

**Interpreting the Spatial Distribution of Lithic Artifacts from
the RLF Paleoindian Site (DdJf-13), Thunder Bay Region,
Northwestern Ontario**

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Submitted to the Faculty of Graduate Studies in Partial Fulfillment of the Requirements
for the Degree of Masters of Environmental Studies in Northern Environments and
Cultures

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ABSTRACT

This thesis explores the intra-site organization of Late Paleoindian, Lakehead Complex populations at the RLF site (DdJf-13), located east of Thunder Bay, Ontario. Situated upon a relic Lake Minong beach ridge, the RLF site's modest lithic composition and simple depositional context offered an ideal scenario for interpreting the organization of activities during a relatively brief occupational event.

The analysis and interpretation of the RLF site was conducted using a combination of spatial analytical techniques and ethnoarchaeological/archaeological case studies. This resulted in the identification and interpretation of eight distinct cluster sub-zones situated within two larger zone areas.

The results of this thesis suggest that the RLF site represents a brief Late Paleoindian occupation during which early stage biface production was conducted. Lithic reduction took place in distinct flint knapping areas and was oriented towards the production of transportable biface blanks. Additionally, the southern portion of the site exhibited evidence of cutting/scraping activities, likely associated with either food preparation or hide working. Further spatial patterning, in correlation with the results from near surface geophysics (NSG), provided evidence for the possible presence of a built structure and hearth focused lithic distribution in the northern portion of the site.

The RLF site analysis is a valuable case study for the application of intra-site spatial analysis on Boreal forest sites, as well as those utilizing CRM derived data sets. Furthermore, it provides a starting point from which future studies of Lakehead Complex site organization and use can be compared.

ACKNOWLEDGEMENTS

I would first like to thank my advisor Dr. Scott Hamilton (Department of Anthropology, Lakehead University) for the countless hours he spent helping me throughout the process of this thesis. Thank you to Dr. Matt Boyd (Department of Anthropology, Lakehead University) and Dr. Terry Gibson (Senior Manager and Founding Partner of Western Heritage - Adjunct Professor, Department of Anthropology, Lakehead University) for their valuable feedback throughout the review process. I want to thank Dr. David F. Overstreet (College of Menominee Nation) for the insight he provided as external examiner for this thesis.

I would like to thank Western Heritage and all of the people involved with this project, from initial excavation to the final analysis. Without the dedication of everyone involved with the RLF site project this thesis would not have been possible.

Lastly, I would like to thank my family, friends, and colleagues (you know who you are). I could not have completed this project without your support. I owe all of you a drink. Cheers.

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Chapter 1

Introduction

1.0 *Introduction*

This thesis presents research conducted to assess the spatial organization of artifacts in order to interpret activities that occurred at the RLF site (DdJf-13), located east of Thunder Bay, Ontario. Excavated during the summer of 2011, this Late Paleoindian, Lakehead Complex (Fox 1975, 1980), site yielded modest lithic remains, exhibiting distinct and localized clustering. The site's small size and relatively simple depositional context suggests a brief occupation, offering an opportunity to address long-standing questions regarding the spatial organization of Late Paleoindian sites in the Thunder Bay region.

While research regarding the Lakehead Complex has contributed to the understanding of the lithic industry, tool use, site selection, and regional trade employed by past populations, it has been unable to address site organization at the intra-site level (exception see Adams 1995). This limited spatial research has not been without effort (e.g. Hinshelwood and Weber 1987), but rather, a consequence of poor taphonomic and recovery conditions resulting in reduced spatial integrity. Compounding these issues is the tendency for previous excavations to focus on large, complex, and repeatedly occupied sites with severe bioturbation of shallow artifact deposits. While similar taphonomic issues are expected at the RLF site, the comparatively brief and simple occupation profile improves its interpretive resolution.

The discovery and excavation of the RLF site provides the opportunity to study the intra-site organization of Lakehead Complex people, and increase the understanding of how these past populations utilized their site environments.

1.1 *Site Summary*

The RLF site is located in the Thunder Bay region of Northwestern Ontario. For the purpose of this thesis, the Thunder Bay region is used to refer to an area spreading east to include the Sibley Peninsula, west to the Canada/United States border, and approximately 50km inland from the shores of Lake Superior. The RLF site was first discovered in 2010 during an archaeological survey, prior to the twinning of Highway 11/17 east of Thunder Bay, Ontario. The site is located approximately 20km east of Thunder Bay, and 1.2 km inland from the current Lake Superior Shoreline (Figure 1.1.1). There are five other archaeological sites of proposed Late Paleoindian association in close proximity to the RLF site. These include the Mackenzie I site (DdJf-9), the Mackenzie II site (DdJf-10), and the Electric Woodpecker Sites I, II, and III (DdJf-11, DdJf-12, DdJf-14). Archaeological excavations were conducted on these sites in order to collect cultural information prior to highway construction.

The RLF site excavations consisted of approximately 206m² units yielding 14,790 artifacts. While the recovered material remains consisted of few finished formal tools warranting in-depth analysis, the relatively discrete clustering of material suggested that the lithic recoveries may represent interpretable primary deposits of past human activity.

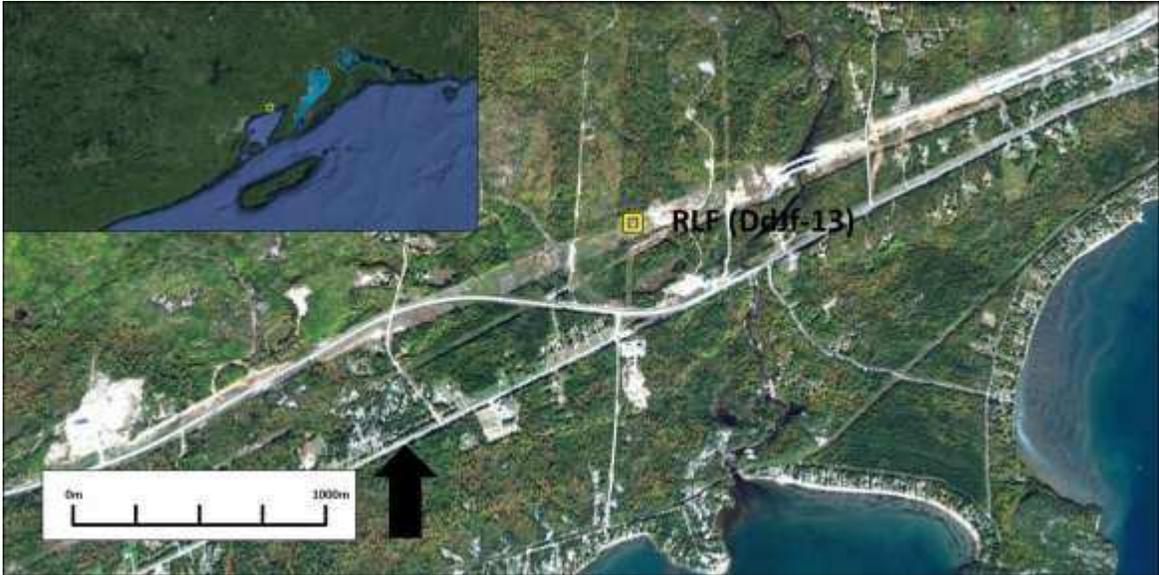


Figure 1.1.1: Location of the RLF site along the north shore of Lake Superior.

1.2 *Study Objectives*

The primary objective of this thesis is to explore how the Late Paleoindian occupants of the RLF site organized themselves within their living space. More specifically, it explores whether the spatial distribution of artifacts at the RLF site enables interpretation of site use and activity distribution. To accomplish this, a series of primary objectives are proposed:

- I. Determine if artifact clustering is present at the RLF site;
- II. Assess the nature of artifact clustering as deriving from either natural or cultural processes;
- III. Determine the function of culturally produced artifact clusters; and,
- IV. Interpret site function and organization based on the distribution of clusters/activity areas

The results of these objectives will help to expand current interpretations regarding Late Paleoindian life within the Thunder Bay region. This research will also serve as a case study through which further investigations can be conducted both regionally and beyond.

1.3 *Thesis Outline*

The following chapters are organized to introduce the current archaeological research within the study region, review the theory and methods involved in intra-site spatial research, and to present and discuss the spatial analysis of the RLF site as a case study.

The initial Chapters offer a conceptual framework of Paleoindian studies within Northwestern Ontario. Chapter 2 describes conditions prior to initial occupation of the region, and discusses the various aspects of deglaciation, glacial lake development, and floral recovery within the study region. This provides an understanding of site environment and conditions that may have been present during the occupation of the RLF site.

Chapter 3 introduces the Late Paleoindian period human populations who spread northward into this recently deglaciated land. Cultural characteristics are presented as a background regarding the people who occupied the RLF site. The current state of regional Paleoindian studies as they pertain to intra-site studies is also discussed.

Chapter 4 introduces the RLF site assemblage. This chapter discusses aspects of site location and stratigraphy, excavation methods, and artifact recoveries. This provides a base from which spatial interpretations can be made.

Chapters 5 and 6 introduce the key concepts and methods of spatial analysis.

Chapter 5 explores the current theories associated with intrasite spatial analysis including the development of spatial theory, key concepts for identifying various activity types, and the concerns and limitations associated with spatial research. Results of the RLF analysis are addressed within this framework in order to identify culturally related activity patterns. Chapter 6 outlines the methodologies used to apply these concepts to the analysis of the RLF site.

The results of the RLF spatial analysis are presented in Chapter 7. How these results fit within the understanding of site function and organization will be presented in Chapter 8. This chapter will expand upon how the observed patterns identified in Chapter 7 can be used to infer Late Paleoindian organization at the RLF site.

Chapter 9 discusses how the RLF site fits within the current understanding of Late Paleoindian site organization in the Thunder Bay Region and discusses the implications of this thesis regarding the study of small scale lithic sites in general. Concluding remarks and observations will be presented in Chapter 10.

Chapter 2

Deglaciation and Paleoenvironmental Context

2.1 *Introduction*

The events following the Last Glacial Maximum (LGM) in North America played an important role in the spread of Paleoindian populations, often influencing site location selection, subsistence economy, and technological development (see Chapter 3).

Understanding these processes, however, is complex. The development and fluctuations of Lake Minong throughout its history affected how and where Late Paleoindian people would move and interact on the land. Understanding relative chronologies for this development and fluctuation can allow for relative date ranges to be applied to archaeological deposits. This can provide researchers with important information regarding possible site environment and use during occupation. This chapter briefly reviews the processes of deglaciation, lake evolution, and vegetative development as the Laurentide Ice Sheet (LIS) retreated from northwestern Ontario. Through this, an understanding of the environmental conditions faced by early Paleoindian populations inhabiting the RLF site can be established, aiding in the overall interpretations of site organization.

2.2 *Glacial History of Northwestern Ontario*

The LGM occurred ~21,700 cal (18,000¹⁴C) yrBP during a period of relative climatic stability and low global sea levels, at which point the Laurentide and Cordilleran ice sheets had coalesced (Dyke 2004, Dyke et al. 2002). Following a period of relative

stability in ice limits, the Laurentide Ice Sheet (LIS) began to retreat northwards towards the Great Lakes Watershed (Larson and Schaetzl 2001).

2.2.1 *Pre-Marquette Glacial Retreat ~13,500-11,500 cal (11,700-10,000¹⁴C) yrBP*

Mapping the northward retreat of the LIS is accomplished through the study of glacial end moraines. End moraines represent the approximate locations of glacial deposits from retreating ice fronts throughout time. Dating the deposition of these moraines is difficult due to the lack of organic materials, however, relative ages of end moraines have been estimated through radiocarbon dating of associated basal organic materials (Björck 1985; Dyke 2004; Teller et al. 2005; Loope 2006; Lowell et al. 2009).

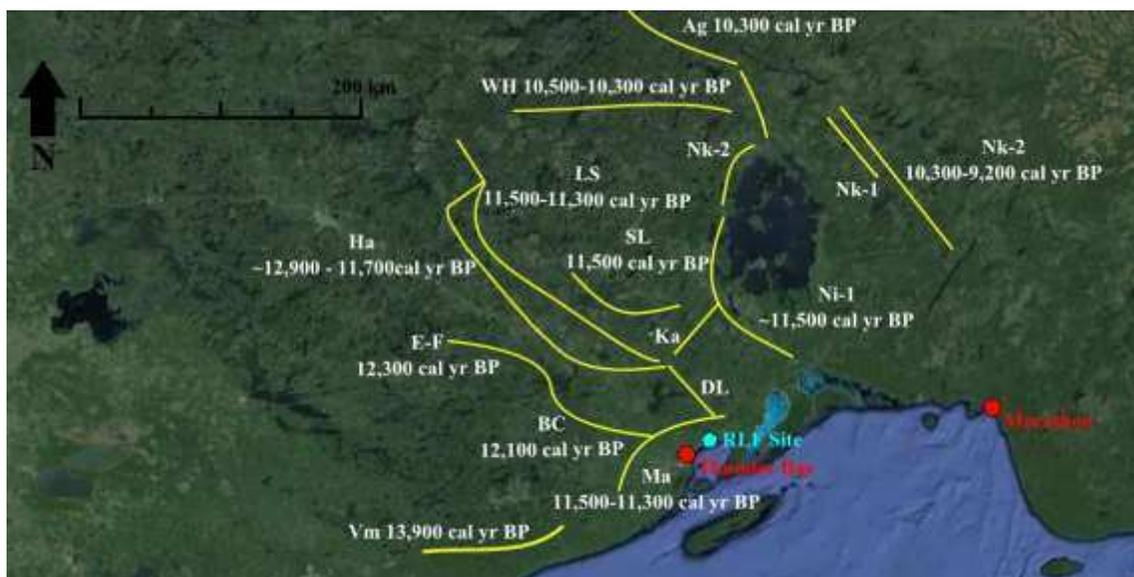


Figure 2.1.1: Approximate locations of end moraines within Northwestern Ontario with relative depositional chronology. Where Vm) Vermillion, E-F) Eagle-Finlayson, BC) Brule Creek, Ma) Marks, Ha) Hartman, DL) Dog Lake, LS) Lac Seul, SL) Sioux Lookout, Ka) Kaiashk, WH) Whitewater, Ag) Agutua, Ni) Nipigon, and Nk) Nakina (After Björck 1985, Kingsmill 2011, and Lowell et al 2009).

In Northwestern Ontario, extensive mapping of end moraines was combined with dated organic materials in order to provide a relative chronology for regional deglaciation

(Lowell et al. 2009; Zoltai 1965, Figure 2.1.1). The general sequence of moraine deposition begins with the Vermillion Moraine, dating to ~13,900 cal yrBP (Lowell et al. 2009). By ~12,300-12,100 cal yrBP ice had retreated to the Eagle-Finlayson/Brule Creek Moraines (Lowell et al. 2009). Although not directly connected, these two moraines are thought to be contemporaneous (Zoltai 1965). The formation of the Hartman/Dog lake Moraines occurred either during or near the end of the Younger Dryas ~12,900-11,700 cal yrBP (Lowell et al. 2009). The final moraines that formed prior to the re-advance of glacial ice were the Lac Seul/Kaiashk Moraines ~11,300-11,150 cal yrBP (Lowell et al. 2009).

These early stages of glacial retreat may have provided an opportunity for human migrations northward into the region. Unfortunately, the subsequent southward readvance of glacial ice during the Marquette advance likely destroyed any evidence of this occupation.

2.2.2 The Marquette Advance ~11,500 cal (10,000¹⁴C) yrBP

The retreat of the LIS was interrupted during the Marquette advance when glacial ice spread south across the Superior basin. The advance of ice covered an area reaching 1000km from Duluth, Minnesota to North Bay, Ontario, and to the southern portions of Lake Superior where it deposited the Grand Marais I moraine and buried a portion of forest near Lake Gribben, Michigan (Lowell et al. 1999).

By dating nine wood samples recovered from the buried Lake Gribben forest, Lowell et al. (1999) estimate the timing of the Marquette advance to ~11,500 cal (10,000¹⁴C) yrBP. The recovery of the buried forest from within lacustrine and outwash

deposits indicates that the forest was buried by sediments from ice marginal melt-water associated with the Marquette advance (Lowell et al. 1999). The locations of the ice sheet during this time are recorded by the Grand Marais I Moraine sequence in Marquette, Michigan, while the Marks Moraine indicates the extent of Marquette related ice in Northwestern Ontario (Farrand and Drexler 1985).

Following the Marquette advance, the LIS once again began to retreat and by ~10,000 cal (9,000¹⁴C) yrBP glacial ice had retreated from the Great Lakes Watershed (Breckenridge 2007; Larson and Schaetzl 2001; Loope 2006).

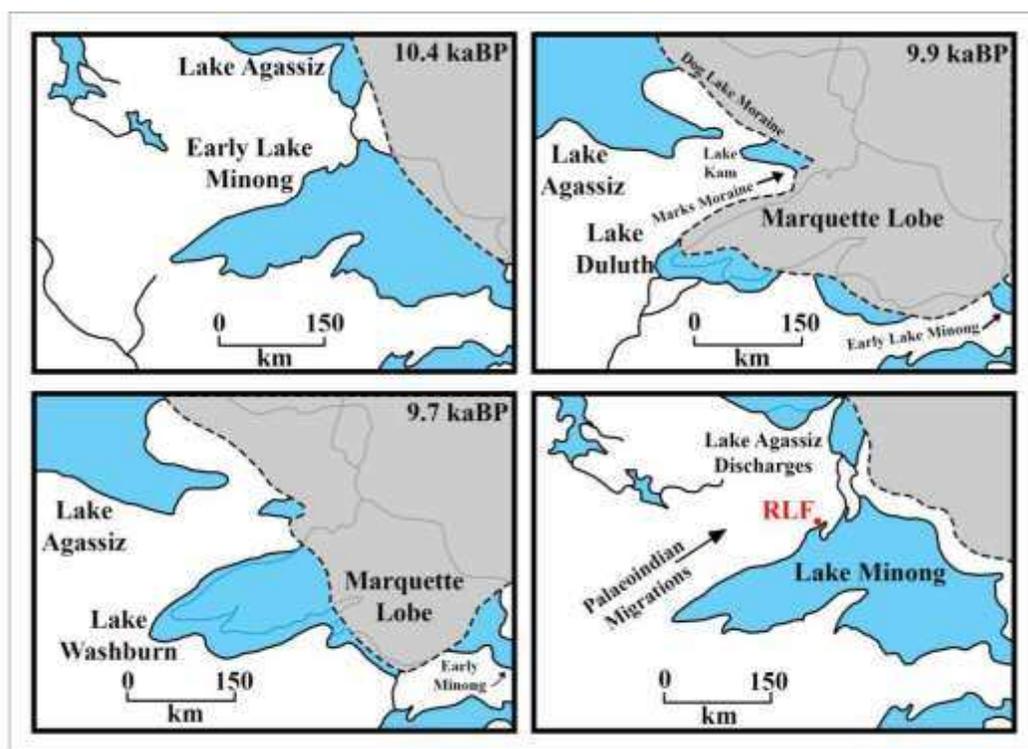


Figure 2.1.2: Approximate locations of the Laurentide Ice Sheet margin during the Marquette advance, ~10.4 to 9.5 kaBP. (After Phillips 1993)

2.3 *Glacial Lake Development*

The processes of ice retreat and advance during the de-glaciation of North America resulted in the formation and evolution of numerous water bodies. Glacial lakes

first occupied the Superior Basin ~12,900 cal (11,000¹⁴C) yrBP (Saarnisto 1974). Along the western front of the LIS, Glacial Lakes Ontonagon, Ashland, and Nemadji coalesced to form Glacial Lake Duluth (Saarnisto 1974). Between ~12,900 and 11,700 cal (11,000-10,100¹⁴C) yrBP, various Post-Duluth lakes occupied the western Lake Superior Basin (Saarnisto 1974). At the same time, post-Main Algonquin lakes occupied the southern Superior Basin (Farrand and Drexler 1985; Saarnisto 1974). With the southward push of ice associated with the Marquette readvance, post-Main Algonquin water was expelled from the Superior Basin, leaving only Post-Duluth lake waters to the southwest and early Minong waters to the southeast (Farrand and Drexler 1985). As Marquette ice retreated, early Lake Minong rapidly expanded to fill the Superior Basin, reaching its maximum by ~10,800 cal (9,500¹⁴C) yrBP (Farrand and Drexler 1985). The development of Lake Minong was heavily influenced by the alternating drainage of Glacial Lake Agassiz (Boyd et al. 2012; Breckenridge 2007; Breckenridge et al. 2010; Farrand and Drexler 1985; Leverington and Teller 2003; Saarnisto 1974; Teller and Thorleifson 1983). As such, an understanding the drainage history of Glacial Lake Agassiz is needed in order to properly understand the lake-level fluctuations in the Superior Basin during the Late Paleoindian period.

2.3.1 Glacial Lake Agassiz and Lake-Level Fluctuations in the Superior Basin

~13,500-8,800 cal (11,700-8000¹⁴C) yrBP

Forming between the ice of the LIS and recently deglaciated land, Glacial Lake Agassiz was the largest proglacial lake to occupy North America, with a drainage basin covering at least 1.5 million km² (Teller and Clayton 1983; Leverington and Teller 2003).

Over the course of its roughly 5,000 year existence, the size and extent of Lake Agassiz was controlled by factors such as glacial ice advance and retreat, spillway elevations, and the transformation of terrain morphology through differential isostatic rebound and erosion (Teller 1985; Teller and Leverington 2004; Leverington and Teller 2003). These various influences had the effect of alternating the drainage of Lake Agassiz through five main outlets, with a sixth outlet carrying the final drainage north (Teller et al. 2005, Figure 2.2.1). The transition of Lake Agassiz drainage both towards and away from the eastern outlets had profound effects on lake levels within the Superior Basin (Farrand and Drexler 1985).

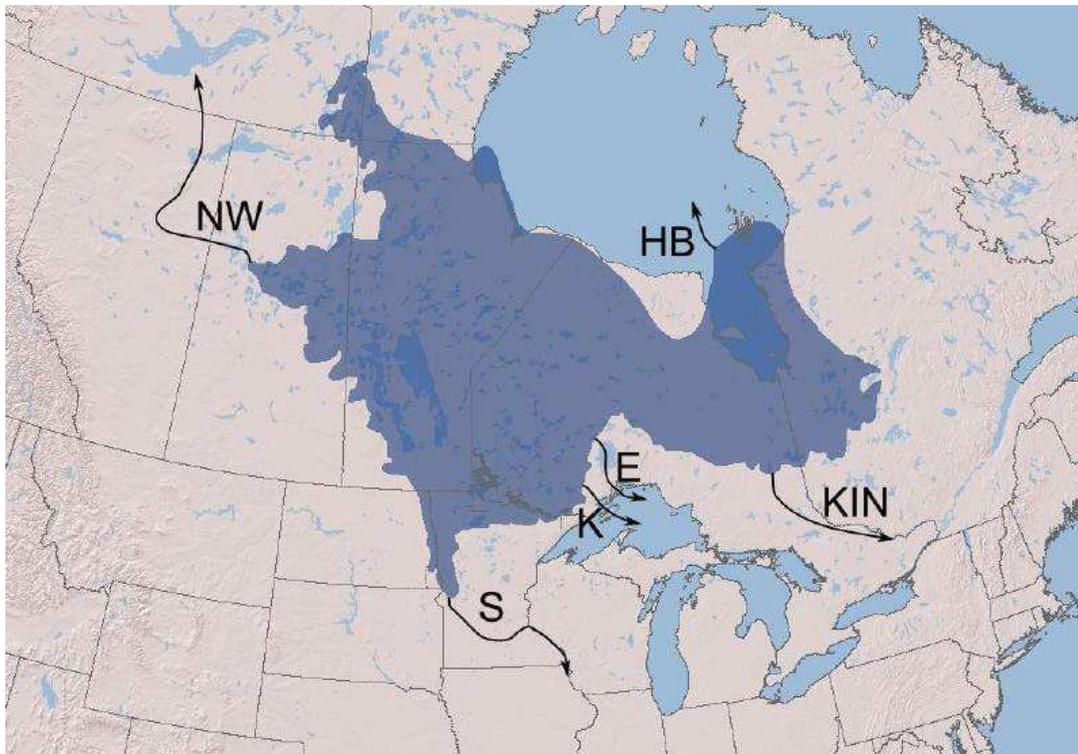


Figure 2.2.1: Various drainage outlets of glacial Lake Agassiz over the course of its existence. NW) Northwestern outlet, S) Southern Outlet, K) Eastern outlets through Thunder Bay area, E) Eastern outlets through Nipigon basin, KIN) Kinojevis outlet, HB) Hudson Bay final drainage route. (From Shultis 2013 after Teller et al. 2005)

The initial drainage of Lake Agassiz occurred during the Lockhart Phase ~13,500 cal (11,700¹⁴C) yrBP. During this period, Lake Agassiz drained south through the Minnesota River and Mesabi Range outlets (Teller 1985, Figure 2.2.1-S) These outlets, however, were abandoned by ~12,700 cal (10,800¹⁴C) yrBP when glacial outlets to the east (Breckenridge 2007; Teller 1985; Teller and Thorleifson 1983, Figure 2.2.1-E) or northwest (Lowell et al. 2009; Teller et al. 2005, Figure 2.2.1-NW) were free from retreating glacial ice. This change in drainage initiated the start of the Moorhead Phase.

The Moorhead Phase lasted until ~11,500 cal (10,000¹⁴C) yrBP and resulted in a drop of Lake Agassiz water levels to below the Campbell beach level (Teller 1985; Teller et al. 2005; Teller and Thorleifson 1983). During this time the Superior Basin was occupied in the east by a series of Post-Duluth lakes and to the west by Post-Algonquian waters (Farrand and Drexler 1985)

By the end of the Moorhead Phase, ice from the Marquette re-advance cut off access to both the eastern and northwestern outlets, returning drainage to the south (Fisher 2003; Teller 1985; Teller and Thorleifson 1983). While Lake Agassiz rose to approximately the Campbell levels, establishing the Emerson Phase, the Lake Superior Basin was separated into a Post-Duluth lake in the west and Early Minong to the east (Farrand and Drexler 1985; Fisher 2003; Teller 1985; Teller and Thorleifson 1983)

The final retreat of glacial ice following the Marquette re-advance allowed the merging of Post-Duluth and early Minong lakes to form Lake Minong (Farrand and Drexler 1985). At this time the eastern outlets from Lake Agassiz to the Lake Superior Basin were once again opened initiating the Nipigon Phase of Lake Agassiz by ~10,600 cal (9,400¹⁴C) yrBP (Fisher 2003; Teller and Thorleifson 1983). While ice continued to

retreat further north, a series of five progressively lower drainage outlets were opened. This allowed melt water from Lake Agassiz to flow into Lake Kelvin (modern Lake Nipigon) and through the Nipigon Basin into the Superior Basin (Leverington and Teller 2003). It has been speculated that flow through the Nipigon Basin into Lake Superior occurred in catastrophic surges, exceeding $100,000 \text{ m}^3\text{s}^{-1}$ in volume (Teller and Thorleifson 1983). The result of these outbursts was the eventual erosion of a sill at Nadoway Point and the rapid decline of Lake Superior water levels (Farrand and Drexler 1985). This rapid drainage and the introduction of high levels of freshwater to the North Atlantic Ocean has been interpreted as the cause for the global cooling event of $\sim 9,300$ cal yrBP (Yu et al. 2010).

The flow of water into the Superior Basin ended by $\sim 8,800$ cal ($8,000^{14}\text{C}$) yrBP during the Ojibway Phase. As the LIS retreated beyond the Nakina moraines, drainage from the amalgamated Lake Agassiz-Ojibway bypassed the Superior Basin. This resulted in water flowing through the Ottawa River Valley to the St. Lawrence and into the North Atlantic Ocean before transitioning and discharging for the last time north through Hudson Bay by $\sim 8,500$ cal ($7,700^{14}\text{C}$) yrBP (Leverington and Teller 2003; Teller 1985; Teller et al. 2005; Teller and Thorleifson 1983, Figure 2.2.1-KIN/HB). Due to the lack of Lake Agassiz discharge into the Superior Basin, and the erosion of the Nadoway sill, water levels in the Superior Basin dropped resulting in the Houghton Low phase of Lake Superior by $\sim 8,800$ cal ($8,000^{14}\text{C}$) yrBP (Boyd et al. 2012; Breckenridge et al. 2004; Farrand and Drexler 1985; Saarnisto 1974; Yu et al. 2010).

2.4 Vegetation Change within Northwestern Ontario after ~11,500 cal (10,000 ¹⁴C) yrBP

Following the retreat of the LIS, the biotic capacity of the Thunder Bay region began to develop. Vegetation initially consisted of park-tundra adapted plants but this transitioned quickly (within 50-100 year period) into a tundra/sparse forest, and then to closed forest environment (Björck 1985). Cores from Oliver Pond and Cummins Pond near Thunder Bay suggest that by ~11,500 cal (10,000 ¹⁴C) yrBP the region was comprised mostly of a closed spruce (*Picea*) dominated forest (Julig et al. 1990). As Hypsithermal warming increased, jack pine (*Pinus*) and birch (*Betula*) became increasingly present (Björck 1985; Julig et al. 1990). Julig et al. (1990) suggest that by ~8,800 cal (8,000 ¹⁴C) yrBP pine, birch, and alder became the dominant tree species within the Thunder Bay area. Organics associated with a buried forest component along the Kaministiquia River Valley suggest that Boreal forest cover was established by at least 9,100 cal (8140 ¹⁴C) yrBP (Boyd et al. 2012). Areas with wetter conditions (e.g. along water-ways) may have continued to maintain a spruce-dominated environment. This results in variable interpretations of local forest landscapes based on geographic location, while maintaining a general Boreal forest composition (Boyd et al. 2012; Julig et al. 1990).

2.5 Summary

The deglaciation of northwestern Ontario began ~13,900 cal yrBP (Lowell et al. 2009). The retreat of glacial ice was interrupted during the Marquette re-advance at ~11,500 cal (10,000¹⁴C) yrBP when glacial ice covered the Superior Basin. Following the

final retreat of ice, a series of post-glacial Lakes formed. The first of these Post-Glacial lakes to occupy the whole of the Superior Basin was Lake Minong (Farrand and Drexler 1985). Water levels of this pro-glacial lake were heavily influenced by the influx of water from Glacial Lake Agassiz (Boyd et al. 2012; Breckenridge 2007; Breckenridge et al. 2004; Farrand and Drexler 1985; Saarnisto 1974).

While glacial ice retreated and the Lakes of the Superior Basin evolved, vegetation developed in newly exposed lands. The development of vegetation within northwestern Ontario transitioned quickly through park-tundra and forest-tundra environments (Björck 1985), to establish a general Boreal Forest assemblage within the Thunder Bay region by at least 9,100 cal (8140 ^{14}C) yrBP (Boyd et al. 2012).

The evolution of lakes and their water levels within the Superior Basin, and the development and spread of flora, provide the broad environmental context of the RLF site at the time of occupation. This provides an understanding of possible occupation date ranges and the local environment in which these people lived.

Chapter 3

History of Paleoindian occupation in the Thunder Bay Region, Northwestern Ontario

3.1 *Introduction*

The initial peopling of the Americas is believed to have occurred between 16,500-12,700 cal (13,500-10,800¹⁴C) yrBP (Fiedel 1999; Waters and Stafford 2007). As glacial ice began to retreat, some Paleoindian populations migrated to inhabit the newly opened land. When the last glacial ice had finally receded from the Thunder Bay area ~10,200 cal (9,000 ¹⁴C) yrBP, populations of Late Paleoindian (Plano) people entered the region (Fox 1975; Ross 1995). The term Plano is used to describe Paleoindian groups who manufacture un-fluted, lanceolate style projectile points (Fiedel 1987) and includes complexes such as Agate Basin, Hell Gap, Cody, Lusk, Plainview/Goshen, and Angostura (Julig 1994). Within the Thunder Bay region, this Late Paleoindian tradition is termed the Lakehead Complex (Fox 1975, 1980).

3.2 *The Lakehead Complex*

There have been numerous sites of Late Paleoindian affiliation recorded in the Thunder Bay region since the initial excavations of the Brohm site by MacNeish in 1950 (MacNeish 1952). However, the study of these sites is limited as few have been extensively excavated (Julig 1994). Despite this, Fox (1975, 1980) provided the first cultural synthesis for the region, introducing the Lakehead Complex as a means of describing these sites.

Dating the Lakehead Complex occupation of Northwestern Ontario is difficult due to poor organic preservation. Instead, the timing for site occupation is often indirectly inferred based upon their spatial association with post-glacial landscape features, especially relict beaches. For example, the frequent recovery of Paleoindian materials from proglacial beach formations associated with the Minong Phase of Lake Superior suggests that the earliest possible occupation likely occurred between ~10,700-10,500 cal (9,500-9,300¹⁴C) yrBP (Fox 1975, 1980; Julig 1994).

A few radiocarbon dates have been recovered from Lakehead Complex sites, although the security of these dates remains open to debate. A date of 9503 ±509 cal (8,480±390¹⁴C) yrBP (CRNL-1216) was obtained from a disturbed cremation burial at the Cummins site and represents one of the few recovered dates (Dawson 1983). Due to the disturbed nature of the recovery, its direct association with the site occupation remains open to debate. Charcoal recovered from artifact bearing levels at the Electric Woodpecker II site yielded dates of 9,760-9,540 cal (8,680 ±50¹⁴C) yrBP (Beta-323410). While this date is consistent with a late Paleoindian affiliation, the charcoal and artifacts are not directly associated within an anthropogenic feature such as a hearth. Furthermore, sediment dating of other artifact bearing locations using Optically Stimulated Luminescence (OSL) have yielded conflicting dates of a much more recent age, at 6,090 ± 41 cal yrBP (SUTL-2458). Some of these deposits are interpreted as relating to the Minong phase of the Superior Basin (Shultis 2012) suggesting that these OSL dates may not be dating the occupation, but rather the most recent exposure of sediments to sunlight. Conversely, these more recent dates may be dating a subsequent Archaic period occupation that cannot clearly be differentiated from the earliest late Paleoindian period

deposits. What appears consistent within the dating of Lakehead Complex, and other Northern sites, is the relative inconsistency between absolute dates (Mulholland et al. 1997).

