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Old Collections, New Insights: Technological Organization of the Lungren Site (13ML224), A Middle Archaic Residential Camp

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Old Collections, New Insights: Technological Organization of the Lungren Site (13ML224), A Middle Archaic Residential Camp

by

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Abstract

The Lungren Site (13ML224) is a Middle Archaic campsite located in Mills County, Iowa. The site was excavated in the 1960s during the Smithsonian River Basin Surveys, and represents one of a relatively small number of well-preserved Archaic period sites known in western Iowa. Lithic artifacts from the Lungren assemblage were reanalyzed as part of this thesis in order to derive better understanding of technological strategy and land-use by the mid-Holocene bison hunters who left these tools behind. Analysis of lithic debitage and raw material illustrates heavy utilization of locally acquired raw material for tool making. This includes both expedient and formal items that comprised a specialized tool kit well suited for a population of mobile bison hunters. While the Archaic period in many areas of the Great Plains remains poorly understood, data from this thesis will be useful in developing a better understanding of technological strategy and lifeways of peoples on the Eastern Plains during this time period.

Acknowledgements

It is a shame that only one name can be on a master's thesis, when it took the help of so many to make it happen. First, many thanks go to Dr. Mark Muñiz and Dr. Robb Mann of St. Cloud State University for their guidance on this committee as well as their support throughout graduate school. Thank you as well to John Doershuk, State Archaeologist of Iowa for serving on my committee as well as your insight in developing broader regional understandings of the Archaic period.

The staff of the Smithsonian Institution was instrumental in making this research possible. Thank you to James Krakker for allowing me access to the Lungren collection, and also to Caitlin Haynes of the National Anthropological Archive, for assistance in finding the site forms and notes from the 1963 excavation. Finally, thank you to Lionel Brown, for surveying and excavating the site over 50 years ago. Without your help, this thesis likely wouldn't exist.

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Chapter 1: Introduction and Goal of Research

The Lungren Site (13ML224) is a Middle Archaic campsite located in southwestern Iowa. Excavated in the summer of 1963 by archaeologist Lionel Brown during the Smithsonian River Basin Surveys (RBS), it was the only Archaic-period excavation during the survey of Pony Creek. This excavation produced an assemblage of chipped stone tools, including scrapers, bifaces, hammerstones and a side-notched projectile point, found in association with recorded bison bones and hearth features.

Lungren is one of a handful of well-excavated and documented Archaic period sites in western Iowa. These sites are most strongly associated with bison hunting complexes of the eastern border of the Great Plains. Despite this, beyond Brown's initial report there has been no further work done with this site. This situation is not unique to Lungren; the large number of excavations during the 1940s through 1960s left little time for thorough interpretation (Mitchell 2006). Funding and time constraints of the present day have not remedied this situation, even as new technologies and better understanding of disciplines such as animal and human ecology, lithic analysis, geomorphology, and climatology have allowed more substantial understanding of ancient peoples and their lifeways.

Although the work done during the River Basin Surveys often lacked the more rigorous precision of modern excavation procedures, recovered RBS collections still contain important data. Excavated yesterday or fifty years ago, these artifacts can be valuable tools in answering modern research questions regarding the past. The goal of this proposed research is to analyze the lithic assemblage from Lungren to evaluate the technological organization strategy of Archaic peoples living along the eastern prairie, as well as answer questions regarding particular local adaptations of Holocene hunter-gatherers such as mobility, tool preference, and resource procurement strategy.

Chapter 2: Literature Review

Site and Excavation History

Lungren is located in Mills County, north of the town of Glenwood in Southwest Iowa (Figures 1 and 2). The site is positioned on a terrace adjacent to Pony Creek, deep in the Loess Hills region of Iowa (Brown 1967). During the 1963 survey of the area, Lionel Brown and his crew observed cultural deposits along a headward-eroding drainage flowing into Pony Creek. At the time, observed artifacts during survey included bone, stone tools and charcoal. These deposits were located over 10 ft (3 meters) below the surrounding ground surface, with agricultural activity having left the site largely intact (Brown 1967). Brown (1967) notes 9 layers in the site's stratigraphy, with a cultural component represented as a thin layer of charcoal and artifacts (level 8). Soils in the site vicinity are mapped as Napier Series silt loam (NRCS Soil Survey 2017). These soils are alluvium and colluvium derived from surrounding loess, re-deposited after eroding from uplands (Prior 1991). Based on this, Lungren likely represents a single component site associated with an old terrace, buried beneath younger deposits of slope wash and channel fill.

Five test pits (size not defined) were excavated along the erosional surface in an attempt to narrow site boundaries. This was followed by the opening of a larger excavation block where artifacts were concentrated (Brown 1967), likely intersecting one of the test pits. The main excavation block (Figure 3) was broken down into test units (5 ft by 5 ft), measured from a fixed site datum. Measuring the site map by Brown (1967), the main excavation block was approximately 300 sq ft (27.87 sq m) in size.

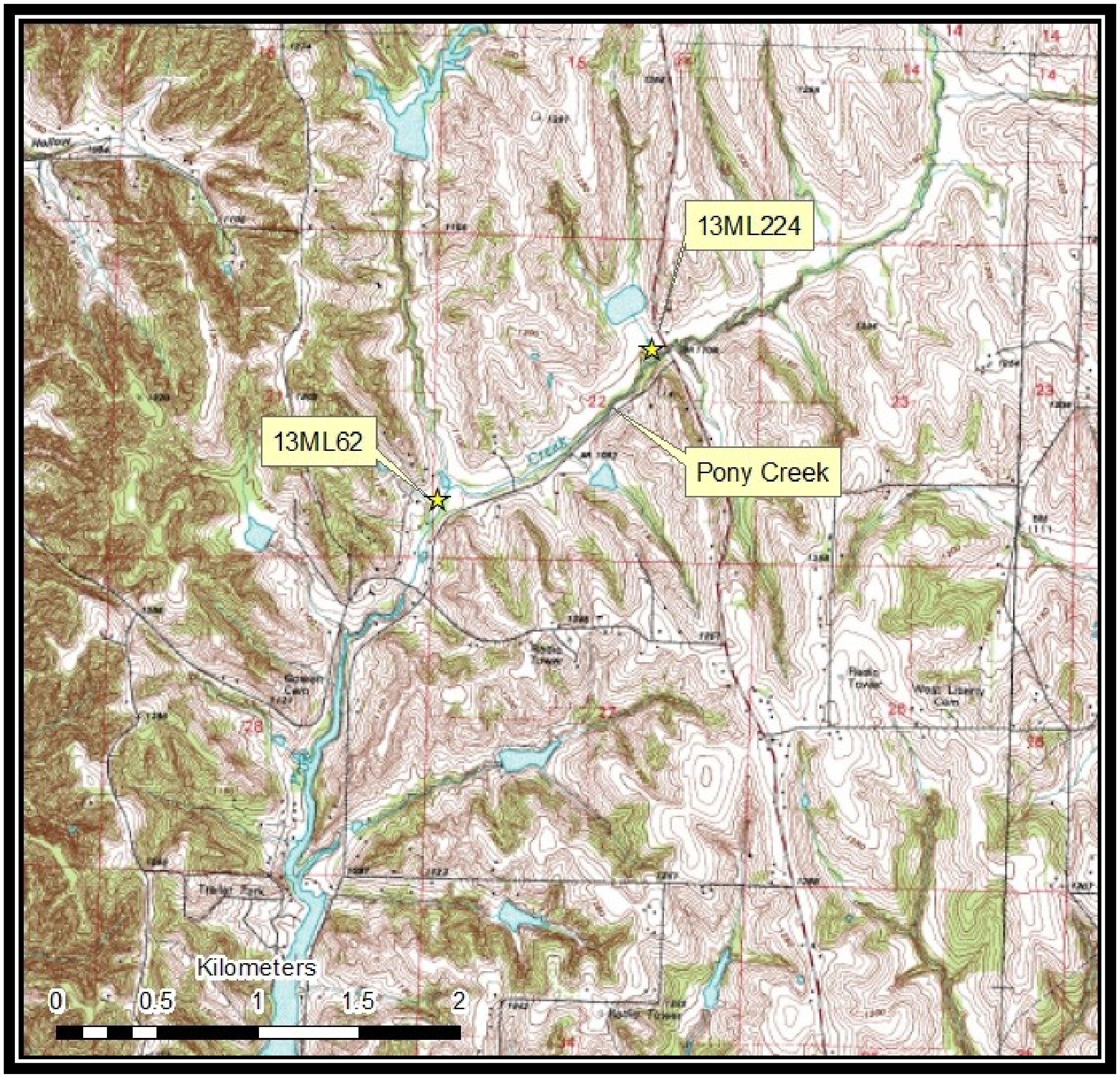

Figure 1. Location of Site 13ML224 (Lungren) in Mills County, Iowa, relative to nearby 13ML62 (Hill) in the Pony Creek watershed.

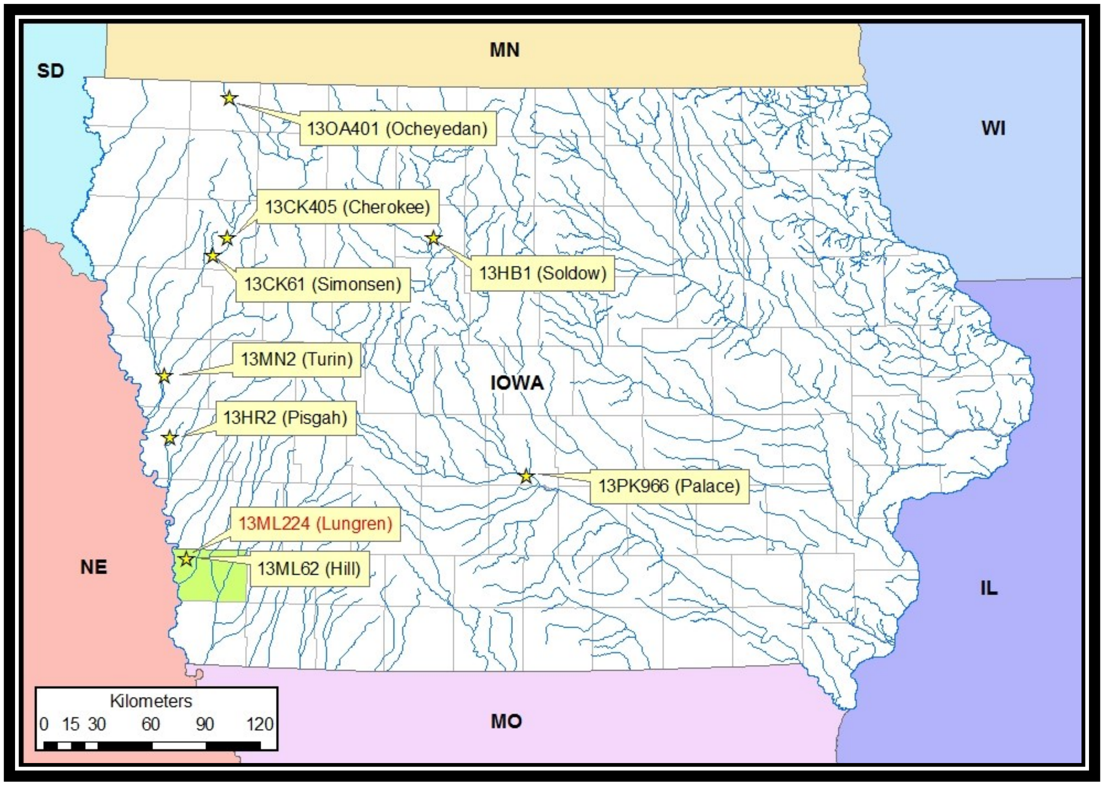

Figure 2. Map of Archaic sites in Iowa mentioned in this thesis.

Within the site area, surface brush and grass were cleared away. Following this, 8.5 ft (2.59 m) of overburden was mechanically stripped from the excavation area, with a grid system established for excavation control (Brown 1967). Shovels were used to remove 0.5 ft (15.35 cm) levels, while cultural deposits were trowel excavated. Stone tools were collected during excavation and mapped. Based upon field notes from the Smithsonian, animal bones observed during excavation, including bison bone, were mapped and sometimes photographed, but not collected. This was often standard practice during the RBS period (Steven DeVore personal communication 2016). There was no mention in Brown's report of screening excavated soil through wire mesh. It was likely that shovel skimming was employed based upon the quantity of debitage collected.

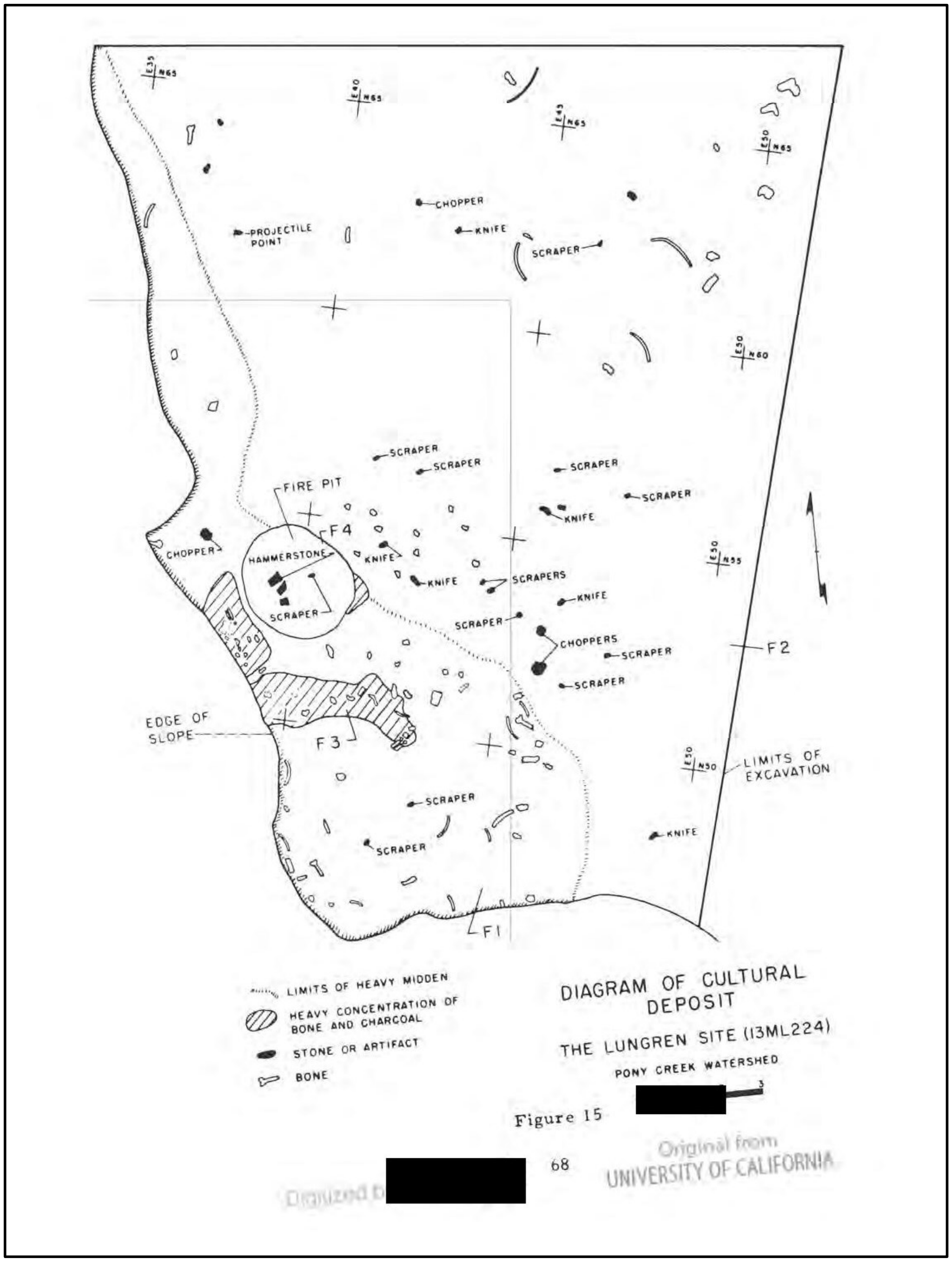

Figure 3. Map of main excavation block from site 13ML224 (Lungren). (From Brown 1967).

The excavation at Lungren produced 550 pieces of debitage and more than 70 chipped-stone tools (Brown 1967). This included 1 side-notched projectile point, 18 cores (bifacial and unifacial), 17 utilized flakes, 12 end scrapers, 10 side scrapers, 5 hammer stones, 4 bifacial knives, 3 quartzite ‘chopper’ tools, and 3 scoria abraders (Table 1). The numbers here are from Brown’s final report, and do not reflect what was found in the Smithsonian’s collection for this study. A series of geographic information system (GIS) maps illustrating artifact densities are located in Appendix A. Raw material of artifacts was largely described by color and material (i.e., ‘tan brown chert’) with no reference to fossils, mottling, or other inclusions.

Four features were observed during excavation. Two of these features (Feature 1 and 2), consist of charcoal-impregnated areas with associated bone and debitage associated with the cultural horizon, and encompass most of the excavation block (Brown 1967:65-66). Feature 1 was described as a midden, though it is uncertain if Brown was referring to it specifically as a spoil pile or pit. Feature 3 represents a concentrated area of burned bone and charcoal along the southwest edge of the excavation. Finally, Feature 4 is defined as a basin shaped area of heavy charcoal and bone, likely a roasting pit (Alex 2000). Artifacts appear to be heavily concentrated towards the southwest of the excavation block, where Feature 3 and 4 overlap Feature 1. Despite the recorded presence of hearths, no fire-cracked rock was recovered from the excavation.

Table 1. Inventory of materials recovered from Lungren. (From Brown 1967).

Artifact Type	**Count**
Projectile Point	1
Knives	4
End Scrapers	12
Side Scrapers	3
Cores (Bifacial)	13
Cores (Other)	5
Hammerstones	5
Whetstones	3
Utilized Flakes	17
Debitage	550
Total Artifacts	613

The Pony Creek report on Lungren largely served as an inventory of artifacts. This included general description of knives, cores, scrapers and other chipped stone artifacts, which included shape, general assessment of flaking patterns, and dimensions (Brown 1967). The only mention of use-wear analysis is in regards to his classification of ‘miscellaneous chipped stone tool’, which referenced utilized flakes. These may actually be flakes modified through rejuvenation processes based upon his description of “poorly executed, unifacial pressure flake scars” (Brown 1967).

Based upon the diagnostics of the projectile point, Brown (1967:71) determined that Lungren is most closely affiliated with the Logan Creek complex (described later this chapter). After publication of the Pony Creek report, a radiocarbon date of 6280 +/- 120 Radiocarbon Years Before Present (RCYBP) was obtained through charcoal recovered at Lungren (Tiffany 1981). This translates to a calibrated date of 7320-7012 years before present (calBP). Although only a single date, this supports Brown’s assessment of an Archaic period affiliation for Lungren.

As of 2017, the Lungren assemblage is currently curated at the Smithsonian Institution Museum Support Center (MSC) in Suitland, Maryland. Record searches through the University of Iowa Office of the State Archaeologist (OSA) have indicated no further archaeological work has been undertaken at Lungren.

Physical Setting and Geomorphology

Lungren is located within the Loess Hills region (Figure 4). The Loess Hills are composed of irregular, abrupt hills of wind-deposited loess located on the eastern edge of the Missouri River floodplain (Prior 1991). Heavy meltwater during post-glacial times deposited large amounts of this fine grain sediment into the Missouri River trench west of the hills. By warmer times, this sediment had formed into desiccated mud flats, before being re-deposited by wind as loess (Prior 1991). This loess can be 50 to 100 ft thick, and some areas over 200 ft in depth have been recorded by well drilling activities. Loess can be highly erodible. Colluvial drapes of displaced loess redeposit over alluvial sediment along valley walls, and alluvial fans along drainages are not uncommon.

Early Holocene-aged river valleys in the Loess Hills and Iowa in general are either associated with the Gunder or Corrington members of the DeForest formation (Bettis 1990). The Gunder member consists of Holocene valley alluvium overlaying older alluvial or colluvial deposits. In contrast, Bettis notes the Corrington member consists of wide alluvial fans in valleys where smaller drainages intersect larger ones, with stratified, deep profiles representing a series of depositional episodes. Given the location of Lungren along a small tributary of Pony Creek, it is more likely the site is associated with a Gunder soil rather than a Corrington fan. Both Gunder and Corrington sediments may overlay Wisconsin-aged terraces and valley slopes.

The more arid conditions of the mid-Holocene and the impacts of modern agriculture have made preservation of Archaic archaeological sites somewhat unpredictable. Despite this, Archaic period sites known to be preserved in loess-capped upland conditions, especially along slopes (Bettis and Hajic 1995). On uplands, Archaic sites have been recorded on backslopes, shoulders, and spur summits far more frequently than what might statistically be expected (Benn and Thompson 2009). On the other hand, Archaic sites in river valleys tend to be deeply buried within early-Holocene terraces. They are often protected from human impacts, but discovering them can be more difficult. Several archaeological sites, including Lungren and the nearby Hill Site (13ML62), have been found more than 10 ft (3 m) below the modern ground surface. The potential depth of Archaic-age sites presents special considerations for surveying and locating these sites (Benn and Thompson 2009; Hedden 1996).

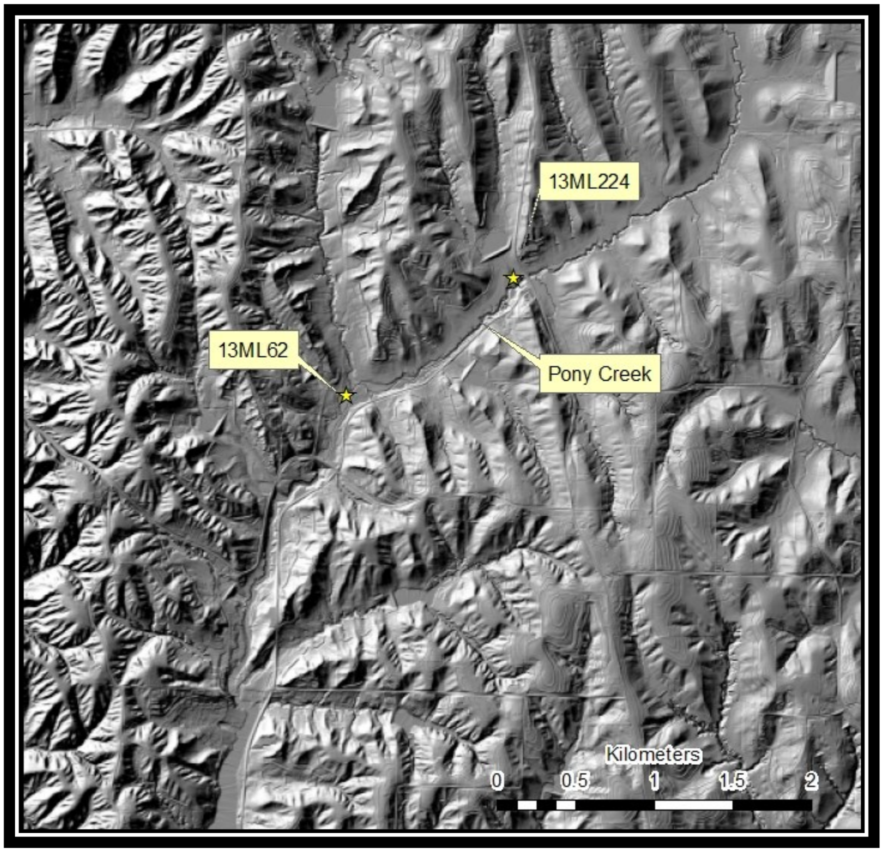

Figure 4. LiDAR image of Pony Creek drainage, showing 13ML62 (Hill) and 13ML224 (Lungren). Note the rugged topography of the Loess Hills region. Background image taken from Iowa Geographic Map Server.

The Logan Creek Complex: Culture History and Site Comparisons

The Archaic period in Iowa spans from roughly 10,450 to 2800 calendar years before present (BP), with the Middle Archaic period spanning 7450 to 4950 years BP (Alex 2000). The Middle Archaic period on the Great Plains, part of the Plains Archaic lifeway, was characterized by adaptations to the Holocene Hypsithermal episode (approximately 9000–5000 BP) (Bettis and Hajic 1995). During the early Holocene, wetter conditions supported the expansions of spruce-heavy forests in the Upper Midwest (Baerreis 1980; Bettis and Hajic 1995; Wendland 1980). By

6000 BP, warm, drier conditions dominated the Great Plains and Upper Midwest, resulting in the recession of forests as tallgrass prairie environments began to expand. It should be noted that this change in climate was not uniform, as eastern Iowa maintained higher levels of rainfall even as western Iowa experienced drier-than-modern conditions (Baerreis 1980; Semken 1980).

This Prairie Peninsula environment spread from the Central Plains into Iowa and farther east. In Iowa, subsistence relied heavily on the hunting of bison in the western part of the state, while deer, fish, and other small species saw more utilization in the east (Alex 2000; Styles and McMillian 2009). Across the region, side-notched projectile points are characteristic of much of the Archaic in both the Great Plains and Eastern Woodlands, in contrast to large lanceolate, stemmed or barbed point styles of earlier Paleoindian times (Alex 2000; Frison 1998; Kay 1998).

Along the eastern Great Plains, many Middle Plains Archaic sites are considered part of the Logan Creek Complex (Kay 1998). Logan Creek, as defined by Kay, runs from 8600 to 6000 calendar years BP. The complex is defined by an eponymous, multi-component type site (25BT3) in eastern Nebraska, excavated by Marvin Kivett in the 1950s. Data from Logan Creek was never officially published, except with data shared during conferences and in a 1959 manuscript attributed to Kivett. In this report, Logan Creek is described as having four cultural horizons containing circular hearth features, with side-notched, basally concave projectile points similar to those found at other Archaic sites in western Iowa as well as earlier lanceolate forms in lower strata (Kivett 1962). According to the 1959 manuscript, charcoal recovered from the second strata (Zone B) yielded a radiocarbon date of 6633 +/- 300 RCYBP (7829–7247 calBP). Brown (1967), citing Crane and Griffin (1962), notes a radiocarbon date of 7250 +/- 300 RCYBP (8369–7795 calBP) for the lowest level (Zone D) of Logan Creek.

Side-notched points alone do not necessarily define Logan Creek complex sites, as these point forms appear across far too broad a geographical and temporal area to be of use as the sole diagnostic cultural marker. For example, small side-notched forms (Plains Side-Notched) appear in Late Prehistoric sites along the western and northern Great Plains as well (Peck and Ives 2001). In addition to these points, a type of lanceolate point has been defined in western Logan Creek sites, such as Spring Creek (Grange 1980). It is uncertain if these types of projectile points are found in the east. Even if present, it is possible researchers may have considered them non-diagnostic bifacial knives.

