A MORPHOLOGICAL ANALYSIS OF END SCRAPERS AT NOBLES POND (33ST357), A GAINEY PHASE PALEOINDIAN SITE IN NORTHEAST OHIO

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by

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CHAPTER 1

Introduction

Stone tools comprise a large portion of the archaeological record in North America. Since this aspect of material culture is sometimes the sole insight into prehistoric lifestyles, a methodological framework centered on the role of technology is essential to help elucidate cultural adaptations. The organization of technology concept has been central to the study of stone tools in archaeology since the 1970’s in North America (Andrefsky 2009) and serves this role for many archaeological investigations. The organization of technology methodology focuses on why tools were created as well as how they functioned and changed throughout their use-lives. Additionally, this concept attempts to understand the mindset of past people and how their treatment of stone tools can potentially reflect additional aspects of society. An organization of technology approach allows archaeologists to more fully understand past societies through examination of the use-lives of the tools that they left behind.

The notion of tool curation is integral to the organization of technology concept (Binford 1973: 242-244; 1979; Bamforth 1986; Odell 1996). The idea of curation relates to raw materials, tool blanks, and finished tools that have been created and/or transported in “…anticipation of future usage” (Binford 1979:269). Bamforth (1986:39) breaks this
concept into a number of different facets: “production of implements in advance for use, design of implements for multiple uses, transport of implements from location to location, maintenance, and recycling.” As his delineation suggests, the concept of curation is necessarily intertwined with that of use-life and also reduction sequence.

The organization of technology framework offers a unique way to examine the role of stone tools in cultures that have long since disappeared. In essence, because certain stone tools have been made, used, salvaged, recycled, and discarded in specific ways, the use-life models created can demonstrate many unique characteristics about the people who made the tools, as well as the environment in which they lived.

An organization of technology approach is extremely useful when examining the remains of Paleoindian people in North America, as their technological suite consisted mainly of stone tools. These pioneer populations existed in North America from roughly 11,600 B.P. to 10,000 B.P. The existence of Paleoindians was above all focused on day-to-day survival, which typically meant following groups of large mammals across the landscape on at least a seasonal basis (Kelly and Todd 1988:233; Seeman 1994:275). The mobility of large mammals demanded that humans themselves lead highly mobile, highly efficient lives, trends that should presumably be reflected in the stone tool assemblages recovered from Paleoindian sites (Frison 1968; Kelly 1988; Kelly and Todd 1988: 235; Shott 1986). Paleoindian sites generally have low-visibility in the archaeological record, a result of the small group sizes and short-term encampments typical of hunter-gatherers (Binford 1978, 1980). What has been demonstrated about
Paleoindian lifestyles in general is that these groups of hunters were living lightly on the land, leaving sparse traces of their presence.

The study of Paleoindian stone tools has the potential to illuminate behavioral adaptations during this important transitional period of prehistory. ‘Paleoindian’ is the term used by archaeologists to signify the first people to inhabit the Americas. As is common in a culture history approach to the past, this period is divided into phases spanning both time and space. Generally based on projectile point typologies, phases tend to be spatially distinct. In the Midwestern United States, the earliest occupation of Paleoindians was roughly 11,500 years ago.

The phase that is relevant to the present study is the Gainey Phase (11,200-10,800 B.P.), which represents a very early incursion of people into this region (Seeman 1994). Although short-lived (roughly 400 years), this cultural horizon was spatially extensive, spreading from Michigan to New England. Nobles Pond (33ST357) is a large Gainey Phase site located in Stark County, Ohio, with the largest assemblage of end scrapers (a diagnostic unifacial scraping tool) recovered from an eastern Paleoindian context.

The assemblage from this site presents a unique opportunity to study how Early Paleoindian groups adapted to the dynamic environments present as the last glaciers retreated from the lower Great Lakes region. As discussed later at length, Wilmsen (1970) has noted that certain geographic trends in lithic technology have been documented as Paleoindian populations moved into the Eastern Woodlands as a result of these variable, cold and wooded environments. In addition, the fact that end scrapers are numerous tools in Paleoindian assemblages allows us to examine questions about the
form and function of these tools with the confidence afforded by large sample sizes. It is important to note that the Nobles Pond scraper assemblage is extremely varied in shape and size, a pattern documented at other Paleoindian sites that has caused researchers to speculate that these tools served a wide range of functions.

The purpose of this thesis is to perform a morphometric analysis on a sample of end scrapers from Nobles Pond to document where the variation lies within this large assemblage and to interpret how this variation is related to functionality. Such a wide range of variation in form could be interpreted in two general ways, either 1) as indicative of multifunctionality or 2) as a result of depletion.

Regarding the single function interpretation, Grimes and Grimes (1985:40-41) suggest that flakeshavers, a unifacial tool type similar in form to end scrapers, were used for whittling wood or bone. In contrast, Wilmsen (1970), in his seminal work on Paleoindian lithic technology, declares that end scrapers were created in two different forms for two different tasks. By observing the angle that the bit of the tool forms (referred to as the retouch angle), he designated those tools with acute bits as specifically designed hide-working tools, while those with steeper bits were made for working wood and harder materials.

This functional argument also incorporates a geographic element. Wilmsen suggests that Paleoindian groups west of the Mississippi River used end scrapers primarily for hide scraping. When populations migrated into the Eastern Woodlands from the Plains, however, Wilmsen asserts that the main function of these tools changed from hide working to working harder materials such as wood and bone. While the
current study cannot address this issue in its entirety, it can provide evidence for or against key elements in Wilmsen’s thesis.

The central focus of this thesis is to evaluate Wilmsen’s findings regarding the functional significance of the distal edge angle (retouch angle) on Paleoindian end scrapers. His conclusions will be tested using a number of methods in a bottom-up approach. Specifically, the sample will first be analyzed in a univariate framework. Following this, retouch angle will be examined in association with a number of other morphological characteristics related to end scraper function and/or depletion in order to determine if any relationships are evident. Finally, three multivariate tests will be conducted in order to determine the nature of morphological variation in the Nobles Pond assemblage of end scrapers and to see if retouch angle is in any way related to this variation. My intent is to use increasingly complex statistical tests to examine morphometric variability within this tool class.

Following the lead of Wilmsen, many subsequent researchers have interpreted Paleoindian end scrapers as multifunctional tools. In his report on the Leavitt Paleoindian site, Shott (1993:75-76) concludes through statistical and edge-wear analyses that these unifacial tools were used for many purposes, such as cutting and scraping, among a number of other possibilities. Similarly, Collins and Byrd (1994) utilize a Principle Components Analysis and a Cluster Analysis to document the variation in end scraper morphology at Paleo Crossing, an early Paleoindian site in Medina County, Ohio, concluding that tangible functional clusters of these tools exist. Frison and Todd (1987), in their analysis of the Horner site, also came to the conclusion that end scrapers were
multifunctional, though their support for this claim was tenuous. Each of these researchers independently concluded that given the opportunity, Paleoindian end scrapers were utilized for many tasks, such as hide-working, bone working, and wood-working.

While documenting the variation in end scraper form is the goal of this project, developing conclusions as to the specific function or functions of these tools is not. Instead, I rely on the literature, which generally demonstrates that ethnographically, the predominant design function of end scrapers was hide-working (Clark and Kurashina 1981; Gallagher 1977; Shott and Weedman 2007; Weedman 2000). Trianguloid end scrapers like those found at Nobles Pond have been documented across many spatiotemporal boundaries. Sites from Paleolithic Europe (eg: Bolus and Conard 2001; See also Blades 2003 for a cogent comparison of scraper technology in Europe and the Americas) to those of the proto-historic deer skin trade in the southeastern United States (eg: Hoffman 1992) have produced analogous formal tools. Despite the archaeological and ethnographic evidence, the possibility remains that these hafted tools could have in fact been designed for other single scraping functions such as woodworking or butchering, to name a few.

An ancillary research question to be addressed by this study is the relationship of sample size to formal variability. By assembling the Nobles Pond end scrapers incrementally for analysis, a depiction of how the descriptive statistics of the assemblage change with increased sample size can be recorded. Ideally, as the sample size increases, the standard error around the means of each variable will decrease in turn and eventually even out. This will help identify when the point of diminishing returns occurs, or when
adding more cases to the sample has decreasing utility. Such a measure will allow an accurate estimation of how many end scrapers are needed to obtain a representative sample of the population. In turn, this will be useful to other researchers whose available assemblages are not as extensive as that of Nobles Pond.

This morphometric analysis of Noble’s Pond end scrapers serves to address the issue of variation in end scraper form with the hope of illuminating issues of functionality. Through several statistical tests, the hypothesis that the variation in end scraper morphology is due to depletion of a functionally redundant class of tools will be tested.
Chapter 2

Background

Before advancing to the morphometric analysis of the end scraper assemblage from Nobles Pond, a brief background of end scrapers and some of the research that has been done on these tools is warranted.

Paleoindian End Scrapers

Paleoindian end scrapers have been defined as “unifacially flaked tools made from a flake blank…[whose] striking platform…generally forms the proximal, or ‘butt’ end of the tool and the distal end…generally forms the distal ‘bit’ or working end” (Morrow 1997:71). More simply, they are unifacial flakes which “…always have a steep retouch that forms a bit on the edge opposite the butt” (Irwin and Wormington 1970: 28). End scrapers frequently have been labeled as diagnostic Paleoindian artifacts (Judge 1973; Morrow 1997) and are often the most abundant tools recovered at such sites, especially in eastern North America (MacDonald 1969; Witthoft 1952).

Most Paleoindian end scrapers were undoubtedly hafted tools, an inference supported by their small size, symmetry, characteristic lateral retouch, and the presence
of paired notches on some specimens (Ellis and Deller 2000; Shott 1995:55-59; Wilmsen 1968:157; see also Grimes and Grimes 1985:40 for a similar discussion on Paleoindian flakeshavers). Hafting served the purpose of supporting the bit as the force of the tool was directed through it (Ellis and Deller 2000). The trianguloid outline is assumed to facilitate some sort of socketed hafting arrangement where the bit is inserted in a handle of wood, bone, or antler.

Wilmsen

Despite the variation in this formal tool type, early Paleoindian studies were often simply descriptive and lack any functional interpretation (eg, Wormington 1957; Whitthoft 1952). Beginning in the 1960’s, however, the “New Archaeology” movement provided a clear agenda for studying the relationship between the form and function of tools. Testing explicit hypotheses allowed researchers to elucidate the cultural meaning associated with prehistoric tools. This trend is exemplified in Wilmsen’s (1970) seminal work on Paleoindian stone tools, *Lithic Analysis & Cultural Inference: A Paleoindian Case*, in which he attempts to construct “general laws of cultural processes” (1970:1). In this monograph, he brings together a wealth of information on various types of Paleoindian sites throughout the continental United States. Today, these sites are regarded as some of the most complete and thoroughly studied from this time period and as such represent one of the best comparative Paleoindian lithic studies.

Wilmsen selected a sample of 494 tools from eight sites across the North American continent (see Wilmsen 1970:9). Overall, 42 variables were observed in his analysis, 9 of which were continuous. For these continuous variables, typical descriptive
statistics such as mean, standard deviation, and standard error were computed.

Unsatisfied with simple typological or descriptive methods, Wilmsen describes the variation within the assemblage of formal tools using a factor analysis, which resulted in 16 categories of tools, 5 of which he defined as different forms of end scrapers (see Wilmsen 1970: 56-58).

Interestingly, the 5 ‘types’ of end scrapers defined by Wilmsen have a geographic relationship. Those end scrapers with higher retouch angles tend to be east of the Mississippi River. This trend leads Wilmsen to assert that the move eastward into more wooded environments necessitated end scrapers with higher retouch angles. In essence, his argument is that in the more open landscapes of western North America, end scrapers were typically used as hide working tools. As Paleoindians moved into the Eastern Woodlands, Wilmsen asserts, they began using these tools primarily for wood working and bone working (1970:73).

As this assertion suggests, retouch angle is an important functional marker in Wilmsen’s study. He states that “… the different angle sizes are related to different functions. More acute bits (≈ 55º), in this interpretation, are associated with the preparation of hides, while steeper bits (≈ 75º) are associated with heavy wood and bone working” (1970:71). From this argument, we can assume that end scraper assemblages could easily be differentiated into two general functional categories based on retouch angle, a problem which will be revisited later.
Grimes and Grimes

While Wilmsen’s study provides one of the first processual studies of Paleoindian lithic technology, it is lacking the use-life lens typically offered by organization of technology studies. Grimes and Grimes (1985) present the first attempt to bring an organization of technology methodology to the study of Paleoindian unifacial stone tools. The authors develop a use-life model of flakeshavers from the Bull Brook site in Massachusetts, taking into account the complexities of their reuse. Flakeshavers are elongated unifacial tools, similar to end scrapers, which are commonly recovered from eastern North American Paleoindian sites in association with fluted points (Grimes and Grimes 1985:35). Because of the similarities between flakeshavers and end scrapers both in form and, assumedly, general function, the results of their study on flakeshavers are imminently relevant to the use-life of end scrapers at Paleoindian sites.

By documenting the possible ways in which a tool may have progressed through its use-life, information can be obtained on the decisions that were made at each step and the needs that fueled them. Grimes and Grimes create a use-life model of flakeshavers (1985:51) much in the tradition of Schiffer (1972), in that they look at the processes in the ‘systemic context,’ or real life context, that could have produced what we see in the ‘archaeological context.’ Central to this model is the breakage and subsequent retouch and reuse of flakeshavers.

Reworking and reuse of broken formal tools is a typical Paleoindian characteristic (Frison 1968; Kelly and Todd 1988). When the acquisition of high-quality raw material resources may have been limited to only a few times a year (Binford 1979), recycling and
salvaging broken stone tools would have provided a necessary safeguard. In the case of the Bull Brook flakeshavers, 67% of the tools are reworked fragments (Grimes and Grimes 1985:36-39). Such a distinct trend highlights the need to make do with viable reworked pieces instead of using valuable stone to create new ones. This is visible in a number of specimens in which “…breakage at the haft did not necessarily represent the end of the useful life of the tool,” but instead “…the snapped distal portions have been retouched to produce a new base” (Grimes and Grimes 1985:41). The new base would have been morphologically similar to the proximal portion of the original tool in order to facilitate re-hafting.