While site location on pro-glacial Lake Minong shorelines provides an approximate date range (~10,800-10,000 cal yrBP), it also allows researchers to interpret preferred site locations. Along with an association to proglacial beach formations, Lakehead Complex sites exhibit a strong correlation with Gunflint Formation bedrock outcrops, river crossings, and permanent water sources (Fox 1975; Julig 1994). As no systematic survey has been conducted on a full range of landforms (due to the difficulties associated with boreal forest survey) these observed trends may represent a sample bias (Julig 1994). It is likely that sites representing inland or winter habitation sites may be underrepresented within the current site database (exception see Ross 2011).

Site locations have heavily influenced early interpretations of Late Paleoindian subsistence for the Lakehead Complex. The location of sites near river crossings would have been strategic in exploiting migrating animals, suggesting a subsistence pattern involving the primary exploitation of caribou, with a lesser focus on the exploitation of fish and various water fowl (Dawson 1983; Fox 1975). A caribou-focused subsistence orientation was further supported by the recovery of calcined faunal remains from the Cummins site, and a caribou antler recovered from Steep Rock Lake near Atikokan, Ontario (antler dated to 11,400 cal (9,940 ±120 ¹⁴C) yrBP) (Jackson and McKillop 1989; Julig 1984). While the latter of these two recoveries was not recovered in association with cultural artifacts, they both indicate that caribou was present within the region during the late Paleoindian period. Blood residue analysis conducted on tools from within

the region (Newman and Julig 1989, see critique by Fiedel 1996) and the faunal analysis of Paleoindian sites in adjacent regions (Kuehn 1998) suggests that Late Paleoindian populations also employed a broad based subsistence strategy consisting of large and small game animals and collected organics (see also Adams 1995:8).

The close association between site location and Gunflint Formation outcrops is directly related to lithic raw material use by Paleoindian populations. Among Lakehead Complex sites, there is a strong preference for the use of Gunflint Formation materials (e.g. Taconite, Gunflint Silica, Kakabeka Chert) as a primary raw material for tool manufacture (Fox 1975, see frequency example in Table 3.1.1). Though there is a strong tendency for the use of bedrock sources, the use of cobbles collected from outwash till and gravels has also been observed (Halverson 1992; Julig 1994).

Table 3.1.1: Frequency of Late Paleoindian material recoveries illustrating preference for the exploitation of Gunflint Formation materials (After Fox 1975; Halverson 1992; Hinshelwood 1990).

DEBITAGE MATERIAL FREQUENCIES FOR VARIOUS LAKEHEAD COMPLEX SITES					
MATERIAL	Simmonds (DcJh-4)	Naomi (DcJh-42)	Cummins (DcJi-1)	Brohm (DdJe-1)	Biloski (DcJh-9)
	% Total	% Total	% Total	% Total	% Total
TACONITE	90.18	100	98.6	94.4	100
GUNFLINT SILICA	3.03	0	0	1.8	0
CHERT	6.3	0	0	0.4	0
SILTSTONE	0.3	0	0	0.4	0
HIXTON SILICIFIED SANDSTONE	0	0	0	0.3	0
QUARTZ	0.15	0	0	2.0	0
OTHER	0.15	0	1.4	0.7	0
TOTAL	100	100	100	100	100

Due to a lack of preserved organic materials, these lithic artifacts provide the sole basis for the study of Lakehead Complex material culture. Lithic recoveries from Lakehead Complex sites have included anvils, hammerstones, cores, debitage, used flake tools, retouched flakes, unifacial tools, bifaces, wedges, denticulates, and projectile points (Adams 1995; Halverson 1992; Hinshelwood 1990; Hinshelwood and Webber 1987; Julig 1994; Norris 2012).

Like many complexes, projectile point attributes are used as a defining characteristic within the Lakehead Complex. Lakehead Complex projectile points are of a Plano (unfluted lanceolate) morphology with a trend towards constricting or eared lanceolate forms and the shared attribute of parallel oblique flaking pattern (Markham 2013, Figure 3.1.1). With a sample size of 163 analyzed projectile points collected from the Mackenzie 1 site (DdJf-9), 161 (99%) exhibit some application of parallel oblique flaking (Markham 2013:151-152). Also present within the projectile points of the Lakehead Complex is the application of lateral and basal grinding, possibly for the use of hafting (Markham 2013)



Figure 3.1.1: Examples of Late Paleindian projectile points of the Lakehead Complex. A) Various Lakehead Complex Sites B) Mackenzie 1 Site. (From Bennett 2015, images by Markham 2013)

Many of these projectile point attributes occur within surrounding regions such as Northern Minnesota and Northern Wisconsin (Ross 1995). This resulted in the development of the Interlakes Composite as a way of interpreting this collection of similar, yet regionally distinct, cultural complexes (Ross 1995).

3.3 *The Interlakes Composite*

The Interlakes Composite was defined by Ross (1995) as a way of describing the observed shared characteristics between the Lake of the Woods/Rainy River, Quetico Superior, Lakehead, and Reservoir Lakes complexes (Figure 3.3.1). Differentiated from one another on the basis of geographic location and preferred raw tool material, complexes of the Interlakes Composite exhibit a number of shared morphological traits in projectile point manufacture. These include the presence of parallel oblique flaking, the application of basal and lateral grinding, and the general lanceolate morphological shape of the projectile points (Ross 1995).

The use of exotic materials, such as Hixton Silicified Sandstone, in the Interlakes Composite further suggests that these regions were connected. Bedrock exposures of Hixton Silicified Sandstone are known from only one quarry in south-central Wisconsin (Ross 1995). Despite this, formal tools manufactured from this raw material are found (though in limited numbers) in all complexes of the Interlakes Composite (Ross 1995). While a few formal tools manufactured from Hixton Silicified Sandstone are reported in complexes far removed from the source, the very limited recovery of debitage suggests that these tools were manufactured near the lithic source and transported as completed tools (Ross 1995).

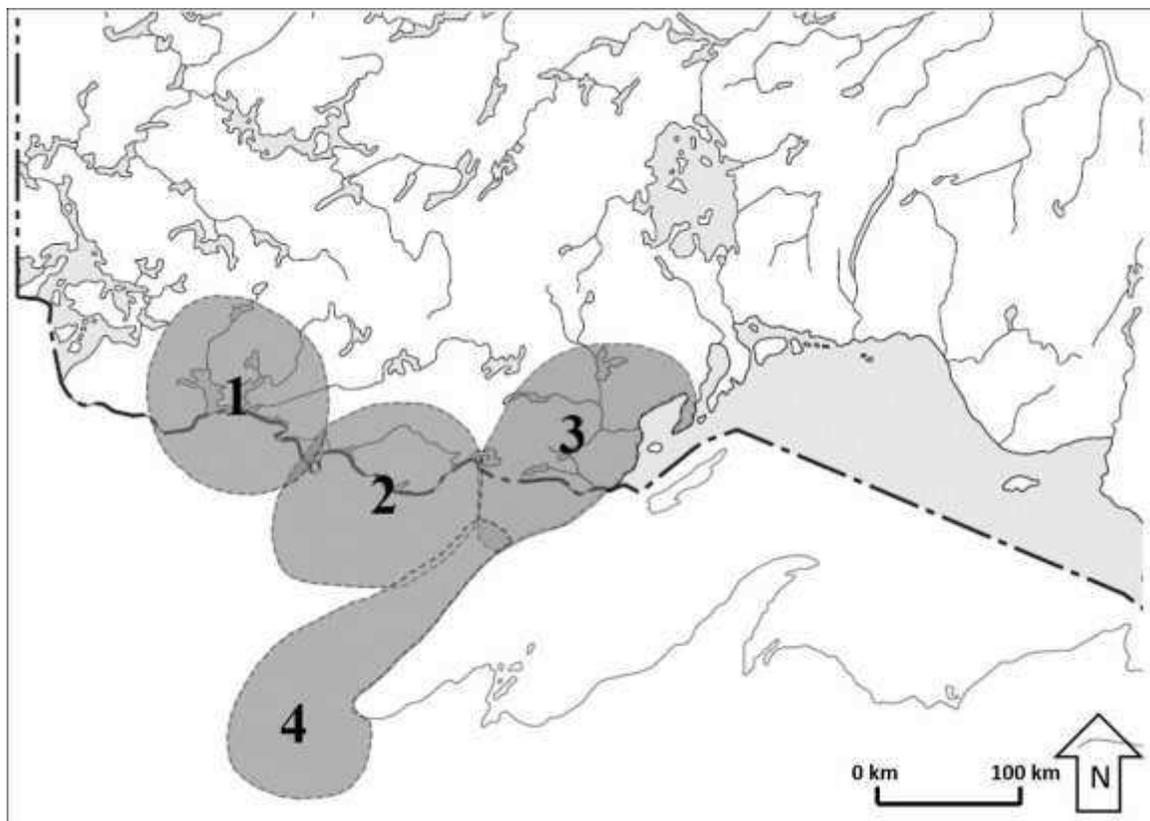


Figure 3.3.1: The Interlakes composite, including 1) Lake of the Woods/Rainey River, 2) Quetico/Superior, 3) Lakehead, and 4) Reservoir Lakes (After Ross 1995).

3.4 Spatial Investigations of Lakehead Complex Sites

Though archaeological survey has resulted in the documentation of numerous Late Paleoindian sites within the boundaries of the Lakehead Complex, few have been excavated and studied to address the intra-site spatial and structural distribution of artifacts. As such, there is currently little data pertaining to the intrasite organization of Lakehead Complex sites. Many interpretations regarding site activity do not go beyond describing the general site functions. The following discussion will summarize the available material for two Lakehead Complex sites that provide the best spatial interpretations from which to compare the results of the RLF study.

3.4.1 *The Naomi Site (DcJh-42)*

The Naomi site was excavated during the summer of 1994 as part of a cultural resource management investigation by Adams Heritage Consultants on behalf of the Ministry of Transportation Ontario (MTO) (Adams 1995). On the basis of projectile point morphology and the use of Hixton Silicified Sandstone, Adams concluded that the site was most likely of Paleoindian age.

Excavations of the Naomi site included the collection of fine-resolution spatial data, enabling the study of intra-site artifact patterning. As a result, Adams (1995) was able to identify three distinct lithic clusters which he referred to as areas 'A', 'B', and 'C' (Figure 3.4.1).

Area 'A' was excavated from an area covering 5x5 m. This cluster yielded a large lithic spread, sloping downwards to form a lithic debris midden. These distributions were found in association with a group of large rocks. Although the rocks did not readily exhibit any signs of pecking, Adams (1995:18) suggested that they were likely used as anvils for lithic production. Reduced lithic recoveries within the centre of the cluster was believed to be the result of a tree throw event (Adams 1995:18).

The recovery of formal tools from within lithic debitage distribution suggested that the tools were discarded during production (Adams 1995:18). Tools of note consisted of a finely flaked drill made of a fine-grained blue-grey silicified siltstone (possibly from the Wabigoon Greenstone Belt), and a finely made projectile point base made of taconite (Adams 1995:18). The drill recovered represented the only non-taconite formal tool within Area 'A'.

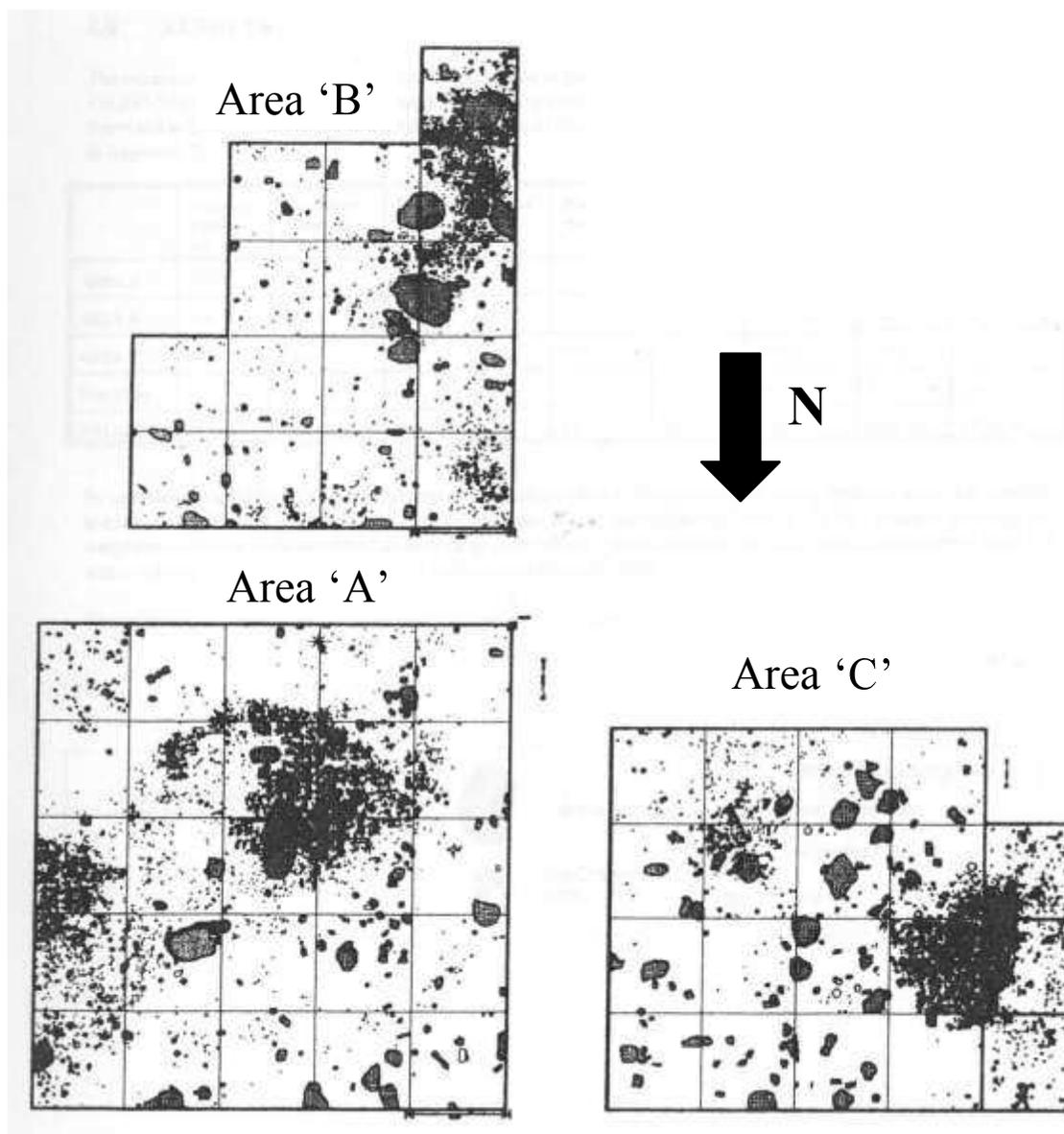


Figure 3.4.1: Lithic distributions from the Naomi site (DcJh-42). A) Cluster 'A', B) Cluster 'B', and C) Cluster 'C' (From Adams 1995).

Area 'B' was excavated in an irregular shape covering an area of 15 m². Similar to Area 'A', the location of lithic debitage was located in relation to a group of large boulders derived from till (Adams 1995:20). One of the boulders located within this area displayed clear evidence of use wear, likely due to its use as an anvil.

Formal artifacts were once again recovered in close proximity to the concentration of lithic debitage, suggesting discard during manufacture (Adams 1995:20). Located within Area 'B' was an extensively re-worked projectile point made of Hixton Silicified Sandstone. A small collection of fire cracked rocks (FCR) in Area 'B' may suggest the presence of a small hearth near the eastern edge of the boulder group associated with lithic manufacture.

Area 'C' differed from Areas 'A' and 'B' in that the location of lithic debitage was not in association with any large glacial boulders. However, formal tools were once again recovered from either within or directly adjacent to a large cluster of taconite flakes. This excavation area covered 19m² and included two lithic clusters. It was noted that the eastern cluster was less concentrated and relatively smaller than the other.

Through the analysis of lithic reduction loci, debitage, and a detailed biface staging, Adams (1995:29) concluded that the Naomi site likely functioned as a small biface reduction station. Due to the relatively high proportion of failed bifaces produced and discarded during early stage reduction, and limited tertiary debitage recovery, Adams suggested that reduction was focused primarily on the production of biface blanks that were suitable for transportation and finishing at a later time.

Although relevant data was not recovered to enable the interpretation of site function on the basis of floral and faunal resources, it was suggested that the observed biface reduction may have served as a secondary site activity (Adams 1995:29). Adams (1995:29) proposes that the Naomi site was located near a shallow bay or swamp that was present during site occupation. The decision to perform lithic reduction activities near this shallow bay/swamp, rather than near lithic resources, suggests that subsistence was a

primary consideration for the selection of site location. This would support Fox's (1975:42) interpretation of Lakehead Complex sites as subsistence focused, with lithic production representing a secondary objective. However, the lack of supporting evidence left Adams (1995) to conclude that this was largely speculative.

The intra-site analysis of the Naomi site provides a good example of what a relatively undisturbed lithic reduction loci may look like for Lakehead Complex sites. This can be applied to the analysis of the RLF site in regards to lithic clustering, and provides a possible analog for biface production and caching methods among Lakehead Complex groups.

3.4.2 *The Crane Cache (DcJj-14)*

The Crane Cache (DcJj-14) was discovered in 1982, when Mr. Alex Crane recovered a number of taconite bifaces while working in his potato garden (Ross 2011). The discovery was brought to the attention of the regional archaeologist, Bill Ross, who upon further investigation discovered two *in-situ* biface caches beneath Mr. Crane's garden. In total, 153 different bifaces were recovered, with 126 recovered from *in-situ* cache deposits and 27 from outside of the cache area (Ross 2011:10).

Within the excavation of four 1x1m units, Ross (2011) recovered not only two biface caches (Cache 'A' n=20, Cache 'B' n=106), but also a number of post-molds of varying sizes. Two large post-molds were observed within the first two excavated units, while a number of smaller post-molds formed a slight arc throughout the other units. The lack of immediately available water sources, distance from bedrock lithic sources, and no

obvious game lookouts, led Ross (2011:10-11) to propose that the Crane site likely represented a winter structure and camp.

The lack of diagnostic Lakehead Complex projectile points does not directly associate the Crane Cache with Paleoindian populations. However, the nature of biface reduction, and the exclusive use taconite for tool production strongly suggests Lakehead Complex affiliation (Ross 2011). This makes the recovery and excavation of the Crane Cache extremely important in the understanding of Paleoindian site use. Not only does the site represent the first professionally excavated biface cache of Late Paleoindian age within the region (Ross 2011), it also has some of the only evidence of structural remains.

While the Crane Cache site likely represented a winter encampment, it does provide a glimpse into the possible site structure employed by Lakehead Complex populations within their domestic areas. However, the limited data currently available regarding the spatial structuring of the Crane Cache hinders its application within overall site structure analysis.

3.5 *Summary*

As glacial ice retreated from the Thunder Bay region, Late Paleoindian populations of the Lakehead Complex occupied the region (Fox 1975). These groups primarily utilized taconite available from local Gunflint Formation outcrops to make Plano-style projectile points with unique parallel oblique flaking patterns (Fox 1975, 1980; Markham 2013). The presence of Hixton Silicified Sandstone as well as similarities in projectile point morphology suggests that the populations of the Lakehead Complex were part of

the larger Interlakes Composite, which also included the Lake of the Woods/ Rainy River, Quetico/Superior, and Reservoir Lakes complexes (Ross 1995).

Sites of the Lakehead Complex exhibit a strong correlation with pro-glacial beaches, Gunflint Formation outcrops, river and stream crossings, and permanent water bodies (Julig 1994). The lack of site survey conducted within the region, however, likely under-represents interior and/or winter encampments (Julig 1994).

While a number of Lakehead Complex sites have been excavated, few provide any substantial data from which intra-site structure or pattern can be interpreted. The Naomi site (DcJh-42) (Adams 1995) and the Crane Cache (DcJj-14) (Ross 2011) present the best contexts through which spatial investigations of the RLF site can be compared.

Chapter 4

The RLF Site

4.1 Introduction

The excavation of the RLF site was conducted during the summer of 2011 and resulted in the recovery of 14,790 artifacts from an excavation area of 206m². This chapter reviews the nature of site excavation and the laboratory analysis of recovered artifacts. Primary interpretations of the RLF site are proposed on the basis of recovered materials and location within its physical environment. These interpretations serve as a basis from which the intra-site analysis of artifact distribution is conducted.

4.2 Site Location and Environment

The RLF site is located ~ 20km east of Thunder Bay, Ontario and ~ 800m from the west bank of the Mackenzie River (Figure 4.2.1). Approximately 100m to the east of the site there is a small stream that drains into a standing beaver pond. Modern vegetation at the site is typical of boreal forest cover for the region, consisting dominantly of birch, spruce, and pine trees.

The site was discovered during archaeological inspection of the centre line of the north highway lane. Trees were uprooted and pushed over with a bulldozer, and then pushed into windrows. Lithic debitage was encountered in sediment disturbed by tree roots pulled out of the ground. Prior to site excavation the balance of the tree cover along the road right of way was removed through the use of mechanical harvesting equipment. Tree removal was carried out during the late winter and early spring in order to minimize

the impact on archaeological materials. The north-western section of the excavated block exhibited some disturbance resulting from the piling and/or pushing of tree trunks during the initial bulldozing operations. The effects of this disturbance on artifact distributions will be discussed further during spatial inquiry.



Figure 4.2.1: Location of RLF site at the time of excavation.

While understanding that site environment upon recovery is important for addressing questions of post-depositional effects on artifacts distributions, it does not provide answers for why Late Paleoindian populations would have selected this location for their camp site. To address this, hypotheses are proposed using site stratigraphy and location in relation to key geographic and topographic features.

4.2.1 Site Stratigraphy

Interpretations of site deposition and stratigraphy at the RLF site are addressed by Shultis (2012). In her analysis, Shultis (2012:216-217) identifies three lithofacies within the stratigraphic profiles of RLF; 1K, 2K, and 3K.

Lithofacies 1K consists of parallel-stratified low angle fine-grained sand with pebble layers in the northern portions of the site, and medium-grained sand with pebble layers in the southern units (Shultis 2012:216). Shultis identifies this layer as being consistent with a beach environment.

Lithofacies 2K is seen throughout the southern portions of the RLF site and is represented by fine-grained to medium-grained sand with pebble layers. Magnetite-rich layers are interbedded with non-magnetite layers, likely as a result of wave action and sorting (Shultis 2012:216-217). This is interpreted as representing a beach front environment, with massive layers present within the lithofacies indicative of storm events during which higher energy waves deposited larger particles (Shultis 2012:217).

The final lithofacies, 3K, is interpreted as the result of bioturbation consistent with boreal forest tree root patterns (Shultis 2012:217). This lithofacies consists of a 30cm wide by 40cm deep tapered concave feature with a diffuse contact and consistent root evidence throughout.

The elevation of these interpreted beach formations, at 243m above sea level (ASL), are consistent with those of Glacial Lake Minong levels (Shultis 2012:217).

Lithic artifacts from the RLF site are recovered primarily from levels 2 (5-10cm, n=3253 22.07%) and 3 (10-15cm, n=4175 28.32%) (See Figure 4.2.2). In the northern portions of the site this correlates with the bioturbated portions of lithofacies 1K, which consisted of very fine-grained to fine-grained sand with pebble layers. Artifact recoveries from the southern portion of the site were associated with the bioturbated portions of lithofacies 2K (fine-grained sand with pebble layers) and 3K (silty medium-grained sand with pebbles). From this, Shultis (2012:217) suggests that occupation at the RLF site may

have been contemporaneous with active Minong beaches. However, with the absence of identifiable stratigraphic sequences associated directly with artifact bearing levels, this interpretation cannot be confirmed. To help address this, the location of the RLF site recoveries in relation to topographic features can be explored.

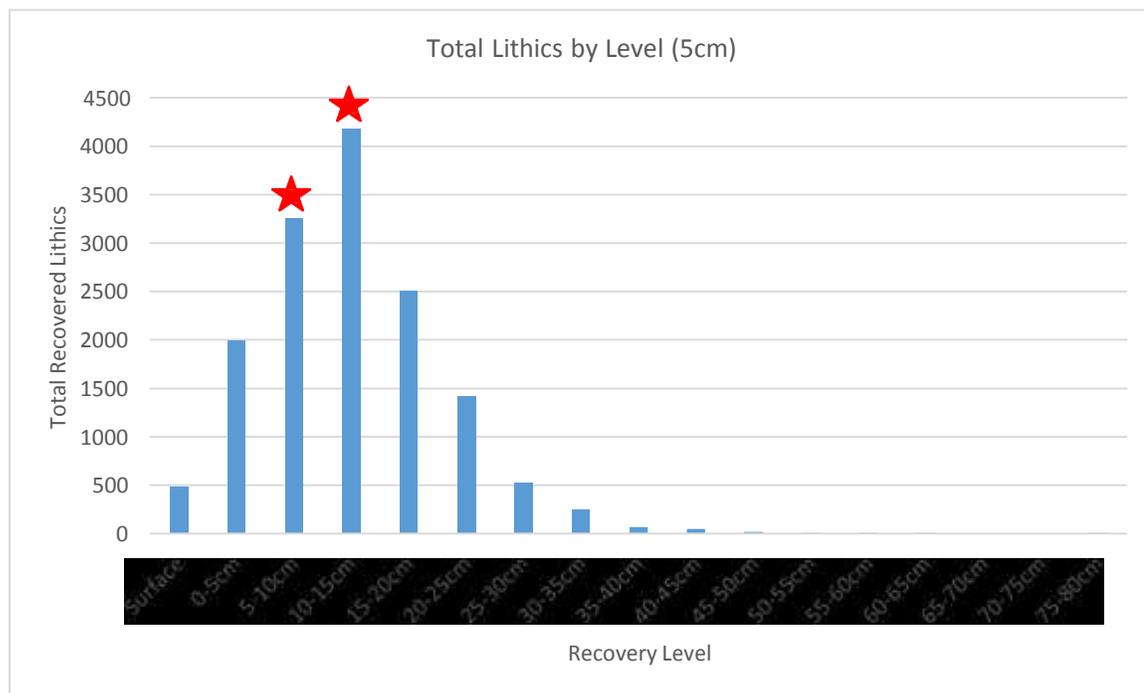


Figure 4.2.2: Vertical distribution of artifacts by level at the RLF site. Recovery levels 2 and 3 indicated by red star.

4.3 *Proposed Site Environment during Site Occupation*

At the time of excavations, the RLF site was located ~ 1.2km inland from the modern Lake Superior shoreline. However, with stratigraphic analysis suggesting that site occupation may have occurred during active Lake Minong levels it is likely that local resources would have been different during site occupation.

By considering the RLF site in its topographic context, artifact clustering occurs on what appear to be dune-like formations. This clustering is situated back from an

abrupt slope which grades down towards current lake levels (Figure 4.3.1). These dune formations are interpreted as representing back beach deposits. Occupation on this may have provided a better drained area upon which to locate a camp. While stratigraphic analysis places artifacts within active beach sediments, a lack of water-rolling on lithic recoveries suggests that the deposition of these materials occurred back from the active beach front.

With very-fine sediments occurring within the northern occupation levels (lithofacies 1K) and fine to medium sediments in the southern occupation levels (lithofacies 2K and 3K), it can be proposed that occupation may have occurred shortly after active water levels had receded, and prior to finer sediment build-up within the south portion of the site. This would place occupation close to the active beach, but far enough back so as to not be effected by fluctuating water levels resulting it water-rolled cultural materials. It can be speculated that the northern clusters of the occupation may have been placed within the scrub brush/tree line of the beach, with the southern clusters located on the open beach (Figure 4.3.2).

What can be proposed from these interpretations is that the RLF site location was chosen based on its slight, well-drained, rise along the Lake Minong shoreline. Located within a short distance of multiple water sources, this site may have provided an ideal location at which lithic reduction could take place, while allowing occupants to watch up and down the beach for possible game. Unfortunately, geoarchaeological investigations conducted at the RLF site do not allow for the confirmation of this proposal, and as such it remains speculative.

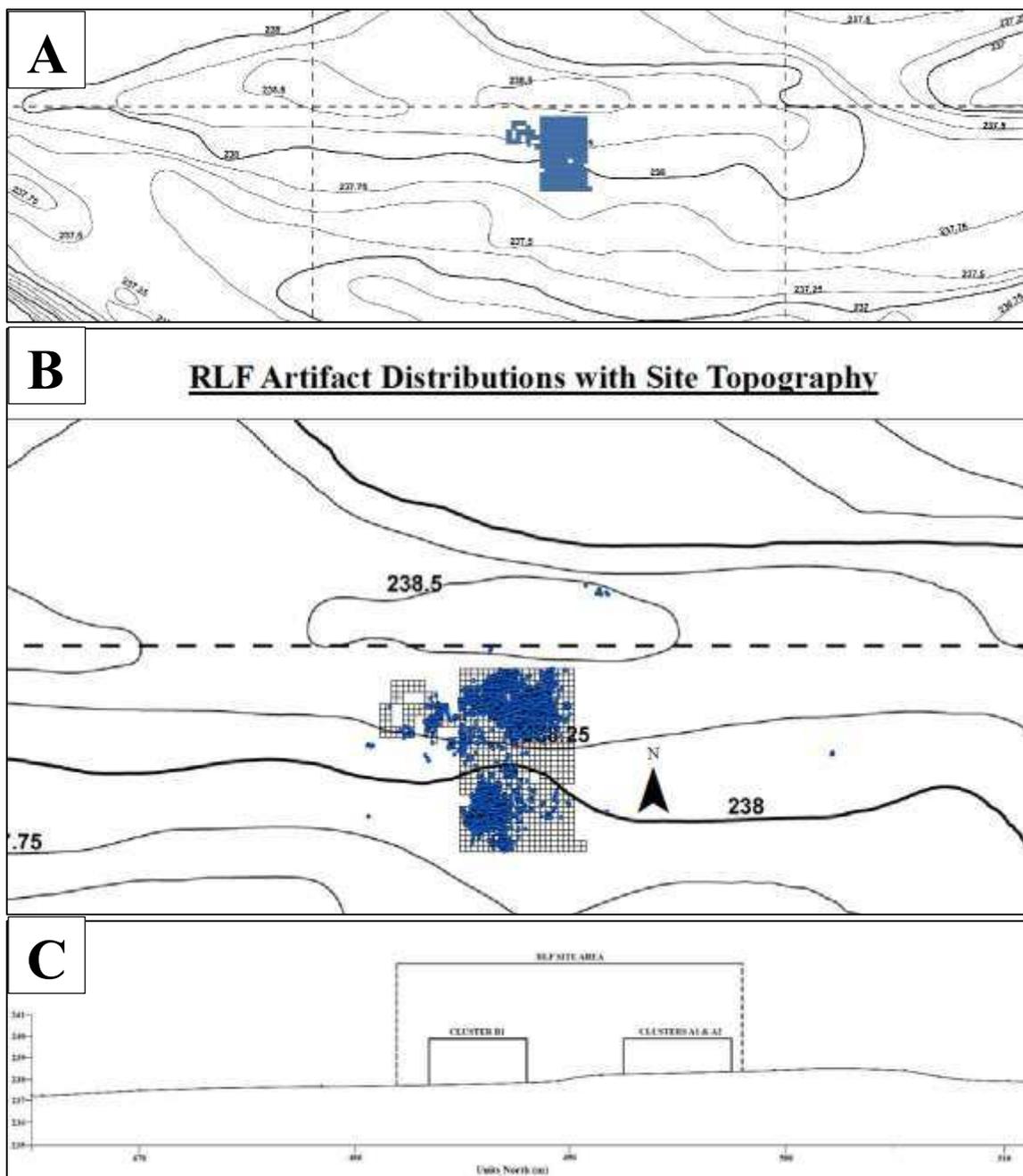


Figure 4.3.1: Topography of the RLF site area: A) Plan Map, B) Plan map with artifact clusters, and C) Side relief of site topography with general artifact cluster areas illustrated. Note: Elevation by metres.

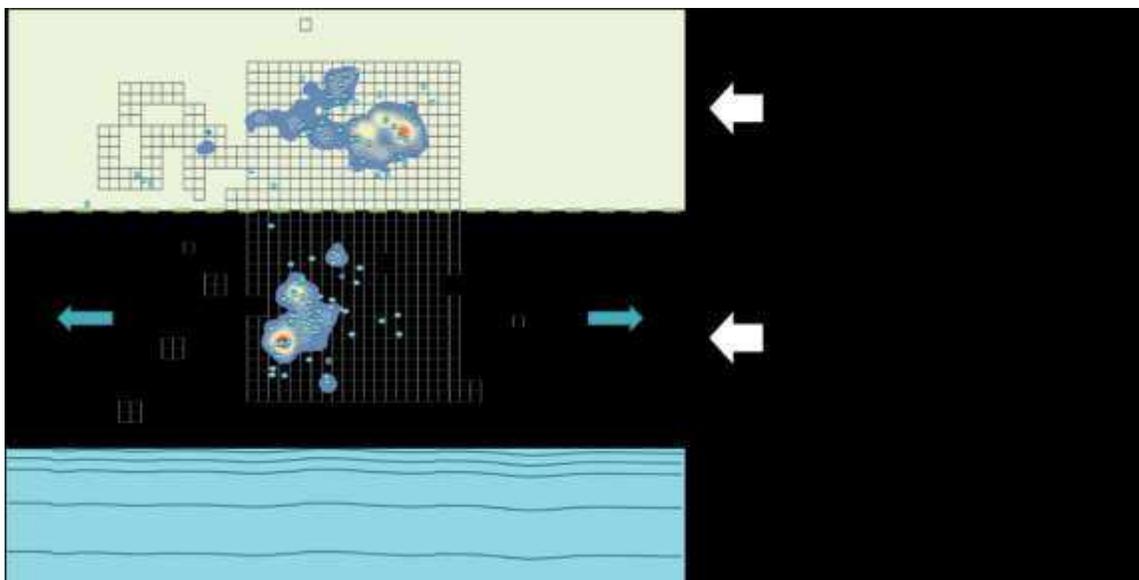


Figure 4.3.2: Conceptual placement of the RLF site within the local environment based on topography and stratigraphic sequences. This proposal is highly speculative.

