ORGANIZING CHIPPED LITHIC TECHNOLOGY AT THE LONE PINE SITE

Trevor Ormerod

Excavations conducted by the University of Toronto's Princess Point Project recovered a large sample of informal flake-based tools from the Lone Pine site (AfGx-113) during the 1993 season. Of interest is the choice of technology represented by these tools and its emphasis on expedient, utilized flakes. This analysis suggests that the potential function of these implements, the exceptional availability of raw material in the vicinity, and the mobility strategy of the site's occupants were guiding factors in the overall technological strategy chosen and the resulting design of tools.

INTRODUCTION

The analysis of flaked lithic aggregates has traditionally taken a functional approach in which formal tools have been given precedence over informal tools in delineating past industries. Within this framework, formal tools are typically assigned to discrete and exclusive functional classes and their morphological structure is described and quantified in exhaustive detail. Often, the relative frequency of formal tool classes produced by this type of analysis is employed as an index of prehistoric activities, especially those pertaining to economic organization (Bordes 1961). As Shott (1986) and other analysts have endeavoured to illustrate, however, there are problems with this traditional approach. Foremost among these is that informal tools often compose the largest percentage of a tool kit. To ignore the significance of these informal, expedient, tools can only bias the overall interpretation of the assemblage. In addition, several authors (Henry and Odell 1989, Jochim 1983, Kleindienst 1975, Nelson 1991, Torrence 1983, Yerkes and Kardulias 1993) note that traditional lithic analyses have also failed to consider, in any appropriate detail, that flaked stone material relates not only to a set of activities, but also to other parts of a cultural system. In fact, flaked lithic technology is an integral part of many cultural systems and may be regarded as a means by which human individuals attempt to solve both internal (social) and external (environmental) problems in their environment (Hutchings 1990, Steward 1955, Torrence 1989). Koldehoff suggests that "technology can be conceptualized as a subset of a society's learned behaviour; it is the body of knowledge a society draws upon to cope with its environment," and it "is also dynamic and can be viewed as a problem solving process" (Koldehoff 1987:152).

In other words, lithics, and the associated technological mind-set, allow a unique glimpse into how groups of individuals coped with everyday problems in their environment. Growing awareness of this concept has inspired many scholars to explore models which focus on human behaviour with the aim of revealing more about the nature of a society. Although behavioral approaches to lithic material have existed in the archaeological literature for some time (Holmes 1919, Knudson 1973), since the 1970s there has been a noticeable resurgence of theoretical concepts which incorporate behavioral variables. Examples of this include the study of tools as optimal solutions (Torrence 1989, Jochim 1989), applications of design theory (Hutchings 1990) and the examination of technological organization (Binford 1979, Parry and Kelly 1987, Nelson 1991, Andrefsky 1994, Odell 1996).

This study examines the flaked lithic aggregate of an early Late Woodland site in southern Ontario with the aim of addressing behavioral correlates of the lithic technology used at the site. Facets of technological organization and use-wear analysis are combined with more traditional aspects of tool typology in an attempt to infer human behaviour from the lithic assemblage. Theoretical aspects concerning this behavioral approach are discussed first, and are then followed by the application of principles to the Lone Pine chipped lithic assemblage.

ORGANIZATION OF TECHNOLOGY: CURRENT APPROACHES

Research has increasingly focussed on behaviour and its organization. There has been increased emphasis on how aspects of technology are organized in relation to making, using, discarding and transporting stone tools (Nelson 1991:57). Koldehoff, following Binford (1977, 1979) defines the organization of technology in the following manner:

> The way in which a culture or society designs its tools and structures tool production, use, and maintenance, so that the tools can respond effectively to the demands placed upon them by the society in its daily interaction with the environment (both biophysical and social)...[Koldehoff 1987: 154].

Studies of technological organization consider a number of factors when investigating the dynamic behaviour of a society. Typically, an effort is made to examine the types of raw material employed in tool manufacture, distances to these material sources, basic food procurement strategies, tool function, the mobility and predictability of biotic resources, as well as the mobility of the social group. In observing these variables, the analyst keeps two important concepts in mind: (1) the dynamics of technological behaviour, and (2) the concept of strategy (Nelson 1991:576). These concepts underlie the rationale for how particular strategies will come into existence and how planning will play a role in tool kit structure. Ultimately, humans are viewed as individuals interacting with an environment which conditions behaviour, resulting in the inevitable choice of some technological alternatives at the expense of others (Bleed and Bleed 1987). A number of scholars (Torrence 1983, Jochim 1989) have suggested that this will lead towards optimal solutions in technology. This notion, however, is problematic. Ethnographic studies (White 1968, White and Thomas 1972, Miller 1979) have indicated that optimal tech nological solutions are not always the best choice, nor are they always sought after. There are always a number of suitable and appropriate designs in any given circumstance which may work well for the tasks at hand (Pye 1964), but may not serve as the best choice for optimizing time or energy. In addition, it is important to remember that the idea of time and energy optimization, or Zipf's well-known "principle of least effort", is very much a modern notion and may not necessarily hold true for all prehistoric people.

Currently, scholars of technological organization acknowledge two different technological strategies: "curated" and "expedient". These are typically viewed as a continuum in which curated strategies are replaced by expedient ones over time. Curated strategies are defined as those which successfully mitigate the incongruities between the availability of tools or raw materials and the location of tool using activities (Nelson 1991:63). Binford (1977) suggests that these strategies tend to be highly organized, representing a great deal of time and production investment in the early stages of planning and manufacture as they relate to resource acquisition. Curated tools are used and maintained for extensive periods of time and are typically identified by tools that are manufactured in anticipation of future tasks. Curated tools are often transported from location to location and are recycled for other tasks when they are no longer useful for their original purpose. Nelson (1991) suggests that bifacial tools represent a good example.

Conversely, expedient strategies are defined as those which display "minimized technological effort under conditions where time and place of use are highly predictable" (Nelson 1991:64). Binford (1979) theorizes that expedient strategies are responsive to particular conditions at hand and can be viewed as a sort of situational gear. Similarly, Parry and Kelly (1987) suggest that expedient tools will be made with little expenditure of time or effort, with a specific task in mind. Expedient strategies employ a prodigious quantity of raw materials, largely due to the short period of use and discard associated with expedient tools. Nelson (1991) suggests that informal flake tools are good examples of expedient tools.

Because of the shorter investment of time associated with expedient strategies, Bamforth (1986) has suggested that expedient tools are more primitive than curated tools. Bamforth's assessment, however, fails to consider the fact that expedient tools offer different advantages than do curated tools. It does not necessarily follow that expedient tools are more primitive because less time is spent in their manufacture. Bamforth's characterization may have to do with the term "expedient", which tends to denote something that is makeshift or used only in emergencies because it is convenient (M. Kleindienst, personal communication 1993). Perhaps the term "situational" would serve better to describe this strategy.

Variables Influencing Technological Organization

There are a number of variables which will influence technological organization and the design of tools. Scholars have generally argued that one or two variables have greater influence than others. Following Bamforth (1986), however, it is argued that the organization of technology is a complex problem which requires a multi-variable explanation. In the case of lithic manufacture at Lone Pine, it is argued that aspects of group mobility, raw material availability, and tool function were the guiding factors influencing how tools were designed, as well as how groups geared technology towards tool production.

Mobility. Many archaeologists (Shott 1986, Nelson 1991, Binford 1979, Parry and Kelly 1987, Kuhn 1994) argue that settlement mobility directly affects technological organization and the resulting design of tools. In the most obvious sense mobility limits the number of tools, the size and transportability of tools, and may even dictate the range of uses a particular tool or tool kit may have. This has precipitated the argument that strategies featuring curation will be more common to mobile groups, as they will allow a more efficient balancing of costs and investments in raw material acquisition (Binford 1979, Nelson 1991). Conversely, strategies based on flake tools tend to be associated with groups that are sedentary during parts of the year, especially if there is ample raw material available and less concern with budgeting of resources in relation to mobility. Parry and Kelly (1987) have noted an interesting correlation of core technology with settlement mobility in the Eastern Woodlands which reflects this idea. When groups become less mobile (ca. A.D. 500-900) tool kits emphasizing versatile biface tools are replaced by more flexible tool kits of smaller projectile points and many flake-based tools. Fox (1981:2) has observed this trend in southern Ontario noting that, "the frequency of larger bifaces decreases from Middle to Late Woodland times."

