42DC1412	1/Level 2	Debitage	CCS	1412-09	2				2									1	1			
42DC1412	1/Level 2	Debitage	CCS	1412-09	8					8				5		4		6	2			
42DC1412	1/Level 2	Debitage	CCS	1412-09	2						2							2				
42DC1412	1/Level 2	Debitage	QZT	1412-10	1				1					1					1			
42DC1412	1/Level 2	Debitage	QZT	1412-10	1					1				1				1				
42DC1412	2/Surface	Debitage	CCS	1412-13	7							1			1			3	4			
42DC1412	2/Surface	Debitage	CCS	1412-13	1				1									1				
42DC1412	2/Surface	Debitage	CCS	1412-13	1					1				1		1		1				
42DC1412	2/Level 1	Debitage	CCS	1412-14	43							43				5		37	6			
42DC1412	2/Level 1	Debitage	CCS	1412-14	5				5					4				1	4			
42DC1412	2/Level 1	Debitage	CCS	1412-14	3					3				1		1		3				
42DC1412	2/Level 1	Debitage	CCS	1412-14	3						3						3					
42DC1412	2/Level 1	Debitage	QZT	1412-15	7							7						6	1			
42DC1412	2/Level 1	Debitage	QZT	1412-15	1				1										1			
42DC1412	2/Level 1	Debitage	QZT	1412-15	1					1								1				
42DC1412	2/Level 1	Debitage	QZT	1412-15	1								1					1				

HIGH MOUNTAIN LAKES FLAKE TOOL ANALYSIS KEY

The Sagebrush flake tool catalog is comprised of 18 fields. The following provides a key to codes and abbreviations used in the catalog. Measurements are in millimeters with negative values for incomplete measurements.

Site No: Site number

Description: Artifact classification

MTRL: Material type

CCS: Cryptocrystalline silicate   QZT: Quartzite

Length: Length (proximal to distal; maximum dimensions on whole or fragmentary artifacts that cannot be oriented)

Width: Width (perpendicular to length)

Thickness: Maximum thickness

BLK: Blank type

Int-Interior flake

NOMOD: Number of modified edges

MOD1: Modification of edge 1:

1-unifacial   2-alternating unifacial   3-bifacial

SURF: Surface used

MOD2: Modification of edge 2:

1-unifacial   2-alternating unifacial   3-bifacial

Use Wear: Micro-chipping, edge flaked, or indeterminate

HT: Presence of heat treatment:

0-None   X-Present

COMP: Complete (indicated by X)

FRAG: Fragment (indicated by X)

Comments: Any distinguishing characteristics (i.e. heat treatment, cortex, material color or texture).

SITE NO	DESCRIPTION	CATELOG	MTRL	LENGTH	WIDTH	THICK	BLK	NOMOD	MOD1	SURF	MOD2	SURF	USE WEAR	HT	COMPL	FRAG	COMMENT
42DC1340	FORMED FLAKE TOOL	1340-04	CCS	21.5	14.6	3.1	Int	1	Bifacial	Dorsal/Ventral	0	0	IND	0			Scraper
42DC1340	FORMED FLAKE TOOL	1340-06	CCS	-29.1	-22.4	10.6	Int	2	Unifacial	Dorsal	Unifacial	Dorsal	Micro-chippi	X		X	Uniface
42DC1340	SIMPLE FLAKE TOOL	1340-08	QZT	-29	19.6	5.1	Int	2	Unifacial	Dorsal	Unifacial	Dorsal	IND	0		X	
42DC1340	SIMPLE FLAKE TOOL	1340-12	QZT	30.9	24.4	5.2	Int	2	Unifacial	Dorsal	Bifacial	Dorsal/Ventral	Micro-chipping		X		
42DC1340	FORMED FLAKE TOOL	1340-15	CCS	30.8	18.3	18.1	Int	1	Unifacial	Dorsal	0	0	IND	X	X		Steep-sided scraper
42DC1340	SIMPLE FLAKE TOOL	1340-25	CCS	32.4	16.1	6.1	Int	1	Bifacial	Dorsal/Ventral	0	0	IND	0	X		
42DC1341	SIMPLE FLAKE TOOL	1341-24	CCS	28.3	-18.7	2.9	Int	1	Bifacial	Dorsal/Ventral	0	0	IND	0		X	
42DC1411	SIMPLE FLAKE TOOL	1411-03	CCS	29.8	-23.8	8	Int	2	Unifacial	Dorsal	Bifacial	Dorsal/Ventral	IND	0		X	
42DC1412	SIMPLE FLAKE TOOL	1412-16	QZT	66.5	57.1	8.7	Int	1	Alternating	Dorsal/Ventral	0	0	IND	0	X		

HIGH MOUNTAIN LAKES BIFACE TOOL ANALYSIS KEY

The Sagebrush biface catalog is comprised of 17 fields. The following provides a key to codes and abbreviations used in the catalog. Measurements are in millimeters with negative values for incomplete measurements.

Site No: Site number

Unit/Level: Designated unit and level number. Level 1 is first level excavated (typically 0-5 centimeters below the surface); Level 2 is typically 5 to 10 centimeters below the surface.

Description: Artifact classification

MTRL: Material type

CCS: Cryptocrystalline silicate   OBS-Obsidian   QZT: Quartzite

Length: Length (proximal to distal; maximum dimensions on whole or fragmentary artifacts that cannot be oriented)

Width: Width (perpendicular to length)

Thickness: Maximum thickness

BLK: Blank type

1-cobble	3-chunk
2-flake	4-indeterminate

STG: Stage

1-blank prep	3-early thinning	5-finished/notching
2-edge prep/shaping	4-late thinning	

CTX: Cortext (0=Absent)

SHP: Planar Shape: ovate, irregular, and indeterminate

REW: Use Wear: Absent or Present

Use Wear: Micro-chipping, edge flaked, or indeterminate

HT: Presence of heat treatment:

0-None   X-Present

COMP: Complete (indicated by X)

FRAG: Fragment (indicated by X)

Comments: Any distinguishing characteristics (i.e. XRF data).

BIFACE ANALYSIS CATALOG

SITE NO	DESCRIPT	CATALOG	MTRL	LENGTH	WIDTH	THICK	BLK	STG	CTX	SHP	REW	USE	HT	COMPL	FRAG	COMMENT
42DC1341	BIFACE	1341-02	CCS	-35.2	-21.4	6.5	2	3	0	Ovate	Absent	Absent	X		X	
42DC1341	BIFACE	1341-08	CCS	-23.7	-22.4	8.5	4	3	0	Ovate	Absent	Absent	0		X	
42DC1342	BIFACE	1342-13	CCS	-31.4	-34.2	9.8	4	2	0	IND	Absent	Absent	X		X	
42DC1411	BIFACE	1411-01	QZT	42.6	30.9	9.8	2	2	0	Irregular	Absent	Absent	0	X		
42DC1412	BIFACE	1412-12	CCS	15.6	6.7	2.3	4	5	0	IND	Absent	Absent	X		X	
IF5-2000	BIFACE	IF5-01	OBS	-21.7	-19.7	5.4	4	4	0	IND	Absent	Absent	0	0	X	Medial fragment; XRF-Topaz Mountain

HIGH MOUNTAIN LAKES PROJECTILE POINT ANALYSIS KEY

The Sagebrush projectile point catalog is comprised of 16 fields. The following provides a key to codes and abbreviations used in the catalog. Measurements are in millimeters with negative values for incomplete measurements.

Site No: Site number

Description: Artifact classification

MTRL: Material type

CCS: Cryptocrystalline silicate   QZT: Quartzite

ML: Maximum length (proximal to distal; maximum dimensions on whole or fragmentary artifacts that cannot be oriented)

MW: Maximum width (perpendicular to length)

MT: Maximum thickness

WT: Weight (in grams)

BW: Base width

NW: Neck width

STL: Stem length

HT: Presence of heat treatment:

0-Absence   X-Present

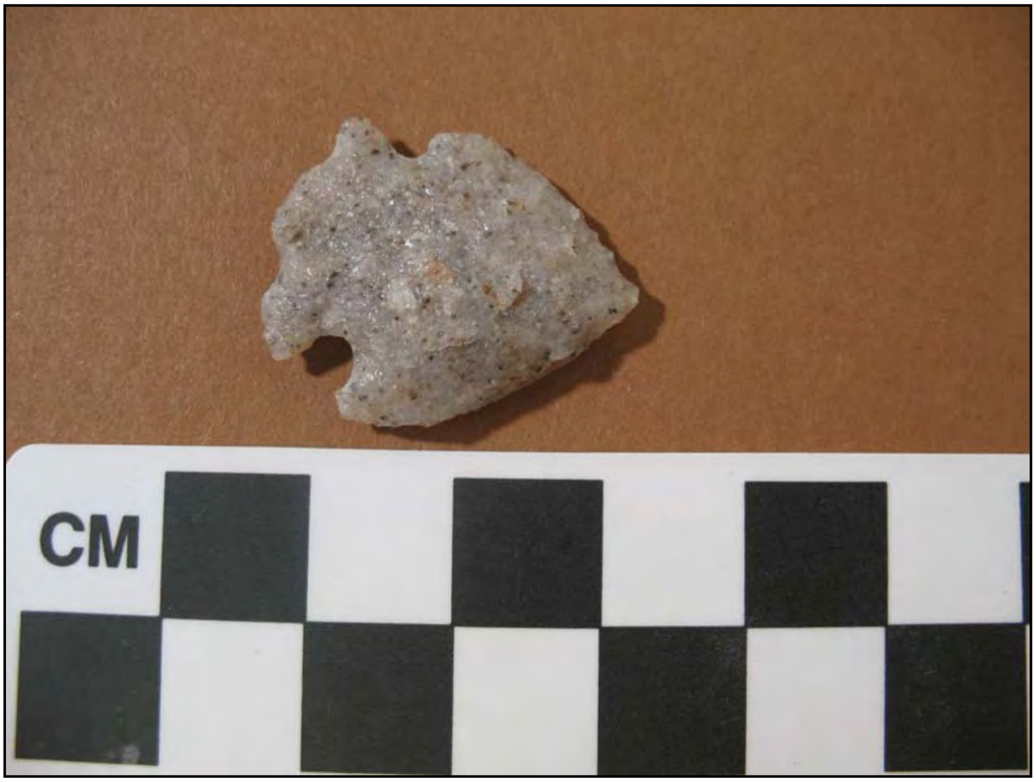
COMP: Complete (indicated by X)

FRAG: Fragment (indicated by X)

Comments: Any distinguishing characteristics

SITE NO	DESCRIPTION	CATALOG	MTRL	TYPE	ML	MW	MT	WT	BW	NW	STL	HT	COMP	FRAG	COMMENT
42DC1340	PROJECTILE POINT	1340-01	CCS	PINTO SQUARE-SHOULDER	-31.7	15	3.9	2.3	10.7	9.1	6.2	X		X	Nearly complete- tip missing; two conjoining fragments
42DC1340	PROJECTILE POINT	1340-02	CCS	CONCAVE BASE	-10.5	-12.7	-3.4	0.6	10.9	11.6	0	X		X	Non-diagnostic base fragment
42DC1340	PROJECTILE POINT	1340-03	QZT	ELKO CORNER-NOTCHED	24.6	21.3	4.4	2.7	17	12.6	4.6	0	X		Heavily reworked
42DC1340	PROJECTILE POINT	1340-05	CCS	INDETERMINATE	-18.6	-14.1	4.5	1.1	0	0	0	X		X	Distal end- discoloration/potlidding
42DC1341	PROJECTILE POINT	1341-01	CCS	CORNER-NOTCHED	-39.6	-29.3	5.3	8	15.4	14.5	9.3	0		X	Large, proiximal end; uniformly serrated edge
42DC1341	PROJECTILE POINT	1341-03	CCS	DESERT SIDE-NOTCHED	20.8	12.5	1.9	0.6	-8.2	5.3	4.2	0	X		Distal tip and one tang broken off
42DC1341	PROJECTILE POINT	1341-04	CCS	ELKO SIDE-NOTCHED	-27.5	20.6	4.4	3.2	0	13	0	0		X	Stem broken off
42DC1341	PROJECTILE POINT	1341-05	QZT	HUMBOLDT CONCAVE BASE	31.5	15.5	4.5	2.8	13.3	0	0	0	X		Basal thinning flakes
42DC1342	PROJECTILE POINT	1342-01	QZT	INDETERMINATE	-16.2	-15.2	2.3	0.8	0	0	0	0		X	Distal end
42DC1342	PROJECTILE POINT	1342-03	QZT	INDETERMINATE	-16.4	13.3	3.1	1	0	0	0	0		X	Medial fragment; median ridge on one side
42DC1412	PROJECTILE POINT	1412-01	CCS	INDETERMINATE	-13.2	-11.1	3.2	0.6	0	0	0	0		X	Distal end; crude shape
42DC1412	PROJECTILE POINT	1412-02	CCS	INDETERMINATE	-14	-11.5	2.9	0.4	0	0	0	0		X	Distal end; partial oblique flake pattern
42DC1412	PROJECTILE POINT	1412-05	QZT	HUMBOLDT CONCAVE BASE	40.6	15.6	4	2	14.8	0	0	0	X		Finely pressure flaked
42DC1412	PROJECTILE POINT	1412-06	QZT	HUMBOLDT CONCAVE BASE	44.4	17.9	4.3	3.9	17.6	0	0	0	X		Two conjoining fragments; horizontal transverse flaking
42DC1412	PROJECTILE POINT	1412-11	CCS	HUMBOLDT SERIES	33.4	20.1	4.9	3.4	18.4	0	0	0	X		Reworked on one margin
IF-A	PROJECTILE POINT	IF-A-01	CCS	GATECLIFF SPLIT STEM	51.2	23.4	4.8	4.9	11.8	13.5	8.4	X	X		Random flakeing pattern

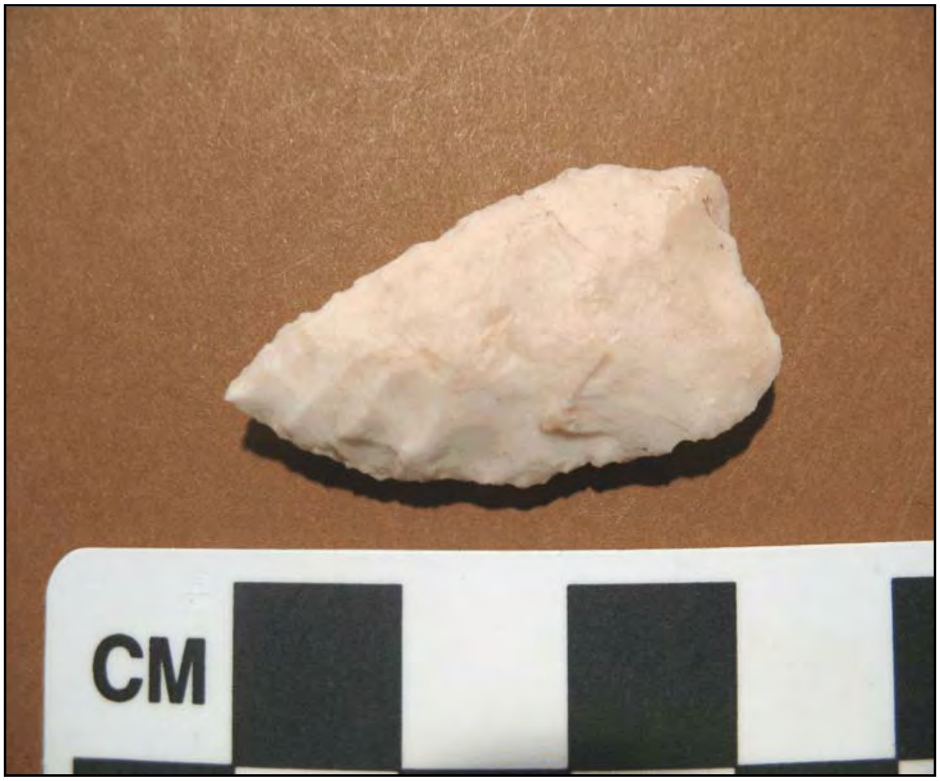
42Dc1340. Pinto Square-shouldered (Catalog No. 1340-01) of Cryptocrystalline Silicate. Surface Collected Artifact.



42Dc1340. Heavily Reworked Elko Corner-notched (Catalog No. 1340-03) of Ouartzite. Surface Collected Artifact

42Dc1341. Desert Side-notched (Catalog No. 1341-03) of Cryptocrystalline Silicate. Surface Collected Artifact.

42Dc1341. Elko Side-notched (Catalog No. 1341-04) of Cryptocrystalline Silicate. Surface Collected Artifact.



42Dc1341. Humboldt Series (Catalog No. 1341-05) of Cryptocrystalline Silicate. Surface Collected Artifact.

42Dc1412. Humboldt Concave Base (Catalog No. 1412-05) of Cryptocrystalline Silicate. Excavation Unit 1, 0-4 cmbd.

42Dc1412. Humboldt Concave Base (Catalog No. 1412-06) of Ouartzite. Excavation Unit . 0-4 cmbs.

42Dc1412. Humboldt Series (Catalog No. 1412-11) of Cryptocrystalline Silicate. Excavation Unit 2. Surface Collected Artifact.

Appendix C:

Results of Pollen/Phytolith, Macrofloral, Organic Residue and AMS Radiocarbon Dating Analysis

(Paleo Research Institute)

POLLEN, PHYTOLITH, MACROFLORAL, ORGANIC RESIDUE, AMS RADIOCARBON DATING, AND/OR BOTANIC ANALYSES FOR SITES 42DC1412, 42DC1340, AND 42DC1342, UTAH

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Paleo Research Institute Technical Report 08-39

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June 2008

INTRODUCTION

Samples from sites 42Dc1412 and 42Dc1340 in the Uintah Mountains of the Ashley National Forest were submitted for pollen, phytolith, macrofloral, and organic residue (FTIR) analyses. Pollen and phytolith analysis will identify plants that are part of the local and regional vegetation communities. Examination of three pieces of groundstone and two sediment samples using FTIR analysis to identify organic residues was undertaken to recover evidence of plant processing. Macrofloral analysis of sediment samples from each of these sites also will provide information concerning types of wood burned as fuel and possible subsistence information. An AMS radiocarbon date was obtained for charcoal from each of the macrofloral samples. A single botanic specimen from site 42Dc1342 also was submitted for identification.

METHODS

Pollen

A chemical extraction technique based on flotation is the standard preparation technique used in this laboratory for the removal of the pollen from the large volume of sand, silt, and clay with which they are mixed. This particular process was developed for extraction of pollen from soils where preservation has been less than ideal and pollen density is lower than in bogs or lake sediments.

Hydrochloric acid (10%) was used to remove calcium carbonates present in the soil, after which the sample was screened through 150 micron mesh. The sample was rinsed until neutral by adding water, letting the sample stand for 2 hours, then pouring off the supernatant. A small quantity of sodium hexametaphosphate was added to the sample once it reached neutrality, then the beaker again was filled with water and allowed to stand for 2 hours. The sample was again rinsed until neutral, filling the beaker only with water. This step was added to remove clay prior to heavy liquid separation. At this time the sample was dried, then pulverized. Sodium polytungstate (density 2.1) was used for the flotation process. The sample was mixed with sodium polytungstate and centrifuged at 1500 rpm for 10 minutes to separate organic from inorganic remains. The supernatant containing pollen and organic remains was decanted. Sodium polytungstate again was added to the inorganic fraction to repeat the separation process. The supernatant was decanted into the same tube as the supernatant from the first separation. This supernatant was then centrifuged at 1500 rpm for 10 minutes to allow any silica remaining to be separated from the organics. Following this, the supernatant was decanted into a 50 ml conical tube and diluted with distilled water. The sample was centrifuged at 3000 rpm to concentrate the organic fraction in the bottom of the tube. After rinsing the pollen-rich organic fraction obtained by this separation, the sample received a short (20-30 minute) treatment in hot hydrofluoric acid to remove any remaining inorganic particles. The sample then was acetolated for 3-5 minutes to remove any extraneous organic matter.

A light microscope was used to count the pollen to a total of approximately 200 pollen grains at a magnification of 500x. Pollen preservation in this sample was poor. Comparative reference material collected at the Intermountain Herbarium at Utah State University and the University of Colorado Herbarium was used to identify the pollen to the family, genus, and species level, where possible.

Indeterminate pollen includes pollen grains that are folded, mutilated, and otherwise distorted beyond recognition. These grains are included in the total pollen count, as they are part of the pollen record. The charcoal frequency registers the relationship between pollen and charcoal. The total number of microscopic charcoal fragments was divided by the pollen sum, resulting in a charcoal frequency that reflects the quantity of charcoal observed, normalized per 100 pollen grains.

Pollen aggregates were recorded during identification of the pollen. Aggregates are clumps of a single type of pollen and may be interpreted to represent pollen dispersal over short distances or the introduction of portions of the plant represented into an archaeological setting. Aggregates were included in the pollen counts as single grains, as is customary. The presence of aggregates is noted by an "A" next to the pollen frequency on the pollen diagram. Pollen diagrams are produced using Tilia, which was developed by Dr. Eric Grimm of the Illinois State Museum. Total pollen concentrations are calculated in Tilia using the quantity of sample processed in cubic centimeters (cc), the quantity of exotics (spores) added to the sample, the quantity of exotics counted, and the total pollen counted and expressed as pollen per cc of sediment.

Pollen analysis also included identification of starch granules to general categories, if they were present. Starch granules are a plant's mechanism for storing carbohydrates. Starches are found in numerous seeds, as well as in starchy roots and tubers. The primary categories of starches include the following: with or without visible hila, hilum centric or eccentric, hila patterns (dot, cracked, elongated), and shape of starch (angular, ellipse, circular, eccentric). Some of these starch categories are typical of specific plants, while others are more common and tend to occur in many different types of plants.

Phytoliths

A pressurized (closed) microwave digestion technique was used to oxidize the majority of the organic fraction of the samples. Specific protocols were developed by PRI, but based on a few previous studies (Parr, et al. 2001; Parr, et al. 2004). Sediment (1.25 ml) was placed in a glass vial with 5 ml nitric acid (HNO_3), 1 ml hydrochloric acid (HCl), and 1 ml of hydrogen peroxide (H_2O_2). Each glass vial was placed and sealed into a Teflon vessel with outer casement and screw cap seal. One vessel was connected to a pressure sensor transducer for real-time pressure monitoring by the in-built microwave computer system (Floyd Inc. Remote Microwave System 150). Samples were programmed for exposure to 80 psi at a dwell time of 45 minutes, using 50% magnetron power, then allowed to cool and depressurize. Samples were then removed from microwave and rinsed to neutral in 50 ml centrifuge tubes (4 X 3000 rpm for 2 min). One ml of 5% potassium hydroxide (KOH) was added to each sample and then throughly mixed. KOH aids in removal of humic substances undigested by acid oxidation. Samples were then rinsed to neutral and sieved through a 250 µm mesh, transferred to 15 ml and then dried using a partial vacuum drying system (lyophilization). The lyophilized samples were then subjected to heavy liquid flotation to separate silica phytoliths from non-silica particles using sodium polytungstate with a density of 2.3 g/ml. Samples were centrifuged for 10 minutes at 1700 rpm, and the supernatant containing phytoliths decanted. The supernatant was then diluted with distilled water and centrifuged at 3000 rpm for 10 minutes to concentrate the phytolith fraction in the bottom of the tube. Additional rinses were then conducted to wash any remaining heavy liquid from the sample. The remaining clay-sized particles were removed with short-time centrifugation in 15 ml tubes (typically 1 or 2 spins at 3000 RPM for 1.5 min). After several alcohol rinses, samples were transferred to storage vials, and a small portion mounted in Cargille Type-A immersion oil (refractive index 1.515), with two opposite coverslip corners affixed with nail polish to allow for controlled phytolith rotation and counting with a light microscope at a magnification of 500x. Phytolith diagrams were produced using Tilia, which was developed by Dr. Eric Grimm of the Illinois State Museum for diagraming pollen.

Macrofloral

The macrofloral samples were floated using a modification of the procedures outlined by Matthews (1979). Each sample was added to approximately 3 gallons of water, then stirred until a strong vortex formed. The floating material (light fraction) was poured through a 150 micron mesh sieve. Additional water was added and the process repeated until all floating material was removed from the sample (a minimum of five times). The material that remained in the bottom (heavy fraction) was poured through a 0.5-mm mesh screen. The floated portions were allowed to dry.

The light fractions were weighed, then passed through a series of graduated screens (US Standard Sieves with 2-mm, 1-mm, 0.5-mm and 0.25-mm openings) to separate charcoal debris and to initially sort the remains. The contents of each screen then were examined. Charcoal pieces larger than 2-mm, 1-mm, or 0.5-mm in diameter were separated from the rest of the light fraction and the total charcoal weighed. A representative sample of these charcoal pieces was broken to expose a fresh cross section and examined under a binocular microscope at a magnification of 70x. The weights of each charcoal type within the representative sample also were recorded. The material that remained in the 2-mm, 1-mm, 0.5-mm, and 0.25-mm sieves was scanned under a binocular stereo microscope at a magnification of 10x, with some identifications requiring magnifications of up to 70x. The material that passed through the 0.25-mm screen was not examined. The heavy fractions were scanned at a magnification of 2x for the presence of botanic remains. Remains from the light and heavy fractions were recorded as charred and/or uncharred, whole and/or fragments. The single botanic sample was examined under a binocular microscope at a magnification of 10x. The term "seed" is used to represent seeds, achenes, caryopses, and other disseminules. Macrofloral remains are identified using manuals (Martin and Barkley 1961; Musil 1963; Schopmeyer 1974) and by comparison with modern and archaeological references.

Samples from archaeological sites commonly contain both charred and uncharred remains. Many ethnobotanists use the basic rule that unless there is a specific reason to believe otherwise, only charred remains will be considered prehistoric (Minnis 1981:147). Minnis (1981:147) states that it is "improbable that many prehistoric seeds survive uncharred through common archaeological time spans." Few seeds live longer than a century, and most live for a much shorter period of time (Harrington 1972; Justice and Bass 1978; Quick 1961). It is presumed that once seeds have died, decomposing organisms act to decay the seeds. Sites in caves, water-logged areas, and in very arid areas, however, can contain uncharred prehistoric remains. Interpretation of uncharred seeds to represent presence in the prehistoric record is considered on a sample-by-sample basis. Extraordinary conditions for preservation are required.

AMS Radiocarbon Dating - Charcoal and Wood

Wood and charcoal samples submitted for radiocarbon dating are identified and weighed prior to selecting subsamples for pre-treatment. The remainder of each sample, if there is any, is permanently curated at Paleo Research. The subsample selected for pre-treatment is first subjected to hot (at least 110 °C), 6N hydrochloric acid (HCl), with rinses to neutral between each HCl treatment, until the supernatant is clear. This removes iron compounds and calcium carbonates that would hamper removal of humate compounds later. Next the samples are subjected to 5% potassium hydroxide (KOH) to remove humates. Once again, the samples are rinsed to neutral and re-acidified with pH 2 HCl between each KOH step. This step is repeated until the supernatant is clear, signaling removal of all humates. After humate removal, each sample is made slightly acidic and left that way for the next step. Charcoal samples (but not wood samples) are subjected to a concentrated, hot nitric acid bath, which removes all modern and recent organics. This treatment is not used on unburned or partially burned wood samples because it oxidizes the submitted sample of unknown age.

Each submitted sample is then freeze-dried using a vacuum system, freezing out all moisture at -98 °C. Each individual sample is combined with cupric oxide (CuO) and elemental silver (Ag^{o}) in a quartz tube, then flame sealed under vacuum.

Standards and laboratory background samples also are treated in the same manner as the wood and charcoal samples of unknown age. A radiocarbon "dead" EUA wood blank from Alaska that is more than 70,000 years old (currently beyond the detection capabilities of AMS) is treated using the same chemical processing as the samples of unknown age in order to calibrate the laboratory correction factor. Standards of known age, such as Two Creeks wood that dates to 11,400 RCYBP and others from the Third International Radiocarbon Intercomparison (TIRI), are also processed simultaneously to establish the laboratory correction factor. Each wood standard is run in a quantity similar to the submitted samples of unknown age and sealed in a quartz tube after the requisite pre-treatment.

Once all the wood standards, blanks, and submitted samples of unknown age are prepared and sealed in their individual quartz tubes, they are combusted at 820 °C, soaked for an extended period of time at that temperature, and then slowly allowed to cool to enable the chemical reaction that extracts carbon dioxide ($C0_2$) gas.

Following this last step, all samples of unknown age, the wood standards, and the laboratory backgrounds are sent to the Keck Carbon Cycle AMS Facility at the University of California, Irvine, where the $C0_2$ gas is processed into graphite. The graphite in these samples is then placed in the target and run through the accelerator, which produces the numbers that are converted into the radiocarbon date presented in the data section. Dates are presented as conventional radiocarbon ages, as well as calibrated ages using Intcalc04 curves on Oxcal v.3.10.