What can be proposed from these interpretations is that the RLF site location was chosen based on its slight, well-drained, rise along the Lake Minong shoreline. Located within a short distance of multiple water sources, this site may have provided an ideal location at which lithic reduction could take place, while allowing occupants to watch up and down the beach for possible game. Unfortunately, geoarchaeological investigations conducted at the RLF site do not allow for the confirmation of this proposal, and as such it remains speculative.

The small creek located just east of the site may have provided some form of resource to the site inhabitants. However, the nature of this stream during occupation is not known. The Mackenzie River would have provided a more substantial resource for occupants of the RLF site to exploit.

4.4 Excavation Methods

While the initial Stage 2 archaeological assessment of the RLF site yielded limited cultural material, the recovery of a large number of taconite flakes from a tree push following initial tree removal prompted further excavations. The subsequent investigations were conducted through the joint operations of Lakehead University and Western Heritage, with both parties completing different phases of research. Despite all excavations being conducted following the *Standards and Guidelines for Consulting Archaeologists* (Ministry of Tourism, Culture, and Sport (MTCS) 2011), some variation in excavation methodologies was observed. As such, general excavation methodologies will be outlined separately for both Lakehead University and Western Heritage.

4.4.1 Field Methodologies: Lakehead University

The excavation by Lakehead University was conducted as part of an archaeological field school offered through the Department of Anthropology. In order to provide a variety of experience to field school students, excavations involved both a 5 x 5 m gridded test pit survey and 1 x 1 m unit excavations. Both of these were conducted following Stage 2 and 3 archaeological assessment guidelines (Scott Hamilton personal communication).

The 1x1 m excavation units were further subdivided into 50x50 cm quadrants (quads) and dug following 5cm arbitrary levels. All sediment was sifted through both 6mm and 3mm mesh screens. Students' initial training involved the excavation of units using hand trowels, while later units were excavated using shovel shaving techniques as students became more confident in their skills. During trowel excavations, all artifacts were mapped *in situ* (using X, Y, and Z co-ordinates) if possible. Later shovel

excavations focused on only mapping the *in situ* locations of formal tools, with lithic debitage being collected in bulk by quad and level. Throughout the excavation all significant changes in soil colour or staining were to be mapped and described.

The excavations conducted by Lakehead University are comparable in both quality and speed to those completed by Western Heritage during Stage 4 investigations. This serves to limit variations within the quality of catalog data, with any significant differences reflecting the academic nature of the Lakehead University field school. This results in field school excavations generally yielding better composed maps, notes, and field photography.

4.4.2 Field Methodologies: Western Heritage

Western Heritage excavations at the RLF site included the initial Stage 2 test pitting survey, as well as the final stage 4 block excavations. Stage 4 block excavations were conducted in order to document, remove, and preserve all available site information since site avoidance or protection was not possible (MTCS 2010:74). This required that Western Heritage employees expand upon the excavations conducted by Lakehead University until all cultural material was deemed to have been collected. This involved excavating all units to a depth that yielded at least 1-2 sterile levels (devoid of cultural material), with a buffer of one sterile excavation unit around the periphery of the site area. In some areas of the site this general guideline was deviated from based on the professional judgement of the supervising archaeologist.

Similar to Lakehead University investigations, excavation units were 1x1 m in size, segmented into 50x50 cm quads. These were dug using shovel shaving techniques

following 5cm arbitrary levels. All dirt was screened through both 3mm and 6mm screen mesh with lithic debitage collected in bulk by quad and level while lithic tools were mapped *in situ*. All changes in soil colour were to be mapped whenever possible; however due to the time-restricted nature of CRM archaeology this level of detail was not always maintained. This resulted in some field notes yielding limited excavation data beyond the collected materials.

4.5 *Near Surface Geophysics*

Prior to initial excavations, Western Heritage conducted a gradiometer survey in order to provide value added research that would otherwise have not been part of CRM oriented investigations. Near surface geophysics (NSG) is a form of passive subsurface remote sensing, reading changes in subsurface magnetic fields rather than producing its own (Gaffney 2008; Kvamme 2005, 2006). Features of anthropogenic origin exhibit magnetic fields that differ from the surrounding sedimentary matrix. These can include buried walls, foundations, rock formations, filled pits, metallic objects, or heated surfaces such as hearths or ovens (Kvamme 2006).

The significance of utilizing NSG on the RLF site is the ability to identify hearth features that, through the natural acidity and intense leaching of boreal forest soils, may not yield any preserved organic features or staining. When soils in a hearth are repeatedly heated, a build-up of magnetic soils occurs (Gibson 1986). This accumulation of magnetically susceptible soils allows for the detection of hearth features, as they will produce a secondary magnetic field different from their surroundings (Gibson 1986). This magnetic build-up can also occur as a result of long-term organic decay.

NSG can also detect the presence of fired artifacts such as fire cracked rock, ceramics, or bricks as a result of thermoremanent magnetization (Gibson 1986; Kvamme 2005). At temperatures beyond the Curie point (approximately 600° C) the magnetic properties of an object (including magnetic minerals in sediments) re-align to the earth's magnetic field, where they remain situated upon cooling (Kvamme 2006). Artifacts heated beyond the Curie point can intensify the magnetism observed in localized areas, making them detectable using NSG. This can be used to detect hearth related FCR fragments and lithics in the absence of defined hearth features.

It is important when interpreting NSG results to keep in mind that both anthropogenic and natural fires may produce magnetic signatures. Therefore, determining the nature of the magnetic anomaly depends on the strength and isolation of the anomaly and its 'ground truthing' to document artifact densities (Kvamme 2006). Other factors that can affect the validity of NSG results are the presence of metallic objects, processes of natural decay and weathering, and natural concentrations of magnetically rich soils (Kvamme 2006). In order to confirm the anthropogenic nature of magnetic anomalies within site areas, it is therefore important to assess whether the presence of such events may be the result of the observed magnetic anomalies. It should be noted that all figures used within this thesis illustrating NSG results were produced using the original maps provided by Western Heritage.

4.6 *Artifact Analysis and Cataloging: ADEMAR*

The cataloging of all recovered artifacts was conducted by Western Heritage with the use of the Archaeological Data Entry, Management, and Reporting program

(ADEMAR v 7.0). ADEMAR represents the latest version of cataloging software developed by Western Heritage to aid in the management and analysis of site recovery data.

Using ADEMAR while conducting a spatial analysis of the RLF site permitted both the manipulation and export of tabular data suitable for use within computer mapping software as well as the compilation and analysis of relative artifact frequencies and attributes (e.g. artifact size, material, recovery level, etc.).

Furthermore, the use of ADEMAR allowed for the randomization of data point locations (X and Y) for artifacts collected in bulk (e.g. debitage by quad/level). This randomization allows for the visual interpretation of artifact distributions despite a lack of formal provenienced location. This randomization of recovery location is limited to within the excavation quad. While ADEMAR produces new randomized co-ordinates (termed Xrand and Yrand) for all tabular exports, only one master export file was used throughout this thesis to maintain consistency. While the use of randomized co-ordinates within excavation quads limits the application of fine scale spatial interpretation, they allowed for statistical analysis across the larger site area (see Chapter 6).

4.7 Artifact Recoveries: Overview

In total, 14,790 artifacts were cataloged from the RLF site during both field school and CRM excavations. These recoveries fall within four basic categories: bone (n=2), charcoal (n=21), lithic items (n=14,744), and miscellaneous (including ochre, wood fragments, etc. n=23) (See Table 4.7.1). With the exception of lithic materials (see

sections 4.7/4.8), many of the catalogued items likely represent either intrusive or non-cultural items.

Table 4.7.1: Total recoveries from the RLF site for the four basic catalog categories. Note: Bone is likely modern intrusion, item #3391 removed as fragments

MATERIAL	TOTAL #
BONE	2
CHARCOAL	21
LITHIC ITEMS	14742
MISC (E.G. OCHRE, UNIDENTIFIABLE, MISC. ORGANICS	23
TOTAL =	14788

Faunal remains recovered from the RLF site consisted of two items (Table 4.7.2). Unfortunately, artifact 2491 is no longer with the collection and was not photographed (possibly lost during artifact transportation). Artifact 3237, a carpal (likely deer), was recovered within the upper levels of the excavation and likely represents a naturally deposited fragment.

Charcoal recoveries consist of two catalog batches (Table 4.7.3). Currently there have been no attempts made at dating these charcoal samples, as the depositional context of the recovery is suspect. The frequent occurrence of small, naturally occurring charcoal fragments within the organic levels of excavation may account for some of the recovered charcoal. The possibility of charcoal in association with possible hearth location will be further discussed in Chapters 7 and 8.

Table 4.7.2: Faunal recoveries from the RLF site.

FAUNAL		
CATALOG #	Frequency	Level
2491	1	5
3237	1	2

Table 4.7.3: Charcoal recoveries from the RLF site.

FAUNAL		
CATALOG #	Frequency	Level
2491	1	5
3237	1	2

During the RLF site excavations there was no clear association observed for the presence of ochre fragments and archaeological material. The recovered ochre may represent a natural occurrence.

4.8 Lithic Artifacts

A total of 14,727 lithic artifacts were cataloged during the analysis of the RLF site materials. These include tools, cores, debitage, microdebitage, fire cracked rock, and other materials (e.g. amethyst, quartz, and unidentifiable lithics) (Table 4.8.1). Materials collected and catalogued as ‘other’ were kept based on material type, but are represented primarily by water-rolled pebbles. Based on appearance, these artifacts likely represent naturally occurring materials.

Table 4.8.1: Breakdown of lithic recoveries from the RLF site by basic type.

LITHIC*	
ARTIFACT TYPE	Total #
TOOL (INCL. PREFORM)	107
CORE	43
DEBITAGE (INC. SHATTER)	11451
MICRODEBITAGE	3041
FIRE CRACKED ROCK (FCR)	67
OTHER LITHIC	18
TOTAL =	14727
* REFIT ITEMS UNDER ONE CATALOG NUMBER ARE COUNTED AS A FREQUENCY OF '1'	

4.8.1 *Lithic Artifacts: FCR*

Fire cracked rock (FCR) occurs primarily as the result of human activity. It is identified by the degradation or fracturing of rocks as a result of the application of concentrated heat from cooking activities (Quigg 1978; Quigg 1986). At the RLF site, this degradation resulted in a crumbled/cracked appearance. A total of 67 FCR pieces were collected from the RLF site, weighing over 6,600g.

While Thoms (2008:130) observes a “virtual absence” of FCR recoveries from Paleoindian sites within the United States, this was offered in comparison to the use of rock-filled earth ovens among subsequent cultures. The recovery of FCR in limited quantities has been recorded for Paleoindian sites within Northwestern Ontario that bear diagnostic cultural materials (Adams 1995:29). Similar to the recoveries from the RLF site these FCR pieces are present, but extremely limited, especially when compared with frequencies one might expect from Archaic period sites (Thoms 2008). This suggests that while the use of heated stones for cooking is unlikely, stones were being used within hearths; either for holding heat or some other alternative function.

4.8.2 *Lithic Artifacts: Non-Debitage*

In total, 152 non-debitage lithics were recovered during excavations (Table 4.8.2), and include formal flaked tools, expedient flake tools, cores, and knapping tools (such as anvils and hammerstones).

The identification and cataloging of flaked stone tools was conducted following basic morphological trait analysis. In order to maintain inter-assemblage consistency, tools were typed following methods and descriptions used within the current Lakehead

Complex literature (e.g. Julig 1994). It is important to keep in mind that many stone artifacts likely functioned as multi-use tools (Andrefsky 1998). However, without proper multi analytical residue and use-wear studies, this multi-use must remain speculative. Consequently, this thesis will utilize the generic use as the primary classification method. A breakdown of flaked stone tools and their description is offered below.

Table 4.8.2: Breakdown of non-debitage lithic recoveries from the RLF site.

LITHIC TOOLS*				
TOOL TYPE	Material	Number	Total #	% Total
BIFACE**	Taconite	42	50	32.9
	GFS	3		
	Chert	2		
	Mudstone	1		
	Siltstone	2		
FAILED PROJECTILE/DRILL	Taconite	1	1	0.7
ADZE	Siltstone	1	1	0.7
SPOKESHAVE	Taconite	1	1	0.7
CORE	Taconite	39	42	27.6
	GFS	3		
WEDGE	Taconite	1	1	0.7
PERFORATOR	Taconite	2	2	1.3
GRAVER/ PERFORATOR	Taconite	2	2	1.3
RE-TOUCHED FLAKE	Taconite	27	28	18.4
	Chert	1		
RACLETTE/BLADE FLAKE	Taconite	4	4	2.6
SCRAPER	Taconite	6	6	3.9
UNIFACE	Taconite	4	4	2.6
UNDETERMINED TOOL	Taconite	1	1	0.7
GRINDING STONE***	Other Material	1	2	1.3
	Siltstone	1		
POSSIBLE ABRADING STONE	Other Material	1	1	0.7
HAMMER-STONE	Other Material	2	2	1.3
OTHER TOOL (ANVILS)	Other Material	4	4	2.6
		Total =	152	100
<p>* REFIT ITEMS UNDER ONE CATALOG NUMBER ARE COUNTED AS '1' ** REFIT ITEMS UNDER ONE CATALOG #: 1613, 3126, 3148 *** ITEM 3391 NOT COUNTED AS THEY ARE BROKEN PORTIONS FROM ITEM 3390</p>				

Raw material use for the production of flaked non-debitage lithics exhibits a strong preference for the exploitation of Gunflint Formation materials. Taconite is the most common material recovered at 90.9% (n=130) with gunflint silica at 4.2% (n=6). Other materials recovered include siltstone (2.1%, n=3), chert (2.1%, n=3), and mudstone (0.7%, n=1).

While flaked tools can be identified by the presence of reduction related processes (discussed below), hammer stones and anvils were identified by the presence of pecking as well as depositional placement relative to high concentrations of lithic materials. While it is possible that some of these anvils may have functioned as grinding stones, a lack of preserved organics and micro-botanical research did not currently allow exploration of this proposal.

Bifaces

Of the 50 bifaces recovered from the RLF site, 42 were made of taconite, three were made of gunflint silica, two were made of chert, two were made of siltstone, and one was made of mudstone. In order to provide a more in-depth analysis of lithic tool production at the RLF site, the reduction stage represented by each biface was determined.

The use of bifacial reduction stages as a method of inferring general production activities has frequently been employed at Lakehead Complex sites (see Halverson 1992; Hinshelwood and Weber 1987; Adams 1995). This bifacial staging allows for the organization of bifacial production into separate categories based on level of completeness, as well as shifting reduction objectives and tool functionality. These stages

reflect the primary objectives of flint knappers on a site and can be used to determine whether tool production, re-sharpening, or replacement was undertaken. The staging of bifaces at the RLF site was completed following the non-metric descriptions employed by Bennett (2015). The results of this staging analysis are summarized in Table 4.8.3. These results include not only tools identified primarily as bifaces, but also bifacially worked tools such as a failed projectile point/drill (3132) and adze (3135).

Table 4.8.3: Results of biface staging for RLF site recoveries. Staging conducted following the non-metric descriptions by Bennett (2015). Note: Includes Adze and Drill/Projectile Point

BIFACES (STAGE)				
STAGE	Type	General Description	Total #	% Total
N/S	N/A	Unable to stage due to limited observable attributes	2	3.8
STAGE 1	Blank	Tabular blocks or large, tabular flakes with limited flake scars	6	11.5
STAGE 2	Edge Blank	Random flaking on edge of piece. No edge preparation with flakes rarely reaching midline of piece.	16	30.8
STAGE 3	Primary Thinning	Beginning of patterned flake removal exhibiting edge preparation. Most of the remaining cortex is removed however the piece is still relatively thick.	22	42.3
STAGE 4	Secondary Thinning	Increased use of serial patterned flake removal, platform preparation, and start of basal thinning. Objective was to reach optimal thinness. At this stage the bifaces could be cached for later refinement.	4	7.7
STAGE 5	Preform	Finishing of the biface into the desired formal tool. Flaking is largely parallel oblique. By the end of this stage these bifaces could be called finished, however they lack distinctive hafting elements and traits.	1	1.9
STAGE 6	Formal Tool	Finishing of the hafting portion of the biface for use. For non-hafted bifaces, the sharpening of edges and grinding of the held portions represents formal finishing.	1	1.9
TOTAL=			52	100

What these results suggest is that the primary lithic production objective at the RLF site was the manufacture of bifacial blanks that could later be turned into a finished tool. The discard of early stage bifaces (stages 1-3) appears to be deliberate and due to inherent flaws in the raw material causing breakage during manufacture, and account for 84.6% of the total biface recoveries from the site. This is significant not only for the characterization of a possible site use or objective, but also as a site-specific snapshot of the general reduction sequence observed by Bennett (2015) within the Mackenzie 1 site assemblage.

The comparative manufacture similarities between the bifaces recovered from the RLF site and those from the Mackenzie 1 site help to place the RLF site within the Lakehead Complex. Bifaces from the RLF site exhibit edge grinding as preparation for flake removal, another characteristic observed within Lakehead Complex manufacturing techniques (Hinshelwood and Webber 1987; Julig 1994)

Adzes

One siltstone adze was recovered during the RLF site excavations (Figure 4.8.1). It is roughly flaked on all sides and lacks a distinctive fault plane that often characterize the trihedral adzes of the Thunder Bay region.

The use and cultural affiliation of various adze forms within Northwestern Ontario is heavily debated as none have been recovered from secure site contexts. Some adze morphologies, such as the trihedral adze, have been placed within the temporal periods of the Paleoindian and/or Shield Archaic cultures (Fox 1977; Julig 1994; Steinbring and Buchner 1980). Residue work by Cook (n.d.) will begin to address these

issues, but until a developmental sequence can be recovered from secure datable contexts this cannot be verified. It is possible that these various adze morphologies could have functioned as wood working tools. However, without the application of use-wear or residue analysis this cannot be confirmed.

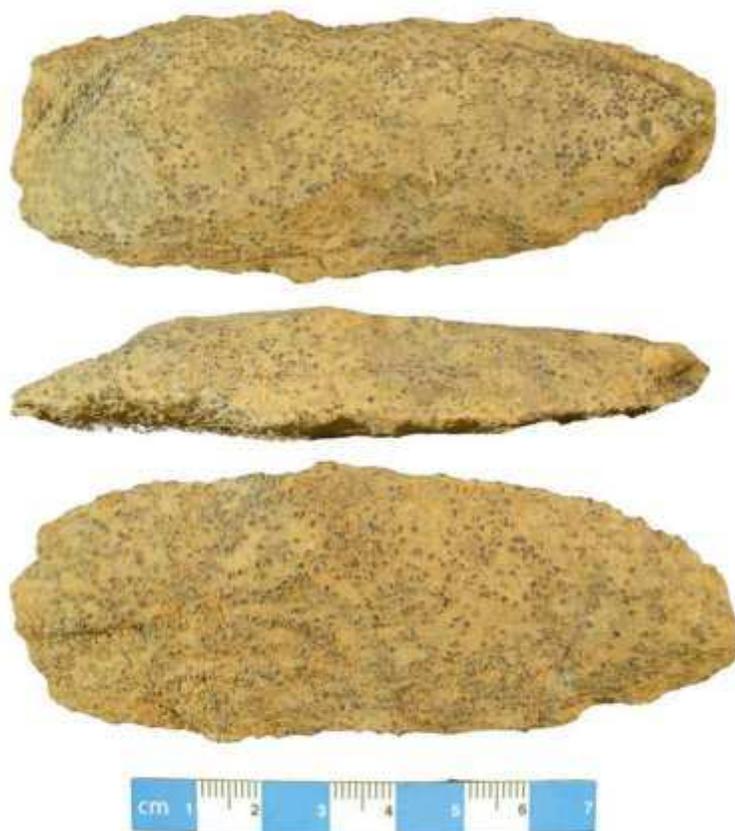


Figure 4.8.1: Adze recovered from the RLF site.

Wedges

One taconite wedge was identified during artifact cataloging (Figure 4.8.2). It exhibits crude bifacial flaking with possible battering/crushing on the distal end of the artifact. Further analysis however suggest that this battering/crushing may be the cobbled cortex of the initial piece that was not yet removed. Flakes removed from the tool exhibit a number of faults that may have resulted in the discard of the item.



Figure 4.8.2: Taconite artifact catalogued as being a wedge with scale in centimetres. This piece may represent an early stage failed biface. End exhibiting possible battering indicated by red stars.

Drill/Failed Projectile Point

Artifact 3132 has been identified as a possible failed taconite projectile point that was later re-purposed as a perforator/drill, or, discarded due to flaws (Figure 4.8.3). This artifact exhibits a mix of crude parallel oblique and co-lateral flaking with a prominent dorsal ridge. Multiple attempts appear to have been made by the flint knapper to remove this ridge resulting in compounding hinge fractures. With limited evidence of further reduction occurring on the face opposite this ridge, it is likely that the inability to remove it resulted in tool discard. A fracture on the tools tip may suggest later use as a perforator/drill however without the application of residue or use-wear analysis this cannot be confirmed.



Figure 4.8.3: Possible failed projectile point or drill.

With no hafting element present on the tool, assigning cultural affiliation is not possible. The thick cross section resulting from the dorsal ridge and un-finished nature of the point also limit metric analyses that may help to culturally associate the tool. While speculative, the presence of extremely crude parallel oblique flaking may suggest a connection with Lakehead Complex manufacturing techniques.

Spokeshaves, Perforators, and Gravers

One spokeshave, two perforators, and two perforators/gravers were identified during artifact cataloging. All of these artifacts were identified based on morphological traits.

The spokeshave (artifact 3186) exhibits a concavity on its proximal end that may have functioned as an expedient tool. There does not appear to be any distinctive retouching within this area suggesting that it may also represent a conveniently shaped flake. The artifact was recovered in two pieces, having broken along an oxidized fault running through the item.

The proposed perforating tools also do not exhibit clear indications of intentional retouching or use-wear. It is possible that these artifacts (2105 and 3125) may only represent fragments of shatter.

This interpretation is similar for the two identified gravers/perforators. While these items are similar in morphology to gravers identified by Julig (1994:138) from the Cummins site, a lack of observable retouch or use-wear could suggest that these represent convenient fragments of shatter. Until a proper residue/use-wear study can be conducted these artifact interpretations must remain speculative.

Unifaces and Retouched Flakes

A total of 39 artifacts were identified as unifacially flaked or retouched. Of these, 11 are classified as formal unifacial tools and 28 as expedient flake tools.

Unifacial tools have been divided into two classes: those that can be clearly identified as scraping tools (n=7), and those that are unifacially worked to a greater degree than retouched flakes but are not yet scrapers (n=4). The latter of these two classes appear to represent scraper preforms that failed part way through production.

The classification as a scraper requires the presence of flaking greater than 1.5 mm in length (Julig 1994:102). Of the seven identified scrapers, there are five end scrapers, one side/end scraper, and one side scraper.

Initial cataloging identified 28 retouched flake tools. A re-examination of these items resulted in the separation of the cataloged tools into two groups based on intentional and un-intentional retouch. While intentional retouch represents flakes that exhibit a clear, use-oriented flake removal, un-intentional retouched flakes exhibited random, non-functional flakes that were likely removed either during artifact transport, or through depositional trauma such as trampling. A lack of in-depth use-wear studies meant that unworked utilized flakes were not identified prior to this thesis.

There were four expedient blade flakes recovered from the RLF site similar to those described by Julig (1994). These thin flake tools appear to have minimal retouching along their edges. Based on their unique morphological shape, these artifacts are cataloged separate from other retouched flake tools.

Cores

There were 43 cores recovered during the RLF site excavations. All of these were made from Gunflint Formation materials with 39 (92.9% made of taconite and three (7.1%) of gunflint silica.

Of these, 17 (39.5%) exhibited some form of cortex. In this study, cortex refers to the rough, weathered outer portion of the lithic material as the result of either chemical (exposure to heat or water altering the composition of the material) or mechanical (changes in material texture as a result of events such as water-rolling or abrasion)

processes (Andrefsky 1998). To describe these different cortex types, the term ‘tabular’ cortex refers to removal from a bedrock source, while ‘cobble’ refers to cortex produced through water rolling.

Both tabular and cobble derived cores were observed at the RLF site. Of the 17 cores exhibiting cortex, six (35.3%) were tabular and 11 (64.7%) were cobble derived. While Lakehead Complex sites generally exhibit the use of bedrock materials, the use of cobble derived cores has been observed at the Simmonds site (Halverson 1992). This mixed exploitation with a greater reliance on cobble material would be understandable given that the RLF site is not located within the immediate vicinity of any documented Gunflint bedrock exposures.

The tabular cores at the RLF site likely represent materials that were transported to the site by its occupants; similar to observations at the Naomi site (Adams 1995). Cobble derived cores may have been collected locally from either rivers such as the Mackenzie River, or from shore deposits.

Two core recoveries from the RLF site were unique from the others. These cores (2820 and 3208) appear to have been used for the removal of blade flakes (Figure 4.8.4). One of these cores refits with a recovered blade flake (2299) and exhibits evidence of multiple flake blade removals. Similar cores have been recorded from the Cummins site (Julig 1994:98-99). These likely do not represent prepared blade cores, but rather cores that provided convenient opportunities to strike off multiple blades.



Figure 4.8.4: Core 2820 with blade flake removal. Note: blade flake is missing striking platform (indicated by red star).

4.8.3 *Lithic Artifacts: Debitage*

A total of 14,492 pieces of lithic waste material was collected during the RLF excavations. Initial cataloging of these materials involved sorting the artifacts into four basic categories: debitage flake, debitage shatter, microdebitage flake, and microdebitage shatter (Table 4.8.4).

Differentiating debitage from microdebitage was based on size, with debitage referring to artifacts larger than 6mm and microdebitage being smaller than 6mm. Identifying debitage and microdebitage as being flake or shatter was based on the presence of identifiable flake features. Flakes exhibit attributes such as a bulb of percussion or striking platform, while shatter is generally amorphous and blocky in nature with no discernible characteristics

Table 4.8.4: RLF lithic waste recovery frequencies by four base categories.

DEBITAGE			
TYPE	Material	Sub-Total	Total
DEBITAGE-FLAKE	Taconite	9610	10437
	GFS	685	
	Chert	6	
	Siltstone	110	
	Quartz	1	
	Other Material	25	
MICRODEBITAGE-FLAKE	Taconite	2673	2946
	GFS	249	
	Chert	9	
	Siltstone	13	
	Quartz	2	
DEBITAGE-SHATTER	Taconite	929	1014
	GFS	50	
	Chert	11	
	Siltstone	12	
	Quartz	4	
	Amethyst	3	
	Other Material	5	
MICRODEBITAGE-SHATTER	Taconite	81	95
	GFS	3	
	Chert	4	
	Quartz	6	
	Amethyst	1	
		Total =	14492

Key attributes collected during cataloging were lithic material, size, and flake type. These descriptors help to further classify and group various forms of debitage during spatial analyses.

Debitage: Material Types

Debitage material type is dominated by Gunflint Formation materials, with taconite representing the primary material type at 91.7% (13,293). Gunflint silica was second most frequent at 6.8% (987). Other materials recovered in lesser amounts include

siltstone, chert, quartz, amethyst, and ‘other’; where ‘other’ materials includes unidentifiable materials (Table 4.8.5).

Table 4.8.5: RLF lithic waste recovery frequencies by material type.

MATERIAL	TOTAL	% TOTAL
TACONITE	13293	91.73
GFS	987	6.81
CHERT	30	0.21
SILTSTONE	135	0.93
QUARTZ	13	0.09
OTHER	30	0.21
AMETHYST	4	0.03
TOTAL=	14492	100

Debitage: Size

Lithic production represents a reductive process, and as such, it is generally understood that as a stone tool nears completion, the size ofdebitage produced will become progressively smaller (Andrefsky 2001). Knowing this information allows for more complex interpretations regarding lithicdebitage when lithic sizes are included within site analysis. During the cataloging of the RLF site, basic measurements were collected for alldebitage and microdebitage.

Understanding the time sensitive nature of CRM excavation and cataloging, the collection of individual measurements for alldebitage was not feasible. As an alternative, the collected materials were divided into size grades using graduated squares. To do this,debitage was placed face up on a series of squares that decreased in size until the artifact no-longer fit within the borders of the square. The smallest square that the artifact could fit in without going over would represent the artifacts size grade (Figure 4.8.5). The sizes used during RLF site analysis were 0-2mm, 2-6mm, 6-12mm, 12-25mm, 25-50mm, and 50+mm. The results of this size grading can be seen in Table 4.8.6.

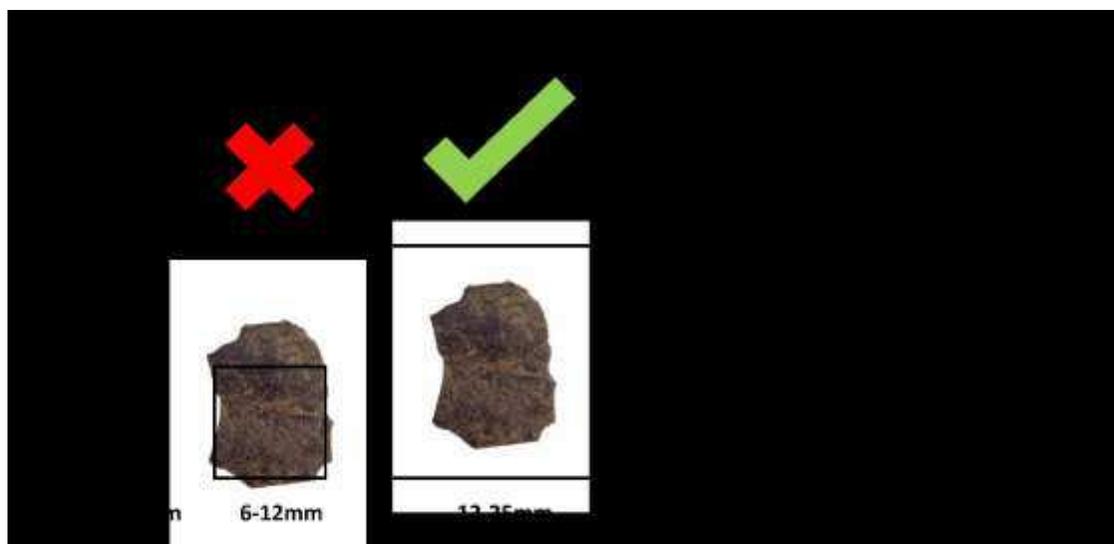


Figure 4.8.5: Example of RLF size grade sorting during artifact cataloging.

At the RLF site, size recoveries tend to be centred on debitage 6-12mm in size. There is a notable absence of debitage in the size grade of 0-2mm. This low representation could be the result of excavation methods, as 6mm and 3mm nested screens would not have allowed for the recovery of these artifacts.

Table 4.8.6: RLF lithic waste recovery frequencies by size.

SIZE	TOTAL	% TOTAL
0-2MM	17	0.12
2-6MM	3026	20.88
6-12MM	6392	44.11
12-25MM	3928	27.10
25-50MM	1058	7.30
50+MM	71	0.49
TOTAL	14492	100

Debitage: Type

Further debitage attributes also allowed lithic flakes to be classified by type. A breakdown of these flake types and the total identified pieces can be seen in Table 4.8.7.

Table 4.8.7: Description of methods used to classify RLF debitage by type with total recovery frequencies.

DEBITAGE BY TYPE			
TYPE	Description	Total	%
PRIMARY	Flakes exhibiting some form or cortex or fault plane with limited flake scars on the dorsal surface	257	1.9
SECONDARY	Any flakes greater than 12mm exhibiting flake scars on the dorsal surface	10167	76.0
TERTIARY	Flakes smaller than 12mm exhibiting flake scars on the dorsal surface	1413	10.6
UNKNOWN	Undetermined flake type	1544	11.5
TOTAL		13381	100

Similar to debitage size, information on flake types allow for further interpretations of lithic reduction to be developed. Primary flakes exhibiting large amounts of cortex are produced during the earliest stages of lithic manufacture (Andrefsky 2001). Therefore, if primary flakes are present at a site, then it can be proposed that some form of early stage lithic reduction was occurring.

4.9 Summary and Preliminary Site Interpretation

Prior to the application of spatial analysis on the RLF site, an understanding of possible site function should be explored. Based on the analysis of site location, stratigraphy, and artifact recoveries, preliminary interpretations for the RLF site can be developed.

While no datable materials were recovered from the RLF site, its location along a pro-glacial beach ridge in sediments suggesting a near beach environment suggest that site occupation occurred during the Minong phase of the Lake Superior Basin (~10,800-8,800 cal, 9,500-8,000 ¹⁴C yrBP). This, combined with the almost exclusive use of taconite and bifacial reduction techniques supports the initial proposal that the RLF site

belongs to the Lakehead Complex. This is further supported the close proximity of other Late Paleoindian period sites such as Mackenzie I to the RLF site. While the re-occupation of Late Paleoindian sites by Shield Archaic groups has been observed within the region (Hinshelwood 2004), there is little material evidence to suggest this occurred at the RLF site.