Raw Material. The overall availability of raw material will also have a pronounced affect on the choice of tool strategies (Binford 1979, Nelson 1991, Andrefsky 1994, Odell 1996). When material is scarce, strategies which feature the curation of raw material are more appropriate. They make better use of the material and conserve it for periods of shortage. If material is readily available, however, expedient strategies that make use of large quantities of raw material will be possible. Andrefsky (1994) has recently incorporated this concept of raw material availability with raw material quality, suggesting that the two may work together to influence technological organization. His study of several chipped lithic assemblages in the states of Washington, Wyoming and Colorado has resulted in an interesting pattern. He notes that when material abundance and material quality are high, strategies emphasizing both formal and informal tool types are observed. Under conditions where material abundance is high and quality is low, informal tools dominate an assemblage. Conversely, when raw material is not abundant and material quality is high, formal tools are most common. Finally, when material quality is low and abundance is also low, informal tools predominate over formal tool forms (Table 1).

Tool Use. Although rarely mentioned, tool function is also among the more important variables guiding the choice of a technological strategy. After all, a tool must ultimately function to complete a task, or it is considered a failure (Pye 1964). To decrease failure rates, groups will organize technology and tool design for success. Pye (1964) argues that there will always be some degree of failure in any design. Tools, however, will likely be manufactured so that they function adequately in the required task. Tools will not always be produced to optimize their function, but there will be at least some intention to manufacture tools which will function without immediate failure. Gearing tool manufacture towards function has the potential to reduce the overall time required to complete a task with the

Table 1. Raw Material Abundance and Quality (based on Andrefskv 1994).

	RAW MATERIAL QUALITY HIGH	RAW MATERIAL QUALITY LOW
RAW MATERIAL ABUNDANCE HIGH	formal and informal tool production	primarily informal tool production
RAW MATERIAL ABUNDANCE LOW	primarily formal tool production	primarily informal tool production

manufactured tool and can save on the amount of raw material employed in making the tool. Use-wear analysis is the key to determining tool function and is among the more important tools used to investigate the relation of the archaeological record to human behaviour. As Yerkes and Kardulias (1993:100) state, use-wear studies allow the analyst to, "connect the static archaeological record with the dynamic cultural context."

THE LONE PINE CASE STUDY

Site Location and Date

Excavations were initiated at Lone Pine in the summer of 1993 by G. Crawford and D. Smith of the University of Toronto; this coincided with the beginning of the Princess Point Research Project and the 1993 Erindale archaeological field school. Temporally, the site could be assigned to either the late portion of the Princess Point Complex, or the early part of the Glen Meyer period (D. Smith, personal communication 1993). Pottery from the site is dominated by cord-wrapped stick decoration, typical for Princess Point ceramics. Pottery seriation, however, indicates that the site is later than Porteous (Bekerman 1995) and may represent early Glen Meyer, or a transition from Princess Point to Glen Meyer. Maize kernels recovered from the site have yielded dates of 1040 ± 60 B.P., calibrated to A.D. 1010 (TO-4586) and 800 B.P. ± 50 B.P., calibrated to A.D. 1255 (TO-4083). The later date has been rejected by Smith and Crawford (1995) as being too late in time.

Lone Pine is located on Rogers Creek, a tributary of the Grand River, and covers an area of approximately one-half hectare (Figure 1). The site is positioned in close proximity to several Princess Point sites, including Grand Banks, Young 1 and Cayuga Bridge. Smith and Crawford (1995) suggest that these sites represent three different types of settlement locations for Transitional Woodland sites. Grand Banks and Cayuga Bridge are viewed as river bar settlements, while Young 1 may represent an occupation of the first terrace back from the Grand River. Lone Pine is unusual because it is situated at an inland location, but may represent a short-lived stage in the movement away from the clay plains to the sand plains that culminated in the subsequent Glen Meyer period. Lone Pine could also represent the transition from 'pre-village' sites like Grand Banks and Young 1 to a more centralized community (Smith and Crawford 1995).

Artifacts recovered during the 1993 season are dominated largely by flaked stone, followed by earthenware. Faunal remains are surprisingly sparse. Eastern grey squirrel (Sciurius carolensis) elements are the most numerous. These are followed in frequency by white-tailed deer (Odocoileus *virginianus),* and racoon (Procyon lotor) elements (Cabeceiras 1994, Knight 1993). Floral findings include both cultigen and non-cultigen species (Bowyer 1995). No ground stone was recovered. According to the landowner, the site has never been plowed and the overall state of the artifacts seems to support this claim. The number of diagnostic artifacts located on the surface suggests that looting has been limited. The site is covered largely by deciduous growth, with the occasional conifer, and the soil is composed of a layer of humus (ca. 15 cm in depth) over a base of Haldimand clay.

Sampling

This study considers a sample of 6,000 (roughly 40 percent) of the chipped lithics found during the 1993 season. Sampling of the

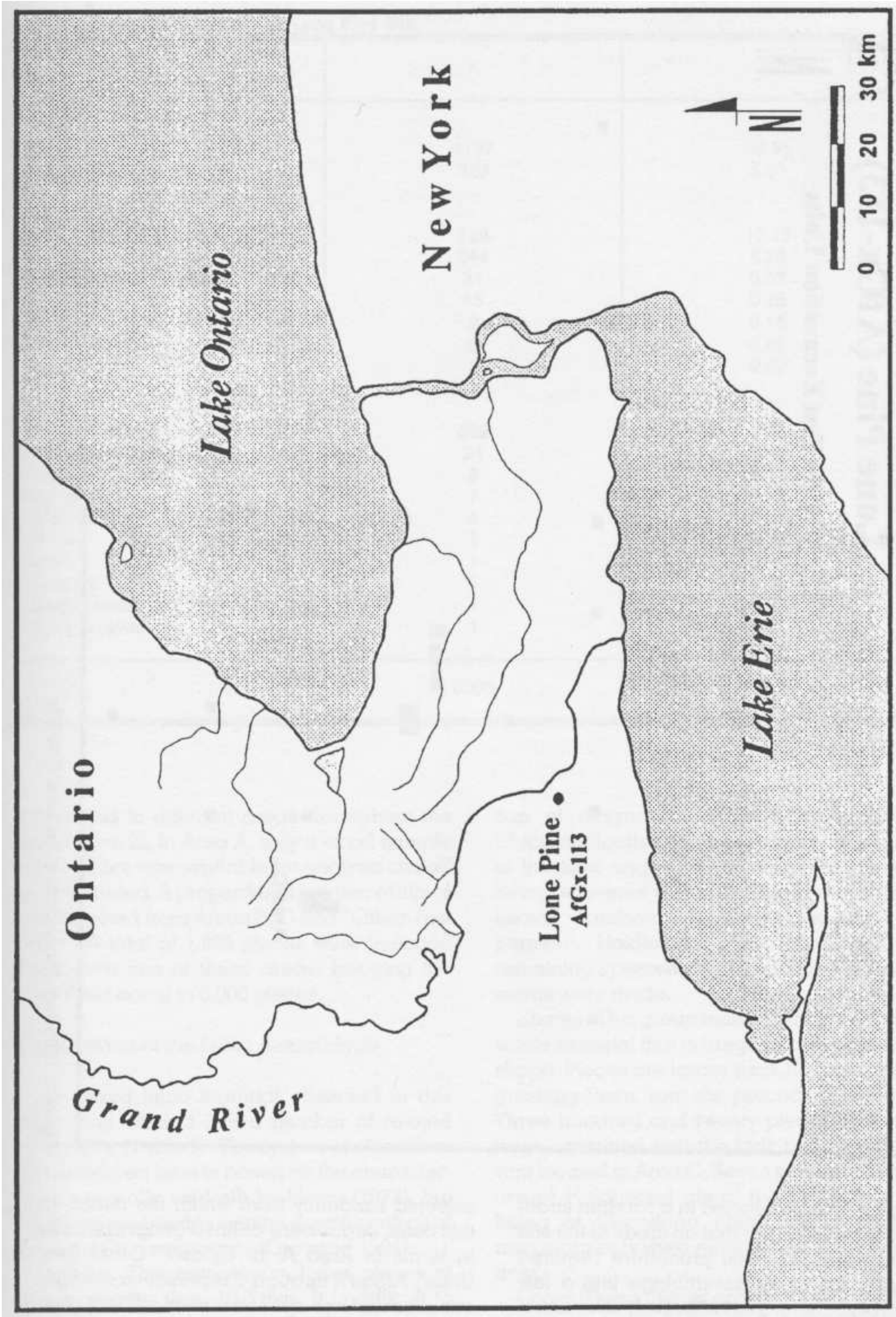

Figure 1. Location of the Lone Pine Site (AfGx-113)