The geographical range for Logan Creek is not well known, though the 'core' area is observed to be eastern Nebraska and western Iowa (Kay 1998). However, the 'range' of this complex may be larger than Kay suggests, based upon the discovery of a site in southwestern Nebraska with a Logan Creek side-notched point (Holen and Muñiz 2005), as well as the presence of sites in Minnesota, North Dakota, and South Dakota (Ahler and Toom 1989; Michlovic and Running 2005; Shay 1971). Based upon known sites (Grange 1980; Holen and Muniz 2005; Roper and Hughes 2014), the western extent of Logan Creek seems to be the Red Willow Reservoir area in south central Nebraska (Grange 1980; Holen and Muniz 2005; Roper and Hughes 2014).

Kay (1998) defines four criteria for Logan Creek sites: 1) reliance upon 'Logan Creek' style projectile points (side-notched, medium sized, basally thinned forms); 2) sites dated to an Early-Middle Plains Archaic time range through projectile-point type or absolute dating; 3) utilization of local resources (including locally available chert sources and bison) and 4) diverse site forms and function suggesting "a successful adaptation to Hypsithermal conditions on the eastern prairies" (Kay 1998). Archaeologically, this manifests as residential campsites or animal kill sites with tools derived from locally available chert. At least one possible burial site (Turin) is also known (Fisher et al. 1985). Based upon the large geographical area that such sites are found, each of these groups would have had to contend with different environments, with varying availability of chert, wood, food, or water. Behaviorally, this might result in differences in site size, distance to outcrops of utilized raw material, different tool preference or technological strategy, or varying preferences on where these sites are found on the landscape. Despite these variables, the majority if not all of these sites suggest heavy evidence of bison hunting for subsistence by site inhabitants. These criteria are important when defining Logan Creek as distinct from other nearby complexes, such as the Helton complex to the east, Munkers Creek to the south, and McKean to the northwest (Kay 1998; Wiant et al. 2009). While local resources are favored at Logan Creek sites, artifacts of exotic raw materials have observed, represented by obsidian flakes recovered from two sites in Nebraska near Spring Creek (Roper and Hughes 2014). This obsidian was chemically sourced to southeastern Idaho. It is unknown if this represents trade of material from the Rockies onto the Great Plains, or whether Logan Creek people may have ranged so far west.

Perhaps the most well-studied Logan Creek affiliated site is Cherokee Sewer (13CK405). This site is a multicomponent camp discovered in Cherokee, Iowa in 1973 during excavation of a sewage treatment plant (Anderson and Shutler 1978). Construction had damaged the uppermost, Middle Archaic horizon. Excavation by archaeologists later uncovered an Early Archaic and Late Paleoindian horizon buried underneath. All three horizons were deeply buried beneath a Corrington alluvial fan (Shutler et al. 1980). Horizon I (Middle Archaic) was dated at 5980 +/-

80 RCYBP (6929–6731 calBP) and 6400 +/-90 RCYBP (7498–7265 calBP), while Horizon II (Early Archaic) was dated to 7370 +/- 100 (8319–8053 calBP) and 7480 +/-100 RCYBP (8445–8199 calBP) (Anderson et al. 1980). Both Horizon I and II contained side notched projectile points with concave bases. Horizon III produced lanceolate points similar to Paleoindian period Agate Basin and Hell Gap points, though somewhat younger in age than commonly accepted (Anderson 1980; Kay 1998). One point recovered from Horizon I resembles the Lungren projectile point in overall dimensions and form.

Other stone tools such as bifaces, end scrapers, modified and utilized flakes show up in all three horizons at Cherokee. Raw material for these artifacts varies by time period. Site inhabitants during Horizon III times favored 'Fusulinid chert' common to southwestern Iowa and eastern Nebraska (Anderson 1980). This material likely consists of Plattsmouth, so-called 'Nehawka', or another Pennsylvanian (Upper Carboniferous) variety of chert. In contrast, Anderson (1980) notes, during Horizon II (Early Plains Archaic) times the site inhabitants overwhelmingly utilized thermally treated Tongue River Silica common in local glacial till. Inhabitants during Horizon I (Middle Archaic) favored a mix of semi-local Pennsylvanian cherts available to nearby southwestern Iowa. These different proportions of raw material suggest a difference in tool stone sourcing over time.

All three occupations operated as winter hunting camps, with bison being the preferred catch along with some deer and possibly canid (Pyle 1980). However, different groups favored different strategies in regards to which bison they took. Faunal analysis indicates that hunters during Horizon III favored younger bison, Horizon II was less selective regarding which bison they took, and Horizon I favored more senior individuals (Whittaker 1998).

Finally, in addition to faunal and lithic artifacts, pollen and gastropod samples were taken during excavation. These samples helped construct paleo-climactic data over the three Cherokee horizons from the late Pleistocene to the Middle Holocene, and provided a regional model of environmental change at the site (Baerreis 1980; Wendland 1980). More pertinent, this data helped establish the arid paleo-environmental conditions in western Iowa during the Hypsithermal that impacted Logan Creek peoples in one form or another.

In addition to Cherokee, there are a number of other excavations of Archaic sites in western Iowa. Most of these happened before or around the time of the Cherokee excavation. These sites include Lungren, Simonsen, Hill, Pisgah, Turin, Soldow, and the Palace.

The Simonsen Site (13CK61) had been excavated near Quimby, Iowa in 1956. The site was discovered from bones eroding from the riverbank of the Little Sioux River (Agogino and Frankforter 1960). Several cultural zones were excavated. Artifacts recovered included bison bones, side-notched projectile points, bifaces, scrapers, and lithic debitage. Most of the debitage consists of heat-treated Tongue River Silica, as well as Mississippian chert from southern and eastern Iowa, such as Warsaw and Burlington cherts (Nycz 2013). Four of the projectile points are made of Tongue River Silica, while another is made of black chalcedony. These projectile points resemble forms from both Horizon I and II of Cherokee Sewer (Anderson 1980; Nycz 2013). While an initial radiocarbon date associated with the site dated to 8430 +/- 540 RCYBP, later research suggested two 2-Sigma calibrated dates of 7430–7270 and 7800–7610 CalBP to be more accurate (Widga 2006). Unlike Cherokee and Lungren, Simonsen is interpreted as a bison kill and processing site, rather than a residential camp.

The Hill Site (13ML62), located roughly a mile downstream from Lungren on Pony Creek, was excavated in the summer of 1958 by W.D. Frankforter. The site was discovered during construction activities when a cultural horizon was located 17 ft below then-current ground surface (Frankforter 1958). Unfortunately, a period of heavy rain prior to excavation severely impacted the site; further work was largely salvage in nature. Pottery and ground axes were previously observed above the main cultural horizon, but were not present at the time of excavation. Several features were recorded, including a burned charcoal and bone area, and a concentration of broken bison bones and quartzite fragments (Frankforter 1958). Excavated materials include five projectile points and multiple biface fragments, as well as several side-notched hafted scrapers, flake-derived side scrapers and ground stone tools made of quartzite. This site is interpreted as a residential campsite based upon the presence of observed features and tool assemblage (Kay 1998; Nycz 2013). A radiocarbon date of 7250 +/- 400 RCYBP (8435–7666 calBP) was reported for Hill (Tiffany 1981). However, a more recent dating calibrated to a 2-Sigma date of 7570–7420 calBP has also been reported (Widga 2006).

Pisgah (13HR1) is a bison kill site excavated six miles south of the town of the same name in Harrison County, Iowa (Frankforter 1961; Kay 1998). This site was discovered when bison bones were observed eroding out of a highway cutbank near Steers Creek. These bones were later excavated by archaeologists from the Sanford Museum. A largely articulated bison skeleton was recovered, along with a side-notched projectile point similar to those recovered at Simonsen (Frankforter 1961). Based on recovery of a single, unprocessed bison, this site is interpreted as a bison kill site, like Simonsen (Kay 1998). There is no reported radiocarbon date associated with Pisgah, but the presence of the Simonsen point with a bison kill in the locale of the eastern prairie border suggests that Pisgah is chronologically and culturally associated with the Logan Creek Complex.

Turin (13MN2) is an Archaic burial site in Monona County, Iowa. Discovered in 1955 near the town of Turin in a quarry operation, it was later excavated by Reynold Ruppe and W.D. Frankforter (Fisher et al. 1985). Four sets of human remains in flexed position were recovered from Turin, one of which was buried 13 to 20 ft (3.9 to 6.1 m) below surface. Associated with a burial along the cliff of the excavation site was a side notched, basally thinned and ground projectile point, as well as 18 *Anculosa* sp. beads assumed to be the remnants of a necklace (Fisher et al. 1985). The projectile point is typologically similar to those from the Horizon I of Cherokee Sewer (Anderson et al. 1980), though it is fashioned from Knife River flint, an exotic material for this area (Alex 2000). Although these burials were initially assumed to be Wisconsin in age, a radiocarbon date of 4720 +/- 250 RCYBP (5774–5332 calBP) was obtained from the skeleton with associated burial goods, and 6080 +/- 200 RCYBP (6998–6905 calBP) from a bison bone buried 8 ft (2.7 m) beneath the burials. These date ranges would suggest an Archaic rather than Pleistocene burial. Kay (1998) is skeptical of Turin's association with Logan Creek however, as the comparatively recent date from the human remains would suggest an extremely long time depth for the complex. While exotic raw material for the Turin projectile point is also rare of Logan Creek, it has been infrequency reported in Nebraska (Roper and Hughes 2014).

Soldow (13HB1) is a multi-component site in Humbolt County, Iowa, 20 miles north of the city of Fort Dodge. The site is located along a sandy knoll adjacent to the east fork of the Des Moines River (Flanders 1977). Unlike the other comparable sites located in the Missouri River drainage basin, Soldow is part of the Mississippi River basin. Artifacts recovered included several surface-collected Scottsbluff points, as well as a late Paleoindian lanceolate fragment, several side-notched Archaic points, and smaller Woodland side-notched points. The Archaic side-notched points resemble those from Horizon I and II of Cherokee (Anderson et al. 1980), while another resembles the point recovered at Lungren. Several drills, various scrapers, numerous pieces of debitage, and hammer and grinding stones were also recovered (Flanders 1977). Chipped stone artifacts are largely comprised of locally available, till-derived cherts. The sandy soil and history of agricultural activity in the area heavily affected cultural deposits at Soldow. Consequently, non-diagnostic artifacts as well as culturally diagnostic artifacts from different cultural periods are likely mixed and unable to be separated stratigraphically. The site's relationship with Archaic sites in western Iowa or the Logan Creek complex in general is uncertain.

The Ocheyedan Site (13OA401) is located 3 miles southwest of the town of the same name in Osceola County, Iowa. This site was reported as a surface scatter of side-notched projectile points similar to those recovered from Horizon I and II of Cherokee, as well as notched and unnotched end scrapers, bifaces, flake tools and bison teeth (Anderson 1973). Like Cherokee Sewer and Archaic sites such as Hill and Simonsen, the site is often referenced in northwest Iowa culture histories. Despite this, a records search indicates no further work occurred at Ocheyedan, and aside from Anderson's (1973) entry in the *Northwest Chapter of the Iowa Archaeology Society* newsletter, there are no further publications. The site's function is unknown.

The Palace site (13PK966) is a multi-occupation Middle Archaic site located in Des Moines, Iowa. Located on the Des Moines River floodplain, it was discovered during construction of a water treatment facility in 2010, and was excavated by OSA staff the following year (Whittaker et al. 2014). Excavations uncovered five loci which produced lithic and faunal artifacts as well as possible house depression features, hearths, and a burial. The loci represent five separate occupations, with a calibrated date-range from 15 AMS dates of 7100–6400 calBP.

Recovered lithic artifacts from the Palace include Middle Archaic side-notched Raddatz and Matanzas points, Late Archaic Durst points, unclassified corner notched points, and utilized flakes, bifaces, wedges, adzes, and other tools for both hide and wood working (Whittaker et al 2014). These artifacts were a mix of semi-local Pennsylvanian and Mississippian (Lower Carboniferous) chert as well as locally available glacial till. Faunal remains consist largely of deer, with some elements of bison, turtle, bird, and local marine shells. The faunal and lithic artifacts recovered from the Palace place the site and its inhabitants closer in association with the Helton complex and other Eastern Woodlands Archaic sites in the east, rather than the Plains-based Logan Creek complex. Based upon faunal information and comparison with similar sites, the Palace represents a summer occupation, possibly a seasonal gathering of related or associated groups.

Four of these sites, Logan Creek, Cherokee Sewer, Hill, and Lungren, likely represent residential campsites based upon Kay's (1998) synopsis. Bison—the majority faunal species identified in nearly every site—were found in association with a variety of chipped and sometimes ground stone tools usable for animal processing. In contrast, Pisgah and Simonsen represent kill sites, where bison were killed but lacked evidence of heavy processing. Turin represents a burial—the only one known within the commonly accepted time frame for Logan Creek. Though a single example, this suggests funerary treatment of the dead shows up on the landscape fairly early in the region. Soldow may represent a Logan Creek residential campsite, but the mixing of elements from Paleoindian and Woodland components makes exact site type difficult to determine. The Palace site, though having more in common with the Helton phase than Logan Creek, likely represents a multi-group seasonal gathering in the Des Moines River valley. It is unknown if Logan Creek peoples had an analogous site type, and by extension similar large gatherings such as this.

Based upon raw material sourcing and lipid protein analysis, Logan Creek peoples were mobile, but nonetheless maintained a core area along the eastern prairie (Nycz 2013). The tool kits at each site are heavily reliant upon bifaces, which would be suited for a mobile hunter-gatherer group. With the exception of Soldow, most Logan Creek sites in Iowa are located not far from the Missouri River valley, near or within the Loess Hills area. Bison, the predominant fauna found in Logan Creek sites, were predominant in the area at the time, and traveling far for food would not have been necessary (Widga 2006). In southwestern Iowa, chert from glacial till and Pennsylvanian subperiod bedrock sources was locally available and heavily utilized in sites in that area. In northwestern Iowa, glacial till outcrops of chert and Tongue River silica were used at Cherokee Sewer and Simonsen (Anderson et al. 1980). The projectile point found at Turin, fashioned from Knife River flint, suggests the possibility of some exotic raw material trade or acquisition. However, Knife River flint is sometimes available in glacial till, so a more local acquisition from a stream deposit cannot be ruled out.

Seasonality is generally lacking for most Logan Creek sites. Cherokee Sewer is the exception, as it is well established from faunal analysis that it was occupied in the winter (Anderson et al. 1980; Whittaker 1998). In comparison, the Palace is a summer occupation representing a multi-group gathering. Further analysis of faunal remains would be necessary to ascertain seasonality at other Logan Creek sites with any certainty.

Interstate Site Comparisons

In addition to the Logan Creek site in Nebraska, several other sites along the eastern edge of the Great Plains contain archaeological deposits that compare favorably to those in Iowa. Many of these sites are outside the core Logan Creek area outlined by Kay (1998), which is largely in eastern Nebraska and western Iowa. However, these sites (with the exception of Koster, included for comparison) otherwise fit Kay's previously outlined criteria for Logan Creek in regards to technological and subsistence strategies utilized.

The Spring Creek site (25BT31) is located on a second terrace along Spring Creek, within the Red Willow reservoir in southwestern Nebraska. Initially discovered in 1948 during archaeological survey, this site was excavated in the early 1960s as part of salvage operations during dam construction (Grange 1980). This is a multi-component site, containing evidence of occupations from 19th century, historic Native American, late-prehistoric Central Plains Tradition, Plains Woodland, and Archaic periods. A total of 21 projectile points (many side-notched), 11 bifacial tools, and many scrapers were recovered during excavation of the Archaic component, as well as bone tools and a faunal assemblage largely comprised of bison. Grange (1980) noted the similarity of the side-notched projectile points to those recovered from Logan Creek, as well as Simonsen and Hill. Spring Creek has a single radiocarbon date of 5860 +/- 160 RCYBP (6501–6972 calBP), which led Grange to propose a westward expansion of Logan Creek through time.

The Rustad Quarry site (32RI775) is located 3 km southwest of Kindred, North Dakota. The site was discovered in 1992 during a geological survey, with artifacts eroding out of a riverbank near a soil quarrying operation along a delta of the Sheyenne River (Michlovic and Running 2005). Multiple excavations which included several field schools were conducted between 1992 and 1998. Paleoindian, Early Archaic, and Woodland components were uncovered at Rustad. Side-notched points were uncovered in the Early Archaic component in addition to bison bones. These points compare favorably to those found at Logan Creek, Simonsen, and Hill (Michlovic and Sather 2005).

The Itasca Bison Kill Site in northwestern Minnesota was discovered in 1937 during road bridge construction across Nicollet Creek (Shay 1971). Similar to Soldow, it is located in the Mississippi drainage basin rather than that of the Missouri. Excavations occurred in 1937, as well as through 1963-65. Radiocarbon dates range from 8810 +/- 300 RCYBP (10227–9537 calBP) for the oldest horizons to 6430 +/-125 RCYBP (7471–7184 calBP) for the youngest (Shay 1971). The site has been interpreted as a bison kill and hunting camp, similar to Cherokee (Anderson 1980). Associated with bison bones, chipped stone tools and debitage are a number of projectile points ranging from lanceolate forms to side-notched forms similar to the Simonsen points (Shay 1971). This would suggest some potential in overlap of the inhabitants of Itasca with those of Lungren, Cherokee Sewer, Hill, Logan Creek, and other bison-hunting Archaic sites in neighboring states.

The Medicine Crow site (39BF2) is a stratified multicomponent site in Buffalo County, South Dakota, located in the Middle Missouri sub-area. The site was first referenced in the 1940s and excavated in the 1950s and 70s as part of federally sponsored excavations (Ahler and Toom

1989). Medicine Crow is well known for its Plains Village component, which includes well-preserved house features. However, the site also contains earlier Paleoindian and Archaic occupations. Lithic artifacts recovered from the excavation includes thousands of pieces of debitage, dozens of chipped stone tools, and projectile points excavated from Paleoindian, Archaic, Woodland and Plains Village components. (Ahler and Toom 1989). This includes eight side-notched Archaic points resembling those associated with the Logan Creek complex. A date range of 8000–7000 BP has been ascribed to the early Archaic component of Medicine Crow, based upon typology of these side-notched points.

The Koster site (11GE4) is a multicomponent, open-air site near Eldred, Illinois. It is located on the edge of the Eastern Woodlands, far removed from from Lungren and other Logan Creek-affiliated sites, but is mentioned here for broad regional comparison. Koster is located on a terrace in Greene County in the lower Illinois River Valley, 40 km north of its confluence with the Mississippi (Doershuk 1989). It is a deeply buried, stratified site with Early Archaic through Woodland and Mississippian occupations. Intensive excavation has been conducted since the 1970s. There are several horizons at Koster associated with Middle Archaic components, including those with materials affiliated with the Helton phase (Doershuk 1989). Radiocarbon dates for the Middle Archaic components range from 8230 +/- 120 RCYBP (9396–9031 calBP) (designed Middle Archaic I), to 4880 +/- 250 RCYBP (5909–5319 calBP) (Middle Archaic III/Helton Phase) (Wiant et al. 2009). These components show evidence of residential camp use with complex use of hearth space and tool production areas (Doershuk 1989). The occupants of these different components show varying degrees of sedentism.

Recovered faunal remains from Koster were largely deer and riverine shell along with lesser counts of smaller mammals, birds, and fish (Doershuk 1989). Lithic artifacts included a number of debitage, scrapers, flake tools, and side-notched projectile points. Evidence of plant use included hickory shells and squash rinds (Simon 2009). It is evident that the various Middle Archaic occupations of Koster represent a more broad-spectrum subsistence of both deer and plants with a more sedentary lifeway that is perhaps similar to the Palace site. This is in strong contrast with the Logan Creek complex, which while roughly contemporaneous with Koster relied heavily on bison hunting, distinct from the groups of the Eastern Woodlands.

Chapter 3: Research Design and Theoretical Considerations

The purpose of this thesis is to take the lithic assemblage from Lungren, currently held at the Smithsonian, and build on Brown's (1967) prior research and analysis in order to form a better understanding of the technology of Plains Archaic people in southwestern Iowa. Research was conducted with the following questions in mind.

1. What does the lithic assemblage from Lungren tell us about the technological organization of the people who lived at the site, based on interpretation of tool and debitage morphology and macroscopically observable evidence for use? How might aspects such as raw material availability and subsistence strategy influence tool manufacture, use and discard?
2. What does the lithic assemblage from Lungren tell us about mobility strategy, based on raw material selection and technological organization of the tool kit? Is there evidence of curated or expedient technology with specialized or general cores?

Technological organization can be defined as "…the study of the selection and integration of strategies for making, using, transporting, and discarding tools and the materials needed for their manufacture and maintenance" (Nelson 1991). It is in effect the strategy of a group or groups of people planning, creating, and utilizing tools throughout their existence in order to survive day to day. This concept can be broad, and can be affected by a number of variables such as raw material availability, social factors, game availability, and climate (Nelson 1991). Technological organization to a degree might be considered a more specific area of hunter-gatherer mobility and subsistence strategies, as both of these indirectly or directly impact how a group may organize its technology (Binford 1980, Kelly 1988). Simply put, how an observed group organizes its technology is reflective of their lifeway in a given place.

Site function and activity at Lungren must be analyzed from the perspective that the site represents one place in time for a mobile group pursuing a hunter-gatherer way of life across a now-altered landscape. In regards to hunter-gatherers, Binford (1980) defines a spectrum of collecting verses foraging. Put simply, a forager strategy will result in groups moving around frequently through a seasonal 'round' to obtain resources whose locations they are well accustomed to (residential mobility). In contrast, collectors move around less frequently and obtain goods through specialized resource-gathering groups (logistical mobility). It should be noted that there is a continuum between forager and collector, not a binary. It is likely most groups practice a combination of both behavioral types (Andrefsky 2005; Binford 1980).

While it is reasonable to assume that hunter-gatherer groups are mobile, the exact range and nature of this mobility for prehistoric groups has been debated (Knell 2012; Nycz 2013). Based upon ethnographic studies of the Nunamiut, raw material acquisition for stone tools occurred incidentally as part of resource gathering for other valuable items (notably hunting for food), and rarely as the sole focus of a sojourn (Binford 1978). The 'embedding' of incidental resource acquisition while on the path for other resources ensures a resource gathering trip does not return empty-handed. It should be noted, as Binford stated, that his subject matter (the Nunamiut) represented an 'extreme' case where seasonality and access to various resources were very specific. For the Nunamiut, chert—a specific and necessary resource—happens to be available in known locations for large stretches of the year. These known chert locations happen to be on the route to obtain game, such as seal or caribou. Unlike chert, this game is acquired through seasonal activities that do not allow for much deviation. Different groups in other locales may have variables that affect their resource acquisition (different chert availability, year-round food resources, etc.).

There are disagreements with Binford's model of embedded procurement. For example, Gould and Saggers (1985) observed Australian aboriginals in the Outback making journeys specifically for raw material, rather than simply relying upon incidental acquisition while traveling for a different purpose. While the authors conceded that acquiring lithic raw material certainly could be incidental, their research highlighted situations of deliberate 'exotic' raw material acquisition. The ability and need to seek out raw material for items in a deliberate or embedded basis is thus conditional and highly variable for a group's technological organization strategies while interacting in their environment.

Just as different groups would favor varying degrees of residential or logistical mobility based upon resource acquisition strategies, these choices would also affect technological organization in regards to the tools these groups made and used. Mobile populations may have a certain preference for portable stone tool technology that is easily transported, such as bifaces (Andrefsky 2005). These bifaces are an example of curated technology, where the items are prepared, transported, reworked, used for a variety of tasks, and see an investment of energy in creation (Binford 1979). Curated technology is clearly illustrated by the assemblage at camps of bison-hunting groups such as Cherokee Sewer (Anderson 1980), or Clovis sites where bifaces have been cached for later use (Muñiz 2014).

Curated technology is contrasted by expedient technology, where minimal effort is placed into creating specialized tools for predictable, specialized tasks (Binford 1979). A good example of this would be utilized flakes, fashioned from flaking debris freshly knapped from a core. These tools are fashioned as need arises, with less thought given to future use. Some have even taken this as far as to assume that the ratio of cores to bifaces at a site may itself be an index of group mobility or sedentism (Bamforth and Becker 2000). Nelson (1991) considers the existence of an 'opportunistic' tool category separate from expedient tools, where unexpected developments result in a need to manufacture tools for a solution. This might be considered distinct from Binford's expedient tool strategy as it is purely responsive to a new development.

While it is plausible that more logistically mobile groups may favor curated technology over expedient technology, there are advantages to both and their use is certainly not exclusive. These categories are also not entirely distinct; a biface (curated) may produce flakes that can be used for a particular task (expedient or opportunistic) (Kelly 1988). Even people utilizing bifacial knives for tasks may nonetheless find freshly knapped flakes to be better for a task (Frison 1979; Muñiz 2013). There are also critiques to Binford's notion of curated technology being more efficient, as creation of such tools such as bifaces, and associated retooling, may be less efficient from both a material and time standpoint than simply knapping a fresh flake (Bamforth 1986; Prasciunas 2007).

Bamforth (1986) further argues that Binford's definition of curation from a subsistence-settlement organization model is insufficient to describe the varying tasks that a group may expect to do in its subsistence strategy, and how particular tools may be fabricated for multiple tasks or very particular ones. Rather, he argues for the hypothesis that scarcity or uncertainty regarding raw material acquisition may heavily (though not exclusively) impact the need for curation. In short, curation as a strategy is implemented when access to particular raw materials are uncertain in the future, rather than a variable simply linked to how mobile a group is.

Site organization and formation may be highly influenced by subsistence strategy and technological organization. Residential camps might have a wider variety of site function than resource-collection sites such as hunting camps (Andrefsky 2005; Binford 1978). In his study of aboriginal groups in the Arctic, Binford (1978) made observations on how the groups organized, shared, and used a variety of items such as cups, bullets, cards, and 'waste' items such as cans. Observations were made and recorded for locations various activities took place, as well as where said items might enter the archaeological record (Binford 1978). The last one is notable as items may be discarded when no longer in 'fair' condition, or 'scuttled' because they may have served a particular purpose that does not warrant further transport (Binford 1979). While acknowledging that this ethnoarchaeology is of a modern group that relies upon modern produced metal and ceramic goods such as binoculars and rifles and utilize technology such as snowmobiles, clear activity areas can nonetheless be established from items that are found in specific areas of a site. Relevant to a pre-contact site, this can be seen when corroborating flintknapping activities and formal tools. One may be present while the other is not, which may infer when tools may have been taken off site after construction, or whether they were constructed elsewhere (Andrefsky 2005).