The materials recovered from the RLF site consist primarily of early stage bifaces and cores, suggesting that the site occupants were participating in the reduction of lithic materials in order to produce cache stage bifaces. These bifaces would have likely been further reduced elsewhere when needed. The acquisition of raw materials appears to have been a combination of tabular lithic blocks transported to the site from elsewhere, and locally collected river cobbles of Gunflint Formation materials.

What these interpretations suggest is that the RLF site represents a small scale lithic reduction camp along the shores of Lake Minong. Occupants of the site spent their time reducing cobbles of knappable material, as well as some quarried materials brought with them to site. These were then made into cache stage bifaces that would have been more easily transported. These finished cache bifaces were then transported away from the RLF site where they could later be turned into finished tools.

Chapter 5

Spatial Analysis in Archaeology

5.1 *Introduction*

The analytic importance of artifact patterning within archaeological sites has long been known as a key component of interpretation. However, it wasn't until the 1970s that archaeologists began to implement the systematic study of the spatial relations between artifacts. With the help of archaeological and ethnoarchaeological observations, spatial statistical inquiry, and experimental replication, spatial analyses have become critical for inferring site function, organization, and structure. This chapter provides a summary of the development of spatial analysis in archaeology. It will also explore how these studies have provided an understanding of the formation processes of different archaeological activity assemblages, as well as how natural processes can serve to disrupt and blur these patterns.

5.2 *Current Approaches to the Archaeology of Northwestern Ontario*

While spatial patterning of material on Lakehead Complex sites has been examined (see Adams 1995), these studies have focused largely on point plotted artifact locations to aid interpretation of site function. While this is one of the most common methods for inferring site use/organization it requires meticulously plotted artifact locations, relatively discrete clustering of artifacts, and areas of minimal disturbance or reoccupation - characteristics frequently lacking on boreal forest sites. This has resulted in regional research that is more focused on the artifacts themselves rather than their

intra-site spatial relationships (see Bennett 2015; Bouchard n.d.; Hodgson n.d.; Markham 2013). While these studies have been able to provide insight into the methods of tool production, use, and broader cultural relations, they have not been able to address how these populations utilized their site environments.

Limited investigation of spatially interpretable sites has constrained spatially based statistical studies of Lakehead Complex materials. This thesis provides the first step in introducing current spatial-analytical techniques within the research of Lakehead Complex materials (see also McCulloch n.d.).

5.3 *Spatial Analysis in Archaeology*

The archaeological application of intra-site spatial analysis developed out of a desire to understand how past populations organized themselves within their site environments, and how the relationships between observable spatial clusters can be used to infer past human behaviour (Carr 1984). Initial spatial studies were met with criticism regarding the underlying assumptions that clearly visible ‘activity areas’, defined by Binford (1983:148) as “places, facilities, or surfaces where technological, social, or ritual activities occur”, were a natural aspect of site formation (Gibson 2001; Kroll and Price 1991). Today, spatial analysts have become concerned with determining whether or not discernible activity areas can be observed within the distributions of archaeological debris, and if so, what can the composition of such areas tell us about the human use of space (Kroll and Price 1991).

Attempts by archaeologists to identify functional or activity areas within sites has resulted in the development of a wide array of analytical methods. The earliest spatial

studies relied heavily on the visual interpretation of artifact distribution maps (Kroll and Price 1991). However, as spatial archaeology evolved, numerous techniques were developed in order to address more complex questions of spatial relations and site development, including: the visual interpretation of artifact distribution maps (e.g. Lavachery and Cornelissen 2000; Rigaud and Simek 1991), aggregate analysis of materials (e.g. Kroll and Isaac 1984; Healan 1995), the application of spatial statistical tests (e.g. Gregg et al. 1991; Lavachery and Cornelissen 2000; Rigaud and Simek 1991), and the analysis of refitted artifacts both horizontally and vertically within a site (e.g. Bamforth et al 2005; Kroll and Isaac 1984; Lavachery and Cornelissen 2000; Rigaud and Simek 1991).

Simply identifying areas within a site where artifact clustering occurs does not fulfill the primary goals of spatial archaeology. Once identified, these clusters need to be interpreted, and the statistical strength and validity of spatial patterns need to be critically assessed. Lavachery and Cornelissen (2000:156) describe artifact clustering as the result of either an *in-situ* activity zone, an accumulated refuse zone, or a natural accumulation of artifacts caused by natural or post-depositional processes. Determining which of these clustering processes is responsible for the observed site patterns relies heavily on the use of ethnoarchaeological, archaeological, and experimental data (Binford 1978, 1983; Schiffer 1975, 1987).

Ethnoarchaeology developed as a result of the understanding that introduction of artifacts into the archaeological record was not as simple as previously thought. Ethnoarchaeology in itself is the study of existing populations and how their manipulation of material culture, and their use of space within a site results in the

disposal of materials as an archaeological deposit (David and Kramer 2001). These studies have resulted in the development of numerous site formation models and hypotheses (e.g. Binford 1978, 1983; Kent 1984; Yellen 1977, compiled works in Kroll and Price 1991).

It is important to stress though that no ethnographic study of modern hunter-gatherer groups can be applied directly to past cultures as no two populations can be assumed to act in an identical manner. While cultural variability limits the direct application of site formation models towards the interpretation of past populations, valuable examples of behavioural modelling regarding hunter gatherer campsites have been developed on the basis of analogy (Binford 1978, 1983; Gibson 2001; Stevenson 1986, 1991). Traditionally, these models have been concerned primarily with the mode or method of refuse discard within a site context and include: drop zone discard (Binford 1978, 1983), toss zone discard (Binford 1978, 1983), displacement zone discard (Stevenson 1986, 1991), and cluster discard (Gibson 2001:74, Figure. 5.3.1).

The drop and toss zone discard model was developed by Binford (1978) during ethnoarchaeological work with the Nunamiut Eskimo at the Mask site in North Central Alaska. While watching the hunters perform activities around a hearth, Binford noted that smaller fragmentary objects would fall within the direct vicinity of the individual. This area he termed the *drop zone*. Meanwhile larger items that would have created an inconvenience if left within the drop zone would be picked up and tossed backwards from the hearth (or occasionally into the hearth) into what Binford termed the *toss zone*.

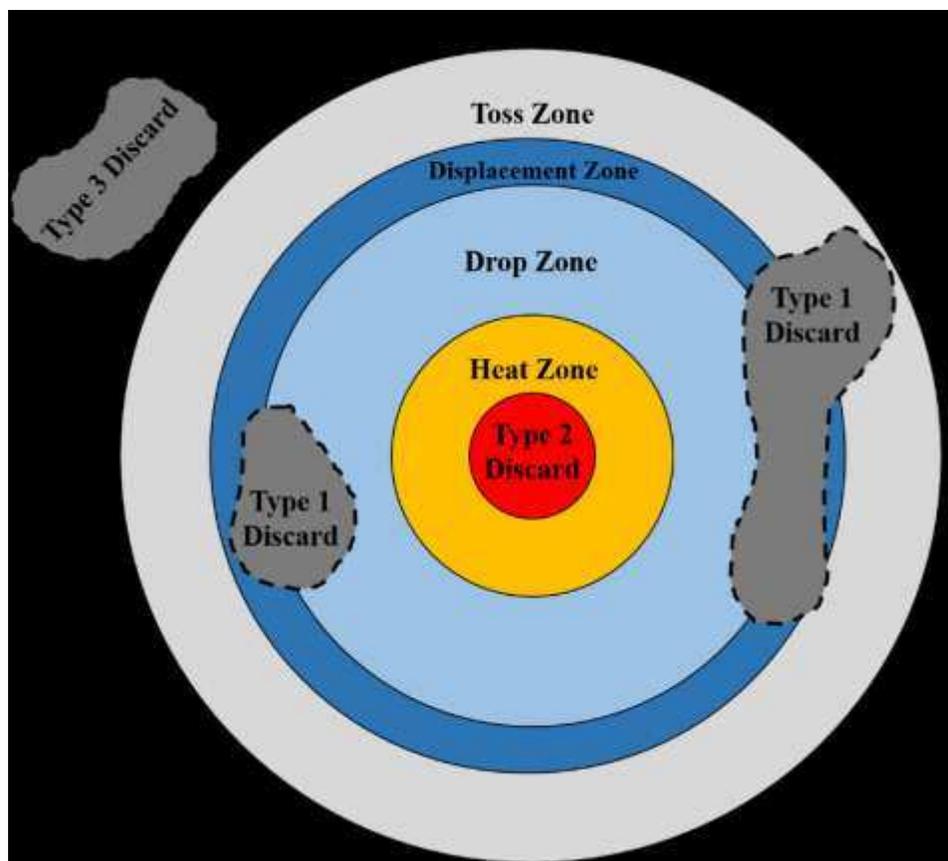


Figure 5.3.1: Stylized example of the drop/toss/displacement model with various cluster discard models indicated. (After Binford 1983; Gibson 2001; and Stevenson 1986, 1991)

The introduction of the idea of displacement zone discard was developed as an extension to Binford's drop/toss model (Stevenson 1986, 1991). The displacement discard zone represents an intermediate area between the drop and toss zones where larger items would be placed away from the individual rather than tossed (Gibson 2001).

A drawback of the Binford-Stevenson model is that both were developed regarding activity around open-air hearths (Gibson 2001). This did not take into account the depositional variation that may occur within the constraints of a structure, where limited space would not allow for such an accumulation of debris. Binford (1978:350) does note that within a structure the toss zone pattern would be unlikely, instead larger

objects would be placed near hearths for easy clean up. Gibson (2001) goes beyond this to classify a fourth discard method: *cluster discard*. This cluster discard is described as the purposeful collection of materials, presumably on skins, during an activity and dumping away from the use areas. Gibson (2001) classifies three basic types of cluster discard within his analysis of the Bushfield West site structures: *Type 1*) where the heterogeneous collection of materials are discarded expediently to the side of the individual into the drop/toss zones, *Type 2*) where materials are collected and dumped within the hearth centre, and *Type 3*) where materials are gathered and removed from the structure entirely and discarded in a peripheral dump pile.

Based on the nature of discard and the composition of the collected materials, the characterization and interpretation of artifact clusters can be developed. It is from these ethnoarchaeological and archaeological models and the work conducted through previous spatial investigations that the interpretations of the RLF site distributions will be compared.

5.4 Lithic Recoveries as an Indicator of Activity Location

Poor organic preservation severely impedes identification of activities that involved the use of organic materials. However, the patterned distribution and co-occurrence of lithic recoveries still enables interpretation of site use. Understanding that individual tools may have served multiple functions, it is important to develop interpretations using populations of artifacts, rather than the presence of single tool items (Andrefsky 1998).

5.4.1 *Lithic Reduction and Maintenance Loci*

Of primary importance to the study of intra-site organization at the RLF site is the identification and characterization of lithic reduction events. This is due to the fact that the primary recoveries are waste flakes produced during tool production, and tool forms that failed at an early production stage. Lithic reduction has been the primary focus of the limited number of spatial studies performed on Lakehead Complex Sites, but few have moved beyond the visual interpretation of cluster plots (e.g. Adams 1995; Halverson 1992; Hinshelwood and Weber 1987). Studying the placement and characteristics of lithic debitage within a site context allows for interpretations regarding reduction objectives to be inferred.

Identifying lithic reduction loci relies primarily on the interpretation of debitage distributions based on their relative size. Stone tool production is a reductive process and as such it is generally understood that as a tool nears completion the maximum size of waste flakes produced will also decrease (Andrefsky 1998:126-127, 2001:3). Additionally, smaller waste flakes will be produced throughout the reduction process (Andrefsky 2001), likely as a result of platform preparation and unintentional fracturing of the stone. It is these smaller flakes that allow researchers to interpret the location of reduction events.

In areas where lithic reduction is occurring, a great deal of waste will be produced. If this accumulation of debris becomes too great, the site occupants may decide to clear it away into discard piles (e.g. Gibson 2001). While larger debris will be collected, smaller objects are more likely to be overlooked and remains *in-situ* (Stevenson 1991). While the identification of primary reduction loci generally depends of

the collection and study of microscopic debitage, Healan (1995) suggests that macroscopic debitage can also be used. Using macroscopic waste flakes, Healan (1995) identifies lithic clusters with a high frequency of flake recoveries within the 2-4mm range as most likely to represent primary deposits.

Understanding this, it can be proposed that homogenous deposits of lithic flakes with few to no small flake recoveries are more likely to represent lithic discard piles. These conclusions however rely heavily on the ability for excavators to effectively identify and collect these smaller flake classes, an issue when working within the constraints of CRM archaeology. As well, if the collection of lithic materials was done with the use of animal skins as suggested by Gibson (2001), then the displacement of smaller grade debitage could also occur. It is therefore important to assess the horizontal distribution along with the composition of lithic clusters in order to provide the best suggestions for *in situ* lithic production loci versus lithic dump areas. Assessing the horizontal distribution of lithic debitage can allow for the characterization of debris zones following the drop, toss, and displacement model (Binford 1978, 1983; Stevenson 1986, 1991).

5.4.2 Bone Tool Production

Traditionally, the identification of bone tool production areas involves the recovery of bone splinters and fragments resulting from tool manufacture. With no organic recoveries from the RLF site this is not possible. As such, the frequent recovery of lithic tools associated with this activity can be used to propose the possible presence of this activity.

The lithic artifacts associated with bone tool production include various forms of scrapers and knives as well as awls and drilling tools (Gibson 2001). The multi-purpose use of many of these artifacts for activities such as wood working mean that without any comprehensive use-wear analysis, confidently identifying the presence of bone tool production is highly unlikely for the RLF site.

5.4.3 Hide Preparation and Working

Hide preparation and working would have involved any of the processes related to the removal, treatment, and manufacture of hide items. Similar to bone tool production, identifying the presence of hide working at the RLF site proves difficult. Material recoveries often associated with this activity are generally organic, and can also include various hearth forms and stretching posts. Lithics involved may have included end scrapers, retouched flakes, awls, or knives (Gibson 2001). Again, use-wear analysis would be required for determining this at the RLF site.

5.4.4 Butchering and Cooking Activities

The identification of butchering and cooking activities at hunter-gatherer campsites relies heavily on the presence of animal remains exhibiting evidence of human modification through butchery, food processing, and consumption. With no faunal remains, lithic tools such as choppers, bifacial knives, retouched flakes, hammerstones, and anvils can be used to infer butchering activities (Gibson 2001). While edged tools would have been used for dismemberment and cutting, hammerstones and anvils may have been used to break open bones for the marrow (Binford 1983).

These items, in association with hearths, would suggest that food consumption activities were likely occurring. The presence of FCR at the RLF site may represent such a hearth location. As previously stated, this FCR does not likely represent the presence of hearth-oven or boiling pit activities (see section 4.7.1).

5.5 Identifying Hearth-Centred Activities

Hearths have been described as anchors for site activities in hunter-gatherer campsites (Bamforth et al. 2005; Vaquero and Pastó 2001), and based on their location and size, can help to determine what sorts of activities may have been performed. Hearth activity can be loosely divided into two categories: domestic and periphery locations (Bamforth et al. 2005). Domestic hearth zones would have been used for cooking, light, heat, and other general purposes within domestic spaces, while hearths located in peripheral areas would have been used for purposes directly related to the activities being carried out (Bamforth et al. 2005:571).

In areas where domestic hearth related activities were being conducted, it is expected that debris would have been cleared to limit the amount of material within high traffic areas (Bamforth et al. 2005). Following this logic it is assumed that hearth related assemblages that yield large quantities of material and/or large debris may reflect non-domestic use within site peripheries (Bamforth et al. 2005). It is possible however that a lack of maintenance or cleanup within domestic areas could reflect brief site occupation, or a short time between debris production and site abandonment (Bamforth et al. 2005; Stevenson 1991).

Both ethnographic and archaeological consideration of hearth related assemblages reveal a variation of the distribution patterns described in the drop, toss, and displacement models (Binford 1983; Gibson 2001; and Stevenson 1986, 1991, see Figure 5.3.1). The results of hearth use, especially when more than one individual is present, produces either a crescent or circular shaped distribution of debris around a central location (e.g. Binford 1978, 1983; Carr 1991; Stevenson 1991). In many of these circumstances, the hearth location will exhibit a relatively low concentration of debris compared to the identified discard zone areas. However, the use of type 2 cluster discard as defined by Gibson (2001) could result in the dumping of materials into hearth centres. Using the observed distributions of artifacts, it may be possible to propose where hearth locations may have been, even without preserved organics or staining.

5.6 *Structure vs. Non-Structure Related Deposits*

The distribution of artifacts around hearths plays a crucial role in interpreting whether or not the observed activities took place within a covered shelter. While most studies of site activity in relation to structures are aided by the presence of organic or sedimentary indicators (e.g. post-molds, tent rocks, or occupation floor compaction), this is not possible for the RLF site. This means that interpretations of lithic dispersal are the only method of identifying built structures.

Non-structure related, or open-air, assemblages contain remnants of activities that would have produced considerable debris or mess (Binford 1983). These open-air hearth distributions would exhibit a distinctive drop-toss-displacement distribution and a lack of artifact confinement (Binford 1978, 1983; Stevenson 1986, 1991). Binford (1983) states

that these “doughnut-shaped” distributions did not occur inside structures, as people would have likely avoided throwing materials against tent walls.

Where activities occurred within structures, one would expect to see a significant degree of maintenance and removal of debris rather than the tossing of items (Binford 1983). Although this could refer to the removal of debris from the structure entirely (Binford 1983), the cluster discard model could result in discard within structures (e.g. type 1 and 2 discard - Gibson 2001). As such, the interpretation of structure related assemblages relies on the identification of relatively contained artifact distributions with a lack of a distinctive toss-zone and evidence of activity area cleaning or maintenance.

Given the significant amount of waste produced during full lithic reduction activities, it is reasonable to assume that it occurred in association with open-air hearths. However, the results of intra-site spatial patterning by Gibson (2001) at the Bushfield West site suggests otherwise. Spatial interpretations at Bushfield West reveal that the reduction of lithic materials was being conducted within tent structures. While lithic debris would have posed a hazard within the structure, cluster discard activities demonstrate that waste was being collected and discarded elsewhere (Gibson 2001). It is suggested that performing these lithic reduction tasks in-doors would have provided a warmer, more productive environment for tasks requiring considerable manual dexterity.

While it is evident that the interpretation of structure related assemblages using only lithic recoveries is fraught with concerns and issues regarding the interpretability of distributions, the general models presented provide a good reference. Using these general models, interpretations for either open-air or structured related deposits can be compared

in order to provide balanced interpretations. Without clear structural evidence however, these interpretations remain speculative.

5.7 *Cultural Transformation Processes Affecting Spatial Interpretation*

As discussed in section 5.3.1, the maintenance of site activity areas can affect archaeological interpretations. These cultural transformation processes are not limited to the clean-up of lithic reduction areas during site use. The curation of lithic materials, re-use/movement of refuse piles, and use of the site by modern, contemporary, and subsequent occupational groups can have the effect of further blurring interpretable site distributions.

The curation of artifacts by hunter-gatherer groups can result in the limited recovery of a number of materials that may have been deemed highly desirable by past populations (e.g. exotic materials). It has already been proposed that the production of cache stage bifaces for later use and refinement elsewhere was occurring at the RLF site. This represents only one form of potential curation behaviour from lithic sites. The collection of larger, usable flakes for the production of flake based tools can also affect sites recoveries. In this scenario, site occupants would collect and store flakes produced during lithic reduction for later use as expedient tool blanks. These curated tools may be limited to smaller, more easily transported items, while larger cumbersome object were either left behind or reduced further for transit (Schiffer 1987)

If sites are re-occupied by subsequent groups, the use of materials or features left behind may occur. Cached materials such as anvil stones or lithic materials could be used by different populations resulting in alternative depositional patterns. Bamforth et al.

(2005) observed the re-use of lithic waste piles by subsequent populations at the Allen site. Rather than re-using the materials left behind, new site occupants may have continued to dispose of refuse into the still visible middens of previous occupations (Bamforth et al. 2005). This re-use of visible site features affects the abilities of researchers to interpret distinct occupation activities based on the composition of artifact clusters.

While not a culturally related transformation process in the sense of site occupation by past hunter-gatherer groups, the disturbance of sites through modern human processes must also be taken into consideration. It has been observed that the trampling of artifacts by people, animals, and machines can result in the reduction of overall artifact size, as well as the sorting and vertical movement of artifacts (Schiffer 1987:268). The results of surface scarring from the removal and stacking of trees, similar to a ploughing effect, results in an upward and lateral movement of artifacts (Schiffer 1987). Properly documenting these disturbances throughout the excavation process will aid in the spatial interpretation of the site.

While these cultural formation processes do pose serious problems regarding the ability for researchers to interpret the spatial distribution of artifacts in relation to cultural behaviour, their effects can be mitigated. The use of vertical and horizontal artifact distribution, when combined with artifact attribute analysis, can be used to determine variations in occupation, presence of site disturbance, and even the general reduction processes undertaken on a site.

5.8 *Non-Cultural Transformation Processes Affecting Spatial Interpretation*

Along with the number of anthropogenic factors that can affect the deposition of material, numerous non-cultural formation processes must also be considered when interpreting site patterns. Of primary concern within the study of the RLF site are the effects of non-cultural soil disturbance, termed pedoturbation (Schiffer 1987; Wood and Johnson 1978), caused by bioturbation, cryoturbation, hydrological, Aeolian, or other events.

Bioturbation is used to describe soil disturbance caused by organic mechanisms including burrowing animals (faunalturbation) and vegetation (floralturbation) (Schiffer 1987; Wood and Johnson 1978). While evidence for animal burrowing was not noted within stratigraphic profiles, there was significant evidence of floralturbation.

Disturbance through floralturbation results in the upwards and downwards movement of artifacts through the push and pull of roots (Schiffer 1987). Tree falls were not clearly identified during the RLF excavation, however these events could have resulted in the mixing and upward displacement of artifacts trapped within the root systems of fallen trees, with subsequent re-deposition during decomposition (Schiffer 1987).

Similarly, cryoturbation activities can result in the vertical displacement of artifacts following deposition. The effects of frost heaving can serve to displace lithic artifacts, with this effect compounding during the duration of time that the item is buried. This will blur the vertical distribution of artifacts within a site. Frost action however, does not only displace artifacts vertically, but also horizontally. Experiments by Bowers et al. (1983) have observed the horizontal displacement of exposed lithic artifacts by as much as 10cm in only a few years.

Hydrological and aeolian activities can further displace artifacts horizontally if exposed to various factors. Schiffer (1987) discusses the effects of water and wind on artifact distributions as following the same basic rules that apply to sedimentology studies. During relatively high energy events, such as a beach face storm event, smaller artifacts will be transported away along with small sediment particles leaving only the larger and heavier objects. This has been observed as a form of site disturbance on archaeological sites elsewhere, resulting in the size sorting and displacement of artifacts (e.g. Lavachery and Cornelissen 2000).

5.9 *Summary*

With the development of ethnoarchaeological behaviour models, archaeologists have been able to better understand how artifact distributions may have entered the archaeological record. The most significant of these involves the discard of materials through drop-zone, toss-zone, displacement, and cluster discard (Binford 1978, 1983; Gibson 2001; Stevenson 1986, 1991). These models of artifact disposal have allowed for the interpretations of hearth related assemblages, linking them to both open-air and structure related activities.

While the RLF site recoveries limit the direct association of artifacts with these features, their patterned distributions are able to provide some insight into possible scenarios. These interpretations translate into the ability to identify site activities that would have relied heavily on preserved organic remains such as bone and hide working. Despite these limitations, there is significant evidence to suggest the ability to identify both lithic reduction events and associated activities through artifact co-occurrence.

Before these interpretations can be made though, an assessment of the post-depositional transformation processes acting upon the RLF site must be considered. These can include the alteration of site deposits through both anthropogenic and natural agencies such as: artifact curation, site re-occupation, trampling and scarring during the past and present, bioturbation, cryoturbation, and hydrological and aeolian activities (Bowers et al. 1983; Schiffer 1987; Wood and Johnson 1978). Understanding processes of depositional alteration allows researchers to better understand and interpret archaeological site patterning.

Chapter 6

Methods

6.1 *Introduction*

This chapter outlines the methodological approaches taken during the intra-site analysis of the RLF site from initial data acquisition to the development of final interpretations. The methodologies outlined below were selected for both their frequent use within the current literature, as well as their ability to address some of the limitations of CRM derived data.

6.2 *Data Access*

The data used within this thesis were obtained from CRM excavation projects jointly conducted by Lakehead University and Western Heritage. This co-operation allowed for the storage of archaeological materials and catalogs at Lakehead University for the purpose of research and analysis by graduate and undergraduate students, thereby furthering the research and understanding of Lakehead Complex sites.

6.3 *Geographic Information Systems (GIS)*

Since their introduction into archaeology in the 1970s and 1980s, geographic information systems, or GIS, have allowed archaeologists to explore the spatial relations of archaeological sites and materials in more depth and with increased efficiency (Gillings and Wheatley 2005; Mills 2009; Wheatley and Gillings 2002). Various GIS programs exist with which archaeologists can work (e.g. SURFER, QGIS, ArcGIS, etc.),

and their use as a tool within intra-site spatial analyses has been explored (Mills 2009; Moyes 2002).

Differing primarily in user interfaces, these programs allow for manipulation, analysis, and presentation of spatially registered data (including archaeological data) (Gillings and Wheatley 2005). For the spatial analysis of the RLF site, ArcGIS was chosen as the preferred platform due to its availability and ease of use. Spatial data were created using artifact catalog outputs generated within the ADEMAR cataloging program and was displayed using randomized Xrand and Yrand co-ordinates for un-provenienced items (see Chapter 4). Various shape files for different catalog categories were developed in order to provide multiple analytical approaches.

Along with the use of GIS as a spatial display tool, it also provided numerous statistical capabilities that helped with the identification of artifact clusters. Tests run within the ArcGIS program included kernel density, nearest neighbour, and Ripley's K .

6.4 *K-Means and Kernel Density Cluster Analysis*

K-means analysis was chosen as the primary method of cluster exploration based upon its ease of use with the available spatial data sets from the RLF site, as well as its extensive use within the current literature (Koetje 1994; Enloe et al. 1994; Gregg et al. 1991; Rigaud and Simek 1991). K-means analysis provides an exploratory tool, through which researchers can assess the nature of artifact clustering through a predetermined set of artifact clusters.

In order to conduct a K-means analysis, a number of different tests were run for various values of K ; where K represents the number of clusters allotted within the test

run. For each test, K seed points would be placed within the study area at random. Each data point is then related to the nearest of these seed points. These distances are then used to place a new seed point within the centre of the observed distances, where data points will again be assigned to the nearest seed point. This re-evaluation and placement of seed points is run continuously until no new seed point can be placed that will reduce the distance values between the data points and seed points. These final data/seed point assignments result in the assigned cluster number (de Smith et al. 2007).

For the RLF site analysis, K-means tests were run for values of K from 2-10 in order to explore a wide range of possible outputs. These tests were run within SPSS (Statistical Package for the Social Sciences), and then later translated into shape files for the visual representation of cluster membership within ArcGIS.

In order to determine which K value provided the most appropriate fit, the $\text{Log}_{10}\%SSE$ (sum of squared errors) for all K values was calculated. When plotted, values of appropriate fit will exhibit an inverse inflection (Gregg et al. 1991). Clusters at this point represent the ideal number through which further analysis of site activity can be based.

While this analysis provided an excellent starting point for analysis, there are some limitations regarding the initial catalog methodology. The use of bulk catalog numbering for similar artifacts from within levels resulted in the frequent occurrence of single data point entries representing multiple cataloged items. To reaffirm the result of the K-means tests, further exploratory tests that could take this frequency into account were required. As such, the results of the best fit K-means tests were mapped against kernel density mapping outputs to assess appropriate cluster membership. This

combination of techniques was employed by Enloe et al. (1994) in order to visually test the validity/selection of K-means results.

Kernel density uses a magnitude per unit area in order to apply a smooth surface contour. Similar to K-means, the kernel density tests provide an exploratory tool for the identification of clustering hot spots (de Smith et al. 2007; Mills 2009). This test is easily run within the ArcGIS program using the point data for all artifacts recovered from the RLF site, and utilizes artifact frequency counts to address some of the catalog limitations.

The combination of both K-means and kernel density provide an excellent exploratory tool to determine artifact clustering that may have been the result of human activity. These clusters are then used to develop sub-zones. These sub-zones provide the basic investigative units through which further analysis is conducted.

6.5 *Nearest Neighbour Analysis and Ripley's K Function*

Since K-means and kernel density function primarily as exploratory tools, it was important to perform follow-up statistical analysis to ensure that the identified clustering was in fact the product of a non-random, clustered distribution. To test this, nearest neighbour analysis and Ripley's K function were run on the distribution of all artifacts from all subzones.

The nearest neighbour statistical test compares the mean observed distances between artifact point data and their nearest neighbour with that of the mean expected distance values of a random distribution (de Smith et al. 2007; Mills 2009). The variance of these mean distances can be explored using a z-test, in order to assess the likelihood

that the observed clusters are the result of a random, normal, or clustered distribution (Mills 2009).

While the nearest neighbour test allows for the testing of cluster strength, it only compares point distances to the nearest single point. Therefore using Ripley's K function in conjunction with nearest neighbour allows for a greater confidence in cluster strength results.

Ripley's K function goes beyond the single nearest neighbour, utilizing all point to point relationships (de Smith et al. 2007). Rather than comparing the observed and expected distances between points, Ripley's K function utilizes circles of defined diameters over artifact point data in order to compare the number of observed points within a circle circumference to the expected number of points if the pattern were random.

Both of these tests were run within the ArcGIS software using point data files for the various defined sub-zones. The use of ArcGIS as a statistical tool provided not only a user friendly interface, but also allowed for the export of cluster data information in the form of charts and graphs that provided a secondary visualization of cluster strength.

This combination approach allows for the further interpretation of the distribution of the archaeological remains. If the artifacts do in fact exhibit significant clustering then further exploration can be undertaken in order to determine the nature of this clustering.

6.6 *Getis-Ord General G_i Clustering Analysis*

Throughout the analysis of the RLF site, the Getis-Ord General G_i statistic (Getis-Ord G_i) was used in order to determine areas of lithic debitage clustering. The Getis-Ord

method is a spatial auto-correlation statistic that utilizes artifact frequencies in relation to neighbouring clusters in order to determine intense clustering ‘hot-spots’ (Mills 2001). The results of the Getis-Ord G_i^* test can be displayed directly in ArcGIS using the resulting z-scores.

As with most spatial statistical test, the Getis-Ord G_i^* method does not in itself provide definitive clustering results. As such, the Getis-Ord G_i^* test within this study is compared directly with observed artifact frequencies.

6.7 *Refitting Analysis*

While the use of artifact refitting provides a valuable tool within the intra-site analysis of archaeological sites (e.g. Bamforth et al. 2005), it was not extensively employed during RLF site analysis and was limited to formal tool items. The exclusion of debitage within the refit analysis was due to the use of a CRM derived artifact assemblage catalog, and the inability to conduct a refit analysis prior to spatial analysis due to time restraints. While this is not ideal, the use of refit tools still provides valuable information regarding post-depositional artifact movement as well as artifact movement related to use. Refitted artifacts were analysed by associated clustered sub-zones identified during K-means analysis.

6.8 *Interpreting Activity Areas*

While the use of statistical and mathematical approaches to the intrasite study of artifact distributions are useful tools for establishing and displaying artifact clustering, they do not in themselves explain how these clusters were produced (Enloe et al. 1994).

In order to develop these interpretations, the observed location, frequency, and morphology of artifacts are compared to ethnoarchaeological and archaeological literature (see Chapter. 5). Hypotheses regarding the use and distribution of artifacts, when combined with cluster locations within the site environment (see Chapter. 4) are then used to build a proposed model for site use and occupancy at the RLF site.

Following the development of interpretations regarding sub-zone activity, the results of the near surface gradiometer (NSG) survey were plotted in order to address the presence or absence of features no longer visible within the archaeological record (e.g. hearths). The decision to explore the results of the NSG following interpretations was made so as to limit biases that may have been introduced within the study prior to initial analysis.

6.9 *Summary*

The intra-site spatial analysis performed for the RLF site required the use of multiple exploratory and clustering spatial statistical tests in order to identify areas of distinct artifact clustering. These tests, including K-means, kernel density, nearest neighbour, Ripley's K, and Getis-Ord G_i were chosen based on their ability to function within a CRM derived data set. The results of these tests are then used to determine 'sub-zone' areas, where unit areas that contain identified clusters are selected for further analysis.

Once artifact clustering is determined and sub-zone areas defined, ethnoarchaeological and archaeological examples for activity area patterns and use are compared to the observed patterns for the RLF site. This will include artifact patterning

that is both cultural and natural in nature. These comparisons, when combined with the results from near surface gradiometer survey, formed the basis through which interpretations of the RLF site were developed.

Chapter 7

Results of Spatial Analysis

7.1 *Introduction*

The intra-site analysis of the RLF site involved the manipulation and query of artifact spatial data. This chapter outlines the results of the spatial analysis through observed and tested artifact patterning. While the results outlined below follow a linear order of development, spatial inquiry often involves the frequent back-checking and re-analysis of observed patterns in light of varying artifact attributes. It is through this analysis/re-analysis that a critical assessment of observed patterns can be made prior to interpretation.

7.2 *Sub-Zone Identification*

Prior to the analysis of artifact patterning, K-means and kernel density clustering analyses were performed in order to: A) identify distinct areas of artifact clustering, and B) segment the RLF site into manageable sections through which a more in-depth analysis was applied. The exploratory nature of these tests allow for the selection and modification of clustering results by the researcher where necessary. This resulted in the designation of what are defined here as cluster ‘sub-zones’.