FTIR (Fourier Transform Infrared Spectroscopy)

A mixture of chloroform and methanol (CHM) was used as a solvent to remove lipids and other organic substances that had soaked into the sediment. This mixture is represented in the FTIR graphics as CHM. The CHM solvent and sample were placed in a glass container, and allowed to sit, covered, for several hours. After this period of time, the solvent was pipetted into an aluminum evaporation dish, where the CHM was allowed to evaporate. This process leaves the residue of any absorbed chemicals in the aluminum dishes. The residue remaining in the aluminum dishes was then placed on the FTIR crystal and the spectra were collected. The aluminum dishes were tilted during the process of evaporation to separate the lighter from the heavier fraction of the residue. The lighter and heavier fractions are designated Upper (lighter fraction) and Lower (heavier fraction) respectively in the subsequent analysis.

FTIR is performed using a Nicolet 6700 optical bench with an ATR and a silicon crystal. The sample is placed in the path of a specially encoded infrared beam. The infrared beam passes through the sample and produces a signal called an "inferogram." The inferogram contains information about the frequencies of infrared that are absorbed and the strength of the absorptions, which is determined by the sample's chemical make-up. A computer reads the inferogram and uses Fourier transformation to decode the intensity information for each frequency (wave numbers) and presents a spectrum.

FTIR (FOURIER TRANSFORM INFRARED SPECTROSCOPY) REVIEW

Infrared spectroscopy (IR) is the study of how molecules absorb infrared radiation and ultimately convert it to heat, revealing how the infrared energy is absorbed, as well as the structure of specific organic molecules. Infrared spectroscopy has been experiencing a renaissance for identifying organic substances during the past few decades. It is currently considered one of the more powerful tools in organic and analytical chemistry. One of the primary advantages to the FTIR is that it measures all wave lengths simultaneously. It has a relatively high signal-to-noise ratio and a short measurement time. Each peak in the spectrum represents either a chemical bond or a functional group.

Since molecular structures absorb the vibrational frequencies or wavelengths of infrared radiation, the bands of absorbance can then be used to identify the composition of the materials under study. In the case of the current research, the portion of the electromagnetic spectrum between 4000-400 cm^{-1} is used for identifying organic materials. Carbohydrates, lipids, proteins and other organic molecules are associated with specific wave number bands (Isaksson 1999:36-39).

The infrared spectrum can be divided into two regions--the functional group region and the fingerprint region. These two groups are recognized by the effect that infrared radiation has on the respective molecules of these groups. The functional group region is located between 4000 and approximately 1500 cm^{-1}. The molecular bonds display specific characteristic vibrations that identify fats, lipids, waxes, lignins, proteins, carbohydrates, etc. The fingerprint region, located below 1500 cm^{-1}, is influenced by bending motions, which further identify the molecules present.

Using the FTIR, it is possible to identify different types of organic compounds and eventually recognize different types of materials such as plant or animal fats or lipids, plant waxes, esters, proteins, carbohydrates, and more. Specific regions of the spectrum are important in identifying these compounds.

The results of the identification of specific wavelengths can be compared with commercial or laboratory-created analytical standards to identify the specific types of bonds present in different materials. By combining the results of the analysis of individual samples with all of the reference materials in the Paleo Research Institute (PRI) library, the % match with individual reference items can be displayed. For instance, plant lipids or fats are identifiable between 3000-2800 wave numbers. A match might be obtained on this portion of the spectrum with nuts such as hickory, walnut, or acorn or with animal fats or corn oil. Recovery of high level matches with several types of nuts (in this example) indicates that nuts were processed. If the match with the PRI library is for meat fats, then the signature is more consistent with that produced by meat than plant parts such as nuts.

Samples containing many compounds are more difficult to identify – and many archaeological samples are complex mixtures. Multi-purpose artifacts, such as manos, which could have been used to crush or grind a variety of foodstuffs, or ceramic cooking vessels, which are expected to have been used to cook many different foods, present a mixture problem. Mixtures sometimes have many absorption bands that overlap, yielding only broad envelopes of absorption and few distinctive features. FTIR analysis is expected to be particularly valuable in examining fire-cracked rock (FCR), since the fats, lipids, waxes, and other organic molecules contained in liquids that seep out of the food being processed becomes deposited on the rocks during the baking process. The PRI extraction method gently removes these organic molecules from the rocks so that they can be measured with the FTIR and subsequently identified.

Organic molecules from sediments can be extracted and the sediments then characterized. This has the potential to be very useful in identifying signatures of the remains responsible for a dark horizon. For instance, if the dark horizons are the result of decaying organic matter (plant or animal), the FTIR will yield a signature of decaying organic remains. If the dark horizons are the result of blowing ash from cultural features, the FTIR signature will be considerably different. This is an affordable technique for making distinctions between horizons and identifying cultural horizons.

DISCUSSION

Sites 42Dc1412, 42Dc1340, and 42Dc1342 are located in the Ashley National Forest of northeastern Utah. This area was heavily impacted by glaciation, meaning that sediments remaining in the area are shallow and residual in nature. Local vegetation is dominated by coniferous trees, and the vegetation community is described as a Douglas Fir Community that includes fir (*Abies*), Douglas fir (*Pseudotsuga*), spruce (*Picea*), pine (*Pinus*), and aspen (*Populus tremuloides*). The understory is variable and includes low shrubs such as service berry (*Amelanchier*), Oregon grape (*Mahonia*), Canadian thistle (*Cirsium* - an introduced plant), smooth scouring rush (*Equisetum*), raspberry (*Rubus*), and assorted grasses (Poaceae). A total of one botanic, two pollen/phytolith, two FTIR sediment, and three FTIR groundstone samples were submitted for analysis from the three sites.

Site 42Dc1412

Site 42Dc1412 is located [redacted] on [redacted] East Timothy Lake and includes a moderate-to-high density lithic scatter. Secondary and tertiary flakes were recovered, suggesting tool retouching. In addition, two possible Humboldt projectile points (5,000-3,000 BP) were recovered. Unit 1 was placed in an area with the highest density of lithics and the best potential for undisturbed deposits. Sample 2 represents fill from the southeast quadrant of the unit sampled for pollen and phytoliths (Table 1). An off-unit control sample also was collected for pollen and phytolith analysis (sample 1). Charcoal-rich fill directly below a projectile point in the southeast quadrant of the unit was examined for macrofloral remains and for organic residues using FTIR (sample 3). Charcoal from sample 3 was AMS radiocarbon dated. Three ground stone fragments from the southeast quadrant of Unit 1 also were submitted for FTIR organic residue analysis.

The pollen record for samples 1 and 2 are quite different from one another. Sample 1, the control sample collected at the surface, is dominated by *Pinus* pollen (Figure 1, Table 2) reflecting local pine trees. Small quantities of *Juniperus*, *Abies*, *Picea*, and *Pseudotsuga* pollen represent juniper, fir, spruce and Douglas fir growing in the area. A moderately abundant quantity of *Artemisia* pollen represents sagebrush also growing in the area. In addition, small quantities of Low-spine Asteraceae, High-spine Asteraceae, Brassicaceae, Caryophyllaceae, Cheno-am, *Sarcobatus*, *Ephedra nevadensis*-type, *Ephedra torreyana*-type, *Mahonia,* Poaceae, *Bistorta*, and Rosaceae pollen indicate local growth of various members of the sunflower family including the ragweed, cocklebur, marshelder group; rabbitbrush, aster, sunflower, and other members of the sunflower family; members of the mustard and pink families; goosefoot and related plants; greasewood; ephedra or Mormon tea; Oregon grape; grasses; bistort; and members of the rose family. Many of these plants would have been part of the meadow vegetation while others represent shrubs that might have grown at the tree or water margin. Microscopic charcoal fragments were moderately abundant and probably represent either intermittent forest fires or campfires. Total pollen concentration was moderate at slightly more than 6000 pollen per cubic centimeter (cc) of sediment.

Sample 2, collected at a depth of 5 cm from Unit 1, displays a very different pollen signature. It is dominated by *Artemisia* pollen, suggesting that the immediate area was relatively open and supported an increased quantity of sagebrush compared with today. In addition, small quantities of *Juniperus*, *Abies*, *Picea*, *Pinus*, and *Salix* pollen were observed, representing local juniper, fir, spruce, pine, and willow. Shrubs and herbaceous plants that grew as part of the meadow vegetation or vegetation associated with sagebrush in the openings is represented by Low-spine Asteraceae, High-spine Asteraceae, Brassicaceae, Caryophyllaceae, Cheno-am, *Sarcobatus*, *Ephedra torreyana*-type, Poaceae, *Bistorta* and Rosaceae, representing various members of the sunflower family that appear to be similar to those growing in the area today, members of the mustard and pink families, goosefoot and related plants, greasewood, ephedra or Mormon tea, grasses, bistort, and a member of the rose family. The quantity of microscopic charcoal is similar in both samples. The total pollen concentration in sample 2 is significantly larger than that observed in the control sample (more than 28,000 pollen per cc of sediment), suggesting the probability that sample 2 has been impacted by intrusion of relatively recent pollen, perhaps during the fall when sagebrush flowers. Samples collected at depths of 5 cm in areas that routinely freeze in the winter should be considered to be affected by freeze-thaw cycles. If cracks open in the sediments either as a result of the freeze-thaw cycles or the alternate wetting and drying associated with water levels around a lake, modern pollen may be introduced into a record that otherwise should represent more ancient deposits. The large total pollen concentration in sample 2 is consistent with cracking and pollen intrusion in the fall when *Artemisia* (sagebrush) pollinates.

The phytolith record from the control and cultural level samples exhibited very similar assemblages dominated by cool season grasses, likely wetland species from the subfamily Pooideae (Figure 2). This is in contrast to the pollen record which exhibits some significant change in the pollen assemblage between the two samples. Phytoliths can provide a very localized, even site-level, record of vegetation. The phytolith homogeneity between the surface sample and the cultural level suggests that cool season riparian grasses have been the dominant vegetation surrounding East Timothy Lake since at least the mid Holocene, assuming that the sample at 5 cm represents primarily a mid-Holocene record and is not influenced by intrusion of particles from the surface through wave action or freeze-thaw cracking. The dominance of Festucoid-class phytoliths, especially trapeziform sinuates, suggest that Canada bluejoint (*Calamagrostis*), reed canary grass (*Phalaris arundinacea*), wheatgrass (*Elymus*), fescue (*Festuca*), sweetgrass (*Hierochloe*), Junegrass (*Koeleria*) alpine foxtail (*Alopecurus*), and/or managrass (*Glyceria*) may have been common. The recovery of *Stipa*-type bilobates suggests the presence of subfamily Stipoideae grasses such as needlegrass (*Stipa*) and ricegrass (*Oryzopsis*). In many areas, the recovery of a phytoliths distinctive of the Panicoideae subfamily indicate the presence of warm season tallgrasses; however, in this area, they are likely derived from some other grass such as *Muhlenbergia richardsonis* (mat muhly), which can occur commonly in wet meadows and around lake margins. *Muhlenbergia* also produces saddle-type phytoliths typically diagnostic of grasses that thrive under hot, dry conditions. The saddle phytoliths observed here are likely derived from a *Muhlenbergia* species as well. A few phytoliths diagnostic of common reed (*Phragmites australis*) were observed and indicate its presence near the site. Diatoms and sponge spicules also were present in both of the samples indicating the presence of water and/or moist soil conditions. The increased presence of pennate diatoms in the surface control sample (sample 1), and their much reduced presence in the cultural layer sample (sample 2), does suggest that the water margin was further away during the time of occupation.

Sample 3 was taken from charcoal-rich fill directly below a projectile point in Unit 1. Pieces of charcoal were picked from the sediment and extracted for FTIR organic residue analysis. Since charcoal is porous, it is expected to soak up organic residues. Two sharp peaks between 3000 and 2800 wave numbers represent fats, oils, and lipids that were removed from the charcoal (Figure 3). Matches with a variety of plant and animal remains provide information concerning possible economic activity associated with this area. Matches with yucca, snowberry (*Symphoricarpos*), bison fat, *Opuntia* (prickly pear) pad, Big Horn sheep blood, and blueberries (*Vaccinium*) suggest the possibility that yucca, waxy berries, prickly pear cactus, and meat that might have included bison and/or sheep might have been processed at this site (Figure 4-7). The match with yucca fits well for the 3000-2800 wave numbers region, as well as the region between approximately 1500-1400 wave numbers (Figure 8). In addition, the double peak in the low 1700s (1741 and 1712 wave numbers) suggests the presence of both saturated an aromatic esters. The left portion of this peak, at 1741 wave numbers, matches with the peak for saturated esters in both bison fat and yucca (Figures 5 and 6). In addition, matches in the region between 1492 and 1429 wave numbers with both bison fat and yucca offer further evidence that both bison and yucca might have been processed in the area or possible feature represented by this sample. The match with blueberries also displays a visual match to sample 3 with cellulose in the region between approximately 1100 and 950 wave numbers (Figure 7), although the computer did not pick this area out as a match.

The macrofloral record from sample 3 contained four fragments of charred parenchymous tissue fragments (Table 3, Table 4). "Parenchyma is the botanical term for relatively undifferentiated tissue, composed of many similar thin-walled cells...which form a ground tissue that surrounds other tissues. Parenchyma occurs in many different plant organs in varying amounts. Large fleshy organs such as ...roots and stems are composed largely of parenchyma. ...The vegetative storage parenchyma in swollen roots and stems stores starch and other carbohydrates and sugars ..." (Hather 2000:1). Recovery of parenchymous tissue might indicate processing of a root or tuber resource, or possibly charred stem tissue. The sample also yielded several charred *Picea* needle fragments and pieces of *Picea* charcoal, suggesting that a spruce branch was burned. The *Picea* needle fragments weighing 0.009 g were processed for AMS radiocarbon dating. These needles yielded a date of 2935 ± 15 RCYBP (PRI-08-39-3), with a two-sigma calibrated age range of 3210-3190 and 3170-3000 CAL yr. BP (Table 5, Figure 9). In addition, the sample yielded one small lithic flake and a few sclerotia. Sclerotia are commonly called "carbon balls". They are small, black, solid or hollow spheres that can be smooth or lightly sculpted. These forms range from 0.5 to 4 mm in size. Sclerotia are the resting structures of mycorrhizae fungi, such as *Cenococcum graniforme*, that have a mutualistic relationship with tree roots. Many trees are noted to depend heavily on mycorrhizae and may not be successful without them. "The mycelial strands of these fungi grow into the roots and take some of the sugary compounds produced by the tree during photosynthesis. However, mycorrhizal fungi benefit the tree because they take in minerals from the soil, which are then used by the tree" (Kricher and Morrison 1988:285). Sclerotia appear to be ubiquitous and are found with coniferous and deciduous trees including *Abies* (fir), *Juniperus communis* (common juniper), *Larix* (larch), *Picea* (spruce), *Pinus* (pine), *Pseudotsuga* (Douglas fir), *Alnus* (alder), *Betula* (birch), *Populus* (poplar, cottonwood, aspen), *Quercus* (oak), and *Salix* (willow). These forms originally were identified by Dr. Kristiina Vogt, Professor of Ecology in the School of Forestry and Environmental Studies at Yale University (McWeeney 1989:229-230; Trappe 1962).

Three fragments of ground stone were partially buried with a surface of the slab fragment visible in the southeast quadrant of Unit 1 (samples 6, 7, and 8). These ground stone fragments were submitted for identification of organic residues (FTIR analysis) that might have soaked into the surface of the ground stone during its use. The FTIR record for sample 6 exhibits peaks in the 3000-2800 wave number range, indicating the presence of fats, lipids, oils, and/or plant waxes (Figure 10). Matches with the reference library include primarily nuts such as *Corylus* (hazelnut), *Quercus* (acorn), and *Carya* (pecan) (Figure 11). Recovery of matches to multiple nuts, some of which are out of range, is not surprising, since many nuts contain oils with similar properties. All matches to nuts should be considered "generic" and not interpreted as indications that specific nuts had been processed. They merely express matches with oils present in nuts in general. In addition to nuts, other matches in this area of the spectrum include *Yucca* and *Cucurbita foetidissima* (buffalo gourd). Buffalo gourd rind is another plant part that appears to have a generic signature and is used as an indicator of the environmental or "background" signature.

The 1770-1690 wave number range was selected to obtain matches on the peak at 1741 wave numbers, representing a saturated ester. Matches for this peak include fish oil, more nuts (walnut, hazelnut, pecan), and yucca (Figures 12 and 13). Piñon nuts also matched with this portion of the spectrum (Figure 14). The final area to yield matches is the 1500-1330 wave number range, which includes proteins. Once again, matches were obtained primarily with nuts (acorn - Figure 15, hickory, walnut, hazelnut), although yucca seeds also were present in this group, probably due to the fact that they also contain proteins similar to those found in nuts. The repetitive recovery of matches to nuts suggests that this piece of groundstone was used to process nuts or perhaps oil seeds. Recovery of evidence for yucca suggests the possibility that yucca also was processed. Finally, a match with fish oils in one portion of the spectrum for this sample suggests the possibility that fish were processed. A broad peak near 1000 wave numbers represents the presence of cellulose that could not be identified further.

The FTIR signature for residue from sample 7 represents primarily deteriorated cellulose, as expressed by the large, broad peak at 1030 wave numbers (Figure 16). The small double peak between 3000 and 2800 wave numbers yielded matches with a variety of nuts including acorns, hazelnuts, and pecans. In addition, matches were observed with yucca pods and buffalo gourds (Figures 17 and 18). The shape match of these double peaks are better with yucca than with acorns or other nuts, which exhibit the extra "bump" to the left of the double peaks. The large peak at 1030 wave numbers yielded a match with deteriorated cellulose between wave numbers of 1210 and 868 (Figure 19).

The FTIR signature for ground stone sample 8 is similar to that of sample 7 in that the peak at 1024 wave numbers, representing deteriorated cellulose, is the largest feature visible (Figure 20). Matches with the 3000-2800 wave number range include primarily nuts and seeds such as hazelnut, pumpkin seed, pecan, acorn, and hickory (Figures 21 and 22), suggesting grinding nuts with this piece of groundstone. Oils in nuts are expected to have a similar signature to one another, so any nuts of the area, including pine nuts, are possibilities for processing. Matches for the 1245-862 wave number range include only deteriorated cellulose for this large, broad peak (Figure 23), indicating deterioration of cellulose against the surface of this piece of groundstone. Since cellulose is a part of the nut signature, it is possible that the deteriorated cellulose originated with the nuts being ground.

Site 42Dc1340

Site 42Dc1340 is a small, low density lithic scatter located on [redacted] Island Lake. Unit 1 again was placed in an area with the highest density of lithic debris. Sample 5 was recovered from charcoal-rich sediment in the northwest quadrant of Unit 1 at a depth of 5-9 cm below the modern surface. Charcoal picked from this sediment sample was processed for FTIR analysis, since the porous nature of charcoal is expected to trap and preserve organic residues. Two distinct signatures were obtained for different portions of the extract labeled Lower B and Lower A (yellow). The signature for Lower B displays double peaks between 3000 and 2800 wave numbers, as well as a peak at 1708 wave numbers, peaks at 1462 and 1378 wave numbers, a broad peak with double points at 1173 and 1123 wave numbers, and a peak at 930 wave numbers (Figure 24). Other minor peaks are noted at lesser wave numbers. The yellow material also observed in the lower portion of the extract drying dish exhibited smaller double peaks between approximately 3000 and 2800 wave numbers, a plateau between approximately 1730 and 1490 wave numbers, a peak at 1117 wave numbers, and a much taller peak that probably represents deteriorated cellulose at 1027 wave numbers (Figure 25).

Matches with the lower portion of the extract include yucca pods, acorns, lanolin, buffalo gourd, and hazelnut (Figures 26-27). Matches for the same portion of the spectrum of the yellow extract include yucca pods, acorns, lanolin, buffalo gourd, and hazelnut (Figures 28 and 29). The differences between these two portions of the extract are not found in this portion of the spectrum, which represents fats, oils, lipids, and waxes. The only other portion of the spectrum that yielded matches is between 1492 and 1350 wave numbers, which yielded matches with acorns and lanolin (Figure 30). This portion of the spectrum records the presence of proteins. FTIR analysis of organic residues from charcoal in sample 5 indicate processing nuts and possibly yucca pods. Recovery of matches to lanolin point to the possibility that sheep were used or processed.

The macrofloral record from sample 5 contained three small fragments of charred parenchymous tissue, reflecting root/tuber or stem tissue that burned (Table 3, Table 4). One charred unidentified seed represents endosperm without the diagnostic outer seed coat and might reflect seed processing activities. Uncharred *Lewisia* seeds and a few uncharred rootlets represent modern plants in the area. The charcoal record consisted of *Pinus*, indicating that local pine wood was burned as fuel. An AMS radiocarbon date of 1595 ± 15 RCYBP (PRI-08-39-5) was obtained for a single pine charcoal fragment. The two-sigma calibrated age range for this date is 1530-1410 (Figure 31).

Site 42Dc1342

Site 42Dc1342 also is a small, low density lithic scatter located on [redacted] Island Lake. A single seed (sample 4) from Level 1 of Unit 2 was submitted for identification. This seed is uncharred and identified as *Pseudotsuga* (Table 3, Table 4), indicating growth of Douglas fir close to the area sampled.

SUMMARY AND CONCLUSIONS

Pollen, phytolith, botanical, and organic residue analysis using the FTIR yielded information concerning local vegetation and resource exploitation at three sites in the Ashley National Forest, Utah. The pollen record from 42Dc1412 with a modern signature dominated by *Pinus* pollen and a subdominant of *Artemisia* pollen represents the local pine and sagebrush communities growing in the vicinity of East Timothy Lake. The dominance of the subsurface unit fill sample by *Artemisia* pollen, along with the very large total pollen concentration, suggests surface cracking during the late summer or fall when sagebrush pollinates and intrusion of relatively recent pollen into the 5 cm level that was sampled. The homogeneity of the phytolith assemblage from samples at 42Dc1412 suggests that riparian and/or mesic grasses have dominated the area near the site since at lease the mid-Holocene if there is not serious intrusion of phytoliths from modern grass stands into the 5 cm level, as suggested by the pollen record. Arboreal-type phytoliths were absent from the record and suggest that trees, presumably spruce and pine species, were situated further away from the site. Thus, a grassy open meadow has likely persisted here since the time of occupation. A single uncharred seed from site 42Dc1342 was identified as *Pseudotsuga*, reflecting historic/modern Douglas fir growing near Island Lake.

The FTIR record for ground stone fragments from 42Dc1412 points to grinding nuts. Although matches were obtained with a variety of nuts in the reference library, it is highly likely, given the local vegetation community, that pine nuts were the dominant nut being processed. Nut oils are expected to be similar in many nuts and the objective for the FTIR analysis was to identify groups of plants being processed. In addition, it is possible that yucca pods and/or seeds were processed. Oils were extracted from charcoal present in charcoal rich sediment samples from sites 42Dc1412 and 42Dc1340. At site 42Dc1412, the FTIR signature suggested processing nuts, yucca, prickly pear cactus, waxy berries, as well as animals such as bison or sheep. In contrast, organic residue spectra obtained from 42Dc1340 suggest processing nuts and yucca pods.

TABLE 1
PROVENIENCE DATA FOR SAMPLES FROM SITES 42DC1412, 42DC1340, AND 42DC1342

Site No.	Sample No.	Unit	Depth (cmbs)	Provenience/ Description	Analysis
42Dc1412	1		Surface	Control	Pollen Phytolith
	2	1	5	Level 1 fill from southeast quadrant of unit; unit placed in area with high density of lithics and the best potential for undisturbed deposits	Pollen Phytolith
	3	1	5	Charcoal-rich Level 1 fill from southeast quadrant of unit; directly below projectile point B	Macrofloral AMS ^{14}C Date FTIR
	6	1	0	Ground stone fragment from southeast quadrant of unit; partially buried with surface of slab fragment visible	FTIR
	7	1	0	Ground stone fragment from southeast quadrant of unit; partially buried with surface of slab fragment visible	FTIR
	8	1	0	Ground stone fragment from southeast quadrant of unit; partially buried with surface of slab fragment visible	FTIR
42Dc1340	5	1	5-9	Charcoal-rich Level 1 fill from northwest quadrant of unit	Macrofloral AMS ^{14}C Date FTIR
42Dc1342	4	2	5	Seed from Level 1 of unit	Botanic ID

FTIR = Fourier Transform Infrared Spectroscopy

TABLE 2
POLLEN TYPES OBSERVED IN SAMPLES FROM SITE 42DC1412, UTAH

Scientific Name	Common Name
ARBOREAL POLLEN:	
Juniperus	Juniper
Pinaceae:	Pine family
Abies	Fir
Picea	Spruce
Pinus	Pine
Pseudotsuga	Douglas-fir
Tsuga	Hemlock
Salix	Willow
Asteraceae:	Sunflower family
Artemisia	Sagebrush
Low-spine	Includes ragweed, cocklebur, sumpweed
High-spine	Includes aster, rabbitbrush, snakeweed, sunflower, etc.
Bistorta	Bistort
Brassicaceae	Cruciferae, also known as the crucifers, the mustard family or cabbage family
Caryophyllaceae	Pink family
Cheno-am	Includes the goosefoot family and amaranth
Sarcobatus	Greasewood
Ephedra nevadensis-type (includes *E. clokeyi, E. coryi, E. funera, E. viridis, E. californica, E. nevadensis,* and *E. aspera*)	Ephedra, Jointfir, Mormon tea
Ephedra torreyana-type (includes *E. torreyana*, *E. trifurca*, and *E. antisyphilitica*)	Ephedra, Jointfir, Mormon tea
Mahonia	Oregon grape
Poaceae	Grass family
Rosaceae	Rose family
Indeterminate	Too badly deteriorated to identify
Selaginella densa	Little clubmoss
Trilete	Fern
Charcoal	Microscopic charcoal
Total pollen concentration	Quantity of pollen per cubic centimeter (cc) of sediment

TABLE 3
MACROFLORAL REMAINS FROM SITES 42DC1412, 42DC1340, AND 42DC1342

Sample No.	Identification	Part	Charred W	Charred F	Uncharred W	Uncharred F	Weights/ Comments
42DC1412 3	Liters Floated						0.15 L
	Light Fraction Weight						3.71 g
	FLORAL REMAINS:						
	Parenchymous tissue			4			0.06 g
	Picea ≥ 1 mm**	Needle		15			0.009 g
	Picea < 1 mm	Needle		X			Numerous
	Rootlets					X	Few
	Sclerotia				X	X	Few
	CHARCOAL/WOOD:						
	Total charcoal ≥ 2 mm						0.48 g
	Picea	Charcoal		40			0.30 g
	NON-FLORAL REMAINS:						
	Flake					1	
	Rock/Gravel					X	Few
42DC1340 5	Liters Floated						0.25 L
	Light Fraction Weight						9.81 g
	FLORAL REMAINS:						
	Parenchymous tissue			3			0.01 g
	Unidentified	Seed endosperm	1				
	Lewisia	Seed			2	2	
	Rootlets					X	Few
	Sclerotia				X	X	Few
	CHARCOAL/WOOD:						
	Total charcoal ≥ 2 mm						4.61 g
	*Pinus***	Charcoal		40			1.63 g
	NON-FLORAL REMAINS:						
	Rock/Gravel					X	Few
42DC1342 4	Liters Floated						
Unit 2	Light Fraction Weight						
Level 1	FLORAL REMAINS:						
0.5 cm	*Pseudotsuga*	Seed			1		

W = Whole
F = Fragment
X = Presence noted in sample
L = Liters
g = grams
**= Submitted for AMS ^{14}C Dating

TABLE 4
INDEX OF MACROFLORAL REMAINS RECOVERED FROM
SITES 42DC1412, 42DC1340, AND 42DC1342

Scientific Name	Common Name
FLORAL REMAINS:	
Lewisia	Bitterroot
Picea	Spruce
Pseudotsuga	Douglas fir
Parenchymous tissue	Relatively undifferentiated tissue composed of many similar thin-walled cells–occurs in different plant organs in varying amounts, especially large fleshy organs such as roots and stems.
Sclerotia	Resting structures of mycorrhizae fungi
CHARCOAL/WOOD:	
Picea	Spruce
Pinus	Pine

TABLE 5
RADIOCARBON RESULTS FOR SAMPLES FROM SITES 42DC1412 AND 42DC1340

Sample No.	Sample Identification	AMS ^{14}C Date*	1-sigma Calibrated Date (68.2%)	2-sigma Calibrated Date (95.4%)	$\delta^{13}C$** ($^{o}/_{oo}$)
PRI-08-39-3 (42DC1412)	*Picea* needle, charred	2935 ± 15 RCYBP	3160-3065 CAL yr. BP	3210-3190 3170-3000 CAL yr. BP	-23.1
PRI-08-39-5 (42DC1340	*Pinus* charcoal	1595 ± 15 RCYBP	1530-1510 1470-1410 CAL yr. BP	1530-1410 CAL yr. BP	-19.6

* Reported in radiocarbon years at 1 standard deviation measurement precision (68.2%), corrected for $\delta^{13}C$

** $\delta^{13}C$ values are measured by AMS during the ^{14}C measurement . The AMS-$\delta^{13}C$ values are used for the ^{14}C calculation and should not be used for dietary or paleoenvironmental interpretations.