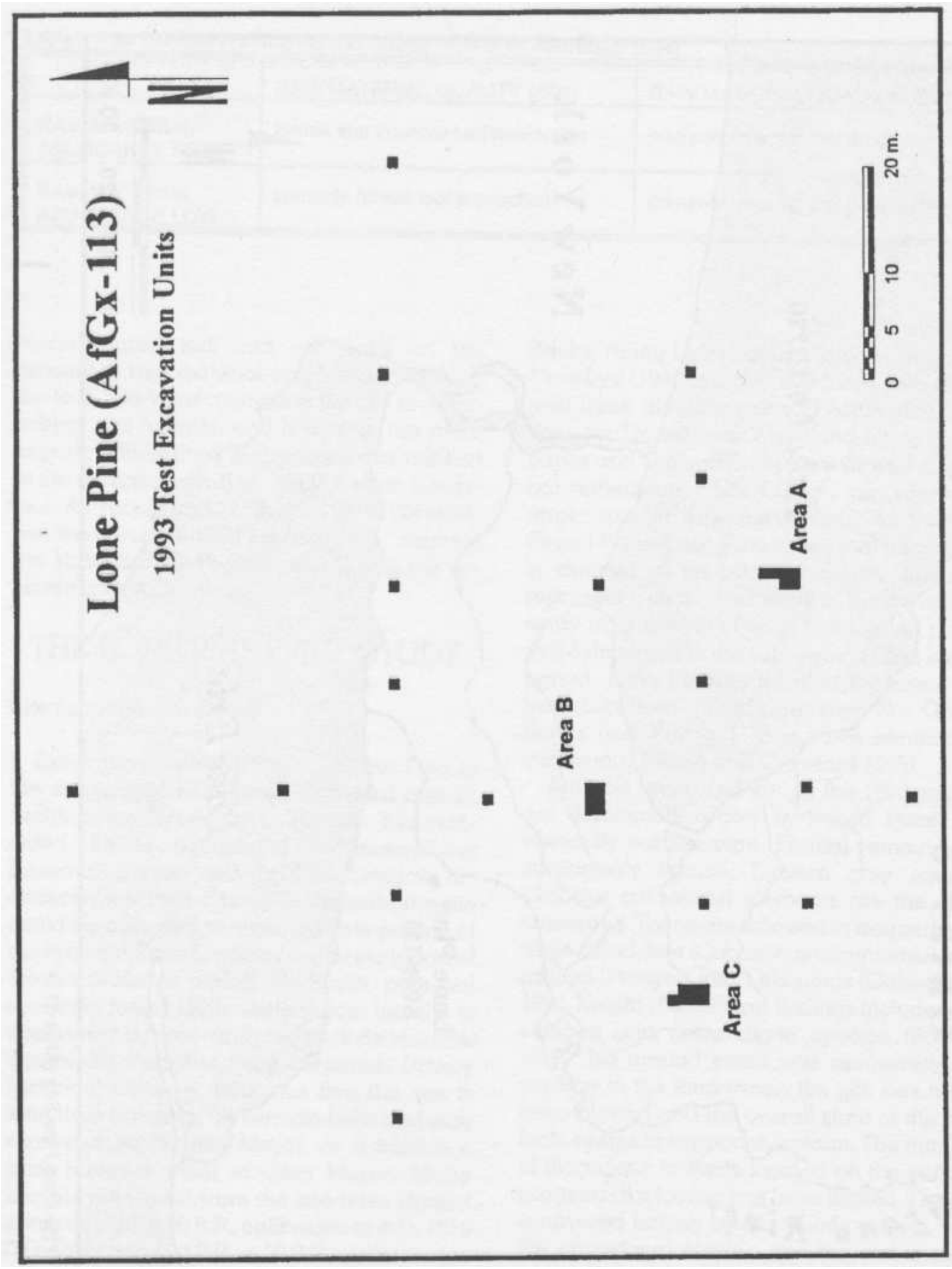

Figure 2. 1993 Test Excavations of the Lone Pine Site

aggregate was conducted in a random stratified manner, ensuring that all areas of the site were represented. This procedure required stratifying the study assemblage into a few mutually exclusive, and collectively exhaustive, categories. Following this, samples were selected randomly from within the strata. In this case, strata were defined geographically in terms of Area A, B, C, and "Other Test Units". Areas A through C represent a continuous area that was opened to view, while "Other Test Units" includes a number of test squares

Table 2. Flaked Lithics From the Lone Pine Site.

ARTIFACT TYPE	n	%
DEBRIS		
Detritus	4197	69.95
Shatter	320	5.33
DEBITAGE		
Biface Trimming Flake	729	12.15
Flakes	**344**	5.73
Core Trimming Flakes	31	0.52
Cores	15	0.25
Blades	9	0.15
Primary Elements	3	0.05
Microburin	1	0.02
TOOLS		
Utlilized flakes	302	5.03
Retouched flakes	24	0.40
Projectile points	8	0.13
Scrapers	7	0.12
Bifaces	4	0.07
Burins	2	0.03
Drills	1	0.02
Gravers	1	0.02
Denticulates	1	0.02
Spokeshaves	1	0.02
TOTAL	6000	100.00

distributed in different areas throughout the site (Figure 2). In Area A, only a small sample of 315 lithics was available for analysis and all were included. A proportional number of lithics was selected from Areas B, C and "Other Test Units". A total of 1,895 pieces were included from each one of these areas, bringing the combined count to 6,000 pieces.

Composition of the Lithic Assemblage

All flaked lithic material observed in this study was divided into a number of related categories (Table 2). The system of classification employed here is based on the characteristics originally set forth by Henry (1973), but has been modified to suit the specific nature of the Lone Pine aggregate (Ormerod 1994).

Detritus. This category includes pieces of debris smaller than 10.0 mm. It is difficult to assign these specimens to specific categories due to their size, which makes the identification of diagnostic characteristics difficult. Chipping detritus makes up nearly 70 percent of the total aggregate, most of the material being recovered in Area B. The detritus class is heavily dominated by Onondaga chert (98 percent). Haldimand chert composes the remaining 2 percent. No quantitative measurements were made.

Shatter. This group includes larger "blocky" waste material that is irregular and angular in shape. Pieces are larger than 10.0 mm, distinguishing them from the preceding category. Three hundred and twenty pieces of shatter were examined and the bulk of this material was located in Area C. Seven pieces of shatter are of Haldimand chert, the remaining 313 being of Onondaga chert. No continuous measurements were recorded for this class of data.

Cores. These pieces are discarded portions of raw material from which other debitage classes have been removed. Fourteen of the fifteen cores noted in this sample are of Onondaga chert, highlighting a clear preference for Onondaga material in the production of tools. The other is of Haldimand chert. The mean maximum length of cores is 43.77 mm (range = 51, standard deviation = 14.1), the mean maximum width and thickness being 28.07 mm (r = 26, s = 7.5) and 18.87 mm (r = 19, s = 6.2) respectively. An investigation of flake-removal facets yields an average of roughly ten scars per core. Facets average 18.83 mm in length(r = 28, s = 9.4) and 14.24 mm in width (r = 20, s = 6.4) suggesting an emphasis in the production of flakes rather than blades. However, it must be noted that most of the cores had been expended to small sizes, thereby biasing facet dimensions considerably. Two of the cores have bipolar flaking patterns. Following Lennox (1981:236), it was possible to determine that three of the cores were taken from till sources, and that four came from primary tabular sources.