Another concept critical to Grimes and Grimes’ analysis is the idea that there is a minimum functional length that exists for hafted tools (1985:41), after which the tool would be either discarded or recycled into a functionally different tool. Taking into account the idea that both flakeshavers and end scrapers were likely hafted tools (Grimes and Grimes 1985:40; Shott 1995:55-59; Wilmsen 1968:157), their inferred minimum functional length would be about 2.14 cm (Grimes and Grimes 1985:43). In the case of these tools, when a little over 2 cm of the tool was remaining outside of the haft, it was viewed as functionally exhausted, and thus discarded. Assumedly, this was a result of the tool being too close to the haft-tool juncture, which may have decreased the functionality of the tool as well as increased the risk of damaging whatever material was being worked on.

Minimal functional length is an important concept when considering to what extent tools in a particular assemblage were being curated. If a large number of tools are
relatively close to the determined minimal functional length, it can be assumed that these tools went through a cycle of use and retouch until their potential utility was exhausted. Conversely, if an assemblage has numerous cases that are longer than the minimum functional length, it can be assumed that tools were not being used to their full potential.

**Collins and Byrd**

The informal patterning of variation in flakeshavers at Bull Brook leaves something to be desired in terms of multivariate statistical methodology. At the 1994 Society for American Archaeology meeting, Collins and Byrd presented a paper entitled *Morphology, Function and Use Life: A Multivariate Evaluation of the Paleo Crossing End Scraper Assemblage*. This paper details the methods and results of a multivariate statistical analysis of end scrapers from Paleo Crossing, a Paleoindian site in Medina County, Ohio. Collins and Byrd analyzed a total of 117 end scrapers, focusing on morphological variation. Drawing heavily on Wynn and Tierson’s work on Acheulean hand-axes (1990:74), Collins and Byrd used a system of rays to capture the shape constraints of the tools. This method was opted for over “…traditional measures, such as length, breadth, thickness, etc. because it was better at measuring asymmetry and seemed to make fewer assumptions about relevant variables” (Collins and Byrd 1994: 4). While this does not precisely mesh with the methodology used in the present analysis of Nobles Pond end scrapers, a basic comparison can be made based on the fact that the same general attributes (i.e. size, shape, and symmetry) on the same type of tool are being observed.
The statistical methods used by Collins and Byrd are comprised of a principle components analysis (PCA) and a cluster analysis of the assemblage, both of which result in what they see as several functional/morphological categories of end scrapers. The PCA was conducted on all 117 complete end scrapers from the Paleo Crossing sample, resulting in 4 components. To look at variation at both ends of the spectrum for each principle component, they observed the three highest and lowest scoring end scrapers. The first principle component accounts for 59.1% of the variation and, as is typical of most morphometric studies, represents size. They point out that the large range in size of end scrapers in this assemblage should not be interpreted as a functional continuum, and go on to state that “it is doubtful that the end scrapers on the opposite ends of this continuum were used for the same purpose, unless one posits an extreme of curation with end scrapers proceeding down the size continuum to these final diminutive end scrapers” (Collins and Byrd 1994). In fact, this (a continuum of extreme curation and functional redundancy) is exactly what the present study posits would be expected.

The second principle component accounts for 16.4% of the variation. Those end scrapers that load highly on this component and are classified by Collins and Byrd as “rectanguloid.” Conversely, those that had low scores were identified as “long and narrow.” In essence, this component seems to identify shape. The third and fourth components only contain 12.7% of the variation of the assemblage between them. As such, the tangible differences become less apparent, but the third component seems to be a measure of symmetry and the fourth component seems to refer to differences in the bit of the tools.
The next test in Collins and Byrd’s multivariate approach was a cluster analysis. Utilizing Ward’s method, which attempts to minimize variance within each cluster (Ward 1963), they used the raw polar coordinates (rays) in order to “…create clusters on the basis of size as well as shape.” After a number of attempts, they decided on a ten cluster solution, based on visual examination. Their clusters are based decidedly on shape and size, though only sparsely explained in terms of length and width. Once again, Collins and Byrd explicitly restate that these clusters are not indicative of a continuum of reduction, but instead represent different functions, or at least a range of functions (sensu Deller and Ellis 1988).

Shott

The Leavitt Site is a Parkhill phase (~10,600 B.P.) Paleoindian site located in Clinton County, Michigan, north of Lansing. Michael Shott’s (1993) organization of technology analysis of the Leavitt Site end scrapers is decidedly less inductive than the approach used by Collins and Byrd and developed from a use-life perspective that is more in keeping with that of the present study. It is also more in keeping with the pioneering study of Grimes and Grimes (1985).

Shott concluded that the function of end scrapers at Leavitt was multifaceted. Following Wilmsen (1970), Shott views variation in end scraper morphology as indicative of different functions. He asserts that the differences stem from the fact that “…more than one morphological and functional class of end scrapers exist in the assemblage” (1993:75). This typological argument boils down to what Shott sees as the overly broad definition of what constitutes an end scraper. Instead of viewing end
scrapers as a distinct tool class, Shott thinks that this typological designation obscures a
number of classes of tools. To test this, he creates a number of clusters using a polythetic
clustering algorithm. These four clusters are based solely on the nominal variables of:
longitudinal curvature, transverse curvature, damage type, damage distribution, retouch
angle, and bit morphology. Overall, Shott suggests that “assuming that the functional
attributions described above are correct, it appears that Leavitt end scrapers may be a
single functional class at the grossest level…but a set of rather distinct functional sub-
types is indicated” (1993:76). Purportedly these functional levels are cutting and
scraping at the grossest level, though what the functional subtypes may be is not
explicitly addressed.

Regardless of functional variation, a key factor in the use-life of an end scraper
for Shott is reduction, that is, how the tool was reshARPeneD for continued use. One of the
preliminary ways in which Shott identifies reduction at Leavitt is simply by looking at the
skew of length measurements in a histogram. For an assemblage of extensively curated
tools, he expects that “very few specimens should lie below some minimum length value,
most should cluster around it, and some – those not used to depletion but instead lost or
abandoned – should be dispersed above the minimum value” (1993:68). The Leavitt
assemblage of end scrapers demonstrates a marked left-skew, the opposite of what Shott
postulated. On this score, he concludes that end scrapers at Leavitt were perhaps not
being completely utilized.

Also, pertaining to reduction, Shott identifies the extent to which end scrapers
have been used relative to their total potential by looking at the “midline length-haft
length ratio” (1993:74-75). As this ratio gets closer to 1, the tool’s remaining utility is lower. The ratio should never be equal to 1 though, as there is an assumed minimum functional length to hafted tools (Grimes and Grimes 1985:43). At Leavitt, the distribution of the ratio of midline-length to haft-length is distinctly bimodal, a fact which Shott interprets as an indicator of multiple functions.

Finally, Shott concludes that “end scraper bits tend to become more perpendicular with use and resharpening, and those with skewed or canted bits tend to be less extensively reduced” (1993: 74). What this essentially means is that as one of these tools progresses through its use-life, the relative “nosed-ness,” or bit depth of that tool, decreases. To support this, he documents a correlation between the haft-length to midline-length ratio and the adjusted bit angle (r= .66). Thus as an end scraper is depleted, its bit will generally be canted.

In his analysis, Shott highlighted a number of variables that he concluded were important in clarifying particular use-life relationships. For example, he assumes that the distribution of length is a good general indicator of curation within an assemblage (Shott 1993:68). Similarly, bit width angle (the angle of the bit on a line drawn between the proximal-most points of the bit on each side of the tool) is seen as a measure of use and resharpening, indicating roughly how far along in a use-life an end scraper was when it was discarded (1993:74). Shott asserts (1993:72) that retouch angle, in contrast to Wilmsen’s interpretation, is not an indicator of degree of use, but a factor that was held constant by Paleoindian artisans. This suggestion has implications for Wilmsen’s (1970) interpretation of end scraper functionality. Midline length and haft length are both
important as they constitute the measure of depletion mentioned above. Bit damage type and distribution, bit curvature, and tool curvature are all incorporated into Shott’s (1993:75-76) clustering algorithm that supposedly found clusters of functionally different end scrapers.

**Nobles Pond Site**

With these previous works in mind, it is time to turn to the analysis of Nobles Pond end scrapers. The sample of end scrapers used in this study was collected at the Nobles Pond site (33ST357) beginning in the 1988 field season. The project was undertaken as a salvage operation as a result of the imminent construction of a housing complex. Located in Stark County, Ohio near Canton, the site sits on a small glacial outwash terrace between Nobles Pond and another glacial kettle lake. The Nobles Pond site is a unique North American Paleoindian site, as it has yielded the largest amount trianguloid end scrapers (n=1,821), although the recovery of a multitude of end scrapers on sites from this era is common throughout the eastern half of the continent. Many major early Paleoindian sites east of the Mississippi River follow this trend, including Shoop in Pennsylvania (Witthoft 1952) and Debert in Nova Scotia (MacDonald 1969).

To ensure precision, noting artifact provenience was stressed when possible, although some artifacts collected from the surface lack specific provenience. After collection and excavation at the site, artifact locations were mapped, creating at least 14 distinct loci of especially dense distributions. For analysis purposes, the sample used in this study is limited to two locations; the “South Field” and “Block F” (see Figure 1). These areas produced distinct assemblages; especially notable is that significantly more end scrapers
were recovered from the South Field than from Block F. The South Field is a group of six concentrations that have been argued to be archaeologically contemporaneous (Seeman 1994) and represent the largest and/or longest occupation of the site. Conversely, Block F is a single, more dispersed locus that has been interpreted as a short term or small group occupation. This distinction points either to different habitation lengths and/or group sizes at these two areas, characteristics which both lend themselves to subsequent comparison.

Figure 1: Map of Nobles Pond Clusters, Block F and the South Field Circled
Chapter 3

Sampling

Nobles Pond is a large site and has yielded a very large collection of discarded end scrapers. In order to increase the representativeness of the results, an effort was made to maximize the sample size used for this investigation, and focus on a comparison between Block F and South Field areas at Nobles Pond. Sampling is a fundamental aspect of archaeological research (Binford 1964). In order to measure the complete range of attributes in the Nobles Pond assemblage of end scrapers, only complete specimens were examined. It should be noted though that some tools were functionally complete yet morphologically incomplete as a result of small haft-breaks that removed the proximal end. Such breakage can take place within the haft as a function of forces generated in resharpening and do not affect functionality (M. Seeman, Personal Communication, 2011). These were included in the study because they still represent functional tools.

In the case of Block F, every complete end scraper from the excavation was included in this analysis (n=26; 26/26 = 100%). Block F is an isolated concentration or locus of activity on the northern part of the site. End scraper raw materials are dominated
by Upper Mercer (69%) and Flint Ridge (23%), as well as a number of less frequently encountered materials.

The South Field consists of a group of six loci that have been linked together by refits, spacing, and raw material choices (Seeman 1994). For these reasons, the South Field has been interpreted as a group of contemporaneous loci and shall be used here as one analytical unit. A sample of 88 out of a total of 149 end scrapers was taken from the South Field assemblage (88/144=59%). The majority of the sample was composed of Flint Ridge (52.3%) and Upper Mercer (38.6%) cherts, with a number of additional raw material types representing the remainder. An effort was made to select all of the complete end scrapers from the South Field, which proved surprisingly difficult. Some of these tools already had been pulled from their provenience unit-lots and placed in frames of end scrapers and some had not. All end scrapers from each available frame were incorporated into the morphometric analysis. Several months after the initiation of the study another frame of 40 complete end scrapers was located. A sample of 50% of these were selected and added into my already initiated study. Approximately five months later, 37 additional end scrapers were located, but not included in the present analysis.

The sampling method utilized for this selection of Nobles Pond end scrapers was aimed to prevent sampling bias such as opting for those end scrapers which fit the preconceived notions of what the ‘typical’ trianguloid specimen should look like.
Chapter 4

Methods

A total of 53 variables were observed on each tool in the sample of 114 complete end scrapers from Nobles Pond. While some variables were taken from Morrow (1997), and Wilmsen (1970), the majority were taken from Shott (1993) in order to facilitate a direct comparison between the Nobles Pond and Leavitt assemblages, and additionally, some variables were either added or modified to capture variation in size, shape, and symmetry as the researcher saw fit. A multi-step and flexible methodology was advantageous in this respect in that it helped provide a more complete analysis of each artifact; certain important trends or aspects were only noticeable after analyzing a number of end scrapers. What follows is a complete list and brief rationale of the variables used in this analysis. Variables are sorted under the headings of manufacture, haft characteristics, depletion, and secondary use.

Those variables listed under the category of manufacture include:

1. Raw material: Type of chert or flint from which the end scraper was produced.

2. Raw material color: Color of the raw material, based on a predetermined scheme used in previous analyses of the Nobles Pond assemblage.

present on the tool. Differentiating between flat and faceted platforms can offer insight into how the end scraper was produced, as flakes removed from a prepared core have fewer facets than those removed from a bifacial core (Carr and Bradbury 2003:136-137).

- Recorded as: Flat, Faceted, Hinged/Damaged, Absent, or Obscured by Recycling

4. **Cortex:** Presence/Absence of cortex on any surface of the tool. The presence of cortex can indicate ad hoc production from small cobbles and/or the relative refinement of the core itself.