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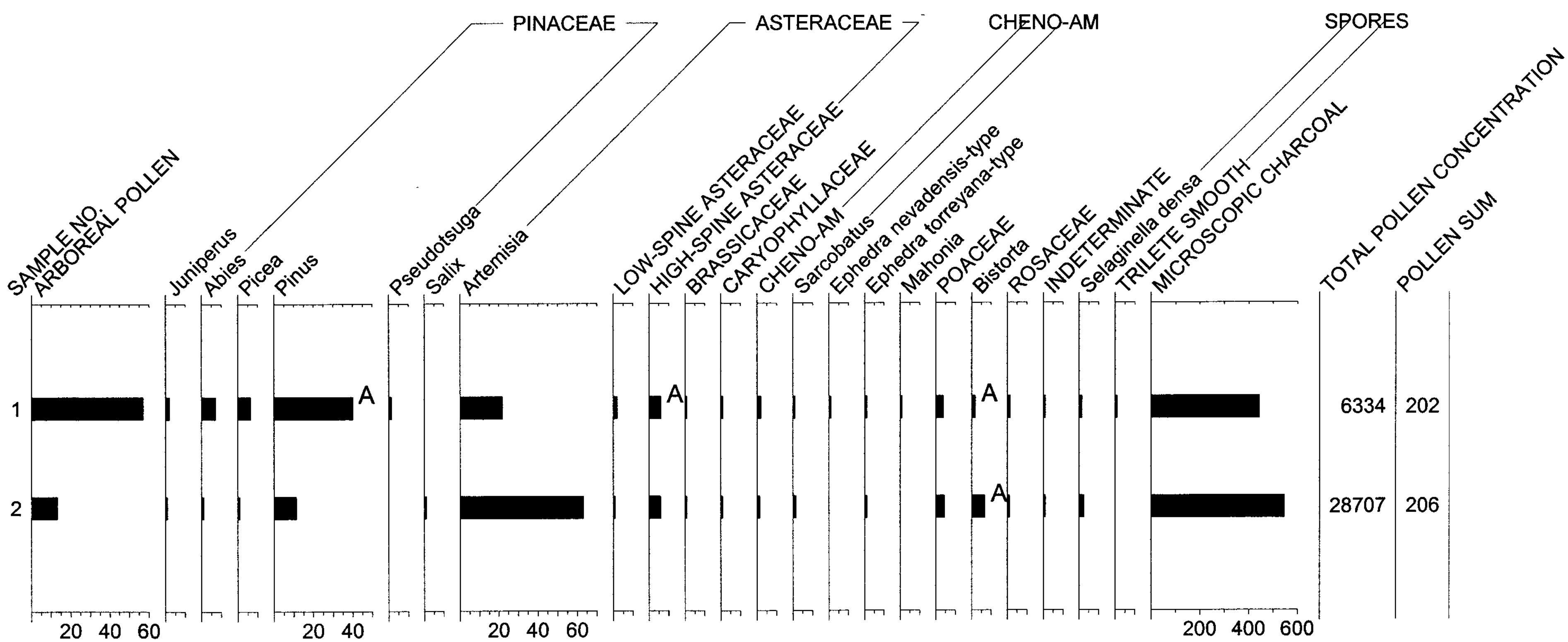


FIGURE 1. POLLEN DIAGRAM FOR 42DC1412, UTAH.

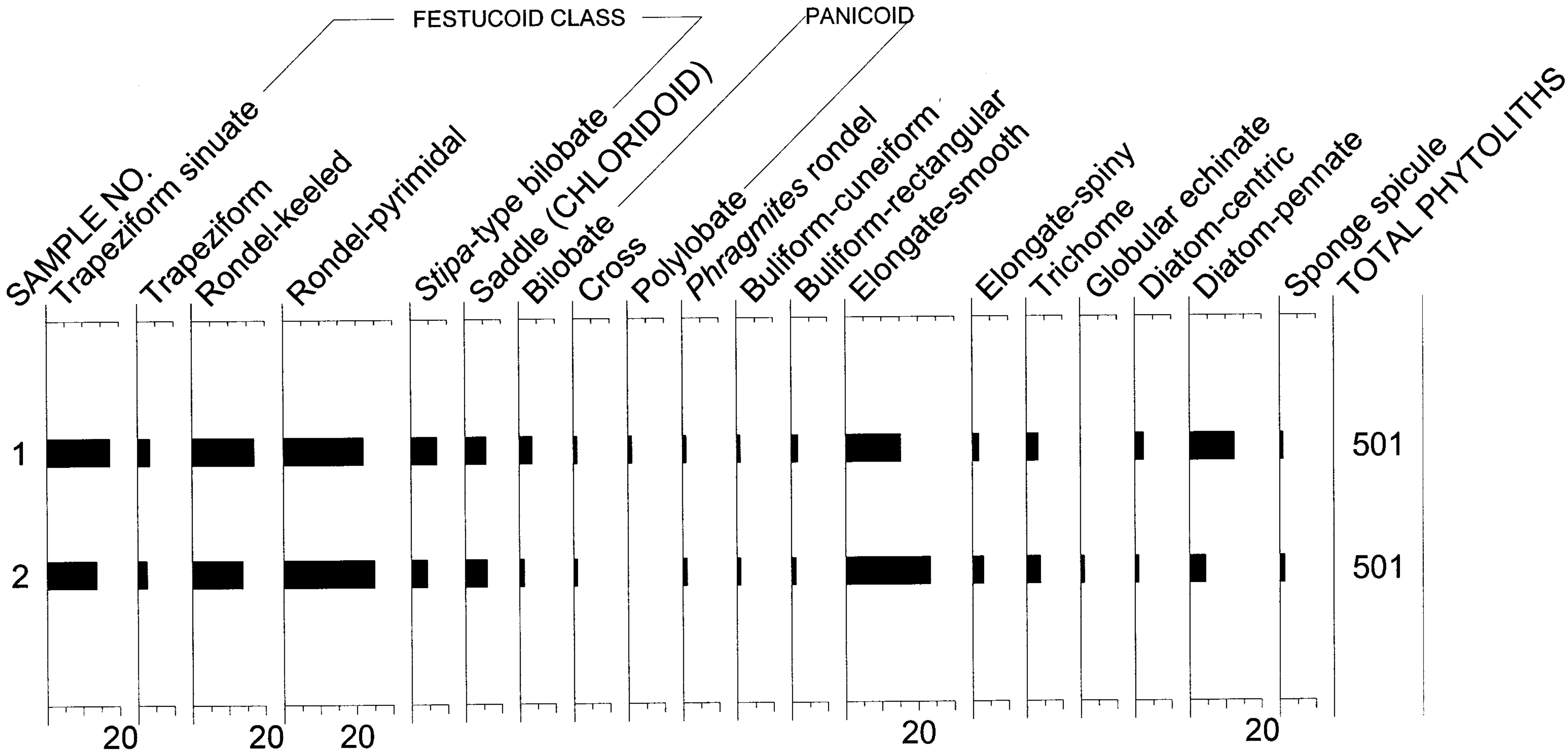


FIGURE 2. PHYTOLITH DIAGRAM FOR 42DC1412, UTAH.

PaleoResearch Institute
Golden, CO 80401

Fri May 30 17:07:20 2008 (GMT-06:00)
FIND PEAKS:
Spectrum: 08-39-3_CHM Extract_Lower
Region: 4000 400
Absolute threshold: 0.0018
Sensitivity: 50
Peak list:

Position:	669	Intensity:	0.0085
Position:	720	Intensity:	0.0086
Position:	751	Intensity:	0.0054
Position:	766	Intensity:	0.0055
Position:	797	Intensity:	0.0054
Position:	824	Intensity:	0.0056
Position:	1037	Intensity:	0.0140
Position:	1111	Intensity:	0.0099
Position:	1172	Intensity:	0.0101
Position:	1377	Intensity:	0.0046
Position:	1465	Intensity:	0.0072
Position:	1712	Intensity:	0.0075
Position:	2849	Intensity:	0.0121
Position:	2917	Intensity:	0.0178

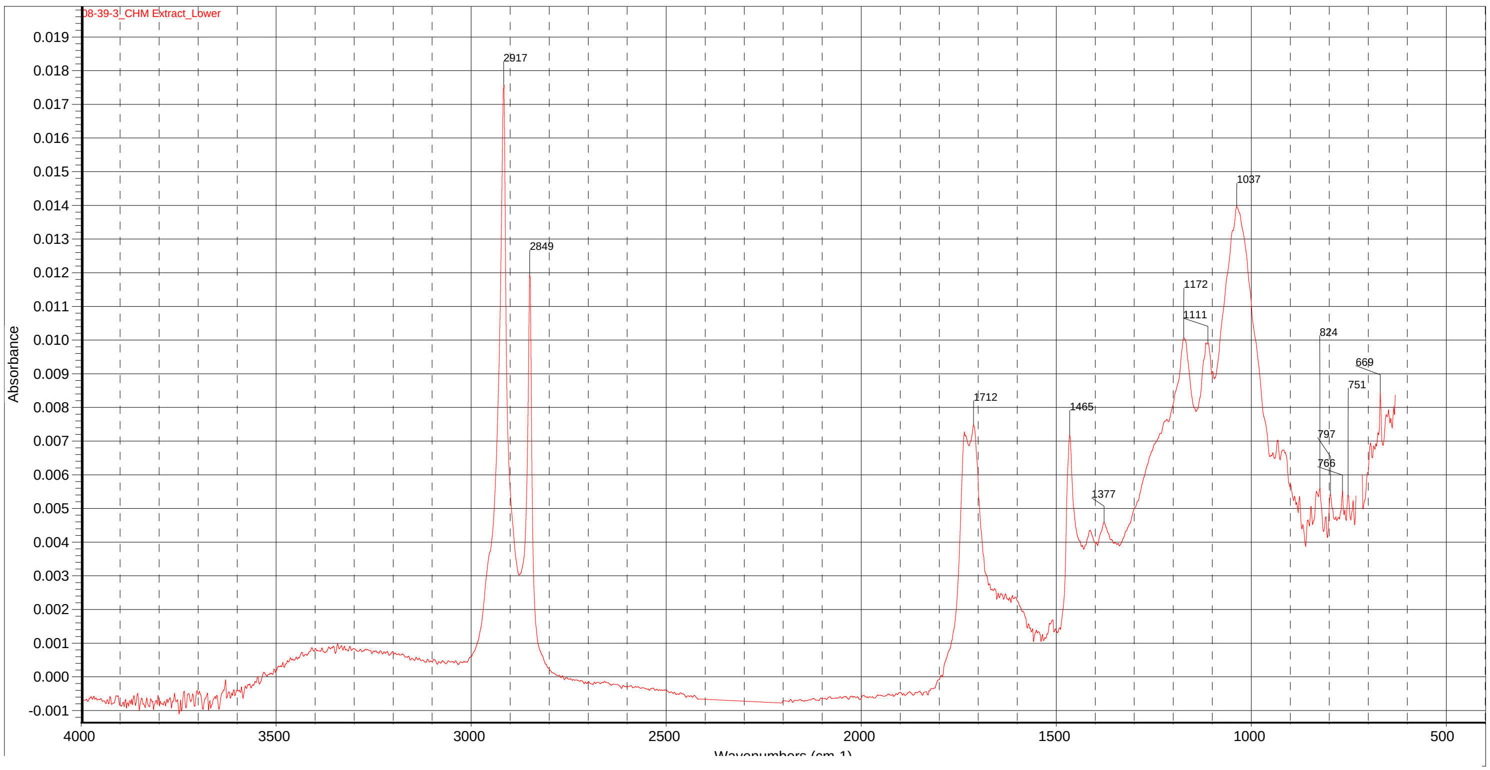
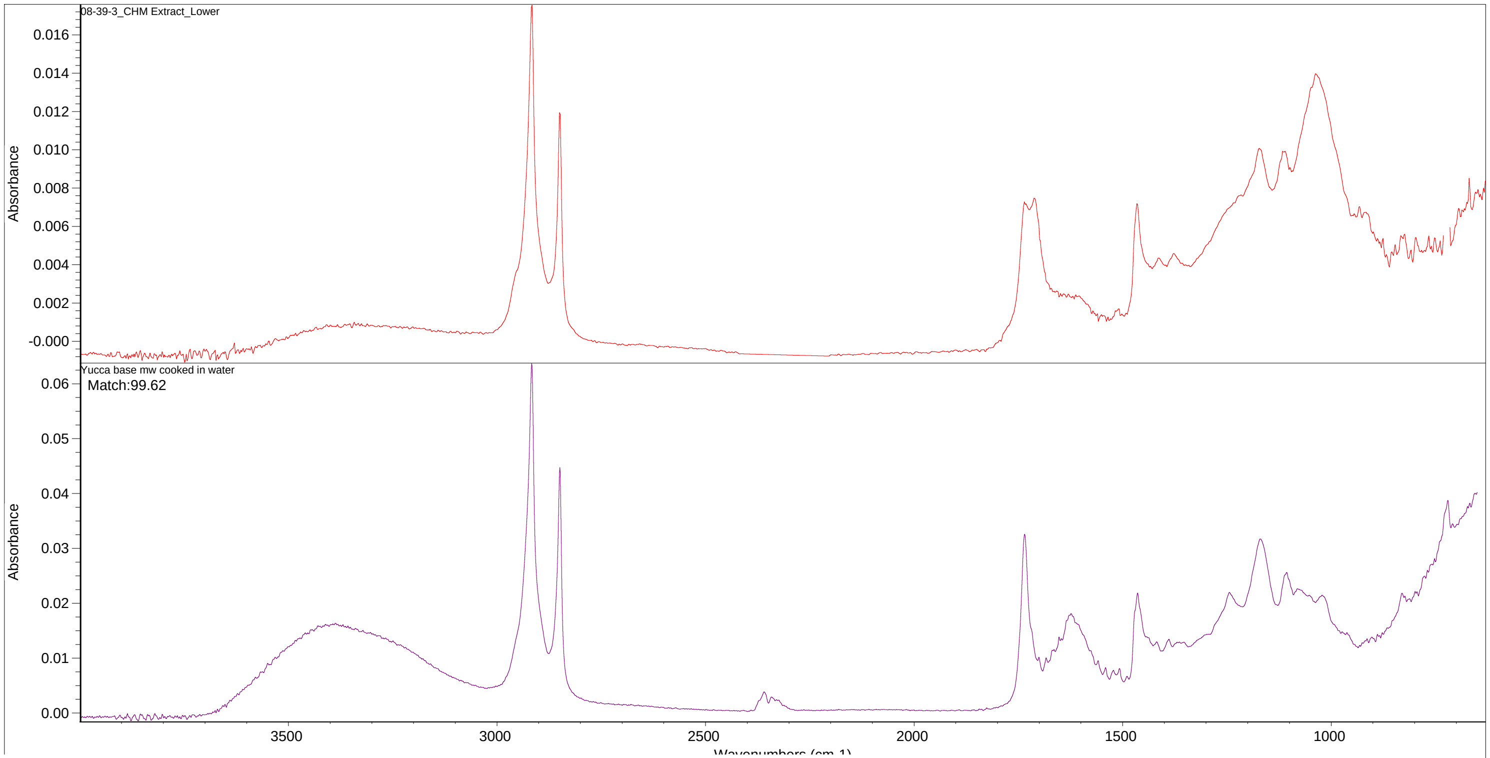


FIGURE 3. FTIR SPECTRUM FOR SAMPLE 3, 42DC1412, SHOWING PEAK LOCATIONS.

PaleoResearch Institute
Golden, CO 80401

Fri May 30 17:07:20 2008 (GMT-06:00)
FIND PEAKS:
Spectrum: 08-39-3_CHM Extract_Lower
Region: 4000 400
Absolute threshold: 0.0018
Sensitivity: 50
Peak list:

Position:	669	Intensity:	0.0085
Position:	720	Intensity:	0.0086
Position:	751	Intensity:	0.0054
Position:	766	Intensity:	0.0055
Position:	797	Intensity:	0.0054
Position:	824	Intensity:	0.0056
Position:	1037	Intensity:	0.0140
Position:	1111	Intensity:	0.0099
Position:	1172	Intensity:	0.0101
Position:	1377	Intensity:	0.0046
Position:	1465	Intensity:	0.0072
Position:	1712	Intensity:	0.0075
Position:	2849	Intensity:	0.0121
Position:	2917	Intensity:	0.0178



Spectrum: 08-39-3_CHM Extract
Region: 3005.80-2803.17
Search type: Correlation
Hit List:

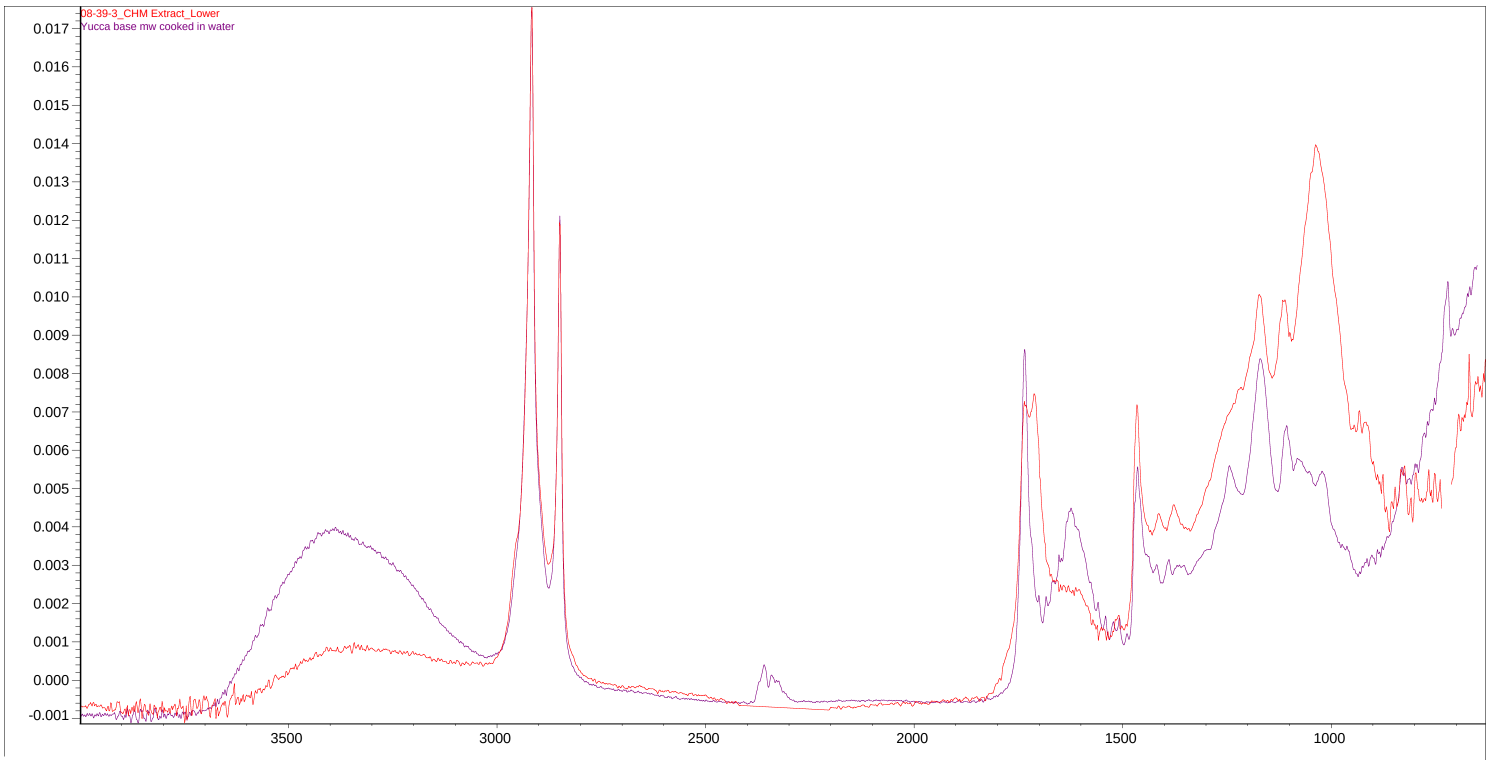
Index	Match	Compound name	Library
82	99.62	Yucca base mw cooked in water	ATR Native Plants macro
53	97.94	Snowberry-Raw-Washington-2007	ATR Native Plant Macro
77	97.07	Yucca glauca Leaf basal section	ATR Native Plants macro
1	96.39	Bison fat from bone sample (marrow)_06-2	ATR Native Animals
79	95.11	Yucca glauca Leaf outer 2	ATR Native Plants macro
81	95.09	Opuntia pad raw semi-dry	ATR Native Plants macro
13	92.57	Big Horn Sheep Dried Blood 2	ATR Native Animals
119	91.45	Blueberry_berry	ATR Native Plant Macro
45	91.31	Vaccinium (Blueberry) dried berry outer	ATR Native Plants macro

FIGURE 4. FTIR SPECTRUM MATCHES FOR SAMPLE 3 LOWER, 42DC1412, WAVE NUMBERS 3000-2800, COOKED YUCCA BASE.

PaleoResearch Institute
Golden, CO 80401

Sat Jun 07 16:46:30 2008 (GMT-06:00)
FIND PEAKS:
Spectrum: 08-39-3_CHM Extract_Lower
Region: 4000 400
Absolute threshold: 0.0016
Sensitivity: 45
Peak list:

Position:	669	Intensity:	0.0085
Position:	720	Intensity:	0.0086
Position:	766	Intensity:	0.0055
Position:	824	Intensity:	0.0056
Position:	1037	Intensity:	0.0140
Position:	1111	Intensity:	0.0099
Position:	1172	Intensity:	0.0101
Position:	1465	Intensity:	0.0072
Position:	1712	Intensity:	0.0075
Position:	2849	Intensity:	0.0121
Position:	2917	Intensity:	0.0178



Spectrum: 08-39-3_CHM Extract
Region: 3008.97-2803.17
Search type: Correlation
Hit List:

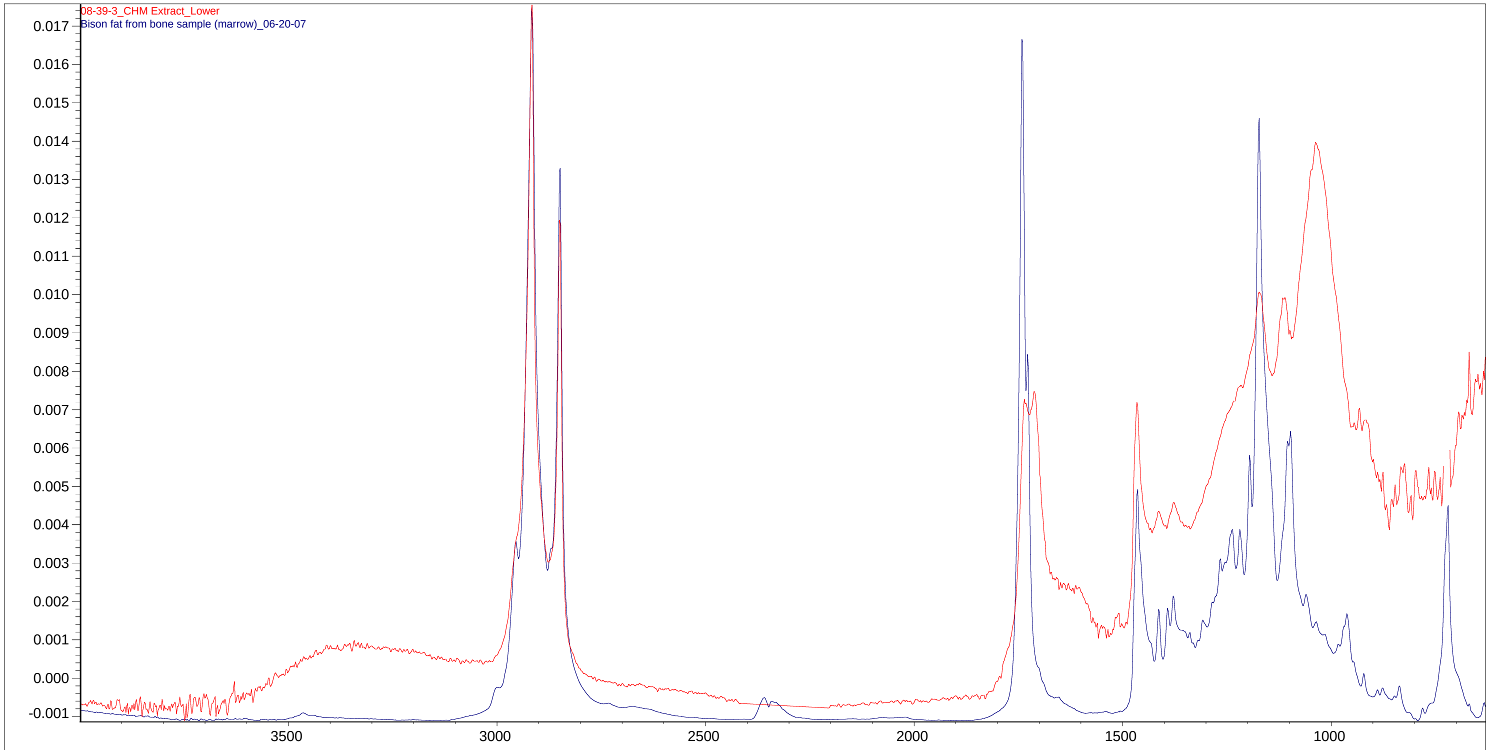
Index	Match	Compound name	Library
82	99.61	Yucca base mw cooked in water	ATR Native Plants Macro
53	97.94	Snowberry-Raw-Washington-2007	ATR Native Plant Macro
77	97.07	Yucca glauca Leaf basal section	ATR Native Plants Macro
81	95.09	Opuntia pad raw semi-dry	ATR Native Plants Macro
79	94.93	Yucca glauca Leaf outer 2	ATR Native Plants Macro
119	91.44	Blueberry_berry	ATR Native Plant Macro
45	91.27	Vaccinium (Blueberry) dried berry outer	ATR Native Plants Macro

FIGURE 5. FTIR SPECTRUM MATCHES FOR SAMPLE 3, 42DC1412, WAVE NUMBERS 3000-2800, COOKED YUCCA BASE OVERLAY.

PaleoResearch Institute
Golden, CO 80401

Fri May 30 17:07:20 2008 (GMT-06:00)
FIND PEAKS:
Spectrum: 08-39-3_CHM Extract_Lower
Region: 4000 400
Absolute threshold: 0.0018
Sensitivity: 50
Peak list:

Position:	669	Intensity:	0.0085
Position:	720	Intensity:	0.0086
Position:	751	Intensity:	0.0054
Position:	766	Intensity:	0.0055
Position:	797	Intensity:	0.0054
Position:	824	Intensity:	0.0056
Position:	1037	Intensity:	0.0140
Position:	1111	Intensity:	0.0099
Position:	1172	Intensity:	0.0101
Position:	1377	Intensity:	0.0046
Position:	1465	Intensity:	0.0072
Position:	1712	Intensity:	0.0075
Position:	2849	Intensity:	0.0121
Position:	2917	Intensity:	0.0178



Spectrum: 08-39-3_CHM Extract
Region: 3005.80-2803.17
Search type: Correlation
Hit List:

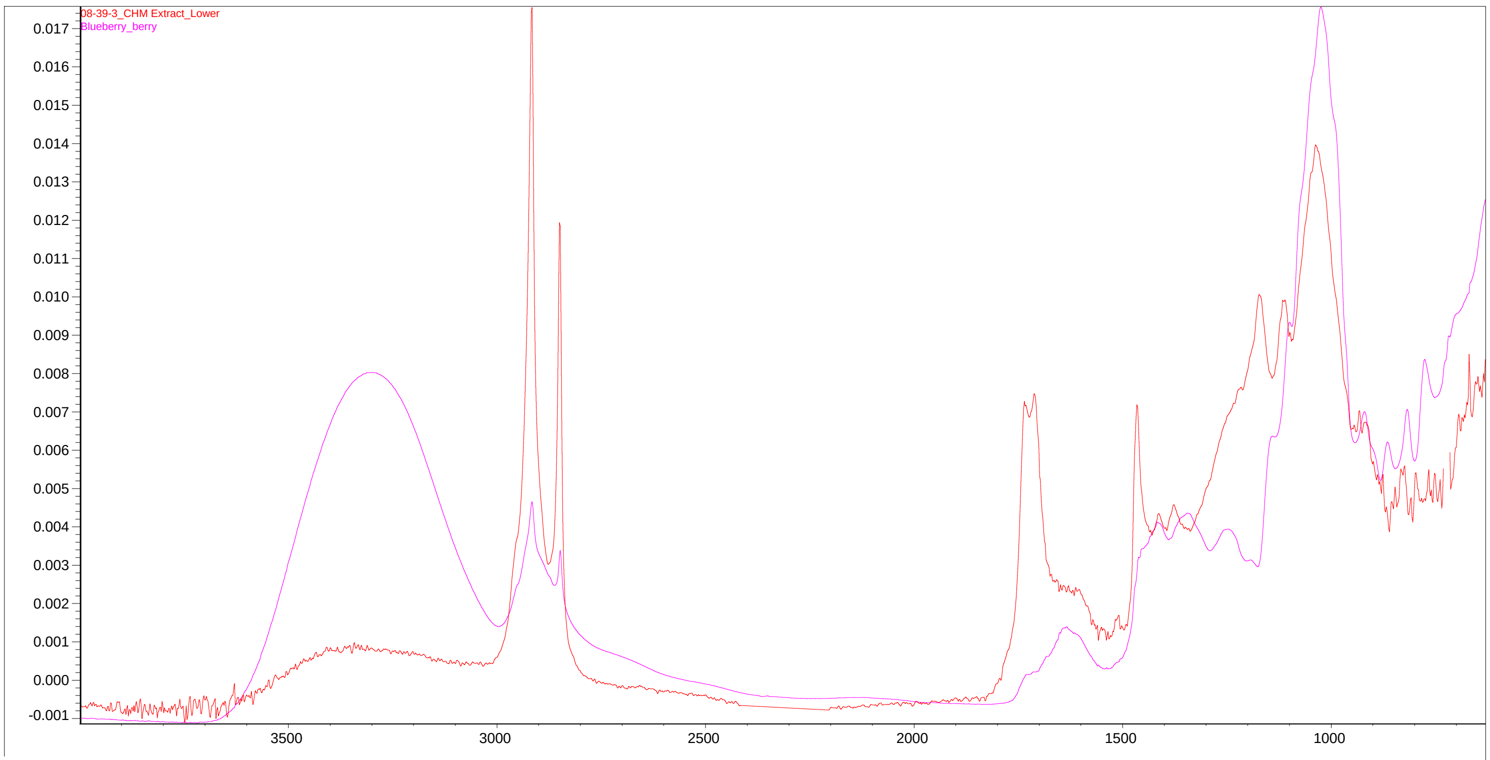
Index	Match	Compound name	Library
82	99.62	Yucca base mw cooked in water	ATR Native Plants Macro
53	97.94	Snowberry-Raw-Washington-2007	ATR Native Plant Macro
77	97.07	Yucca glauca Leaf basal section	ATR Native Plants Macro
1	96.39	Bison fat from bone sample (marrow)_06-2	ATR Native Animals
79	95.11	Yucca glauca Leaf outer 2	ATR Native Plants Macro
81	95.09	Opuntia pad raw semi-dry	ATR Native Plants Macro
13	92.57	Big Horn Sheep Dried Blood 2	ATR Native Animals
119	91.45	Blueberry_berry	ATR Native Plant Macro
45	91.31	Vaccinium (Blueberry) dried berry outer	ATR Native Plants Macro

FIGURE 6. FTIR SPECTRUM MATCHES FOR SAMPLE 3, 42DC1412, WAVE NUMBERS 3000-2800, BISON FAT OVERLAY.