7.2.1 *Initial Clustering Results*

To properly apply K-means, kernel density, and Getis-Ord G_i^* analyses, recovery outliers within the RLF catalog had to be removed (e.g. surface recoveries from outside

the excavation areas or distant excavation units). When included, these outliers resulted in a disproportionate skewing in the placement of clustering points. The results of this catalog trimming can be seen in Figure 7.2.1.

Results of RLF Catalog Trimming

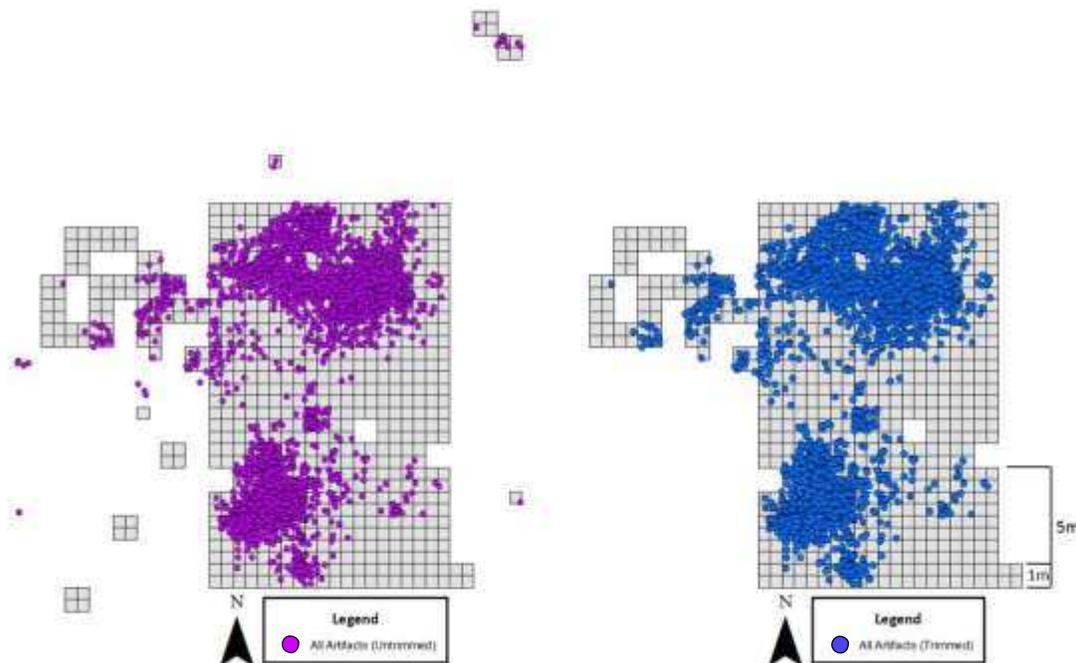


Figure 7.2.1: Results of RLF catalog trimming prior to application of k-means, kernel density, and Getis-Ord G_i^* . Trimmed artifacts were generally the result of surface collection or excavation outliers.

Once the artifact catalog had been trimmed, K-means analysis was run for 2-10 total clusters and the resulting $\text{Log}_{10}\%SSE$ of each was plotted in order to determine the most appropriate cluster number (K). A line graph of the plotted $\text{Log}_{10}\%SSE$ exhibited a sharp inverse bend where $K=8$, suggesting that eight clusters represented the most appropriate fit (Figure 7.2.2, see also Section 6.4).

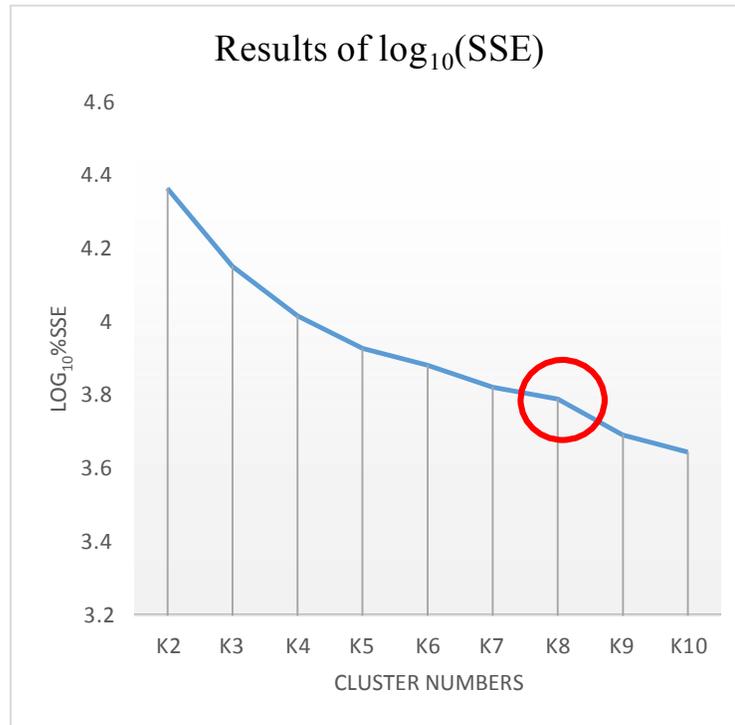


Figure 7.2.2: Line graph of plotted $\text{Log}_{10}\%SSE$ for k-means tests 2 through 10. Inflection at $k=8$ clusters indicated by red circle.

The results for K-means clustering at $K=8$, or eight clusters, was then mapped against the results of kernel density analysis for all artifacts (Figure 7.2.3). With the exception of one K-means cluster (Cluster 4 in Figure 7.2.3), the resulting density zones identified within the kernel density analysis match closely with K-means results. From this outcome it was determined that the clusters for $K=8$ should be used to base cluster sub-zone identification.

Additionally, the use of Getis-Ord G_i^* within this early stage of sub-zone identification allowed for the determination of primary clustering areas, or ‘hot-spots’. These ‘hot-spots’ identify areas of greatest artifact concentration relative to their surroundings (see Section 6.6). As can be seen in Figure 7.2.4, there are two primary clustering zones, with comparatively low clustering in surrounding areas.

Results of K-Means Cluster Analysis, Kernel Density Analysis, and Comparative Overlay

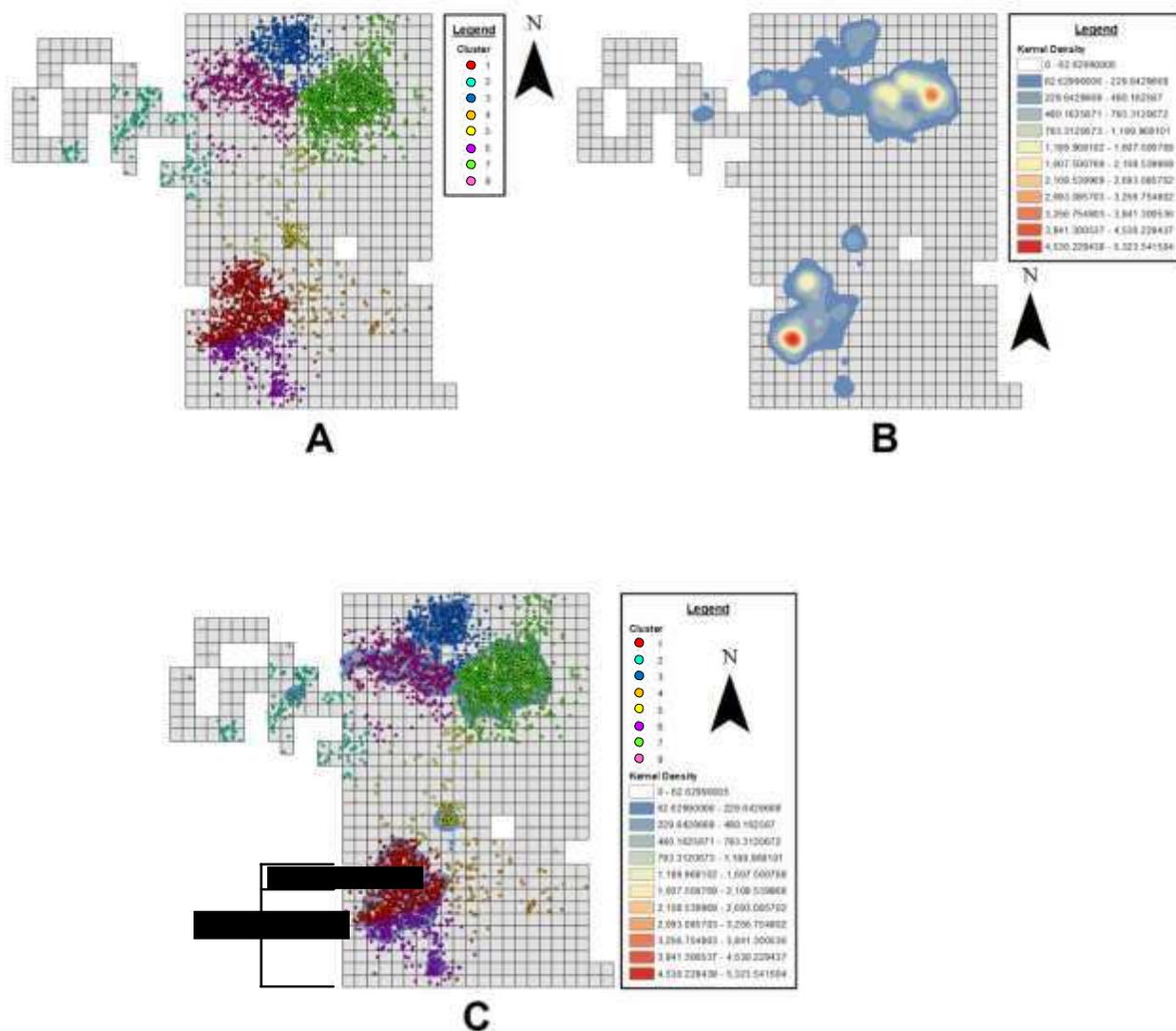


Figure 7.2.3: Maps illustrating the resulting cluster designations (A), kernel density results (B), and map comparing the two results (C). It can be seen here that cluster 4 (orange) was not identified during kernel density analysis. Due to identification within k-means analysis this cluster area will still be explored.

Results of Getis-Ord G_i^* for All Debitage by Quadrat

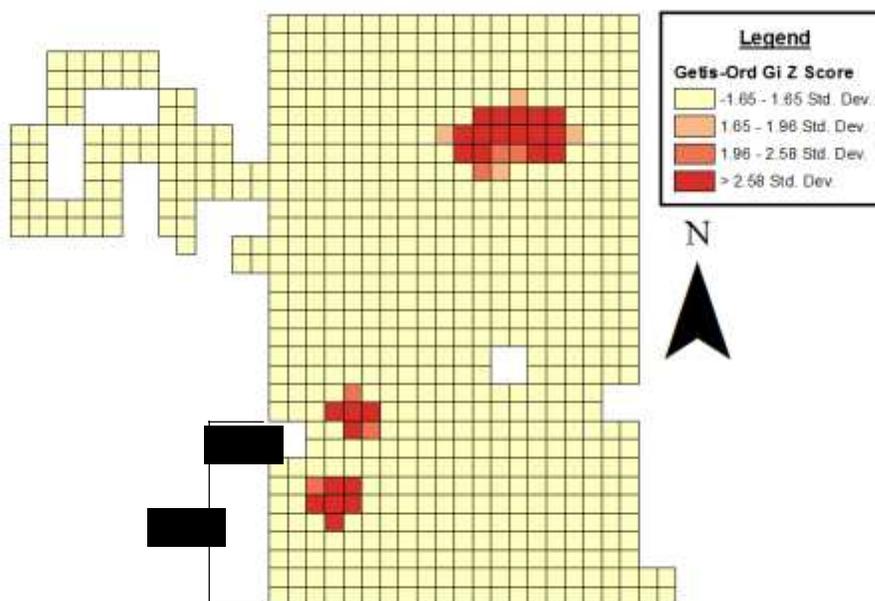


Figure 7.2.4: Results of Getis-Ord G_i^* represented visually by plotting resulting z-scores. This illustrates the two areas of highest recovery, or 'hot-spots', within the RLF site.

7.2.2 Identification of Modern Mechanical Disturbance

Surface disturbance was identified during the initial excavations of the RLF site. Tree felling and stacking activities with a bulldozer resulted in the disturbance of sediments within the northwestern portion of the excavated area (Figure 7.2.5). Field notes for units in the affected area indicate that undisturbed sediments were not encountered within the far west of this area until levels 4-5, or 20-25 cm below surface (see discussed units Figure 7.2.6).

This was a significant factor in the identification of sub-zones within this analysis. As seen in Figure 7.2.7, when artifact recoveries were removed by level the northwest

(area indicated by the yellow square in Figure 7.2.5) becomes devoid of recoveries at the levels of non-disturbance. As almost all recoveries within this area appear to be the result of disturbed push activity, they yield little spatially significant information.

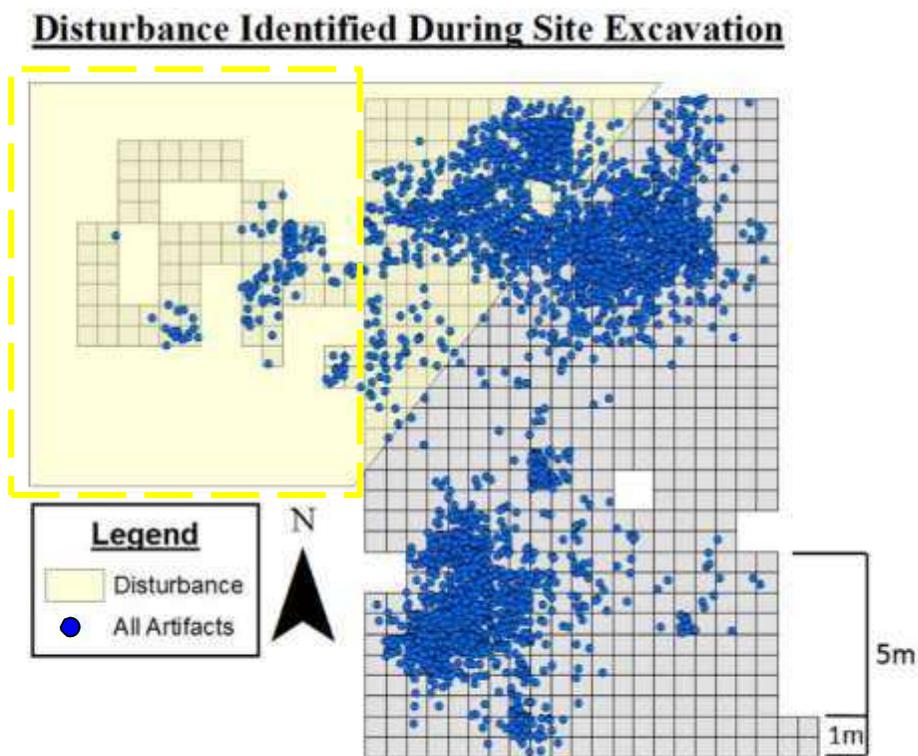
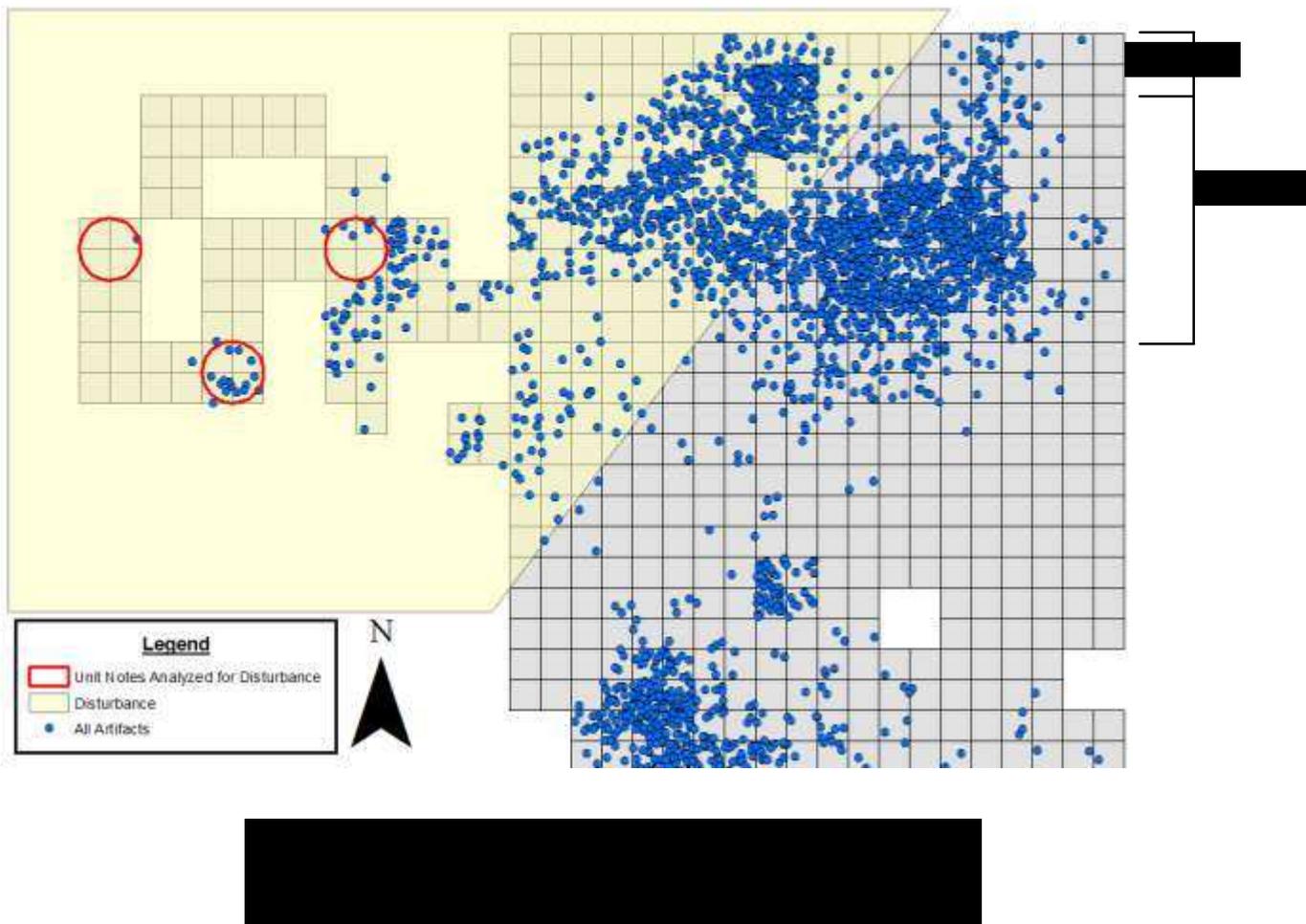


Figure 7.2.5: Areas of site disturbance. Note: the boundaries of this site disturbance area are not well defined and represent the proposed impacted area from field excavation notes. Yellow square indicates the area of greatest disturbance as indicated by field notes.

Location of Units with Field Notes Indicating Disturbance



7.2.3 *Sub-Zones*

Units with evidence of artifact clustering, as identified during K-means and kernel density analyses, were used to determine sub-zones. Due to the disturbance activities discussed in section 7.2.2, not all clusters were given their own sub-zones.

Cluster 2 (teal) consisted primarily of artifacts displaced through disturbance (see Figure 7.2.7) and as such, were removed from sub-zone determination. Removing artifacts from Cluster 2 enabled the trimming of the RLF site map into a more manageable shape and size (Figure 7.2.8). This trimmed map was utilized throughout the remainder of the RLF site analysis.

While the disturbance that impacted Cluster 2 was observed to extend into the primary excavation area, it did not appear to have affected artifact deposition as severely. However, due to their proximity to the disturbance activities, it was determined that Clusters 3 (blue) and 8 (pink) could be combined within one sub-zone in order to further assess artifact displacement. In total this resulted in the designation of six site sub-zones (Figure 7.2.9).

These subzones were differentiated into larger zones 'A' and 'B' based on the observed separation of artifact clusters by a slight rise within topography (Figure 7.2.10 A), see also Section 4.2). As such, sub-zones were given the titles A1, A2, B1, B2, B3, and B4 (Figure 7.2.10 B). In areas where sub-zones bordered one another, overlap was provided. It should be noted that this resulted in the occurrence of some artifacts within multiple sub-zones.

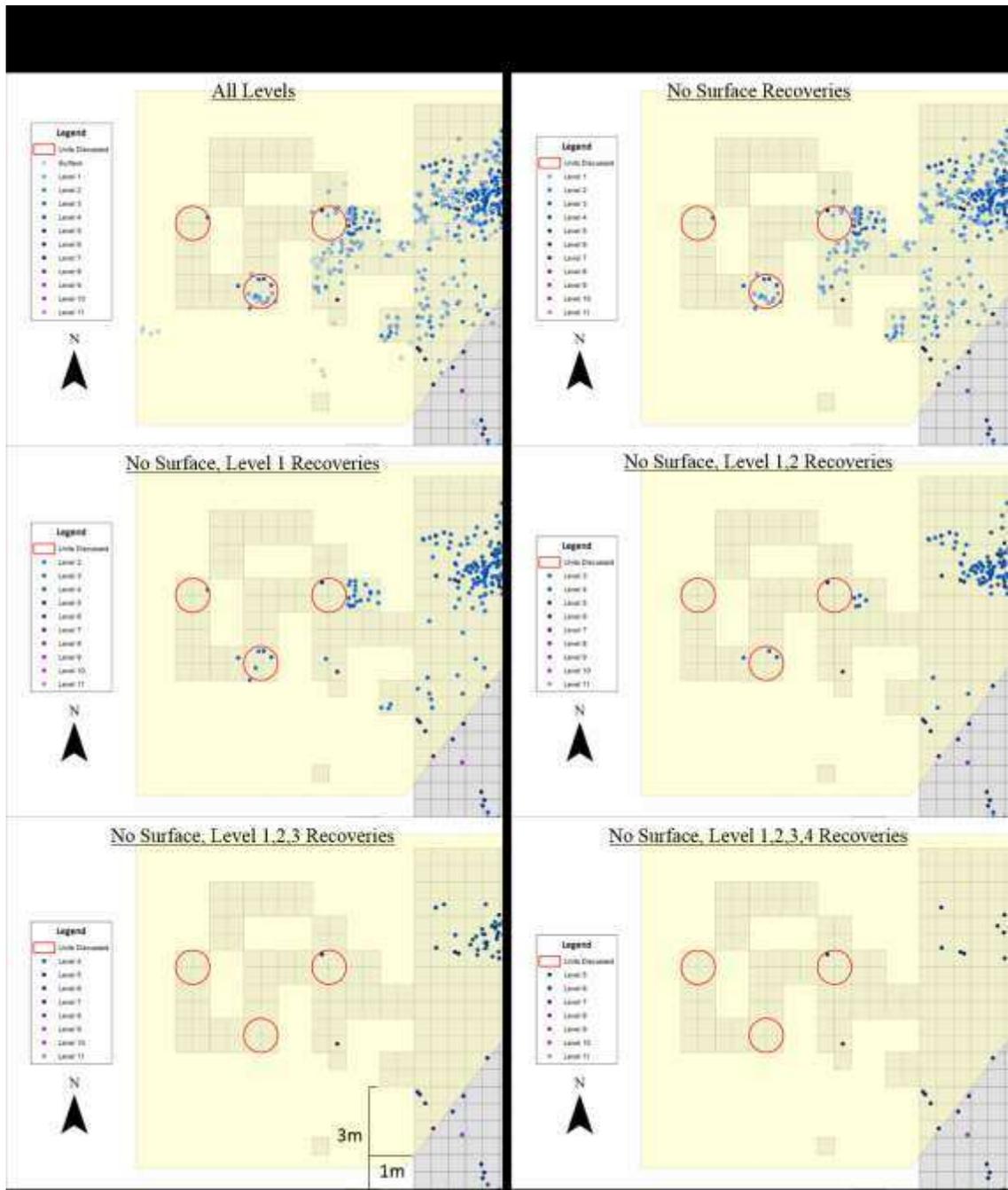


Figure 7.2.7: Mapped artifact distributions by level. This map series illustrates that as level recoveries are removed down to identified undisturbed sediments, little to no artifacts remain within the area.

RLF Site Map Before and After Removing Disturbed Cluster Two

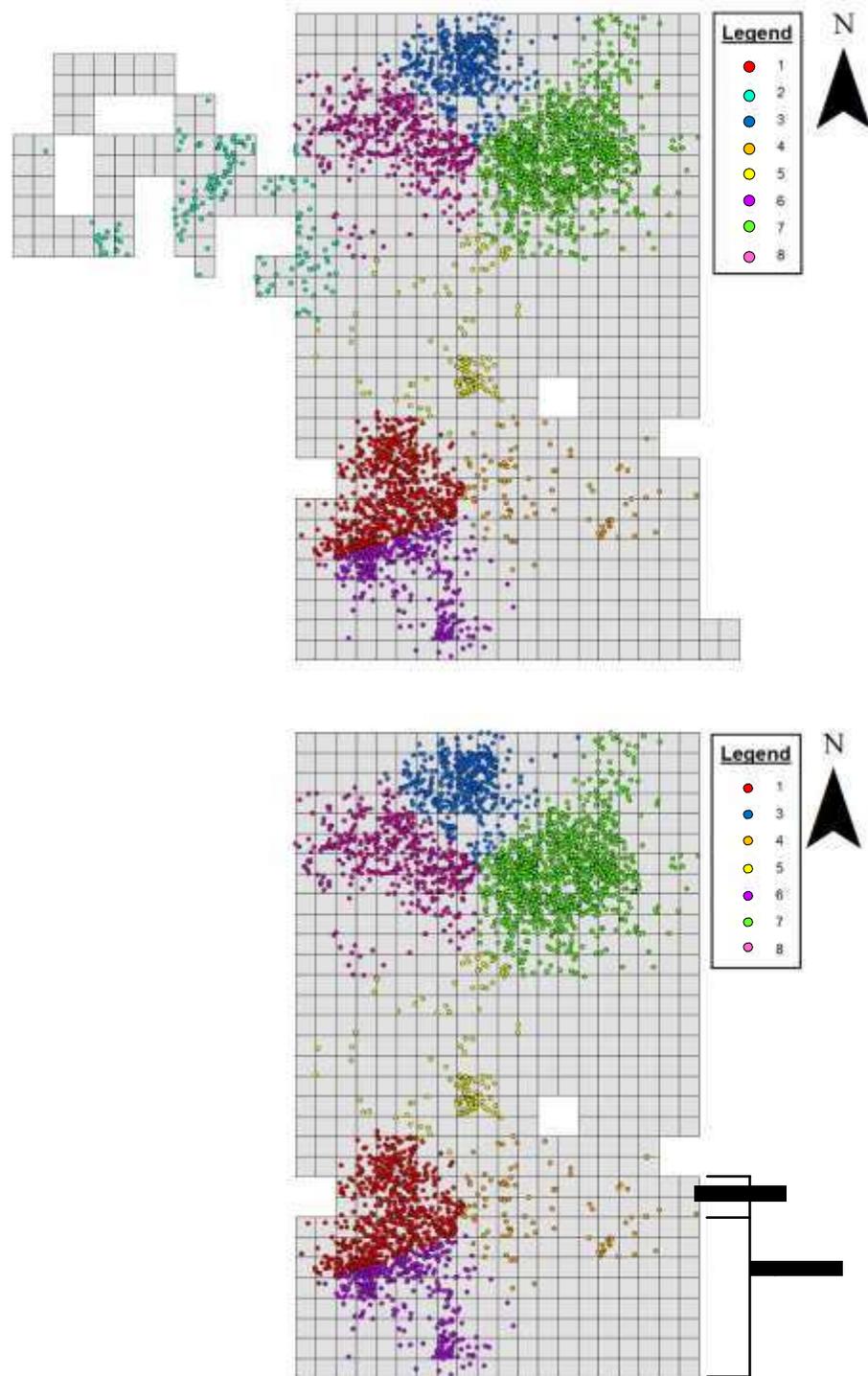
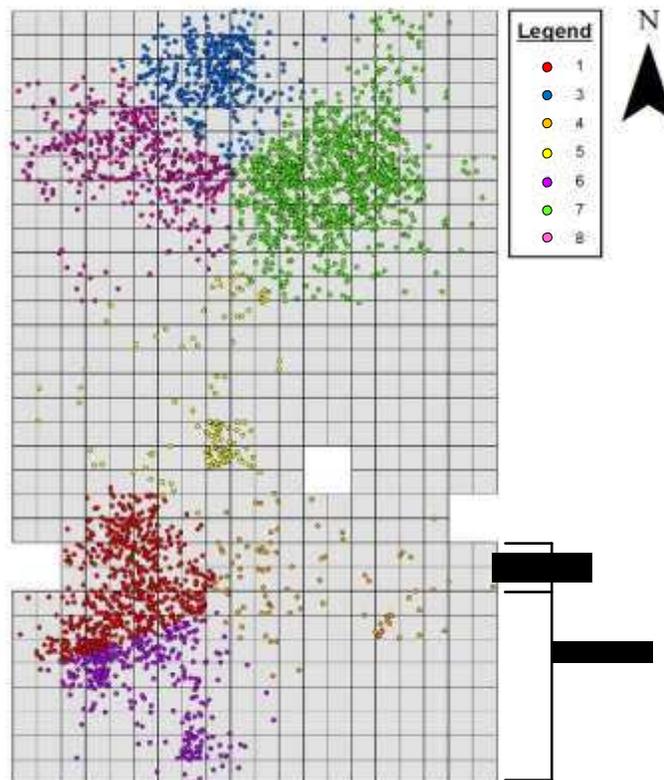


Figure 7.2.8: Map of k-means cluster results for k=8 (A) with trimmed map of defined clusters with cluster two removed (B).

Additionally, not all artifact recoveries were included within these subzones. This did not mean that these artifacts were excluded from the final spatial interpretations, but only excluded from sub-zone analysis in order to focus on primary clustering areas. Furthermore, some K-means clusters were split within sub-zones (e.g. cluster 7). This was due to the observed separation when cluster results were compared with map outputs for kernel density and Getis-Ord G_i analyses.

RLF Site Sub-Zone Designations based on K-Means



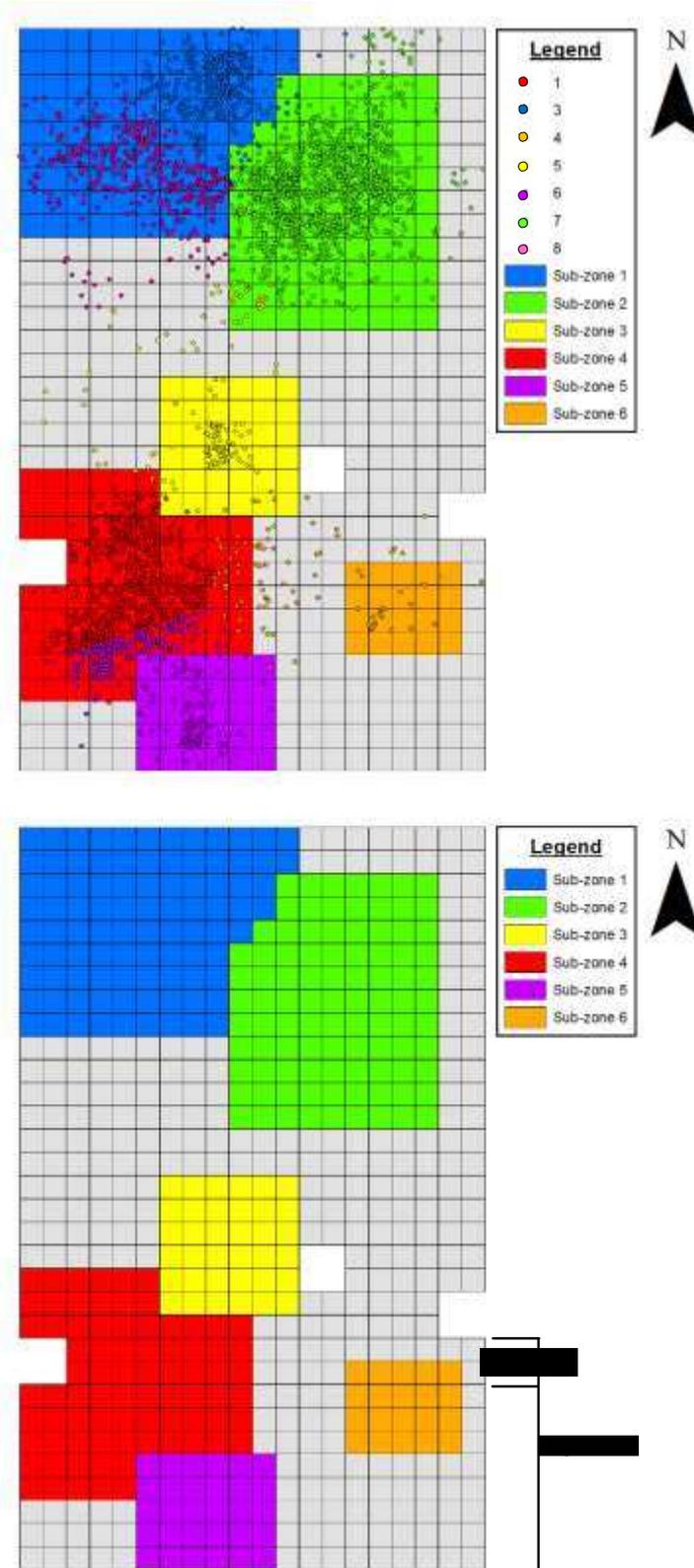


Figure 7.2.9: Defined sub-zone with comparison to cluster designations. It can be seen here that cluster 3 and 8 were combined to form one cluster. This was due to the observed disturbance discussed in section 7.2.2.