5. **Cross-section shape** (Shott 1993: 46): Shape of the tool when viewed head-on from the proximal end. This is potentially indicative of the type of core the end scraper was removed from or if it was salvaged from another tool. The production of end scrapers, as Shott (1993) states, is generally a result of reduction from flakes derived either from a prepared core or from a bifacial core. Those end scrapers that exhibit either keeled or fluted cross-sections are thought to have come from prepared cores. Conversely, those end scrapers with an “all over flaking” cross-section are viewed as a product of biface reduction debris, while those labeled as “other” are thought to have been recycled from other tools.

- Recorded as: Fluted, Keeled, Other, or All-Over Flaking

6. **Blank type:** The type blank that the tool was produced from. This serves to differentiate tools produced from a flake blank from those that were recycled from other tools.

- Recorded as: Tool Fragment, Flake (i.e. bifacial or prepared core), Other
7. **Longitudinal curvature** (Shott 1993:50; Wilmsen 1970:13): Amount of curvature apparent in the tool when viewed from a lateral margin. This measure represents a qualitative way to differentiate between end scrapers removed from prepared cores and those removed from bifacial cores (Shott 1993: 51; 58).

   - Recorded as: Flat, Minimal, Pronounced

8. **Platform angle** (Shott 1993: 46; Wilmsen 1970: 14): Only measured on those tools where the platform was evident and undamaged. This is the angle created by the platform and the ventral side of the flake when placed against a template with different angle ranges. This was measured to the nearest 5° for the sake of repeatability and accuracy.

9. **Platform width** (Shott 1993: 46; Wilmsen 1970: 15): Only measured on those tools where the platform was evident and undamaged. This is measured from the extent of the platform from one lateral margin to the opposite lateral margin, measured to the nearest hundredth of a millimeter.

10. **Platform thickness** (Shott 1993: 46; Wilmsen 1970: 15): Only measured on those tools where the platform was evident and undamaged. This is the extent of the platform from the dorsal margin to the ventral margin.

11. **Platform Area**: This variable was computed by multiplying Platform Width and Platform Thickness. Platform area has been suggested to be a measure of original flake size. (Davis and Shea 1998; Dibble 1997, 1998; Dibble and Pelcin 1995; Dibble and Whittaker 1981; Pelcin 1996, 1997, 1998; for an overview of this topic see Shott et al 2000)

   Measure of the length of the tool from the proximal margin to the most distal point.

   Length of a tool can be indicative of tool depletion, especially if the distribution of the entire assemblage is observed (Shott 1993: 68-69).


   Measure of the tool at the farthest extents of the lateral margins, taken perpendicular to the measure of maximum tool length.


   Maximum measure of dorsal to ventral thickness. When the bulb of percussion was evident, maximum thickness was not measured on it (Shott 1993:46; Wilmsen 1970:19). This measure is thought to be one of the few attributes of the original flake blank still evident on the tool, as it is generally not affected by resharpening.

15. **Axial/medial length**: The length of the tool measured on the midline. Specially designed grid paper was used to capture this and the following six variables.

16. **Axial length to bit** (Shott 1993: 50): The length of the tool on the midline to the most proximal evidence of retouch. This was measured on grid paper as the axial length to the line connecting each bit edge. Axial length to bit measures the relative convexity of an end scraper bit on the midline.

17. **Perpendicular bit width**: The distance from the most proximal extent of the bit to the midline, measured perpendicular to the midline on both left and right sides.

18.-20. **Width at 5mm; Width at 10mm; Width at 20mm**: Measurement of the extent of the tools from the midline to each lateral margin. Taken in ‘left’ and ‘right’
measurements, which were then added into legitimate tool width measurements for each interval. These variables capture tool symmetry throughout the length of the tool.

21. **Symmetry at 20cm**: The absolute value of the difference between the right and left measurements at 20cm. Computed using the formula: $|\text{Width at 20cm Left} - \text{Width at 20cm Right}|$. This measures the symmetry of the tool roughly where the hafting element may have been located.

22. **Perpendicular Bit Symmetry**: The absolute value of the difference between the right and left measurements taken at the bit, perpendicular to the longitudinal axis of the tool. Computed using the formula:

$$|\text{Perpendicular Bit Width Left} - \text{Perpendicular Bit Width Right}|.$$ This measures the symmetry of the bit itself, which may be affected by resharpening intensity.

23. **Area of the ventral surface**: The surface area of the tool measured in cm$^2$. Instead of the rough length*width approximation often used (eg Shott et al. 2000), this was measured using ImageJ, a freeware image editing program. This software allows the user to trace the outline of a shape and provide an accurate measure of surface area, as long as an appropriate scale is used to calibrate the program.

24. **Weight** (Shott 1993: 46): The weight of the tool, measured to the nearest tenth of a gram. This represents a summary measure of tool size.

25. **Triangularity**: This variable reports the width of the tool at 5mm divided by the perpendicular bit width of the tool. This calculation gives a relative sense of how
proximally tapered the tool is; those tools with a measure closer to zero are generally more triangular. It is assumed that the ‘trianguloid’ nature of end scrapers must have been functionally important for hafting, most likely in some sort of socket.

26. **Longitudinal Cross Section**: This variable is the result of the thickness at 10mm divided by the axial thickness of the tool. In order to determine the relative evenness of the cross section, this computation was required. It was devised so that smaller values represent tools that have a relatively even cross section.

27. **Surface Area/Maximum Thickness**: The surface area and thickness variables were conflated into one measure of relative curation. A relatively constant variable (thickness) is compared to one that would be reduced as the tool was retouched and reused (surface area). This provides an individualized measure of relative curation. In this sense, tools with a larger ratio would be less reduced given their size.

Variables labeled as **haft characteristics** are:

28. **Length of haft element** (Shott 1993: 49): Measured if evidence of hafting was observed on the end scraper. This was observed by looking for a change in the angle of each lateral margin. If there happened to be corresponding deviations in lateral edges, these were interpreted as evidence of hafting. This variable is simply the distance from the proximal margin to the spot where hafting is evident, measured on the midline.

29. **Width at haft**: Measured if evidence of hafting was observed on the end scraper. This is the width of the tool at the haft.
30. **Presence of dorsal thinning** (Shott 1993: 49): The presence or absence of flake scars on the dorsal side of the proximal end of the tool, usually running parallel to the tool’s orientation. It is indicative of an attempt to thin the proximal end of the tool in order to fit (or refit) the end scraper into a haft.

31. **Presence of left haft notch** (Shott 1993: 49): Presence/Absence of a haft notch on the left lateral margin of the tool. Notches are somewhat subjective, as many researchers report different gradations of indentations as notches. For sake of consistency and continuity, ‘notches’ were based on characteristics found in Ellis and Deller’s analysis of the Parkhill site (2000:130, Figure 6.20).

32. **Distance from base to left haft notch**: If available, the straight-line distance from the notch to the proximal margin.

33. **Presence of right haft notch** (Shott 1993: 49): Presence/Absence of a haft notch on the right lateral margin of the tool. Notches are somewhat subjective, as many researchers report different gradations of indentations as notches. For sake of consistency and continuity, ‘notches’ were based on characteristics found in Ellis and Deller’s analysis of the Parkhill site (2000: 130, Figure 6.20).

34. **Distance from base to right haft notch**: If available, the straight-line distance from the notch to the proximal margin. This measurement is indicative of the amount of the tool that was inside the haft.

35. **Thickness 10mm from the proximal margin**: Thickness of the tool at 10 mm from the proximal margin. This was taken in order to see if there was an attempt to conform this end of the tool to a specified or standard haft dimension.
36. **Bulb Condition** (Shott 1993: 48 [as Bulb Thinning]): Records whether or not there was an attempt to remove the bulb of percussion, presumably for hafting reasons. A bulb of percussion was assumed to occupy one of three conditions on the ventral side of the tool. It could be present, it could be absent, or third, it could have been present on the original flake blank and subsequently been removed. The removal of the bulb is assumed to relate to hafting considerations. In contrast to evidence for the presence of either a bulb or purposeful bulb removal, the absence of bulb is taken as good evidence of proximal salvage after breakage or recycling from other tool categories.

37. **Bulb Presence**: This dichotomous variable represents a simplification of the above bulb condition variable. In essence, it breaks bulb condition into whether or not the bulb was present on the tool at any time. It was recorded as present, which includes both intact and removed bulbs of percussion, and absent, which includes those tools which have no evidence of a bulb on them.

**Depletion** characteristics focus on the morphology of the working bit, including:

38. **True bit width** (Shott 1993: 50): Straight-line measure from one corner of the bit to the opposite end. This demonstrates the size of the bit at the time of discard and should decrease with depletion.

39. **Bit depth** (Shott 1993: 50 [as Convexity]): The ‘nosed-ness’ of the tool, or how far the bit projects. Tools with shorter bits are thought to be more depleted (Shott 1993:74).

40. **Thickness at retouch termination** (Shott 1993: 50): Measurement taken at the thickest point where retouch scars are evident at the bit/dorsal surface junction. Relative to
maximum thickness, this may demonstrate a general measure of how depleted an end scraper was at discard (sensu Kuhn 1990).

41. **Bit width angle** (Shott 1993:50): The angle created by drawing a line between the two most proximal points of the bit. This was measured by placing a protractor on the midline and taking the angle. How far this angle is off of 90° demonstrates how canted the bit is. This asymmetry demonstrates in a general sense how much resharpening an end scraper underwent. To record this measure, points were established on graph paper at the proximal-most extend of the bit on each margin. These were connected and extended in a line. Using a protractor based on the midline, the angle was then taken.

42. **Bit Angle Off of 90°**: The absolute value of the difference between the angle of the bit and 90°. Calculated by the formula: 
\[ \text{Bit Angle off 90°} = |90 - \text{Bit Width Angle}|. \]
This provides a normalized portrayal of how canted end scraper bits are.

43. **True bit width left and right**: The measure of bit width from the midline, measured on the line created to measure the bit width angle. This was taken on graph paper by marking the proximal-most extend of the bit on each margin, then connecting them with a line. The measurement was then taken on that line, from each point to the medial axis.

44. **Bit Width Symmetry**: The absolute value of the difference between the left and right bit width measurements, measured on the line of the bit angle. Calculated with the formula: 
\[ |\text{True Bit Width Left} - \text{True Bit Width Right}|. \] This measure provides an accurate measure of how symmetric or asymmetric each tool bit is on an axis from
one edge of the bit to the other. Additionally, using the measure from before the absolute value was taken, information can be obtained regarding which direction the asymmetry skews towards.

45. **Thickness on the midline at the axial length-to-bit point** (Shott 1993: 50 [as Bit Thickness]): The point of most invasive retouch, measured on the midline of the tool.

46. **Retouch angle** (Morrow 1997: 72 [as Working Edge Angle]; Shott 1993: 50; Wilmsen 1970: 15 [as angle *delta* distal]): This is the angle between the dorsal and ventral surfaces on the distal end of the tool, measured as close to the midline as possible. It was measured by using a template that consisted of angles in 5° increments. Each tool was classified as the angle that it matched the closest. Though a continuous measurement would have been more useful, both accuracy and replicability would have been sacrificed. Retouch angle was recorded by comparing the bit angle evident within 10 mm of the bit. Since this measurement involves not the intersection of two lines, but two curves, replicability problems increase with attempts at greater precision. Shott (1993:74) suggests edge angle is a function of resharpening and increases with depletion. Wilmsen (1970), on the contrary, suggests that this angle represents the function an end scraper served, with steeper edge angles being associated with woodworking, and more acute angles being associated with hide working.

47. **Bit edge regularity of curvature** (Shott 1993: 50 [as Edge Shape]): How excrivate or uniform the bit of the tool is.

- Recorded as: Regular, Semi-Regular, Irregular
48. **Bit edge scarring type** (Shott 1993: 50): Type of scarring exhibited on the bit of the tool.
   - Recorded as: Scalar, Step, Crescentric, Indistinct

49. **Bit edge scarring distribution** (Shott 1993: 50): How the scarring, if any, is distributed along the bit of the tool.
   - Recorded as: Continuous, Patchy, Isolated, N/A

   **Secondary use** characteristics record whether or not each tool was salvaged or recycled after its initial use-life was exhausted by normal depletion. They include:

50. **Posthaft modification**: Presence/Absence of any type of modification after the tool’s function as an end scraper ended. Recycling of broken or exhausted end scrapers is typically seen in the form of graver spurs, placed on the bit, lateral distal corners, along the lateral edges, or at the proximal margin.

51. **Location of ancillary tool bit on the end scraper**: Place on the end scraper where alternate tools bits are located.
   - Recorded as: N/A, Other tool bit on proximal half of tool, Other tool bit on use-broken surface, Other tool bit on fire-broken surface, Other tool bit on distal half of tools (including graver spurs), Other tool bit on proximal and distal

52. **Notches I**: Location of notches, if present, on the end scraper. Unpaired notches are assumed to relate more to secondary functionality (i.e. spokeshaves) rather than hafting.
   - Recorded as: Absent, Present - prox 1/3 of whole scraper, Present - medial 1/3 of whole scraper, Present - distal 1/3 of whole scraper, Present - prox and medial of whole scraper, Present - prox and distal of whole scraper, Present - medial and distal of whole scraper, Present - on scraper fragment
53. **Notches II**: Whether or not notches were paired. If only one notch was observed, it was recorded as ‘N/A.’ This variable may relate more to hafting characteristics than post-haft modification, but was recorded in this position on the code sheet because of the utility of contrasting it with the preceding attribute.

- Recorded as: N/A, Paired, Unpaired

54. **Type of ancillary bit**: The type(s) of additional tool bit(s) identified on the tool.

- Recorded as: None, Graver, Graver Stub, Perforator, Retouched Flake, Denticulate, Narrow-Nosed Scraper, Spokeshave, Regular End Scraper Bit
- Additionally, each was given a location qualifier: Distal Margin, Outside Haft Element, Inside Haft Element, On Break, On Distal Corner-Right, On Distal Corner-Left, On Distal Corner-Right and Left

55. **Modification for re-hafting**: Presence/Absence of retouch along the proximal margin, which is indicative of a broken tool that was retouched in order to facilitate rehafting. Typically, these are haft breaks, resulting in a piece of the proximal end snapping off from repeated stress inside the haft.