Primary Elements. This category includes those pieces of raw material removed during initial reduction which have at least one third of their surface covered by cortex or natural surface coverage. Only three primary elements were among the study aggregate, making up less than 1 percent of the total flaked lithic artifact count. The average maximum length of primary elements is 30.5 mm (r = 6.5, s = 3.5) and the average maximum width is 21.67 mm (r = 12, s = 4.7). All specimens are of Onondaga chert. The lack of primary debitage at the Lone Pine site indicates that the initial stages of core reduction were carried out at other locations.

Core Trimming Flakes. These flakes have evidence of an old striking platform on the dorsal side, suggesting they were produced during core preparation. Thirty-one core trimming flakes were analyzed. The mean maximum length of these specimens is 29.31 mm (r = 36.2, s = 12.5) and the mean maximum width is 17.79 mm (r = 21, s = 8.5). Core trimming flakes are few in number, suggesting a low frequency of core preparation, or blank standardization, in the reduction strategies of the Lone Pine knappers. All core trimming flakes are of Onondaga chert.

Flakes. Those elements which are removed from cores and display a bulb of percussion and a striking platform are classified as flakes. Three hundred and forty-four flakes were examined. The mean maximum length of these specimens is 21.86 mm (r = 34, s = 16.6) and the mean maximum width is 15.38 mm (r = 21, s = 12.3). Roughly 98 percent of the flakes (n= 335) are of Onondaga chert. The remaining nine are of Haldimand chert.

Blades. These are elements measuring twice as long as they are wide. Sides are approximately parallel. Only nine blades were among the study group. Blades average 28.2 mm (r = 34, s = 13.2) in length and 12.5 mm in width (r = 8.5, s = 4.7). Eight of the blade elements are of Onondaga chert, with one of Haldimand chert. Stothers (1977:69-70) originally noted that blades become less frequent, in comparison to flakes, with the progression of the Princess Point sequence. This substantiates the late AMS date and ceramic evidence discussed previously. No effort was made to distinguish between blades and bladelets, although the majority of specimens observed here would likely fall into the latter category.

Biface Trimming *Flakes.* Byproducts of biface manufacture are classified as biface trimming flakes. They are characterized by a thin shape, and typically have lipped bulbs. The dorsal face exhibits scars and facets from previous flake removal. A total of 729 biface trimming flakes are among the analyzed sample. The mean maximum length of these specimens is 15.23 mm (r = 30, s = 13.7) and the mean maximum width is 10.84 mm (r = 23.6, s = 8.2). Most of the specimens are of Onondaga chert (n=706), 22 are of Haldimand chert, and one is of an unknown material.

Microburins. These pieces represent a secondary technological process in which a flake or bladelet is notched and snapped. Only one microburin was found in the study assemblage and it came from Area B. It measures 20 mm in length, 14.5 mm in width and 4.5 mm in thickness. The specimen is of Onondaga chert.

Projectile Points. These items are bifacial or unifacial triangular pieces which are sometimes notched. Portions of eight points, all of Onondaga chert, were present in the sample considered in this study (Figure 4). Three of the points are un-notched and triangular in shape, two are side-notched, and the rest are broken tips. Metric data is displayed in Table 3. It is interesting to note that the triangular Levanna-like point style occurs in this sample, but that it does not dominate other forms. The three broken projectile points included in this

Table Projectile Point Metrics

SPECIMEN	MAX. LENGTH	BASE WIDTH	NECK WIDTH	MAX. THICKNESS
a	29 mm	29 mm	-	5.5 mm
b	33 mm	32 mm	-	4 mm
c	39 mm	16 mm	-	6 mm
d	41 mm	17 mm	11 mm	7.5 mm
e	-	-	-	4.8 mm
f	-	-	-	3mm
g	-	-	-	7 mm
h	-	-	-	3mm

category could also be considered refined bifaces. Bifaces associated with Princess Point assemblages, however, are typically larger than these pieces, measuring between 65 and 130 mm in length (Stothers 1997:63). This makes it more probable that they are broken projectile points rather than bifaces.

Bifaces. This category includes all tools worked on both sides which do not fall into the other categories defined in this section. Four biface fragments compose only one percent of the total tool count. None of the specimens is complete and no metric data could be compiled for this category. Two of the biface fragments fit together to form the upper portion of a large triangular tool. One of the other specimens represents approximately one-third of an ovate biface. All of the bifaces are fashioned from Onondaga chert.

Drills. These objects resemble projectile points, although the points are thicker and have evidence of chipping and striations relating to use. One complete drill was recovered from Area C. It has a rounded, bulbous, base and is manufactured from Onondaga chert. It measures 34 mm in length, 17 mm in width and 6 mm in thickness.

Scrapers. Pieces characterized by a highly curved ventral surface, an expanding lateral edge, and unifacial modification on at least one margin are classified as scrapers. Seven scrapers were observed in this sample, all made from Onondaga chert. Scrapers average 23.75 mm in length (r = 26.5, s = 11.3), 16.25 mm in width (r = 12, s = 5.0) and 3.75 mm in thickness (r = 4.5, s = 1.8). Three scrapers were classified as endscrapers and two as lateral or sidescrapers. The two remaining unifaces display retouch on over 80 percent of their edges.

Gravers. Gravers are tools displaying a single point, and often, one worked edge. One graving tool, made of Onondaga chert, was recovered in Area C. It is 38 mm in length, 26 mm in width, and 8.5 mm in thickness. The graving beak of the implement measures 10 mm in length.

Denticulates. Implements, typically manufactured from flakes, with multiple points produced by retouch are classified as denticulates. One denticulate, made of Onondaga chert, was recovered from Area B. It has an irregular cutting margin with eleven pointed teeth aligning 35 mm down a single lateral margin. Teeth are spaced approximately two millimetres apart. The specimen measures 41 mm in length, 25 mm in width and 4 mm in thickness.

Spokeshaves. This category includes tools produced on flakes which have a deep concave working edge. One spokeshave, of Onondaga chert, was found in Area A. It differs from other retouched flakes in having a deep (3.5 mm) concave cutting edge. It measures 26.5 mm in length, 14.5 mm in width, and 7 mm in thickness.

Retouched Flakes. Flake tools that have been re-shaped or re-sharpened on at least one margin are included in the retouched flake