PaleoResearch Institute
Golden, CO 80401

Fri May 30 17:07:20 2008 (GMT-06:00)
FIND PEAKS:
Spectrum: 08-39-3_CHM Extract_Lower
Region: 4000 400
Absolute threshold: 0.0018
Sensitivity: 50
Peak list:

Position:		Intensity:	
Position:	669	Intensity:	0.0085
Position:	720	Intensity:	0.0086
Position:	751	Intensity:	0.0054
Position:	766	Intensity:	0.0055
Position:	797	Intensity:	0.0054
Position:	824	Intensity:	0.0056
Position:	1037	Intensity:	0.0140
Position:	1111	Intensity:	0.0099
Position:	1172	Intensity:	0.0101
Position:	1377	Intensity:	0.0046
Position:	1465	Intensity:	0.0072
Position:	1712	Intensity:	0.0075
Position:	2849	Intensity:	0.0121
Position:	2917	Intensity:	0.0178



Spectrum: 08-39-3_CHM Extract
Region: 3005.80-2803.17
Search type: Correlation
Hit List:

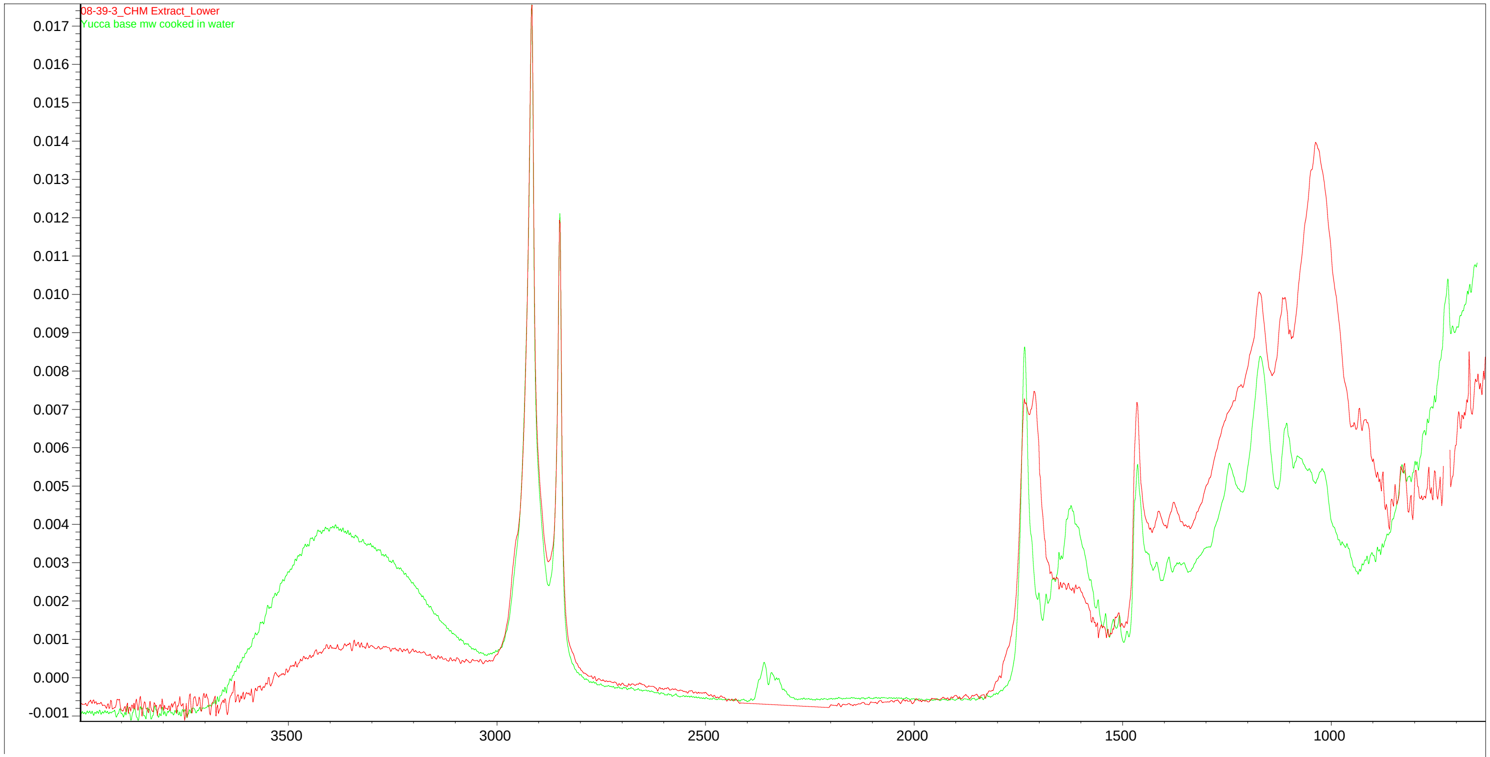
Index	Match	Compound name	Library
82	99.62	Yucca base mw cooked in water	ATR Native Plants Macro
53	97.94	Snowberry-Raw-Washington-2007	ATR Native Plant Macro
77	97.07	Yucca glauca Leaf basal section	ATR Native Plants Macro
1	96.39	Bison fat from bone sample (marrow)_06-2	ATR Native Animals
79	95.11	Yucca glauca Leaf outer 2	ATR Native Plants Macro
81	95.09	Opuntia pad raw semi-dry	ATR Native Plants Macro
13	92.57	Big Horn Sheep Dried Blood 2	ATR Native Animals
119	91.45	Blueberry_berry	ATR Native Plant Macro
45	91.31	Vaccinium (Blueberry) dried berry outer	ATR Native Plants Macro

FIGURE 7. FTIR SPECTRUM MATCHES FOR SAMPLE 3, 42DC1412, WAVE NUMBERS 3000-2800, BLUEBERRY OVERLAY.

PaleoResearch Institute
Golden, CO 80401

Fri May 30 17:07:20 2008 (GMT-06:00)
FIND PEAKS:
Spectrum: 08-39-3_CHM Extract_Lower
Region: 4000 400
Absolute threshold: 0.0018
Sensitivity: 50
Peak list:

Position:	669	Intensity:	0.0085
Position:	720	Intensity:	0.0086
Position:	751	Intensity:	0.0054
Position:	766	Intensity:	0.0055
Position:	797	Intensity:	0.0054
Position:	824	Intensity:	0.0056
Position:	1037	Intensity:	0.0140
Position:	1111	Intensity:	0.0099
Position:	1172	Intensity:	0.0101
Position:	1377	Intensity:	0.0046
Position:	1465	Intensity:	0.0072
Position:	1712	Intensity:	0.0075
Position:	2849	Intensity:	0.0121
Position:	2917	Intensity:	0.0178



Spectrum: 08-39-3_CHM Extract
Region: 1492.35-1429.02
Search type: Correlation
Hit List:

Index	Match	Compound name	Library
1	94.43	Bison fat from bone sample (marrow)_06-2	ATR Native Animals
82	93.34	Yucca base mw cooked in water	ATR Native Plants macro

FIGURE 8. FTIR SPECTRUM MATCHES FOR SAMPLE 3, 42DC1412, WAVE NUMBERS 1500-1420, COOKED YUCCA BASE OVERLAY.

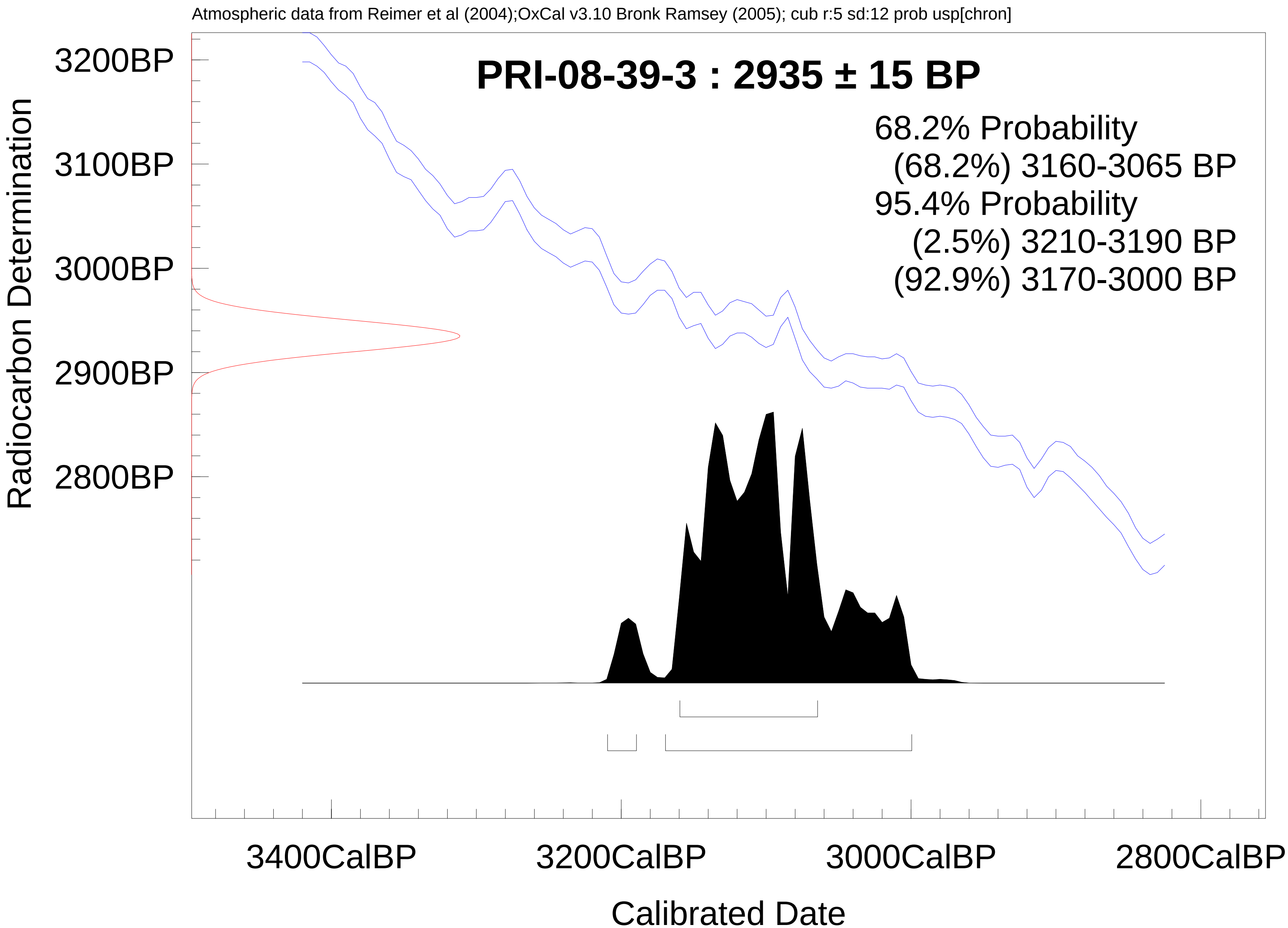


FIGURE 9. AMS RADIOCARBON DATE FOR SAMPLE PRI-08-39-3, 42DC1412.

PaleoResearch Institute
Golden, CO 80401

Fri May 30 18:17:27 2008 (GMT-06:00)
FIND PEAKS:
Spectrum: 08-39-6_CHM Extract
Region: 4000 400
Absolute threshold: 0.0023
Sensitivity: 50
Peak list:

Position:	669	Intensity:	0.0191
Position:	721	Intensity:	0.0178
Position:	797	Intensity:	0.0207
Position:	1058	Intensity:	0.0275
Position:	1459	Intensity:	0.0080
Position:	1741	Intensity:	0.0059
Position:	2852	Intensity:	0.0074
Position:	2923	Intensity:	0.0122

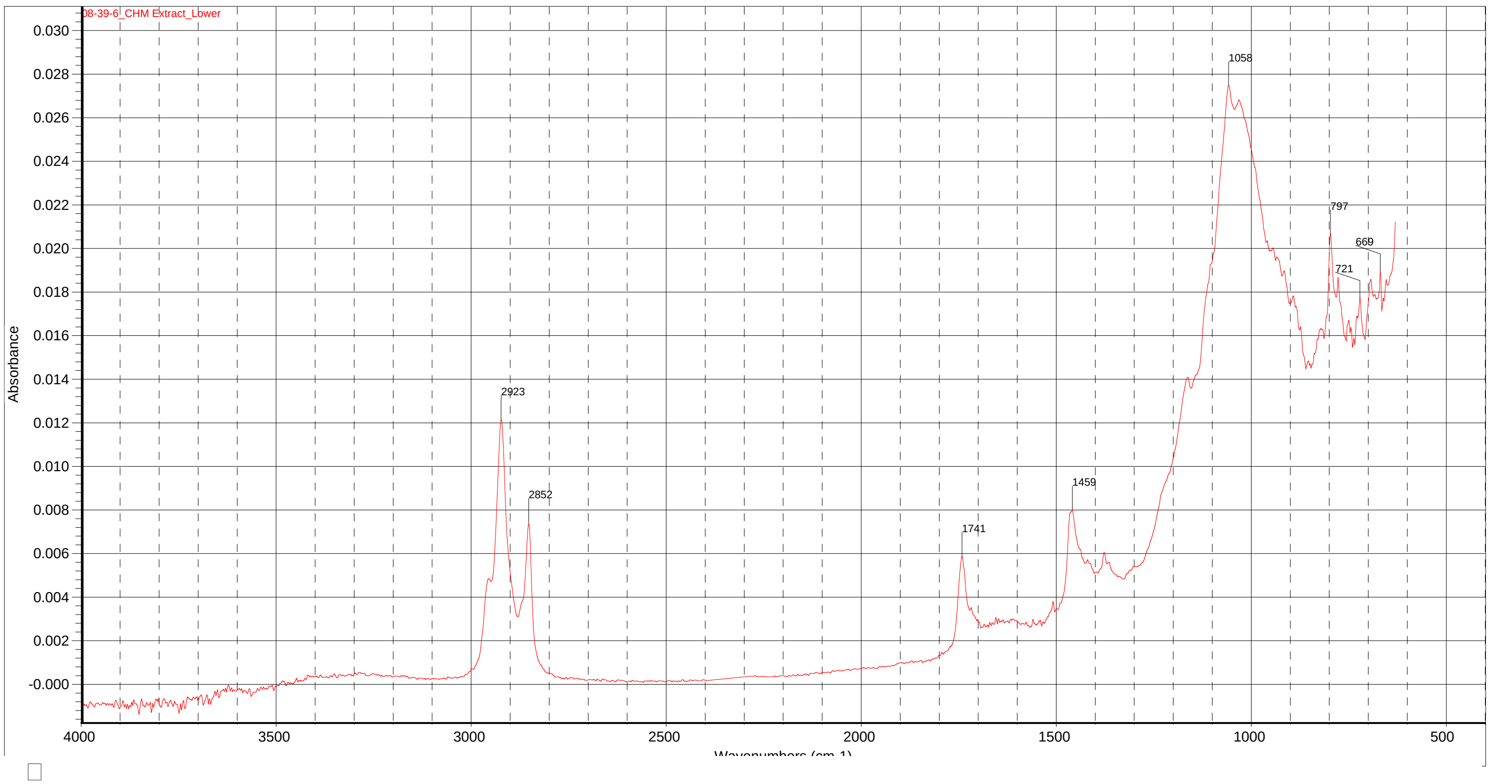
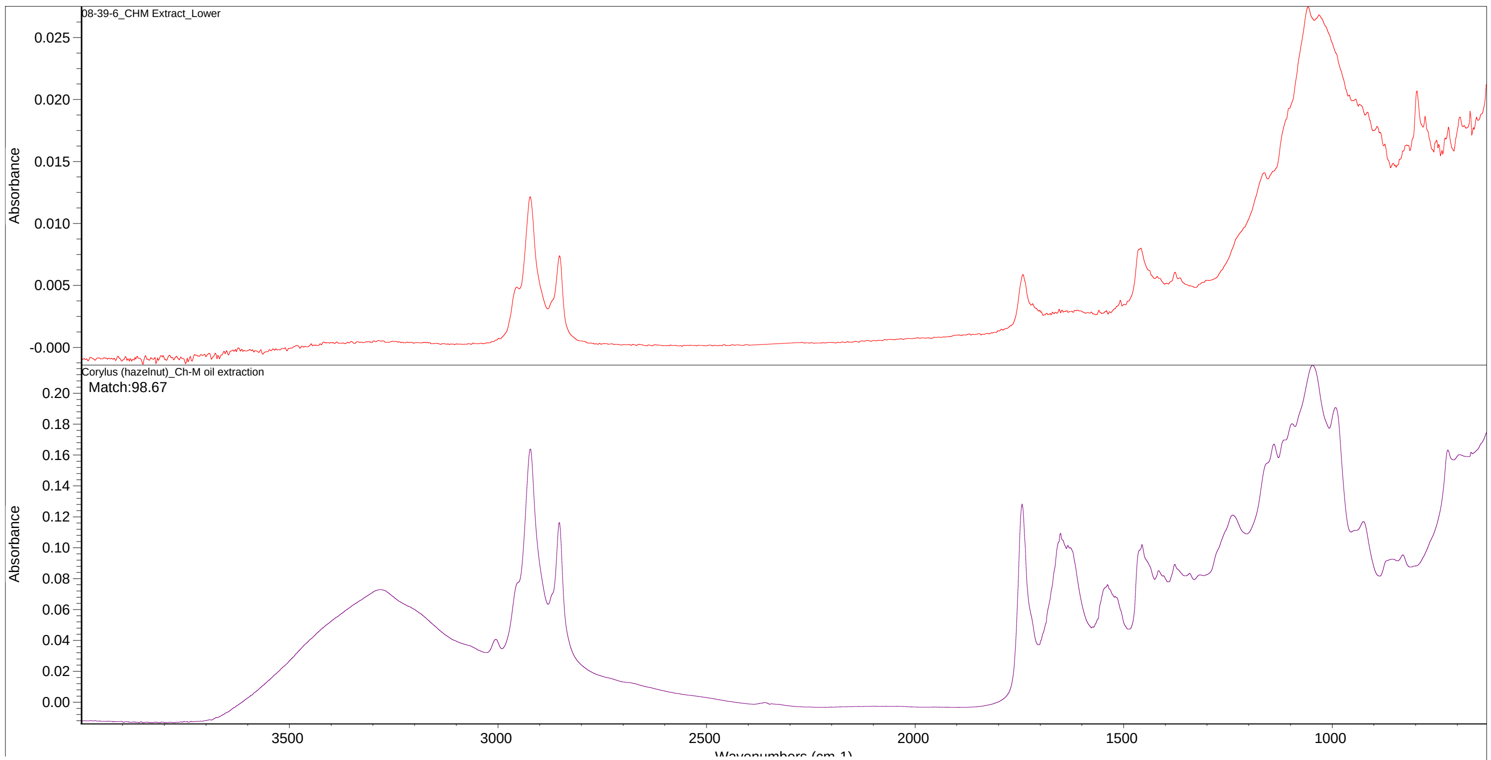


FIGURE 10. FTIR SPECTRUM FOR SAMPLE 6, 42DC1412, SHOWING PEAK LOCATIONS.

PaleoResearch Institute
Golden, CO 80401

Fri May 30 18:17:27 2008 (GMT-06:00)
FIND PEAKS:
Spectrum: 08-39-6_CHM Extract_Lower
Region: 4000 400
Absolute threshold: 0.0023
Sensitivity: 50
Peak list:

Position:	669	Intensity:	0.0191
Position:	721	Intensity:	0.0178
Position:	797	Intensity:	0.0207
Position:	1058	Intensity:	0.0275
Position:	1459	Intensity:	0.0080
Position:	1741	Intensity:	0.0059
Position:	2852	Intensity:	0.0074
Position:	2923	Intensity:	0.0122



Spectrum: 08-39-6_CHM Extract
Region: 3005.80-2803.17
Search type: Correlation
Hit List:

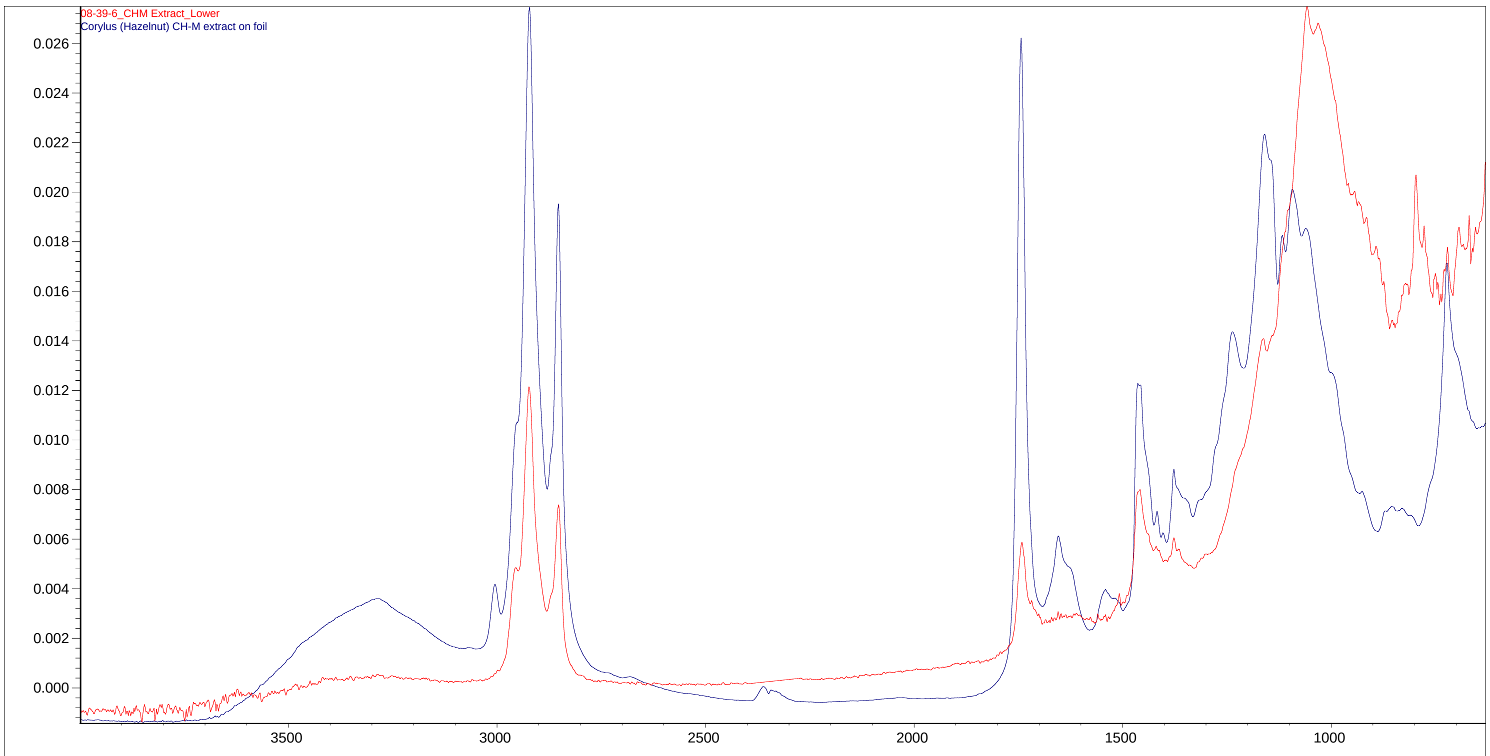
Index	Match	Compound name	Library
135	98.67	Corylus (hazelnut)_Ch-M oil extraction	ATR Native Plant Macro
1	98.66	Yucca Pods Ground	ATR Native Plant Macro
174	98.57	Quercus ilex (oak) CH-M extract on foil 2	ATR Native Plant Macro
134	98.47	Corylus (Hazelnut) CH-M extract on foil	ATR Native Plant Macro
173	98.42	Quercus ilex (oak) benzene extract on foil	ATR Native Plant Macro
44	98.39	Quercus sp. California Live Oak	ATR Native Plant Macro
167	98.34	Carya Illinoinensis (Pecan) oil - CH-M extract_1	ATR Native Plant Macro
189	98.17	Buffalo Gourd-Cucurbita foetidissima	ATR Native Plant Macro
166	98.07	Carya Illinoinensis (pecan) oil - Benzene extraction_1	ATR Native Plant Macro

FIGURE 11. FTIR SPECTRUM MATCHES FOR SAMPLE 6, 42DC1412, WAVE NUMBERS 3000-2800, CORYLUS.