56. **Length between the point of maximum thickness and the point of retouch thickness**: Distance from the point of maximum thickness parallel to the medial axis of the tool to a perpendicular line constructed from the point of maximum retouch thickness. This distance could be a comparative measure of how much remaining utility a tool had when it was discarded (*sensu* Kuhn 1990).

57. **Distance from point of maximum thickness to the proximal margin**: Straight-line distance from the point of maximum thickness to the proximal margin, perpendicular to the long axis of the tools.
58. **Maximum retouch angle**: The maximum retouch angle anywhere on the bit of the tool. If this is present, it could be indicative of a failed resharpening event that contributed to the discard of the tool, especially if it is steeper than the retouch angle as measured at the longitudinal axis (midline) of the tool.

Fifty-seven total variables pertaining to size, shape, symmetry, recycling, and salvage were recorded on end scrapers from the South Field and F Block localities at Nobles Pond. In order to conduct the morphometric analysis, each continuous variable was measured using digital calipers to the nearest hundredth of a millimeter. Descriptive, categorical variables were observed using a lighted magnifying lens (~5x). Each variable was measured and recorded systematically on specifically designed templates (See Appendix A). Some of the more subjective variables required examples. For example, the variable cross-section shape has one unapparent class, “all over flaking,” for which examples (NP#s: 40805, 29145, 34422) were used to ensure systematic identification of this characteristic. Also, in order to differentiate “pronounced” longitudinal curvature from “minimal,” NP#34275 was used as an example of how excurvate these tools can be. Similarly, both the regularity and scarring of the bit required reference examples. Bit edge regularity of curvature had “regular” (NP#50865), “semi-regular” (NP# 47908), and “irregular” (NP#33867) examples. For the most part, bit edge scarring types were self evident, though an example was helpful for the “indistinct” category (NP#40805).

To quantify the symmetry of end scrapers, a method was needed to accurately measure to the left and right of the midline of each artifact. To do this, Wilmsen’s (1970:17-21) idea of polar graph paper was modified to a grid with colored lines and a
solid midline. The base grid was black with every 5mm line highlighted in red, making it more conducive to record the left and right measurements of each tool at 5mm intervals. In addition to these measures of bilateral symmetry, the maximum length on the midline and the location of the edges of the bit also were recorded on this graphic template.

As with most studies, the first step in identifying morphometric trends within the dataset assembled for this thesis was to examine descriptive statistics of the continuous variables. In order to observe several factors relating to the production and reduction of end scrapers, both univariate statistical tables and histograms were used. In terms of production, three major variables will be observed: maximum length, maximum width, and maximum thickness. These have the potential to shed light on both deviations from the original flake blank as well as how this class of tools changed in terms of general shape throughout their use-lives. Additionally, retouch angle will also be analyzed to determine how this important value is distributed, which can illuminate patterns that can help assess the validity of Wilmsen’s (1970) interpretations of end scraper function.

In considering the descriptive statistics, there was the prospect of assessing the costs and benefits from increased sample size, especially in light of the fact that the Nobles Pond population is one of the largest available. Consequently, 3 variables were considered incrementally in order to detect points of diminishing returns with increased sample size. Consequently, cases were measured in ascending intervals of 10 specimens (i.e. first 10, then 20, then 30, etc.). Only the end scrapers from the South Field (n=88) were included in this aspect of the analysis. The expected outcome is that as the sample number increases, the standard errors of the means will decrease, and the means
themselves will begin to even out. The standard error is the standard deviation of sample means; it “measures how representative a sample is likely to be of the population. A larger standard error means that there is a lot of variability…A small standard error indicates that most sample means are similar to the population mean and so our sample is likely to be an accurate reflection of the population” (Field 2009:43). Hopefully, this will demonstrate when the point of diminishing returns occurs. Three common variables were included in this test: maximum length, maximum width, and maximum thickness.

Subsequent to an examination of individual variables and associated descriptive statistics, bivariate scatter plots were used to compare the relationship between two variables. While the visual representation of these data demonstrates a general sense of relatedness, a statistical measure is required as well. The coefficient of determination ($R^2$) is a useful statistic to determine how well a given model fits the data (Carr and Bradbury 2003:135). It is a proportion of variability in the model and as such, represents the relationship between whatever variables are being compared such that zero is no relationship and one is a strong relationship.

The pairs of variables selected to examine co-occurrence are indicative of both production and depletion processes. With respect to original blank size, many researchers have suggested there is a distinct relationship between platform attributes and the size of the original flake blank (Davis and Shea 1998; Dibble 1997, 1998; Dibble and Pelcin 1995; Dibble and Whittaker 1981; Pelcin 1996, 1997, 1998; Shott et al 2000). If this relationship holds true in end scrapers, a significant correlation between Platform Area and Maximum Thickness will be observed.
Absolute measurements of tool size are represented by the variables of length, width, and thickness, the covariation between which is examined. *Length and Width* demonstrate the relationship between two elements of an end scraper that decrease during each reduction sequence. When an end scraper is resharpened from the distal end, length decreases the most, while width decreases regularly, but proportionately less. Consider a triangle that has a set amount of length taken from its base. The length will decrease, but given the nature of the shape, some width is lost as well. For this reason, it is expected that length/width will bear a strong relationship for all trianguloid end scrapers, but that it may weaken with continued resharpening. *Length and Thickness* measures the relationship between what is assumed to be the most variable dimension (length) and the most static dimension (thickness) on most end scrapers as a result of progressive depletion. For this reason, it is expected that this bivariate pair should exhibit a relatively weak relationship. *Width and Thickness* measures the correlation between width, which decreases slightly during each resharpening event, and thickness, which should remain relatively constant. Because of this, it is expected that there will be a weak and somewhat intermediate relationship when compared to the length/width and length/thickness relations.

In addition to the correlations between the three major variables discussed above, a number of other relationships were measured in order to determine how correlated these aspects of end scraper morphology are. Regarding changes in shape as a function of depletion, the relationship between *Length and Bit Depth* is expected to capture some aspect of depletion. It is expected that as the tool is resharpened time after time, length
and the bit depth, or “nosed-ness,” of the end scraper should both decrease (Shott 1993:74). Because of this, we should expect a positive correlation between these two variables. The relationship between Length and Retouch Angle should demonstrate whether or not retouch angle changes as tool length gets shorter or if retouch angle was a characteristic that was maintained (i.e. kept at the same angle) throughout the tool’s use-life. Shott (1993:74) supports the later argument that a constant retouch angle was sought after. The covariation between Length and Bit Width Angle off of 90° should capture the shape of the bit as an end scraper was depleted. Following Shott (1993:74), the expectation is that these two variables with have a relatively weak relationship, though it will perhaps demonstrate a cluster among short, depleted end scrapers with flat bits.

Each of these correlations will be looked at in three ways. First, the entire assemblage from both Block F and the South Field concentrations (n=114) will be observed to in order to demonstrate the tendencies of all end scrapers. Next, those end scrapers removed from prepared cores will be used to reexamine the correlations (n=72). It is assumed that this sub-set of data will produce a strong relationship since flakes derived from prepared cores were conceptualized as blanks for unifacial tools whereas end scrapers made of the flakes that are the byproducts of bifacial reduction or from recycled tools were secondary, or derived from another production sequence. Finally, the rest of the end scrapers (n=42) will be analyzed to determine if irregularly produced tools show a weaker correlation. These three views should help demonstrate how different production techniques affect tool size, shape, and symmetry.
Once the univariate and bivariate observations are completed, end scraper form will be observed in a multivariate sense. In order to use multivariate tests to determine how end scrapers at Nobles Pond vary morphologically, the data from each area (Block F and the South Field concentrations) must be analyzed to determine whether or not they come from the same population. If they represent the same population, these two assemblages can be grouped for analysis. If not, the assemblage from the South Field will be used for subsequent analyses because of the greater number of tools available. To accomplish this, a Discriminant Function Analysis will be utilized. This test presents a distinct way to statistically distinguish between groups of data. The objective of a discriminant function analysis is to “weight and linearly combine the discriminating variables in some fashion so that the groups are forced to be as statistically distinct as possible” (Nie et al 1975). Discriminant Function Analyses look at many variables in order to create a discriminate function variate, which maximizes differences between the group means. While the present study does not attempt to place new specimens using this method, it does use Wilks’ Lambda, a multivariate measure of significance of the discriminant model.

A Discriminant Function Analysis also includes an ANOVA of the variables used, which will identify exactly which aspects of morphology differ between occupations. Examining exactly how the morphology of end scrapers varies between these sites can offer unique insights into the nature of each site. Assumedly, characteristics such as reduction intensity, raw material choice, and salvage frequency could be different based on the intensity, season, or focus of the site.
Once the Discriminant Function Analysis demonstrates the relatedness or non-relatedness of the assemblages from Block F and the South Field loci, a Principle Components Analysis (PCA), one of the most common approaches to identifying variation within multivariate datasets (Jolliffe 2002:1), will be utilized. A PCA does this by reducing “the dimensionality of a dataset consisting of a large number of interrelated variables, while retaining as much as possible of the variation present in the data set” (Jolliffe 2002:1). With the large number of variables involved in this study, a PCA presents a way to reduce them while still including a large portion of the variation inherent in the assemblage. Following in the style of Collins and Byrd (1994), a PCA will be used in this analysis to determine where the variation lies in an assemblage of morphologically dissimilar end scrapers.

The Principle Components Analysis will be performed using SPSS Statistics 17. The analysis is based on the correlation matrix of the dataset, which presents a way to look at the data using standardized variables. Also, the test does not use rotation, ensuring the components will be orthogonal. The variables used in the PCA are: (i) maximum length, (ii) maximum width, (iii) maximum thickness, (iv) the absolute value of the difference between true bit width left and right, (v) surface area, (vi) weight, (vii) true bit width, (viii) bit depth, and (ix) the difference of the bit width angle and 90°, (x) Width at 5mm, (xi) Triangularity, and (xii) Longitudinal Cross Section. These represent a selection of 12 variables from the 36 possible continuous options. A number of variables were left out because they were either redundant (i.e. measured the same aspect of the tool) or because they were not represented on enough end scrapers. First, it was
decided to leave out both platform and haft attributes. Although they have the ability to impart information about the assemblage as a whole, these traits were only observed on a small number of end scrapers (n=29 [25%] and n=26 [23%], respectively). A PCA looks at each of the specimens that contain a full complement of measurements. So if all variables were used, including those that pertain to haft and platform characteristics, only a fraction of the total sample would be analyzed. In fact, SPSS failed to run the program when all variables were used, because of a sample size issue. When the more exclusive set of variables (listed above) was used, the analysis incorporated all of the end scrapers.

Finally, after the PCA, a Cluster Analysis will be performed in order to capture any groups of end scrapers with distinct characteristics. This analysis was included for a number of reasons. First, it serves as a comparison to the number of other similar analyses performed on end scrapers (Collins and Byrd 1994, Shott 1993, Wilmsen 1970). This type of test is typically cited as evidence for functional differences within an assemblage of end scrapers. The results will be used to both evaluate these previous studies as well as to determine to what extent clustering occurs and why. A hierarchical Cluster Analysis was used in order to maintain objectivity when defining clusters. Other forms of Cluster Analysis were avoided because they require the researcher to input the desired number of clusters produced by the test. This approach was avoided for reasons of objectivity. Instead, a hierarchical Cluster Analysis produces a dendrogram with varying levels of association which is then interpreted by the researcher.

Because one of the hypotheses of this study is that differences in end scraper morphology may exist between the two areas of the site, the results of the Discriminant
Function Analysis will be taken into account in this test, ensuring that population differences do not adversely affect the outcome. The variables used in this test were chosen based on the morphology of the tool itself. Aspects of shape, which are generally what have led people to distinguish different tool types within end scraper assemblages, are the defining characteristics of the test. The variables used are: (i) cross-section shape, (ii) longitudinal curvature, (iii) maximum length, (iv) maximum thickness, (v) maximum width, (vi) width at 5mm, (vii) width at 10mm, (viii) width at 20mm, (ix) perpendicular bit width, (x) surface area, (xi) weight, (xii) bulb presence, and (xiii) triangularity.

Once this test was complete, the end scrapers were physically sorted into their respective clusters. At this point, each tool was labeled or identified with the cluster to which it was affiliated, making the ‘cluster’ variable an analytical unit. Subsequent to this step, the retouch angle characteristics of each cluster were examined comparatively. Again, it must be emphasized that Wilmsen (1970) concludes that differences in retouch angle could be indicative of different functional categories of end scrapers.
Chapter 5

Results

Sample Size Test

The initial examination of the Nobles Pond data focuses on how many artifacts are required to provide representative results. This was evaluated in a qualitative sense by visually examining the data to determine a point of diminishing returns. The first characteristic observed was length, seen in Figure 2. This graph demonstrates the mean and standard error of nine successively analyzed groups of end scrapers, each with ten more cases. Notably, there is a dramatic decrease in the standard error and the mean evens out to a steady value in Group 2, when twenty end scrapers are in the sample. Additionally, another noticeable point is when 60 end scrapers are included, though the increase in information is considerably less than at 20.
Width was examined in the same way as length (Figure 3). Width appears to be more variable than length in the sample and it thus takes more end scrapers to provide a representative selection. In this case, it would seem that something on the order of 60 cases are necessary before both mean and standard error no longer decrease considerably with the addition of new data.
Figure 3: Width Means by Ascending Groups of 10 End Scrapers

It would appear that maximum thickness is less variable than either length or width, a pattern that is demonstrated in Figure 4. Once the sample includes twenty or more cases, the mean and standard errors tend to be remarkably similar with only modest decreases in the standard error thereafter.