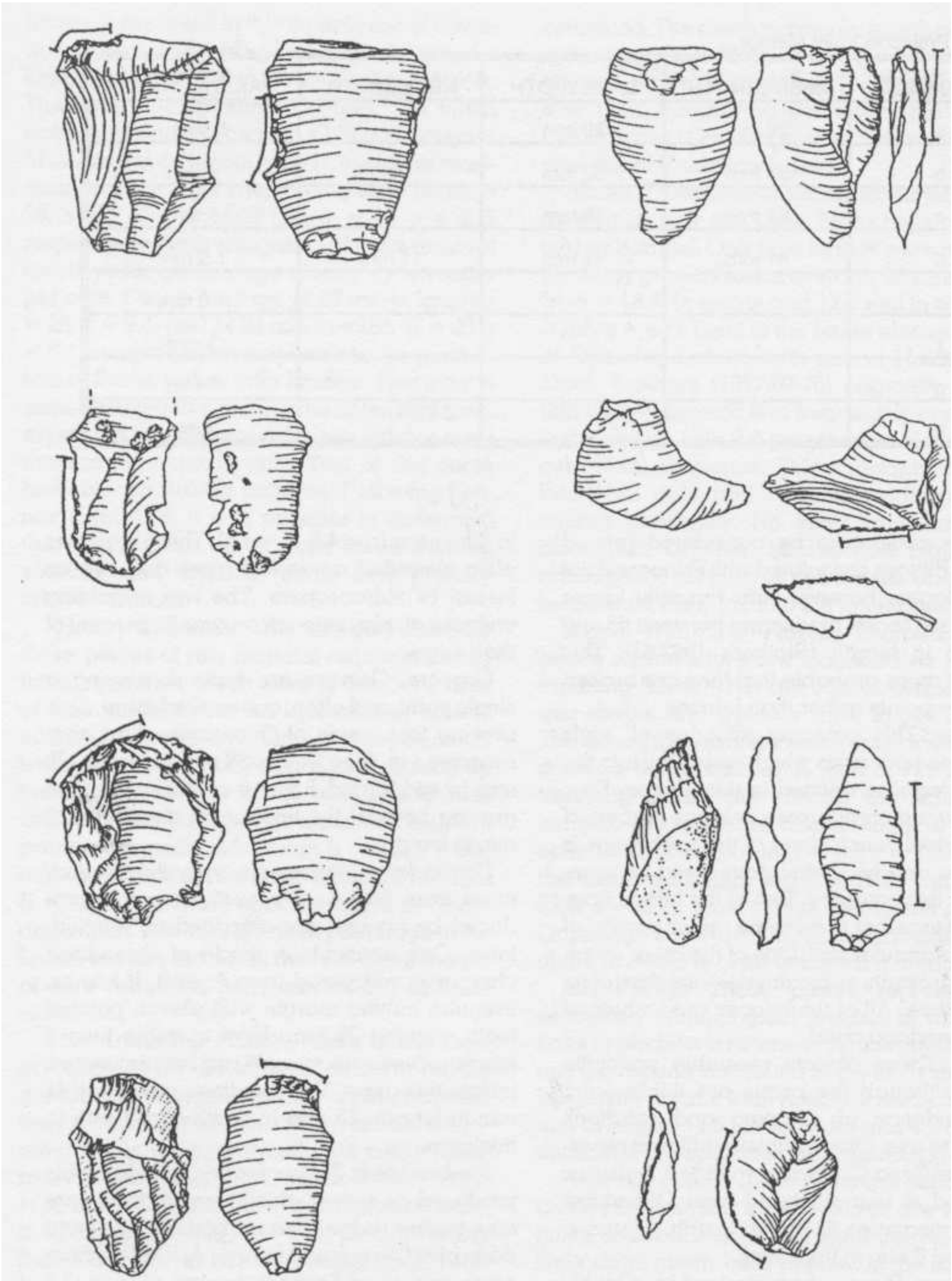

Figure 3. Utilized Flakes from the Lone Pine Site (AfGx-113)

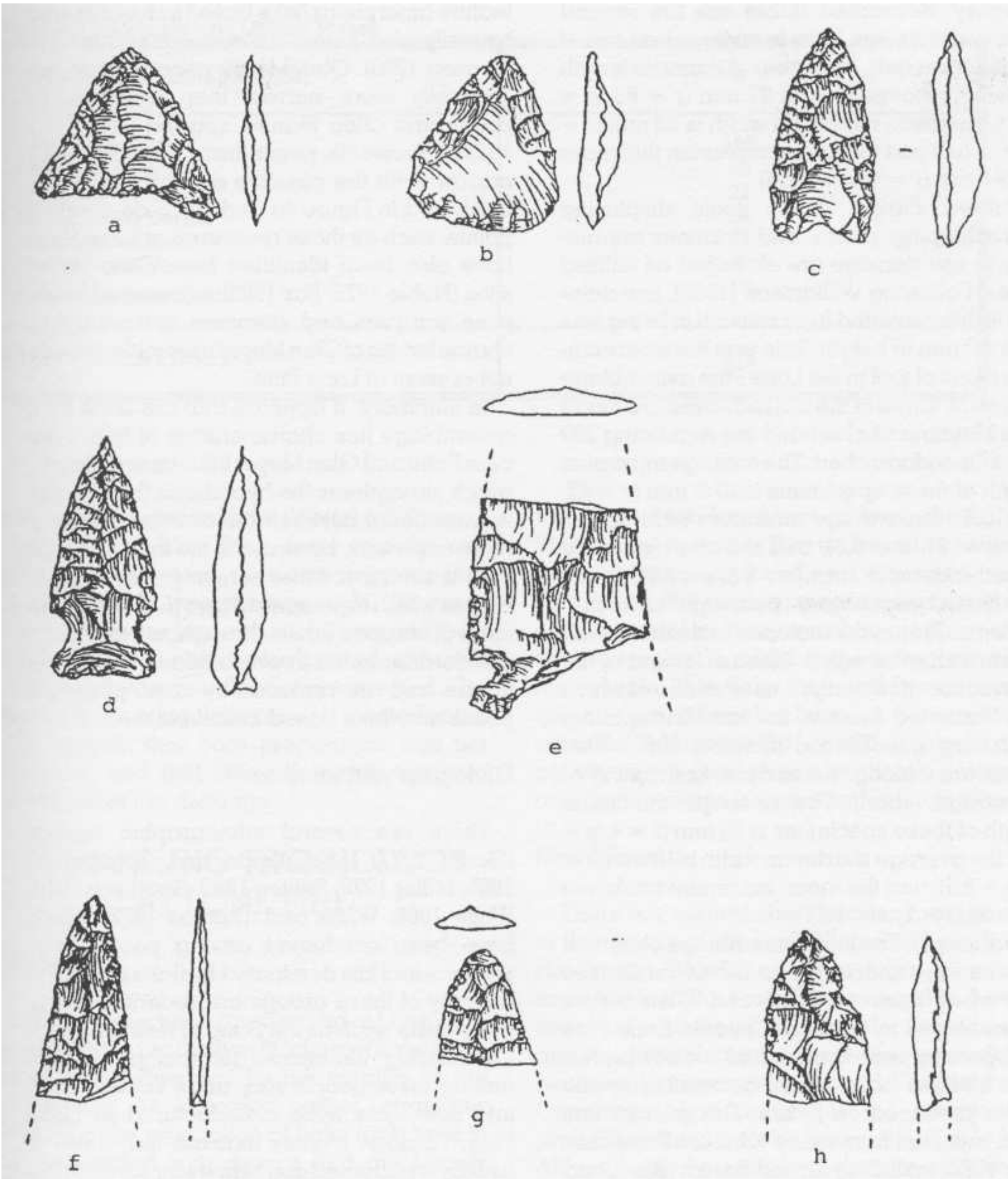

Figure 4. Projectile Points from the Lone Pine Site (AfGx-113). Triangular Points (a-c), Side-Notched Points (d-e), Broken Tips (f-h)

category. Retouched flakes are the second most common tool form (n=24) and all are of Onondaga chert. The mean maximum length of these specimens is 31.97 mm (r = 63, s = 15.2), the mean maximum width is 23 mm (r = 25, s = 5.6) and the mean maximum thickness is 4.94 mm (r = 4.5, s = 2.8).

Utilized Flakes. Flake tools displaying microchipping, polish, and striations attributable to use damage are classified as utilized flakes. Following Williamson (1985), use damage is differentiated from retouch in being less than 1.0 mm in height. This was the most common class of tool in the Lone Pine assemblage (Figure 3). Three of the utilized flakes are made from Haldimand chert and the remaining 299 are of Onondaga chert. The average maximum length of these specimens is 27.3 mm (r = 42, s = 10.4), the average maximum width is 18.5 mm (r = 21, s = 6.8), and the average maxi-mum thickness is 3 mm (r = 2.5, s = 2.2). A total of 318 used edges were observed (Table 4).

Burins. This class includes tools that terminate in a chisel-shaped "biseau" formed by the intersection of two edges, at least one of which is a burinated facet of the lamellar spalling producing the "biseau"(Sackett 1989). Two burins are among the sample, both being of Onondaga chert. The average maximum length of these specimens is 30 mm (r = 4, s = 7.8), the average maximum width is 19 mm (r = 11, s = 8.5), and the mean maximum thickness is 5 mm (r = 1, s = 1.4).

Discussion. The lithic assemblage observed at Lone Pine shares a number of similarities with other Princess Point and Glen Meyer assemblages in southern Ontario. Lone Pine knappers appear to have had a clear preference for flake tools, as well as small projectile points produced on flakes. This pattern has been reported from many Princess Point sites (Fox 1990) including Grand Banks (Shen and Ormerod 1995), Alder Creek (Timmins 1992), Glass and Cayuga Bridge (Stothers 1977). Princess Point bifaces are typically ovate in shape, as is one of the specimens in the Lone Pine assemblage. The drill recovered from Lone Pine could easily fit into Stothers' (1977) 'bulbous base' category for Princess Point drills. In addition, the point illustrated in Figure 4b could be classified as a Princess Point Levanna-like projectile point, since it has the rough shape of an equilateral triangle.