Raw material choice, a commonly measured and quantified attribute in archaeological sites, has complex considerations when quantifying its significance. On an elementary level, raw material selection may be influenced by local accessibility to good quality chert (Andrefsky 1994). The availability of readily accessible local chert may have determined whether ancient people utilized items down to exhaustion, or whether they were more willing to discard a tool in a useful state (Andrefsky 1994; Bamforth 1986; Newman, 1994). From studies in the southwestern United States, it has been suggested that the size of recovered flakes grows smaller the farther an archaeological site is from a raw material source (Newman 1994). These particular flakes are a result of tool maintenance, and suggest that proximity to raw material influences the willingness to re-sharpen and repair tools. Previous excavations that lacked size control (e.g., no screening protocol) may make assessing debitage size of earlier sites more difficult, however.

The quality or nature of raw material may also impact what tools are produced. For example, abundant high quality chert sources may result in the creation of both informal and formal tools, but less frequency of said high quality chert may result in expedient tools being made of lower quality local chert (Andrefsky 1994). Less workable, but more durable materials might see use as heavier processing tools such as mauls or axes (Whittaker 1998). However, it should not be assumed that high quality chert is reserved for tools. In at least one case in West Virginia, exotic Mercer chert was being brought into a site specifically for use as flakes, rather than local, medium-quality chert which was used for biface and projectile point design (MacDonald 2009). While better raw material may not always be used for more formal items, there is a definite understanding that certain material is preferred for certain tools, and by extension certain tasks.

There may be other considerations at play when examining raw material use besides distance. Raw material at sites and distances from their sources may not easily define a hunter-gatherer group's range of travel. Ingbar (1994) demonstrated a thought experiment based around a hypothetical group. This group, making a consistent seasonal round with intermittent retooling and replenishment of raw material, will leave behind materials (artifacts in sites) at various points in their travels. Depending upon at what point in this cycle an archaeologist recovers their tools will heavily influence our understanding of their mobility and range. For example, their proportions of raw materials might have varied considerably had the site been located in one part of their seasonable round rather than another. From this, Ingbar argues that raw material quantities only give a minimal idea of what a group's 'range' might have been.

More useful is when a researcher considers the entire context of stone tool production, use, and discard, in group technological organization. Ingbar (1994) argues that while raw material source is a good starting point, the needs of the community that utilized said raw materials needed to be considered, which included various tasks related to a group's mobility and subsistence strategy (tool creation, use, retooling, etc.). If there is no particular need for a raw material (quartzite for example) in a group's subsistence strategy, it may not be used no matter how convenient it is (Ingbar 1994). However, if curated, prepared technology is part of a group's toolkit, higher quality chert may be preferred. This high quality raw material, even if it takes additional effort to obtain (through trade or travel) is still an important consideration for especially highly mobile groups (Andrefsky 1994). In this, both Andrefsky and Ingbar argue for looking at an entire assemblage (debitage, cores, and tools) to determine what items are made and used as well as what raw materials are being used, to determine how groups roam and utilize the landscape for various resources and subsistence.

It stands to reason that barring mechanisms such as trade, group mobility significantly affects opportunities to acquire exotic or non-locally available chert, and the frequency of artifacts comprised of those materials (Bamforth 1986). A significant amount of the Paleoindian component of Cherokee Sewer was comprised of fusulinid-heavy cherts of Pennsylvanian age common to eastern Nebraska or southwest Iowa (Anderson 1980). This is in contrast to less mobile groups, who would have to make more use of local raw material except for instances of trade (Odell 2004). Early Archaic hunters at Cherokee Sewer resorted to heat treatment of Tongue River Silica from locally sourced river cobbles, rather than the non-local Pennsylanivan cherts of earlier and later occupations (Anderson 1980). This may suggest less overall mobility by Early Archaic hunters, or simply less access to chert outcrops for other reasons. Sedentary groups in chert-poor areas may also resort to bipolar percussion to obtain materials from river cobbles, such as at late prehistoric Dixon site (13WD8) occupied by the Oneota (Fishel 1995). Bipolar percussion is less efficient in regards to usable chert obtained (Morrow 1995), but nonetheless produced workable material. In contrast, many larger artifacts at Dixon such as beveled knives were produced from exotic materials such as Oglalla orthoquartzite, Hixton silicified sediment and Burlington chert (Fishel 1995).

Based upon the information above as well as that provided by previously excavated sites, the Lungren site likely represents a campsite by a group practicing relatively short-ranged mobility. As southwestern Iowa contains an abundance of bedrock chert, it would be expected that most tools would be fashioned from this locally acquired raw material. Depending upon chert quality, a mix of formal and informal tools are likely utilized, with some energy put into producing a tool kit that is at least partially mobile (represented by presence of bifaces). Considering the available raw material resources, a substantial amount of the tool kit may be informal or expedient for situational or unexpected needs (i.e., flake tools or scrapers). As a campsite, Lungren likely contain evidence of subsistence processing of animals (in this case, bison butchering), as well as tool manufacture or maintenance reflecting this butchering or processing. Many of these items, such as scrapers, large butchery tools, and retouched flakes, are likely to be found abandoned at Lungren; they would not have warranted the energy to transport after use.

The presence of stone tools inevitably raises questions of use. Different stone tools—scrapers, knives, flake tools, projectile points—all had different applications (Frison 1979). This means that the presence of a tool or combinations of tools can be used to infer various activities of site inhabitants. This is true even for items related to the same general activity, such as butchery. Fresh flakes, for example, are superior to bifacial tools for initial cuts in butchering a bison hide (Frison 1979; Muñiz 2013; Walker 1978). The sharp edge of a freshly knapped flake will slice through uncut hide more effectively, at the cost of becoming dull more rapidly. Early in use-wear studies, low-powered (macroscopic) magnification experiments illustrated alteration of working edges on flakes and other stone-tools to produce striations, step-fractures, or edge-margin alterations (rounding and development of sheen) depending upon activity (Frison 1979; Odell 2004; Tringham et al. 1974).

Other elements of bison processing, however, may not require sharp flake tools. Bifaces may be useful for butchery after the initial hide cuts when a more resilient tool is required, and even dull flakes can still see use as unifacial flake knives or be converted into scrapers to cut hide once it has been removed from a bison (Frison 1979, Muñiz 2013). However, these studies were based upon use of low-magnification (generally less than 50X magnification), and are inadequate for observing certain kinds of wear indicative of use. Low-magnification may also fail to identify damage to edges from processes such as trampling or depositional processes

(McBrearty et al. 1998). Later studies prioritized microscopic use-wear, often at magnifications of 100X or higher (Keeley 1980). These studies allowed for more nuanced interpretations resulting from tools recovered from sites.

It is important to note that edge-wear analysis has limitations. Although striations are indicative of certain types of wear, many of these traces may only be observed with high-powered magnification (Tringham et al. 1974). Additionally, flake or tool edges can be damaged or modified by natural events or by incidences such as dropping an artifact or trampling (McBrearty et al. 1998; Moss 1983; Tringham et al. 1974). This makes simply examining an edge for damage to be unreliable at best. Finally, many experiments tested tools for one activity at a time, such as bison butchering or wood cutting (Frison 1979; Tringham et al. 1974). It is highly possible that certain artifacts may have been used for several tasks, which would provide inconclusive results when analyzed. Nevertheless, use-wear analysis may add insight to stone tool use and function in addition to the defining of tool morphology and modified or utilized flakes.

Studying an assemblage as a whole unit in order to get a more complete grasp of technological organization strategy requires a method of organizing all of its elements. One method to do this, minimum analytical nodule analysis (hereafter MANA), describes a technique for organizing lithic assemblages into analytical units based upon raw material and production trajectory (Larson 1994; Larson and Kornfeld 1997). The concept behind MANA is that there is a traceable record of human behavior from the time raw material is acquired from its origin source until the material in whatever final form is found by an archaeologist (Larson 1994). Debitage and tools based upon this notion are grouped into minimum analytical nodules (MANs) which represent items made from similar raw material with distinct physical characteristics that hypothetically come from the same parent piece (e.g., core), grouped together to represent a particular trajectory or 'life history' (Knell 2012; Larson and Kornfeld 1997).

Hall (2004) defined four categories of MANs, each reflecting a behavior model of provisioning, manufacture, maintenance, and potentially discard. Type 1 consisted of one or more tools with no debitage and represents curated tools or objects brought into the site as they were and then discarded there. Type 2 is comprised of one or more tools plus debitage, and represents a curated tool being brought into the site, maintained, and then discarded. Type 3 consists of debitage, one or more cores, or one or more tools. This category represents on-site manufacture, maintenance, and discard of artifacts from provisioned raw materials (cores or blanks) brought into the site. Type 4 consists solely of debitage, and represents on-site tool manufacture or maintenance on site, followed by removal of artifact to another location off-site.

It should be noted that Type 1 and 2 as defined by Hall are separated only by the presence of debitage in Type 2, which represented maintenance of curated objects. Doperalski (2013), in this analysis of archaeological sites in Minnesota, makes note of this, and emphasizes that Hall's (2004) methodology excluded flakes 1.5 cm or smaller from the study, citing difficulties in raw material identification. In effect, Doperalski argues, Hall undermines his own classification scheme as Type 1 and 2 are indistinguishable. While the exclusion of smaller sized flakes is not unusual for a study (Knell 2012), it would potentially make it more difficult to identify whether production occurred on or off site.

As such, Doperalski's methodology combines Hall's Type 1 and 2 into one category for his MANA, representing curation of a pre-fabricated tool brought on site, possibly undergoing repair/maintenance on-site, and then discarded on-site. He goes about MANA with raw materials from Minnesota with enough internal variation to allow the breakdown of discrete nodules of similar looking artifacts. These MANs hypothetically represent particular episodes of production, maintenance, and discard at each site (Doperalski 2013). It should be noted that Doperalski had a large enough sample in his study to select raw materials that were ideal for MANA, while excluding those that were too homogenous for breaking down into nodules (such as Knife River flint, which is too homogenous for identifying internal variation). Attempting to be this selective at Lungren would in most practical circumstances result in no artifacts available for MANA.

Knell (2004) takes a more coarse-grained variation to MANA. In what he refers to as a Generalized Nodule Analysis (GNA), he divides chert artifacts at a locality of the Hell Gap site simply on the basis of color and raw material. This analysis has the benefit of demonstrating what these generalized nodules—raw materials and the particular items made from said materials—were used for in the technological system (Knell 2004). The artifacts, sorted into nodules, were then modelled to demonstrate the movement of particular items through Hell Gap in particular scenarios, such as off-site deposit of tools produced on-site, or on-site production and discard of tools. Due to the simplified sorting strategy, this method is perhaps more suited for use with homogenous raw materials such as those at Lungren. However, the nature of generalized nodules, which as Knell admits likely include artifacts that would be separated out into several nodules in a formal MANA, makes interpretation of episodic behavior (specific instances of tool manufacture, repair, discard, or transport) difficult.

Knell (2012) later takes a more nuanced approach to MANA, incorporating technological indicators of tools and debitage into account. He describes five technological trajectories subdivided into 12 proposed scenarios/outcomes based upon technological considerations (flake tools, flake blanks, cores, bifaces, etc.). Seven of these scenarios are production based (on-site tool production), three represent on-site maintenance with off-site transport/discard, and the remaining two represent on-site discard of artifacts curated from elsewhere. In addition to diagnostic tools, Knell also takes into consideration technological variables on debitage, such as bifacial thinning flakes or unifacial re-sharpening flakes, as well as cortex type, tool blank type, manufacturing stage, and breakage type.

It should be noted that MANA is not designed to provide an exact minimum number of associated artifacts from individual specimens like one might do during a faunal analysis (Larson 1994). There could be more or less analytical nodules than actual parent nodules present at a site, depending upon artifact recovery or variability within a particular raw material. Instead, Larson notes, MANA is a method of quantifying and analyzing variation found within an assemblage, with each MAN being an analytical grouping based upon observed similarities, which can then be compared with other MANs with different traits. MANA is also not a refit analysis, which gives more direct information about artifacts that literally fit together (Bruce 2001; Larson and Kornfeld 1997). These two methods can be used concurrently to derive different types of data, though refit analysis is even more time consuming compared to the grueling MANA process.

The advantage of MANA is that it allows a researcher to hypothesize what activities occurred at a site, based upon the types of tools and debitage present, and compare within the site assemblage the various production, use, and maintenance trajectories that occurred (Larson 1994). The method is also highly flexible for the needs or research focus of the researcher or project. Raw material type, patterning such as banding or inclusions, morphological attributes that may imply technological affiliation (such as bifacial thinning flakes), the presence of cortex, artifacts present (such as finished tools or cores), and presence of finished or broken tools may all be considered when organizing variables for MANA (Larson and Kornfeld 1997).

MANA has rarely been done outside the Great Plains, though at least some attempts have been made in the Midwest. This includes a Paleoindian site in Minnesota, (Doperalski 2013), as well as two Middle Archaic sites in Missouri (Bradbury 2011) and Arkansas (Bruce 2001). Larson (1994) conducted MANA in western sites, with distinct, but heterogeneous raw material types where differences in analytical nodule could be easily identified from traits such as inclusions, banding, or mottling. As a consequence, Larson herself raised questions about whether relatively homogenous cherts such as Burlington Chert or Knife River Flint are applicable to this method, and suggested more research was necessary. Nonetheless, Larson noted that even slight variations within these materials may allow some subdivision of lithic assemblages into MANs.

Methods

As the assemblage at Lungren is almost exclusively lithic (both debitage and chipped stone tools), macroscopic lithic analysis was the primary method used for this thesis. This included debitage analysis, macroscopic use-wear analysis, raw material analysis and minimal analytical nodule analysis (MANA) in order to determine lithic material production strategy for inhabitants of the site. Microscopic use-wear analysis was deemed not feasible due to time constraints as well as the lack of available facilities.

Debitage analysis*:* Debitage analysis can potentially determine tool-making activities present at Lungren, the technological strategies for tools being made, and mobility strategies. As field excavation methods would inevitably under-sample smaller debitage due to lack of screening, it is likely that smaller sized debitage was under-sampled by the field crew. Despite this, enough debitage, including some flakes smaller than 1.5 cm in length, was recovered from Lungren to provide a reasonably well-developed picture of overall lithic manufacturing activities.

Debitage was sorted into classifications as described by Odell (2004): complete flakes, broken flakes (either distal or proximal end missing, or a longitudinal split), and shatter. After this, flake attribute analysis as described by Andrefsky (2005) was used to determine more about lithic production activities at Lungren. This included measuring presence/absence of cortex, platform width and thickness, platform type (flat/simple, cortical, abraded, or complex/multiple), completeness of flake, and standard metric dimensions (both maximum and oriented length and width, maximum thickness, and weight). These attributes, in addition to other features (previous tool surfaces or cortex) when present, were used to sort flakes into reduction-sequence related categories such as decortification flakes, or commonly used technological categories described by researchers such as bifacial thinning flakes (Andrefsky 2005; Frison 1968).

A strict size-grade analysis was not undertaken for this study. As noted, excavation at Lungren was conducted without use of sediment screening. As a consequence, it is likely that smaller pieces of debitage, which might include pressure flakes or smaller rejuvenation flakes, were missed by excavators. This would make size-grade analysis of limited use for determining stages of lithic reduction present on site, as such a study is heavily impacted by this sampling bias (Andrefsky 1994). As part of the individual attribute analysis the standard metric attributes mentioned above can be used to quantify attributes for determining lithic reduction activities.

Hypothetically, one can determine how much early stage (i.e., decortification, primary reduction) lithic activity occurred at Lungren through systematic analysis of debitage. Flakes with traits attributable to particular technological types (for example, bifacial thinning flakes) can aid in determining particular types of later-stage, on-site production. Information obtained from debitage analysis was also used for MANA (described below) for determining tool production activities on site.

Chipped stone tool analysis*:* Utilized flakes can be used to answer questions about particular activities performed at the site. For purposes of this study, utilized flakes are artifacts whose overall morphology has not been substantially modified from its original form as a detached flake (they are 'unshaped'). This is distinct from 'shaped' tools whose forms are heavily modified by peoples through flintknapping or use, such as bifaces, end scrapers, or adzes. These criteria are a slightly modified adaptation of that utilized by Muñiz (2009) for organizing and classifying tools on Cody complex assemblages.

As noted previously, flakes sometimes moved beyond mere byproduct and often became an important part of a toolkit, utilized in cutting activities such as bison butchering (Frison 1979). Though Brown (1967) identified some flakes that showed evidence of use in the Lungren assemblage, it is worth reexamining the debitage with the advantage of the use-wear studies and methods that emerged after completion of the Pony Creek report. The debitage of Lungren was examined with a 15X loup lens in order to identify visible use wear, which was categorized by type (feather/scalar, or step terminations). These tools were also measured for dimensions and coded for raw material. This analysis can provide insight on technological strategy in regards to how often expedient technology (as defined by Binford (1980) may have been used in comparison to more formal items. Utilized flakes, like other debitage, were sorted as part of MANA analysis (described later).

Unifacial tools from Lungren include scrapers, gravers, and similar shaped artifacts generally created from a flake. These tools were measured for dimensions and weight, and coded for raw material type. Unifacial tools were also examined with a 15X loup lens to determine a general description of utilized or modified margins, with those margins measured in length. Graver spurs—sharp protrusions created from flake removals—were identified from debitage or other tools and examined for wear.

End scrapers were analyzed with dimensions as established by Muñiz (2013) from work done on Cody Complex end scrapers, as well as measurements proposed by Morrow (1995). End scrapers were measured for maximum length, width, thickness, working edge convexity, general shape, completeness (whether the tool is broken), and working edge angle. Raw material and whether the tool was complete or broken were also coded. These attributes, where possible, were entered into PAST statistical software to quantify variations in dimensions. Scrapers, when possible, were subjected to a calculation to determine a measure of reduction (and by extension, curation). This method was originally described by Kuhn (1990), where he analyzed several standardized attributes of side scrapers, and created a ratio (the Index of Reduction, or IR) that determined how 'utilized' a scraper was before disposal.

Bifaces can serve as a core for flakes, as a preform for larger tools, and as objective, general-purpose tools themselves (Kelly 1988). Reliance upon bifacial core technology is suggested as an indicator of mobility for a group, as bifaces represent a transport-friendly form of technology (Andfrefsky 2005; Bamforth and Becker 2000). While bifaces are transport friendly, they are not the most resource efficient source for flakes, as experimental studies on flake removal from bifaces suggests a smaller return for flakes than when simply taking them from a standardized core (Morrow 1995; Prasicunas 2007). Based largely on size, Brown (1967) had divided bifaces into two categories: knives and bifacial cores. Both categories of biface were measured in size and weight as well as general shape, with edges analyzed with a 15X loup lens to identify retouch from use. Flake scar size, and pattern/flaking regularity were analyzed on each piece to determine if these items are early stage or late stage (preform or 'finished' tool) bifacial artifacts, based upon a methodology devised by Muñiz (2014).

Similar to bifaces, unidirectional and multidirectional cores serve as a source of raw material for items such as flake blanks, blades, and scrapers (Andrefsky 2005). The cores themselves can also indicate what sort of flake technology is being utilized at Lungren, as well as how much 'use' (reduction) the cores received prior to being discarded. Cores collected from Lungren were analyzed for size (weight and maximum linear dimension), number of flake scars, flake scar size, and whether the core is unidirectional or multidirectional. This was based on methodology described by Andrefsky (2005) and Odell (2004). As Brown (1967) observed that several cores seemed to have been utilized as tools, edges were analyzed with a 15X magnification loup lens to determine extent of use.

Raw material analysis*:* Raw materials of each lithic artifact class—flake, core, scraper, etc.—were identified through comparison with the Lithic Raw Material Assemblage (LRMA) at the Office of the State Archaeologist in Iowa City. This collection was supplemented with the guide to Iowa chert identification devised by T. Morrow (1994). Initial observations of raw material were recorded at the Smithsonian Museum Support Center, and then reassessed later with the LRMA in Iowa City. This process was aided through combination of photographs and use of a portable flatbed scanner where permissible.

Identifications were done on basis of Munsell color, texture, fossil inclusions, cortex, and banding. From this, artifacts were matched to lithic type as documented at specific source areas (such as Hertha or Spring Branch chert), or an approximate match based on larger-scale geologic association (such as indeterminate Pennsylvanian) based on geologic bedrock maps provided by the Iowa Geologic Survey. These raw material counts were broken down by artifact types, providing data which was then used in breaking down debitage and tools into tool production trajectories (see section on MANA analysis, below).

There are several caveats to this process. Older artifacts, such as those of Paleoindian or Archaic age, often suffer effects from depositional or chemical processes, such as calcium carbonate accumulation or patination, compared to a 'freshly' knapped chert sample. In addition, color (a trait most affected by depositional/chemical processes) is often the least useful identifying marker of a chert type, and that reliance on inclusions, banding, or mottling are far more useful (Morrow 1994). Some photos of identified chert artifacts from known local Mills County archaeological sites were used as a supplement to the LRMA images. These artifacts were from Nebraska Phase (late prehistoric) sites with less depositional impacts, but nonetheless represent an archaeological sample to compare artifacts from Lungren to for determining raw material.

Another issue is that while heat treatment is sometimes distinct on artifacts, burned (carbonized) or overheated artifacts can obfuscate easy identification. These artifacts were categorized as 'Heated/Burned' for purposes of data collection, based upon presence of heat fracturing, pot-lidding, or burned cortex. These burned items, while recorded, were included in the ‘unknown’ raw material category, and excluded from MANA. Items that were simply thermally altered were identified and included in appropriate categories where possible.

The often similar appearances between certain types of Pennsylvanian chert, notably plain grey or cream-colored types, prevented a bright-line distinction for clear identification. If the artifact could fit the category of several similar looking cherts, it was assumed to come from the chert known to occur in closest proximity to Lungren. If there was no way to distinguish between two types with reasonable confidence based on physical characteristics or geologic information, the artifact was simply considered ‘Pennsylvanian’ if it had identifiable characteristics of Pennsylvanian chert in general (fossil inclusions, color), or ‘unknown’ if it lacked discernable features.

Data acquired from a raw material analysis can answer questions about how extensively resources were procured both locally and from farther away. This information can be tied in with other lithic analyses to determine how raw material may have influenced technological organization in regards to what tools are derived from what materials, what was discarded at Lungren, and what tools may have been taken away from the site. Understanding the use of raw materials at a landscape scale and the flow of those raw materials through the Lungren site will provide information on broad patterns of mobility and strategies for lithic technological organization.

Minimum Analytical Nodule Analysis (MANA): A MANA analysis was performed on the Lungren assemblage, based primarily upon work by Larson (1994), Larson and Kornfeld

(1997), and Knell (2012), on Cody Complex assemblages at Hell Gap, as well as work by Doperalski (2013) on Minnesota collections.

Before conducting the MANA, a General Nodule Analysis (GNA) was performed to help organize raw material data. Artifacts previously separated by raw material were first further sorted by differences of appearance, such as color or inclusions. Artifact types (debitage, bifaces, scrapers, etc.) were then counted within each of these nodules, which provided a table of data for further analysis. Heavily altered (burned) or unidentified items were excluded from this process.

Categories defined from the GNA were then broken down in the MANA. These categories were broken down further on basis of larger-sized artifacts—cores, flake blanks, and bifaces—to help define MANs. These nodules represent the possible parent sources from which smaller objects (flake tools, scrapers, etc.) were derived. This is based upon Morrow's (1994) observation that many Pennsylvanian chert nodules are less than 15 cm in size. Multiple bifaces, cores, or blanks could not occupy a single MAN for this process.

There is no exact cutoff of size for objects to be eligible in defining a MAN. It is instead based upon the object's status as a chert source and thus a source for flakes or tools (such as a multidirectional core), or the artifact itself being a marker of technological trajectory (such as a biface). In many cases, an item that is relatively small may have been the only object in the MAN based upon raw material or appearance variations. However, most were at least 4-5 cm minimum on the longest side, making it likely that they represent an item encompassing most of a parent chert mass. Smaller cores that are easily identified, such as tested river cobbles, were included. In the event there is debitage but no biface or core, then the debitage was used for defining the MAN.

The results of this MANA were then compared to the 3-type classification scheme utilized by Doperalski (2013): Off-site curation and on-site discard (Type 1), on-site manufacture, maintenance, and discard (Type 2), and on-site manufacture with off-site removal and discard (Type 3). Debitage or flake tools (utilized flakes, gravers, drills, and scrapers) associated with these raw material types are coded as either present or absent, and used to represent possible technological scenarios. These scenarios do not represent that specific tools came off of specific cores. They instead represent the possibility that particular types of manufacture may have occurred from the larger objects defining MANs.

The nature of this MANA, both from method as well as raw materials, applies certain limitations. The lack of internal variation in the raw materials from Lungren resulted in a smaller number of larger MANs, something that is unavoidable considering attributes of the chert. Second, the lack of smaller debitage makes it highly likely that behavioral scenario Type 3 (on-site production with off-site removal), may be underrepresented or missed entirely. However, it is possible that this situation may be problematic even in more ideal circumstances. With such homogenous raw materials at play, it may be difficult to tell if hypothetical non-present artifacts were taken off site, as diagnostic debitage (if present) may be mistakenly associated with the wrong MANs/artifacts that are present on-site. Finally, this method illustrated that particular technological scenarios occurred at least once, but could not quantify how often these scenarios occurred within from a particular MAN (for example, how many scrapers were derived from a particular core). However, this method at least gives evidence that a particular technological scenario, such as on-site creation and discard of an end-scraper or graver may have occurred at all.

Although problematic, the potential absence of smaller debitage from Lungren due to a lack of excavation screening might not adversely impact MANA. Knell's (2012) work at Hell Gap excluded smaller (less than 1.5 cm) flakes due to methodological concerns, while Bruce's (2001) study in Arkansas did similar screening of small debitage. Both researchers were able to implement MANA without strong concerns. Bifacial thinning flakes were likewise still identified at Lungren despite these circumstances. While smaller debitage may be underrepresented, there was no guarantee that their inclusion would have provided useful data. Depending upon field method, even without screening it may be possible that Type 3 scenarios may still be identified.

The goal of these analyses (morphological, use-wear, raw material, and MANA) was to provide data for interpretation of site activities and lithic technological organization at Lungren. This information can answer questions about activities performed at the site, assemblage variation, group mobility, extent of tool curation (to what extent tools may be utilized and/or rejuvenated before discard), and overall adaptations to a Hypsithermal Pastern Plains environment. Indirectly, chipped stone tool analysis could also answer questions about subsistence or resource acquisition activities such as animal processing. In *absentia* of bison bones, it may be possible to corroborate analysis of chipped stone with photographs to determine what bison processing activities occurred at Lungren, possibly in conjunction with replicative studies performed by Frison (1968) and Wilmsen (1968). Finally, the information gleamed from Lungren could be used to compare lithic technology organization of other similarly dated Archaic sites.