**Sub-Zone Location and Topography Resulting in the
Designation of Zones 'A'
and 'B'**

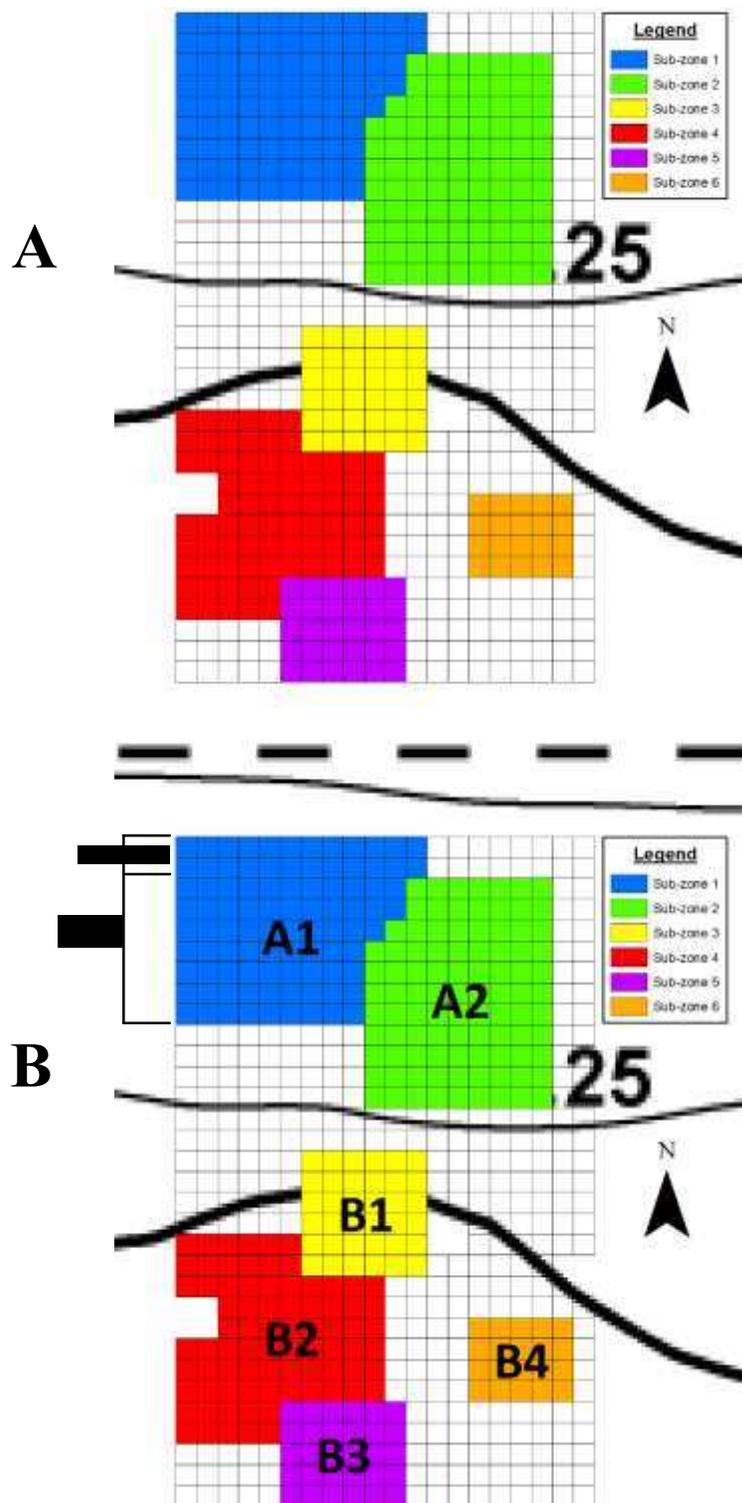


Figure 7.2.10: Defined sub-zone compared with topographic relief map (Represented by black lines) (A) and resulting zone designations (B).

7.3 *Sub-Zone: A1*

Sub-zone A1 consisted of 99, 50 x 50cm quadrats in the northwest corner of the RLF site (Figure 7.3.1). This sub-zone contained Clusters 3 and 8, and was subject to surface disturbance prior to excavation.

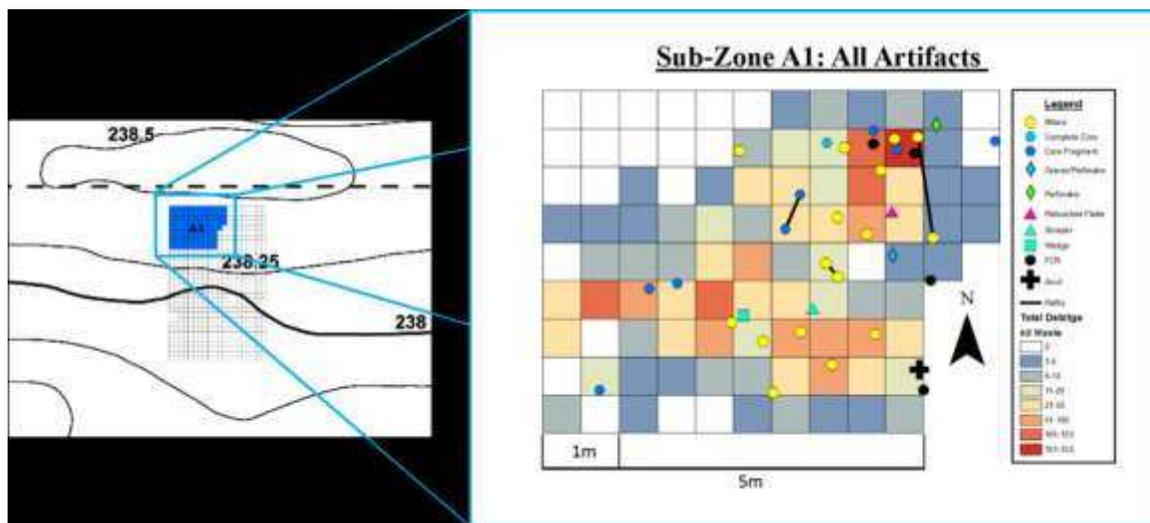


Figure 7.3.1: Sub-zone in relation to topography with a close up of sub-zone A1 illustrating all tool recoveries with total debitage by quad.

7.3.1 *A1: Artifact Recoveries*

Sub-zone A1 consisted of 1,950 artifact recoveries. Of this, 31 were tools (33 excluding tool refits). Tools included nine cores, 16 bifaces, one graver/perforator, one perforator, one retouched flake, one scraper, one anvil stone, and one wedge (Table 7.3.1, biface staging Table 7.3.2). Of the recovered cores, four exhibited a cobble cortex while five did not have any identifiable cortex (Table 7.3.3).

A total of 1,909 lithic waste fragments were located within sub-zone A1, of which 1,599 were classified as debitage and 310 as microdebitage. Waste flakes were further subdivided by type (Table 7.3.4), material (Table 7.3.5), and size (Table 7.3.6). The remainder of artifacts consisted of three pieces of FCR, and five fragments of unknown or non-cultural lithic items.

Table 7.3.1: All tool recoveries from sub-zone A1

A1: TOOLS	
TOOL TYPE	Frequency
CORE	9 (10)
BIFACE	16 (17)
GRAVER/PERFORATOR	1
PERFORATOR	1
RETOUCHED FLAKE	1
SCRAPER	1
WEDGE	1
ANVIL	1

Table 7.3.3: Results of cortex identification for sub-zone A1.

A1: CORES	
CORTEX TYPE	Frequency
N/A	5 (6)
COBBLE	4
TABULAR	0

Table 7.3.5: Debitage frequencies by material

A1: DEBITAGE	
MATERIAL	Frequency
TACONITE	1685
GFS	137
CHERT	9
SILTSTONE	71
QUARTZ	4
OTHER	3

Table 7.3.2: Result of biface staging for sub-zone A1 following Bennett (2015)

A1: BIFACES	
BIFACES STAGE	Frequency
N/S	1
1	2
2	2
3	8 (9)
4	3
5	0
6	0

Table 7.3.4: Debitage frequencies by type

A1: DEBITAGE	
TYPE	Frequency
PRIMARY	53
SECONDARY	1296
TERTIARY	198
UNDETERMINED	101
SHATTER	261

Table 7.3.6: Debitage frequencies by size grades

A1: DEBITAGE	
SIZE	Frequency
0-2MM	0
2-6MM	313
6-12MM	728
12-25MM	627
25-50MM	222
50+MM	19

7.3.2 A1: Vertical Distribution

The effects of site disturbance is clearly evident within the vertical distribution of artifacts in sub-zone A1. Artifacts were concentrated highest around level one, and maintained a high frequency until level 3 before declining with increased depth (Figure 7.3.2)

In order to explore this distribution further, vertical distributions were plotted for all artifacts by size class (Figure 7.3.3). It can be seen from these results that the high frequency of artifacts in level one is attributed largely to artifacts within the 2-6mm and 6-12mm size range. All other size grades in turn cluster around level three, yielding the greatest recovery frequencies.

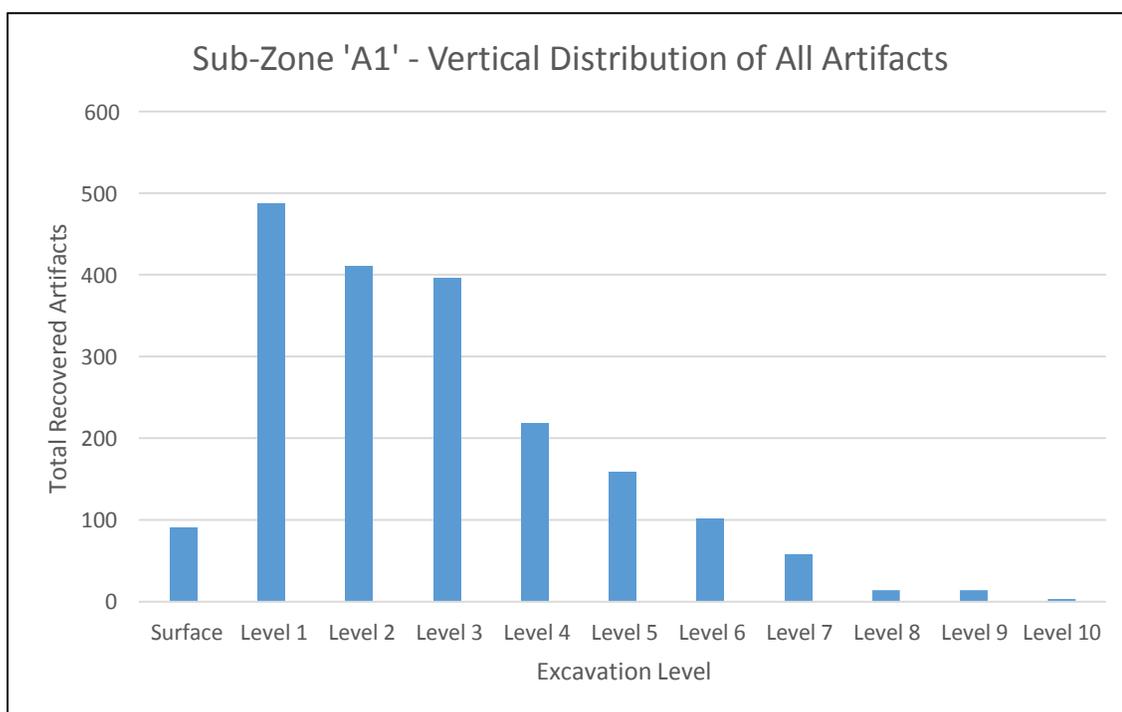


Figure 7.3.2: Total artifact recoveries by level indicating a high recovery frequency within the upper levels; likely the result of disturbance activities previously discussed.

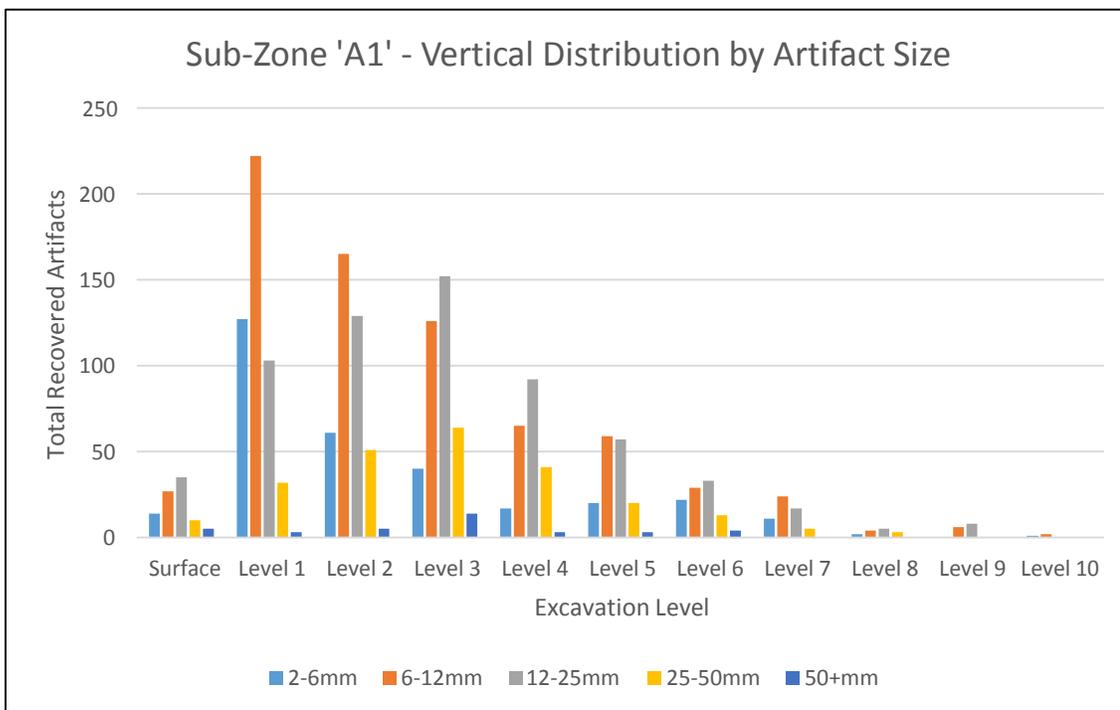


Figure 7.3.3: Total artifact distribution by level and size showing that debitage in the size ranges of 2-12mm are recovered in highest frequencies around level 1, while larger size grades are recovered near level 3.

7.3.3 A1: Horizontal Distributions: General

Prior to artifact distribution analysis, nearest neighbour, Ripley's K function, and Getis-Ord General were conducted in order to determine if artifact clustering within the sub-zone was significant. The results of these tests can be seen in Figures 7.3.4, 7.3.5, and 7.3.6, respectively. These tests indicate that the clustering of artifacts is significant, with nearest neighbour and Getis-Ord G_i results suggesting that there is less than 1% chance that the observed artifact distribution is the result of random chance.

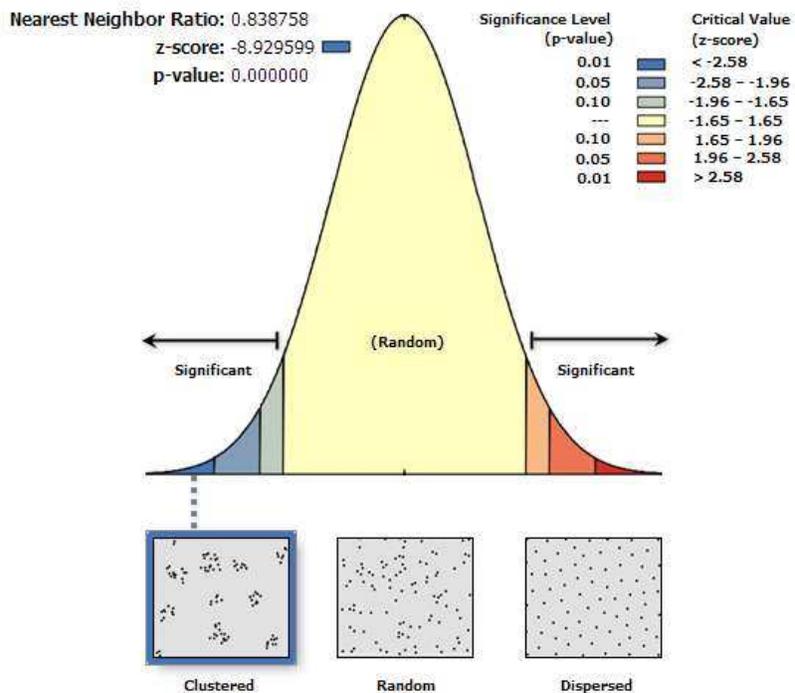


Figure 7.3.4: Results of nearest neighbour analysis indicating that at a z-score of -8.929599 there is a less than 1% chance that the observed distribution is the result of random chance.

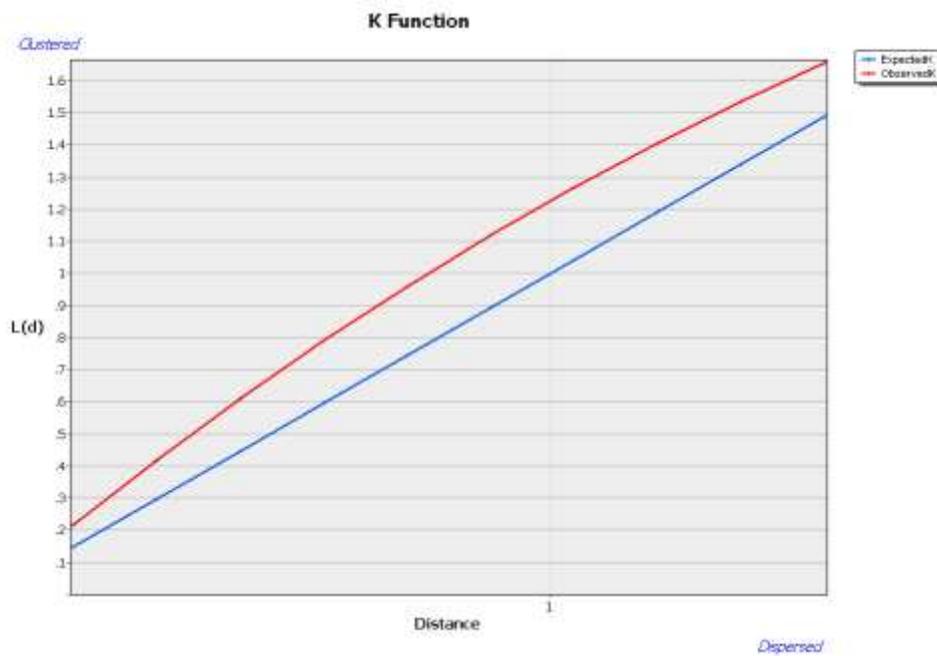


Figure 7.3.5: Graph of Ripley's K function analysis illustrating that the observed distribution is likely the result of a clustered distribution.

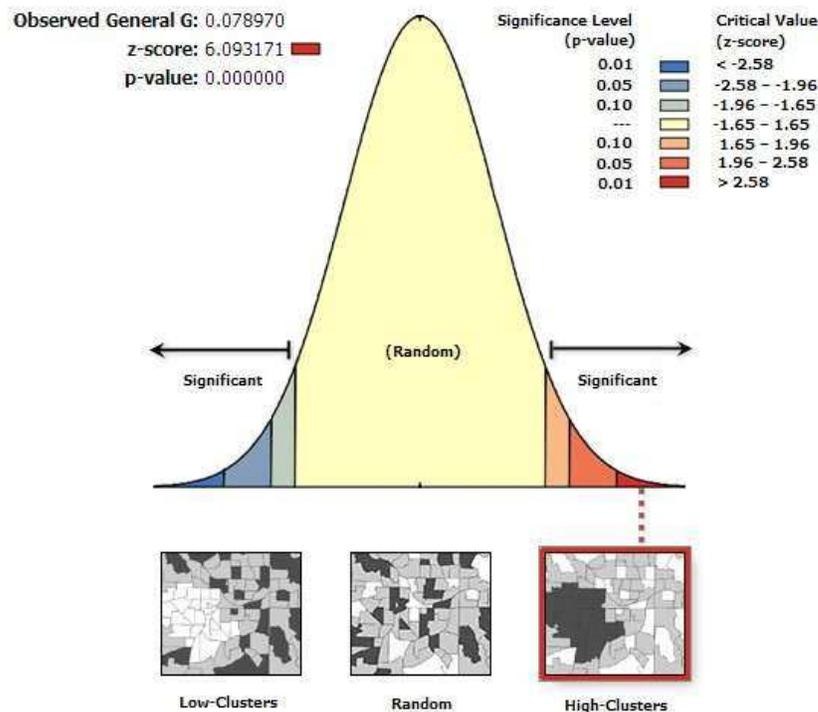
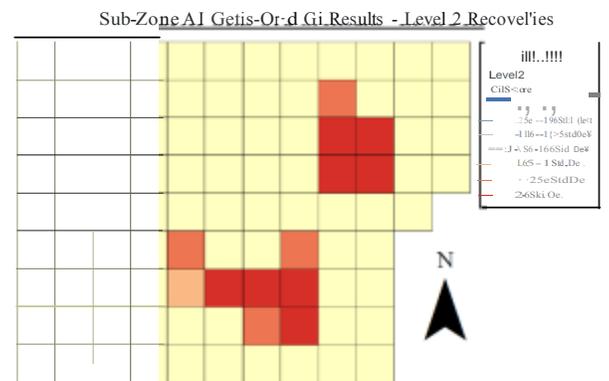
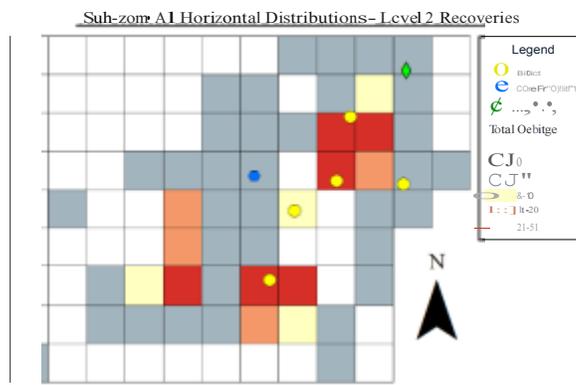
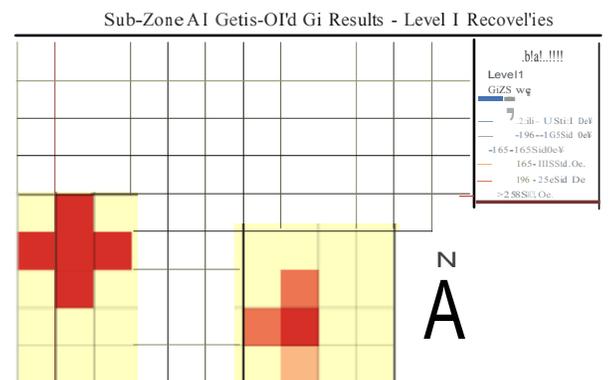
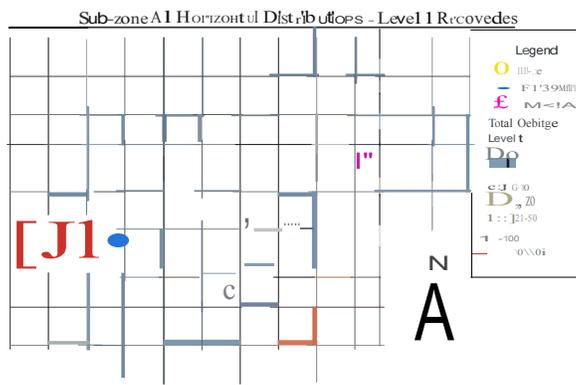
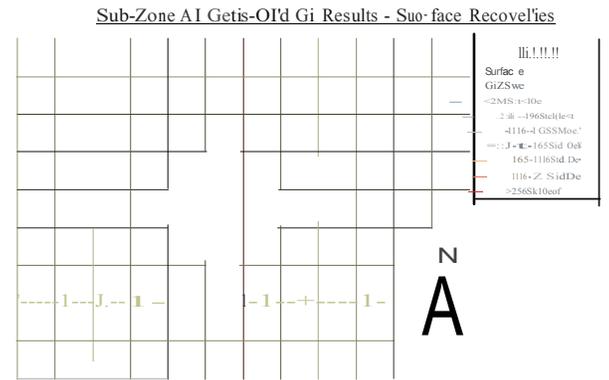
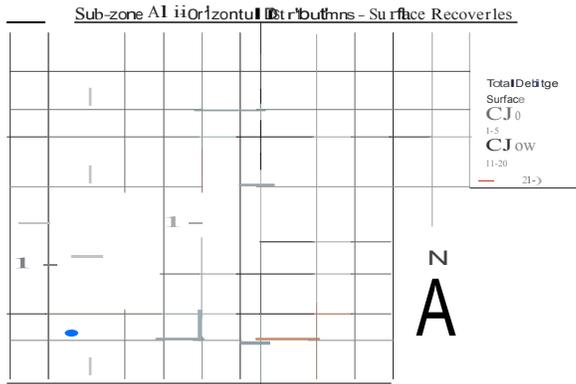


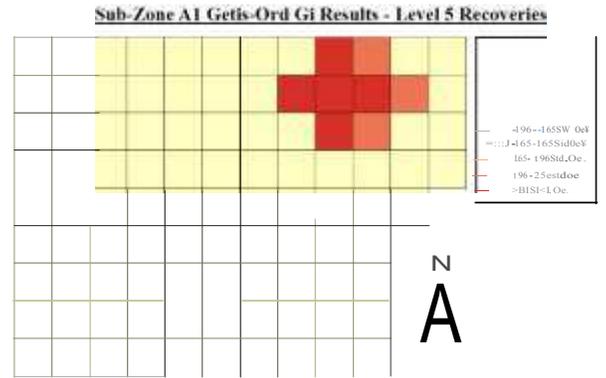
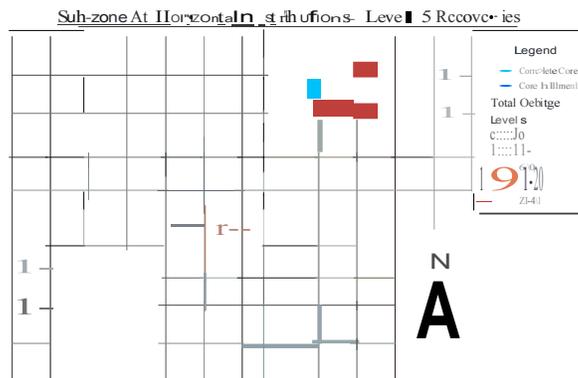
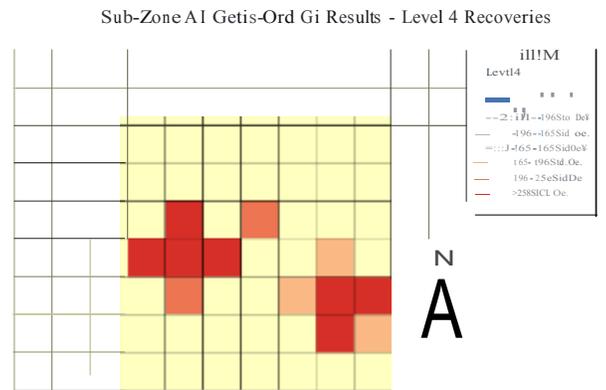
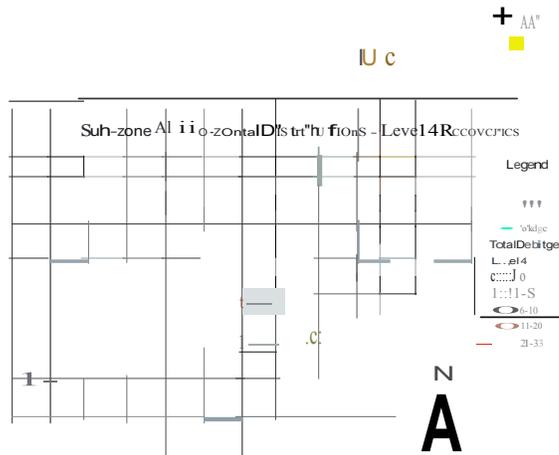
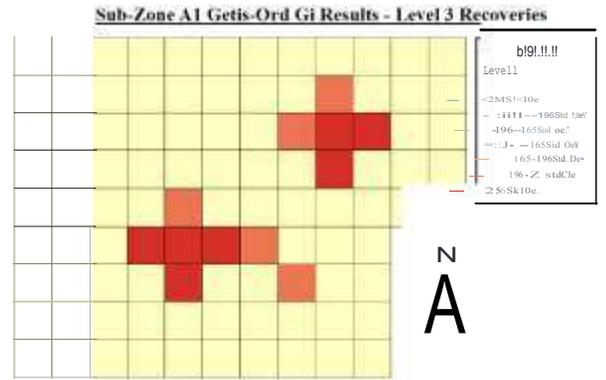
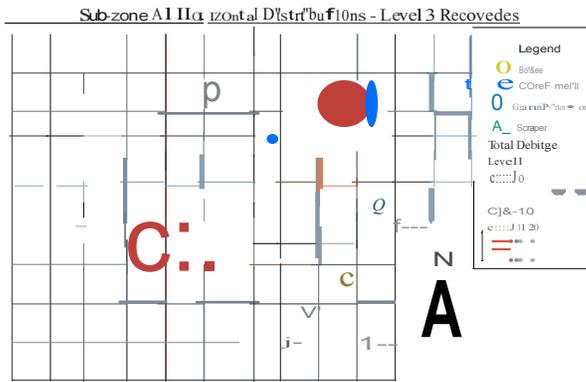
Figure 7.3.6: Results of Getis-Ord G_i analysis indicating that at a z-score of 6.093171 there is a less than 1% chance that the observed distribution is the result of random chance.

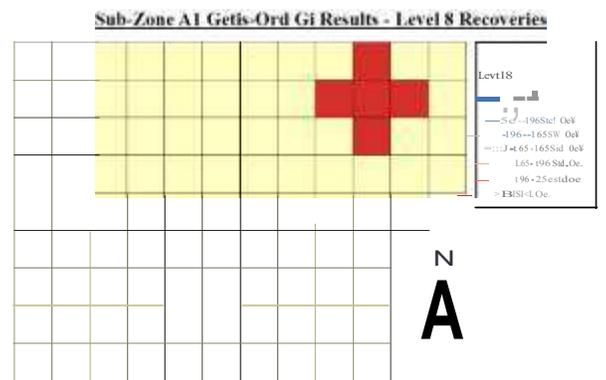
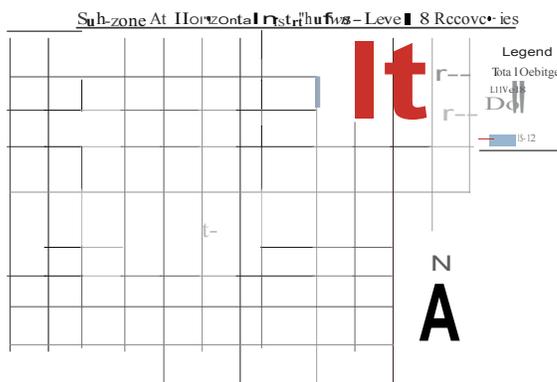
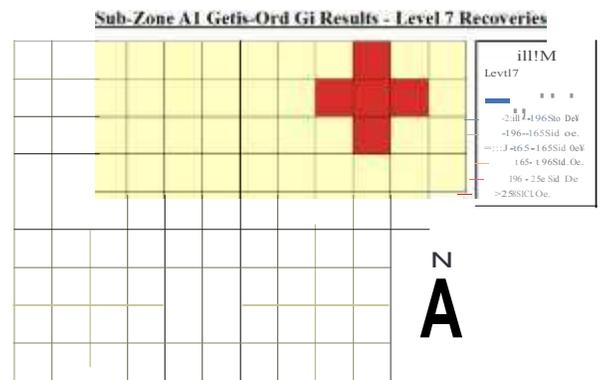
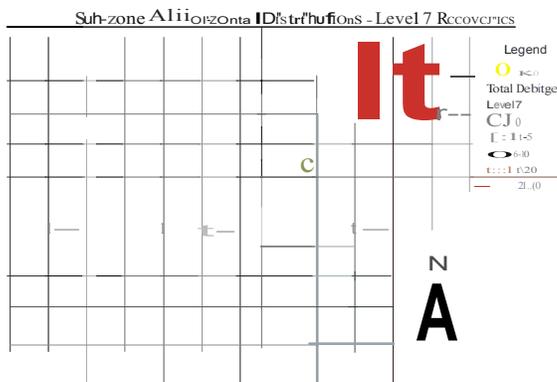
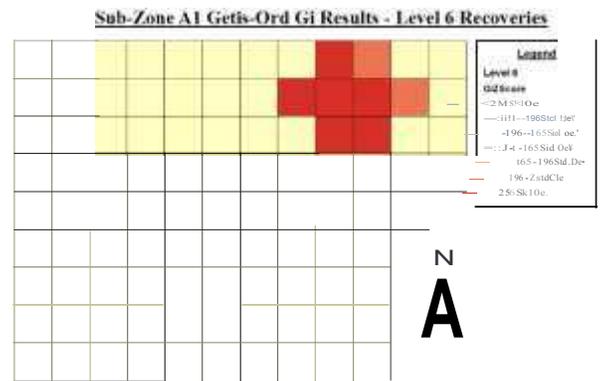
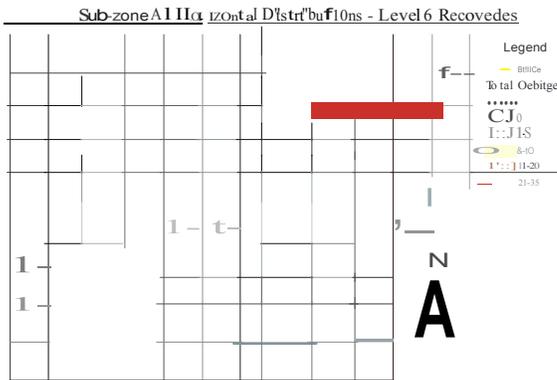
7.3.4 A1: Horizontal Distributions: Recoveries by Level

The recovery of tools by level with corresponding debitage frequencies is shown in Figure 7.3.7. It is apparent that Level 1 exhibits a unique distribution with the highest concentrations of artifacts coming from the western portion of the sub-zone. As recovery levels progress, artifact distributions become concentrated within two cluster areas in the south-central and northeastern areas of the sub-zone; with a possible third area of high concentrations near the shared boundary with sub-zone A2. It should be noted that while limited recoveries exhibited by some distribution maps are not overly useful for the application of spatial statistics, Getis-Ord G_i results are illustrated regardless in order to maintain consistency throughout.