PaleoResearch Institute
Golden, CO 80401

Fri May 30 18:17:27 2008 (GMT-06:00)
FIND PEAKS:
Spectrum: 08-39-6_CHM Extract_Lower
Region: 4000 400
Absolute threshold: 0.0023
Sensitivity: 50
Peak list:

Position:	669	Intensity:	0.0191
Position:	721	Intensity:	0.0178
Position:	797	Intensity:	0.0207
Position:	1058	Intensity:	0.0275
Position:	1459	Intensity:	0.0080
Position:	1741	Intensity:	0.0059
Position:	2852	Intensity:	0.0074
Position:	2923	Intensity:	0.0122



Spectrum: 08-39-6_CHM Extract
Region: 1770.98-1691.82
Search type: Correlation
Hit List:

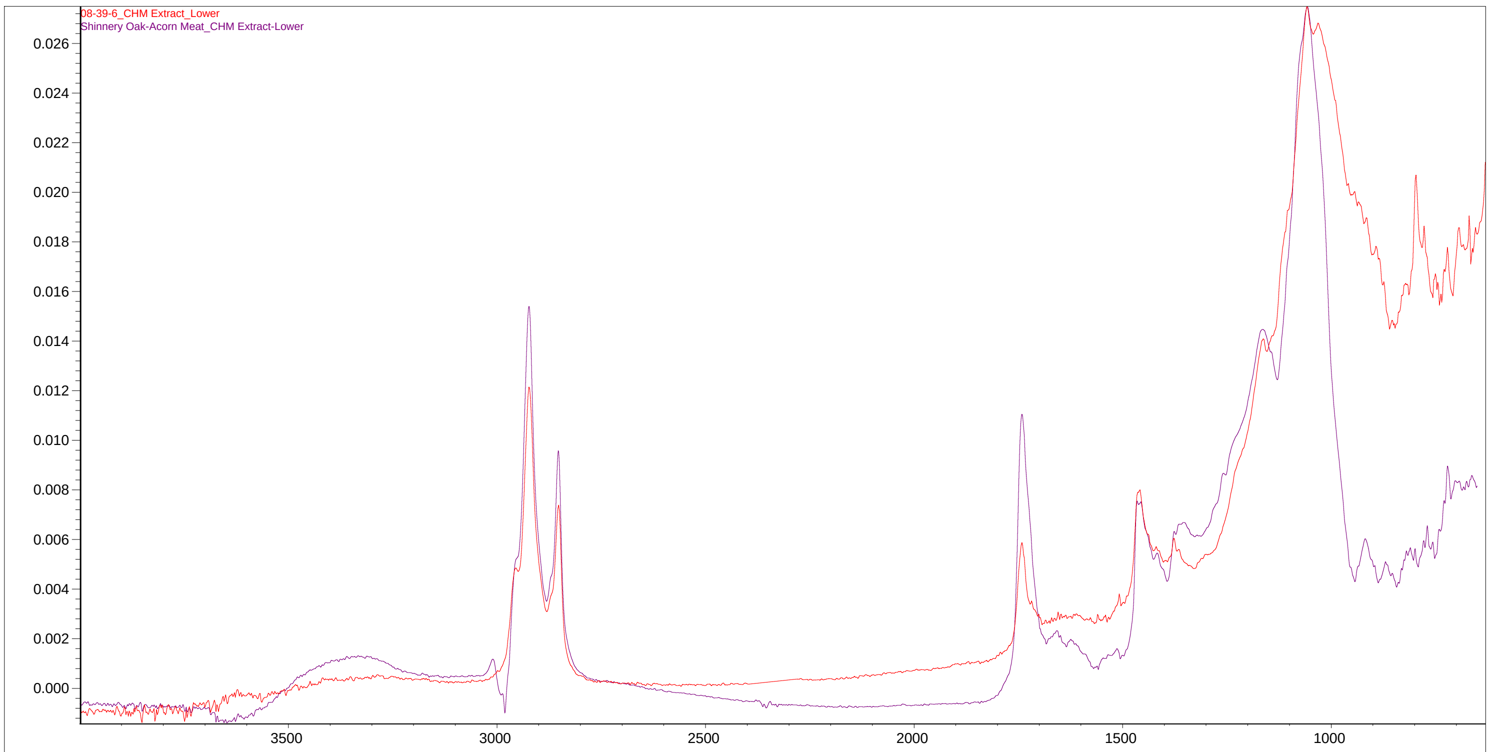
Index	Match	Compound name	Library
58	96.70	Fish oil sample _ 6-21-07	ATR Native Animals
155	96.37	Juglans regia (english walnut) benzene e extract on foil2	ATR Native Plant Macro
134	94.75	Corylus (Hazelnut) CH-M extract on foil	ATR Native Plant Macro
1	94.06	Yucca Pods Ground	ATR Native Plant Macro
167	93.63	Carya Illinoinensis (Pecan) oil - CH-M e extract_1	ATR Native Plant Macro
135	93.26	Corylus (hazelnut)_Ch-M oil extraction	ATR Native Plant Macro
153	92.92	Juglans nigra (black walnut) benzene extract on foil1	ATR Native Plant Macro
115	92.36	Juglans nigra (black walnut) raw meat_1	ATR Native Plant Macro

FIGURE 12. FTIR SPECTRUM MATCHES FOR SAMPLE 6, 42DC1412, WAVE NUMBERS 1770-1690, CORYLUS OVERLAY.

PaleoResearch Institute
Golden, CO 80401

Fri May 30 18:17:27 2008 (GMT-06:00)
FIND PEAKS:
Spectrum: 08-39-6_CHM Extract_Lower
Region: 4000 400
Absolute threshold: 0.0023
Sensitivity: 50
Peak list:

Position:	669	Intensity:	0.0191
Position:	721	Intensity:	0.0178
Position:	797	Intensity:	0.0207
Position:	1058	Intensity:	0.0275
Position:	1459	Intensity:	0.0080
Position:	1741	Intensity:	0.0059
Position:	2852	Intensity:	0.0074
Position:	2923	Intensity:	0.0122



Spectrum: 08-39-6_CHM Extract_Lower
Region: 1770.98-1691.82
Search type: Correlation
Hit List:

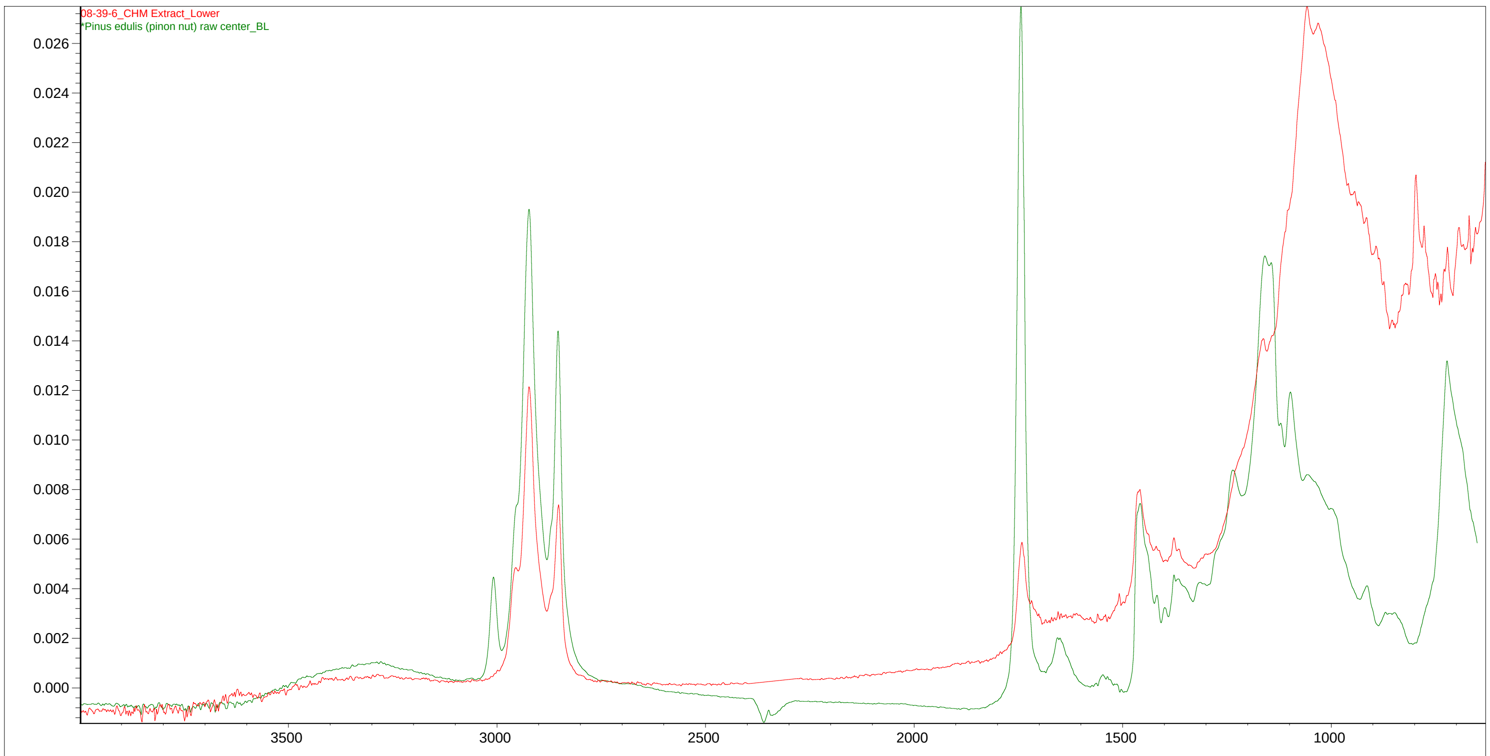
Index	Match	Compound name	Library
58	96.70	Fish oil sample _ 6-21-07	ATR Native Animals
155	96.37	Juglans regia (english walnut) benzene extract on foil2	ATR Native Plant Macro
134	94.75	Corylus (Hazelnut) CH-M extract on foil	ATR Native Plant Macro
1	94.06	Yucca Pods Ground	ATR Native Plant Macro
167	93.63	Carya Illinoinensis (Pecan) oil - CH-M e extract_1	ATR Native Plant Macro
135	93.26	Corylus (hazelnut)_Ch-M oil extraction	ATR Native Plant Macro
153	92.92	Juglans nigra (black walnut) benzene ext ract on foil1	ATR Native Plant Macro
115	92.36	Juglans nigra (black walnut) raw meat_1	ATR Native Plant Macro

FIGURE 13. FTIR SPECTRUM MATCHES FOR SAMPLE 6, 42DC1412, WAVE NUMBERS 1770-1690, ACORN OVERLAY.

PaleoResearch Institute
Golden, CO 80401

Fri May 30 18:17:27 2008 (GMT-06:00)
FIND PEAKS:
Spectrum: 08-39-6_CHM Extract_Lower
Region: 4000 400
Absolute threshold: 0.0023
Sensitivity: 50
Peak list:

Position:	669	Intensity:	0.0191
Position:	721	Intensity:	0.0178
Position:	797	Intensity:	0.0207
Position:	1058	Intensity:	0.0275
Position:	1459	Intensity:	0.0080
Position:	1741	Intensity:	0.0059
Position:	2852	Intensity:	0.0074
Position:	2923	Intensity:	0.0122



Spectrum: 08-39-6_CHM Extract
Region: 1770.98-1691.82
Search type: Correlation
Hit List:

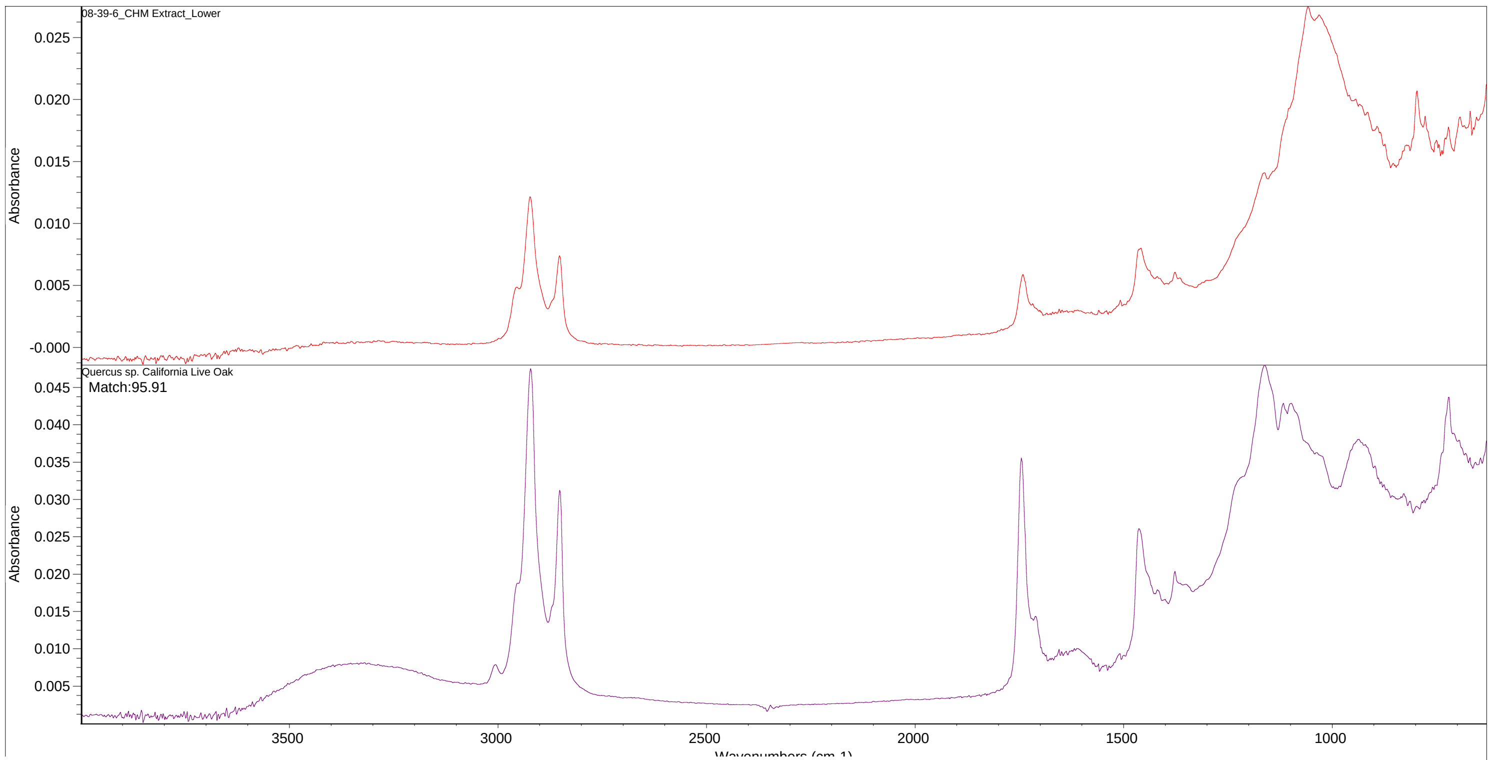
Index	Match	Compound name	Library
58	96.70	Fish oil sample _ 6-21-07	ATR Native Animals
155	96.37	Juglans regia (english walnut) benzene extract on foil2	ATR Native Plant Macro
134	94.75	Corylus (Hazelnut) CH-M extract on foil	ATR Native Plant Macro
1	94.06	Yucca Pods Ground	ATR Native Plant Macro
167	93.63	Carya Illinoinensis (Pecan) oil - CH-M e xtract_1	ATR Native Plant Macro
135	93.26	Corylus (hazelnut)_Ch-M oil extraction	ATR Native Plant Macro
153	92.92	Juglans nigra (black walnut) benzene ext ract on foil1	ATR Native Plant Macro
115	92.36	Juglans nigra (black walnut) raw meat_1	ATR Native Plant Macro

FIGURE 14. FTIR SPECTRUM MATCHES FOR SAMPLE 6, 42DC1412, WAVE NUMBERS 1770-1690, PINYON NUT OVERLAY.

PaleoResearch Institute
Golden, CO 80401

Fri May 30 18:17:27 2008 (GMT-06:00)
FIND PEAKS:
Spectrum: 08-39-6_CHM Extract_Lower
Region: 4000 400
Absolute threshold: 0.0023
Sensitivity: 50
Peak list:

Position:	669	Intensity:	0.0191
Position:	721	Intensity:	0.0178
Position:	797	Intensity:	0.0207
Position:	1058	Intensity:	0.0275
Position:	1459	Intensity:	0.0080
Position:	1741	Intensity:	0.0059
Position:	2852	Intensity:	0.0074
Position:	2923	Intensity:	0.0122



Spectrum: 08-39-6_CHM Extract
Region: 1501.85-1330.87
Search type: Correlation
Hit List:

Index	Match	Compound name	Library
44	95.91	Quercus sp. California Live Oak	ATR Native Plant Macro
94	94.11	Mockernut Hickory	ATR Native Plant Macro
154	93.50	Juglans regia (english walnut) benzene extract on foil1	ATR Native Plant Macro
87	93.43	Hazelnut	ATR Native Plant Macro
155	93.36	Juglans regia (english walnut) benzene extract on foil2	ATR Native Plant Macro
134	93.03	Corylus (Hazelnut) CH-M extract on foil	ATR Native Plant Macro
2	92.91	Yucca Seeds Boiled 2	ATR Native Plant Macro
167	92.84	Carya Illinoinensis (Pecan) oil - CH-M extract_1	ATR Native Plant Macro
166	92.47	Carya Illinoinensis (pecan) oil - Benzene extraction_1	ATR Native Plant Macro

FIGURE 15. FTIR SPECTRUM MATCHES FOR SAMPLE 6, 42DC1412, WAVE NUMBERS 1500-1330, ACORN.

PaleoResearch Institute
Golden, CO 80401

Sat Jun 07 17:28:43 2008 (GMT-06:00)
FIND PEAKS:
Spectrum: 08-39-7_CHM Extract_Lower_Cellulose
Region: 4000 400
Absolute threshold: 0.0137
Sensitivity: 71
Peak list:

Position:	695	Intensity:	0.0253
Position:	723	Intensity:	0.0219
Position:	748	Intensity:	0.0231
Position:	758	Intensity:	0.0233
Position:	779	Intensity:	0.0262
Position:	798	Intensity:	0.0278
Position:	828	Intensity:	0.0219
Position:	1014	Intensity:	0.0609
Position:	1456	Intensity:	0.0152
Position:	1506	Intensity:	0.0142
Position:	1539	Intensity:	0.0145
Position:	1558	Intensity:	0.0146
Position:	1652	Intensity:	0.0149
Position:	1746	Intensity:	0.0146
Position:	2852	Intensity:	0.0152
Position:	2923	Intensity:	0.0169
Position:	3585	Intensity:	0.0147
Position:	3627	Intensity:	0.0153
Position:	3647	Intensity:	0.0149
Position:	3655	Intensity:	0.0143
Position:	3674	Intensity:	0.0147
Position:	3733	Intensity:	0.0139
Position:	3743	Intensity:	0.0140
Position:	3749	Intensity:	0.0140
Position:	3820	Intensity:	0.0138
Position:	3851	Intensity:	0.0143

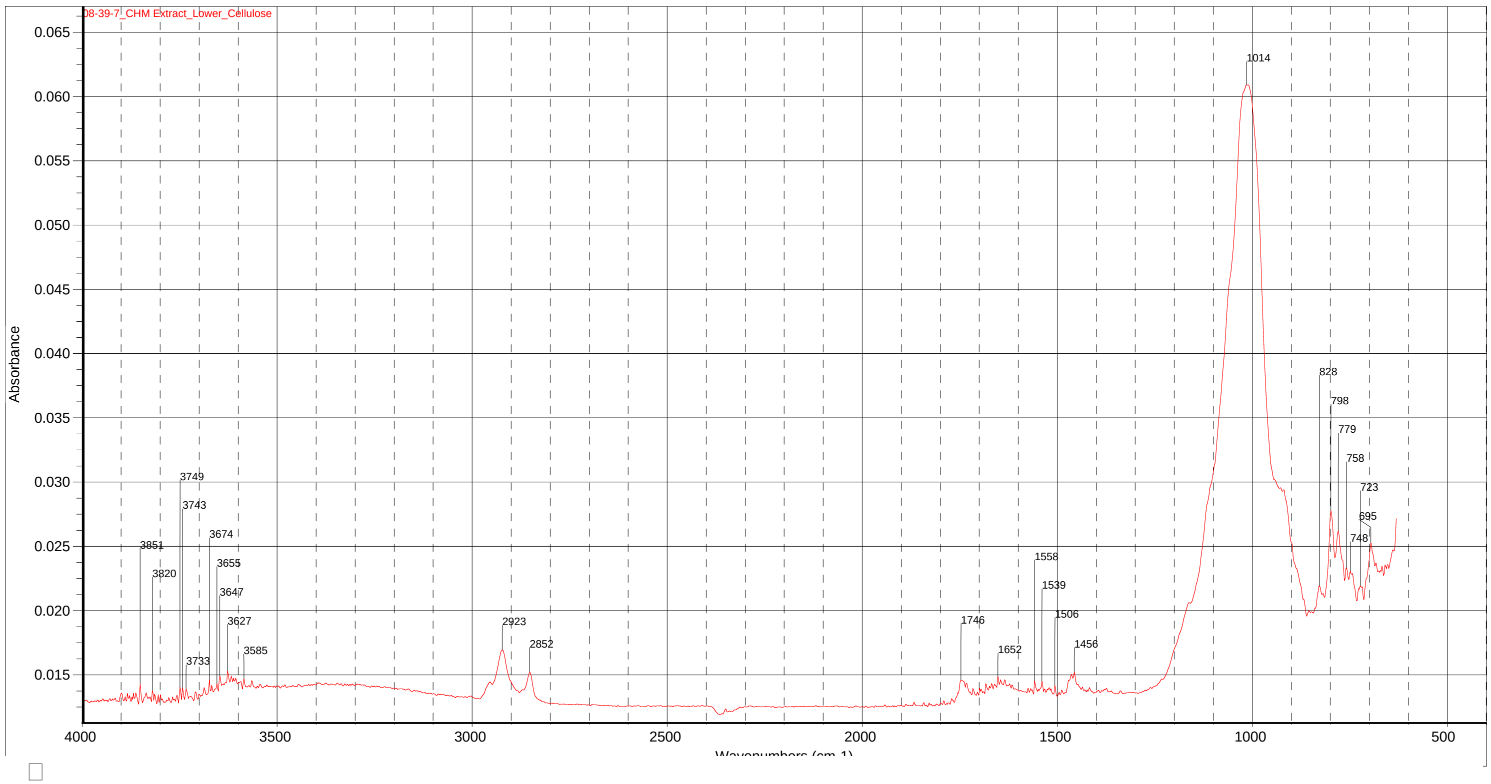
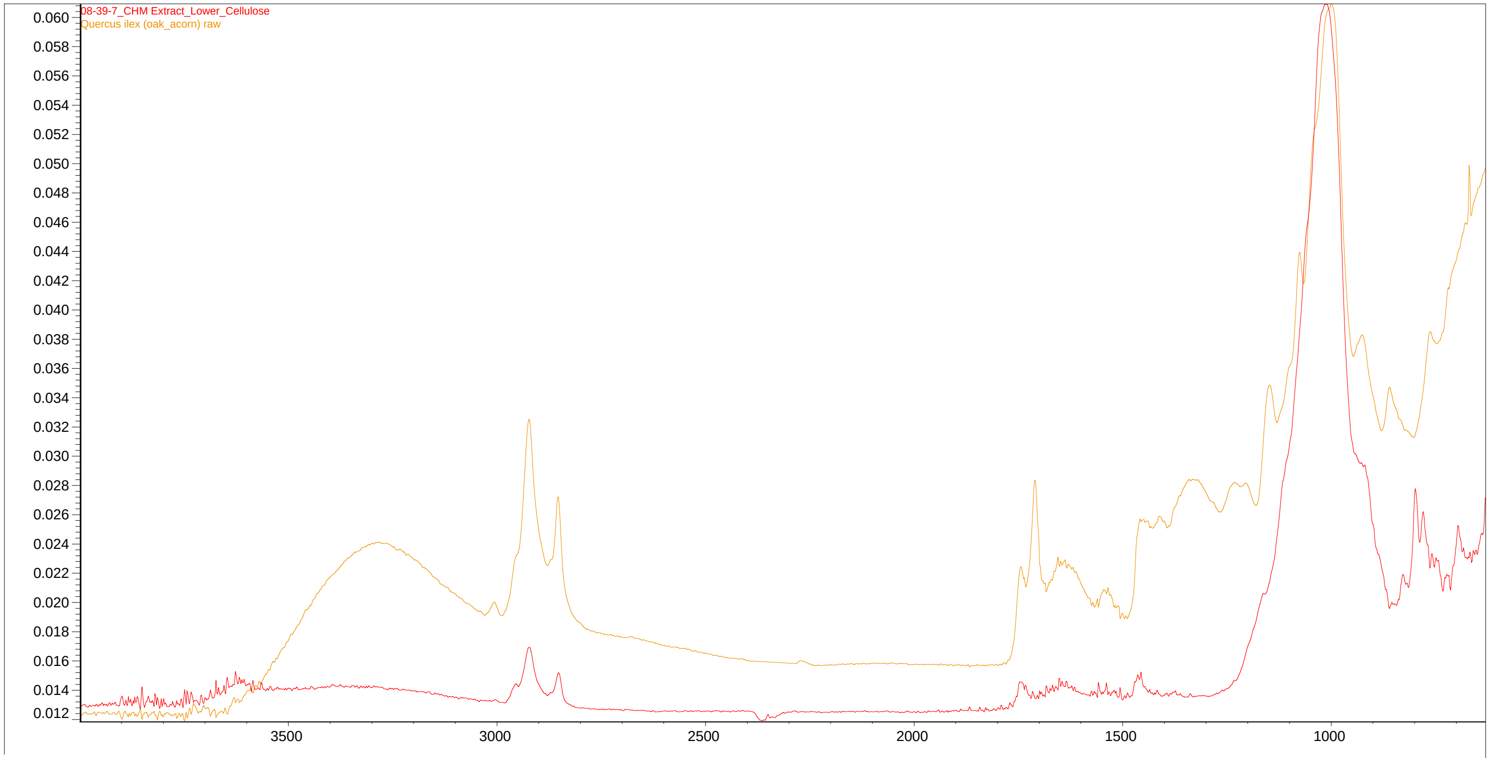


FIGURE 16. FTIR SPECTRUM FOR SAMPLE 7, 42DC1412, SHOWING PEAK LOCATIONS.

PaleoResearch Institute
Golden, CO 80401

Sat Jun 07 17:10:27 2008 (GMT-06:00)
FIND PEAKS:
Spectrum: 08-39-7_CHM Extract_Lower_Cellulose
Region: 4000 400
Absolute threshold: 0.0134
Sensitivity: 55
Peak list:

Position:	695	Intensity:	0.0253
Position:	779	Intensity:	0.0262
Position:	798	Intensity:	0.0278
Position:	1014	Intensity:	0.0609
Position:	1456	Intensity:	0.0152
Position:	1652	Intensity:	0.0149
Position:	2852	Intensity:	0.0152
Position:	2923	Intensity:	0.0169
Position:	3627	Intensity:	0.0153
Position:	3851	Intensity:	0.0143



Spectrum: 08-39-7_CHM Extract_Lower_Cellulose
Region: 3005.80-2803.17
Search type: Correlation
Hit List:

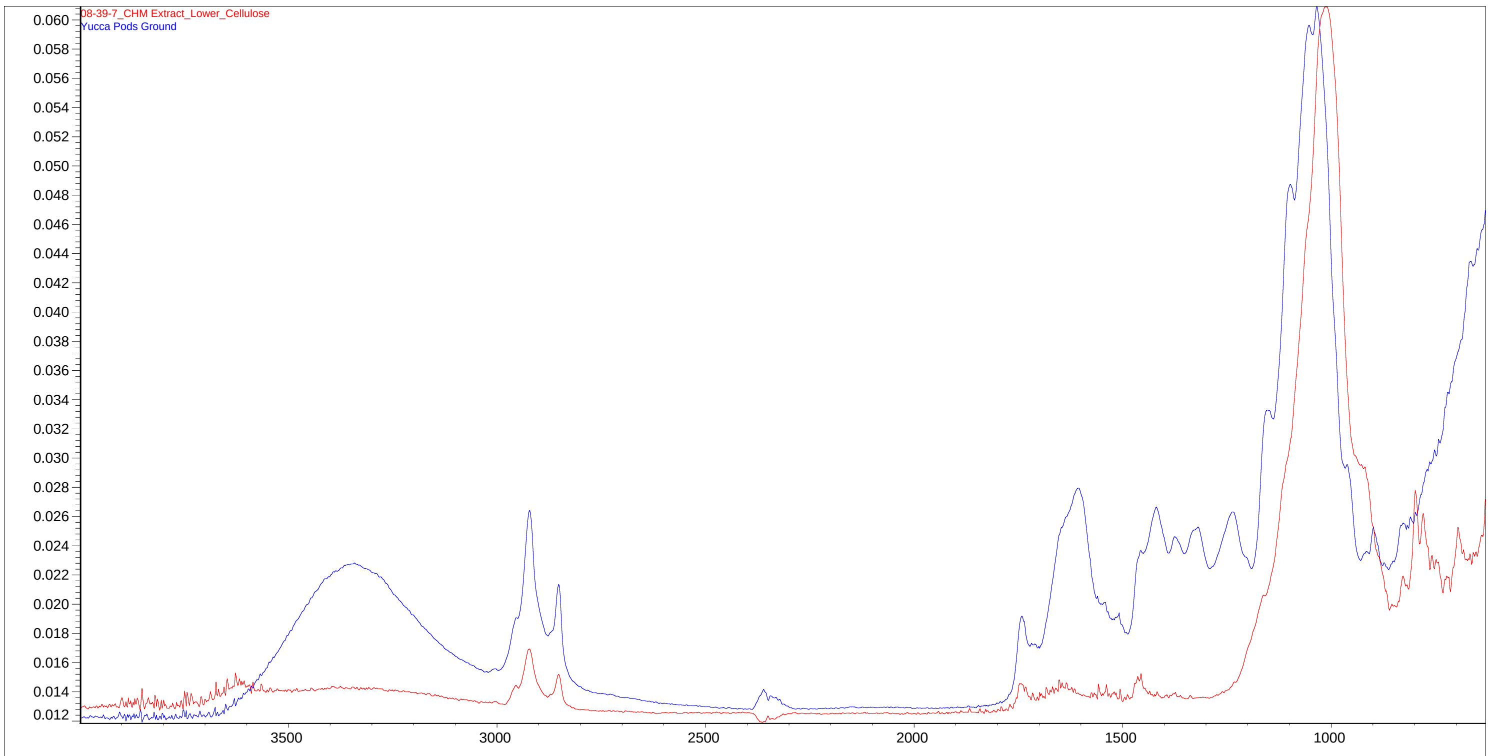
Index	Match	Compound name	Library
174	98.15	Quercus ilex (oak) CH-M extract on foil 2	ATR Native Plant Macro
135	98.13	Corylus (hazelnut)_Ch-M oil extraction	ATR Native Plant Macro
173	98.04	Quercus ilex (oak) benzene extract on fo foil	ATR Native Plant Macro
134	97.99	Corylus (Hazelnut) CH-M extract on foil	ATR Native Plant Macro
167	97.98	Carya Illinoinensis (Pecan) oil - CH-M extract_1	ATR Native Plant Macro
44	97.96	Quercus sp. California Live Oak	
1	97.91	Yucca Pods Ground	ATR Native Plant Macro
177	97.70	Quercus ilex oil extract-Benzene	ATR Native Plant Macro
166	97.69	Carya Illinoinensis (pecan) oil - Benzene	ATR Native Plant Macro
189	97.68	Buffalo Gourd-Cucurbita foetidissima	ATR Native Plant Macro

FIGURE 17. FTIR SPECTRUM MATCHES FOR SAMPLE 7, 42DC1412, WAVE NUMBERS 3000-2800, CELLULOSE OVERLAY.