Chapter 4: Raw Material Analysis

Southwestern Iowa is dominated by Pennsylvanian (upper Carboniferous) bedrock. This area was formed as part of the Midcontinent Basin approximately 323 to 298 million years ago (Heckel 2013). This basin was comprised of a shallow, inland sea that resulted in deposits of limestone, shale, and other sedimentary rock over several regional stages (the Desmoineian, Missourian, and Virgilian stages) of development. The lithographic sequence can be further broken down into groups of formations. These formations each roughly represent a cyclothem—a period of marine transgression and regression, often defined by limestone, shale, and underlying coal seams (Witzske et al. 2003). Pennsylvanian limestone would develop in in shallow water marine conditions, punctuated by periods of non-marine environment when marine conditions receded (Heckel 2013).

Not all bedrock will produce chert, or produce substantial or usable deposits of chert. Chert is generally understood to undergo diagenesis in limestone, when deposits are influenced by low temperature chemical alteration of silica from limestone deposits (Andrefsky 2005). While some Pennsylvanian bedrock is abundant in limestone, others such as the Waubaunasee Group are largely comprised of siliclastic rock such as mudstone or sandstone (Witzske et al. 2003). While these clastic rocks might silicify to form a workable material in some cases (such as Hixton silicified sediment of Wisconsin or Tongue River Silica), they will not form chert, and often they will not form workable material for flint knapping at all. All of these factors result in chert being a resource much like food, wood, or water where availability is not always guaranteed (Bamforth 1986).

In addition to these primary (bedrock) deposits, lithic artifacts from Lungren are also comprised of secondary deposited materials, largely derived from glacial till. Chert derived from glacial till, while often quite usable for tool manufacture, lacks clear geologic or geographical provenience. Glacial till's use as a raw material source is well recorded in Iowa, especially in areas lacking in bedrock chert sources (Anderson 1980; Nycz 2013). Exploitation of Tongue River Silica is well known in western Iowa, such as at Cherokee Sewer (Anderson 1978, 1980). Later groups also made use of local material even while trading in more exotic materials, such as at the Oneota-affiliated Dixon site (Fishel 1995).

A list of raw material types represented in the Lungren assemblage, accompanied by lithostratigraphic data and known source locations are described below (Figure 5).

Shawnee Group (Virginian)

Spring branch chert: Derived from Spring Branch Limestone of the Lecompton Formation, this material is described by Morrow (1994) as a typically medium gray (N5) chert with lighter or darker fossil inclusions, a medium to medium fine texture and dull to satiny luster (Figure 6). Patches of vuggy, bluish-gray (5B 7/1) chalcedony are often present, as are fusulinids and bryozoan fossils. Spring Branch chert is one of the most commonly utilized lithic sources in southwestern Iowa. Outcrops are particularly abundant in Mills County (Morrow 1994), though it has also been sourced to nearby Montgomery County (east of Mills County) in the LRMA.

Heat treatment does not seem to substantially affect Spring Branch chert. The cortex is described as turning pink or red (Morrow 1994), but this is not consistent with samples from the LRMA. Luster and grain do not seem to substantially improve on most pieces compared with their non-altered counterparts.

Likely as a result of chemical action from the soil and hydrology, the Spring Branch chert at Lungren seems to have faded to a light brownish gray (2.5Y 6/2) on some pieces. However, the fusulinids and chalcedonic inclusions still allow for identification.

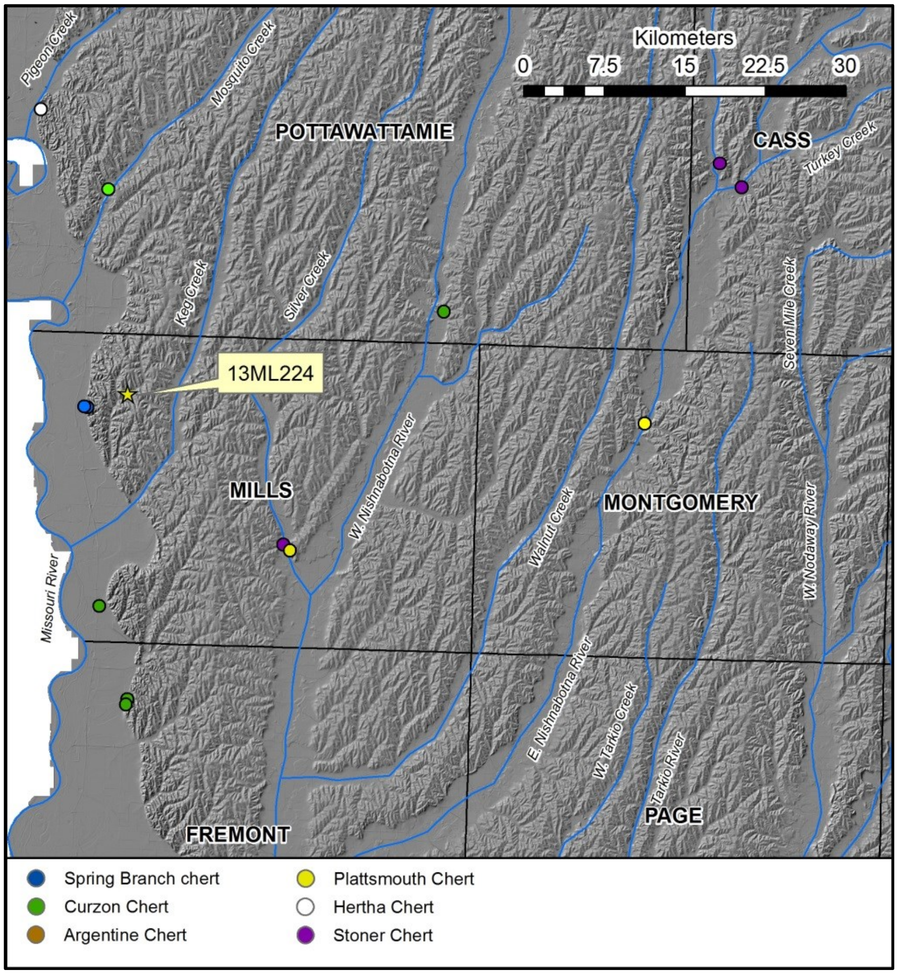

Figure 5. Map of raw material source locations included in LRMA relative to 13ML224.
LiDAR background taken from Iowa Geographic Map Server.

Figure 6. Spring Branch chert artifact.

Curzon chert: Derived from the Curzon limestone of the Topeka Formation, this material is grey (5Y 5/1) to medium light grey (N6) in color (Figure 7). Curzon chert is typically broadly mottled, with some very light grey (N8) to medium grey (N5) streaking, medium to fine grain, and dull in luster. Sometimes, 2-3 mm white (N9) to pale orange (10YR 8/2), ovoid inclusions are present. Samples from the LRMA are from Mills County as well as Fremont County to the far southwestern corner of Iowa.

The effects of heat treatment on Curzon chert are inconsistent. Specimens from Mills County seem to show little if any change. In contrast, Curzon chert from Fremont County in the LRMA shift to a reddish (10YR 5/2) to pinkish grey (10YR 6/2), with cortex in colors of dusky red (10R 3/4), weak red (10R 4/3), pale red (10R 6/4), and reddish black (7.5R 2.5/1) observed.

Figure 7. Selection of Curzon chert flaking debris.

Kansas City Group (Missourian)

Argentine chert: Chert originating from the Argentine Member limestone of the Wyandotte Formation, Argentine chert is described by Morrow (1994) as a typically light gray to tan (N6; 5YR 7/1, 5YR 8/1, 10YR 7/3) chert of medium-fine texture and dull to satiny luster (Figure 8). This description applies largely to Argentine chert recovered from outcrops in Madison County in southwest Iowa. Less well known, samples of Argentine chert in the OSA Lithic Raw Material Assemblage recovered from Pottawattamie County (north of Mills County) are a medium dark grey (N4) to dark grey (N3) in color. Very light grey streaked-mottled inclusions are present, as well as some 1-2 mm, very pale brown (10YR 8/2) fossil fragments. The Pottawattamie variant is broadly mottled with a light yellowish brown (10YR 6/3) cortex. In addition to Madison and Pottawattamie Counties in Iowa, samples in the LRMA can be sourced to Cass and Jackson County, Missouri, in the Kansas City area.

Argentine chert is often broadly mottled with scattered, lighter colored fossil fragments. The fossil inclusions remain lighter even in the darker chert specimens from Pottawattamie

County. Fusulinids are occasionally observed, and nearly complete brachiopod fossils are often encountered. The presence of Argentine chert archaeologically in southwestern Iowa is well documented (Morrow 1994).

The effects of heat treatment on Argentine chert are inconsistent. While Madison County samples overall change little, fossil inclusions on the Pottawattamie variant of Argentine chert become a very pale brown (10YR 8/2-8/3) to pale red (5R 8/4).

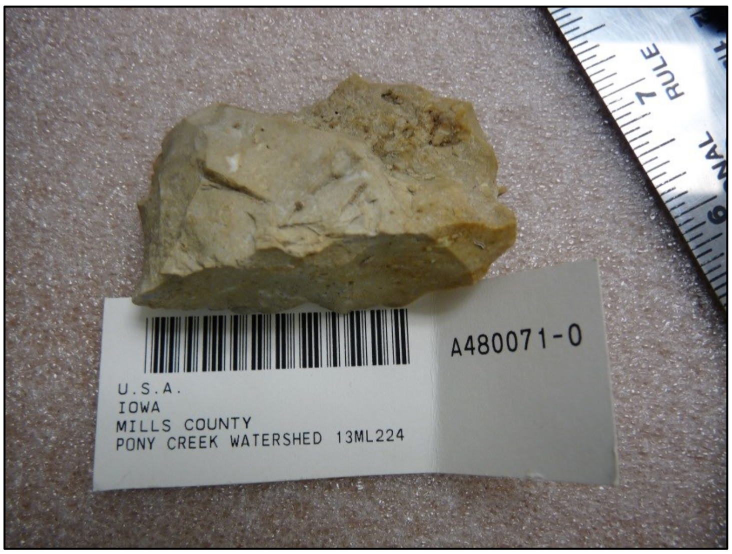

Figure 8. Argentine chert core (lighter variant).

Precambrian (Proterozoic)

Sioux quartzite: Sioux quartzite is hard, reddish metamorphic rock formed in a shallow marine or braided river alluvial environment (Southwick 1985) (Figure 9). In a primary context, it is found in bedrock overlain by Pleistocene aged glacial till and Cretaceous rocks. Bedrock outcrops occur in far northwestern Iowa, southeastern South Dakota and southwestern Minnesota (Emmens and Grout 1943; Southwick 1985). It is known to overlay red catlinite, such as that from Pipestone National Monument used in the production of ceremonial pipes (Emmens and Grout 1943). Sioux quartzite formations were affected numerous times by glacial activity, and till cobbles of the material occur as far south as Kansas (Lyle 2009). The durability of Sioux Quartzite made it useful for tools such as choppers or axes, and at least some tool manufacture with this material occurred at Lungren.

Figure 9. Sioux quartzite artifact.

Other Raw Materials

In addition to the materials described above, many artifacts at Lungren could not be identified down to a specific geologic formation. These included, but are not limited to:

1. A chalky, cream-white Pennsylvanian chert that was heavily weathered from exposure (Figure 10).
2. A brown Pennsylvanian chert with occasional inclusions of black shale, also heavily weathered.
3. A largely fossil free, light gray chert with some chalcedonic inclusions and a light yellow cortex (Figure 11). It is likely a type of Pennsylvanian chert that simply is

lacking in distinguishable features (i.e., fossils, color, inclusions) for more precise identification.

4. A yellow quartzite, likely derived from glacial till.
5. A white quartzite streaked with yellow and orange, likely derived from glacial till.
6. A cream colored chert with yellow and light red mottling and some chalcedonic inclusions. This is likely derived from glacial till.
7. A pink-orange chalcedony, likely derived from glacial till.

Figure 10. Core comprised of weathered, chalky Pennsylvanian material.

Figure 11. Biface comprised of unknown Pennsylvanian material.

Results

A total of 622 artifacts were assessed as part of this assemblage, comprising 521 pieces of debitage and 101 chipped stone tools and cores (Table 2). These are different counts of artifacts than provided by Brown (1967), though Brown’s numbers provided for debitage and cores were approximate. This is due to a combination of factors, from rounding by Brown in his categories, to differences in classification between Brown and this study, as well as loss or misplacement of items in curation. A more thorough inventory of artifacts from Lungren can be found in Appendix B.

Table 2. Raw materials of chipped stone tools and debitage, including count and weight.

Raw Material	Tools	Debitage	Total Artifacts	Wt. (g)
Spring Branch	33	184	218	1887.5
Chalky Penn.	5	41	46	927.5
Argentine	11	40	51	670.9
Curzon	22	67	89	657.3
Unidentified Penn.	13	78	90	396.7
Brown Penn.	3	12	15	153.6
Yellow/White Quartzite	1	1	2	448.7
Sioux Quartzite	1	4	5	207.9
Yellow Quartzite	1	15	16	128.0
Glacial Till	7	38	45	327.2
Other	0	2	2	195
Unknown	4	39	43	345
Total	101	521	622	6386.6

The vast majority of raw materials present at Lungren are local or glacial in origin. Pennsylvanian sub-period raw materials comprise the vast majority of both weight and artifact count at Lungren. Spring Branch chert, the raw material known to be closest to Lungren, is the most commonly represented raw material, with 1,887.5 grams present. The next most common known chert groups are Argentine and Curzon cherts, at 670.9 and 657.3 grams, respectively.

Several unidentified kinds of Pennsylvanian materials—identified from inclusions but highly weathered or chalky—are present at Lungren. This includes a white, largely chalky chert that at 927.5 grams is the second most common material by weight at Lungren thanks to the presence of a core and two large bifaces. This material exhibits a higher proportion of limestone to silica, which likely results in its coarser structure. It is unknown why the inhabitants at Lungren would have used this material, as Mills County is rich in cherts that are considerably better suited for knapping. This white chert may represent Bethany Falls chert, which is often at the top of the lower Missourian series, and is often exposed in weathered condition (Mark Anderson, personal communication 2017). Tools and debitage comprised of a brown

Pennsylvanian chert with shale inclusions was also present at Lungren. Though not common (only 153.6 grams), it nonetheless was seen useful enough for some tool manufacture. It is possible this may be related to the limestone-heavy white Pennsylvanian chert due to some similarities in inclusions. A light grey, medium-to-fine grained chert, largely indistinct save for some bryozoan inclusions, of likely Pennsylvanian origin, is also represented, at 396.7 grams. This material is higher quality than the chalky white or brown Pennsylvanian cherts, being less weathered or limestone heavy and with a medium grain similar to the identified Pennsylvanian cherts in this study. Unfortunately, it lacks particular diagnostic features (color, inclusions, fossils) that would make a more precise identification possible.

A number of non-chert raw materials were also present at Lungren. These were likely sourced from nearby Pony Creek or another local drainage. These include several types of quartzite, including Sioux quartzite and a couple varieties of yellow and white-yellow quartzite. A piece of pink chalcedony (sorted into the 'Other' classification), and a calcareous river cobble worked into a tool (described in the next chapter) were also present, as well as a slate-like flake that likely was removed from this cobble.

Unknown raw materials—too carbonized to identify, lacking a sample in the comparative collection to cross-check, or otherwise not matching other groups—represent 345 grams, or 5% of the weight of all artifacts at Lungren. When the non-provenienced Pennsylvanian raw materials are included, the percent of unidentified materials at Lungren increases to approximately 24% of the total assemblage by weight. This is a small amount of the overall assemblage, and indicates most raw materials for artifacts could be identified.

Exotic materials—lithic material deliberately brought in by human effort from a faraway source—were not identified in the Lungren assemblage. This is consistent with Kay's (1998) hypothesis that inhabitants of Logan Creek sites utilized local raw materials rather than exotic ones. This also compares well with Nycz's (2013) thesis work suggesting local use of either glacial till (at Simonsen) or local Pennsylvanian bedrock chert (in the case of Hill) were the preferred raw material sourcing strategies.

Chapter 5: Debitage Analysis

A total of 521 pieces of debitage were assessed as part of the Lungren assemblage (Figure 12). Of this number, 445 were flakes, either broken or complete, with distinguishing features (flake scars or cortex, bulb of percussion, striking platform, and/or distinguishable ventral side). The remaining 76 were shatter—byproducts of lithic reduction with no discernable platform or clear ventral and dorsal sides. Of these flakes, 288 flakes, or 64.7% of all flakes were complete, with a proximal, medial, and distal end.

As in the bulk raw material analysis, locally available Pennsylvanian cherts were the most well represented raw materials in debitage (Table 3). The most common of these was Spring Branch chert, representing over 35 percent of all debitage by artifact count, and over 41 percent by weight. Debitage comprised of glacial till chert was also represented at about eleven percent of the total sample. This included materials of non-Pennsylvanian origin such as oolitic chert, as well as several varieties of chalcedony and quartzite. This was followed by Curzon chert (12%), Argentine chert (both grey and dark grey varieties) and the white, chalky Pennsylvanian material at approximately seven percent each.

Flakes were classified as either decortification or reduction flakes based upon the presence of cortex along the dorsal side (Table 4). Of these, 92 flakes, or 20.3% of all flakes, were classified as decortification flakes. Due to a lack of controlled screening during excavation, the remaining reduction flakes tend to be large. These would likely result as a byproduct of lithic reduction after decortification, but before later stages where flakes diagnostic of production trajectory (i.e., biface thinning) would be produced and easily identified.

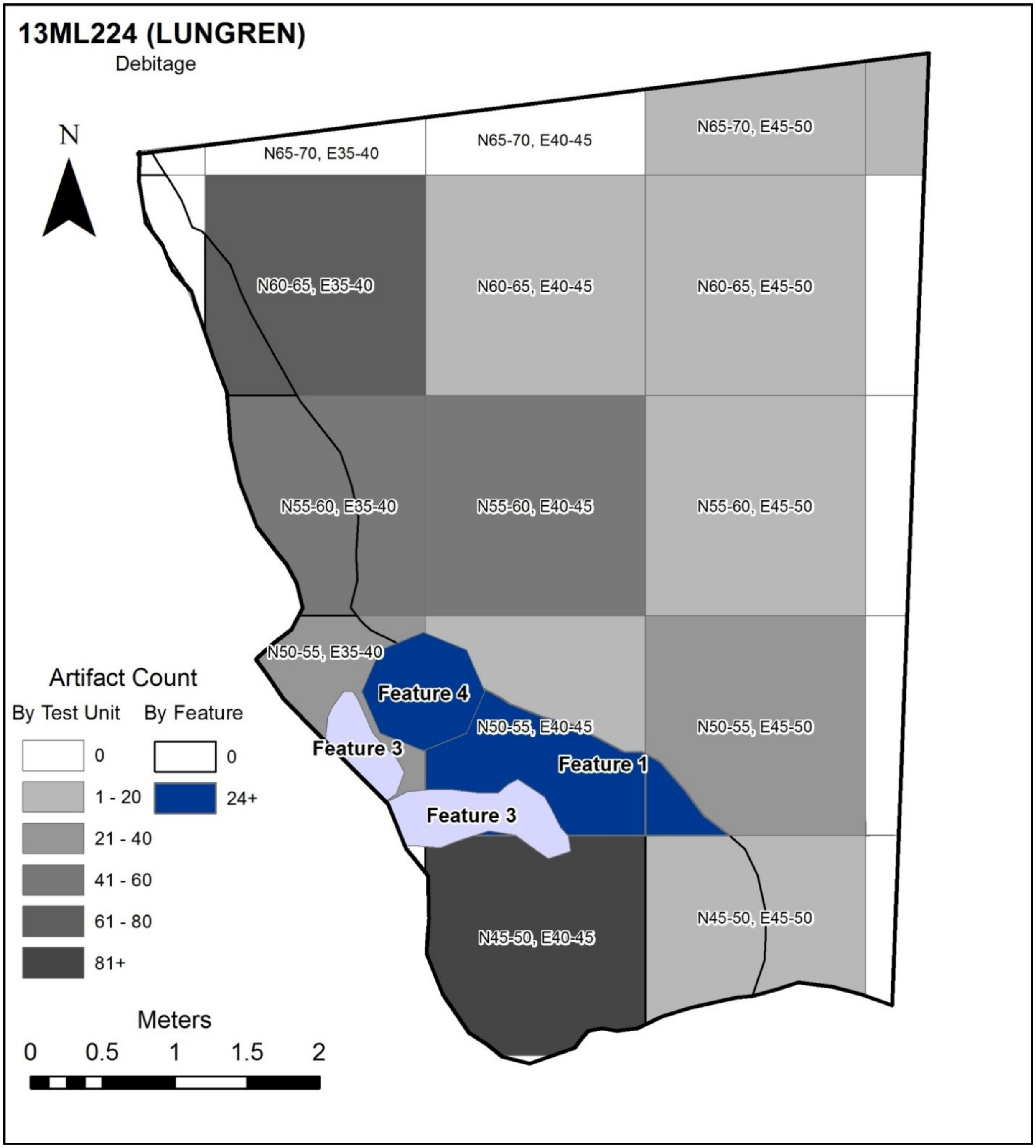

Figure 12. Map of 13ML224 (Lungren) with debitage density by test unit and feature.

Table 3. General debitage attributes.

Raw Material	Total	Flakes	Shatter	Weight	Cortex	Heat Treated	Complete
Spring Branch	184	161	23	1011.1	16.30%	13	69.44%
Chalky Pennsylvanian	41	23	13	281.8	9.76%	1	73.91%
Curzon	67	62	5	248.3	19.40%	3	61.29%
Argentine	40	31	11	237.6	32.50%	1	93.55%
Unidentified Penn.	78	73	5	203.4	15.79%	1	79.41%
Brown Pennsylvanian	12	10	2	55.3	58.33%	0	60.00%
Yellow Quartzite	15	14	1	67.8	20.00%	0	66.67%
Sioux Quartzite	4	4	0	57.9	25.00%	0	50.00%
Yellow-White Quartzite	1	1	0	2.3	0.00%	1	0.00%
Glacial Till (Brown)	8	8	0	121.5	71.43%	0	87.70%
Glacial Till (Oolitic)	2	2	0	11	0.00%	0	100.00%
Glacial Till (Other)	28	23	5	19.5	14.29%	2	69.57%
Pink Chalcedony	1	1	0	1.7	100.00%	0	100.00%
Unknown	39	32	7	127.8	27.50%	4	37.50%
Total	521	445	76	2447.2		26	

Table 4. Flake type by raw material.

Raw Material	Decortification	Reduction	Bifacial
Spring Branch	24	138	4
Curzon	9	47	3
Argentine	13	20	2
Chalky Pennsylvanian	1	22	0
Brown Pennsylvanian	1	10	0
Unidentified Pennsylvanian	18	51	4
Yellow Quartzite	2	12	0
Sioux Quartzite	0	4	0
Yellow-White Quartzite	0	1	0
Glacial Till (Other)	4	20	0
Glacial Till (Brown)	5	3	0
Glacial Till (Oolitic)	0	2	0
Pink Chalcedony	1	0	0
Unknown	15	16	0

Primary lithic reduction (the reduction of cobbles or nodules) seemed to occur on site, rather than with the transportation of blanks from off-site. Flakes with cortex ranged from roughly 10% for the weathered Pennsylvanian materials, to over 28% with flakes derived from glacial till. Flakes made from brown, weathered Pennsylvanian chert were over half cortex (7 flakes from 12 total pieces). The small overall population of this material suggests some attempt had been made to produce tools from this material before abandonment, or that these may have been either from test cobbles or some kind of 'practice' pieces for novice flintknapping. Flakes derived from Spring Branch chert, the most frequent raw material by artifact count and weight, had cortex on approximately 16% of artifacts.

Heat treatment was difficult to detect on Pennsylvanian materials. Often, raw materials from this bedrock source do not appreciably change in luster or color when thermally altered (Morrow 1994). Spring Branch chert, being the largest represented raw material, had 13 heat treated pieces of debitage (7%). Other raw material types ranged from zero to four percent heat treatment of flakes. As a consequence of the lack of response to thermal alteration, there is a strong possibility these numbers underrepresent the use of heat treatment by those at Lungren. On the other hand, with what little heat treatment is present, it cannot be ruled out that thermally altered debitage may be a result of incidental exposure to hearth features or possible post-depositional processes rather than deliberate attempts at heat-treating an artifact.

The average length of flakes recovered from Lungren was 29.62 millimeters (Table 5), with a standard deviation of 12.38 mm, suggesting a fair amount of variation relative to the mean. Within raw material types, this number was more varied, especially as certain categories only consisted of a few flakes. However, the larger groups—Argentine, Curzon, Spring Branch, and unidentified grey Pennsylvanian—average within 4-5 millimeters of this mean. This suggests a fairly tight grouping of size within majorly utilized cherts.

Of the 327 flakes with identifiable platforms, the majority (172, or 52%) were simple platforms, lacking either cortex or multiple facets (Table 6). These flakes would have been removed after decortification activities, when easily struck right angles were present on the core.

Table 5. Flake length attributes of specimens recovered from Lungren.

Raw Material	**Avg. Length (mm)**	**Range**
Spring Branch	33.52	8.71-72.99
Argentine	32.16	16.42-57.89
Curzon	28.55	11.19-56.44
Chalky Pennsylvanian	33.61	16.3-65.96
Brown Pennsylvanian	26.13	20.66-32.39
Unidentified Penn.	24.88	12.48-58.09
Yellow Quartzite	32.14	12.45-75.44
Sioux Quartzite	25.15	21.18-27.21
Glacial Till (Oolitic)	39.55	21.25-57.85
Glacial Till (Brown)	28.24	14.35-54.53
Glacial Till (Other)	25.619	12.11-46.62
Unknown	28.20	10.57-56.61
Average (overall):	29.62	
Std. Deviation	12.38	

Table 6. Flake platforms by raw material type.

Raw Material	Cortex	Simple	Complex	Ground/Abraded	Crushed
Spring Branch	21	66	20	2	7
Curzon	8	16	9	3	2
Argentine	9	11	7	3	3
Unidentified Pennsylvanian	13	36	4	0	1
Chalky Pennsylvanian	1	13	4	0	1
Brown Pennsylvanian	0	7	2	0	0
Glacial Till (Brown)	5	0	2	0	0
Glacial Till (Oolitic)	1	0	1	0	0
Glacial Till (Other)	3	7	5	0	0
Yellow Quartzite	6	3	0	0	0
Yellow-White Quartzite	1	0	0	0	0
Sioux Quartzite	3	1	0	0	0
Pink Chalcedony	1	0	0	0	0
Unknown	6	12	0	0	1
Total	78	172	54	8	15

This would suggest these flakes were reduced earlier in the lithic reduction process. Of the remaining number, 78, or 23% of flakes had cortex present on striking surfaces, suggesting that nearly a quarter of all flakes were removed during decortification.