A1: Horizontal Distribution of Artifacts by Level







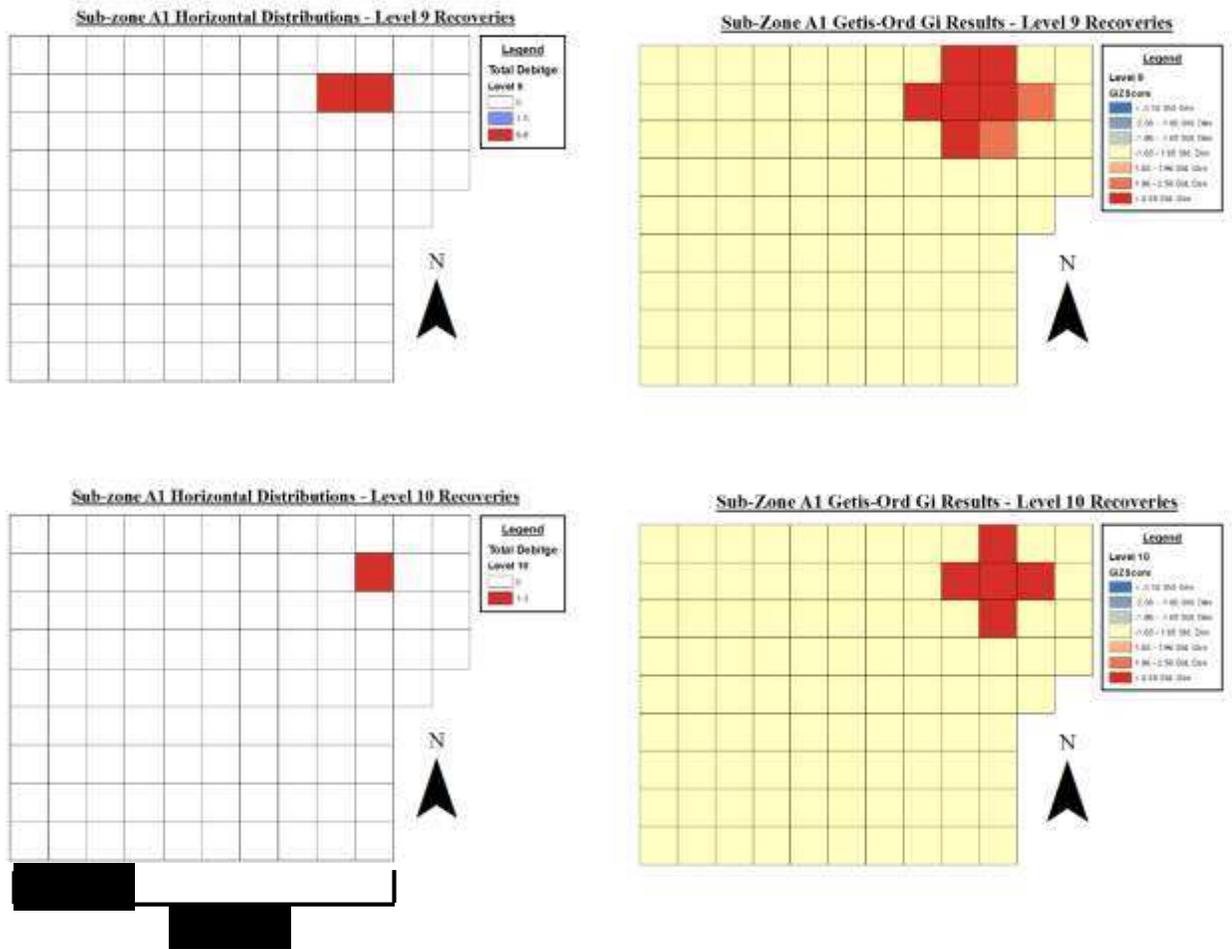


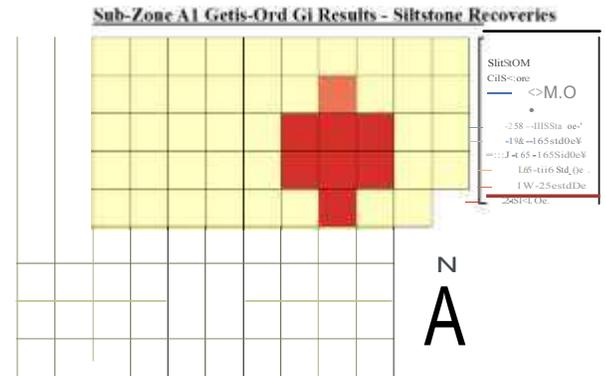
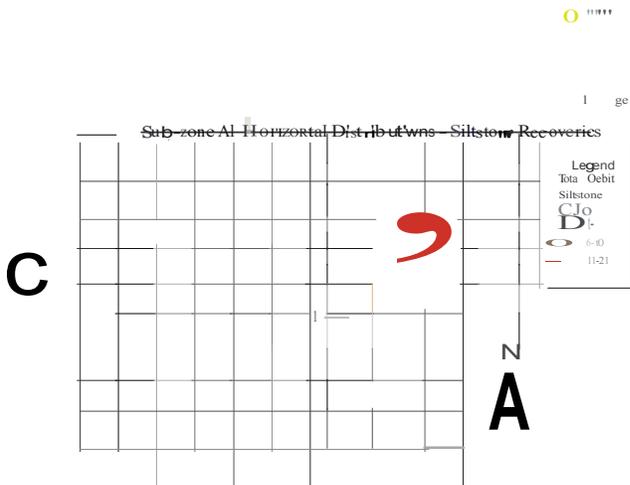
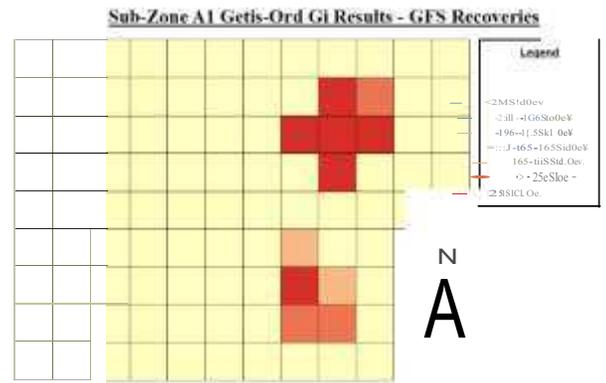
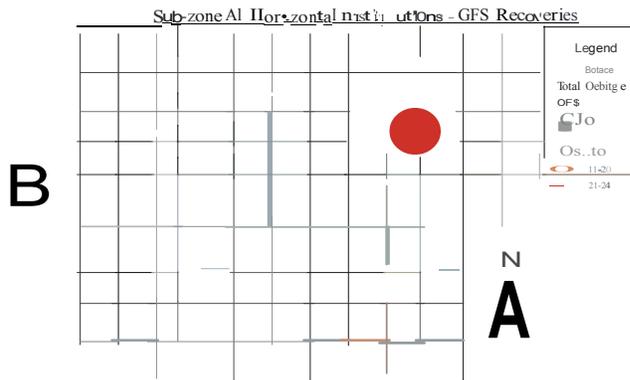
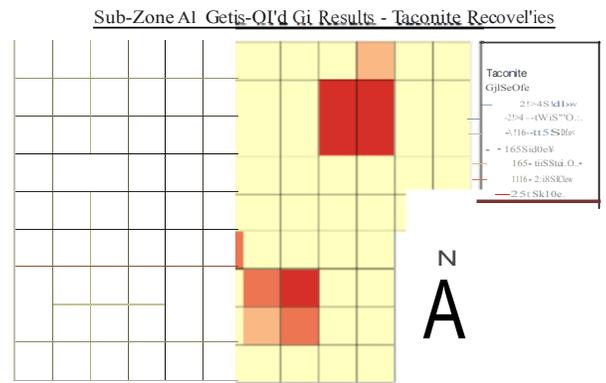
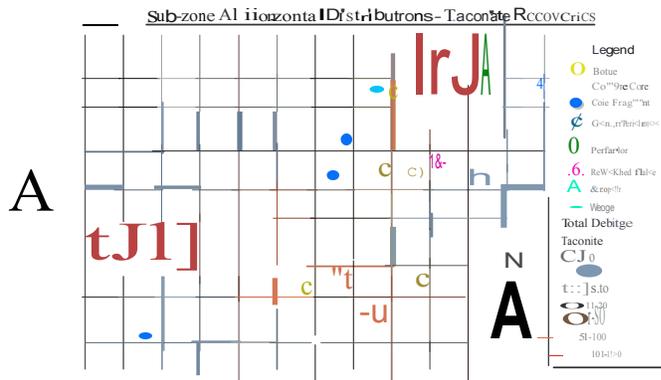
Figure 7.3.7: Sub-zone A1 recoveries by level – Frequency and Getis-Ord G_i . While levels yielding few artifact recoveries are generally not useful for the application of spatial statistics, Getis-Ord G_i results are illustrated for all levels in order to maintain consistency.

7.3.5 A1: Horizontal Distributions: Recoveries by Material Type

Material recoveries from sub-zone A1 consisted of taconite (Figure 7.3.8 A), gunflint silica (GFS - Figure 7.3.8 B), siltstone (Figure 7.3.8 C), chert (Figure 7.3.8 D), and quartz (Figure 7.3.8 E). While quartz and chert were the least frequently represented, their distribution appears to loosely coincide with high density recovery zones identified in Section 7.3.4. However, the low frequency of recovery limits the strength of this interpretation.

Siltstone recoveries, while also limited, were concentrated within the northern area of the sub-zone. Similarly, concentrations of gunflint silica were greatest near high density zones in the northern section of the sub-zone, with a secondary cluster to the south. Mapping taconite recoveries revealed clustering similar to those observed within level-by-level distributions, with a small cluster of artifacts near the southwestern edge of the sub-zone (likely correlating with Level 1 recoveries, Figure 7.3.9-A), and three clusters coinciding with high recovery rates in the northeast and central areas (Figure 7.3.9-B,C, and D).

A1: Artifact Distributions by Material



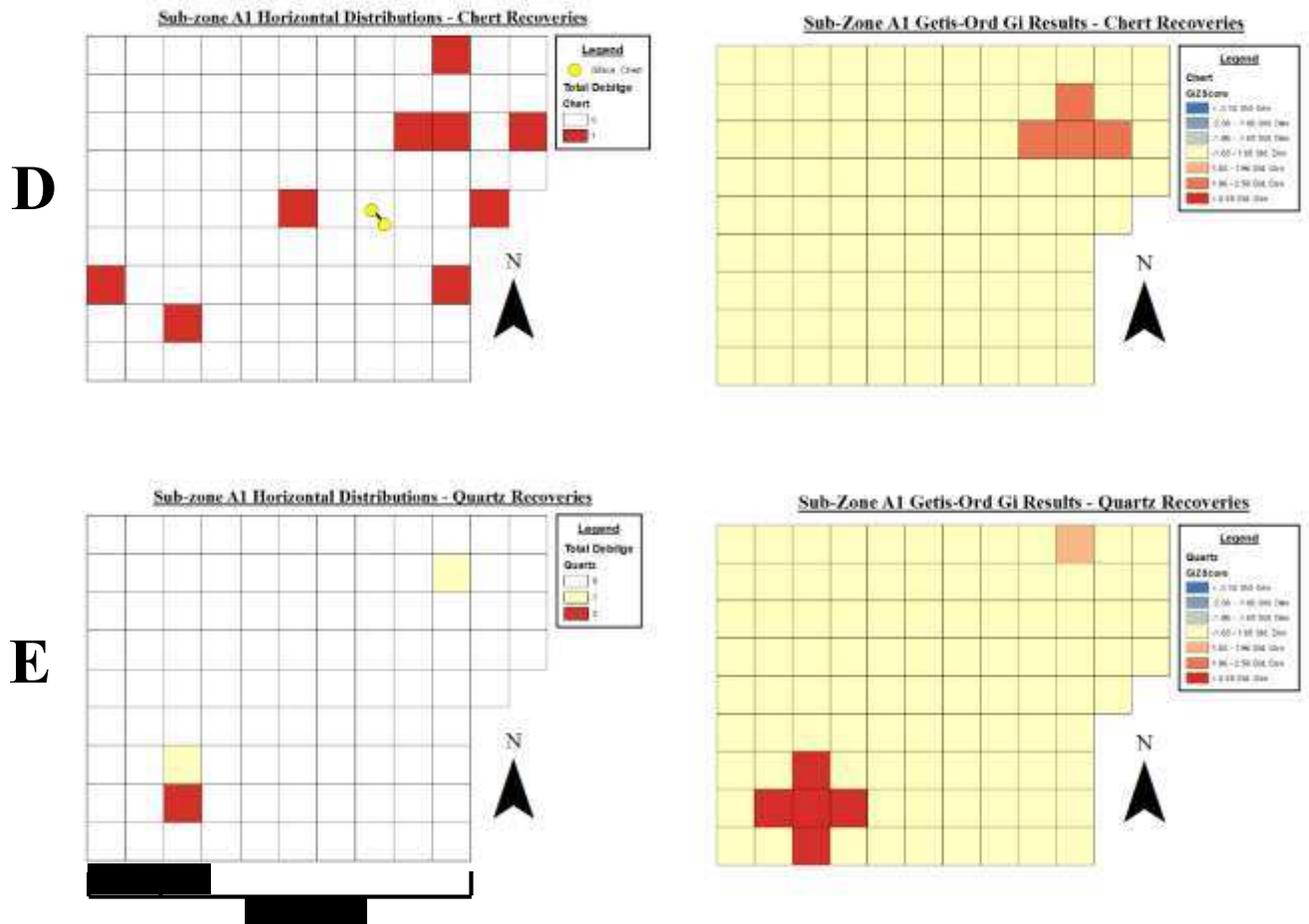


Figure 7.3.8: Sub-zone A1 artifact distributions by material type – Frequency and Getis-Ord G_i. A) Taconite, B) Gunflint Silica, C) Siltstone, D) Chert, and E) Quartz.

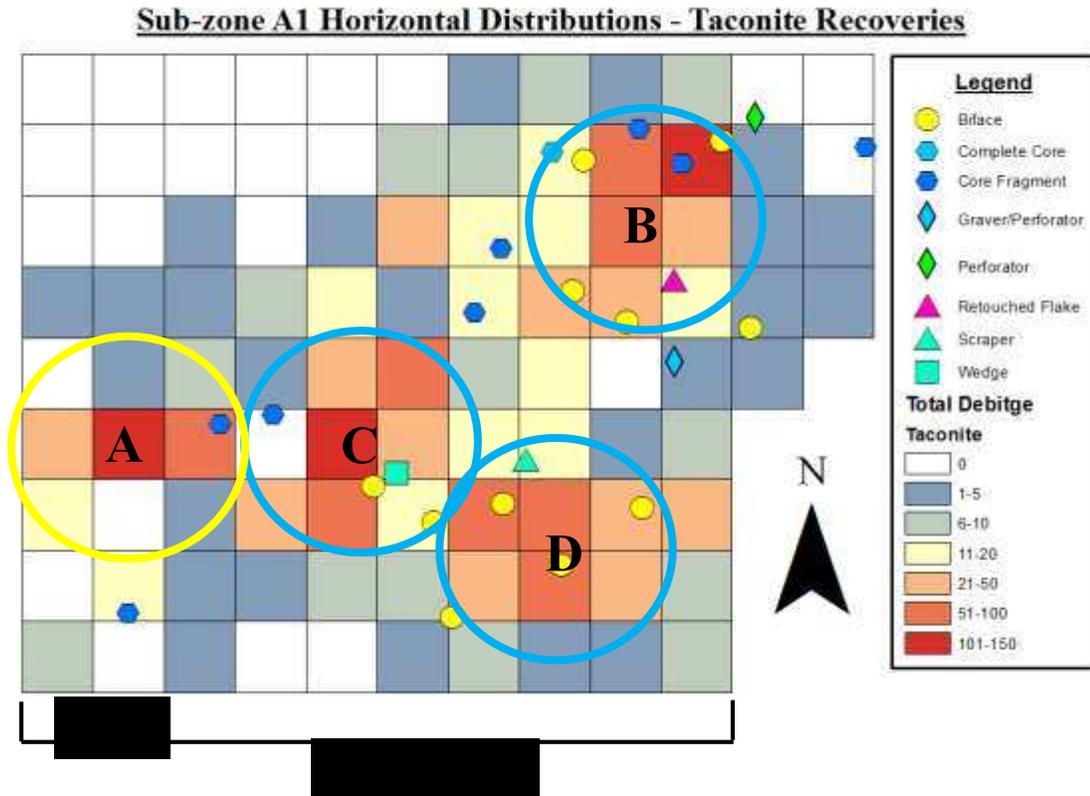


Figure 7.3.9: Artifact cluster identified through the mapping of taconite artifacts. Yellow represents clustering likely related to disturbed artifacts while blue represents clustering observed throughout vertical analysis. Clusters discussed in text as A) Western, B) Northeastern, C) South-central, and D) South-eastern.

7.3.6 A1: Horizontal Distributions: Debitage

Debitage distributions were mapped by both size grade and type in order to test if horizontal distributions were affected by different artifact characteristics.

Debitage Size

Debitage mapped by size exhibits concentrations forming discrete northern and southern clusters (Figure 7.3.10). In the northern cluster (Figure 7.3.9-B),debitage of all sizes appear to concentrate within the same area. Of note within these distributions is the

difference in the location of hot-spots within the southern concentrations between varying size grades. In smaller size grades (2-6mm and 6-12mm) concentrations occur near the shared A2 border (Figure 7.3.9-D), while larger size grades (12-25mm, 25-50mm, and 50+mm) are concentrated slightly to the left of this.

Distributions within the western portion of the sub-zone (Figure 7.3.9-A) appear to focus primarily around flakes within the smaller size range (2-6mm and 6-12mm), though some larger sized debitage does occur.

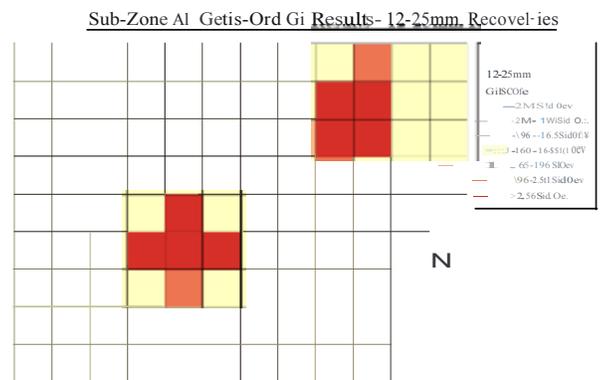
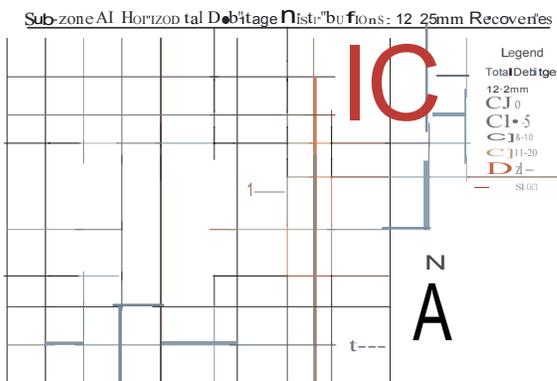
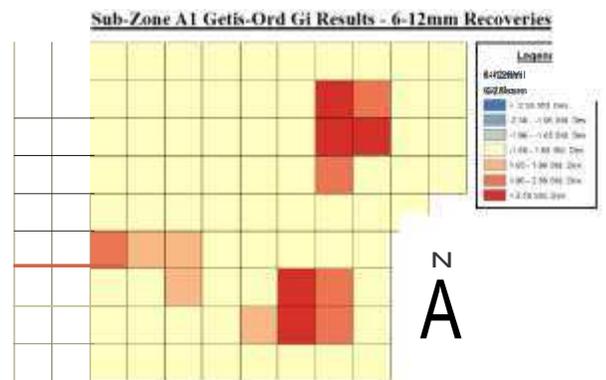
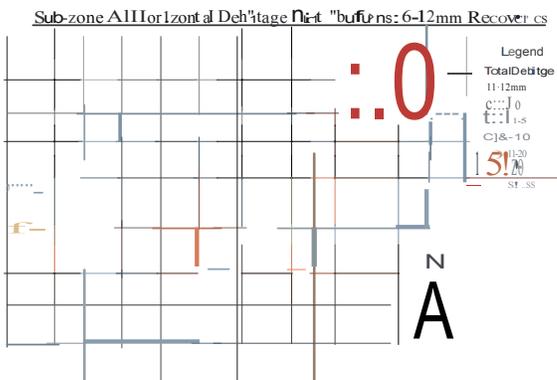
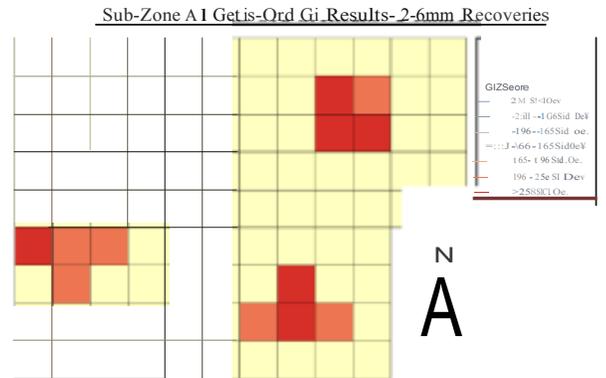
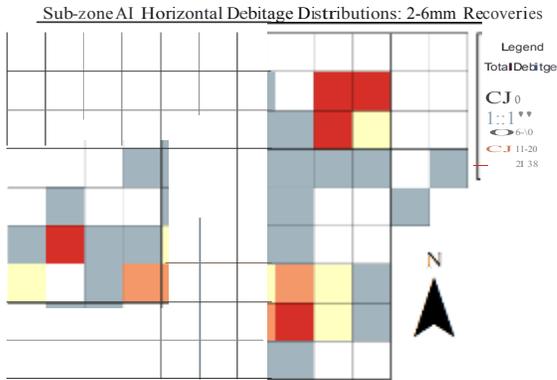
Debitage Type

The debitage types that were mapped included primary, secondary, tertiary, and undetermined flakes as well as shatter (Figure 7.3.11). Limited primary debitage was collected from sub-zone A1, although recovery concentrations appear to correspond loosely with northern and southern clusters (Figure 7.3.9-B, C, and D).

The recovery of secondary debitage best illustrates this distinction between the northern and southern clusters as two distinct clustering areas can be seen. The mapping results for secondary debitage also exhibit a split within the southern cluster recoveries, further suggesting that two clusters may be present (Figure 7.3.11).

To a lesser extent tertiary and undetermined debitage exhibit this similar pattern between northern and southern clustering. Highest concentrations for tertiary debitage, however, occur along the western edge of the sub-zone. Meanwhile, the strongest concentrations of lithic shatter occur within the northern area of the sub-zone with lesser amounts in the southern clusters.

A1: Horizontal Distribution of Debitage by Size



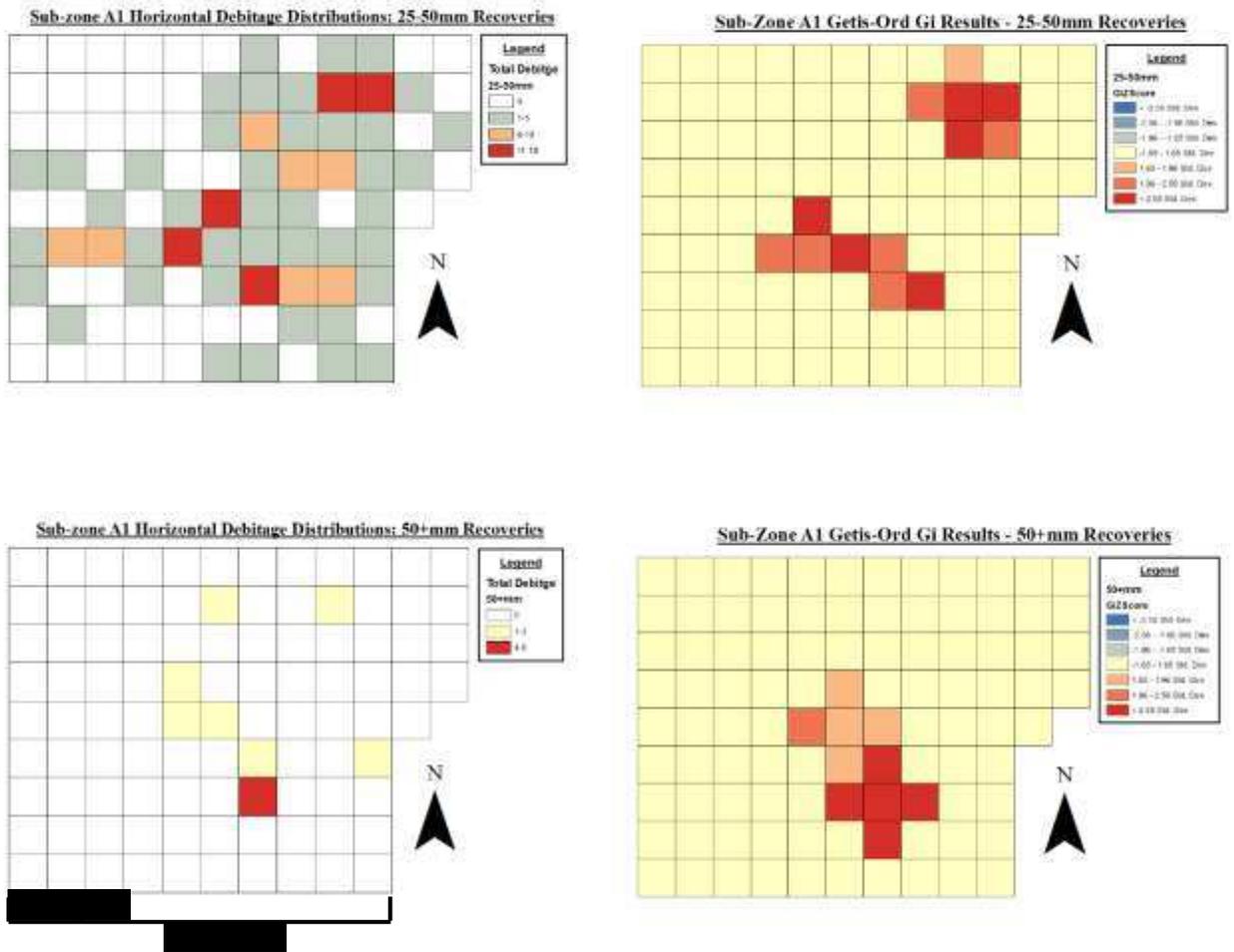
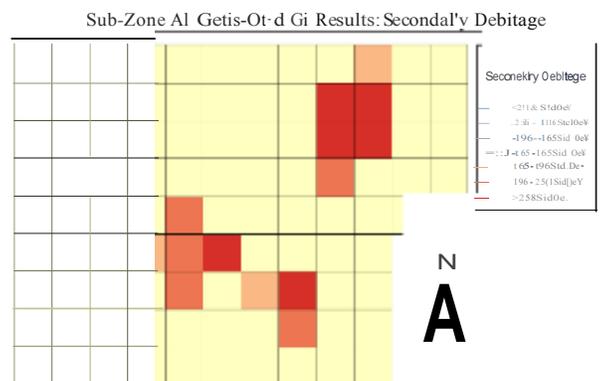
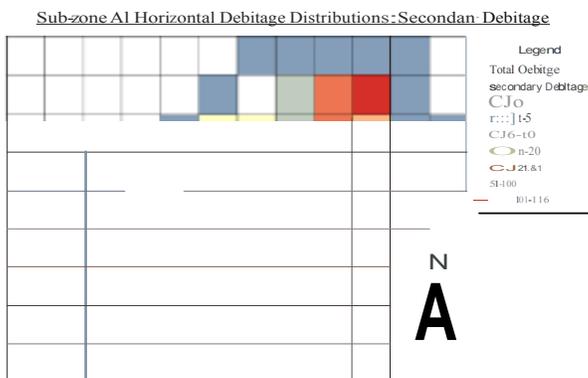
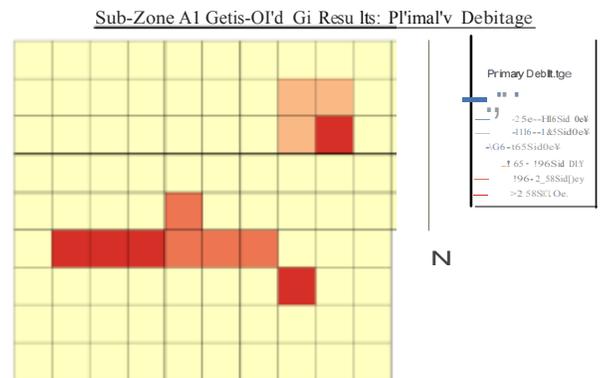
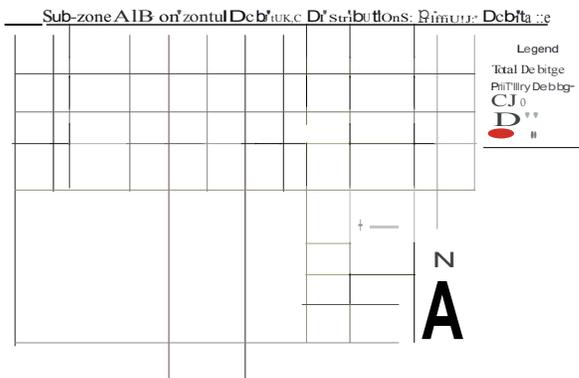
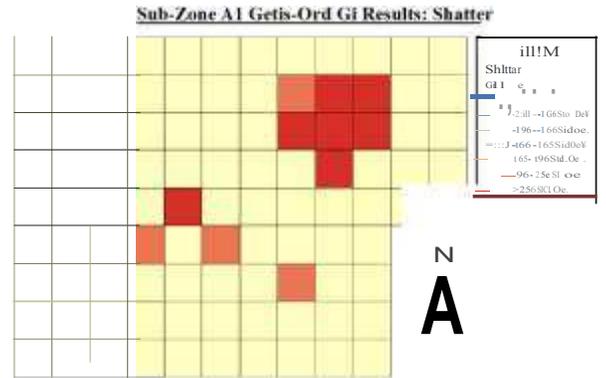
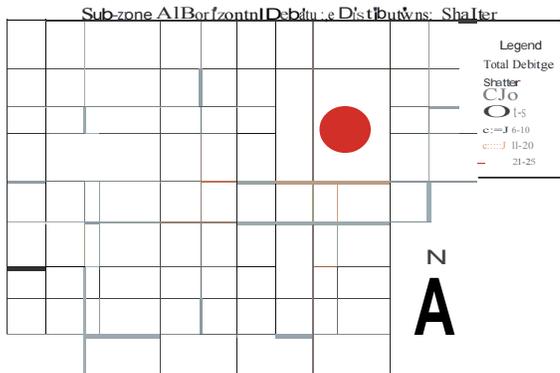


Figure 7.3.10: Debitage distributions by size grade – Frequency and Getis-Ord G_i^* .