Glen Meyer chipped lithic assemblages also feature amorphous flake based industries, and typically also include triangular points (Williamson 1990). Glen Meyer period points are generally more narrow than Levanna-like points and often feature spurred ends (Fox 1982a). Projectile points from Lone Pine are narrow (with the possible exception of those illustrated in Figure 4a and 4e). Side-notched points, such as those recovered at Lone Pine, have also been identified from Glen Meyer sites (Noble 1975; Fox 1982b). Stemmed snubnose scrapers and stemmed strike-a-lights, characteristic of Glen Meyer assemblages, are not present at Lone Pine.

In summary, it appears that the Lone Pine assemblage has characteristics of both Princess Point and Glen Meyer lithic assemblages, which strengthens the hypothesis that the site is transitional between the two time periods. More important, however, is the fact that Lone Pine is similar to other contemporary assemblages which represent a stage in the development of chipped lithics throughout Northeastern North America in which bifaces decrease in size and are replaced by small projectile points and flake based industries.

Ethnographic *Analogies*

There are several ethnographic studies (Gould 1977, MacCalman and Grobbelaar 1965, Miller 1979, Sillitoe 1982, Strathern 1969, White 1968, White and Thomas 1972) which have been conducted among people who produce tool kits dominated by flake tools. The majority of these groups are sedentary horticulturalists, such as the Duna of New Zealand. Considering the record for tool production among these people may allow some insight into how tools were manufactured at Lone Pine. To date, studies indicate that there is usually a patterned sequence employed in the production of informal flake tools. To begin, cores are not usually prepared to any great extent and are always bifacially worked. There is usually little effort made to standardize the products of core reduction. Individuals typically choose flakes for use according to the appropriateness of their edge type and the manner in which they fit the hand. As part of this process, flakes are often tested in various tasks to determine which tools will be useful. Finally, after only a few uses, the flake tools are discarded. This makes the period of manufac-

Table 4. Use Location on Utilized Flakes.

LOCATION OF USE DAMAGE	n
Lateral and Dorsal	195
Lateral and Ventral	45
Distal and Dorsal	22
Proximal and Dorsal	34
Distal and Ventral	3
Proximal and Ventral	6
Edge Indeterminable	13
TOTAL **USED EDGES**	318

ture, use, and discard brief (White and Thomas 1972:286). At Lone Pine, there is some evidence to suggest that such a strategy was also being used to manufacture tools. All cores from the site are "amorphous" (Parry and Kelly 1987). No blade cores were located, although some blades were indeed manufactured. The few core trimming flakes (n=31) located at the site suggest that core preparation was not common and that little effort was made to standardize the debitage.

ORGANIZING TECHNOLOGY AT LONE PINE

Mobility

The lithic technology observed at Lone Pine, featuring the production of informal flake tools, was likely influenced by the mobility of the occupants. As indicated earlier, strategies featuring the production of flake tools tend to be associated with groups that are largely sedentary. Although we are lacking the necessary settlement features and seasonal faunal evidence at Lone Pine, the size of the site, as well as the large number of artifacts, suggests that Lone Pine was occupied by a group which was sedentary for part of the year; it may even have served as a village (Smith and Crawford 1994:151). If this was the case, it follows that aspects of tool design relating to mobility and transportability would not be significant factors. It may not have been necessary to anticipate future tasks, or even manufacture tools that were multi-functional. Indeed, the Lone Pine tool kit indicates that an expedient strategy was being employed over a curated one. This is extremely taxing on raw material and is not the type of strategy a mobile group would seek to employ. In addition, the flake tools are not reliable (thin flake tools will break more quickly than will thicker bifaces), nor are they versatile. This makes the Lone Pine technological strategy a poor choice for mobile groups, and more suitable for more sedentary groups.

Raw Material

There are several chert-bearing formations in the vicinity of the Lone Pine site, including Haldimand (Bois Blanc), Onondaga, Ancaster and Dundee. The Lone Pine occupants, however, had a marked preference for Onondaga and Haldimand chert over all others, possibly because they were close at hand. The fact that Onondaga chert dominates the sample is probably related to its higher quality (Table 5). Although the chert can vary, the material used at Lone Pine has a fine grain and is among the better varieties available. It appears very similar to Morgan's Point chert. Haldimand chert, which has a medium to fine crystalline structure and an irregular to subconchoidal fracture (Eley and von Bitter 1989:19), is less common at Lone Pine. It is interesting to note that while both chert types are available in the lower Grand Valley, outcrops of Onondaga chert occur further from the site area than do Haldimand outcrops (Parker 1986, Parker 1995, Eley and von Bitter 1989). The core data

Table 5. Chert Types at the Lone Pine Site.

MATERIAL TYPE	n	%
Onondaga	5902	98
Haldimand	97	2
Unknown	1	0
TOTAL	6000	100

indicate that primary outcrops of Onondaga chert were being exploited. Fox (1990) has noted that this is a general pattern for Princess Point sites in the lower Grand vicinity. The number of chert outcroppings and till locations in the vicinity of the site would certainly have allowed an expedient strategy, and it is argued that this was a determining factor of tool kit structure.

According to Andrefsky (1994), the choice of finer chert over poorer material has a direct influence on the production and design of tools. Andrefsky's model suggests that both lithic abundance and quality directly influence the tool kit of a site. Given that both Onondaga and Haldimand chert are fairly abundant in the lower Grand River valley, quality is of greatest importance here. Following Andrefsky's reasoning, it would be expected that the high quality chert (Onondaga) was used in the production of both formal and informal tools, while the poor quality chert (Haldimand) was used only for informal tools. This is, indeed, the pattern observed at Lone Pine. Haldimand chert was used in the production of tools in three cases. All are informal utilized flakes. On the other hand, Onondaga was used in producing both informal and formal tools. It is interesting to note that the pattern observed here is also evident in the Princess Point components of the Alder Creek (Timmins 1992) and Grand Banks sites (Shen and Ormerod 1995).

While this pattern tends to support Andrefsky's theory concerning the affect of chert quality on tool production, a different pattern is reported for early Holocene cultures in the region. Parker (1986) has found that Haldimand chert was used in manufacturing both informal (flakes) and formal (bifaces) tools. This suggests that Andrefsky's theory does not hold true in every case and that it may only be applicable during certain periods. Unfortunately, Andrefsky does not provide any tempo ral information for the sites he investigates in his study.

Use-Wear

A use-wear analysis was conducted on the Lone Pine flake-based tools in order to determine the potential uses of such implements, knowing that this will influence the design of tools and the overall technological organization. The method described by Schiffer (1976:109-120) for the Joint Site lithics was adopted for this study.

The first step is to note the presence of use damage. This is accomplished with a lens of 16X magnification. Subsequently, a number of variables are recorded and used to group the artifacts into like categories of use-potential. These variables include size, angle of the working edge, and further modifications made with retouch. Size is defined as the tool area, where area is equal to length by width. In this study, the angle of the working edge was determined with the use of a goniometer and, following Schiffer, results were grouped into categories of less than 45°, 45-65°, and greater than 65°. Finally, other specific retouch modifications, including patterns of denticulation or notching, are recorded.

The four variables have been amalgamated by Schiffer (1976:112-120) into separate flow charts for unifacial, bifacial and non-retouched tools. The analyst begins at the top of the key and is required to reference the different variables which eventually results in a potential use category. Unfortunately, the problem with this technique is that only complete specimens can be used. In addition, the study produces only potential use results, as do all macro-use studies. The results, limited as they are, are as follows.

Scrapers. These implements (n=5) were

Table 6. Informal Tool Use-Wear Data (Complete Specimens Only).