Of the remaining flakes with platforms, 54 flakes have complex platforms, with two or more facets. These are more common in middle or late stage reduction, especially in biface manufacture where these old facets may represent old surfaces of the tool edge. However, it is likely that this later stage debris is highly underrepresented, as much of this debitage created from reduction activities may be of a smaller size as the objective piece (the biface or core) gets smaller from continued reduction. This is likely considering the average size of flakes being 2.9 centimeters, as these later stage reduction flakes may be well under this size and likely not collected during excavation.

Of these later stage flakes, 13 of them were identified as bifacial thinning flakes (Table 4). These flakes were curved in profile with traces of previous removals on the dorsal side and ‘lipping’ on the platform representative of the opposing biface edge (Andrefsky 2005). Unidentified Pennsylvanian chert and Spring Branch chert were the most represented with four flakes each. Argentine and Curzon chert (2-3 count) also had small numbers of these flakes. Each of these raw materials also has a biface represented within their category (see Chapter 5). This type of debitage is important as technological markers of biface maintenance or production on-site, rather than elsewhere.

Chapter 6: Chipped Stone Tool Analysis

Utilized Flakes

Utilized flakes—cutting tools utilizing unmodified flake edges that maintained their original flake morphology before discard—were present at Lungren. There were 26 utilized flakes identified from debitage collected from Lungren (Table 7). This count is different than Brown (1967), and includes a number of utilized flakes previously classified as debitage. A small number of tools (described later) also had minor use-wear along an edge. These flakes averaged about 46.01 mm in length with a standard deviation of 15.17 mm, suggesting moderate variation in size. These flakes are generally larger than the average size of non-tool flakes described earlier (29.62 mm).

Wear on the edge of utilized flakes was almost always scalar or feather in nature. This suggests that utilized flakes at Lungren were generally only used on 'soft' items, e.g., flesh (Tringham et al. 1974). This wear was most often exhibited along only one edge of the flake, with only three examples of utilized flakes having wear on two edges. Utilized flakes were composed most frequently of Spring Branch chert (13 artifacts), with a mix of Curzon, unknown Pennsylvanian, and glacial till. Utilized flakes comprised of Argentine chert were not observed, though unifacial tools comprised of Argentine chert that may have started life as utilized flakes, such as scrapers, are present (described later).

Table 7. Attributes of utilized flakes recovered from Lungren.

Raw Material	Edge-Wear (mm)	Wear Type	Length (mm)	Width (mm)	Thickness (mm)	Weight (g)
Spring Branch	35.65	Striations/Polish	43.86	31.19	8.65	9.9
Spring Branch	18.44	Scalar/feather	36.36	29.08	6.97	5.6
Spring Branch	41	Scalar/feather	64.11	44.23	24.9	51.7
Spring Branch	16.81	Polished	38.04	17.22	5.53	3
Spring Branch	37.55	Scalar/Feather	61.92	65.36	16.53	21
Spring Branch	14.45	Scalar/Feather	39.96	24.41	3.84	4.2
Spring Branch	19.77	Scalar/Feather	45.77	30.18	11.95	12.4
Spring Branch	30.78	Scalar/Feather	63.87	23.4	6.13	12.5
Curzon	21.25	Scalar/feather	38.03	24.77	4.9	4.4
Curzon	12.96 12.8 (notch)	Scalar/Feather	40	20.17	3.86	3.8
Curzon	12.33	Scalar/Feather	34.24	30.72	2.72	3.8
Curzon	38.86	Scalar/Feather	35.15	41.86	12.21	14.9
Curzon	12.07	Scalar/Feather	36.84	24.46	7.28	4.6
Brown Pennsylvanian	38.3, 34.37	Scalar/feather	51.56	41.17	9.26	20.4
Unknown Pennsylvanian	4.72	Scalar/feather	41.43	23.17	4.47	3.9
Unknown Pennsylvanian	8.22 (tip), 44.66 (left)	Scalar/Feather	57.69	28.16	13.7	17.5
Unknown Pennsylvanian	15.34	Scalar/Feather	33.03	30.13	4.19	4.8
Unknown Pennsylvanian	13.89	Scalar/Feather	27.43	24.25	7.97	3.7
Unknown Pennsylvanian	16.09	Scalar/feather	46.08	26.04	16.28	12.1
Unknown Pennsylvanian	16.27, 27.29	Scalar/Feather	29.6	24.3	4.66	3.5
Unknown Pennsylvanian	30.64	Scalar/feather	103.05	94.57	64.95	50.9
Glacial Till	37.79 (side), 29.979 (prox)	Scalar/Feather	40.8	31.02	8.66	10.55
Glacial Till	17.60	Scalar/Feather	36.25	33.28	11.07	8
Glacial Till	22.71		33.63	5.87	5.84	5.2
Spring Branch	35.65	Striations/Polish	43.86	31.19	8.65	9.9
Spring Branch	18.44	Scalar/feather	36.36	29.08	6.97	5.6
Spring Branch	41	Scalar/feather	64.11	44.23	24.9	51.7
Spring Branch	16.81	Polished	38.04	17.22	5.53	3
Spring Branch	37.55	Scalar/Feather	61.92	65.36	16.53	21
Spring Branch	14.45	Scalar/Feather	39.96	24.41	3.84	4.2
Spring Branch	19.77	Scalar/Feather	45.77	30.18	11.95	12.4
Spring Branch	30.78	Scalar/Feather	63.87	23.4	6.13	12.5
Avg. Length (mm)			46.01			
Std. Deviation			15.17			

Gravers

Within the chipped stone assemblage, gravers were identified on 18 artifacts (Table 8). These are unifacial tools with a spur or protrusion along a margin or end, often created or enhanced with a small flake removal along the base (Odell 2004). Many of these graver protrusions are curved, with the spur often rounded or broken from use (Figure 13). This artifact class was not described by Brown (1967) for Lungren.

Table 8. Attributes of gravers recovered from Lungren.

Smithsonian Collection ID	Raw Material	Use-Wear (mm)	Wear Type	Length (mm)	Width (mm)	Thickness (mm)	Wt (g)
A480108	Spring Branch	No		37.19	17.21	12.17	5.6
A480118	Spring Branch	8.64	Scalar/Feather	43.57	26.04	5.91	5.7
A480123	Spring Branch	No		40.87	18.85	7.32	4.5
A180090	Spring Branch	10 (graver spur)	Rounding	29.97	13.34	3.91	
A380141	Spring Branch	7,55 (tip), 15.39 (edge)	Scalar/Feather	39.65	29.7	6.22	5.7
A480105	Spring Branch	5.99 (spur), 10.81 (edge)	Scalar/Feather	40.44	24.73	3.74	3.9
A480099	Unknown	28	Unknown	43.03	28.97	11.67	47.6
A480105	Curzon	7.01	Step	37.47	30.25	13.42	10.9
A480105	Curzon	No		31.71	24.13	6.85	4.8
A480118	Curzon	No		39.71	25.67	14.02	12.4
A480118	Curzon	No		38.54	23.86	6.85	5.3
A480105	Curzon	7.68	Scalar/Feather	32.72	21.06	7.3	3.9
A480105	Curzon	26.67	Scalar/Feather	43.76	45.13	12.43	13.4
A480092	Argentine	39	Step	52.81	32.26	11.33	15
A480074	Unknown Pennsylvanian	14.65	Scalar/feather	66.2	52.63	19.62	50.8
A480099	Unknown	28	Unknown	43.03	28.97	11.67	47.6

Gravers were most commonly manufactured from Curzon chert (5 artifacts), with small (1-2 count) numbers comprised of Spring Branch and other materials. Graver spurs tend to be small, ranging from roughly 4-13 mm in length. Three of these graver tools had evidence of scalar/feather use-wear along one or more edges of the flake, and likely represent additional use as a cutting tool. It should be noted that not all sharp, broken projections on flakes are gravers. Sometimes such spurs, especially on proximal flake ends, may be a result of a flake striking the ground during knapping activities (Barton et al. 1996). Kinetic energy rebounding through the flake as it detaches may also sometimes may also create a spur-like protrusion (Mark Anderson, personal communication 2017). Only gravers with evidence of utilized spurs or deliberate flaking to enhance a spur are included in the above list.

Gravers are not well documented in other Logan Creek sites, likely due to unfamiliarity by researchers authoring earlier reports. Assemblages at Hill and Simonsen do not describe gravers (Frankforter 1958, Frankforter and Agogino 1960). Two examples were recovered from Spring Creek however, fashioned in a similar fashion to those at Lungren by deliberate shaping of a flake end into a projected tip (Grange 1980:198). At least one graver, similar in form to some of those at Lungren, was described and illustrated at Cherokee Sewer (Anderson 1980:209), described as a utilized flake. Shay (1971) describes several examples of gravers at Itasca. It is likely that these are better represented in other Logan Creek sites than previously known.

Figure 13. Gravers recovered from 13ML224. (Photograph courtesy of the Smithsonian).

Scrapers

A total of 15 scrapers were analyzed in this study, defined as unifacial flake tools with wear and reshaping along typically the distal end of a flake (Figure 14). Six of these scrapers were comprised of Spring Branch chert, five were made from Curzon chert, and the remainder a mix of other Pennsylvanian cherts and unidentified materials (Table 9).

Scrapers tended to be fairly restricted in dimensions. On average, end scrapers were 38.38 mm long, 26.9 mm wide, and 11.23 mm thick. This is comparable with scrapers found at Horizon I of Cherokee Sewer, with an average length of 41.55 mm long, 24.55 mm wide, and 9.37 mm thick (Anderson 1980). Overall morphology tends to be fairly restricted as well; 11 of these 15 end scrapers are convergent (tapering occurred towards the distal end) (Morrow 1997). The remaining four scrapers would fit into Morrow’s typology as ovate double sided (working bits on both ends), or irregular in morphology. These morphologies are not intended to imply function and are purely descriptive of shape.

Figure 14. End scraper recovered from 13ML224.

Scrapers had an average angle of approximately 60 degrees on the utilized end. However, distribution of scraper angle was extremely bimodal. Of identified scrapers, seven had angles between 30 and 45 degrees, with an average of 35 degrees. The remaining eight scrapers had working bit angles between 65 and 85 degree angles, with an average of approximately 76 degrees. This bimodal trend is similar to Wilmsen's (1968) distribution of edge angles for Paleoindian artifacts, which had some bimodal peaks. The Lungren sample trend towards steeper working bit angles than in Wilmsen's study.

Table 9. Attributes of scrapers recovered from Lungren. Use-length listed for scraper working bit unless specified otherwise.

Smith-sonian Catalog ID	Raw Material	Comp-lete	Use-Wear (mm)	Wear Type	Length (mm)	Width (mm)	Length (mm)	Wt (g)	IR
A480081	Spring Branch	Yes	21.18	Scalar/Feather, Step	41.34	32.17	14.92	22.5	0.42
A480097	Spring Branch	No	22.30	Step		22.04	9.3	6.5	0.82
A480105	Spring Branch	Yes	14.06	Step	34.04	14.06	5.8	2.8	0.57
A480109	Spring Branch	Yes	24.88 mm	Step	44.7	24.88	11.48	13.7	0.92
A480115	Spring Branch	No	24.13 (base), 26.12 (left-distal)	Step	45.94	34.53	15.62	24.8	0.93
A480124	Spring Branch	Yes	26.69	Step	53.53	42.7	27.03	12.7	0.74
A480138	Spring Branch	No	21.97	Scalar/Feather	29.16	22.97	5.4	4.2	0.55
A480085	Curzon	No	25.14	Step	30.29	26.96	10.8	9.8	0.78
A480105	Curzon	Prox/ Med	No	-	35.16	18.02	13	7.8	-
A480105	Curzon	Yes	11.52	Deep Scalar/Feather	56.64	28.9	16.19	20	0.64
A480122	Curzon	Yes	24.47, (distal) 26.45 (lateral)	Scalar/feather	34.06	24.73	6.25	5.3	.65
A480072	Argentine	Yes	24.98	Scalar/Feather	45.91	26.25	9.23	10.2	0.5
A480112	Argentine	Yes	25.35	Scalar/feather	28.25	25.29	5.51	5.3	0.76
A480109	Chalky Penn.	Yes	25.41	Scalar/Feather	37.59	29.85	10.29	9.3	0.09
A480109	Unknown	Distal	31.06	Scalar/Feather	20.51	31.06	7.68	13.1	0.2

Scrapers from Lungren were measured for index of reduction (IR), using a formula devised by Kuhn (1990) that indirectly measures volume loss of the scraper in relation to the original flake. This was performed on scrapers that were either complete, or enough of the proximal end remained that the utilized edge could be compared to the maximum thickest portion of the tool (14 of 15 total scrapers). The scrapers in the population ranged from having relatively little change (.20 or lower) to almost completely depleted (.90 or higher). Five scrapers had an IR of .75 or higher, suggesting moderate to heavy use. Only two scrapers had .2 or less, suggesting they were relatively 'fresh' as tools before discard. The average IR was .603, with a standard deviation of .24. This would suggest scrapers generally saw at least moderate use before discard, though inhabitants at Lungren were not averse to working a scraper to near-depletion.

Wear on eight of these scrapers was scalar/feather in nature, suggesting use on relatively soft materials, such as potentially hide. On the other hand, wear on the remaining seven consisted largely of step fracturing. Based on Odell's (1980) work involving use-wear, this is more suggestive of use on harder surfaces, such as dry hide or perhaps bone. Although scrapers are often assumed to be used for hides, at least a few studies have illustrated that these tools may be more multi-purpose than the name or morphology may suggest (Andrefsky 2005). The wear type on the scraper seemed independent of the edge angle of the scraper; scrapers with shallow and steep angles like could exhibit either type of wear. Wear present on the flake was generally on the flake's distal end, though sometimes occurred along the longitudinal (side) margin or along the proximal end, or a combination thereof.

The majority of scrapers were comprised of Spring Branch chert (7 count). The remaining scrapers were fashioned mostly from various Pennsylvanian cherts, including Curzon chert (4 count), as well as one of unknown raw material

Other Unifacial Tools

This category includes a variety of unifacial tools typically derived from flakes that do not fit into the category of an end scraper or graver, but exhibit edge modification and alteration to flake morphology distinct from utilized flakes (Figure 15). Many of these would fall into the category of ‘side scrapers’ as described by Brown (1967). That term is avoided in this study as many side scrapers identified by tool morphology may in fact have functioned as cutting tools (Andrefsky 2005).

Table 10. Unifacial tools (other) recovered from Lungren.

Smithsonian Catalog ID	**Identified As**	**Edge-Wear (mm)**	**Wear Type**	**Length (mm)**	**Width (mm)**	**Thickness (mm)**	**Wt (g)**
A480077	Spring Branch	11.51	Scalar/Feather	39.46	29.72	12.05	14
A480076	Spring Branch	48.29 (distal), 14.43 (lateral)	Scalar/Feather	51.87	43.8	14.2	39.9
A480115	Spring Branch	25.03	Scalar/feather	48	34	17	24.6
A480116	Spring Branch	8.37	Scalar/feather	64.96	48.82	16.42	35.3
A480069	Spring Branch	37.07	Scalar/feather	48.16	46.14	9.51	162
A480137	Argentine	12.71	Scalar/Feather	44.46	52.92	29.86	21.1
A480069	Argentine (black)	22.2 (distal), 33.02 (lateral)	Scalar/feather	50.33	31.92	6.86	9.5
	Avg, Length			51.81			
	Std. Deviation			8.38			

Unifacial tools were somewhat larger in size than unmodified debitage or utilized flakes (Table 10). These tools averaged 51.81 mm, with a standard deviation of 8.38 mm. This is compared to 46.01 mm average for utilized flakes. All of these unifacial tools exhibited scalar/feather modification along edges. Spring Branch chert encompassed the majority of these tools (5 count), with the remainder being comprised of Argentine chert.

Figure 15. Unifacial tool recovered from 13ML224.

Large Unifacial Butchery Tools

Several artifacts were recovered from Lungren that are unifacial, but do not cleanly fit into a category of uniface derived from a flake, or a simple core. These tools tend to be larger than most unifaces or even many bifaces, and were likely used for heavier processing activities related to butchering, such as bone splitting or rendering joints.

Included in this category are three ‘choppers’ as defined by Brown (1967), consisting of artifacts produced from quartzite or other non-chert, sedimentary or metamorphic rock (Table 11). These ranged in size from 55 mm long, to 121 mm for the longest specimen. All three choppers are unifacial and roughly ovoid in shape, exhibiting flaking along an interior side. Similar choppers were described by Anderson (1980), recovered from Cherokee Sewer.

Two of these choppers from Lungren, one made from yellow quartzite (A480120), and the other a non-chert calcareous rock (A480082), retained a rounded cortex on one side, with flakes removed only from the interior (Figure 16). The largest chopper, made of a white-yellow quartzite (A480095), had flake removals only from the dorsal (cortical) side along a margin, with the ventral (interior) surface unmodified. This piece also exhibited severe step fracturing along a large portion of the margin visible to the naked eye, suggesting heavy use for battering or smashing.

Figure 16. Large non-chert unifacial tool (chopper) recovered from 13ML224.

In addition to these quartzite choppers, two large unifacial tools comprised of chert were also noted (A480140 and A480068). These were fashioned from flake blanks, but are distinguished from other cores by the extensive evidence of utilization along their margins as well as edge modifications. One of these artifacts is roughly spatulate or 'tear-dropped' in outline, with the flake platform still present.

Table 11. List of large unifacial butchery tools recovered from Lungren.

Smithsonian Catalog ID	Tool Type	Raw Material	Edge-Wear	Wear Type	Length (mm)	Width (mm)	Thickness (mm)	Weight (g)
A480083	Chopper	Chalky Pennsylvanian	26.6 mm	Step	96.3	78.77	41.19	227.7
A480082	Chopper	Unknown Calcaneus	No		92.82	67.19	27.9	193.3
A480095	Chopper	Yellow-White Quartzite	90.06 mm	Step	121.9	90.06	36.94	446.4
A480120	Chopper	Yellow Quartzite	No	Step	55.5	48.4	17.72	60.2
A480138	Denticulate Chopper	Spring Branch	30.69 mm	Step	81.69	49.08	27.79	80.8
A480130	Flake Blank Chopper	Argentine	49.64 mm	Step	63	52.32	15.26	58.4
A480068	Unifacial Core/Scraper	Unknown Pennsylvanian	13.48	Scalar/feather	63.63	35.76	22.42	47

This tool has a series of 5-8 mm flake removals along one utilized edge near the point, forming a denticulate or serrated working edge (Figure 17). The other is a sub-rectangular artifact of Argentine chert, fashioned from a flake blank with several large step fractures along the dorsal face. The presence of step-fracture edge damage on both artifacts suggests use on hard material such as bone (Tringham et al. 1974). For butchery, heavier tools would be preferable for to simple flakes for these more strenuous tasks post-hide removal, as they would be easier to hold and be more durable for these activities (Frison 1979). Such activities likely include separating joints (Muñiz 2013) or bone splitting (Mark Anderson, personal communication 2017).

Several artifacts from Hill described by Frankforter (1958) as ‘scraper knives’ also fit the rough description of these chert butchery tools. These were fit into a broad category of unifacially or bifacially worked knives fashioned from large flakes, often with large removals along one or more edges. Several illustrated examples exhibit a wide-pattern denticulation similar to one of the Lungren denticulate choppers (Frankforter 1958). In contrast, these types of butchery tools were not reported at Simonsen. It is likely that Hill and Lungren's mutual purposes as residential campsites with potentially similar activities would result in this overlap of tool types.

Figure 17. Unifacial denticulate tool recovered from 13ML224.

One unique piece in this category relative to the others is an ovoid piece of chert that seems to be a scraper or unifacial core (A480068) (Figure 18). A series of percussion flake removals have occurred along the margin of the dorsal (cortical) side, though cortex remains on the center of the face. The ventral side is flat, save several small natural breaks obscured by calcium carbonate. One end shows scalar/feather use-wear along a worked edge, suggesting use on something soft such as hide or flesh. This item resembles descriptions of a humpback scraper based upon morphology (Mark Muñiz, personal communication 2018).

Figure 18. Unifacial core ('humpback scraper') recovered from 13ML224.

Cores

There were 19 non-bifacial cores identified during the study of artifacts from Lungren, defined here as an objective mass of lithic raw material with flakes removed from one or more surfaces (Table 12) (Andrefsky 2005). Cores for this study were generally large, amorphous pieces of chert with flake removals that would not be otherwise classified as bifaces (which can also function as cores) or other items such as adzes. Cores may also take the form of flake blanks—large flakes with one or more deliberate flake removals after detachment from the original core—or tested glacial till/river cobbles as well.

Of these cores, 18 are multidirectional cores, defined as cores with flake removals that do not favor a particular direction. This is in contrast to unidirectional cores, which have flake removals largely in one direction, such as a blade core (Andrefsky 2005). Flake removals generally do not follow any particular pattern on multidirectional cores, likely favoring opportunistic platforms after decortification followed by platforms created by prior removals.

These cores are primarily intended as a source of flakes for use as cutting tools, or conversion into unifacial tools (Andrefsky 2005).

Table 12. Attributes of non-bifacial cores recovered from Lungren.

Smith-sonian Collection ID	Raw Material	Flake Scar Count	Flake Scar Size (mm)	Length (mm)	Width (mm)	Thick-ness (mm)	Wt (g)	Core Type
A480105	Spring Branch	13	10-40	39.31	37.94	28.07	15.4	Multidirectional
A480092	Spring Branch	11	15-30	44.88	35.82	18.03	32.2	Multidirectional
A480099	Spring Branch	7	10-20	44.12	51.92	20.53	47.6	Multi-drectional (Fragment)
A480118	Spring Branch	9	10-15	45.62	28	18.75	26.7	Multidirectional (Fragment)
A480133	Curzon	7	15-30	63.19	65.66	33.54	151.2	Multidirectional
A480118	Curzon	10	5-10	37.36	22.3	22.24	28.2	Multidirectional
A480081 A	Curzon	6	10-20	53.4	41.89	17.63	39.7	Flake Blank
A480103	Curzon	6	10-15	50.81	49.56	49.18	56.3	Multidirectional
A480111	Argen-tine	5	10-20	60.84	30.08	15.71	28.1	Multidirectional
A480129	Argen-tine	15+	10-30	81.11	73.23	47.3	217.5	Multidirectional
A480071-0	Brown Penn.	7	10-30	42.34	37.14	22.76	34.6	Multidirectional
A480099	Brown Penn.	5	10-20	45.13	41.34	32.22	43.3	Multidirectional
A480084	Chalky Penn.	5	9-30	95.85	87.2	31.6	267	Multidirectional
A480113	Chalky Penn.	13	10-30	55.14	42.62	31.22	55.14	Multidirectional
A480069	Unk. Penn.	3	8	46.22	24.62	21.76	23.2	Multidirectional
A4800104	Unk. Penn.	5	10-15	24.27	23.05	13.25	7.2	Multidirectional (Fragment)
A3800141	Glacial Till	5		69.81	50.75	28.09	42.6	Tested Cobble
A480092	Sioux quartzite	11	10-20	75.94	59.33	29.19	150	Multidirectional
A480074	Unknown	9	27-29	69.81	61.11	54.54	155	Multidirectional

One of these cores is classified as a flake blank, representing larger percussion flakes removed from a larger chert nodule and serving as a source of smaller flakes. This is likely several of the unifacial cores described by Brown (1967). Unlike the other two flake blanks (see section on large butchery tools, above), this blank shows no evidence of utilization or modification into a tool. This flake blank may have been detached from cores present at Lungren, though it is also possible they were transported from a quarry site in this form (Odell 2004). This blank shows edge damage along a margin, though it is possible this may represent platform abrading prior to its removal from the core (Andrefsky 2005).

Most of these cores are comprised of Pennsylvanian chert. Spring Branch chert is the most well represented (4 cores). Unidentified Pennsylvanian cherts, comprising several types of different raw material (5 cores) and glacial till chert (4 cores) were the next most common raw materials. Small numbers (1-2 count) of Argentine, Curzon chert, quartzite, and unknown materials were represented. In terms of weight, the chalky, weathered Pennsylvanian materials (322 g) were the most well represented by weight, followed by the single, large Argentine chert core (217.5 g). This Argentine core (A480129), a dark colored variant of the material, shows evidence of thermal alteration along fossil inclusions, although tools comprised of this same material do not consistently show similar alteration (Figure 19). It is possible this core was exposed to a campfire or other feature after removal of flakes. However, the smaller size of tools derived from this core makes identification of heat treatment on these items difficult. That Pennsylvanian chert does not always change color when exposed to heat complicates further interpretation.

Based upon their nature as multidirectional cores, it is likely that these artifacts represent a source for flakes and flake-derived tools (Andrefsky 2005). This may be substantiated by the presence of tools fashioned from flakes at Lungren, such as scrapers or gravers.

Figure 19. Argentine (dark variant) multidirectional core recovered from 13ML224, likely heat treated.

Interestingly for a hunter-gatherer campsite, there are more cores than there are bifaces (21 to 8). This is a ratio of 2.65, which when using a ratio of cores to bifaces as a measure of general sedentism, would suggest a high degree of sedentism rather than mobility (Bamforth and Becker 2000). For comparison, Paleoindian sites in Bamforth and Becker's study are often .25 or lower in core/biface ratio. Being that workable chert is readily available in nearby drainages and bedrock, this quirk may be explained in the role of the site as a retooling station, rather than a general trend towards a more sedentary lifestyle.

In Bamforth and Becker's study, it should be noted that even highly mobile groups had sites that produced relatively high core/biface ratios. Some of their sites also had more debitage than could be accounted for by the cores present, which suggests some cores may have been taken off-site after reduction activities. It should also be remembered that these authors were examining western and southwestern sites in their study. Logan Creek peoples along the eastern peripheries of the Plains may have had different technological organization strategies than

Paleoindian groups that would result in a higher core/biface ratio, or perhaps were more likely to transport bifaces with them upon leaving the site, as opposed to caching. If Bamforth's (1986) hypothesis that curation is a result of raw material shortage is applied, then the plethora of moderate grade raw material in southwestern Iowa and southwestern Nebraska results in a situation where curation may not be as necessary. While it should always be remembered that humans may respond to the environment in multiple ways, heavy utilization and subsequent abandonment of multidirectional cores, rather than suggests an understanding that raw material was plentiful in the local environment.