Length, width, and thickness are the most basic measurements taken on unifacial end scrapers, as they are on the majority of stone tools. Although a large sample always provides advantages, based on the results of the present study a sample size of 50 to 60 cases might be useful if covariation and patterning among these variables is an analytical goal. At this point, it is necessary to examine the descriptive results before moving on to more complex patterning.
Univariate Statistics

Because a reporting of descriptive data on all of the variables in this analysis would take up considerable space, these results are summarized in Appendix B. Since length, width, and thickness are the three main variables used to characterize end scraper size in most analyses, they are presented in this section, along with the focus of this thesis, retouch angle. Finally, striking platform area (platform width*platform length) is examined as a variable central to most morphometric characterizations of end scrapers and as a proven estimate of original blank size.

The length attribute shows the most variation of the three size variables. As Figure 5 demonstrates, length is fairly normally distributed, though there is a distinct drop-off of cases below 22mm. Only about 5% of the sample falls below this point. Most end scrapers fall between 25mm and 35mm in length at discard, suggesting a relatively tightly constrained perception of when an end scraper was too short to be of
much further utility. This is congruent with Grimes and Grimes’ (1985: 41) idea of a minimum functional length for hafted tools. The length distribution for the Nobles Pond assemblage is precisely the type of length distribution that Shott (1993: 68) suggests should be indicative of a heavily curated assemblage. He posits that in this type of assemblage, very few end scrapers should fall below a minimum length, most should cluster around it, and those that were lost or abandoned should be discarded well above the minimum value.

![Figure 5: Maximum Length](image)

The distribution of width is distinctly bimodal (Figure 6). The large mode at 23mm represents about 79% of the sample, and exhibits the cluster and tail that is expected for a minimum threshold variable. More simply, the majority of end scrapers were discarded at roughly the same point (the large mode), in similar fashion to length. The small mode, containing 21%, is more difficult to explain, but may represent a discard pattern for a subclass of end scrapers that was by design narrower than the majority.
Of the three main constraints of size, thickness shows the least variability (Figure 7). It is also noteworthy that of the three, thickness can be assumed to be relatively little changed from the thickness state of the original flake blank; that is, it is assumed that depletion affects length dramatically, width somewhat, and thickness only minimally. Results show that thickness is unimodally distributed with little variation. Roughly 83% of the specimens fall within a 5mm range (5mm-10mm). This standardization may reflect constraints imposed by a socket haft. Interestingly, it should be noted that thickness taken 10mm from the proximal margin was similarly distributed, despite being measured at a different portion of the tool. This further supports the interpretation that thickness was under strong cultural control.
Regarding retouch angle, that variable critical to Wilmsen’s (1970) functional interpretation of end scrapers, it should be noted that the distribution is relatively normal (Figure 8), with a mean of 66°, while most end scrapers have a retouch angle between 51° and 81°. Wilmsen (1970) suggested that there should be a bimodal distribution of retouch angles at 55° and 75°, but this is not apparent at Nobles Pond. Retouch angle was more positively skewed than any of the size measurements. To the extent that working big angles of greater than 85° were markedly less effective in hide working, it is very possible that the 5 cases with retouch angles greater than 90° were discarded when it was no longer possible to resharpen them.
Figure 8: Retouch Angle

Platform area is unimodally distributed, with a mean of 18.25mm$^2$. The distribution is tightly constrained, with a minimum threshold of about 5mm$^2$ and a maximum threshold of 30mm$^2$, with some positive skewing. The small sample size makes further discussion difficult, but it should be kept in mind that platform area should relate to original blank size. It should be noted that because some completed end scrapers do not exhibit striking platforms, they were probably damaged or removed in production. The sample size is considerably less than for the other attributes.
Bivariate Statistics

Bivariate scatter plots were constructed to determine the relationship of retouch angle to other dimensions of end scraper shape and size. The main variables under observation were retouch angle, maximum length, maximum width, maximum thickness, bit depth, platform area, and bit width angle. As noted in the methodology section of this thesis, bivariate plots were analyzed through three different lenses. First, data from the entire assemblage of end scrapers are presented, followed by those tools derived from prepared cores, and then from those tools that were either created from a bifacial core or recycled from another tool category.

End Scraper Size:

As expected, the primary elements of overall end scraper size—length, width, and thickness, are inter-correlated in this assemblage. Length and thickness display the strongest correlation ($R^2 = .275$), length and width are nearly as strongly correlated
(R²=.227), and width and length the least (R²=.117). From these results, it is clear that depletion is affecting size dimensions differently. In considering the process of flake blank reduction, thickness should be least affected by depletion, while length should be affected the most. It is interesting to note these are the most highly correlated variable pairs explained. Regarding one of the most consistently mentioned measures of original blank size – platform area – this variable shows no correlation with maximum length (R²=.085), maximum width (R²=.068), maximum thickness (R²=.057), or retouch angle (R²=.016). This makes sense if length and width are maximally reduced from their original condition, while platform area has remained unaffected. It should be noted that thickness according to some conventions should, like platform area, be relatively unaffected by depletion, yet the two – maximum thickness and platform angle – remain uncorrelated. Apparently, in this study they are not equivalent measures of original tool state and hence, not equally strong points for developing a measure of curation.

Regarding these five measures of shape as considered in bivariate fashion, it should be noted that retouch angle correlates with none of the shape variables considered. The correlations with retouch angle are respectively: bit depth (R²=.014), bit width angle (R²=.016), haft triangularity (R²=.006), longitudinal cross section (R²=.015). Further, it should be noted that of all ten possible combinations of the same variables, under consideration, only one, bit depth to bit width angle, showed any statistically significant correlation (R²=.247; Figure 10). An inspection of the resultant scatter plot shows that this correlation is heavily influenced by five outliers, which negates the utility of this
statistical determination. All that really can be said is that these five cases with bit width angles greater than 20° will also have very convex bits.

Figure 10: Bit Width Angle vs. Bit Depth; $R_s = 0.298$; $n=114$

The next results to be reported are the various size and shape attributes reviewed above for the entire sample, but this time controlling for that variable judged to be the best available indicator of original blank type, the configuration of dorsal flake scars. This variable was recorded as pertaining to three variable states: 1) fluted or keeled, which are presumed to result from the sequential removal of blades or long flakes from a prepared, unidirectional core (72/114=63%); 2) “all over flaking,” which is presumed to result from the necessity of more extensively shaping flakes or tool fragments resultant from bifacial thinning flakes or recycling into the appropriately triangular end scraper form (24/114=21%); or 3) “other” dorsal surfaces that could not be categorized easily into the previous categories (18/114=16%). This third category has been combined
subsequently with the second, since the primary aim was to see if blank type affected retouch angle as well as other key size and shape characteristics of the end scrapers at Nobles Pond. Parenthetically, it should be noted that platform type is often viewed as a useful indicator of original blank type, with a primary distinction made between faceted platforms derived from biface thinning (Andrefsky 1998) and flat platforms derived from other forms of lithic reduction, notably from unidirectional or multi-directional cores. Since only seven faceted platforms were recorded at Nobles Pond (7/114=6%), this was not judged a particularly useful basis for comparison.

Correlations between length, width, and thickness in the fluted/keeled category increase considerably when compared to the results for the entire sample, as discussed above. Length and thickness increase dramatically ($R^2 = .416$ vs. .275), while width and length increase moderately ($R^2 = .380$ vs. .227), and with and thickness increase only slightly ($R^2 = .153$ vs. .117). Conversely, size correlations decrease considerably in those cases with either “all over flaking” or “other” dorsal surfaces, compared to the entire sample. Length and thickness decrease ($R^2 = .087$ vs. .275), width and length decrease ($R^2 = .043$ vs. .227), and width and thickness decrease ($R^2 = .035$ vs. .117) to the point of non-significance.

Platform area, which showed no strong or even moderate relationship to length, width, thickness, or retouch angle in the entire sample, similarly showed no meaningful relationship when regarding the keeled/fluted category (length $R^2 = .132$ vs. .085; width $R^2 = .066$ vs. .068; thickness $R^2 = .104$ vs. .057; retouch angle $R^2 = .051$ vs. .016). Similarly, a comparison of the “all over flaking/other” category showed no correlations where
variation in one variable explains more than 7% of the variation in the other. Retouch angle, the variable of primary concern in this study, showed no meaningful or useful relationship to any size variable in the entire sample and it similarly shows none for either of the flake blank categories under investigation. The strongest $R^2$ for either was that of .07 for length and retouch angle within the “all over flaking” category. These results would seem to suggest that blank type does have an effect on the size of discarded end scrapers at Nobles Pond, but not on retouch angle (compare Figure 11 with Figure 12).

![Figure 11: Length vs. Thickness, Prepared Cores; $R_s = 0.625; n=72$](image-url)
End Scraper Shape:

Bit depth, bit width angle, haft triangularity, and longitudinal cross section were used as measures of shape for the larger sample. When controlling for dorsal flake scar configuration as a measure of blank type, results were fairly consistent with the general pattern. First, retouch angle showed no meaningful correlation for either blank type under consideration, which is not unexpected given the similar results in the larger sample. When considering bivariate relationships among other variables considered as indicators of shape, it should be noted that some do vary considerably. Results are: bit depth/bit width angle (all: $R^2=.247$; fluted/keeled $R^2=.163$; all over flaking/other $R^2 = .336$); bit depth/triangularity (all: $R^2=.008$; fluted/keeled $R^2=.000$; all over flaking/other $R^2 = .001$); bit depth/longitudinal cross section (all: $R^2=.005$; fluted/keeled $R^2=.023$; all over flaking/other $R^2 = .001$); bit width angle/triangularity (all: $R^2=.024$; fluted/keeled $R^2=.000$; all over flaking/other $R^2 = .161$); bit width angle/longitudinal cross section (all: $R^2=.247$; fluted/keeled $R^2=.163$; all over flaking/other $R^2 = .336$)
R\(^2\)=.014; fluted/keeled R\(^2\)=.033; all over flaking/other R\(^2\)= .003); triangularity/longitudinal cross section (all: R\(^2\)=.006; fluted/keeled R\(^2\)=.001; all over flaking/other R\(^2\)= .026). In general, shape relationships among the discarded end scrapers at Nobles Pond appear to be less affected by blank type than size. It is possible that all end scrapers must conform to certain general shape constraints to facilitate hafting and the ability to do work, regardless of operational starting point. However, those tools starting out as blades that vary somewhat in size, but very little in shape, are likely to follow a more conventional reduction pathway so that their size at discard bears a more predictable relationship to their original size than do end scrapers originating from more varied origins, for example, as recycled tools or biface reduction flakes. At this point, having explored selected size and shape variables in univariate and bivariate fashion, it is time to take a more comprehensive, multivariate look at the variable structure. As a preliminary step in this phase of analysis, a Discriminant Function Analysis was performed to examine spatial variability between the two areas off the site under consideration, Block F and South Field.

**Multivariate Analyses**

Once the univariate and bivariate analyses were complete, variables were examined in a multivariate fashion to identify broader relationships of morphological patterning. The first step in this multivariate approach involved a Discriminant Function Analysis to test for patterned differences in the assemblage as a function of spatial location within the site. The main areas under investigation include the single loci of
lithic material in Block F and the multiple loci present in the larger South Field block. It has been argued that the South Field loci represent a large, contemporary, long-term occupation (Seeman 1994), whereas Block F is likely to represent a short-term encampment. The Discriminant Function Analysis discerned that despite the large amount of variation among all end scrapers in this sample, there is a highly significant difference (Wilks’ Lambda=0.646; sig<0.000) in the morphology of end scrapers between the two areas in question. Despite a small amount of overlap, the means of each group function are noticeably different (Figure 13).

![Figure 13: Discriminant Scores for Block F (Site 1) and the South Field (Site 2)](image)

Additionally, the test includes a set of univariate Tests of Equality of Group Means (very similar to an ANOVA) that demonstrates exactly where the variation between these two assemblages lies. By looking at these differences, insight into how
production and reduction differed between long-term and short-term Paleoindian occupations can hopefully be gained.

The variables that exhibit highly significantly differences (sig ≤ .01) between Block F and the South Field concentrations are: maximum width (F=7.942; sig=.003), surface area (F=10.784; sig=.001), bit depth (F=6.808; sig=.007), and true bit width (F=13.164; sig<.000). See Figure 14 for all values. First, it should be noted that retouch angle is not significantly different between these two groups. This suggests that the mechanisms affecting retouch angle were similar during each occupation. Second, distal width and bit depth are respectively wider and deeper in Block F.

<table>
<thead>
<tr>
<th>Variable</th>
<th>t</th>
<th>Mean – Block F</th>
<th>Mean – South Field</th>
<th>Standardized Distance</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximum Length</td>
<td>.089</td>
<td>30.24</td>
<td>30.12</td>
<td>.021</td>
<td>.927</td>
</tr>
<tr>
<td>Maximum Tool Width</td>
<td>3.01</td>
<td>24.97</td>
<td>22.24</td>
<td>.659</td>
<td>.003</td>
</tr>
<tr>
<td>Maximum Tool Thickness</td>
<td>.495</td>
<td>7.82</td>
<td>7.61</td>
<td>.113</td>
<td>.621</td>
</tr>
<tr>
<td>PerpDiff (Abs)</td>
<td>2.53</td>
<td>1.41</td>
<td>3.02</td>
<td>.559</td>
<td>.013</td>
</tr>
<tr>
<td>Area of Ventral Surface</td>
<td>3.47</td>
<td>5.62</td>
<td>4.46</td>
<td>.750</td>
<td>.001</td>
</tr>
<tr>
<td>Weight</td>
<td>.845</td>
<td>6.09</td>
<td>5.60</td>
<td>.191</td>
<td>.400</td>
</tr>
<tr>
<td>True Bit Width</td>
<td>3.80</td>
<td>24.67</td>
<td>21.23</td>
<td>.814</td>
<td>.000</td>
</tr>
<tr>
<td>Bit Depth</td>
<td>2.76</td>
<td>6.58</td>
<td>5.41</td>
<td>.607</td>
<td>.007</td>
</tr>
<tr>
<td>Bit Width Angle (Adj)</td>
<td>.272</td>
<td>6.64</td>
<td>7.01</td>
<td>.062</td>
<td>.786</td>
</tr>
<tr>
<td>True Bit Width Diff (Abs)</td>
<td>2.39</td>
<td>1.45</td>
<td>3.12</td>
<td>.533</td>
<td>.018</td>
</tr>
<tr>
<td>Retouch Angle</td>
<td>1.63</td>
<td>62.00</td>
<td>67.67</td>
<td>.366</td>
<td>.106</td>
</tr>
</tbody>
</table>

Figure 14: Discriminant Function Analysis ANOVA Table (significant variables highlighted)
The Discriminant Function Analysis demonstrates that the sub-samples of end scrapers from Block F and the South Field concentrations were statistically different morphologically. This result provides a strong justification for using only the large sub-sample of end scrapers from the South Field concentrations for both the multivariate Principle Components Analysis and the Cluster Analysis.