PaleoResearch Institute
Golden, CO 80401

Sat Jun 07 17:10:27 2008 (GMT-06:00)
FIND PEAKS:
Spectrum: 08-39-7_CHM Extract_Lower_Cellulose
Region: 4000 400
Absolute threshold: 0.0134
Sensitivity: 55
Peak list:

Position:	695	Intensity:	0.0253
Position:	779	Intensity:	0.0262
Position:	798	Intensity:	0.0278
Position:	1014	Intensity:	0.0609
Position:	1456	Intensity:	0.0152
Position:	1652	Intensity:	0.0149
Position:	2852	Intensity:	0.0152
Position:	2923	Intensity:	0.0169
Position:	3627	Intensity:	0.0153
Position:	3851	Intensity:	0.0143



Spectrum: 08-39-7_CHM Extract_Lower_Cellulose
Region: 3005.80-2803.17
Search type: Correlation
Hit List:

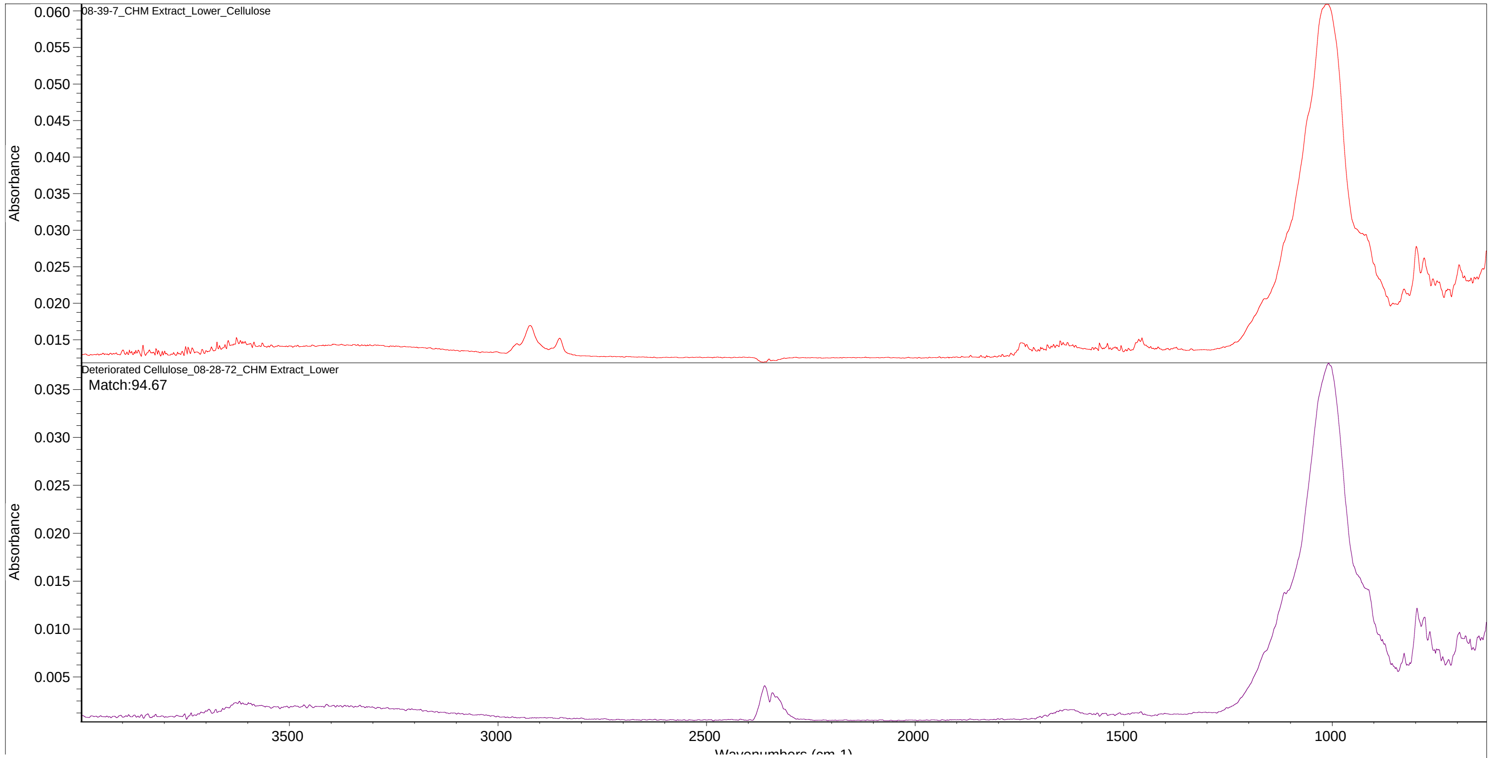
Index	Match	Compound name	Library
174	98.15	Quercus ilex (oak) CH-M extract on foil 2	ATR Native Plant Macro
135	98.13	Corylus (hazelnut)_Ch-M oil extraction	ATR Native Plant Macro
173	98.04	Quercus ilex (oak) benzene extract on foil	ATR Native Plant Macro
134	97.99	Corylus (Hazelnut) CH-M extract on foil	ATR Native Plant Macro
167	97.98	Carya Illinoinensis (Pecan) oil - CH-M e extract_1	ATR Native Plant Macro
44	97.96	Quercus sp. California Live Oak	ATR Native Plant Macro
1	97.91	Yucca Pods Ground	ATR Native Plant Macro
177	97.70	Quercus ilex oil extract-Benzene	ATR Native Plant Macro
166	97.69	Carya Illinoinensis (pecan) oil - Benzene extraction_1	ATR Native Plant Macro
189	97.68	Buffalo Gourd-Cucurbita foetidissima	ATR Native Plant Macro

FIGURE 18. FTIR SPECTRUM MATCHES FOR SAMPLE 7, 42DC1412, WAVE NUMBERS 3000-2800, YUCCA POD OVERLAY.

PaleoResearch Institute
Golden, CO 80401

Sat Jun 07 17:10:27 2008 (GMT-06:00)
FIND PEAKS:
Spectrum: 08-39-7_CHM Extract_Lower_Cellulose
Region: 4000 400
Absolute threshold: 0.0134
Sensitivity: 55
Peak list:

Position:	695	Intensity:	0.0253
Position:	779	Intensity:	0.0262
Position:	798	Intensity:	0.0278
Position:	1014	Intensity:	0.0609
Position:	1456	Intensity:	0.0152
Position:	1652	Intensity:	0.0149
Position:	2852	Intensity:	0.0152
Position:	2923	Intensity:	0.0169
Position:	3627	Intensity:	0.0153
Position:	3851	Intensity:	0.0143



Spectrum: 08-39-7_CHM Extract_Lower_Cellulose
Region: 1210.55-868.60
Search type: Correlation
Hit List:

Index	Match	Compound name	Library
193	94.67	Deteriorated Cellulose_08-28-72_CHM Extract_Lower	ATR Native Plant Macro

FIGURE 19. FTIR SPECTRUM MATCHES FOR SAMPLE 7, 42DC1412, DETERIORATED CELLULOSE.

PaleoResearch Institute
Golden, CO 80401

Sat Jun 07 17:26:16 2008 (GMT-06:00)
FIND PEAKS:
Spectrum: 08-39-8_CHM Extract_Upper
Region: 4000 400
Absolute threshold: 0.0040
Sensitivity: 78
Peak list:

Position:	696	Intensity:	0.0218
Position:	725	Intensity:	0.0169
Position:	777	Intensity:	0.0260
Position:	796	Intensity:	0.0284
Position:	822	Intensity:	0.0184
Position:	1024	Intensity:	0.0611
Position:	1377	Intensity:	0.0057
Position:	1459	Intensity:	0.0067
Position:	1509	Intensity:	0.0052
Position:	1655	Intensity:	0.0054
Position:	1743	Intensity:	0.0051
Position:	2853	Intensity:	0.0057
Position:	2924	Intensity:	0.0077
Position:	3331	Intensity:	0.0043
Position:	3630	Intensity:	0.0042

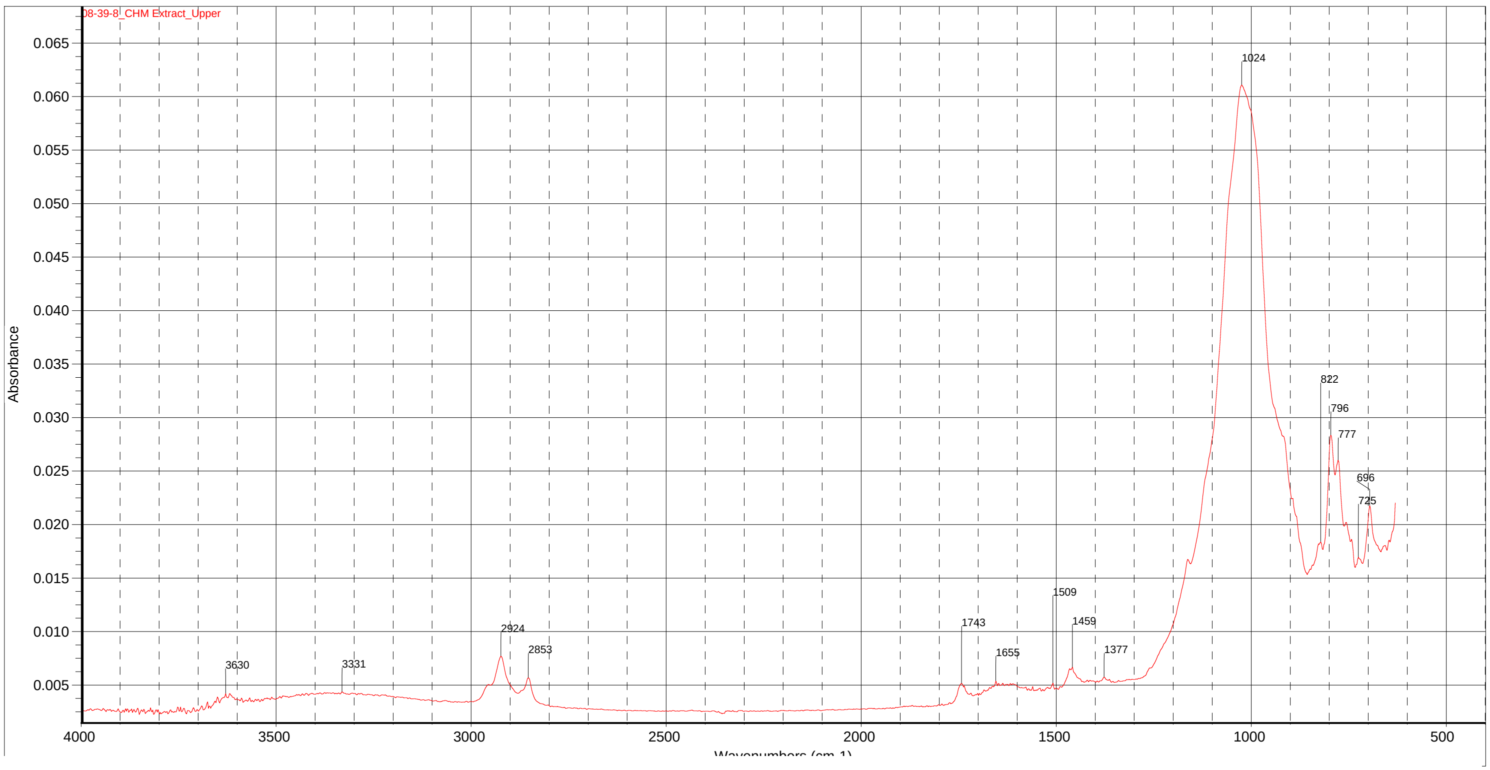
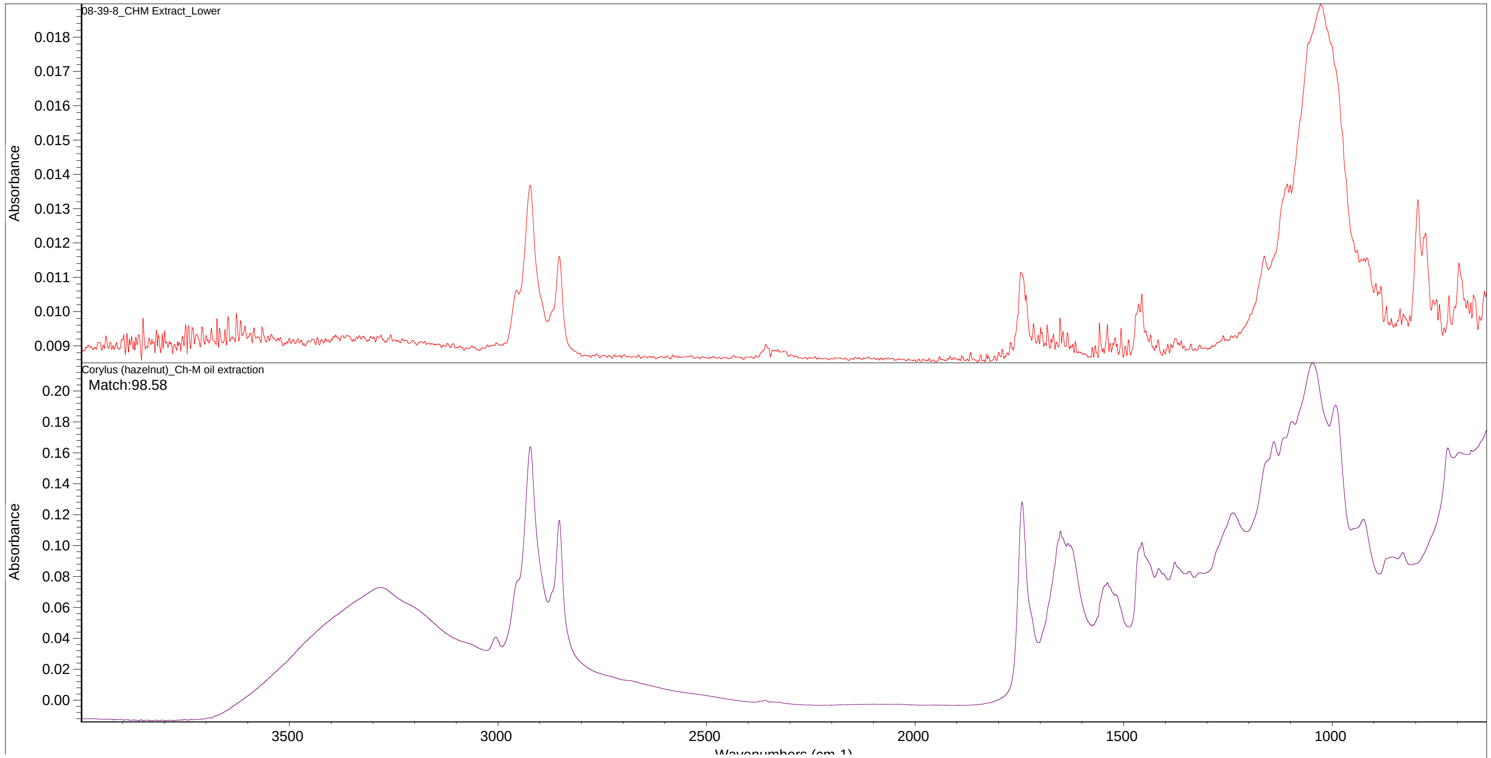


FIGURE 20. FTIR SPECTRUM FOR SAMPLE 8, 42DC1412, SHOWING PEAK LOCATIONS.

PaleoResearch Institute
Golden, CO 80401

Sat Jun 07 17:22:54 2008 (GMT-06:00)
FIND PEAKS:
Spectrum: 08-39-8_CHM Extract_Lower
Region: 4000 400
Absolute threshold: 0.0096
Sensitivity: 34
Peak list:

Position:	696	Intensity:	0.0114
Position:	794	Intensity:	0.0133
Position:	1028	Intensity:	0.0190
Position:	1456	Intensity:	0.0105
Position:	1539	Intensity:	0.0096
Position:	1558	Intensity:	0.0097
Position:	1652	Intensity:	0.0099
Position:	1746	Intensity:	0.0112
Position:	2853	Intensity:	0.0116
Position:	2923	Intensity:	0.0137
Position:	3627	Intensity:	0.0100
Position:	3851	Intensity:	0.0099



Spectrum: 08-39-8_CHM Extract
Region: 3012.14-2803.17
Search type: Correlation
Hit List:

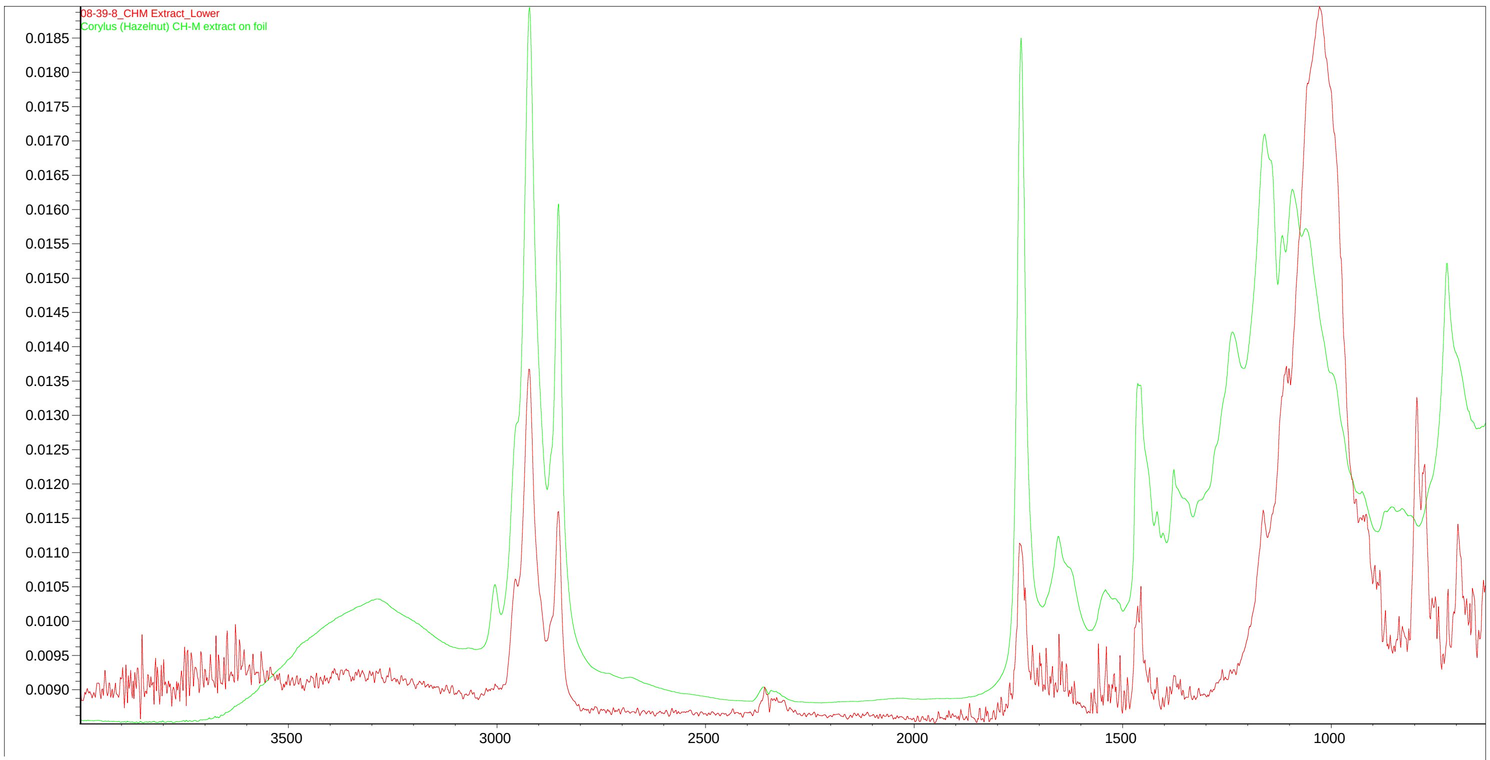
Index	Match	Compound name	Library
135	98.58	Corylus (hazelnut)_Ch-M oil extraction	ATR Native Plant Macro
87	98.47	Hazelnut	ATR Native Plant Macro
188	98.46	Pumpkin Seed-Raw	ATR Native Plant Macro
167	98.35	Carya Illinoinensis (Pecan) oil - CH-M extract_1	ATR Native Plant Macro
174	98.31	Quercus ilex (oak) CH-M extract on foil2	ATR Native Plant Macro
166	98.29	Carya Illinoinensis (pecan) oil - Benzene extraction_1	ATR Native Plant Macro
94	98.27	Mockernut Hickory	ATR Native Plant Macro
134	98.15	Corylus (Hazelnut) CH-M extract on foil	ATR Native Plant Macro
194	98.14	Quercus ilex (oak_acorn) raw	ATR Native Plant Macro
17	98.02	Carya Illinoinensis -raw (pecan) dark outer2	ATR Native Plants Macro

FIGURE 21. FTIR SPECTRUM MATCHES FOR SAMPLE 8, 42DC1412, WAVE NUMBERS 3000-2800, CORYLUS.

PaleoResearch Institute
Golden, CO 80401

Sat Jun 07 17:22:54 2008 (GMT-06:00)
FIND PEAKS:
Spectrum: 08-39-8_CHM Extract_Lower
Region: 4000 400
Absolute threshold: 0.0096
Sensitivity: 34
Peak list:

Position:	696	Intensity:	0.0114
Position:	794	Intensity:	0.0133
Position:	1028	Intensity:	0.0190
Position:	1456	Intensity:	0.0105
Position:	1539	Intensity:	0.0096
Position:	1558	Intensity:	0.0097
Position:	1652	Intensity:	0.0099
Position:	1746	Intensity:	0.0112
Position:	2853	Intensity:	0.0116
Position:	2923	Intensity:	0.0137
Position:	3627	Intensity:	0.0100
Position:	3851	Intensity:	0.0099



Spectrum: 08-39-8_CHM Extract
Region: 3012.14-2803.17
Search type: Correlation
Hit List:

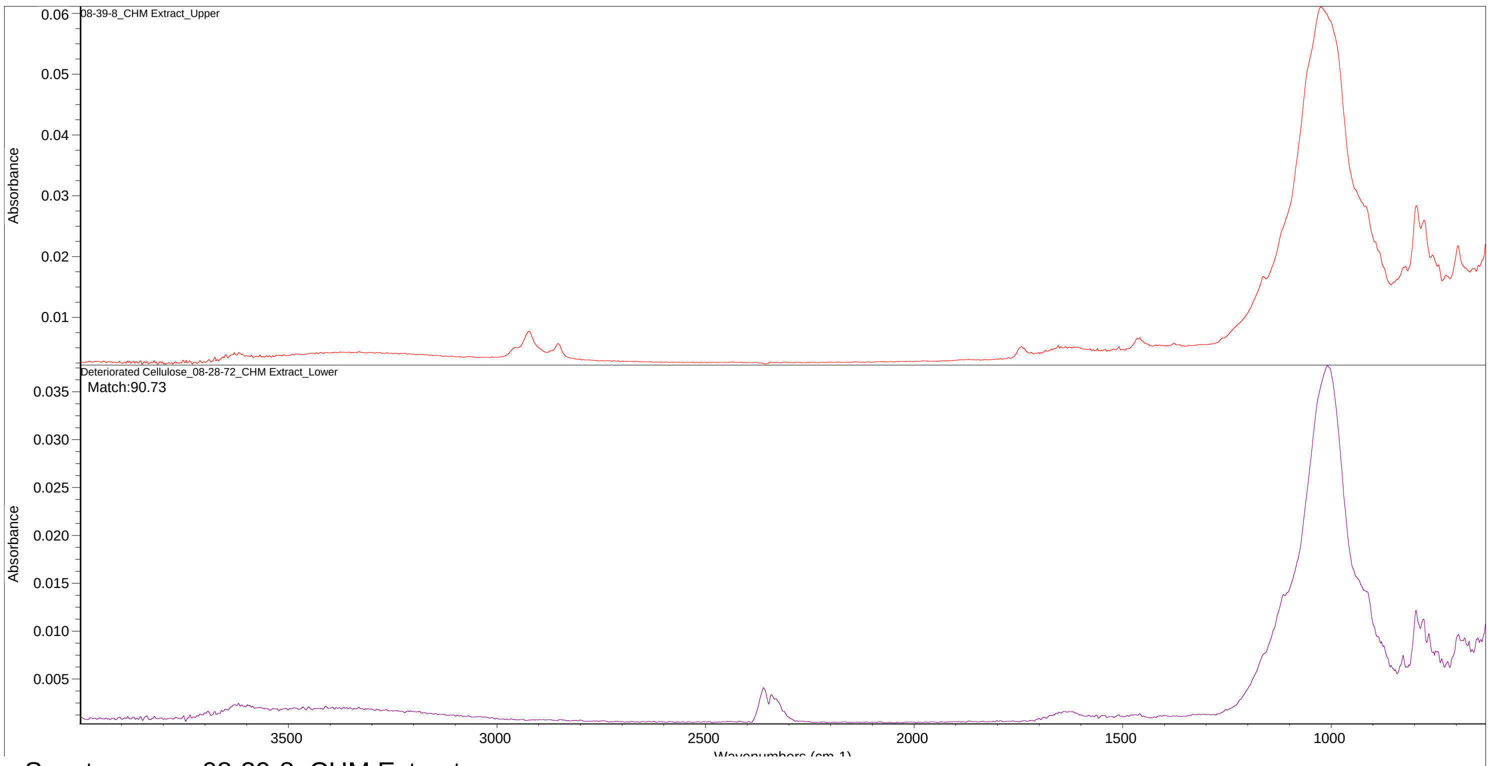
Index	Match	Compound name	Library
135	98.58	Corylus (hazelnut)_Ch-M oil extraction	ATR Native Plant Macro
87	98.47	Hazelnut	ATR Native Plant Macro
188	98.46	Pumpkin Seed-Raw	ATR Native Plant Macro
167	98.35	Carya Illinoinensis (Pecan) oil - CH-M extract_1	ATR Native Plant Macro
174	98.31	Quercus ilex (oak) CH-M extract on foil2	ATR Native Plant Macro
166	98.29	Carya Illinoinensis (pecan) oil - Benzene extraction_1	ATR Native Plant Macro
94	98.27	Mockernut Hickory	ATR Native Plant Macro
134	98.15	Corylus (Hazelnut) CH-M extract on foil	ATR Native Plant Macro
194	98.14	Quercus ilex (oak_acorn) raw	ATR Native Plant Macro
17	98.02	Carya Illinoinensis -raw (pecan) dark outer2	ATR Native Plants macro

FIGURE 22. FTIR SPECTRUM MATCHES FOR SAMPLE 8, 42DC1412, WAVE NUMBERS 3000-2800, CORYLUS OVERLAY.

PaleoResearch Institute
Golden, CO 80401

Sat Jun 07 17:26:16 2008 (GMT-06:00)
FIND PEAKS:
Spectrum: 08-39-8_CHM Extract_Upper
Region: 4000 400
Absolute threshold: 0.0040
Sensitivity: 78
Peak list:

Position:	696	Intensity:	0.0218
Position:	725	Intensity:	0.0169
Position:	777	Intensity:	0.0260
Position:	796	Intensity:	0.0284
Position:	822	Intensity:	0.0184
Position:	1024	Intensity:	0.0611
Position:	1377	Intensity:	0.0057
Position:	1459	Intensity:	0.0067
Position:	1509	Intensity:	0.0052
Position:	1655	Intensity:	0.0054
Position:	1743	Intensity:	0.0051
Position:	2853	Intensity:	0.0057
Position:	2924	Intensity:	0.0077
Position:	3331	Intensity:	0.0043
Position:	3630	Intensity:	0.0042



Spectrum: 08-39-8_CHM Extract
Region: 1245.38-862.27
Search type: Correlation
Hit List:

Index	Match	Compound name	Library
193	90.73	Deteriorated Cellulose_08-28-72_CHM Extract_Lower	ATR Native Plant Macro

FIGURE 23. FTIR SPECTRUM MATCHES FOR SAMPLE 8, WAVE NUMBERS 1250-850, DETERIORATED CELLULOSE.