Bifaces and Projectile Points

There were nine bifaces examined as part of the study, including one side-notched projectile point and one lanceolate point/knife (Table 13 and 14). This category is broadly defined as chert artifacts, either removed from a flake blank from a larger piece of chert or itself originating as a chert nodule, thinned and shaped by flake removal from both sides (Andrefsky 2005). While flaking may not be extensive, at least some retouch on both sides of an edge margin is required for items to fall into this category. Four of these bifaces are comprised of Spring Branch chert. The remaining bifaces are a mix of other Pennsylvanian cherts and other glacial till derived rock.

Four of these bifaces largely fit the description of early stage bifaces, as defined by Muñiz (2014) (Table 13). These tend to be relatively thick (over 31 mm), and are often asymmetrical with edges worked along more than half of the faces. Early stage bifaces may have moderate to heavy remaining cortex, and may exhibit comedial (perpendicular to the artifact's long axis) or transmedial flaking (perpendicular and across the artifact's long axis). Although none of the Lungren bifaces are thicker than 30 mm, these five nonetheless fit the remaining criteria for early stage bifaces. At least one of these (A480070) is broken, with flake removals largely from one face with the other mostly edging around a cortex face.

Table 13. Morphological attributes of bifaces recovered from Lungren.

Smithsonian Collection ID	Raw Material	Type	Morphology	Flaking Pattern	Tool Complete	Edge-Wear
A480070	Spring Branch	Biface (Early)	Trapezoidal	Cortex/edging	Broken	Scalar/Fea-ther
A480067	Spring Branch	Biface (late/preform)	Elliptic	Convergent	Yes	Scalar/Fea-ther
A480075	Spring Branch	Proj. Point (knife)	Lanceolate	Convergent	Yes	No
A480114	Spring Branch	Proj. Point (exhausted)	Side-Notched	Convergent	Yes	No
A480071-0	Argentine	Biface (Mid)	Oblongate	Comedial	Broken	No
A180119	Unknown Pennsylvanian	Biface (late/preform)	Deltoid	Convergent	Yes	No
A480070	Chalky Pennsylvanian	Biface (Early)	Irregular	Convergent	Yes	No
A480065	Glacial Till	Biface (Early)	Oblongate	Comedial/Cort ex	Yes	No
A480139	Glacial Till	Biface (Early)	Elliptic	Comedial	Yes	No

Table 14. Dimensions and weights of bifaces recovered from Lungren.

Smithsonian Collection ID	Length (mm)	Width (mm)	Thickness (mm)	Weight (g)
A480070 (Sp. Branch)	70.67	50.09	20.81	93.6
A480067	76.14	35.08	14.52	41.4
A480075	54.04	31.61	8.44	14.9
A480114	38.56	18.21	7.25	4
A480071-0	44.57	59.66	22.84	58.7
A180119	52.41	44.59	13.27	34.5
A480070 (Chalky Penn.)	80.78	46.54	29.31	86.6
A480065	77	46.3	28.11	43.5
A480139	31.69	42.92	29.36	103.3

Of the remaining three early stage bifaces, one (A480070) was comprised of chalky, weathered Pennsylvanian chert (Figure 20). A large flat platform on one end is still present, and several flake terminations ended in step fractures. Two others (A480065 and A480139) were comprised of glacial till. All three pieces have been worked into oblong or elliptic shapes, though they remain thick in cross section with only larger flake removals along faces. There was no evidence of utilization on any of these pieces.

Figure 20. Early stage biface (A480070) comprised of chalky Pennsylvanian chert recovered from 13ML224.

Three of the remaining bifaces fall into mid or late stage bifaces. A mid-stage biface, as defined by Muñiz (2014), is approximately 21-30 mm thick, with comedial or transmedial flake scars covering faces, edging along more than half of flake margins, and little cortex. In contrast, a late-stage biface is thinner (approximately 11-20 mm thick), with comedial or transmedial flake scars covering faces, edging along more than half of flake margins to standardize edges/platforms, and an absence (or near absence) of cortex.

One of these bifaces, a broken specimen of Argentine chert (A480071-0), was classified as mid stage. It exhibits sharp square corners and remnants of a platform along the proximal end, and represents a biface not far removed from a flake blank. Only one side exhibits minor, random flaking along the face; the other face is largely cortex with some similarly random flaking/shaping along the edges. The rough nature of this biface suggests a relatively brief life before discard.

The last two bifaces match the description for late stage bifaces. One biface (A180119) is comprised of unknown Pennsylvanian material, and deltoid/subtriangular in outline, and largely symmetrical along margins. Somewhat wide step fracturing is consistent along several edges, suggesting some attempt to alter the margins without thinning the biface. No use-wear is observed on the macroscopic level, putting Brown's notion of its use as a knife into question in terms of function in regards to methods used in this study. Assuming there is no microscopic evidence of use such as polish or striations, this biface may represent a preform that would have undergone further reduction into a projectile point.

The other late stage biface (A480067), oblong in outline, had been described by Brown (1967), as a knife (Figure 21). This biface is asymmetrical, with thinning along roughly three-quarters of the object's margins. One long edge is broken beneath the tip, contributing to this tool's irregular shape. Use-wear was evident along both edges near the tip (distal end), suggests Brown categorization of a knife was correct.

Figure 21. Bifacial knife (A480067) recovered from 13ML224, comprised of Spring Branch chert.

A lanceolate biface (A480075) comprised of Spring Branch chert was observed (Figures 22 and 23). It was described by Brown (1967) as a knife. It exhibits a slight arc along its length, indicative of its origin as a moderately sized flake. It was worked along one face in a random flaking pattern, while the opposite side only has moderate retouching along the edge. Most of the ventral side representing the original flake blank remains unmodified It is slightly asymmetrical between left and right sides, and step fractured along the margin below the tip. The base appears to have been ground at some point, perhaps to support hafting.

Several similar bifaces of a lanceolate, largely unifacial nature have been described in other Logan Creek sites, though they have only been described sporadically as unique items in literature. Ahler and Toom (1989) note lanceolate bifaces with ground bases at Medicine Crow that may be Simonsen point preforms, but with no mention of these maintaining a sinuous profile or ventral flake surface. Kivett (1962) only references ‘crudely’ flaked lanceolate blades at Logan Creek, as well as an unnotched triangular projectile point forms with a ground base.

Figure 22. Unifacial lanceolate projectile point/knife (A480075), comprised of Spring Branch chert, recovered from 13ML224.

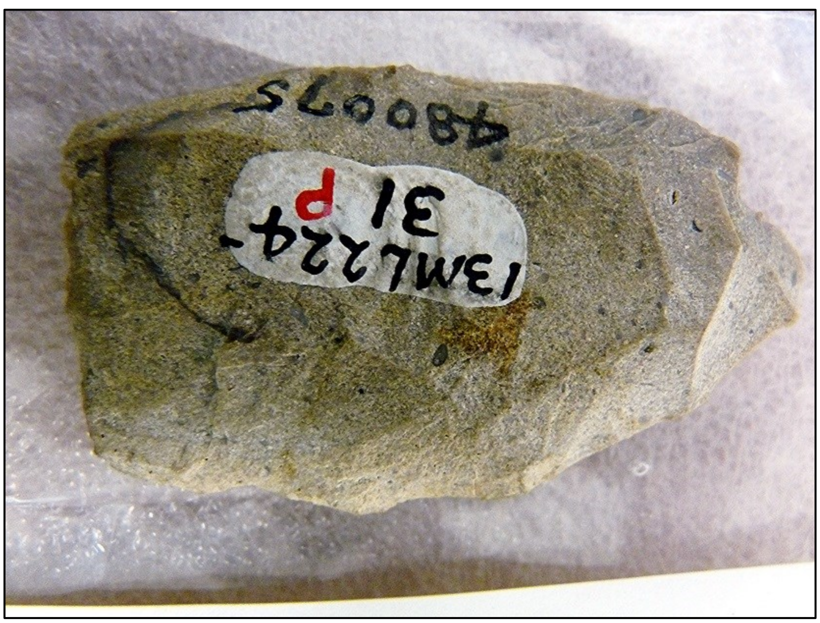

Figure 23. Unifacial lanceolate projectile point/knife (A480075), ventral side.

A biface comprised of fusulinid (Pennsylvanian) chert was recovered from Horizon I at Cherokee Sewer (Anderson 1980:209), smaller than the Lungren specimen but of similar lanceolate shape. Although shaped and thinned on one face by a series of narrow flake removals, the ventral side is slightly curved, with a ventral flake surface only minimally worked along the margins. Similar examples were also recovered at Spring Creek, identified as lanceolate projectile points (Grange 1980:35). In Minnesota, a lanceolate point was described at Itasca (Shay 1971:56). Several projectile points and bifaces from Hill (Frankforter 1958) are also described as having remnants of the original flake ventral surface present.

Although the sample size is relatively small, the occurrence of bifacial lanceolate points, worked largely on one side with preserved ventral surface, curved profile and ground base across multiple sites, suggests the possibility that this may be a deliberate choice by knappers of this area and time period rather than happenstance. This style of point would thus represent a possible diagnostic projectile point/knife for the Logan Creek complex, complementing the more familiar side-notched projectile points and side-notched scrapers. What this point style may represent functionally is uncertain. Use as a knife would certainly be possible, though no wear was detected macroscopically on the Lungren specimen. High powered magnification may reveal polish from skinning or meat cutting (Keeley 1980). Whether they might represent preforms as has been speculated for other lanceolate forms is uncertain, though it is certainly possible in its history of use that one of these lanceolates may have been utilized as a knife before being reworked into a side-notched point.

Finally, a single side-notched projectile point was recovered from Lungren. It is approximately 38 mm. long, 18.2 mm wide, and lenticular to almost round in cross section

(Figure 24). Common to Logan Creek points, some thinning has occurred through removal of pressure flakes along the basal edge. The blade is several millimeters narrower in width than the ears of the tang. There is also a slight 'twist' in the length of the blade, and a slight degree of asymmetry as the tip of the point deviates slightly to the side from true center. Combined with the thick, almost ovoid cross section and relatively small size of the overall artifact, this all suggests this point has been reworked through pressure flaking from a slightly larger, broken form. It is likely that the original point was slightly more elliptical in cross section, prior to being reworked along the edges to form a more ovoid shape.

In regards to overall morphology, this point has the closest resemblance to specimens recovered from Horizon I of Cherokee Sewer (Table 15). Coincidentally the inhabitants of this horizon would also be roughly contemporaneous with those at Lungren. While the largest of the Cherokee Sewer points is almost double the length (6.15 cm) of the Lungren specimen, others are pretty similar in overall dimensions. Unlike the Lungren point, at least two points recovered from Cherokee Horizon 1 are unifacial, having been roughly shaped from a flake before notching (Anderson 1980). Even accounting for re-sharpening, the Lungren point is otherwise considerably smaller than many points at other Logan Creek sites, such as those from Logan Creek, Hill, Turin, or Simonsen.

Figure 24. Side-notched projectile point recovered from 13ML224, comprised of Spring Branch chert.

Table 15. Dimensions from the side-notched projectile point at Lungren, compared with specimens from Horizon I of Cherokee Sewer (from Anderson 1980).

Provenience	**Raw Material**	**Length (mm)**	**Width (mm)**	**Thickness (mm)**
Lungren	Spring Branch	38.56	18.21	7.25
Cherokee Horizon I	Fusulinid Chert	6.1	26.8	7.5
Cherokee Horizon I	Fusulinid Chert	42.5	16	5.8
Cherokee Horizon I	Grey-Tan Chert	37.2	16.8	5.2
Cherokee Horizon I	Grey-Tan Chert	32.1	12	6.7
Cherokee Horizon I	Fusulinid Chert	27.5	12.2	2.7
Average (Horizon 1)		29.08	16.76	5.58

Other Artifacts

In addition to chert and quartzite artifacts, several other artifacts were recovered from Lungren. This includes one ovoid igneous rock described by Brown (1967) as a hammerstone. Evidence of battering is present along several sides, suggesting use (Adams 2002). Two broken rocks were also recovered from Lungren. Brown proposed that they may have been similarly used for hammerstones, but it is impossible to tell what they might have been used for. A fourth amorphous rock was recovered. This was classified by Brown as a mano, likely due to a flat surface along one side.

A shaft abrader comprised of scoria or some other kind of vesicular rock was also recovered at Lungren. This is possibly comprised of paralava formed from non-igneous rock metamorphosed by coal seams or other sources of heat on the Northern Plains. This material often floats from upstream along the Missouri River and its tributaries, and is often found in archaeological sites to the south (Estes et al. 2010). A pronounced semi-cylindrical channel can be seen in the artifact, clearly indicative of its function. Despite Brown's (1967) notes of three abraders, only one was found in the Lungren collection.

Finally, one freshwater mussel shell was recovered at Lungren. Though non-lithic, it was the only faunal item recovered from the 1963 excavation that was in the Smithsonian's current collection. This shell was formed by a local freshwater species of mussel still common in Iowa (Cherie Haury-Artz, personal communication 2017). As it was unmodified, it likely represents a food stuff, and is thus an 'ecofact'.

Chapter 7: MANA

In preparation for the MANA, artifacts from Lungren were organized by raw material and variations in appearance, before being compiled into a General Nodule Analysis (GNA). Included in each of these nodules were debitage, cores, and various types of chipped stone tool. Results of this GNA are shown below (Table 16).

General Nodule Analysis (GNA) Results

A total of 16 general nodules were identified from 14 raw material types. These raw material types were comprised of 9 types of chert, 3 types of quartzite, 1 type of chalcedony, and 1 type of non-chert, calcareous rock. Variation within raw material type only occurred within Argentine and Curzon chert, with all other materials in the assemblage considered one unit for purposes of analysis save glacial till, which was broken down by appearance. Pennsylvanian cherts represented eight of these general nodules, with the remainder derived from glacial till.

Tool variety by raw materials or general nodules varied widely, though the most commonly represented raw materials tend to demonstration variation in tool form. Spring Branch chert, the most local as well as most common raw material at Lungren, contained nearly every artifact type identified at Lungren present, including gravers, unifacial tools, scrapers, flake blank and multidirectional cores, as well as the site’s two projectile points. This suggests that Spring Branch chert was considered adequate for a variety of roles in the technological organization strategy of Lungren’s inhabitants.

Table 16. GNA of artifacts recovered from Lungren.

Type	DEB	PT	UF	GR	UN	BI	COR (BK)	COR (MT)	SCR	CHP	OU
Argentine (tan)	20	0	0	1	1	1	1	1	2	0	0
Argentine (black)	20	0	0	0	1	0	0	1	2	0	0
Brown Penn	12	0	1	0	0	0	0	2	0	0	0
Chalky Penn	41	0	0	0	0	1	0	2	1	1	0
Curzon (dark)	50	0	5	1	2	0	1	1	3	0	0
Curzon (tan)	17	0	1	5	0	0	0	2	1	0	0
Glacial Till (brown)	8	0	0	0	0	0	0	0	0	0	0
Glacial Till (oolitic)	2	0	4	0	0	0	0	1	0	0	0
Glacial Till (other)	28	0	0	0	0	2	0	1	0	0	0
Calcareous Rock	0	0	0	0	0	0	0	0	0	1	0
Pink Chalcedony	1	0	0	0	0	0	0	0	0	0	0
Yellow-White Quartzite	1	0	0	0	0	0	0	0	0	1	0
Sioux Quartzite	4	0	0	0	0	0	0	1	0	0	0
Spring Branch	184	2	9	7	5	2	1	4	7	1	0
Unid. Pennsylvanian	78	0	6	1	1	1	0	2	0	1	1
Yellow Quartzite	15	0	0	0	0	0	0	0	0	1	0

DEB=Debitage, PT=Point, UF=Utilized Flake, GR=Graver, UN=Unifacial Tool BI=Biface, COR (BK)=Flake Blank Core, COR (MT)=Multidirectional Core, SCR=Scraper, CHP=Chopper, OU=Other Uniface.

Other raw materials tended to be more sporadic in their utilization. The grey unidentified Pennsylvanian material, one of the most common materials present, saw use as utilized flakes, gravers, multidirectional cores and bifaces. In this it was used for almost as many roles as Spring Branch chert, but with somewhat less variety and smaller quantities of tools. Both varieties of Curzon and Argentine chert saw limited roles, being fashioned into utilized flakes, cores, scrapers, and gravers. The tan variety of Argentine had similar uses, as well as the inclusion of one early stage biface. These materials are not as local to the site as Spring Branch chert (although Curzon chert still occurs in Mills County), but they were still seemed valuable enough to import.

The weathered chalky white and brown Pennsylvanian cherts saw little overall use. Only one utilized flake was fashioned from the brown Pennsylvanian chert, though two multidirectional cores were present. These cores were likely attempts at testing the nodules for workable chert, rather than serving any real use as a source of raw material. On the other hand, the chalky Pennsylvanian material was used to produce two cores, an early stage biface, a scraper, and a unifacial chopper. The chopper, with the step wear evident along the edge, suggests that while the chalky Pennsylvanian material is not useful for sharp flakes, it was durable enough for other activities. On the other hand, the biface was abandoned early in production with no observed evidence of use. Considering the availability of raw material in the area, it seems unlikely that the Lungren inhabitants would need to resort to producing bifaces with such low quality chert. It is possible that this may represent a practice piece by a novice knapper (Mark Anderson, personal communication 2017). Evidence of children's tools are present in the archaeological record, in the form of crudely worked small arrowheads (Dawe 1997) or poorly executed bifaces (Sternke and Sorensen 2007).

Glacial till cherts took a variety of forms and served a variety of purposes. At least two bifaces and a core were fashioned from a lighter colored till, though no flake tools were recovered fashioned from this material. On the other hand, the oolitic glacial till was used for utilized flakes, though the original core was not recovered. A brown variety of glacial till likewise had debitage present at Lungren, but no core or biface from where they came from. A single piece of pink chalcedony represented the only example of such material from Lungren. It is unknown what this piece was worked from, or what may have happened to it.

Use of quartzite and the black calcareous rock were limited entirely to unifacially worked choppers. The material would have been more difficult to work than chert, but the resulting tools would be more suitable for heavier chopping or crushing. However, this is at least partially speculative, as it is difficult to identify battering or use-wear on the large grain quartzite.

Nonetheless, significant effort was put into breaking open the parent nodules in order to only work down the interior, leaving the cortex intact. The Sioux quartzite core may represent a failed attempt to create one of these choppers, before an errant fracture ended the attempt.

MANA Results

Thirty-seven MANs were parsed out from the 16 general nodules (Table 17). As noted previously, these nodules each represent one larger objective artifact—a core, scraper, chopper, or other similar artifact fashioned from the bulk of a chert nodule's usable material, assuming an original clast size approximating what has been observed in the area during modern times. The exceptions to this rule were the brown glacial till, oolitic glacial till, and pink chalcedony, where only debitage or utilized flakes were represented.

Spring Branch chert—the raw material most represented at Lungren—contained 9 MANs representing cores, bifaces, or projectile points, each representing an artifact use and discard episode. The smaller flake tools—scrapers, gravers, and utilized flakes—were likely derived from one of these episodes of manufacture. It is perhaps unsurprising that the largest represented raw material at Lungren by weight and artifact count had the most discrete episodes of manufacture as well as variations in tool form.

Table 17. Attributes of MANA based upon large objective pieces.

MAN	Analytical Nodule	Artifact Type	Debitage (reduction)	Debitage (bifacial)	Util. Flk	Gra-vers	Uni-faces	Scra-pers	Scena-rios
ARG1A	Argentine (bk)	Core	Yes	No	No	No	Yes	Yes	2
ARG1B	Argentine (bk)	Core							
ARG2A	Argentine (tan)	Biface	Yes	Yes	Yes	Yes	Yes	Yes	2
ARG2B	Argentine (tan)	Flake Blank							
BRP1A	Brown Penn	Core	Yes	No	Yes	No	No	No	2
BRP1B	Brown Penn.	Core							
CLR1A	Calcareous Rock	Chopper	Yes	No	No	No	No	No	
CHP2A	Chalky Penn	Biface	Yes	Yes	No	No	No	Yes	2
CHP2B	Chalky Penn.	Chopper							
CHP2C	Chalky Penn.	Core							
CHP2D	Chalky Penn.	Core							
CRZ1A	Curzon (dark)	Core	Yes	Yes	Yes	Yes	Yes	Yes	2
CRZ1B	Curzon (dark)	Fk. Blank							
CRZ2A	Curzon (tan)	Core	Yes	No	Yes	No	No	Yes	2
CRZ2B	Curzon (tan)	Core							
GLT1A	Glacial Till (brown)	Flakes	Yes	No	No	No	No	No	3
GLT2A	Glacial Till (oolitic)	Util. Flakes	Yes	No	Yes	No	No	No	3
GLT3A	Glacial Till	Biface	Yes	No	No	No	No	No	2
GLT3B	Glacial Till	Biface							
GLT3C	Glacial Till	Tested Cobble							
PKC1A	Pink Chalcedony	Flake	Yes	No	No	No	No	No	3
SXQ1A	Sioux Quartzite	Core	Yes	No	No	No	No	No	
SB1A	Spring Branch	Biface	Yes	Yes	Yes	Yes	Yes	Yes	2
SB1B	Spring Branch	Biface							
SB1C	Spring Branch	Dent. Chopper							
SB1D	Spring Branch	Core							
SB1E	Spring Branch	Core							
SB1F	Spring Branch	Fk. Blank							
SB1G	Spring Branch	Core frag.							
SB1H	Spring Branch	Core Fragment							
SB1I	Spring Branch	Point							
UNP1A	Unknown Penn.	Point	Yes	Yes	Yes	Yes	Yes	Yes	2
UNP1B	Unknown Penn.	Core							
UNP1C	Unknown Penn.	Core frag.							
UNP1D	Unknown Penn.	Uni. Core							
YWQ1A	Yellow Quartzite	Chopper	Yes	No	No	No	No	No	2
YLQ1A	Yellow-White Quartzite	Chopper	Yes	No	No	No	No	No	2

The next most well-represented category of MANs were those of the unidentified grey Pennsylvanian cherts (4 MANs), followed by light colored glacial till (3 MANs). The next plentiful materials, Curzon and Argentine cherts, were each subdivided into two MANs each based upon differences in color or inclusions. The brown and chalky white Pennsylvanian materials, despite being used for a limited variety of tools, contained two and four MANs respectively. The remaining raw materials, such as the quartzites, were each comprised of a single MAN, with associated debitage from a single manufacturing episode.

Every large tool representing a MAN had associated debitage, suggesting on-site manufacture. In MANs that included bifaces, decortification flakes, reduction flakes, and bifacial thinning flakes were included within Spring Branch, Argentine, Curzon, and unidentified Pennsylvanian materials. These reflect manufacture of bifaces and projectile points from chert cores on site. Various categories of unifacial tool, debitage, and multidirectional cores were often represented in the same MAN, likewise suggesting on-site manufacture of these tool types.

Based upon Doperalski's (2013) classification scheme, most of these MANs would be considered Type 2 scenarios, representing on-site manufacture of raw material, followed by on-site disposal. While it is possible that Type 1 (off-site manufacture and curation, on-site discard) is possible, it is difficult to discount the presence of debitage associated with each of these MANs. Likewise, the debitage could be debris from tools that were removed from the site (Type 3). However, Type 2 remains the most likely scenario due to the presence of tools as well as technologically associated debitage of grouped raw materials. Three Type 3 scenarios (brown glacial till, oolitic glacial till, and pink chalcedony) were also present in the MANA results due to absent cores or bifaces from which debitage and flake tools could be derived.

Chapter 8: Conclusions

This thesis used several types of analyses in order to model technological organization and mobility strategies of the inhabitants at Lungren. Aggregate debitage analysis, macroscopic use-wear analysis, raw material identification, and MANA/GNA were used to establish overlapping lines of evidence to create comprehensive illustration of life during the Middle Archaic periods. These analyses were limited by both in-field constraints during excavation 40 years ago, as well as in-lab constraints by the researcher, and modified accordingly. Such challenges will probably not be unique to Lungren, and may be expected when analyzing other RBS survey collections or other older collections in general.

Artifact counts provided by Brown (1967) differ from those in this study (Table 18). Reasons for this include the fact Brown's estimates for cores and flakes were approximates, differing identification rates for utilized flakes, as well as the identification of tools (gravers and the curved lanceolate knife) which had not been recognized in the original study. The possibility that artifacts may have been misplaced while in curation also cannot be ruled out.

As noted previously, Kay (1998) defined three types of Logan Creek sites— residential camps, kill sites, and burials. Based upon multiple lines of evidence (lithic analysis, use-wear analysis, and excavation notes), Lungren would be best described as a residential camp in this scheme. Table 19 summarizes the various activities performed at the site, which would reflect a habitation rather than strictly a kill site. Somewhat muddling this clear distinction is the presence of bison bones on site, with at least one articulated bison vertebra present (Brown 1967).

Table 18. Comparison of artifact counts between Brown (1967) and this thesis.

Artifact Type	Count (Brown 1967)	Artifact Type	Count (This thesis)
Projectile Point	1	Projectile Points	2
Knives	4	Bifaces	7
End Scrapers	12	End Scrapers	15
Side Scrapers	3	Unifacial Tools	7
Cores (Bifacial)	13	Gravers	17
Cores (Other)	5	Cores	19
Hammerstones	5	Heavy Butchery Tools	8
Whetstones	3	Hammerstones	1
Utilized Flakes	17	Whetstones	1
Debitage	550	Utilized Flakes	26
		Debitage	521
Total Artifacts	613	Total Artifacts	624

Though the bones were not collected, photographs and excavation notes taken by Brown suggest that these broken and burned bones were scattered across the site, and are heavily associated with several fire-based features. Although much of this fire-related evidence may be post-depositional, the site's location along a creek in a deeply dissected drainage valley would likely mitigate major effects by fire, while the drier mid-Holocene conditions and the ease that loess erodes would make it likely that the site was buried relatively quickly after use. The association of these bones with hearth features also makes it difficult to rule out cultural modification regardless of post-depositional impact by fire.

Without bones to conduct a faunal analysis, it is difficult to surmise whether the entire bison was present or if it was brought in as parts, although Brown's (1967) mention of vertebra, mandibles, and rib bones scattered across the site suggests a degree of intensive processing. Considering the mass of a bison, it is highly unlikely the animal was moved post-mortem. It is more likely that camp was set up for processing of the bison in an opportune spot where it was killed, or it was chased into Pony Creek before its death. That Lungren is a residential campsite suggests something of a forager strategy for the Lungren inhabitants (Binford 1980), where the group has moved to where the bison was caught in order to engage in heavier processing activity. In contrast, bison kill sites such as Pisgah or Simonsen represent an episode of bison hunting with less processing of game or tool manufacture/repair after the fact.

Table 19. List of activities at Lungren based upon results of this thesis.