The Principle Components Analysis performed on the South Field sample of end scrapers resulted in three components, representing 79.281% of the variation within the assemblage.

<table>
<thead>
<tr>
<th>Component Matrix</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximum Length</td>
<td>.768</td>
<td>.141</td>
<td>-.312</td>
<td>-.292</td>
</tr>
<tr>
<td>Maximum Tool Width</td>
<td>.872</td>
<td>-.237</td>
<td>.065</td>
<td>.199</td>
</tr>
<tr>
<td>Maximum Tool Thickness</td>
<td>.596</td>
<td>.227</td>
<td>-.296</td>
<td>-.317</td>
</tr>
<tr>
<td>Area of Ventral Surface</td>
<td>.899</td>
<td>-.129</td>
<td>-.037</td>
<td>-.010</td>
</tr>
<tr>
<td>Width at 5 mm</td>
<td>.609</td>
<td>-.371</td>
<td>.649</td>
<td>-.096</td>
</tr>
<tr>
<td>Weight</td>
<td>.923</td>
<td>.031</td>
<td>-.131</td>
<td>-.169</td>
</tr>
<tr>
<td>True Bit Width</td>
<td>.808</td>
<td>-.244</td>
<td>.017</td>
<td>.378</td>
</tr>
<tr>
<td>Bit Depth</td>
<td>.580</td>
<td>.477</td>
<td>.258</td>
<td>.420</td>
</tr>
<tr>
<td>Bit Width Angle Adj</td>
<td>.034</td>
<td>.768</td>
<td>.160</td>
<td>.081</td>
</tr>
<tr>
<td>True Bit Width Diff Abs</td>
<td>.104</td>
<td>.768</td>
<td>.160</td>
<td>.152</td>
</tr>
<tr>
<td>Triangularity</td>
<td>-.044</td>
<td>-.082</td>
<td>.843</td>
<td>-.485</td>
</tr>
<tr>
<td>Longitudinal Cross Section</td>
<td>-.225</td>
<td>-.371</td>
<td>.157</td>
<td>.522</td>
</tr>
</tbody>
</table>

Figure 15: Principle Components Analysis: Component Matrix. Important Values Highlighted
The first principle component accounts for 39.838% of the variation within the sample from the South Field loci. This represents size variation, a finding congruent with first the principle component in most morphological studies. The variables that load highly on the component are maximum length, maximum width, maximum thickness, width at 5 cm, surface area, weight, true bit width, and bit depth (see Figure 15). Those specimens that scored highly on this component are large in all respects, though mostly in width, weight, and surface area. True bit width is included in this because it loads highly, but this could just be a factor of its relationship with maximum width. Bit depth loads highly on PC1, highlighting the important contribution of the distal portion of the tool to size. It may also generally support Shott’s (1993:74) proposal that bit depth decreases with increased curation since many large (less depleted) tools have deep bits. End scrapers that scored low on this component are generally small in all of these respects, corresponding to the expectations of greater depletion.

Principle Component Two accounts for 16.969% of the variation within the sample of end scrapers from the South field loci at Nobles Pond. It appears to represent shape, especially the shape and symmetry of the bit. The variables that load highly on this component are bit depth, the adjusted bit width angle, and the absolute value of the difference between true bit width left and right (see Figure 15). Each variable that was adjusted to demonstrate symmetry loads highly on this principle component. End scrapers that score highly on this component represent asymmetric specimens, whose bits are canted to one direction or the other. Additionally, their bit angles are skewed away from a level 90 degrees. Notably though, they are not flat ‘nosed’ end scrapers. End
scrapers that score low on Principle Component Two are those pieces that retain a semblance of their inherent symmetry. Component Two is interpreted as measuring unusual production and/or reduction, possibly because the original tool was made on an asymmetrical blank, or the original tool broke in use and the salvaged piece had an asymmetrical distal margin, or a portion of the bit broke in resharpening, requiring the production of an atypical shape to keep the tool in use.

The third principle component accounts for 12.870% of the variation within the assemblage. This represents relatively short, thin, rectanguloid specimens which have medium-sized bits. The tools loading highly on this factor would meet conventional expectations for little if any remaining utility, and hence extreme depletion.

The fourth component accounts for 9.603% of the variation within the assemblage. Particular variables loading highly on this component include: longitudinal cross section shape, lateral convergence, bit depth, bit width, and length. Principle Component Four appears to be an additional shape component in that it may report an alternative product of depletion, but more specific interpretations are not offered at this time.

Overall, the principle component analysis has demonstrated that there is a large range of variation in end scraper morphology that is based on size, bit symmetry, and perhaps some variations in both production and reduction techniques. The analysis suggests that these end scrapers reflect a use-life sequence that results in depleted and exhausted pieces that undergo many morphological changes.
After the PCA was completed, a Cluster Analysis was performed. This hierarchical cluster analysis identified five discernable clusters (Figure 16); three of them are large groups, while the other two have fewer specimens. Notably, three specimens were omitted from this analysis on the basis that they were too short to have measurements at 20mm. Because of this, 96.6% (n=85) of the South Field sample was used in the analysis.

Figure 16: Cluster Analysis Dendrogram, Identified Clusters Circled
Briefly, the general characteristics of end scrapers in each cluster will be described from largest to smallest in size. Cluster 5 has four members, each larger than any other end scraper in the sample. These end scrapers are interpreted as representing broken or lost end scrapers, as they entered the archaeological record before they had the opportunity to be depleted. Cluster 3 has 21 members, each of which is large, generally thick, and notably triangular. These end scrapers probably represent tools derived from prepared cores, as they have retained some semblance of their original triangularity. Cluster 2 has 9 members, which are large and fairly rectangular and probably came from other tool types or biface thinning flakes. Cluster 1 has 26 members which are medium-sized and amorphously shaped. Little more can be said about this cluster at this time. Cluster 4 has 24 members and is composed of the smallest specimens from the sample, ranging from small triangular end scrapers to relatively long linear ones. Notably, four long, narrow specimens were included in this cluster, which seems to break the mold of a ‘small’ cluster. One of the factors that went into selection was surface area, which would explain, in part, their inclusion in this group. See Appendix C for images of each cluster.

The clusters identified in this exploratory Cluster Analysis are imposed by the nature of the statistical program. Any cluster analysis will result in the construction of groupings or “types” by partitioning the variation in the sample. It is possible to interpret these clusters as distinct morphological classes or types, but it must be recognized that they may simply represent products of the statistical routine rather than something that is of distinct typological utility. To further evaluate this potential problem, the first two Principle Components (size and shape) were plotted against one another, with each
cluster differentiated by shape and color (Figure 17). If the clusters represent legitimate functional groups, they should be markedly distinguished from one another. As Figure 17 demonstrates, there is limited clustering among these groups on the basis of size and shape. Most notably, Cluster 4, which was uniquely composed of end scrapers that were especially small in size, is the most clearly clustered and thus potentially supporting distinctive morphometric identification for this cluster. Results supporting the typological utility of the other clusters are compromised by the fact that they show intergradation when examined against the distributions of Principle Component 1 and Principle Component 2.

The small amount of overall visual clustering evident is probably a result of the two analyses (The PCA and Cluster Analysis) using many of the same variables. The conclusion that can be drawn from the Cluster Analysis and the subsequent observation of Principle Component 1 vs. Principle Component 2 is that the clusters are not meaningful in terms of tool types for the majority of cases. Instead, it is evident from the broad overlap in shape and size of end scrapers that these tools represent a continuum of reduction, from new, large end scrapers to depleted, discarded ones.
The result of these three multivariate tests implies that a continuum of reduction is evident in the end scrapers from Nobles Pond. The data suggest that end scrapers were created, used, reworked, and discarded upon depletion. While this model may be an accurate generalization of the use-life of end scrapers at Nobles Pond, there are many intricacies and dynamics that flesh-out this model and require further explanation. These patterns are important, and the sample from Nobles Pond presents a unique opportunity to gain insight into many dynamics inherent to Paleoindian life.
Chapter 6

Discussion

The nature of end scraper production, use, depletion, and discard at Nobles Pond has been observed in a number of ways throughout this thesis. The following discussion of these findings is arranged in a manner that mirrors these characteristics. First, aspects of production will be discussed in order to fit the findings of this thesis into a broader framework of stone tool production. Next, morphological trends of the tools will be discussed, followed by the implications of reuse and recycling practices at Nobles Pond. Retouch angle, a central focus of this thesis, will then be discussed in light of univariate and multivariate findings. Finally, the differences in end scraper morphology between Block F and the South Field loci will be examined, shedding light on some differences in the occupational intensity of Paleoindian sites.

Stone tools which have been recovered from archaeological sites frequently are depleted, obscuring the form of the original tool. One of the major problems inherent to lithic studies is how to determine the size of the original flake blank of a tool, a measure which could be used to determine how depleted, or curated, that tool was. Many researchers have proposed that the platform dimensions of a flake tool are indicative of
the size of the blank. In a number of highly controlled experiments, Shott et al (2000) determined that the area of a flake’s striking platform can reliably predict the surface area of the flake. This makes sense because a larger striking platform generally means that the flint knapper has directed his/her point of impact well interior to the platform edge and with enough force to detach a flake that itself should tend to be relatively large.

Incorporating this finding regarding platform area and flake size into a real-world morphological study can help determine the utility of this claim for the analysis of actual archaeological assemblages. The Nobles Pond end scraper sample used in this thesis provides an opportunity to do this. Thickness is often regarded as the part of a tool most likely to closely reflect the tool’s original form, and by extension, the form of the flake blank. Assuming this is true, and assuming Shott et al (2000) are correct, the correlation between maximum thickness and platform area in an assemblage should be strong. As summarized on page 50 of this thesis, the current study found quite the opposite, specifically that there is no correlation between maximum tool thickness and platform area ($R^2 = .085$).

Do highly controlled studies accurately represent real-world relationships? According to the thickness/platform area from Nobles Pond, the answer is that they may not. Perhaps this is because of the nature of the initial empirical tests, i.e. that they were so controlled that their results are not applicable in regard to the real-world mechanics of stone fracture and for the choices that earlier knappers made regarding the flakes that were used for end scraper blanks. An additional possibility may be that the extent to which end scrapers are depleted at Nobles Pond could obscure the relationship between
platform attributes and a tool’s form. Platform attributes remain relatively static throughout a tool’s use-life (as long as they were on that tool to begin with), while a tool’s form is affected by each resharpening event.

As this thesis has demonstrated, the end scrapers at Nobles Pond are heavily curated. The effect that this has on a tool’s form is considerable. Attempting to predict the size of the original flake blank may be near impossible in this situation. Many, if not all, attributes have in some way been modified, usually extensively, from the tool’s original form. Shott et al.’s (2000) determination that platform area is indicative of the size of the original flake blank may indeed be accurate, but applying this concept to known assemblages, especially curated ones, may be misleading at best.

While platform attributes may not be a significant analytical aspect of unifacial scraper morphology, the type of core that end scrapers were derived from is an important consideration based on the current study. This thesis has discerned an important pattern with regard to determining the type of core from which end scrapers were removed. The fact that Paleoindian end scrapers were produced on flakes derived from both prepared unidirectional flake cores, as well as from biface thinning flakes, has been recognized for some time (Shott 1993). For a number of reasons, end scraper production from prepared cores appears to be the preferred method of Paleoindian artisans at Nobles Pond. A prepared core allows for the most control by a skilled flintknapper. When a specific template was desired both for function and for hafting, a technique which allowed this much control would be useful for consistency as well as long-term efficiency in raw
material use. This thesis has identified several nuances in the dichotomy between end scrapers made from prepared cores versus bifacial thinning flakes.

Blade technology is an important component of the toolkits of many mobile populations, including Clovis people (Collins 1999), though the roles of these tools and the cores used to produce them have not been thoroughly studied (Rasic and Andrefsky 2003:62). The ubiquity and utility of this technology suggests that small, standardized stone tools were important among many mobile foragers of the Pleistocene (Nelson 1991:68). End scrapers, which are assumed to have a standardized form for socket hafting considerations, fall neatly into this category and would be reasonably compatible with blade making, yet the production of Paleoindian end scrapers from blades has received very little attention in the literature.

It is posited in the present study that Paleoindian artisans used a modified form of blade technology in order to systematically create end scraper flake blanks at Nobles Pond. The shape of end scrapers derived from prepared cores is dominated either by a keeled or a fluted dorsal surface. These cross section shapes are reminiscent of the single and multiple arris dorsal configurations (aka triangular and trapezoidal cross-section, respectively) common in blade technologies. These configurations are a result of removing successive flakes from a blade core (Sheets and Muto 1972). The advantage of this technique is that blade cores are designed to “…maximize the size of blanks relative to core size” (Rasic and Andrefsky 2003:71). This type of control would have been necessary to create trianguloid end scrapers, while largely side-stepping the issue of variability in blank form as the use-life of the core increases (Shott 1993: 50-58). In their
study of Alaskan blade cores, Rasic and Andrefsky (2003:77) conclude that: “the use of blade cores,…because of their specialized nature, would be dictated more by the types of tasks that were expected.” While not versatile (sensu Shott 1986), the prepared blade-like cores used to produce end scrapers nevertheless played a vital role in eastern Paleoindian toolkits.