PaleoResearch Institute
Golden, CO 80401

Fri May 30 18:05:43 2008 (GMT-06:00)
FIND PEAKS:
Spectrum: 08-39-5_CHM Extract_LowerB
Region: 4000 400
Absolute threshold: 0.0024
Sensitivity: 50
Peak list:

Position:	719	Intensity:	0.0180
Position:	741	Intensity:	0.0171
Position:	764	Intensity:	0.0168
Position:	827	Intensity:	0.0174
Position:	886	Intensity:	0.0178
Position:	930	Intensity:	0.0185
Position:	1123	Intensity:	0.0162
Position:	1173	Intensity:	0.0174
Position:	1378	Intensity:	0.0087
Position:	1462	Intensity:	0.0102
Position:	1708	Intensity:	0.0078
Position:	2851	Intensity:	0.0070
Position:	2920	Intensity:	0.0111

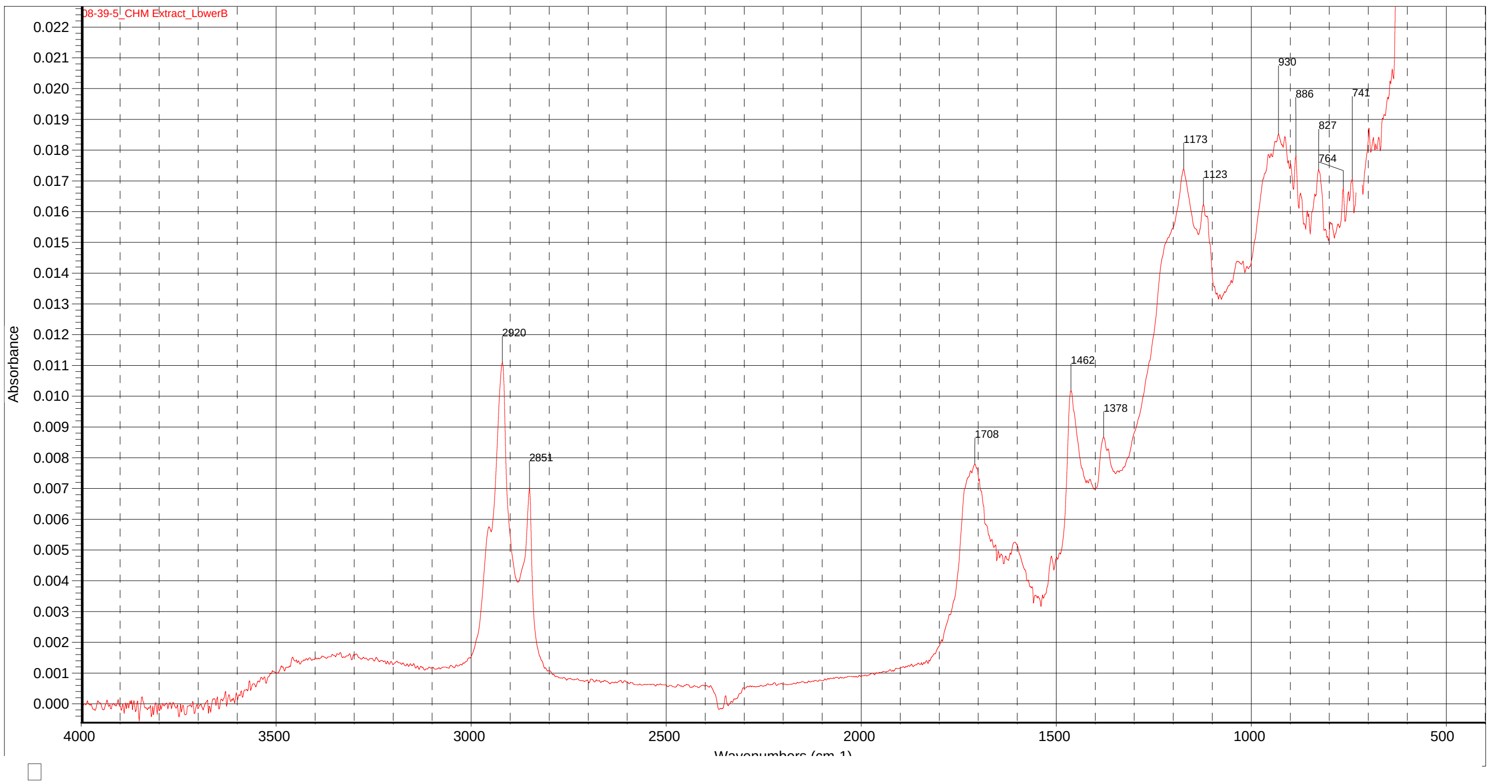


FIGURE 24. FTIR SPECTRUM FOR SAMPLE 5, 42DC1412, SHOWING PEAK LOCATIONS.

PaleoResearch Institute
Golden, CO 80401

08-39-5_CHM Extract_LowerA_Yellow at bottom

Fri May 30 17:18:38 2008 (GMT-06:00)
FIND PEAKS:
Spectrum: 08-39-5_CHM Extract_LowerA_Yellow at bottom
Region: 4000 400
Absolute threshold: -0.0003
Sensitivity: 50
Peak list:

Position:	693	Intensity:	0.0037
Position:	722	Intensity:	0.0020
Position:	742	Intensity:	0.0029
Position:	750	Intensity:	0.0029
Position:	798	Intensity:	0.0032
Position:	827	Intensity:	0.0024
Position:	1027	Intensity:	0.0136
Position:	1117	Intensity:	0.0062
Position:	1460	Intensity:	0.0014
Position:	1701	Intensity:	0.00058
Position:	2852	Intensity:	0.00063
Position:	2921	Intensity:	0.0018
Position:	3385	Intensity:	0.00001

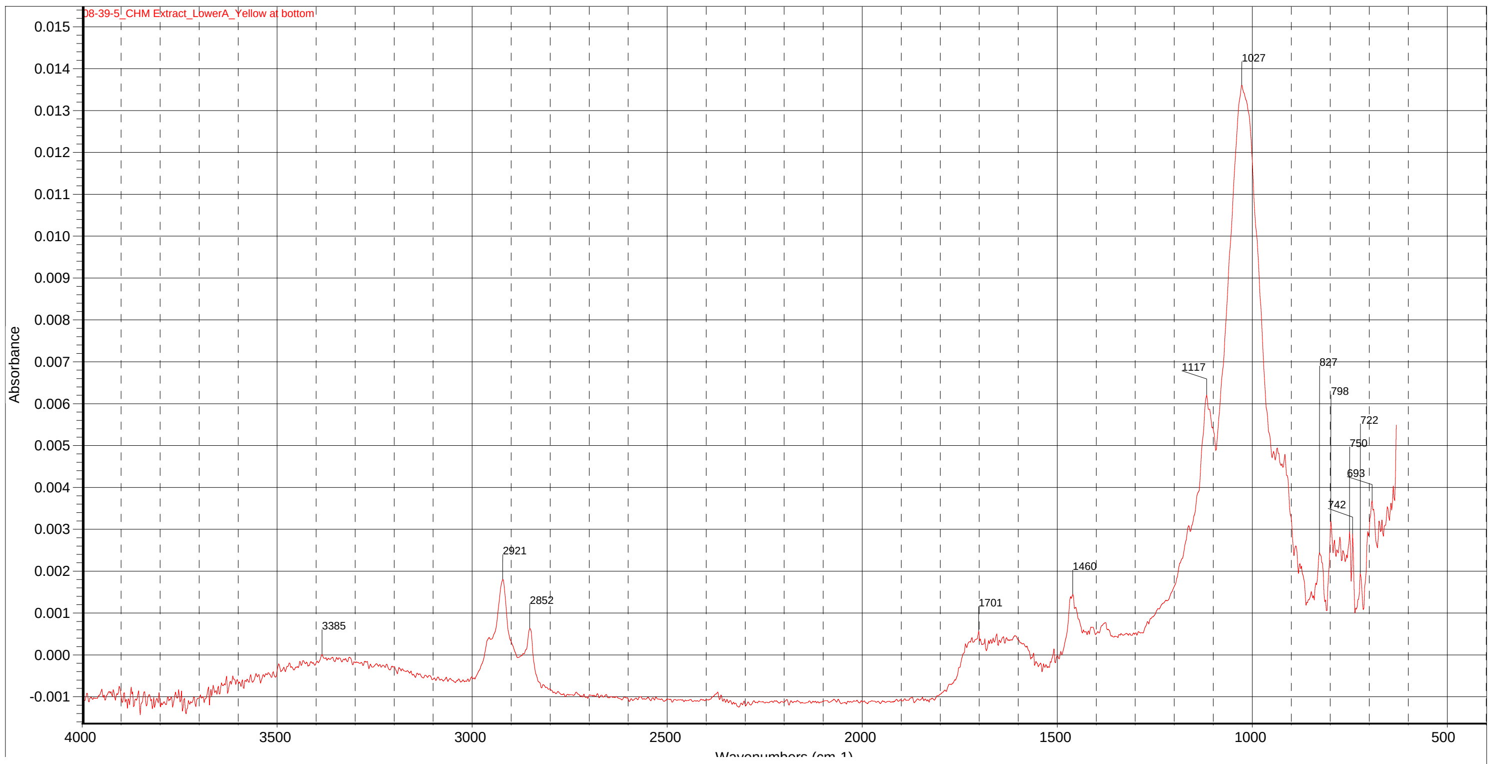
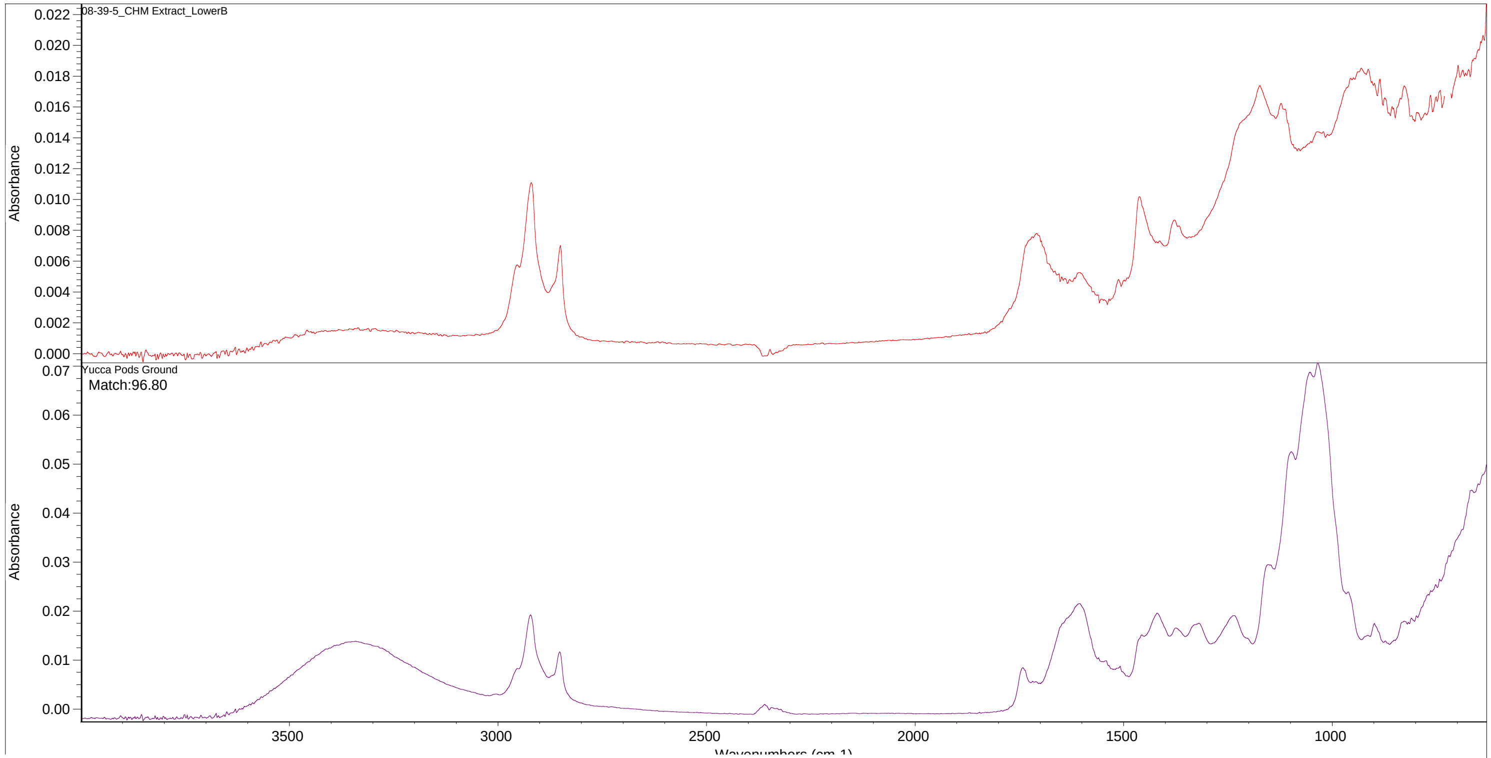


FIGURE 25. FTIR SPECTRUM FOR SAMPLE 5, LOWER YELLOW, 42DC1412, SHOWING PEAK LOCATIONS.

PaleoResearch Institute
Golden, CO 80401

Fri May 30 18:05:43 2008 (GMT-06:00)
FIND PEAKS:
Spectrum: 08-39-5_CHM Extract_LowerB
Region: 4000 400
Absolute threshold: 0.0024
Sensitivity: 50
Peak list:

Position:	719	Intensity:	0.0180
Position:	741	Intensity:	0.0171
Position:	764	Intensity:	0.0168
Position:	827	Intensity:	0.0174
Position:	886	Intensity:	0.0178
Position:	930	Intensity:	0.0185
Position:	1123	Intensity:	0.0162
Position:	1173	Intensity:	0.0174
Position:	1378	Intensity:	0.0087
Position:	1462	Intensity:	0.0102
Position:	1708	Intensity:	0.0078
Position:	2851	Intensity:	0.0070
Position:	2920	Intensity:	0.0111



Spectrum: 08-39-5_CHM Extract_LowerB
Region: 3005.80-2803.17
Search type: Correlation
Hit List:

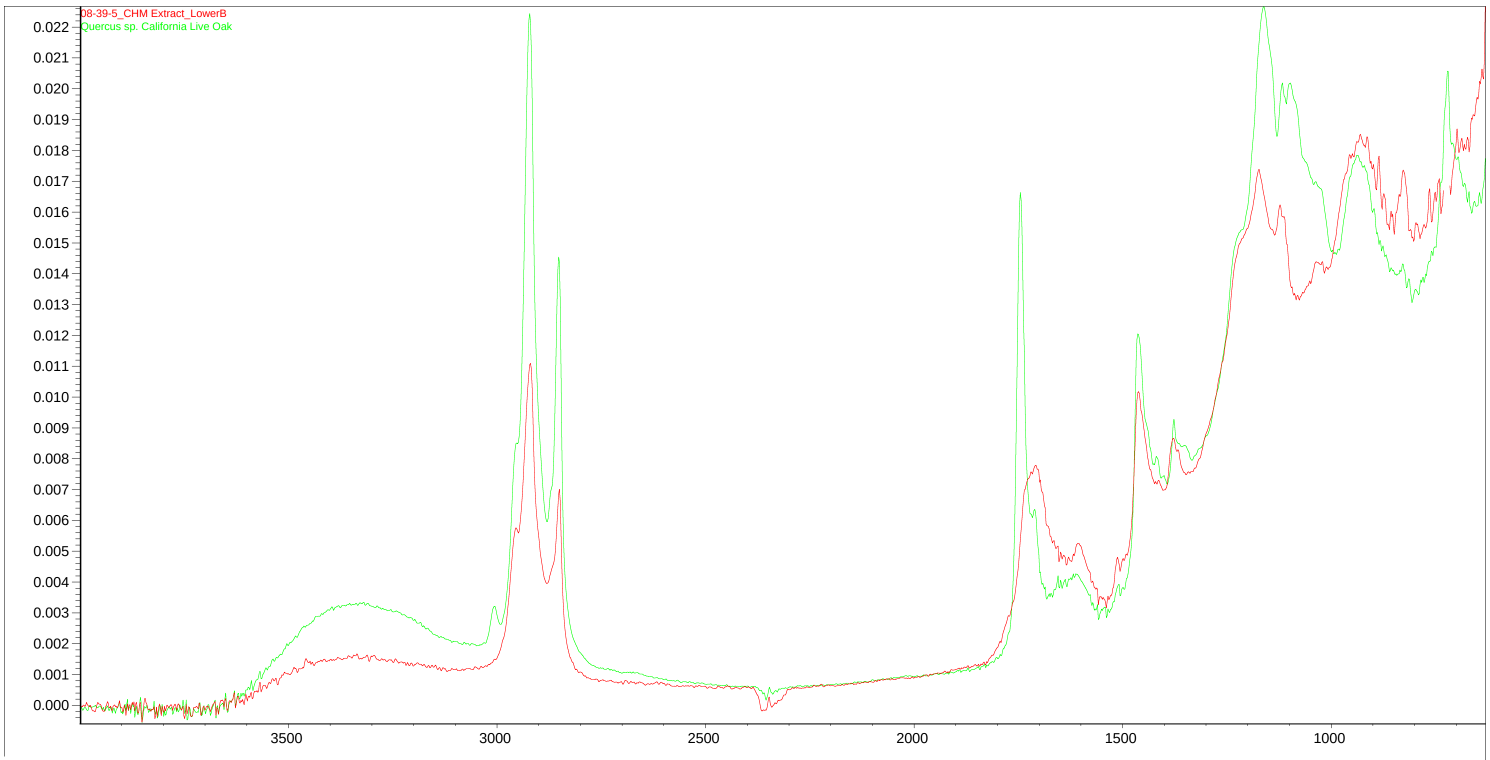
Index	Match	Compound name	Library
1	96.80	Yucca Pods Ground	ATR Native Plant Macro
44	96.74	Quercus sp. California Live Oak	ATR Native Plant Macro
2	94.38	Adeps Lanae (lanolin) oil	ATR Native Animals
189	94.35	Buffalo Gourd-Cucurbita foetidissima	ATR Native Plant Macro
173	93.88	Quercus ilex (oak) benzene extract on foil	ATR Native Plant Macro
177	93.37	Quercus ilex oil extract-Benzene	ATR Native Plant Macro
175	93.22	Quercus ilex (oak) CH-M extract on foil	ATR Native Plant Macro
134	92.60	Corylus (Hazelnut) CH-M extract on foil	ATR Native Plant Macro
135	92.32	Corylus (hazelnut)_Ch-M oil extraction	ATR Native Plant Macro
8	91.54	aluminum foil - dull side	ATR PRI Misc. Library

FIGURE 26. FTIR SPECTRUM MATCHES FOR SAMPLE 5, 42DC1412, WAVE NUMBERS 3000-2800, YUCCA PODS.

PaleoResearch Institute
Golden, CO 80401

Fri May 30 18:05:43 2008 (GMT-06:00)
FIND PEAKS:
Spectrum: 08-39-5_CHM Extract_LowerB
Region: 4000 400
Absolute threshold: 0.0024
Sensitivity: 50
Peak list:

Position:	719	Intensity:	0.0180
Position:	741	Intensity:	0.0171
Position:	764	Intensity:	0.0168
Position:	827	Intensity:	0.0174
Position:	886	Intensity:	0.0178
Position:	930	Intensity:	0.0185
Position:	1123	Intensity:	0.0162
Position:	1173	Intensity:	0.0174
Position:	1378	Intensity:	0.0087
Position:	1462	Intensity:	0.0102
Position:	1708	Intensity:	0.0078
Position:	2851	Intensity:	0.0070
Position:	2920	Intensity:	0.0111



Spectrum: 08-39-5_CHM Extract_LowerB
Region: 3005.80-2803.17
Search type: Correlation
Hit List:

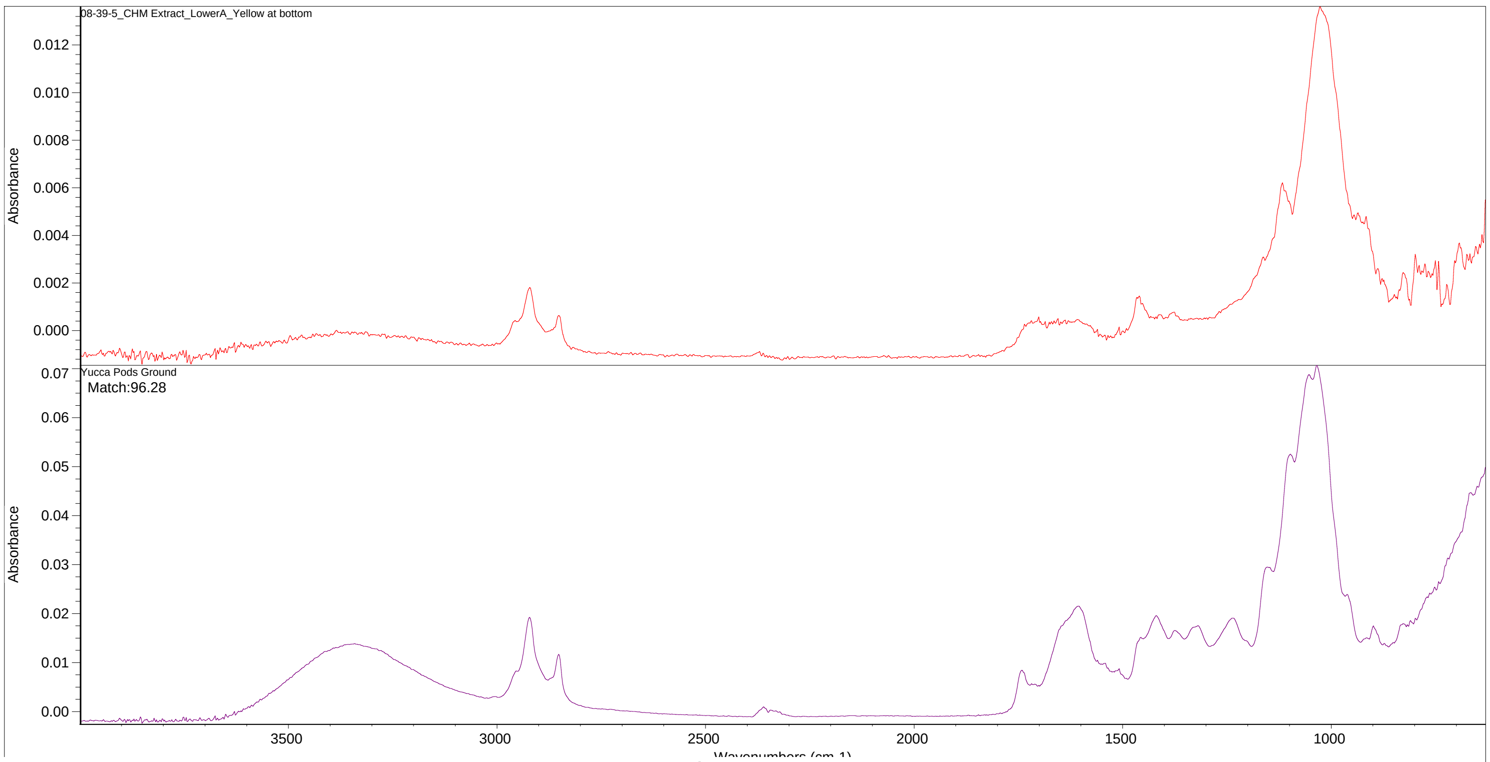
Index	Match	Compound name	Library
1	96.80	Yucca Pods Ground	ATR Native Plant Macro
44	96.74	Quercus sp. California Live Oak	ATR Native Plant Macro
2	94.38	Adeps Lanae (lanolin) oil	ATR Native Animals
189	94.35	Buffalo Gourd-Cucurbita foetidissima	ATR Native Plant Macro
173	93.88	Quercus ilex (oak) benzene extract on foil	ATR Native Plant Macro
177	93.37	Quercus ilex oil extract-Benzene	ATR Native Plant Macro
175	93.22	Quercus ilex (oak) CH-M extract on foil	ATR Native Plant Macro
134	92.60	Corylus (Hazelnut) CH-M extract on foil	ATR Native Plant Macro
135	92.32	Corylus (hazelnut)_Ch-M oil extraction	ATR Native Plant Macro
8	91.54	aluminum foil - dull side	ATR PRI Misc. Library

FIGURE 27. FTIR SPECTRUM MATCHES FOR SAMPLE 5, 42DC1412, WAVE NUMBERS 3000-2800, ACORN OVERLAY.

PaleoResearch Institute
Golden, CO 80401

Fri May 30 17:18:38 2008 (GMT-06:00)
FIND PEAKS:
Spectrum: 08-39-5_CHM Extract_LowerA_Yellow at bottom
Region: 4000 400
Absolute threshold: -0.0003
Sensitivity: 50
Peak list:

Position:	693	Intensity:	0.0037
Position:	722	Intensity:	0.0020
Position:	742	Intensity:	0.0029
Position:	750	Intensity:	0.0029
Position:	798	Intensity:	0.0032
Position:	827	Intensity:	0.0024
Position:	1027	Intensity:	0.0136
Position:	1117	Intensity:	0.0062
Position:	1460	Intensity:	0.0014
Position:	1701	Intensity:	0.00058
Position:	2852	Intensity:	0.00063
Position:	2921	Intensity:	0.0018
Position:	3385	Intensity:	0.00001



Spectrum: 08-39-5_CHM Extract_LowerA_Yellow at bottom
Region: 3005.80-2803.17
Search type: Correlation
Hit List:

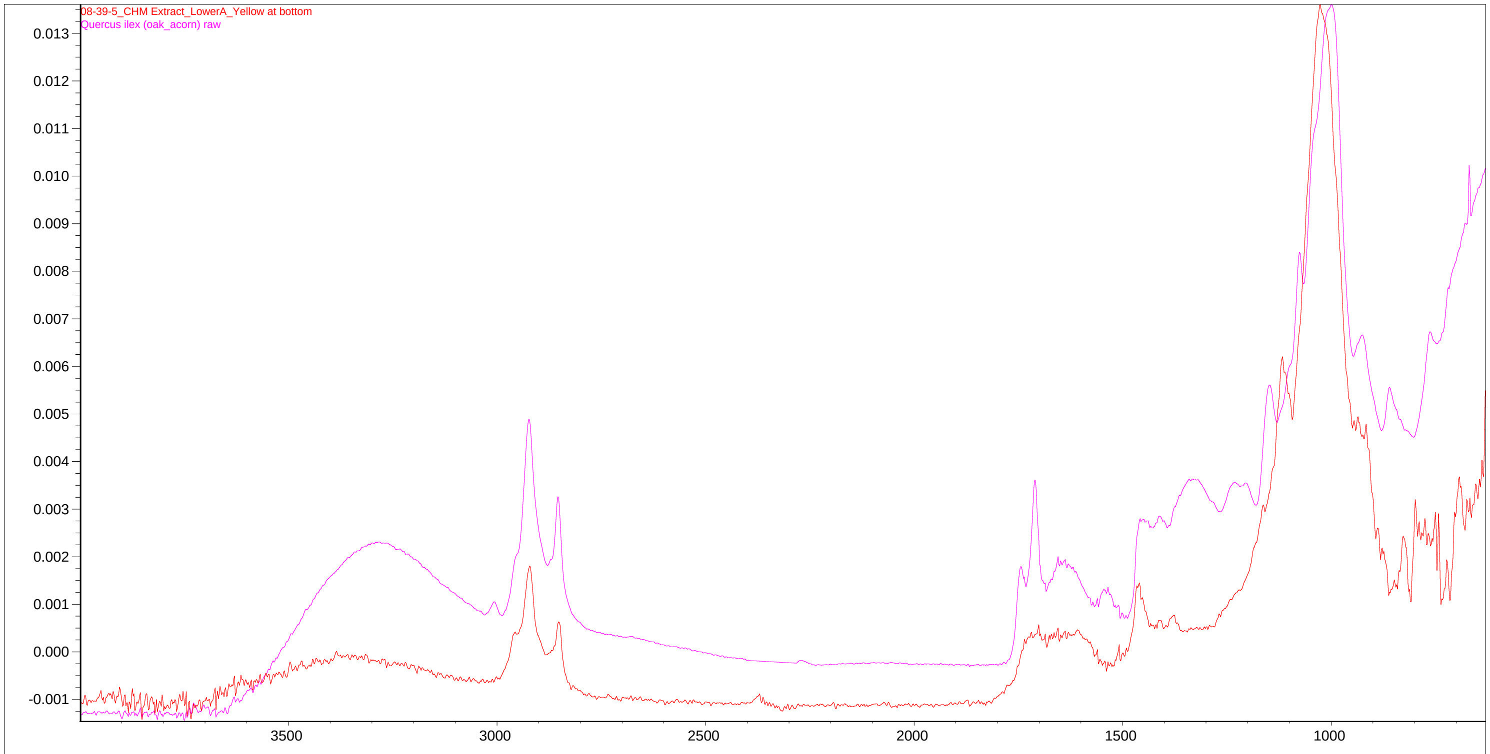
Index	Match	Compound name	Library
1	96.28	Yucca Pods Ground	ATR Native Plant Macro
44	95.60	Quercus sp. California Live Oak	ATR Native Plant Macro
2	94.89	Adeps Lanae (lanolin) oil	ATR Native Animals
189	93.88	Buffalo Gourd-Cucurbita foetidissima	ATR Native Plant Macro
173	93.78	Quercus ilex (oak) benzene extract on foil	ATR Native Plant Macro
175	93.66	Quercus ilex (oak) CH-M extract on foil	ATR Native Plant Macro
177	93.56	Quercus ilex oil extract-Benzene	ATR Native Plant Macro
134	93.54	Corylus (Hazelnut) CH-M extract on foil	ATR Native Plant Macro
135	93.50	Corylus (hazelnut)_Ch-M oil extraction	ATR Native Plant Macro
167	92.55	Carya Illinoinensis (Pecan) oil - CH-M e extract_1	ATR Native Plant Macro

FIGURE 28. FTIR SPECTRUM MATCHES FOR SAMPLE 5 LOWER YELLOW, 42DC1412, WAVE NUMBERS 3000-2800, YUCCA PODS.