Activity	Evidence
Stone Tool Manufacture	Multidirectional cores; debitage; unfinished tool forms (blanks, bifaces/preforms); hammerstones.
Heat Treatment of lithic material	Thermal altered chert; fire features.
Hide Working	Scrapers; utilized flakes; gravers/gravers.
Chopping/Smashing of Bone	Choppers; other heavy cutting tools.
Hunting (in vicinity)	Projectile points; bison bones.
Skinning/Cutting/butchery	Bifacial knives; utilized flakes.
Shaft Abrading	Scoria abraders.
Resource Acquisition (in vicinity).	Cobbles; cores (local material)
Cooking/Heating	Fire features; burned bone, thermally altered chert

It is entirely possible that choice of camp location and type (kill site or processing/residential camp) may be a seasonal element, or perhaps based upon other natural resources. In western Iowa, bison have always been present in significant numbers through the Holocene, especially in the Loess Hills and Missouri River valley (Chris Widga, personal communication 2017). The same environments favored by bison in winter would have likewise been appealing for humans of the time period as well (Bettis and Hajic 1995). Bison tend to favor the open plains during the summer months, and wait until colder months to break off into smaller groups seeking shelter in valleys (Tatum 1980; Widga 2006). While the bison at Lungren could have been chased up Pony Creek drainage to its death in another season, this would have been easiest to do when weather conditions would have made an encounter near the valleys more likely. In addition, though faunal remains were not recovered, the description by Brown (1967) of heavily broken and burned bones, the presence of hearth features as well as heavy butchery tools suggests site inhabitants were heavily processing the bison carcass. While this could have been for retrieval of hide, this is also often a strategy to extract additional nutrition in winter hunts, when bison are malnourished (Tatum 1980). Environmentally, meltwater and rain in spring would have made Lungren's position within the deeply dissected valley wet and unpleasant, as loess would have eroded and the valleys would have been prone to flash flooding. Conversely, in the summers the valleys could be dry and humid.

Based upon this evidence, it is most likely that Lungren represents a winter campsite. Environmental conditions would have made camping alongside a creek more favorable than in more wet or hot weather, with low chance of a flash flood or oppressive humidity. Bison, though possibly malnourished, would have been closer to the valleys where they could be chased or ambushed. Wood for fuel and chert for tool provisioning would have been readily available. While it is possible that this site could have been occupied during another season, the specific combination of variables above make a winter kill, followed by establishing a camp for shelter while processing the bison and retooling the most ideal scenario for this area.

Coincidentally or not, Cherokee Sewer was also an early winter campsite with bison kill episodes in a protected river valley, used repeatedly by Paleoindian and Archaic peoples (Whittaker 1998). Lungren as well as Hill are located in similar settings, and these sites may have developed under similar circumstances as a favorably small number of bison were ambushed or ran into drainages before they were caught. The amount of debitage and tools recovered in these respective assemblages represent significant time processing game compared to sites such as Simonsen. However, excluding Cherokee, seasonal data is lacking for most

Logan Creek sites. As such, determining seasonality of different site types remains speculation. Nonetheless, the differences in assemblages between kill sites and campsites are significant.

Raw materials present at Lungren consist of large amounts of Pennsylvanian (upper Carboniferous) cherts, laid down when the midcontinent was a shallow sea (Heckel 2013). It has in the past been assumed that chert is a somewhat static resource that is less dependent upon variables such as seasonality (Binford 1979). It may be better to view it as any other natural resource which, depending upon various circumstances (weather, erosion, or politics,) can be acquired, depleted, or become unavailable at varying times (Bamforth 1986). While chert outcrops may certainly have been different in the mid-Holocene compared to earlier or later eras, inhabitants at Lungren and Hill certainly had access to plenty of locally available chert, possibly even available on-site. This would be either bedrock-derived nodules exposed near valleys where streams and rivers had cut through the loess, or river cobbles deposited near these same environments (Kay 1998). All of these factors likely played into the subsistence, technological organization, and settlement strategy of these peoples. Glacial till served as a source of both additional workable chert usable for a variety of tools, as well as for harder materials such as quartzite and igneous or metamorphic rock for hammer stones and hearth rock.

The lithic assemblage left by those at Lungren reflects a technological organization strategy reflective of their subsistence preferences—that is, bison—as well as the resources available in their environment. Unlike in some other areas, a variety of natural resources—water, wood, bison and lithic raw material—were plentiful in western Iowa during the mid-Holocene. Items representative of high mobility, such as projectile points and bifaces are supplemented by less formal forms such as multidirectional cores, utilized flakes, gravers, and larger butchery tools such as choppers. In this, the Lungren assemblage represents a mix of formal tools with expedient tools, capable of dealing with a variety of bison-processing activity. While utilized flakes have long been acknowledged in Logan Creek assemblages as well as those of other complexes, previous studies have at times missed identifying some of items such as gravers, with some exceptions (Grange 1980). Nonetheless, these less formal tools still play as much of a role in bison subsistence activities (killing, skinning, butchering) as more formal items such as bifacial knives.

Based upon excavation notes of bison remains scattered through the site, as well as tools recovered from Lungren, a more or less 'complete' suite of bison processing activities likely occurred at Lungren. Based upon Frison's (1979) work, utilized flakes were likely used for hide or meat cutting, along with bifacial knives and unifacial tools. Heavier butchering and processing tools—the large unifacial artifacts—were used for dealing with bone and joint splitting. Scrapers were likely used for hide softening/cleaning, though they have also been used on other materials (Andrefsky 2005). Gravers were probably used either for perforating hide, or any general activity where a sharp point was necessary. It should be noted that the lack of collected bison bone makes the exact nature of what all was extracted from the processed bison difficult to determine with confidence. However, it can be assumed from the variety of tools in the assemblage as well as presence of fire features (including possibly roasting or boiling pits), and excavation notes that the extent of the processing was quite through. Possibilities include general subsistence (meat), leather making, and marrow extraction.

The lanceolate projectile point/knife recovered from Lungren illustrates the potential of a lesser understood style of diagnostic tool associated with Logan Creek sites. Although macroscopic use-wear did not identify anything more than grinding along the base, the largely-unifacial nature of this point is intriguing when compared to similar points at Cherokee Sewer, Hill, Spring Branch, and Logan Creek. Although the sample size is small, there are not many substantial Logan Creek sites to begin with, and it is difficult to accept bent lanceolate forms across multiple sites as mere coincidence. As side notched points are too easily associated with multiple Middle Archaic complexes as well as later time periods, the identification of another diagnostic artifact, in temporal and geographical association with side-notched, hafted scrapers and a bison hunting tool kit, is important for identifying further Logan Creek sites. High powered magnification in future studies might reveal the function of these items.

The exact reason for tool abandonment seems to vary. Though tools are often discarded due to breakage, either from use or manufacturing error, most tools at Lungren were not broken. Since inhabitants of Lungren were mobile, particular elements of the toolkit that may have been more important for certain times and less so for others. Cores are a good example of this, as while they are a good source of raw material, their weight makes their transportation an undesirable option. Tools such as scrapers or gravers with particular applications may have been useful during episodes of butchery during extended encampment, but unnecessary while on the hunt. Alternatively, the inhabitants at Lungren may be benefitting from inhabiting a region laden with workable chert. It is likely that the site inhabitants may have had few concerns about acquiring material for future tools, and were comfortable with jettisoning items considered no longer necessary (Bamforth 1986).

The large number of cores left behind at Lungren, in addition to their relatively limited use, suggests that raw material conservation was of comparatively little consequence to the site’s inhabitants. That said, it could not be argued that curation, a trait often used as a reflection of mobility, was absent. It is highly unlikely that Lungren's inhabitants abandoned the site empty handed. While lithic studies often focus on scarcity (Andrefsky 1994, Bamforth 1986), it might be better in this case to assess how resource abundance affects technological strategy. Tools such as bifaces and projectile points may have left the site with inhabitants for the next hunt. In contrast, tools not directly useful for hunting—scrapers, gravers, drills, and choppers—were left behind. Local resources were understood to be plentiful enough that these hunters were comfortable abandoning both acquired raw material (cores) as well as situationally specific tools, seemingly confident that new tools could be fashioned later. It is also quite possible that the number of cores present at Lungren may have represented a caching strategy, as the previous site inhabitants could potentially have returned to recover and utilize them later. In regards to Bamforth and Becker's (2000) index of sedentism based upon biface to core ratio, it might be suggested that this ratio should be used more as an index of local raw material availability and utilization, rather than an index of sedentism or mobility.

The MANA and accompanying GNA suggest that higher quality local cherts (notably Spring Branch) were most frequently utilized for tools, and were used for a variety of tool types. Both artifacts derived from multidirectional cores as well as bifaces were fashioned from this material. Other materials, both Pennsylvanian and glacial till did not see as intensive use, but nonetheless were included in the Lungren inhabitant's manufacturing activities. The presence of debitage with cores or bifaces in the same MAN in multiple instances suggests that extensive tool manufacture occurred at Lungren from cores rather than flake blanks acquired from elsewhere.

Succinctly put, inhabitants at Lungren were willing to produce a variety of tools from a multitude of locally sourced chert. Contrary to materials used by many groups in Paleoindian times, this chert was often low to medium quality, with less guaranteed workability per nodule than more prized items from previous times such as Burlington chert or Knife River flint. Though the Lungren inhabitants favored the locally available Spring Branch chert most often, they did not seem willing to use only particular cherts for particular artifact types. Bifaces, cores, and flake tools fashioned from associated debitage were represented in nearly every locally available chert MAN. Materials that might be considered lower quality chert, such as the chalky white and brown Pennsylvanian materials, saw at least minimum utilization for bifaces, cores, and unifacial tools. Despite the presence of local raw material in bedrock, smaller glacial till cobbles saw utilization as cores as well. This could have represented incidental exploration of raw material while site inhabitants were camped alongside Pony Creek. This may further support the suggestion of a winter site, as cobbles would have been easily accessible in fall or winter as water levels would have been low. In contrast, non-chert MANs almost exclusively consisted of unifacial choppers as the sole element. While several of these large, unifacial tools were also present in Spring Branch chert and glacial till, those MANs also contained other tool types. This was not the case for tools of quartzite or calcareous rock. In assessing the limited nature of tool production using these materials, it is likely that they favored the durability of these materials over ease of knapping, with more particular needs in mind in their construction.

It should be noted that there are clear limitations to these results. Type 1 scenarios (on-site disposal of an artifact created off-site) were still certainly plausible in materials representing Type 2 (on-site creation and disposal), but would be missed if both scenarios occurred with the same materials. For example, the projectile point recovered from Lungren, being reworked from a larger form, might actually represent a curated artifact brought in from off-site. Type 3 scenarios (on-site production with removal off-site) may similarly be missed if artifacts manufactured and taken off site are produced from the more common raw material types. A 'false positive' could also occur if post-depositional erosion rather than human action removes the artifact from the site.

The coarse nature of this MANA and GNA also prevented completely answering other questions involving the nature of technological variables in production—what Knell (2007) refers to as a technological constituent. In a more ideal scenario, the size of a MAN can indicate the nature of knapping activities, such as whether they are production events or merely maintenance/retooling. A more thoroughly-collected assemblage, in addition to better characterizing general metric attributes of debitage such as average sizes or weights, might also help to determine the technological nature of activities in a MAN as well, be they biface thinning or resharpening a scraper. The robust size of MANs in this study, as well as the lack of screening procedures during the 1963 excavation both serve to make assessment difficult. On the other hand, the inclusion of smaller pieces of debitage into MANA has often been unsuccessful, and in practice is rarely performed (Knell 2012). Given the flexibility of MANA however, with a more complete collection of debitage, it would be possible to incorporate size grade data into MANs to study production.

Finally, it should be noted that a MANA is only moderately suited for replication of results (Knell 2007, Larson 2004). It is entirely possible for two researchers to come up with very different MANA results from the same assemblage, as it is perceived variations in similar raw materials, or association of particular artifacts with technologically similar debitage (i.e., biface thinning flakes) that produce the analytical nodules. Similar shortcomings also exist for other forms of aggregate analysis however, including raw material, debitage analysis and use-wear analyses. This shortcoming should not invalidate the validity of these any of these research methods.

The occupants at Lungren in certain ways performed activities and behaviors that would be expected for a hunter-gatherer group in this time period. The site likely represents a campsite occupied by a small group, based upon site contents and size (debitage, chipped stone tools, and notes on fauna). It is unlikely that this site exceeded 20 people, as many more would have left more evidence (debitage, tools, fauna, or hearth features) behind. It is unlikely that there were many groups nearby to interact with. Even later in time, the eastern Great Plains did not support a great number of people. However, there still may have been enough people on the landscape to perform communal hunts, such as people at Cherokee Sewer did (Anderson and Shutler 1980). In this case, the group probably only procured one or two bison.

Based upon evidence from other Logan Creek sites, the occupants at Lungren likely did not have a large range. Most things necessary for survival were located within the Missouri River valley, and many of these materials (shelter, food, chert, and water) were located effectively in the same place. Even in times of local bison shortages, more could be found within a hundred kilometers away in western Iowa, while other, albeit smaller animals would have been available locally as well (Widga 2006). These people were likely not alone on the landscape, as similar sites with comparative tool kits show up across the Eastern Plains border as well as into Nebraska and Kansas. Though these other groups may have needed larger seasonal ranges to acquire raw materials and food, and possibly may have organized their hunts differently, the fundamentals of their way of life—mobile groups subsisting through bison hunting, through use of a specialized tool kit—were the same.

The environment at Lungren would have most likely favored a late fall or winter occupation, providing shelter, natural resources, and food when occupants would not have to deal with spring rains or floods, or harsh summer conditions. Colder conditions would have allowed potential production of leather, which might be one explanation for some features present. The site inhabitants produced chipped stone tools from locally procured sources, either bedrock or glacial till. The most local raw materials—in this case moderate grade Pennsylvanian cherts—saw the most extensive and widest variety of use in artifacts such as bifaces, scrapers, and flake tools. This tool kit, at least in part, reflected use by a mobile group. Biface derived technology (knives and projectile points) handy for transport were accompanied by more expedient or situation-specific tools such as unifacial flake tools, gravers, large butchery tools (so called ‘choppers’) or scrapers.

Somewhat more unexpected was the heavy reliance upon cores and core derived tools in relation to more mobile technology. Although bifaces were present, they were heavily outweighed by less ‘mobility friendly’ multidirectional cores, as well as tools derived from them. It is possible that cores were transported more often than expected at these hunter-gatherer sites, creating the illusion that bifaces were more prevalent than cores by Paleoindians and Archaic people (Bamforth and Becker 2000). Even if this were the case, the quantity of cores at Lungren represent the extreme opposite, where seemingly nothing was taken. A larger portion of the toolkit was more need-specific than anticipated, with expedient tools and situation-specific items (such as scrapers and gravers) better represented than initially expected. In addition, many cores were abandoned before being even moderately utilized. It would not be an understatement to say that the people had a strong grasp of local chert resources around them, were able to utilize them to suit their needs, and yet were not concerned with raw material shortages. The people at Lungren did not practice much curation or caching (though the number of cores present at Lungren may represent a caching behavior rather than abandoning of items). It is highly likely that they were familiar with the availability of other sources (wood, water, food, and shelter) as well. Although it is difficult to say when dealing with such a degree of time depth, Logan Creek people were utilizing the land intensively in a way that was not terribly different from later people that would come after them.

Simply put, despite the dry conditions of the Great Plains during the mid-Holocene and notions of tough times that come with it, the inhabitants of Lungren were in an environment that for their way of life was one of relative bounty rather than desperation or scarcity. They were well adapted to the drying conditions of the mid-Holocene, and based upon information from numerous sites, were able to maintain their way of life for at least 1,500 years.

Further Research

Many further questions remain in regards to our understanding of the Logan Creek Complex. One of the more fundamental issues is chronological or cultural historical framework. As noted by Kay (1998), what we identify as Logan Creek spans at least several thousand years (8600-6000 B.P.), with the possibility of some considerably later sites, such as Lewis Central School (13PW5). There are some questions about whether some finer chronological units could be established within what we consider 'Logan Creek', based upon projectile point variation, raw material choice, or technological organization.

Kay (1998) likewise defined a core Logan Creek area, centered on or near the Missouri River area, and also wisely cautioned against defining the presence of a Logan Creek site purely on the presence side-notched projectile points. Despite these restrictions, 'confirmed' Logan Creek sites stretch from North Dakota (Rustad) to Kansas (Spring Creek), in some cases far removed from the Missouri River valley. These sites take different forms, with varying quantities of chert and bison availability compared to those of the 'core' area. Even assuming that these people lived roughly the same way of life (that is, hunter-gatherer lifeway based upon bison hunting), how different are the technological organization strategies of people across such a wide area as a result of different local resources? While condition in western Iowa resulted in three site types (kill sites, campsites, and burials), perhaps different terrain would bring about different adaptive strategies that would be signaled in the archaeological record. Applying some of the remaining criteria set by Kay, are there other Logan Creek sites outside of the core area, perhaps from previously excavated or collected sites, that have not yet been identified as such? Is it possible to define with confidence a wider area for Logan Creek?

Finally, related to the previous questions, is it possible to define trends to site type by area, be it time-transgressive, or seasonality? It is quite possible that the sites seen in western Iowa (Lungren, Cherokee, Hill) represent the same part of a larger seasonal round, while sites like Pisgah and Simonsen represent a different part, and we only recognize a few snapshots in this yearly cycle. While is unlikely that this round strays very far geographically for any group

(Nycz 2013), it would be interesting to see if patterns might exist across or within different regions of the eastern Great Plains.

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Appendix A: Maps

Data included in the Smithsonian catalog for 13ML224 was entered into a geographic information system (GIS) system, which was used to recreate graphics of the main excavation block of the site. This allowed for the displaying and analyzing of spatial data that Brown (1967) only generally quantified in his report. While smaller excavation blocks (1 by 1 meter, rather than the 5 by 5 foot squares used at the time) may have illustrated more nuanced results, these maps largely confirm Brown's assertion that artifacts were largely concentrated towards the southwest, largely associated with identified features.

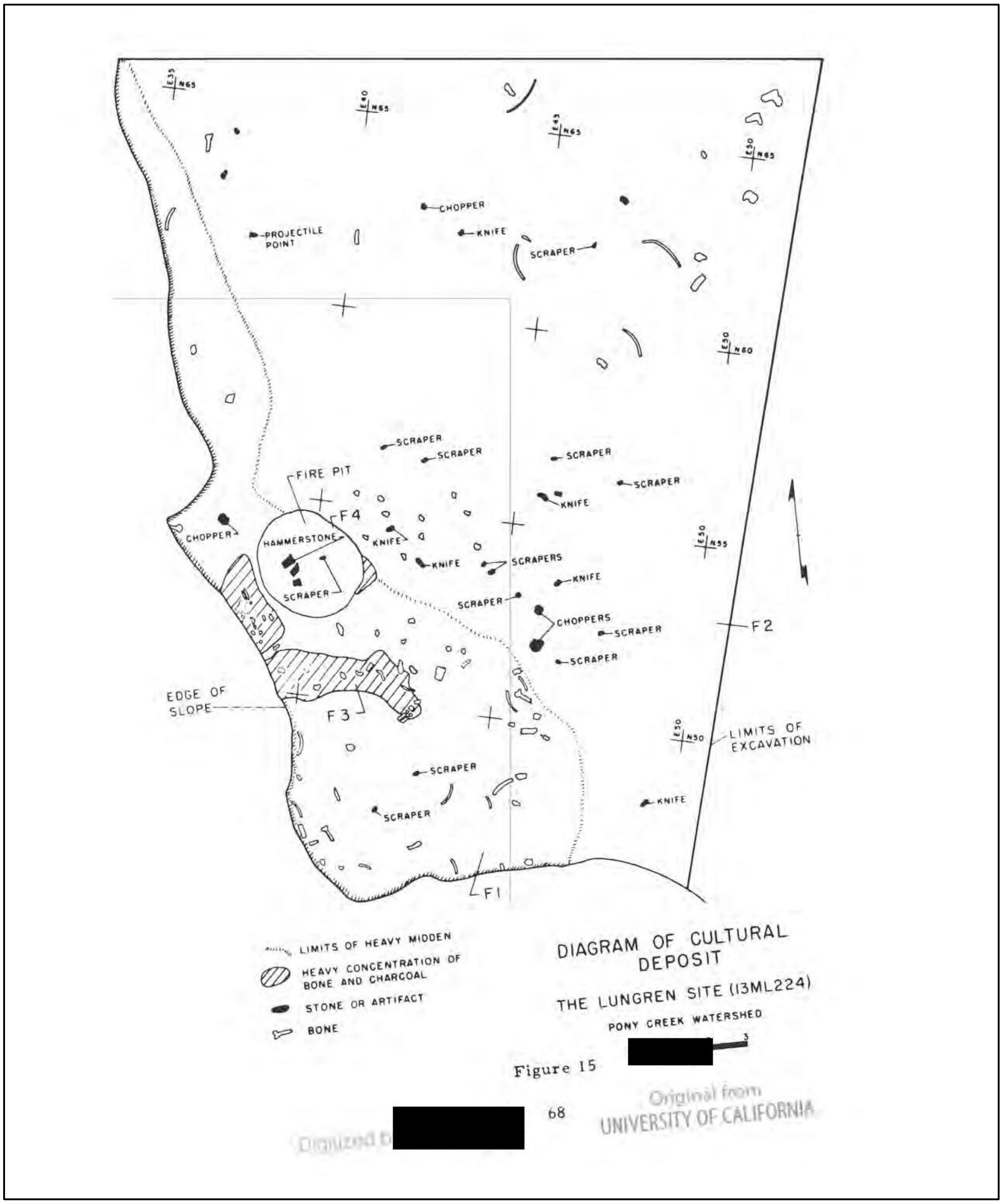

Figure 1A. Map of main excavation block of site 13ML224 (Lungren). (From Brown 1967).

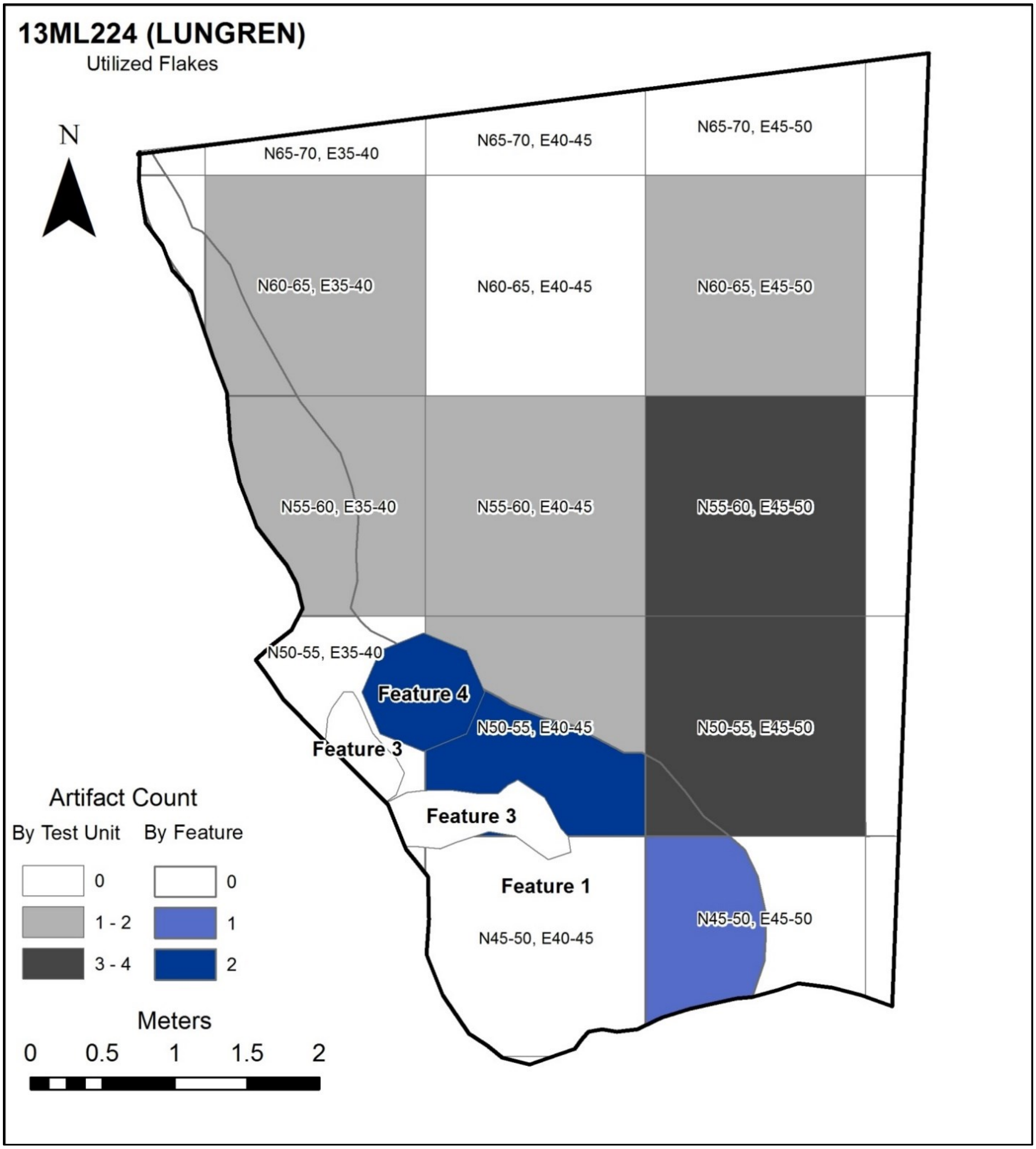

Figure 2A. GIS-mapped plan of 13ML224 (Lungren), showing location of utilized flakes by test unit and feature.