In the present study of Nobles Pond end scrapers, a number of lines of evidence support the legitimacy of the dichotomy between prepared blade cores (end scrapers with fluted and keeled cross-sections) and ‘other’ cores (biface reduction flakes or salvage/recycling of other tool categories). The first evidence is the significantly stronger correlations observed in basic size variables in those end scrapers derived from prepared cores compared to those that were produced from ‘other’ core types. This suggests that these tools were created in a way which enhanced conformity in shape and size, which in turn ideally resulted in a more conventional reduction sequence, explaining why these size variables were more strongly correlated, even in depleted tools.

Shott (1993) dichotomizes end scraper assemblages into prepared core and bifacial core production techniques. Using the Leavitt site assemblage of unifacial tools, Shott develops a number of assumptions on the characteristics of end scrapers produced from these inherently different methods. The traits that Shott uses to differentiate these types of end scrapers are often very similar, resulting in a typology that is somewhat vague. End scrapers which were removed from a prepared core were typically differentiated by observing the direction of dorsal facets as well as the general curvature of the flake. Similarly, those tools created from biface reduction flakes are grouped
based on how curved the flake is as well as how extensively faceted the dorsal surface is. Although simplified here, the problem with this scheme is apparent. The continuum of flake size and shape that is produced from both of these techniques makes it difficult to accurately determine exactly how and particular tool was created using Shott’s criteria.

Another major conclusion that Shott (1993) arrives at regarding the production of end scrapers at Leavitt is the use of snap-fracture production. This technique, he asserts, involves producing a purposefully long flake blank and then snapping it into two pieces in order to remove the production characteristics from the flake (i.e. the bulb of percussion and the striking platform); the distal portion is then used for an end scraper and the proximal portion is discarded. It is assumed that this technique would have been utilized to facilitate hafting by removing the production characteristics from the proximal end of the tool. Bulb removal, a common trait at Nobles Pond and in many Paleoindian assemblages, would have removed these characteristics without the loss of valuable raw materials that is implicit to snap-fracture production.

Simply looking at the number of tools that have or had (i.e. it was removed) a bulb of percussion, as opposed to those with no evidence of this feature, could help shed light on this production issue at Nobles Pond. Based on Shott’s (1993) description, we can assume that an assemblage dominated by a snap-fracture production technique would result in at least (but likely much more than) half of the assemblage with no bulb of percussion on the tool. Not surprisingly, more than half (55%) of end scrapers retain some trace of a bulb of percussion. This number increases (60%) when observing only those tools which came from a prepared core, as Shott assumes most would have been.
Interestingly, the ratio is much more ambiguous (48% have some bulb presence) when looking at end scrapers presumed to result from biface thinning or tool recycling bifacial/recycled tools. In sum, the expectation that snap-fracture production would result in a large majority with no evidence of bulbs was not met. It is apparent that most of these tools were reduced from intact flake blanks. Further, refit analysis confirms that many end scrapers lacking a bulb and platform are the result of in-use socket snaps rather than manufacturing considerations (Seeman 2011, personal communication).

The production technique of unifacial end scrapers played a large role in the morphology of the original tool whereas the size and shape of recovered specimens is dominated by the process of depletion and resharpening. The morphology of end scrapers found at Nobles Pond, with a few exceptions, is that of a depleted assemblage. As both the Principle Components Analysis and the Cluster Analysis demonstrated, there are two general shapes of depleted end scrapers at Nobles Pond, trianguloid and rectanguloid. This contrast may be explained by the two production methods highlighted above. Those tools that were removed from a prepared core were more standardized and by extension would have had a more ‘ideal’ use-life, resulting in tools that retained some semblance of their original trianguloid form at discard. Conversely, those tools that were created either from biface reduction flakes or that were salvaged from other tools most likely did not start their use-lives as an ideally shaped tool, requiring more work and morphological adjustments for both hafting and continued use through resharpening. Thus these tools tended to end their use-lives as bulkier rectangular tools.
Although blank type seems to have an effect on the shape of end scrapers throughout their use-lives, the depletion process imposed many constraints on tool shape and size. When discussing his expectations on how end scrapers at Leavitt were reduced, Shott (1993:68) first analyzes how the distribution of length measurement skews. In an exhausted assemblage of end scrapers, he predicts that there should be a central measure that most cases cluster around, while very few cases are shorter than this value and a few broken or lost tools lie above this central tendency. The distribution of the Leavitt end scraper assemblage, however, reflects the opposite trend. The left-skew found in length of end scrapers suggests that those end scrapers at Leavitt were actually not completely reduced, but were for some reason discarded before their utility was exhausted.

At Nobles Pond, and in contrast to Leavitt, there is much more support for this initial prediction. Taking into consideration each of Shott’s expectations regarding length and reduction, it seems as though the end scrapers from the Nobles Pond assemblage were almost all completely exhausted before discard. Reconsidering the distribution of length measurements from this site (Figure 17), there is a central range of lengths (22mm-34mm) within which most (72%) end scrapers fall. Additionally, there are a few cases shorter than this (7%) and a larger number of specimens which are larger than the central range (21%) that were probably broken or lost.
If Nobles Pond represents a ‘gearing-up’ location, it stands to reason that the tools used in this process would be fully utilized. If, though, the hide-working done at a site was
incidental, the tools may not have been used to their full extent, but only as much as needed (Compare this to the pattern Shott observes at Leavitt, Figure 18).

Another measure of reduction Shott (1993) uses to observe the tendencies of the Leavitt end scraper assemblage is the ratio of midline-length to haft-length. The idea here is the assumption that the haft length remains static as the length of the tool itself is reduced during each retouch event. The bimodal distribution of this measure at Leavitt was indicative to Shott (1993:75; Fig. 5.15) of differential functionality (See Figure 20). Observing this same measure from the Nobles Pond assemblage tells a markedly different story (Figure 19). The distribution is distinctly unimodal and positively skewed with two outliers. The reason that the Leavitt assemblage demonstrates a bimodal distribution may be based in the extremely small sample (n=8) of end scrapers with identifiable hafting elements.

Figure 20: Midline Length to Haft Length Ratio at Nobles Pond
A typical Paleoindian trait that is inherently related to utilizing tools until exhaustion is the reuse of tools and raw materials. This practice is very pragmatic considering the broad spatial range that these people traversed. In this regard, it makes sense to discuss how end scrapers at Nobles Pond reflect such technological efficiency. In terms of their original use-lives, end scrapers were specially designed tools with an explicit function. They were designed extremely well and were often completely utilized in pursuit of this purpose.

It already has been noted that end scrapers from the Nobles Pond sample typically have one of two general shapes upon depletion. These tools, once exhausted, are generally either small and triangular or small and rectangular. This trend was demonstrated by both the Principle Components Analysis and the Cluster Analysis. As
was noted above, this is thought to be a function of different methods of production and the respective use-life trajectories that tools derived from these methods would follow.

Once tools reached this depleted phase of their use-life, two general options were available. The tool could either be discarded, becoming part of the archaeological record, or the tool could be recycled into another type of tool. From the sample of end scrapers taken from Nobles Pond, discard seems to be the most common option (n=69; 69/114=60.5%), though recycling is fairly common as well (n=45; 45/114=39.5%). Of these tools that were recycled, the overwhelming trend seems to be that sharp lateral corners were made into isolated graver spurs, noted by either a remaining spur or a broken graver stub. Over 90% (n=41; 41/45=91.1%) of recycled tools are gravers or the remains of gravers. The remaining tools are either additional scraper bits on the proximal margin (n=2), a burin (n=1), or a denticulate (n=1).

Graver spurs are designed to either puncture or engrave materials. This requires a small, sharp point on an adequately sized tool to hold onto. As such, discarded end scrapers with already sharp corners would have been a perfect option (Weedman 2002). A question raised by Weedman (2002), in her study of Ethiopian hide scrapers, was whether or not what many archaeologists identify as ‘gravers’ are actually incidental byproducts of depletion. Considering the process of depletion typically results in small end scrapers with straight bits, Weedman’s question is warranted. While not observed quantitatively throughout this analysis, the researcher can offer discussion on qualitative trends that were noticed. Many end scrapers have sharp edges on the bit corners, supporting Weedman’s assertion, though many graver spurs display attributes that
indicate they are not just passive remnants of depletion. Often, they are obviously isolated from the dorsal side, the ventral side, or both sides. In these cases it is apparent that the flake scars that were used to isolate the graver spurs were later than those of the original end scraper. This suggests that these ancillary tools are not incidental, but often great care was exhibited to place these spurs precisely where desired.

A central theme of this thesis has been retouch angle, that variable which Wilmsen (1970) proposed can be used to determine functionality in an assemblage of end scrapers. His argument is based on changing environmental factors, which presumably affected mobile Paleoindian populations as they moved into the forests east of the Mississippi from the Great Plains. Wilmsen looked for notable patterned differences in retouch angles on end scrapers from a number of geographically distributed sites. His conclusion is that those tools with acute angles (~55°) were used for cutting and scraping purposes while those tools with larger edge angles (~75°) were used for scraping and whittling of wood or bone. This static view of edge angles assumes that the tool’s morphology did not change throughout its use-life, an idea which the current analysis of the Nobles Pond sample of end scrapers refutes. Similar to Wilmsen, Shott (1993: 76) suggests that Paleoindian unifacial end scrapers were multifunctional tools, citing differences in bit morphology and use-wear to support this conclusion. Interestingly, despite this conclusion, he states that “…in the Leavitt end scraper assemblage, form and function of tools are weakly related” (1993:76). The current study suggests the opposite, that the form of end scrapers is inherently related to their singular function.
Retouch angle was observed on 114 specimens in the sample of end scrapers from Nobles Pond in order to evaluate previous conclusions regarding this important attribute as well as to determine how it is related to tool morphology on a site-wide basis. The first way that this variable was analyzed was in a simple univariate sense. The distribution of retouch angles immediately demonstrates that the two modes predicted by Wilmsen are not evident. In fact, the distribution is fairly normally distributed, suggesting a different kind of mechanism acting on this morphological feature. The small group of outliers with retouch angles of over 100° are interpreted as failed retouch attempts, in which part of the tool retains a highly worked edge, thought in an attempt to retouch it, the artisan made a mistake which ended the utility of the tool, resulting in its discard.

In order to observe what, if any, relationship exists between retouch angle variables pertaining to tool size and shape, bivariate scatter plots were created. Importantly, retouch angle does not correlate with any major size (i.e. length, with, or thickness) variables in the sample, suggesting that whatever driving factor controls retouch angle is independent of size considerations, and therefore depletion as well. In terms of bit attributes encompassing both shape and size, the lack of any relationship remains. The fact that retouch angle remains independent of any other measures is very important, and holds true when looked at in a multivariate light as well.

The multivariate tests used to explore the nature of morphological variation within the sample from Nobles Pond were a Principle Components Analysis and a Cluster Analysis. In both of these tests, retouch angle was purposefully excluded so that
subsequent analyses would not be confounded. The PCA identified components of size, symmetry, and production/depletion. This test accounts for almost 80% of the variation within the assemblage, though none of the factors correlate significantly with retouch angle. Similarly, the clusters devised from the Cluster Analysis were examined to determine if retouch angle differs as end scrapers are sorted by numerous shape and size variables. Interestingly, there is no significant difference in retouch angle between the clusters ($F=.918; \text{sig}=.458$). In fact, most of the clusters exhibit mean retouch angles of $68^\circ \pm 4^\circ$, which is highly constricted given the large overall range of retouch angle within the sample (between $35^\circ$ and $110^\circ$).

This progression of tests demonstrates that retouch angle is largely independent of the morphology of the rest of the end scraper. This is surprising, considering how highly standardized many of these tools are. To say that retouch angle is essentially free to vary suggests something very important about this characteristic. Considering this discovery and the fact that the angle of the distal edge of the tool governs how the bit interacts with the material being worked on, it stands to reason that retouch angle may be the factor of end scraper morphology that was ultimately controlled for.

This revelation has implications for the use-life of Paleoindian end scrapers. For example, while it was assumed that thickness and length are important for reasons pertaining to structure and curation, respectively, each of these seem to be of ancillary value. Instead, it seems that these tools were ideally made long and thick both for longevity as well as to facilitate rejuvenating the bit to maintain an ideal retouch angle. This assertion is supported in part by the large end scraper reduction flakes recovered at
Nobles Pond, which suggest that sometimes significant portions of the bit were removed in order to facilitate production of an optimal retouch angle. This further suggests that retouch angle was even more important than raw material efficiency, a critical issue in Paleoindian life. This sacrifice makes sense when considering the larger issue that a malfunctioning end scraper would either bring about torn hides or would not remove much material. If the sole purpose of these tools was to prepare hides for clothing production, an inefficient tool that ruined the material would be of no use. In fact, it would be detrimental to the process and by extension, survival.

Additionally, the cycle of bit rejuvenation and the importance of maintaining a consistent bit angle suggest that what we see on end scrapers with regard to retouch angle may not, in itself, be a significant morphometric variable at discard. Instead, what we have observed seems to be an arbitrary point in the cycle of bit retouch. When the tool was reduced to a minimum functional length (Grimes and Grimes 1985), it was discarded. The retouch angle at this point was incidental, not indicative of any specific function of functions.

While the morphometric analysis of the stone end scrapers from Nobles Pond is the main goal of this thesis, one of the important ancillary research questions that the many spatial clusters at Nobles Pond can address is whether or not temporally distinct clusters represent different functional loci. More specifically, they offer the chance to observe if end scrapers were created or used in different ways based on the duration of site occupation. To test this in terms of end scraper morphology, samples were taken from two of these clusters, Block F and the South Field loci. A Discriminant Function
Analysis was the primary method of comparison. As mentioned above, this test serves to distinguish different populations from one another on a multivariate level. The discriminant function analysis confirms that there were indeed differences in end scraper morphology between the two clusters.