PaleoResearch Institute
Golden, CO 80401

Fri May 30 17:18:38 2008 (GMT-06:00)
FIND PEAKS:
Spectrum: 08-39-5_CHM Extract_LowerA_Yellow at bottom
Region: 4000 400
Absolute threshold: -0.0003
Sensitivity: 50
Peak list:

Position:	693	Intensity:	0.0037
Position:	722	Intensity:	0.0020
Position:	742	Intensity:	0.0029
Position:	750	Intensity:	0.0029
Position:	798	Intensity:	0.0032
Position:	827	Intensity:	0.0024
Position:	1027	Intensity:	0.0136
Position:	1117	Intensity:	0.0062
Position:	1460	Intensity:	0.0014
Position:	1701	Intensity:	0.00058
Position:	2852	Intensity:	0.00063
Position:	2921	Intensity:	0.0018
Position:	3385	Intensity:	0.00001



Spectrum: 08-39-5_CHM Extract_LowerA_Yellow at bottom
Region: 3005.80-2803.17
Search type: Correlation
Hit List:

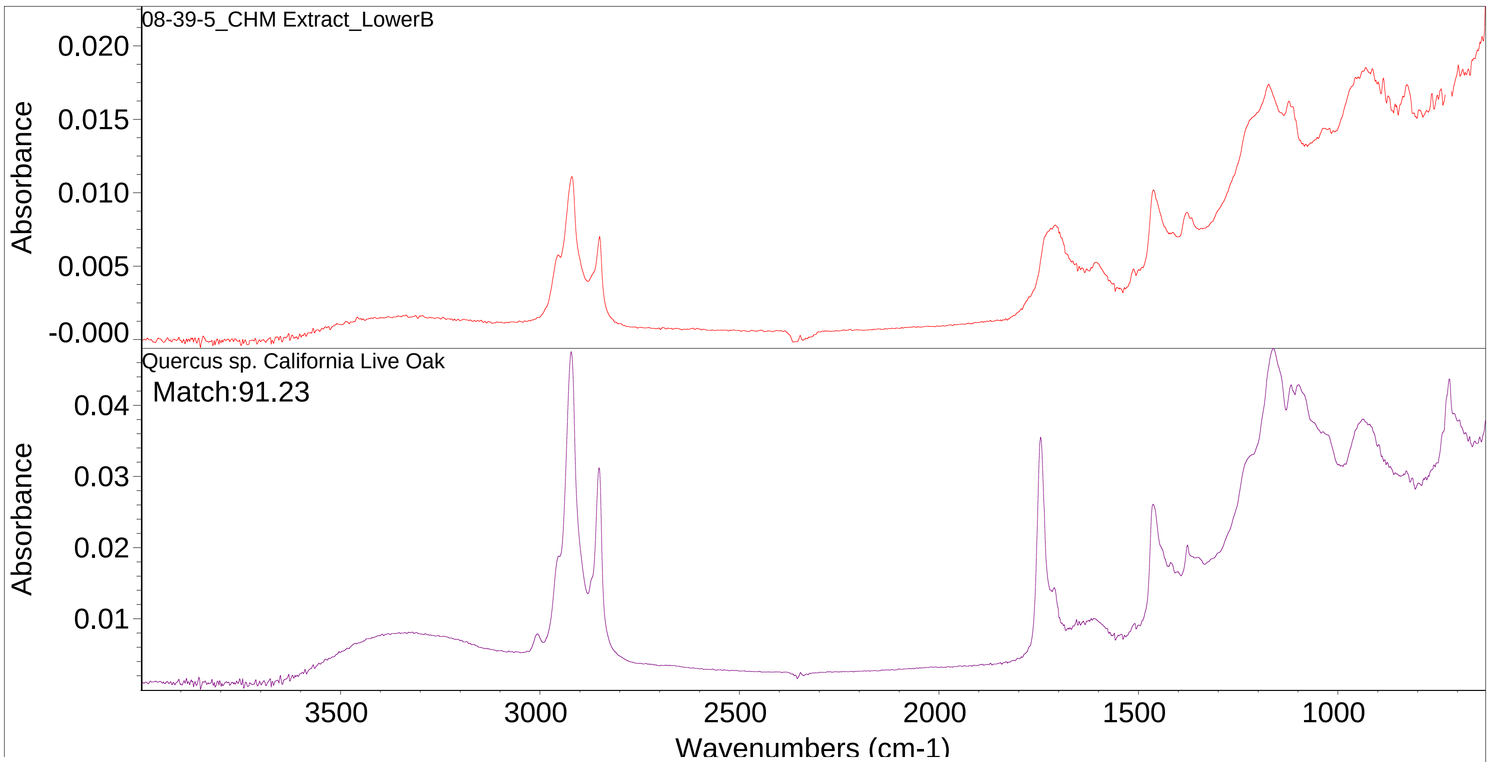
Index	Match	Compound name	Library
1	96.28	Yucca Pods Ground	ATR Native Plant Macro
44	95.60	Quercus sp. California Live Oak	ATR Native Plant Macro
2	94.89	Adeps Lanae (lanolin) oil	ATR Native Animals
189	93.88	Buffalo Gourd-Cucurbita foetidissima	ATR Native Plant Macro
173	93.78	Quercus ilex (oak) benzene extract on foil	ATR Native Plant Macro
175	93.66	Quercus ilex (oak) CH-M extract on foil	ATR Native Plant Macro
177	93.56	Quercus ilex oil extract-Benzene	ATR Native Plant Macro
134	93.54	Corylus (Hazelnut) CH-M extract on foil	ATR Native Plant Macro
135	93.50	Corylus (hazelnut)_Ch-M oil extraction	ATR Native Plant Macro
167	92.55	Carya Illinoinensis (Pecan) oil - CH-M e extract_1	ATR Native Plant Macro

FIGURE 29. FTIR SPECTRUM MATCHES FOR SAMPLE 5, 42DC1412, WAVE NUMBERS 3000-2800, ACORN OVERLAY.

PaleoResearch Institute
Golden, CO 80401

Fri May 30 18:11:40 2008 (GMT-06:00)
FIND PEAKS:
Spectrum: 08-39-5_CHM Extract_LowerB
Region: 4000 400
Absolute threshold: 0.0032
Sensitivity: 50
Peak list:

Position:	719	Intensity:	0.0180
Position:	741	Intensity:	0.0171
Position:	764	Intensity:	0.0168
Position:	827	Intensity:	0.0174
Position:	886	Intensity:	0.0178
Position:	930	Intensity:	0.0185
Position:	1123	Intensity:	0.0162
Position:	1173	Intensity:	0.0174
Position:	1378	Intensity:	0.0087
Position:	1462	Intensity:	0.0102
Position:	1708	Intensity:	0.0078
Position:	2851	Intensity:	0.0070
Position:	2920	Intensity:	0.0111



Spectrum: 08-39-5_CHM Extract_LowerB
Region: 1492.35-1349.87
Search type: Correlation
Hit List:

Index	Match	Compound name	Library
44	91.23	Quercus sp. California Live Oak	ATR Native Plant Macro
2	90.20	Adeps Lanae (lanolin) oil	ATR Native Animals

FIGURE 30. FTIR SPECTRUM MATCHES FOR SAMPLE 5, 42DC1412, WAVE NUMBERS 1492-1350, ACORN.

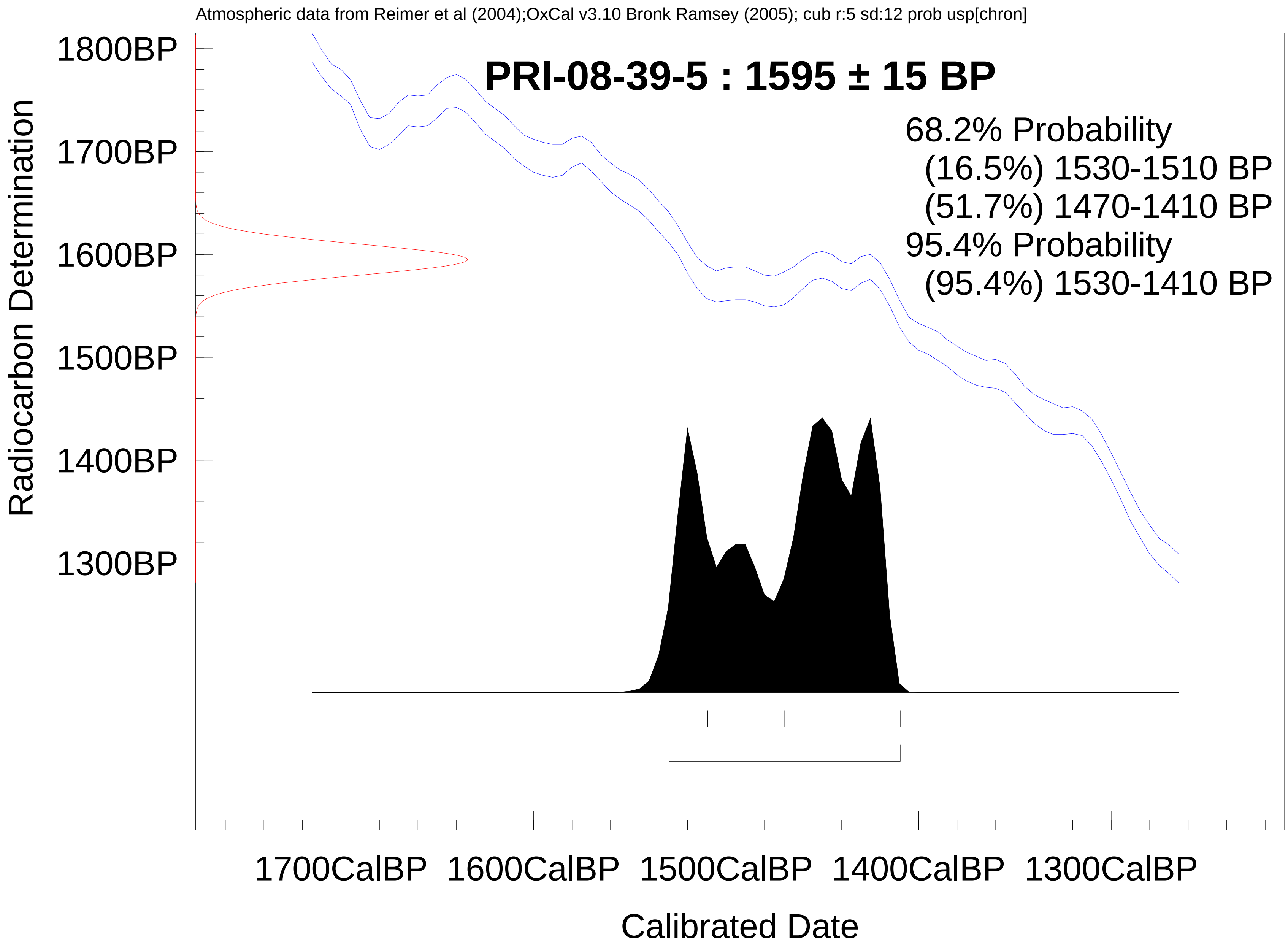


FIGURE 31. AMS RADIOCARBON DATE FOR SAMPLE PRI-08-39-5, 42DC1340.

Appendix D:

X-Ray Fluorescence Results
(Northwest Research Obsidian Studies Laboratory)

X-Ray Fluorescence Analysis and Obsidian Hydration Measurement of Artifact Obsidian from 42-DC-1341, 42-DC-1344 and IF5, Duchesne County, Utah

Craig E. Skinner and Jennifer J. Thatcher
Northwest Research Obsidian Studies Laboratory

Ten obsidian artifacts from 42-DC-1341 (N=2), 42-DC-1344 (N=7) and IF5 (N=1), Duchesne County, Utah, were submitted for energy dispersive X-ray fluorescence trace element provenance analysis. The specimens were also processed for hydration rim measurements. The samples were prepared and analyzed at the Northwest Research Obsidian Studies Laboratory under the accession numbers 2008-25 and 2008-101.

Analytical Methods

X-Ray Fluorescence Analysis. Nondestructive trace element analysis of the samples was completed using a Spectrace 5000 energy dispersive X-ray fluorescence spectrometer. The system is equipped with a Si(Li) detector with a resolution of 155 eV FHWM for 5.9 keV X-rays (at 1000 counts per second) in an area 30 mm^2. Signals from the spectrometer are amplified and filtered by a time variant pulse processor and sent to a 100 MHZ Wilkinson type analog-to-digital converter. The X-ray tube employed is a Bremsstrahlung type, with a rhodium target, and 5 mil Be window. The tube is driven by a 50 kV 1 mA high voltage power supply, providing a voltage range of 4 to 50 kV. For the elements Zn, Rb, Sr, Y, Zr, Nb, and Pb that are reported in Table A-1, we analyzed the collection with a collimator installed and used a 45 kV tube voltage setting and 0.60 mA tube current setting.

The diagnostic trace element values used to characterize the samples are compared directly to those for known obsidian sources reported in the literature and with unpublished trace element data collected through analysis of geologic source samples (Northwest Research 2008a). Artifacts are correlated to a parent obsidian source (or geochemical source group) if diagnostic trace element values fall within about two standard deviations of the analytical uncertainty of the known upper and lower limits of chemical variability recorded for the source. Occasionally, visual attributes are used to corroborate the source assignments although sources are never assigned solely on the basis of megascopic characteristics.

Obsidian Hydration Analysis. An appropriate section of each artifact is selected for hydration slide preparation. Two parallel cuts are made into the edge of the artifact using a lapidary saw equipped with 4-inch diameter diamond-impregnated .004" thick blades. The resultant cross-section of the artifact (approximately one millimeter thick) is removed and mounted on a petrographic microscope slide with Lakeside thermoplastic cement and is then ground to a final thickness of 30-50 microns.

The prepared slide is measured using an Olympus BHT petrographic microscope fitted with a video micrometer unit and a digital imaging video camera. When a clearly defined hydration layer is identified, the section is centered in the field of view to minimize parallax effects. Four rim measurements are typically recorded for each artifact or examined surface. Hydration rinds smaller than one micron often cannot be resolved by optical microscopy. Hydration thicknesses are reported to the nearest 0.1 µm and represent the mean value for all readings. Standard deviation values for each measured surface indicate the variability for hydration thickness measurements recorded for each specimen. It is important to note that these values reflect only the reading uncertainty of the rim values and do not take into account the resolution limitations of the microscope or other sources of uncertainty that enter into the formation of hydration rims.

Additional details about specific analytical methods and procedures used for the analysis of the elements reported in Table A-1 and the preparation and measurement of hydration rims are available at the Northwest Research Obsidian Studies Laboratory World Wide Web site at *www.obsidianlab.com* (Northwest Research 2008a).

Results of Analysis

X-Ray Fluorescence Analysis. Three geochemical groups, all of which were correlated with known obsidian sources, were identified among the ten artifacts that were characterized by X-ray fluorescence analysis. The locations of the sites and the identified obsidian sources are shown in Figure 1. Analytical results are presented in Table A-1 in the Appendix and are summarized in Figure 2 and Table 1.

The geologic setting and prehistoric use of the Pumice Hole Mine and Topaz Mountain sources are discussed by Arkush and Pitblado (2000), Christiansen et al. (1986), Hull (1994), Jones and Beck (1990, 1992), Nelson (1984), Nelson and Holmes (1979), Raymond (1994), and Sappington (1981). Additional descriptive information about the sources may also be found at *www.sourcecatalog.com* (Northwest Research 2008b).

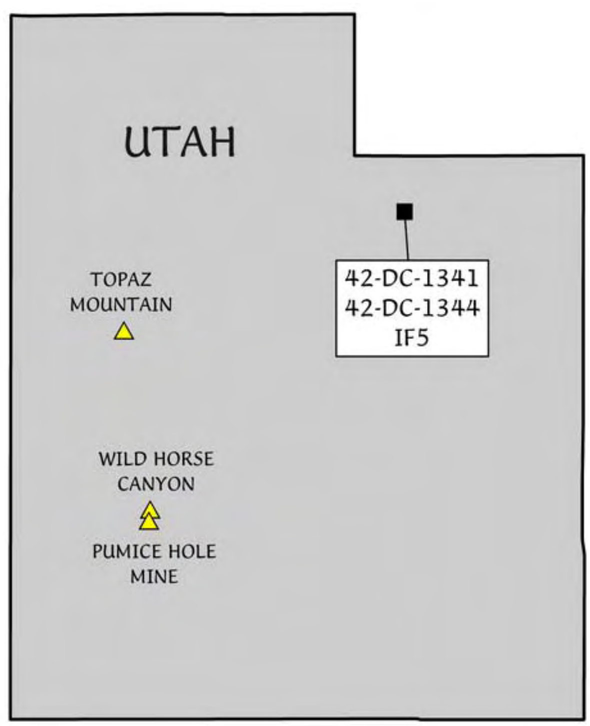


Figure 1. Locations of the sites and the sources of the obsidian artifacts.

Table 1. Summary of results of trace element studies of artifacts from the project sites.

Source	Project Sites			Total
	42-DC-1341	42-DC-1344	IF5	
Pumice Hole Mine	–	7	–	7
Topaz Mountain	–	–	1	1
Wild Horse Canyon	2	–	–	2
Total	**2**	**7**	**1**	**10**

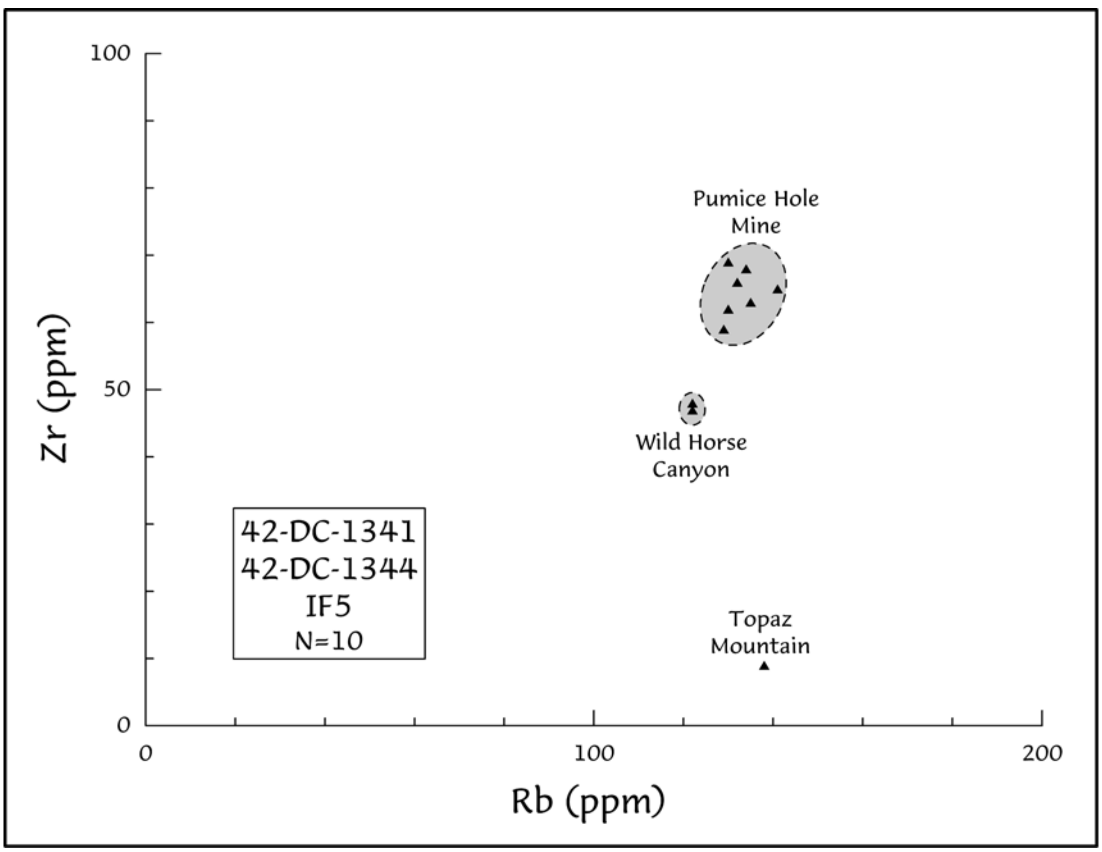


Figure 2. Scatterplot of rubidium (Rb) plotted versus zirconium (Zr) for all analyzed artifacts.

Obsidian Hydration Analysis. The 10 obsidian artifacts that were characterized by X-ray fluorescence analysis were prepared for obsidian hydration analysis and yielded 10 measurable rims. The specimen slides are curated at the Northwest Research Obsidian Studies Laboratory under accession numbers 2008-25 and 2008-101. The results are reported in Table B-1 in the Appendix and are summarized in Table 2.

Table 2. Summary of results of obsidian hydration analysis of the artifacts.

Obsidian Source	Rim Measurements (microns)			Total
	42-DC-1341	**42-DC-1344**	**IF5**	
Pumice Hole Mine	–	1.3, 1.3, 1.5, 1.5, 1.5, 1.8, 1.9	–	7
Topaz Mountain	–	–	2.1	1
Wild Horse Canyon	3.3, 3.3	–	–	2
Total	**2**	**7**	**1**	**10**

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Appendix

Results of X-Ray Fluorescence and Obsidian Hydration Analysis

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Table A-1. Results of XRF Studies: 42-DC-1341, 42-DC-1344, and IF5, Duchesne County, Utah

Site	Specimen No.	Catalog No.	Trace Element Concentrations											Ratios		Geochemical Source
			Zn	Pb	Rb	Sr	Y	Zr	Nb	Ti	Mn	Ba	$Fe_2O_3^T$	Fe:Mn	Fe:Ti	
42-DC-1344	1	Sample #1	20	22	170	59	27	129	23	1089	241	265	0.62	23.4	20.4	Pumice Hole Mine
			± 14	5	5	9	3	10	2	90	27	32	0.11			
42-DC-1344	2	Sample #2	40	35	188	63	27	135	22	1231	259	280	0.59	20.7	17.2	Pumice Hole Mine
			± 10	5	5	9	3	10	2	90	27	32	0.11			
42-DC-1344	3	Sample #3	45	38	183	62	27	130	21	NM	NM	270	0.56	12.1	19.2	Pumice Hole Mine *
			± 10	5	5	9	3	10	2	90	28	32	0.11			
IF5	4	Sample #4	59	41	472	9	47	138	65	960	562	0	0.72	11.3	26.3	Topaz Mountain
			± 10	5	5	10	3	10	2	89	28	31	0.11			
42-DC-1344	1	1	39	29	206	68	26	134	23	NM	NM	NM	NM	23.3	34.5	Pumice Hole Mine *
			± 12	6	5	11	3	8	2	NM	NM	NM	NM			
42-DC-1344	2	2	17	32	206	65	24	141	26	NM	NM	NM	NM	23.4	34.5	Pumice Hole Mine *
			± 13	5	5	11	3	8	2	NM	NM	NM	NM			
42-DC-1344	3	3	55	27	194	69	32	130	21	NM	NM	NM	NM	23.9	31.2	Pumice Hole Mine *
			± 11	6	5	11	3	8	2	NM	NM	NM	NM			
42-DC-1344	4	4	36	32	191	66	27	132	24	NM	NM	NM	NM	22.5	29.8	Pumice Hole Mine *
			± 11	5	5	11	3	8	2	NM	NM	NM	NM			
42-DC-1341	5	5	41	39	231	47	23	122	27	NM	NM	NM	NM	19.9	32.5	Wild Horse Canyon *
			± 11	5	5	11	3	8	2	NM	NM	NM	NM			
42-DC-1341	6	6	41	41	231	48	24	122	26	NM	NM	NM	NM	20.4	34.5	Wild Horse Canyon *
			± 11	5	5	11	3	8	2	NM	NM	NM	NM			
NA	RGM-1	RGM-1	25	31	152	107	27	216	6	1569	293	NM	1.72	49.5	36.9	RGM-1 Reference Standard
			± 12	5	5	9	3	10	2	92	27	32	0.11			

All trace element values reported in parts per million; ± = analytical uncertainty estimate (in ppm). Iron content reported as weight percent oxide.
NA = Not available; ND = Not detected; NM = Not measured.; * = Small sample.

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Table B-1. Obsidian Hydration Results and Sample Provenience: 42-DC-1341, 42-DC-1344, and IF5, Duchesne County, Utah

Site	Specimen No.	Catalog No.	Unit	Depth (cm)	Artifact Type[A]	Artifact Source	Hydration Rims: Rim 1	Hydration Rims: Rim 2	Comments[B]
42-DC-1344	1	Sample #1	--	Surface	DEB	Pumice Hole Mine	1.5 ± 0.1	NM ± NM	--
42-DC-1344	2	Sample #2	--	Surface	DEB	Pumice Hole Mine	1.9 ± 0.1	NM ± NM	--
42-DC-1344	3	Sample #3	--	Surface	DEB	Pumice Hole Mine *	1.8 ± 0.1	NM ± NM	--
IF5	4	Sample #4	--	--	BIF	Topaz Mountain	2.1 ± 0.1	NM ± NM	--
42-DC-1344	1	1	Unit 1	Surface	DEB	Pumice Hole Mine *	1.5 ± 0.1	NM ± NM	--
42-DC-1344	2	2	Unit 1	Surface	DEB	Pumice Hole Mine *	1.3 ± 0.0	NM ± NM	--
42-DC-1344	3	3	Unit 1	0-5	DEB	Pumice Hole Mine *	1.5 ± 0.1	NM ± NM	--
42-DC-1344	4	4	Unit 1	0-5	DEB	Pumice Hole Mine *	1.3 ± 0.1	NM ± NM	--
42-DC-1341	5	5	--	Surface	DEB	Wild Horse Canyon *	3.3 ± 0.1	NM ± NM	--
42-DC-1341	6	6	Unit 2	Surface	DEB	Wild Horse Canyon *	3.3 ± 0.1	NM ± NM	--

[A] BIF = Biface; DEB = Debitage
[B] See text for explanation of comment abbreviations
NA = Not Available; NM = Not Measured; * = Small sample

Abbreviations and Definitions Used in the Comments Column

All hydration rim measurements are recorded in microns.

BEV - (Beveled). Artifact morphology or cut configuration resulted in a beveled thin section edge.

BRE - (BREak). The thin section cut was made across a broken edge of the artifact. Resulting hydration measurements may reveal when the artifact was broken, relative to its time of manufacture.

DES - (DEStroyed). The artifact or flake was destroyed in the process of thin section preparation. This sometimes occurs during the preparation of extremely small items, such as pressure flakes.

DFV - (Diffusion Front Vague). The diffusion front, or the visual boundary between hydrated and unhydrated portions of the specimen, are poorly defined. This can result in less precise measurements than can be obtained from sharply demarcated diffusion fronts. The technician must often estimate the hydration boundary because a vague diffusion front often appears as a relatively thick, dark line or a gradation in color or brightness between hydrated and unhydrated layers.

DIS - (DIScontinuous). A discontinuous or interrupted hydration rind was observed on the thin section.

HV - (Highly Variable). The hydration rind exhibits variable thickness along continuous surfaces. This variability can occur with very well- defined bands as well as those with irregular or vague diffusion fronts.

IRR - (IRRegular). The surfaces of the thin section (the outer surfaces of the artifact) are uneven and measurement is difficult.

1SO - (1 Surface Only). Hydration was observed on only one surface or side of the thin section.

NOT - (NOT obsidian). Petrographic characteristics of the artifact or obsidian specimen indicate that the specimen is not obsidian.

NVH - (No Visible Hydration). No hydration rind was observed on one or more surfaces of the specimen. This does not mean that hydration is absent, only that hydration was not observed. Hydration rinds smaller than one micron often are not birefringent and thus cannot be seen by optical microscopy. "NVH" may be reported for the manufacture surface of a tool while a hydration measurement is reported for another surface, e.g. a remnant ventral flake surface.

OPA - (OPAque). The specimen is too opaque for measurement and cannot be further reduced in thickness.

PAT - (PATinated). This description is usually noted when there is a problem in measuring the thickness of the hydration rind, and refers to the unmagnified surface characteristics of the artifact, possibly indicating the source of the measurement problem. Only extreme patination is normally noted.

REC - (RECut). More than one thin section was prepared from an archaeological specimen. Multiple thin sections are made if preparation quality on the initial specimen is suspect or obviously poor. Additional thin sections may also be prepared if it is perceived that more information concerning an artifact's manufacture or use can be obtained.

UNR - (UNReadable). The optical quality of the hydration rind is so poor that accurate measurement is not possible. Poor thin section preparation is not a cause.

WEA - (WEAthered). The artifact surface appears to be damaged by wind erosion or other mechanical action.