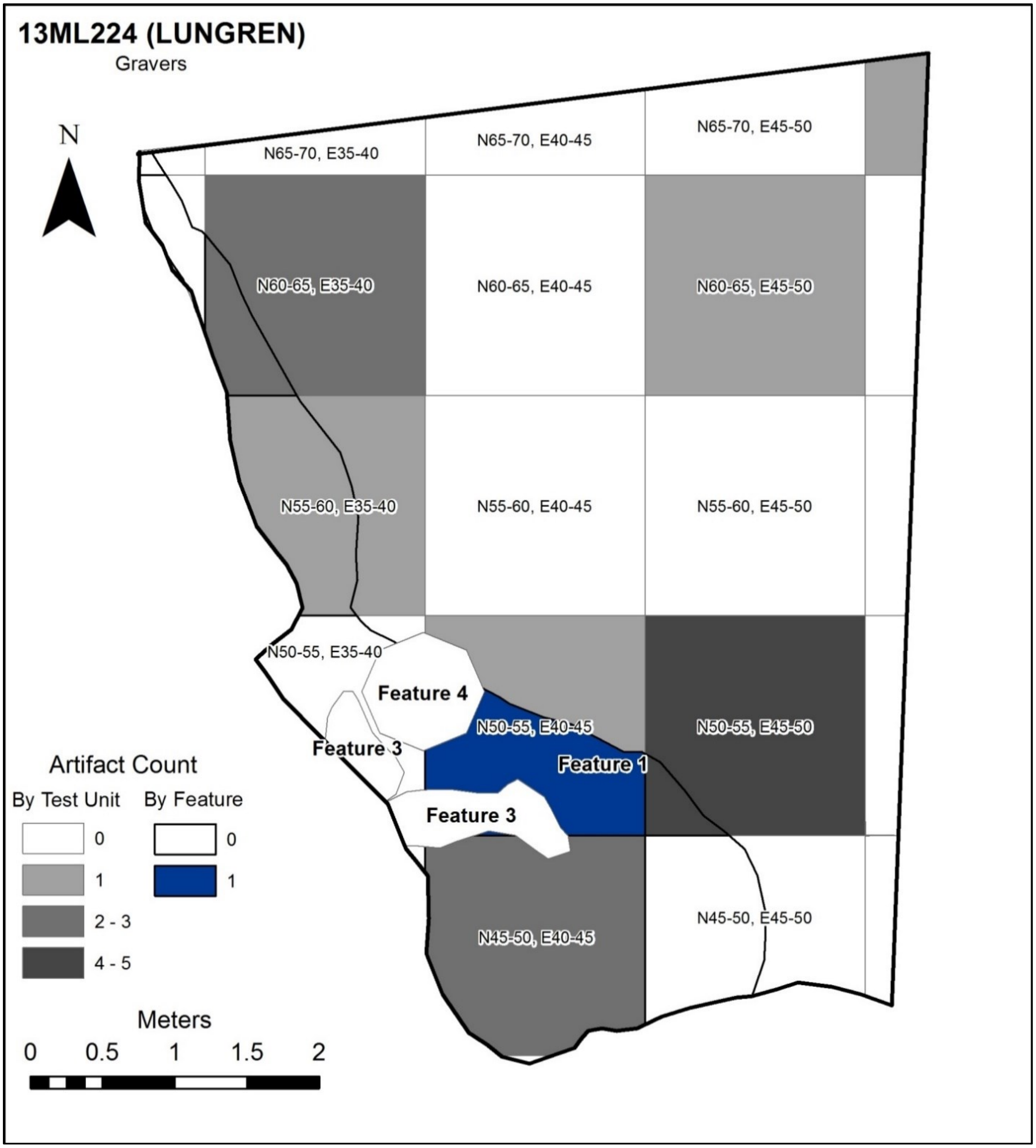

Figure 3A. GIS-mapped plan of 13ML224 (Lungren), showing location of gravers by test unit and feature.

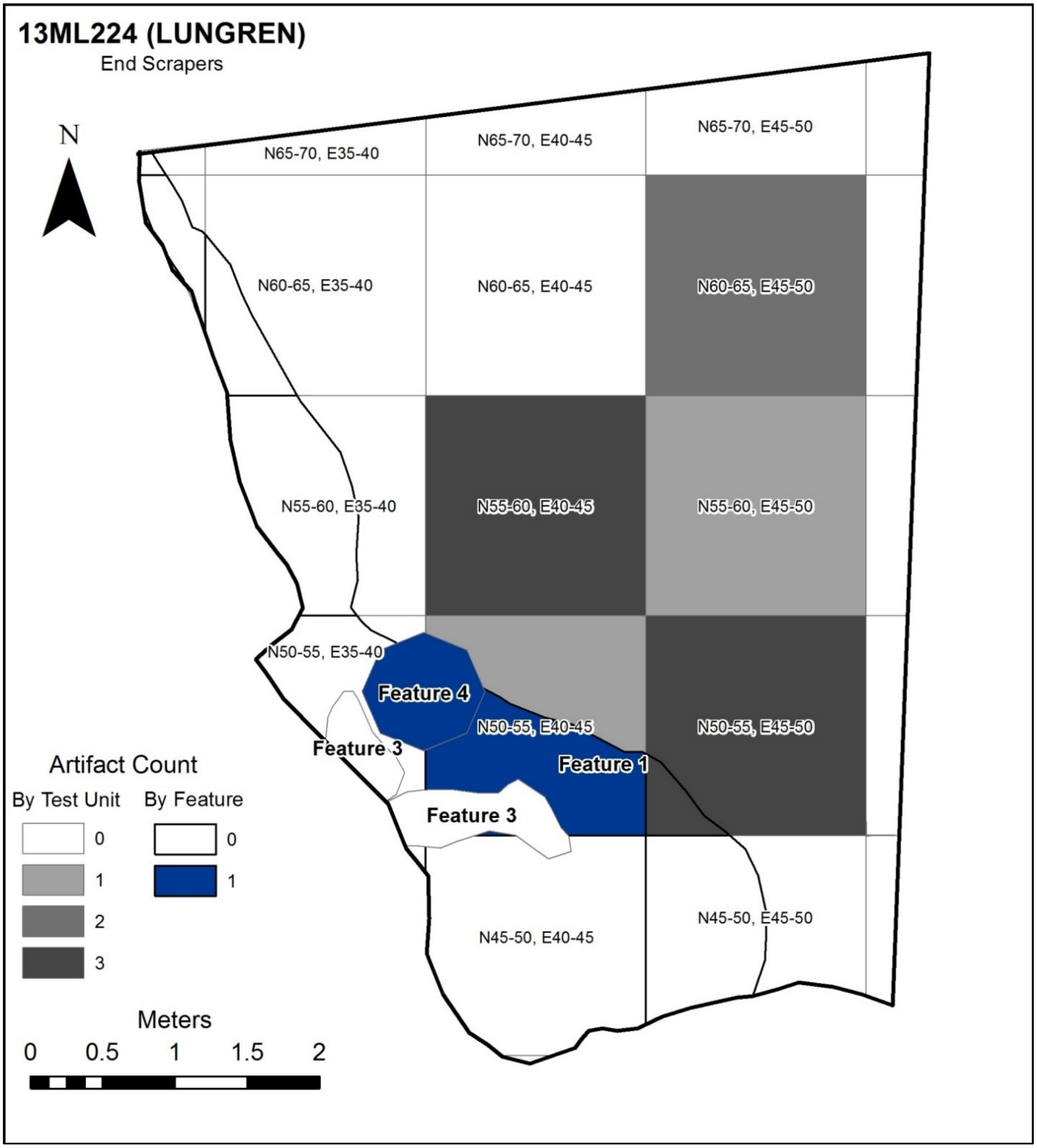

Figure 4A. GIS-mapped plan of 13ML224 (Lungren), showing location of end scrapers by test unit and feature.

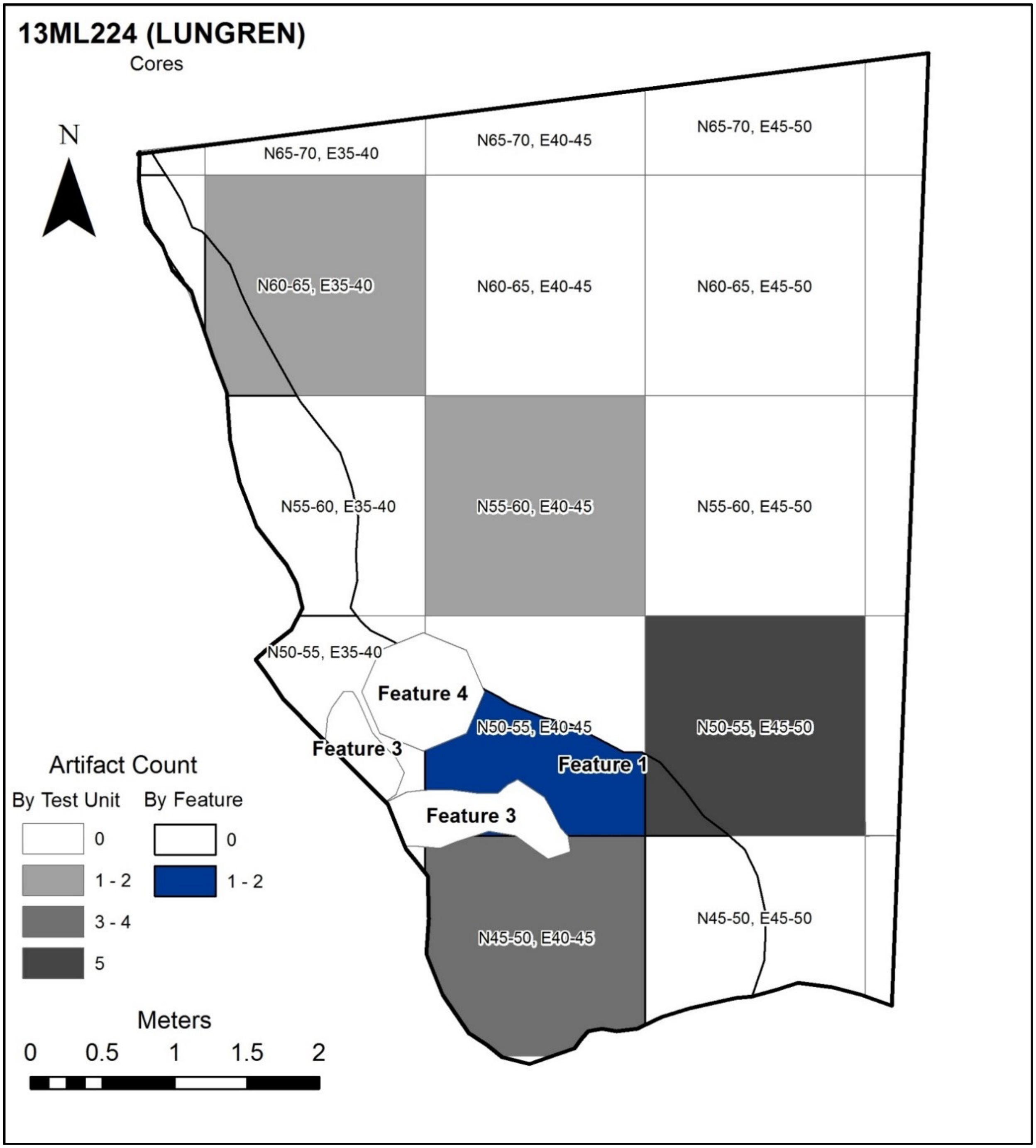

Figure 5A. GIS-mapped plan of 13ML224 (Lungren), showing location of multidirectional and flake blank cores by test unit and feature.

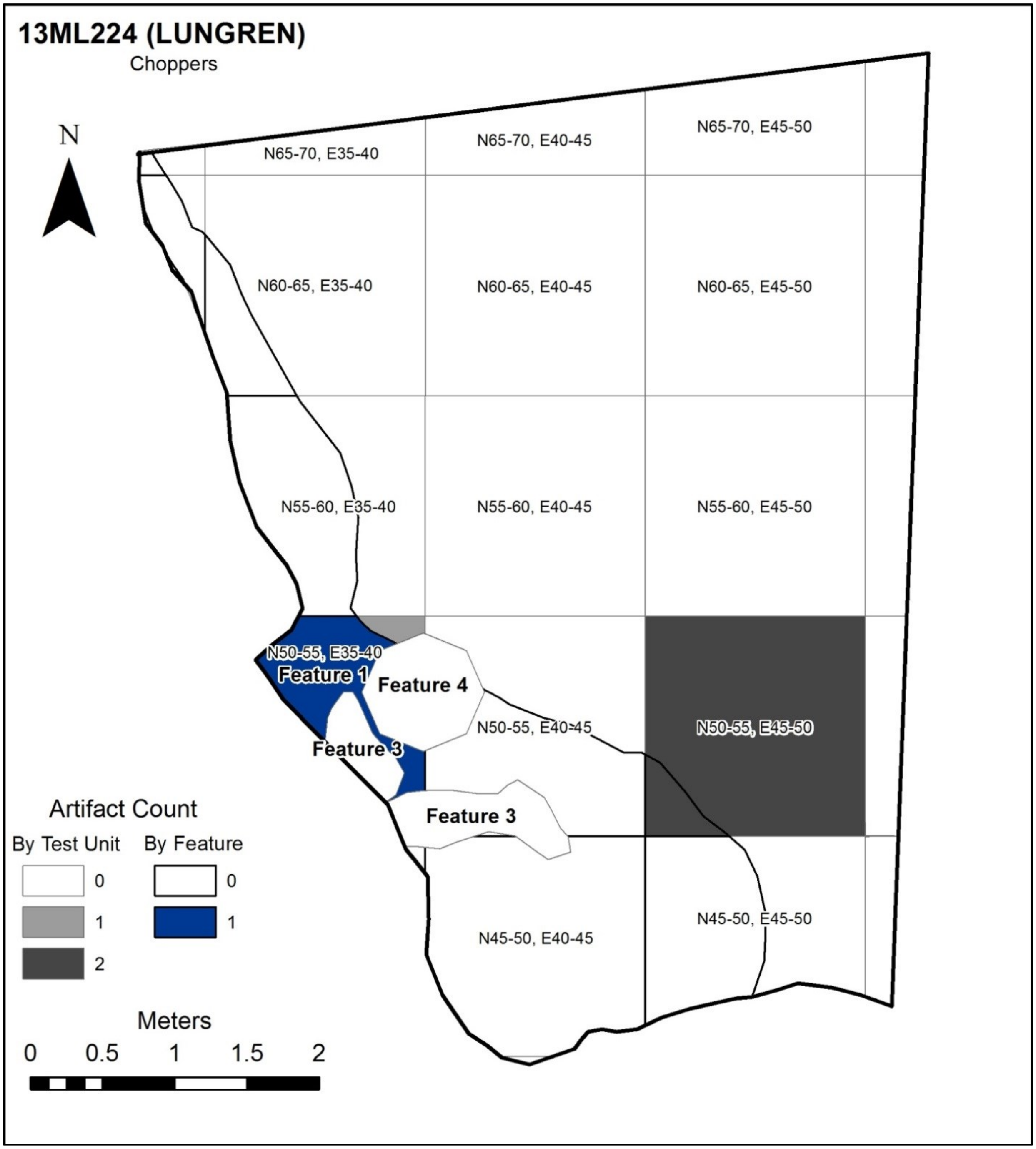

Figure 6A. GIS-mapped plan of 13ML224 (Lungren), showing location of large unifacial butchery tools by test unit and feature.

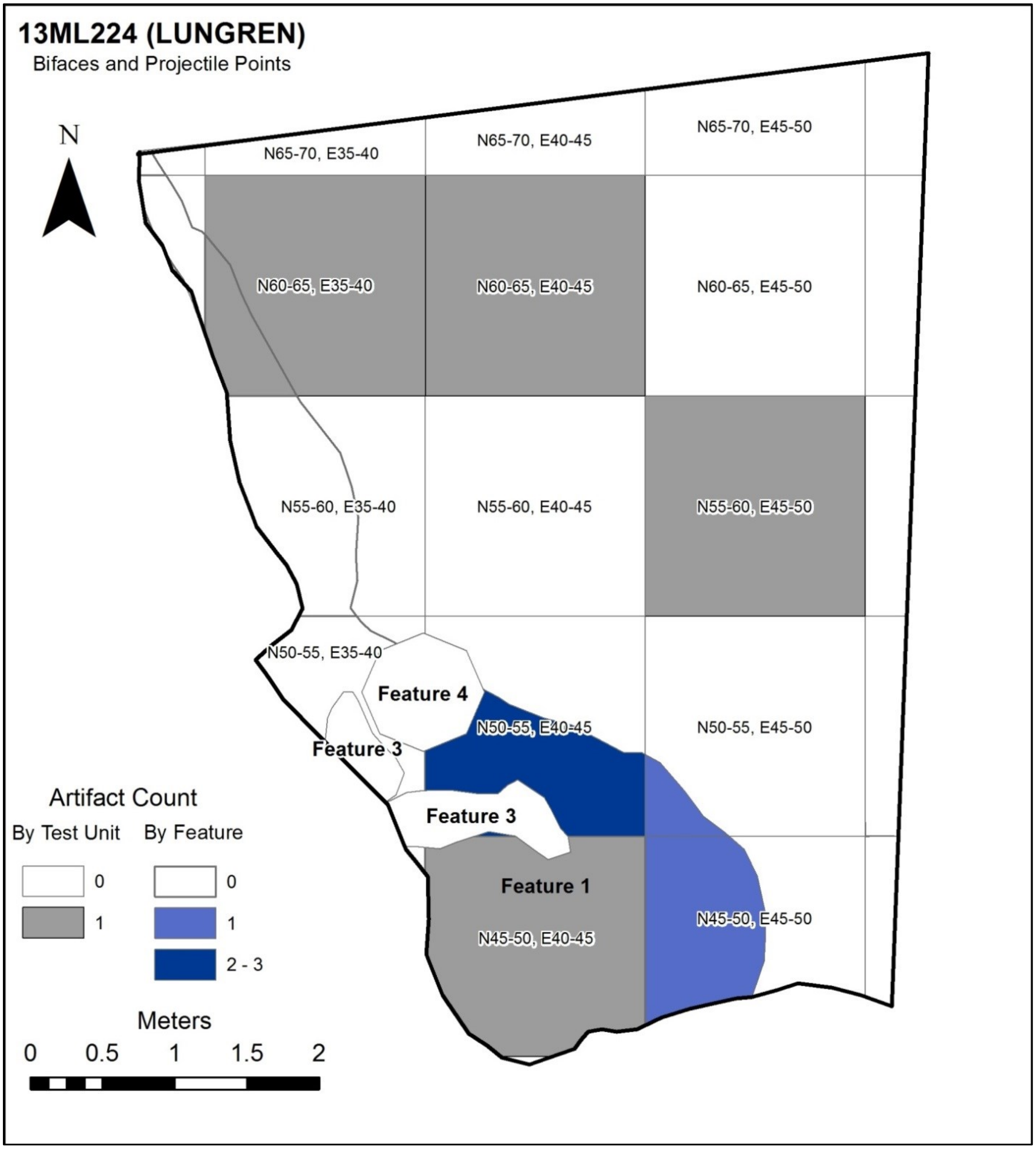

Figure 7A. GIS-mapped plan of 13ML224 (Lungren), showing location of bifaces by test unit and feature.

Appendix B: List of Chipped Stone Tools with Accession and Provenience Information

Smithsonian Catalog ID	Provenience	Tool Type	Identified As	Heat-Treatment
A480071-0	N50-55, E40-45, F1, CD	Biface	Argentine	No
A480070	N50-55, E40-45, F1, CD	Biface	Chalky Pennsylvanian	No
A480065	N45-50, E45-50, F1, CD	Biface	Glacial Till	No
A480139	Slump Material	Biface	Glacial Till	No
A480070	N50-55, E40-45, F1, CD	Biface	Spring Branch	Yes
A480067	N50-55, E40-50, F1, CD	Biface	Spring Branch	Yes
A480075	N55-60, E45-50, F2	Biface	Spring Branch	Yes
A180119	N60-65, E40-45, CD	Biface	Unknown Pennsylvanian	No
A480118	N60-65, E35-40, CD	Broken rock - hammerstone?	Other	No
A480083	N50-51, E45-46, CD	Chopper	Chalky Pennsylvanian	No
A480082	N50-51, E45-46, CD	Chopper	Other	No
A480095	N50-55, E35-40, CD	Chopper	Yellow-White Quartzite	Yes
A480111	N55-60, E40-45, CD	Core	Argentine	No
A480129	CD I Cutbank	Core	Argentine (black)	Yes
A480084	N50-51, E45-46, CD	Core	Chalky Pennsylvanian	No
A480111	N55-60, E40-45, CD	Core	Chalky Pennsylvanian	No
A480133	Associated with CD	Core	Curzon	No
A480118	N60-65, E35-40, CD	Core	Curzon	No
A480092	N45-50, E40-45, CD	Core	Sioux Quartzite	No
A480105	N50-55, E45-50	Core	Spring Branch	No
A480074	N50-55, E45-50, F1, CD	Core	Unknown	No
A480069	N55-55, E40-50, F1, CD	Core	Unknown Pennsylvanian	No
A480099	N45-50, E40-45, CD	Core	Brown Pennsylvanian	No
A480071-0	N50-55, E40-45, F1, CD	Core	Brown Pennsylvanian	No
A480092	N45-50, E40-45, CD	Core	Spring Branch	No
A480130	Cultural Deposit I West Side of Arroyo	Core (Flake blank)	Argentine	No
A480081A0	N50-51, E45-46, CD	Core (Flake lank)	Curzon	No
A480138	Slump Material	Core (Modified blank)	Spring Branch	No
A380141	Slump Material	Core (Tested cobble)	Glacial Till	No
A480103	N50-55, E45-50, CD	Core (utilized)	Curzon	No
A480099	N45-50, E40-45, CD	Core Fragment	Spring Branch	Yes
A480118	N60-65, E35-40, CD	Core Fragment	Spring Branch	No
A480105	N50-55, E45-50	Core Fragment	Unknown Pennsylvanian	No

A480072	N50-55, E45-50, F1, CD	End Scraper	Argentine (black)	Yes
A480112	N55-60, E45-50, CD	End Scraper	Argentine (black)	Yes
A480109	N55-60, E40-45, CD	End Scraper	Chalky Pennsylvanian	No
A480085	F4 (Firepit)	End Scraper	Curzon	No
A480105	N50-55, E45-50	End Scraper	Curzon	No
A480105	N50-55, E45-50	End Scraper	Curzon	No
A480122	N60-65, E45-50	End Scraper	Curzon	Yes
A480081	N50-51, E45-46, CD, Same Elevation as F3	End Scraper	Spring Branch	No
A480097	N50-55, E40-45, CD	End Scraper	Spring Branch	Yes
A480105	N50-55, E45-50	End Scraper	Spring Branch	No
A480109	N55-60, E40-45, CD	End Scraper	Spring Branch	No
A480115	N60-65, E35-40, CD	End Scraper	Spring Branch	No
A480124	N60-65, E45-50	End Scraper	Spring Branch	No
A480138	Slump Material	End Scraper	Spring Branch	No
A480109	N55-60, E40-45, CD	End Scraper	Unknown	No
A480092	N45-50, E40-45, CD	Graver	Argentine	No
A480105	N50-55, E45-50	Graver	Curzon	No
A480105	N50-55, E45-50	Graver	Curzon	No
A480118	N60-65, E35-40, CD	Graver	Curzon	No
A480118	N60-65, E35-40, CD	Graver	Curzon	No
A480069	N55-55, E40-50, F1, CD	Graver	Glacial Till	No
A480108	N55-60, E35-40, CD	Graver	Spring Branch	No
A480118	N60-65, E35-40, CD	Graver	Spring Branch	No
A480123	N60-65, E45-50, CD	Graver	Spring Branch	No
A180090	N65-70, E50-55	Graver	Spring Branch	No
A380141	Slump Material	Graver	Spring Branch	No
A480099	N45-50, E40-45, CD	Graver	Unknown	No
A480074	N50-55, E45-50, F1, CD	Graver	Unknown Pennsylvanian	No
A480080	F2, CD	Graver/Core	Unknown Pennsylvanian	No
A480105	N50-55, E45-50	Graver/Unifacial	Curzon	No
A480105	N50-55, E45-50	Graver/Unifacial	Curzon	No
A480105	N50-55, E45-50	Graver/Unifacial	Spring Branch	No
A480100	N50-55, E40-45, 0.4' below CD	Graver/Unifacial	Spring Branch	No
A480088	F4 (Firepit)	Hammerstone	Other	No
A480087	F4 (Firepit)	Mano	Other	No
A480114	N60-65, E35-40, CD	Projectile Point	Spring Branch	No
A480071-0	N50-55, E40-45, F1, CD	Rock Fragment	Other	No
A480137	5.6' BS	Unifacial Tool	Argentine	No
A480069	N55-55, E40-50, F1, CD	Unifacial Tool	Argentine (black)	Yes
A480077	N55-60, E45-50, F2, CD	Unifacial Tool	Spring Branch	No
A480076	N55-60, E45-50, F2, CD	Unifacial Tool	Spring Branch	No
A480115	N60-65, E35-40	Unifacial Tool	Spring Branch	No
A480116	N60-65, E35-40, CD	Unifacial Tool	Spring Branch	No
A480068	N55-55, E40-50, F1, CD	Unifacial Tool	Unknown Pennsylvanian	No

A480120	N60-65, E40-45, CD	Unifacial Tool	Yellow Quartzite	No
A480069	N55-55, E40-50, F1, CD	Unifacial Tool	Spring Branch	No
A480069	N55-55, E40-50, F1, CD	Utilized Flake	Brown Pennsylvanian	No
A480097	N50-55, E40-45, CD	Utilized Flake	Curzon	Yes
A480087	N50-55, E40-45, F1, CD	Utilized Flake	Curzon	No
A480105	N50-55, E45-50	Utilized Flake	Curzon	No
A480104	N50-55, E45-50	Utilized Flake	Curzon	No
A480110	N55-60, E40-45, CD	Utilized Flake	Curzon	No
A480118	N60-65, E35-40, CD	Utilized Flake	Curzon	No
A480135	AREA B	Utilized Flake	Glacial Till	No
A480135	AREA B	Utilized Flake	Glacial Till	No
A480102	N55-60, E45-50, CD	Utilized Flake	Glacial Till	No
A480127	FACE OF CD	Utilized Flake	Spring Branch	No
A480097	N50-55, E40-45, CD	Utilized Flake	Spring Branch	Yes
A480070	N50-55, E40-45, F1, CD	Utilized Flake	Spring Branch	Yes
A480107	N55-60, E35-40, CD	Utilized Flake	Spring Branch	No
A480111	N55-60, E40-45, CD	Utilized Flake	Spring Branch	No
A480113	N55-60, E45-50, CD	Utilized Flake	Spring Branch	No
A480113	N55-60, E45-50, CD	Utilized Flake	Spring Branch	No
A480118	N60-65, E35-40, CD	Utilized Flake	Spring Branch	No
A480086	F4 (Firepit)	Utilized Flake	Unknown	Yes
A480089	F4 (Firepit)	Utilized Flake	Unknown Pennsylvanian	No
A480064	N45-50, E45-50, F1, CD	Utilized Flake	Unknown Pennsylvanian	No
A480104	N50-55, E45-50	Utilized Flake	Unknown Pennsylvanian	No
A480104	N50-55, E45-50	Utilized Flake	Unknown Pennsylvanian	No
A480069	N55-55, E40-50, F1, CD	Utilized Flake	Unknown Pennsylvanian	No
A480113	N55-60, E45-50, CD	Utilized Flake	Unknown Pennsylvanian	No
A480078	N60-65, E45-50, F2, CD	Utilized Flake	Unknown Pennsylvanian	No