The most tangible morphological difference lies in the width of end scrapers, specifically in the width of the bit. Overall, those end scrapers from Block F are wider than those from the South Field, though neither locus has tools that are noticeably longer or thicker. Additionally, bit symmetry and retouch angle differ to a degree that is approaching statistical significance. What the Discriminant Function Analysis and the associated ANOVA suggest is that the specific differences of end scrapers between Block F and the South Field lie in the bit morphology.

The fact that most other major morphological attributes are not significantly different indicates that there were not obvious functional differences in end scrapers at these sites. Instead, it suggests that perhaps there was a different mentality concerning discard processes and raw material use. Depending on whether these groups were coming from or going to lithic raw material sources, their attitude towards utilization and exhaustion could have been different. Indeed, Binford (1979) suggests that procurement of such resources would have been embedded in the cyclical rounds of hunter-gatherers, a phenomenon which would most likely affect to what extent tools were curated.

The biggest difference in morphology between these clusters is width, especially the width of the bit. A viable explanation can be found in the ‘triangularity’ variable. This measures the relative shape of each end scraper by dividing the width at 5mm by the
width at the bit; values closer to 1 are assumed to be more rectangular, while values closer to 0 are assumed to conform more to the archetypical trianguloid shape. Observing the relative triangularity of end scrapers from each cluster demonstrates a significant difference \((t=-3.229; p=.002)\). Those end scrapers from Block F have a lower value of this measure, signifying that they are generally more triangular. What this means in terms of width is that those tools from Block F would be wider at the shoulder and thinner at the base than those from the South Field, resulting in the evident disparity in width between the loci.

In terms of larger-scale systematics, this suggests that for some reason those end scrapers at Block F were better made and perhaps had a more ‘ideal’ use-life than those from the South Field. Shott’s (1993) measure of curation, the measure of midline length to haft length, supports this interpretation. The sites are significantly different in terms of curation \((t=3.228; p=.002)\); Block F has a less curated assemblage (mean value: 2.49), while the South Field has a more curated assemblage (mean value: 1.95). This suggests that the conditions at Block F did not necessitate utilizing end scrapers as exhaustively as those at the South Field. To further observe this pattern, the other characteristics that differ between each of the sites will be reviewed.

Those variables that were moderately different between the South Field and Block F loci were retouch angle and the symmetry of the bit. Despite the fact that retouch angle was approaching significance \((p=.077)\), the real difference between these angles was less than this might suggest. Those end scrapers at Block F have a mean retouch angle of 62.00° \((±14.93°)\), while those from the South Field have a mean of 68.24° \((±15.44°)\). For
any intent, these display no major differences. In terms of Wilmsen’s (1970) functional interpretation of retouch angle, these means and standard deviations straddle both categories (acute-55°; steeper-75°; see Figure 22).

In essence, there is no real tangible difference between the retouch angles of end scrapers at these loci. What it does tell us about these loci and retouch angle in general is that end scrapers were typically discarded with a retouch angle of between roughly 50° and 80°.

In terms of bit symmetry, both the symmetry of the true bit measurement and the symmetry of the perpendicular bit width were approaching significance (p=.018 and
p=.013, respectively). In both cases, end scrapers from the South Field have a higher level of bit asymmetry. This is perhaps indicative of greater utilization and resharpening of end scrapers at this locus, as bits become more asymmetrical with increased use and resharpening. If this is the case, it suggests that either raw material resources may have been scarcer during this particular occupation at the South Field loci or perhaps the amount of hide-working done was greater, with the latter correlating with the longevity of the occupation.
Chapter 7

Conclusion

This research project has helped document the nature of the morphological variation within the Nobles Pond assemblage of Paleoindian end scrapers. While these tools were all discarded with little remaining utility, the morphological variability within this group might seem to suggest that they served different functions. Indeed, many have argued that the variation within Paleoindian end scraper assemblages is indicative of tools that were used for a number of purposes (Shott 1993; Wilmsen 1970). This study instead supports the view that because of this extreme variation, end scrapers actually represent a single tool class. The evident variability is caused by the process of continued utilization and retouch. As the “Frison Effect” suggests, tools change shape and size throughout their use-lives, sometimes dramatically (Jelinek 1976). This phenomenon has been captured in the assemblage of end scrapers at Nobles Pond, perhaps in part because of the comparatively large sample size.

A number of statistical tests have been used to identify and document the variation found within this assemblage. After a description of the univariate statistics, a Discriminant Function Analysis was performed in order to determine what, if any,
differences exist between two artifact clusters used as samples in the study. As a result of the significantly different morphological trends found in end scrapers from these clusters, it was decided that the remainder of the tests should be conducted solely on the South Field sample, as its larger sample size has the potential to impart more information.

The first multivariate test performed on the South Field sample was a Principle Components Analysis, performed in order to partition the variation within the assemblage based on a number of morphological characteristics. This analysis demonstrated that the main source of variation within the assemblage is size, followed by symmetry, and finally by shape/production method. This variation conforms closely to what an assemblage dominated by continuous use and retouch of one type of tool should portray. Size varies from those few large tools that were discarded as a result of breakage or retouch failure, to those small end scrapers (which represent the majority of the assemblage) that were discarded because their utility was exhausted. Variation in symmetry is expected in a curated assemblage because as an ideal specimen is continuously retouched, its symmetry is inexorably degraded, a phenomenon which is governed by the form of the tool itself as well as the artisan.

Following this analysis of formal variation, a Cluster Analysis was performed to see if the end scrapers from the South Field sample could be sorted into meaningful categories based on size, shape, and symmetry. Additionally, the cluster analysis was used to replicate similar tests (either statistical or visual) conducted by other researchers, who have independently concluded that end scrapers are functionally diverse because they are so morphologically diverse. The analysis identified five major clusters, each
notably different in size and shape. Despite the artificial partitions imposed by this analysis, these clusters are obviously representative of a continuum, both of shape and size. What this signifies is that the shape and size of these tools underwent a continuous process of morphological diminishment from reduction, a conclusion supported by the Principle Components Analysis.

This analysis also indicates that the arbitrary delineations of statistical tests such as cluster analyses can sometimes lead to false conclusions. Collins and Byrd’s (1994) study exemplifies how reifying statistics can be misleading. Their cluster analysis could easily be interpreted as representative of a number of functional tool types. Exploring their cluster data in even a univariate fashion leads to a more convincing explanation, namely that their clusters also represent a continuum of reduction much like those from the Nobles Pond sample of end scrapers.

End scraper function has traditionally been measured by analyzing the retouch angle of the tool, a variable first used by Wilmsen (1970) in his seminal work on Paleoindian lithic technology. His analysis on the association of retouch angle with function, Wilmsen asserted that a steeper retouch angle was indicative of tasks which involved working hard materials, such as wood. Conversely, he thought that more acute retouch angles represent tools used for working softer materials such as hides. If true, this should have resulted in a bimodal distribution of retouch angle in an assemblage of end scrapers, a pattern which is not evident in the sample from Nobles Pond. Instead, the relatively normal distribution suggests that there was a range of retouch angles present on those end scrapers recovered from this site. Taking into account the idea that tools could
have been discarded for a number of reasons, and that retouch angle was not static throughout a tool’s use-life, it stands to reason that this normal distribution alludes to a continuum of retouch angles, or a single functional tool class undergoing processes of depletion.

Testing this idea of functional redundancy among end scrapers ultimately leads to another aspect of Paleoindian life. It is simplistic to think that all Paleoindian sites are identical and represent the same suite of activities. To address this, two non-contemporaneous ‘clusters’ were analyzed at Nobles Pond. The results of this comparison demonstrated that there were indeed different focuses at these clusters, which can be tangibly observed in their respective end scraper assemblages. These foci are not strictly speaking functional, but rather a matter of intensity. Block F, the smaller of the two clusters, has fewer end scrapers (n=26) that are less completely utilized. The South Field, which is both larger and has many more end scrapers (n=149; 88 sampled), contains an assemblage that is significantly more completely utilized. The differences between these two loci could indicate a number of patterns regarding Paleoindian systematics. The disparity between end scraper utilization may suggest that there were different levels of hunting success at the times these sites were occupied, resulting in dissimilar amounts of hide working. An alternative interpretation is that these loci could have been occupied at different seasons or at different points in the seasonal rounds of these groups of people (i.e. coming from or going to a raw material source). The proportions of major raw material types used to produce end scrapers at each site were notably different, suggesting that Paleoindian people were acutely aware of their pattern
of mobility. The implication here is that these groups of people were cognizant of their location relative to viable raw material sources and used their tools with this in mind. Each of these interpretations is quite plausible, though no doubt many others fit the data as well.

What this thesis has demonstrated is that there is a surprising amount of variation within one formal class of Paleoindian tools. The variability inherent to this sample of end scrapers from Nobles Pond has the potential to mask the fact that these tools are in reality functionally redundant. Many researchers have mistakenly assumed that the large range in both shape and size of end scrapers as proof of multi-functionality. This research project has instead taken steps to show that the clear morphological variation in this assemblage instead represents a continuum of reduction and reuse of one functional class of tools.

**Directions for Future Research**

The length of time required to complete this research project was in part shaped by the large number of variables examined on each end scraper. Although an inclusive study generates the most detailed data, sometimes the data gain is not worth the cost in time. Future morphometric analyses of Paleoindian end scrapers would benefit from a reduced, though still informative, set of key variables that can be compared across assemblages.

The size variables of *maximum length, maximum width, maximum thickness, weight*, and *surface area* are all important as well as ubiquitous in morphological
analyses of this type. Length measurements are important in terms of depletion as well as a potential measure of remaining utility (Grimes and Grimes 1985). Width is important for depletion and retouch as well, though it is also an important shape aspect when considering the relative triangularity of the tool. Thickness is important as it may be one of the few measures on a tool that accurately reflects the original condition of that tool. Weight and surface area represent important generalized indicators of size. Additionally, retouch angle is a critical variable considering Wilmsen’s (1970) seminal work, though the functional importance of this characteristic has been diminished somewhat by the current project.

In terms of shape, the cross-section shape attribute has been demonstrated to be of critical importance when attempting to determine the type of core that an end scraper was derived from, which, as this project has concluded, is also an important factor which influences the use-life of the tool. An additional important shape variable is bit depth, which determines the convexity of the tool bit, a measure which can be a general proxy for depletion, as an end scraper’s bit becomes flatter with continued reduction (Shott 1993).

One of the most important symmetry variables is the adjusted bit width angle, which demonstrates how canted the bit of the end scraper is off of 90°. This characteristic is assumed to become more asymmetrical during the middle of and end scraper’s use-life and then approach evenness again as the tool approaches its minimum functional length as a result of hafting constraints. Another important symmetry measurement is the adjusted bit width, which demonstrates how far off of the midline
each margin of the tool is at the bit. In a sense, it captures the lateral symmetry of the tool bit, which could be indicative of depletion, handedness, uneven resharpening because of faults in the material, or a number of other reasons.

Additional variables that are important to note are bulb presence and the type of ancillary bits that are present on each tool. Bulb presence is an important marker of whether or not an end scraper is part of the original flake blank it was derived from, which has implications on both production and depletion. Determining the type and location of ancillary bits on a tool is critical to understanding if and how an end scraper was recycled after is primary function was no viable.

In order to capture the shape of the tool itself, those variables required for the Triangularity variable and the Longitudinal Cross Section variable are necessary. Apart from variables already mentioned above, these include the width of the tool at 5mm and the thickness of the tool at 10mm. Each of these two compound variables is important in their own respects. The Triangularity of the tool can help demonstrate how ideal the tool’s shape is, as well as support how it was produced and how efficiently it was hafted. The Longitudinal Cross Section of a tool provides a measure of how uniform the cross section of the tool is. Tools with greater disparity in this measure are typically more ideal, as they get smaller at the proximal margin, where an end scraper would fit into a haft.

In terms of future research, similar assemblages throughout eastern North America should be analyzed following a methodology similar to that used in this project. There are assemblages of Paleoindian end scrapers (Paleo Crossing, for example) that, if
analyzed, could either support the findings of the present project, or offer new insights into the utility and functionality of these tools. Also, analyzing previously studied assemblages through an organization of technology viewpoint could lead to a number of new findings. Considering the paucity of Paleoindian material, we must extensively analyze everything available in the most efficient, comprehensive, and comparable way possible to help elucidate patterns of behavior and adaptation in this important period of prehistory.
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<td>True Bit Width – Left</td>
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<td>True Bit Width – Right</td>
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<td>Thickness on midline at axial length-to-bit point</td>
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<td>Length from Max Thk to Retouch Termination Thk</td>
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<td>Bit edge regularity of curvature</td>
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<td>Bit Edge Scarring Type</td>
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<td>Bit Edge Scarring Distribution</td>
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<td>47.</td>
<td>Notches I</td>
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## APPENDIX B

### DESCRIPTIVE STATISTICS FOR ALL VARIABLES

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<td>4.1325</td>
<td>.55484</td>
<td>5.92406</td>
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<td>2.398</td>
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<td>25.50</td>
<td>4.1325</td>
<td>.55484</td>
<td>5.92406</td>
<td>1.703</td>
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<td>.73004</td>
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<td>110.00</td>
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<td>4.19</td>
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APPENDIX C

CLUSTER IMAGES

Cluster 1
Cluster 3
Cluster 4
CLUSTER 5
APPENDIX D

HISTOGRAMS OF ALL VARIABLES

![Histogram of Platform Angle](image1)

Mean = 68.45
Std Dev = 11.23
N = 29

![Histogram of Platform Width](image2)

Mean = 6.88
Std Dev = 1.93
N = 29