ARTIFACT TYPE	n	USE POTENTIAL
Utilized Flakes	160	fine, light-duty cutting on skin, meat, plant or cord
Utilized Flakes	9	light-duty scraping on hides, wood or plant
Utilized Flakes	7	fine, medium-duty cutting of skin, meat, plant or cord
Utilized Flakes	5	medium-duty scraping of hides, wood or plant
Utilized Flakes	2	light-duty scraping and shredding on wood or plant
Retouched Flakes	13	medium-duty scraping on hides, plant or wood
Retouched Flakes	2	incising or grooving of bone or wood
Retouched Flakes	1	medium-duty cutting of plant or wood
Scrapers	5	medium-duty scraping and shredding of hides, wood or plant
TOTAL	204	

possibly used in medium-duty scraping and shredding activities. The most likely materials to be worked by these items include hides, wood, or plant material.

Retouched Flakes. Results indicate that 13 of the specimens were potentially employed in medium-duty scraping and shredding activities on hides, wood, or plant material. Two other flakes were likely used in either incising bone or wood. A final specimen appears to have been employed in cutting activities on wood or bone.

Utilized Flakes. The majority of these tools (n=160) may have been employed in fine, light-duty cutting activities on either skin, meat, plant fibre, or cordage. Nine implements may have been used as light scraping utensils on hides, wood, or plant fibre. Another seven flakes suggest use in fine, medium-duty cutting on skin, meat, plant fibre, or cordage. Five more flakes may have been employed in the scraping of medium-duty hides, wood, or plant fibre. Finally, two of the specimens may have been used as scraping and shredding implements on wood or plant fibre.

Discussion. It is interesting to note that none of the tools considered in this use-wear study are potentially capable of the type of heavy-duty scraping or shredding activity that is possible with larger unifacial or bifacial tools. Although the few points and bifaces at the site could have been used in such activities, their small number clearly indicates that this was not common. Instead, the tool kit is composed of tools primarily capable of working in light to medium-duty activities. It is certainly true that formal tools could have functioned in these light to medium-duty cutting activities. Smaller flake tools (which are as sharp as any retouched formal tool) are more easily made, however, and it is not surprising to observe the preference for an expedient strategy geared towards producing flake tools. This is especially true given the abundance of raw material in the area.

CONCLUSIONS

Excavations conducted by the University of Toronto at the Lone Pine site during the 1993 excavation season produced a lithic assemblage heavily dominated by informal flake-based tools. Comparisons of the Lone Pine material with Princess Point and Glen Meyer lithic assemblages reveals some overlap in the characteristics of these assemblages and may indicate that the site is transitional between Princess Point and Glen Meyer. Late AMS dates and ceramic seriation tend to suggest either a late Princess Point or an early Glen Meyer occupation.

Tool kit composition, especially the number of formal tools, has been substantially altered at a number of sites in the Grand area by local collectors (L. R. Parker, personal communication 1994). Lone Pine, however, is positioned in an inaccessible woodlot and appears to have remained relatively undisturbed. The sheer quantity of artifacts, including diagnostics, retrieved from the surface during both the 1993 and 1994 excavation seasons indicates that Lone Pine has been exposed to little, if any, previous collection. In addition, the site has apparently never been plowed.

It is argued that one reason for the choice of technological strategy at the site relates to the relative abundance of raw material outcrops in the site vicinity. Several exploitable chert outcrops occur in the Lone Pine area, and seem to have allowed a strategy which was particularly taxing on raw material. Further, following Andrefsky (1994), it is argued that raw material quality also influenced the manufacture of tools. This pattern, however, is not evident in local Holocene assemblages, suggesting that material quality is not always influential on the types of tools made.

Group mobility also appears to be a variable which influenced the technological organization of the Lone Pine people. Evidence collected to date suggests that the Lone Pine occupants were relatively sedentary. Such a mobility strategy did not require that tools be transportable, versatile, or multi-functional. Nor did it require that raw material be curated. Instead, it allowed for a strategy which made ample use of raw material and featured less versatile and resilient tool designs.

The potential use of tools at the Lone Pine site also may have influenced the overall technological organization. A macro-damage use study suggests that tools may have functioned largely in light-duty scraping, cutting and shredding activities. While such tasks can be performed by formal tools, they may also be performed by informal flake tools. It is important to remember that a freshly detached flake is as sharp, if not sharper, than any retouched tool. Thus, it is not surprising to see a preference for flake tools over manufactured formal tools at this site. Informal tools are also easier to make and are more quickly produced.

This assessment of the Lone Pine flaked lithic aggregate has incorporated aspects of technological organization and use-wear analysis in an attempt to determine behavioral correlates for tool kit structure and composition. Such an approach is useful in generating alternative types of data and will allow other avenues of interpretation to be considered in the future.

Acknowledgments. I would like to thank Gary Crawford, Maxine Kleindienst, and David Smith for reading earlier drafts of this paper. In particular, Maxine Kleindienst deserves special mention for her helpful criticisms during the early stages of this research. Without her guidance this work would simply not have been possible. Chen Shen must be thanked for preparing the lithic illustrations, which do much to better the overall presentation of this paper. I would also like to acknowledge Bud Parker and Fred Moerschfelder for sharing their knowledge of raw material sources in the vicinity of the Grand River. Finally, I thank the editor of *Ontario* Archaeology, Alexander von Gernet, for his helpful editorial comments.

REFERENCES CITED

Andrefsky, W. Jr.
1994 Raw-Material Availability and the Organization of Technology. American Antiquity 59(1) :21-34.

Bamforth, D.
1986 Technological Efficiency and Tool Curation. American *Antiquity* 51(1):38-50.
Bekermam, A.
1995 *Relative Chronology of Princess Point Sites.* Unpublished M. Sc. thesis, Department of Anthropology, University of Toronto, Toronto, Ontario.
Binford, L. R.
1977 Forty-seven Trips: A Case Study in the Character of Archaeological Formation Processes. In *The Explanation of* Culture Change, edited by R. V. S. Wright, pp. 24-36. Australian Institute of Aboriginal Studies, Canberra.
1978 *Nunamiut Ethnoarchaeology.* Academic Press, New York.
1979 Organization and Formation Processes: Looking at Curated Technologies. *Journal* of Anthropological Research 35(3):255-273.
Bleed, P., and A. Bleed
1987 Energetic Efficiency and Hand Tool Design: A Performance Comparison of Push and Pull Stroke Saws. *Journal of Anthropological* Archaeology 6:189-197.
Bordes, F. H.
1961 *Typologie* du paleolithique, ancien et *moyen.* Publications de L' Institute de Prehistoirie de 1' Universite de Bordeaux, Memoire 1, vol. 1 and 2. Bordeaux, France.
Bowyer, V.
1995 Palaeoethnobotanical Analysis of *Two Princess Point* Sites: *Grand Banks (AfGx- 3) and* Lone *Pine (AfGx-113) in* the *Grand River Area, Ontario.* Unpublished M.Sc. thesis, Department of Anthropology, University of Toronto, Toronto, Ontario.
Cabeceiras, D.
1994 *Faunal* Report: The Lone Pine Site *(AfGx-113).* Unpublished Ms. on file at the Department of Anthropology, University of Toronto, Mississauga, Ontario.
Eley, B. E., and P. H. von Bitter
1989 Cherts of Southern *Ontario.* Royal Ontario Museum, Toronto.
Fox, W. A.
1981 The Foliate Biface. *Kewa* 81(3):2-4.
1982a Glen Meyer Points. *Kewa* 82(1).
1982b Edge Seriation: A Protohistoric/Historic Iroquoian Attribute. *Kewa* 82(3):2-3.
1990 The Middle Woodland to Late Woodland Transition. In The Archaeology of Southern *Ontario to A. D. 1650,* edited by C. J. Ellis and N. Ferris, pp. 171- 188. Occasional Publication of the London Chapter, Ontario Archaeological Society 5. London, Ontario.
Gould, R. A.
1977 Ethno-archaeology; or, Where do Models Come From? A Closer Look at Australian Aboriginal Lithic Technology. In Stone Tools as *Cultural Mark*ers: Change, Evolution *and* Com*plexity,* edited by R. V. S. Wright, pp. 162-168. Australian Institute of Aboriginal Studies, Canberra.
Henry, D.
1973 *The Natufian of Palestine: its material culture* and ecology. Unpublished Ph.D. dissertation, Department of Anthropology, Southern Methodist University, Dallas.
Henry, D., and G. Odell (editors)
1989 *Alternative* Approaches to *Lithic Analysis.* Archaeological papers of the American Anthropological Association 1.
Holmes, W. H.
1919 *Handbook of Aboriginal American Antiquity, Part I.* Introduction: The *Lithic* Industries. Smithsonian Institution, Bureau of American Ethnology, Bulletin 60. Government Printing Office, Washington D. C.
Hutchings, W. K.
1990 The *Nachcharini* Composite *Projec*tile: Design *Theory* and the *Study of Hunting* Systems *Technology at Mugharat En-Nachcharini in* the Post *Natufian* Levant. Unpublished M. A. thesis, Department of Anthropology, University of Toronto, Toronto, Ontario.

Jochim, M. A.
1983 Optimization Models in Context. In *Archaeological Hammers* and Theories, edited by J. A. Moore and A. S. Keene, pp. 157-169. Academic Press, New York.
1989 Optimization and Stone Tool Studies: Problems and Potentials. In Time, *Energy* and Stone Tools, edited by R. Torrence, pp. 106-111. Cambridge University Press, Cambridge.

Kleindienst, M. R.
1975 Comment. *Current Anthropology* 16:382-383.

Knight, M.
1993 The Lone Pine Site. *Faunal Report: Emphasis* on *Mammalian* Remains. Unpublished Ms. on file at the Department of Anthropology, University of Toronto, Mississauga, Ontario.

Knudson, R.
1973 Organizational *variability in late Paleo-Indian assemblages.* Unpublished Ph.D. dissertation, Department of Anthropology, Washington State University, Pullman, Washington.

Koldehoff, B.
1987 The Cahokia Flake Tool Industry: Socioeconomic Implications for Late Prehistory in the Central Mississippi Valley. In The Organization of Core Technology, edited by J. K. Johnson and C. A. Morrow, pp. 151-185. Westview Press, Boulder.

Kuhn, S. L.
1994 A Formal Approach to the Design and Assembly of Mobile Toolkits. American Antiquity 59(3):426-442.

Lennox, P.
1981 The Hamilton Site: A Late Historic *Neutral Town.* National Museum of Man, Archaeological Survey of Canada, Mercury Series Paper 103:211-403.

MacCalman, H. R., and B. J. Grobbelaar
1965 Preliminary Report of Two Stone-Working Ovatjimba Groups in the Northern Kaokoveld of South West Africa. Cimbebasia 13:1-39.

Miller, T. Jr.
1979 Stone-work of the Xeta Indians of Brazil. In *Lithic Use-Wear* Analysis, edited by B. Hayden. pp. 401-407. Academic Press, New York.

Nelson, M. C.
1991 The Study of Technological Organization. In Archaeological *Method and Theory,* edited by M. B. Schiffer, pp. 57-101. University of New Mexico Press, Albuquerque.

Noble, W.C.
1975 Van Biesen: A Study in Glen Meyer Development. Ontario Archaeology 24:3-83.

Odell, G. H.
1996 Economizing Behavior and the Concept of "Curation". In Stone Tools: Theoretical Insights into *Human Prehistory,* edited by George H. Odell, pp. 51-100. Plenum Press, New York.

Ormerod, T.
1994 The Lone Pine *Flaked Lithic* Aggregate: *Behavioral* Implications *for a Transitional Woodland* Site. Unpublished M. Sc. thesis, Department of Anthropology, University of Toronto, Toronto, Ontario.

Parker, L. R.
1986 Haldimand Chert: A Preferred Raw Material in Southwestern Ontario During the Early Holocene Period. *Kewa* 86(4):4-21.
1995 The Johnson Flats Site (AgGx-214): A Stratified Prehistoric Occupation on the Lower Grand River Floodplain. *Kewa* 95(1):2-19.

Parry, W. J., and R. L. Kelly
1987 Expedient Core Technology and Sedentism. In The *Organization of* Core *Technology,* edited by J. K. Johnson and C. A. Morrow, pp. 285-304. Westview Press, Boulder.

Pye, D.
1964 *The nature* of design. Reinhold Publishing Co., New York.

Sackett, J. B.
1989 Statistics, Attributes, and the Dynamics of Burin Typology. In Alternative *Approaches* to *Lithic Analysis,* edited by D. Henry and G. Odell, pp. 51- 82. Archaeological Papers of the American Anthropological Association, No.l.

Schiffer, M. B.
1976 *Behavioral Archaeology.* Academic Press, New York.

Shen, C.
1992 *Tor Hamar (J431): An Assemblage of the Mushabian Complex from Southern Jordan.* Unpublished M. A. thesis, Discipline of Anthropology, University of Tulsa, Tulsa, Oklahoma.

Shen, C., and T. Ormerod
1995 *Lithic Production on Princess Point Sites: manufacture and utilization.* Paper presented at the 60th Annual Meeting of the Society for American Archaeology, Minneapolis, Minnesota, 1995.

Shott, M.
1986 Technological Organization and Settlement Mobility: An Ethnographic Examination. *Journal of Anthropological Research* 42(1):15-51.

Sillitoe, P.
1982 The Lithic Technology of a Papua New Guinea Highland People. *The Artefact* 7(3-4):19-38.

Smith, D. G., and G. W. Crawford
1994 The Princess Point Project: 1993 Field Season. *Annual Archaeological Report, Ontario* 5:147-152. Toronto, Ontario.
1995 The Princess Point Complex and Origins of Ontario Iroquoian Societies. In *Origins of the People of the Longhouse: Proceedings of the 21st Annual Symposium of the Ontario Archaeological Society*, edited by A. Bekerman and G. Warrick, pp. 55-70. Toronto, Ontario.

Steward, J. H.
1955 *Theory of Culture Change.* University of Illinois Press, Urbana.

Stothers, D. M.
1977 *The Princess Point Complex.* National Museum of Man Mercury Series Paper 58. National Museum of Canada, Ottawa.

Strathern, M.
1969 Stone Axes and Flake Tools: Evaluations From Two New Guinea Highland Societies. *Proceedings of the Prehistoric Society* 35:311-329.

Timmins, Peter A.
1992 *The Alder Creek Site (AiHd-75): Interior Paleo-indian and Princess Point Settlement Patterns in the Region of Waterloo, Ontario.* Ms. on file with Ministry of Transportation, Southwest Region, Environmental Unit.

Torrence, R.
1983 Time Budgeting and hunter-gatherer technology. In *Hunter-Gatherer Economy in Prehistory*, edited by G. Bailey, pp. 11-22. Cambridge University Press, Cambridge.
1989 Tools as optimal solutions. In *Time, Energy and Stone Tools*, edited by R. Torrence, pp. 1-6. Cambridge University Press, Cambridge.

White, J. P.
1968 Ston Naip Bilong Tumbunda: The Living Stone Age in New Guinea. In *La Prehistoire: Problemes et Tendances*, edited by D. de Sonneville-Bordes, pp. 511-516. Centre National de la Recherche Scientifique, Paris.

White, J. P., and D. H. Thomas
1972 What mean these stones? Ethno-taxonomic models and archaeological interpretations in the New Guinea Highlands. In *Models in archaeology*, edited by D. L. Clarke, pp. 275-308. Metheun Press, London.

Williamson, R. F.
1985 *Glen Meyer: People in Transition.* Unpublished Ph. D. thesis, Department of Anthropology, McGill University, Montreal, Quebec.
1990 The Early Iroquoian Period of Southern Ontario. In *The Archaeology of Southern Ontario to A.D. 1650*, edited by C.J. Ellis and N. Ferris, pp. 291-320. Occasional Publication of the London Chapter, Ontario Archaeological Society 5. London, Ontario.

Yerkes, R. W., and P. N. Kardulias
1993 Recent Developments in the Analysis of Lithic Artifacts. *Journal of Archaeological Research* 1(2):99-117.

Trevor Ormerod
Department of Anthropology, University of Toronto at Mississauga
3359 Mississauga Road North, Mississauga, Ontario L5L 1C8