A1: Horizontal Distribution of Debitage by Type



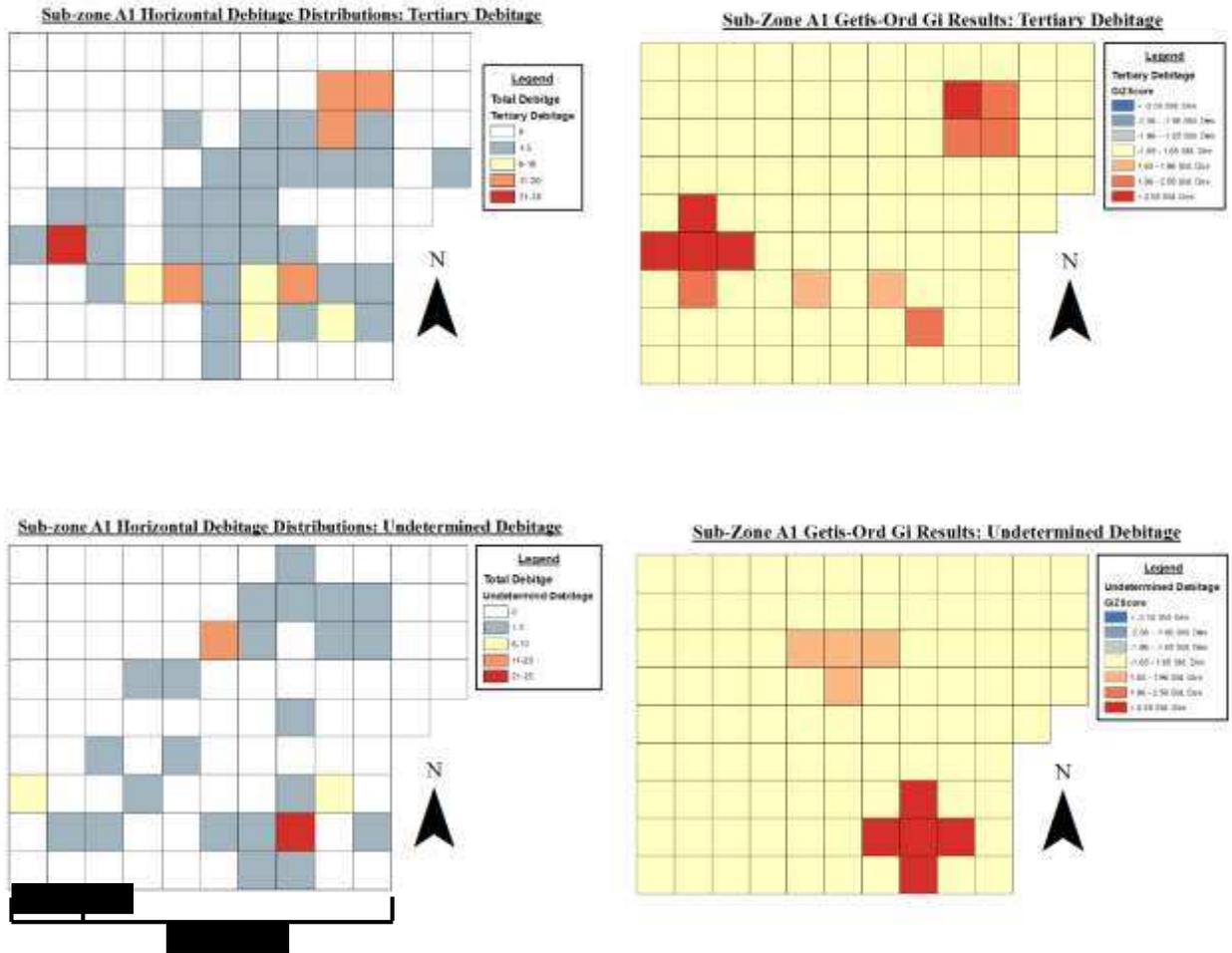


Figure 7.3.11: Debitage distributions by type – Frequency and Getis-Ord G_i.

7.3.7 A1: Horizontal Distributions: Tools

The distribution of all tool recoveries for sub-zone A1 is shown in Figure 7.3.12.

While a variety of tools were recovered, cores and bifaces were the most abundant.

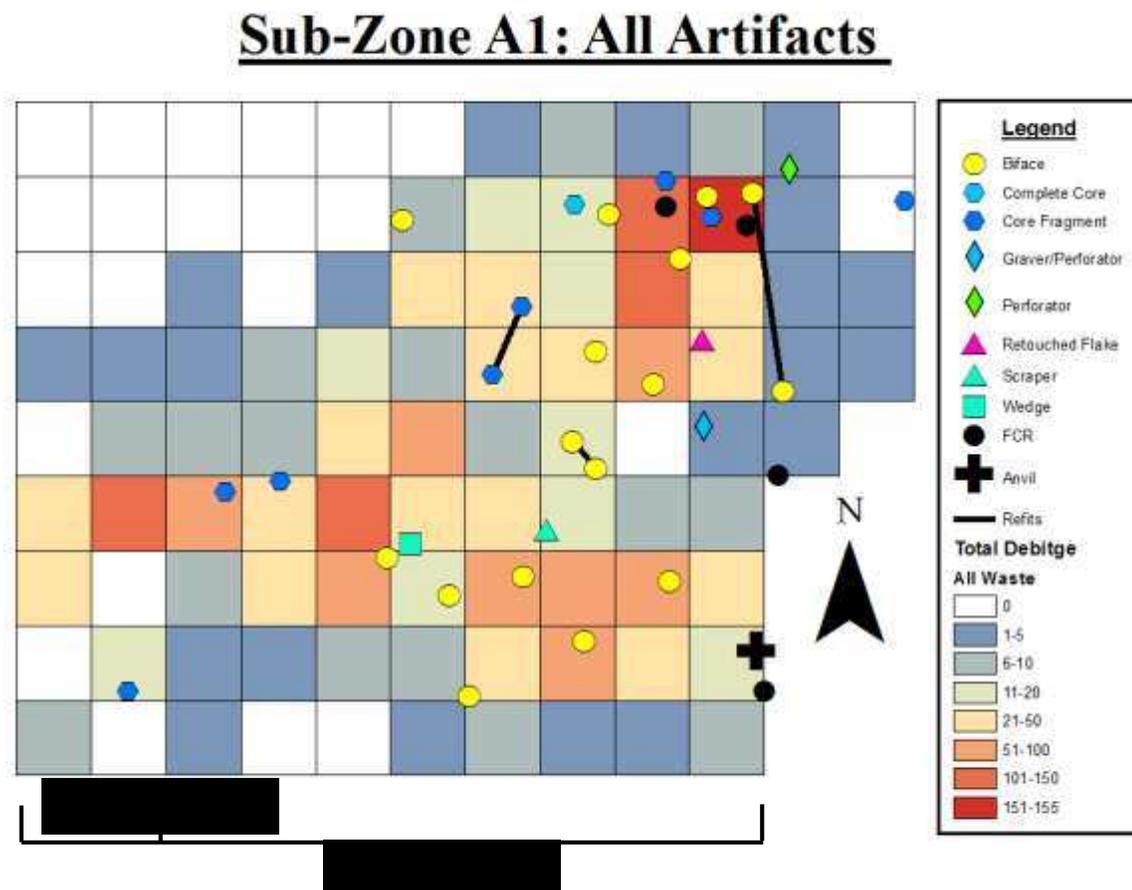


Figure 7.3.12: Distribution of all tool recoveries from sub-zone A1 with total debitage by quadrat.

Cores

Cores recovered from sub-zone A1 can be seen in Figure 7.3.13. While affected by small recovery numbers, the distribution of cores appears to correlate with both the northern and southern cluster areas. Core recoveries by level indicate that one outlier, located within the southwestern corner of the sub-zone, was recovered from the site

surface. There does not appear to be a correlation to core cortex and location as cortex types are comingled across the sub-zone.

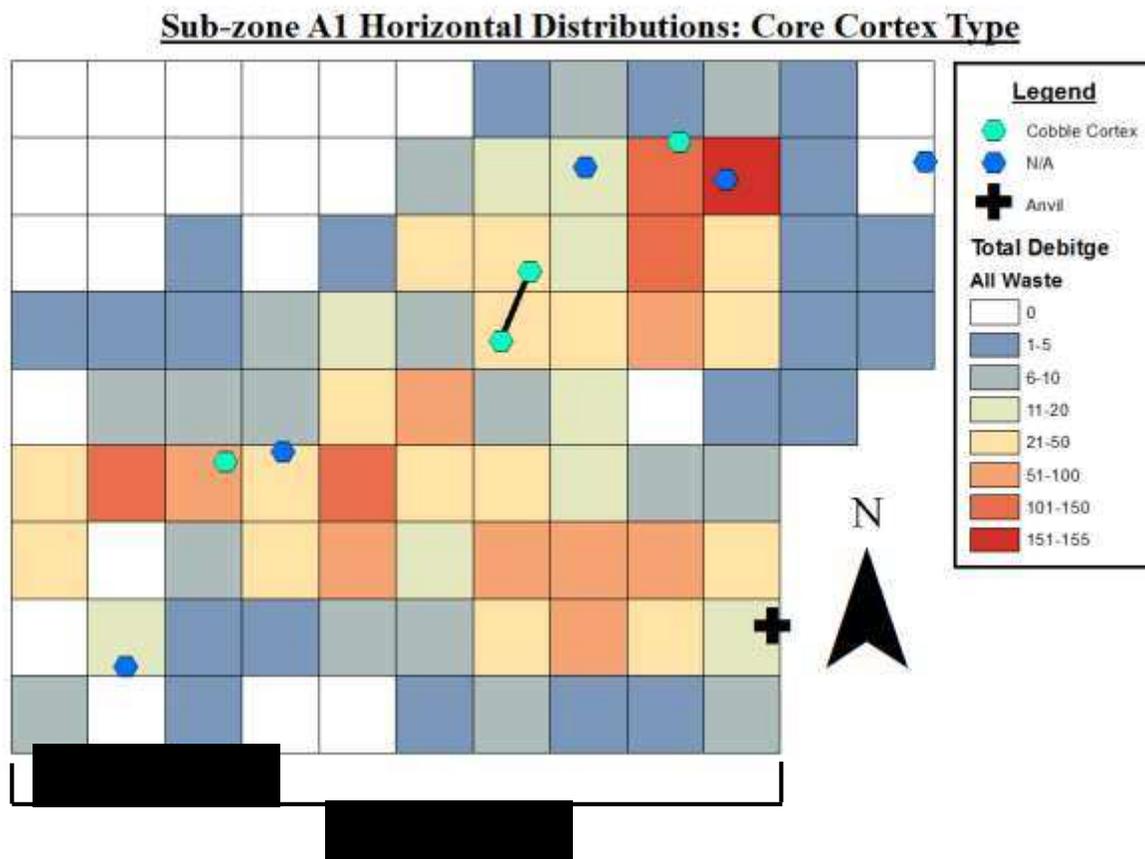


Figure 7.3.13: Distribution of sub-zone A1 cores by cortex type and level.

Bifaces

The distribution of bifaces can be seen in Figures 7.3.14 (bifaces by level) and 7.3.15 (bifaces by stage). Similar to core distributions, bifaces appear to be concentrated in relation to the northern (B) and southern (C and D) debitage clusters.

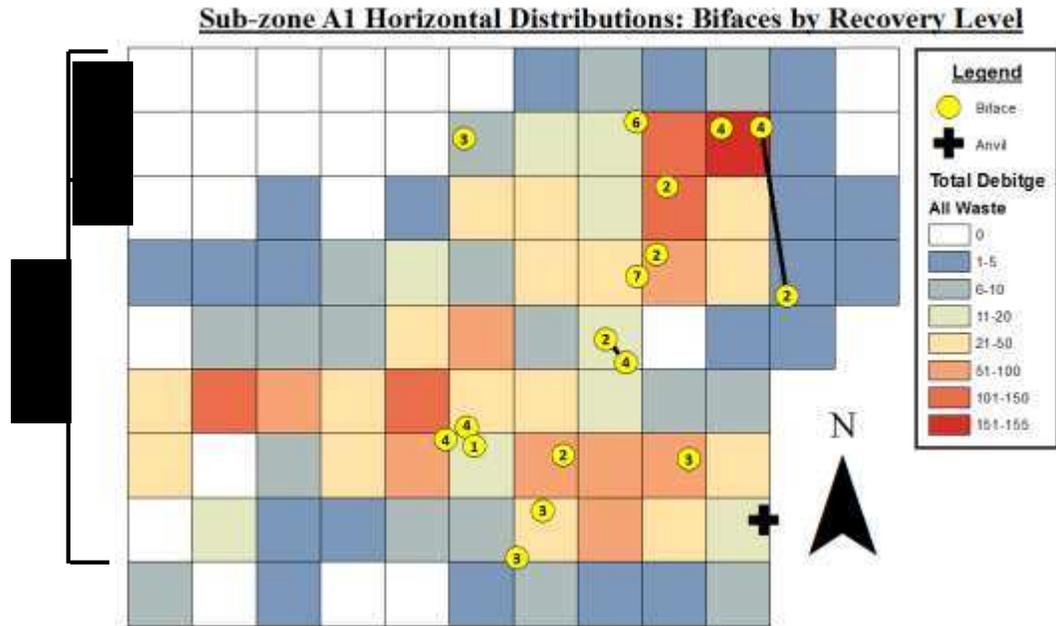


Figure 7.3.14: Distribution of sub-zone A1 bifaces by level (indicated within yellow circle).

Biface location does not appear to exhibit any pattern in relation to stage of production. It can be noted that Stage 4 bifaces appear to be limited to the northern cluster area, however with only two recoveries this does not represent a pattern.

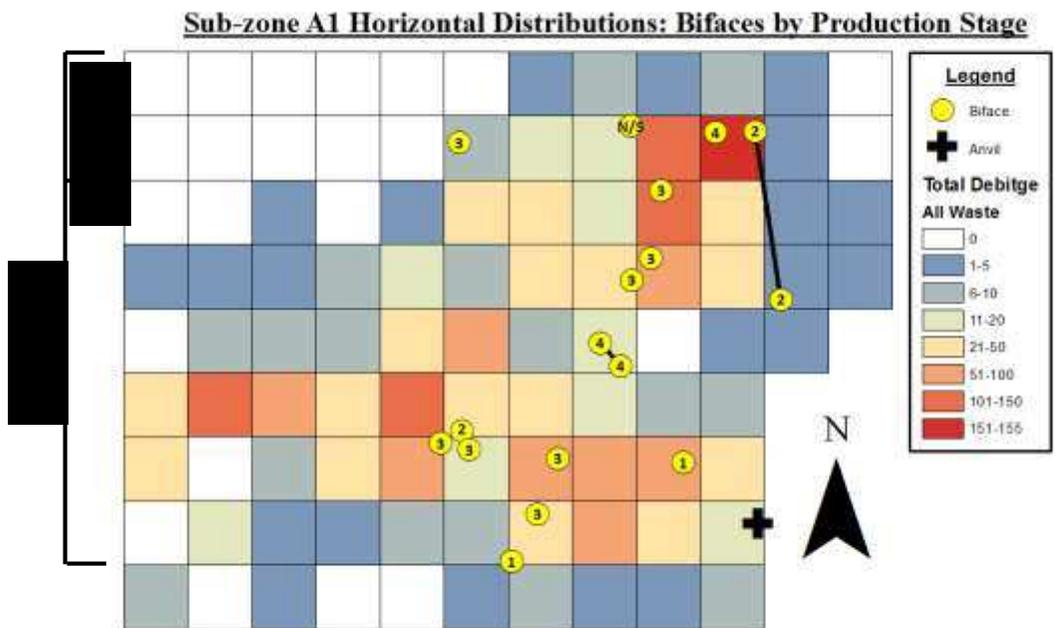


Figure 7.3.15: Distribution of sub-zone A1 bifaces by production stage (indicated within yellow circle).

Tool Refits

Three tool fragments refit within sub-zone A1. These included one core and two bifaces (see Figure 7.3.12). Two of these refits occur within a relatively short distance from one another, either in the same or adjacent quadrat. The third refit occurs over a slightly greater distance, but remains within the debitage cluster area.

Vertical separation between refitted artifacts varied. The refit core pieces were recovered from one level apart (0-10cm vertically), while biface refits were recovered from three levels apart (10-15cm vertically).

General Tool Distributions

Other tool recoveries from within sub-zone A1 appear to occur at random (see Figure 7.3.12). This is due largely to the limited number of tools recovered. The anvil stone located within the southeastern corner of the sub-zone is shared with sub-zone A2 and will be further discussed in section 7.4.7. While the anvil stone from sub-zone A1 is located near high debitage recoveries within the southern clusters, it does not occur in direct proximity limiting interpretations of direct association.

7.3.8 A1: NSG Results

The results from NSG do not appear to indicate that any substantial magnetic anomalies are present within the A1 sub-zone. However, a slightly higher magnetic reading does occur within the upper northeast corner of the sub-zone, in the general vicinity of highest artifact clustering (Figure 7.3.16).

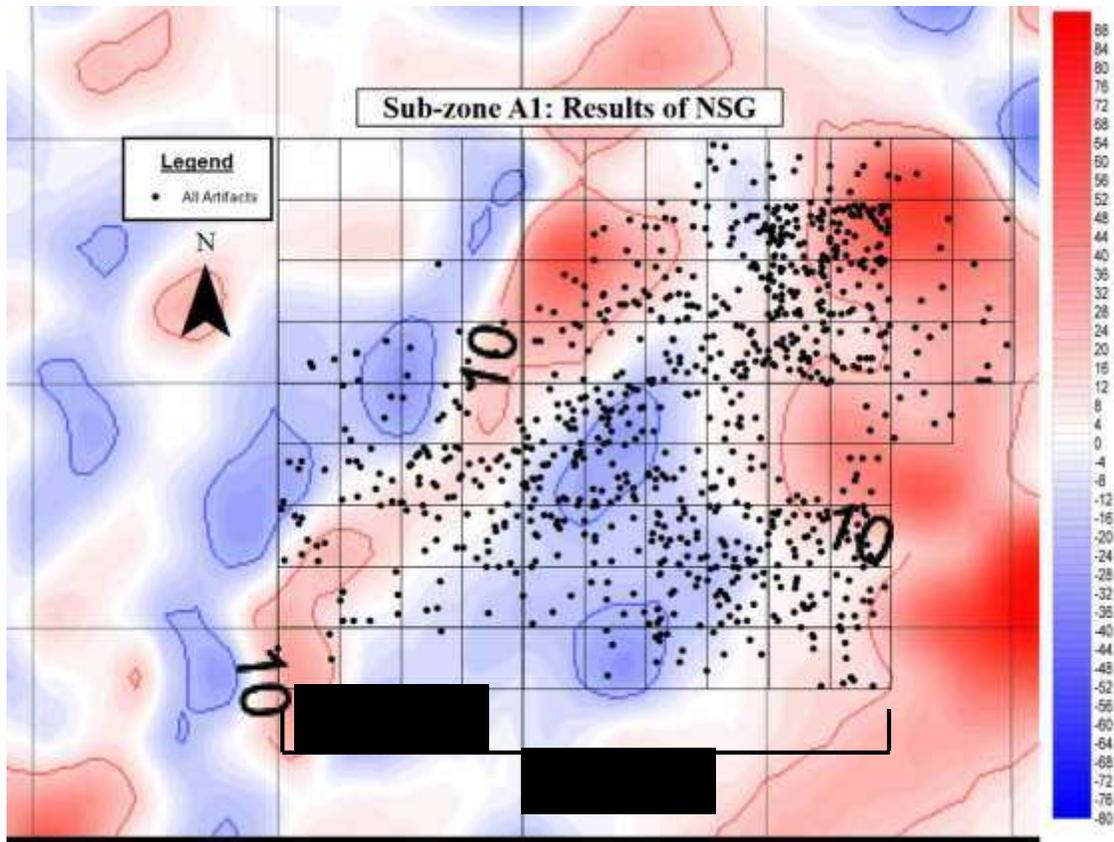


Figure 7.3.16: NSG results in relation to sub-zone A1.

7.4 *Sub-Zone: A2*

Sub-zone A2 consisted of a tightly clustered concentration of lithic debris in the northeastern portion of the site (Figure 7.4.1). This sub-zones contained cluster 4 and covered 94 50 x 50cm quadrats, overlapping along its western side with sub-zone A1.

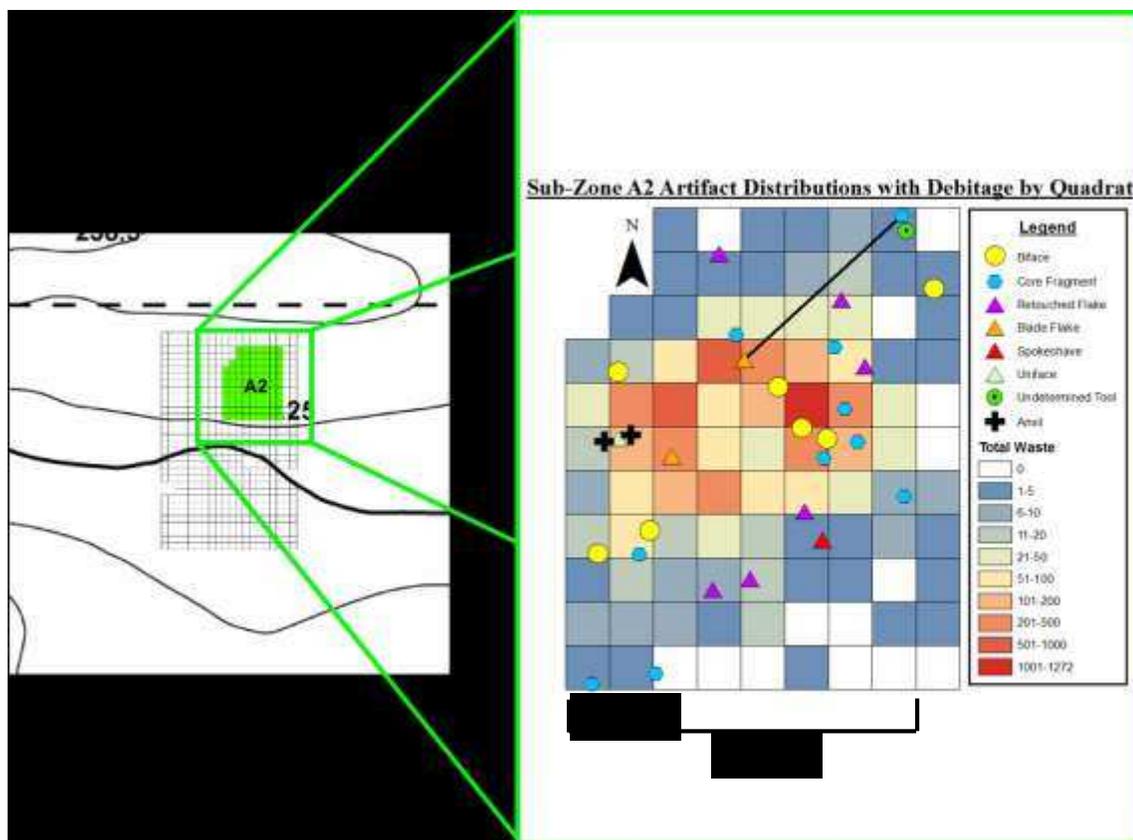


Figure 7.4.1: Sub-zone in relation to topography with a close up of sub-zone A2 illustrating all tool recoveries with total debitage by quad.

7.4.1 A2: Artifact Recoveries

A total of 6,446 artifacts were recovered from sub-zone A2. This included 30 tools (frequency = 33) consisting of ten cores, seven bifaces, six retouched flakes, two blade flakes, one spokeshave, one uniface, and one undetermined tool (possible biface fragment)(Table 7.4.1).

Many of the recovered tools did not exhibit a clear function. Retouched flakes within sub-zone A2 consisted of three incidental retouched tools and three intentionally retouched tools. As previously discussed, the artifact identified as a ‘spokeshave’ may

have also taken this form unintentionally. Meanwhile, cores and bifaces were further broken down into core cortex type (Table 7.4.2) and biface stage (Table 7.4.3).

A total of 6,378 lithic waste pieces were recorded for sub-zone A2. A breakdown of their type, size, and material type can be seen in Tables 7.4.4, 7.4.5, and 7.4.6, respectively.

Table 7.4.1: All tool recoveries from sub-zone A2

A2: TOOLS	
TYPE	Frequency
ANVIL	2
CORES	10 (11)
BIFACE	7
RETOUCHED FLAKES	6 (7)
BLADE FLAKES	2
SPOKESHAVE	1 (2)
UNIFACE	1
UNDETERMINED	1

Table 7.4.2: Results of cortex identification for sub-zone A2.

A2: CORES	
CORTEX	Frequency
N/A	7 (8)
COBBLE	2
TABULAR	1

Table 7.4.3: Result of biface staging for sub-zone A2 following Bennett (2015)

A2: BIFACES	
STAGE	Frequency
N/S	0
1	1
2	1
3	4
4	1
5	0
6	0

Table 7.4.4: Debitage frequencies by type

A2: DEBITAGE TYPE	
PRIMARY	58
SECONDARY	4337
TERTIARY	1023
UNDETERMINED	553
SHATTER	407

Table 7.4.5: Debitage frequencies by material

A2: DEBITAGE	
SIZE	Frequency
0-2MM	17
2-6MM	1605
6-12MM	2881
12-25MM	1571
25-50MM	290
50+MM	14

Table 7.4.6: Debitage frequencies by size grades

A2: DEBITAGE MATERIAL	
TACONITE	6237
GFS	98
CHERT	13
SILTSTONE	10
QUARTZ	4
OTHER	16

7.4.2 A2: Vertical Distribution

The vertical distribution of artifacts in sub-zone A2 peak in level 3, with the balance of recoveries being from level 2 to 5 (Figure 7.4.2). This general trend is observed for all artifact size grades (Figure 7.4.3)

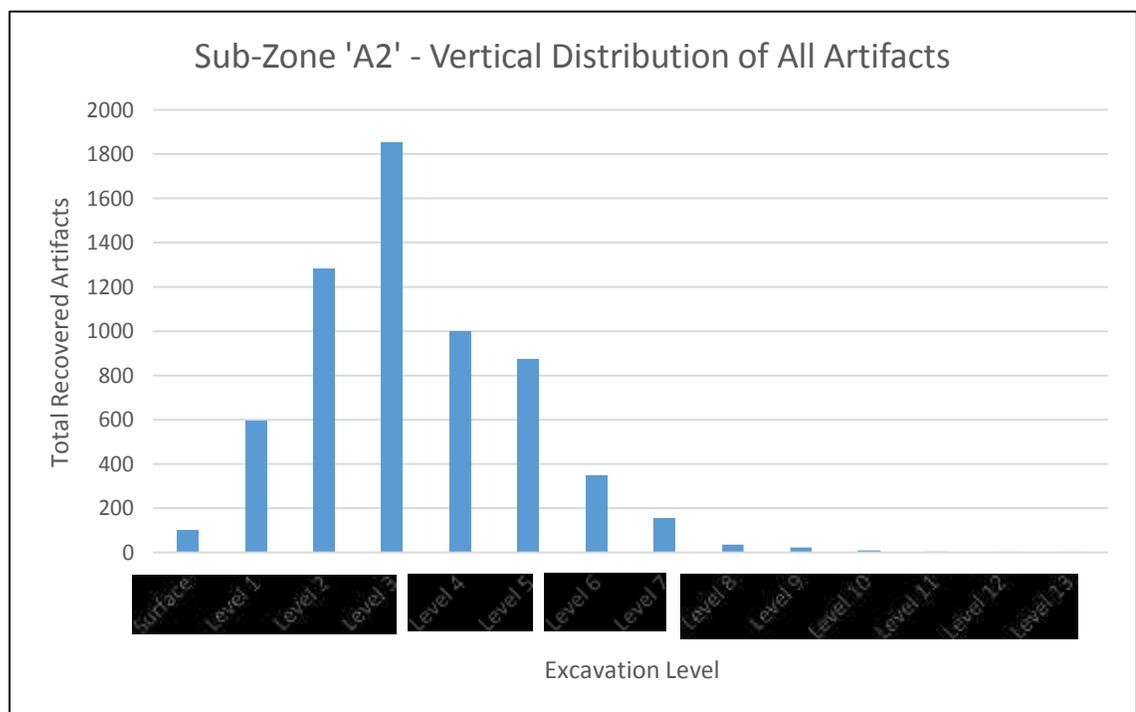


Figure 7.4.2: Total artifact recoveries by level indicating highest artifact clustering around level 3.

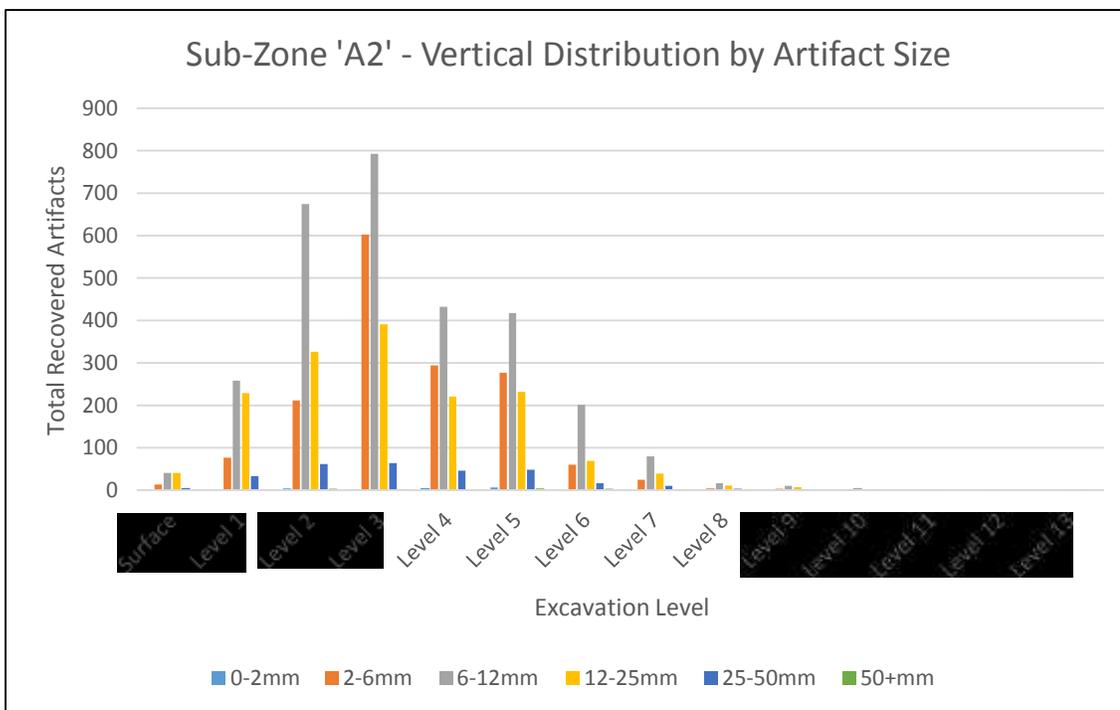


Figure 7.4.3: Total artifact recoveries by size and level.

7.4.3 A2: Horizontal Distribution: General

The results of statistical analysis indicate that there is significant artifact clustering within sub-zone A2. Both nearest neighbour (conducted on all artifacts) and Getis-Ord G_i^* (conducted on debitage) indicate that there is a less than 1% chance that the observed artifact distribution is the result of random chance (Figures 7.4.4 and 7.4.5). This is supported by the results from Ripley's K function (Figure 7.4.6).

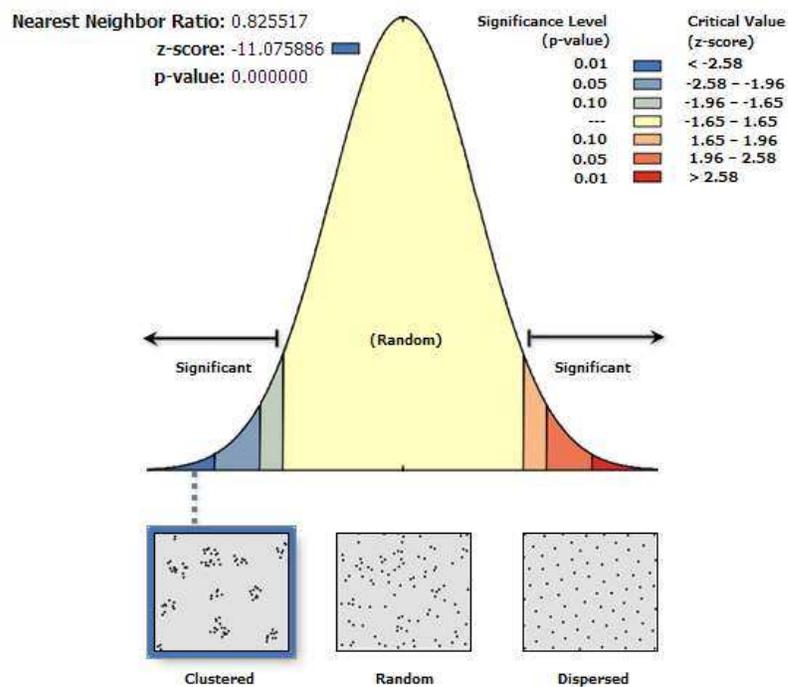


Figure 7.4.4: Results of nearest neighbour analysis indicating that at a z-score of -11.075886 there is a less than 1% chance that the observed distribution is the result of random chance.

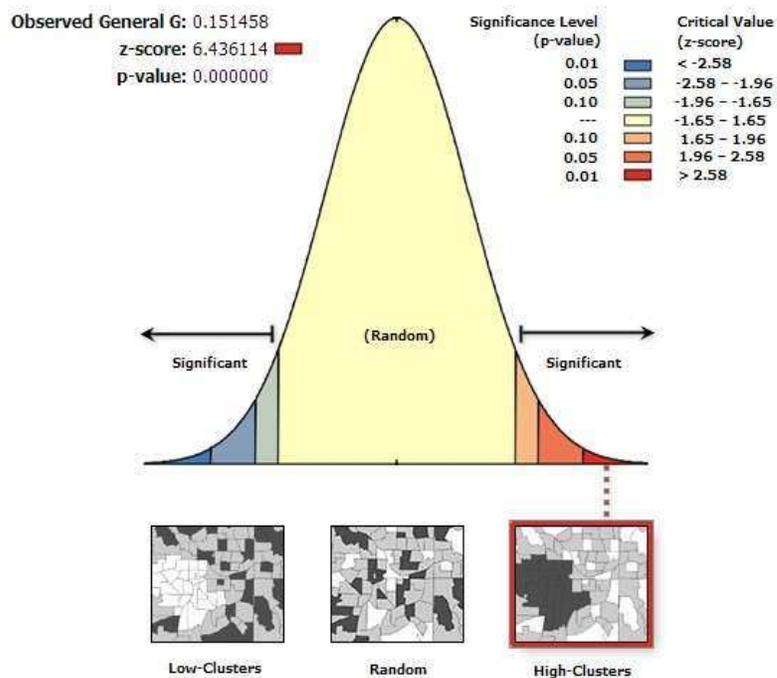


Figure 7.4.5: Results of Getis-Ord G_i analysis indicating that at a z-score of 6.436114 there is a less than 1% chance that the observed distribution is the result of random chance.

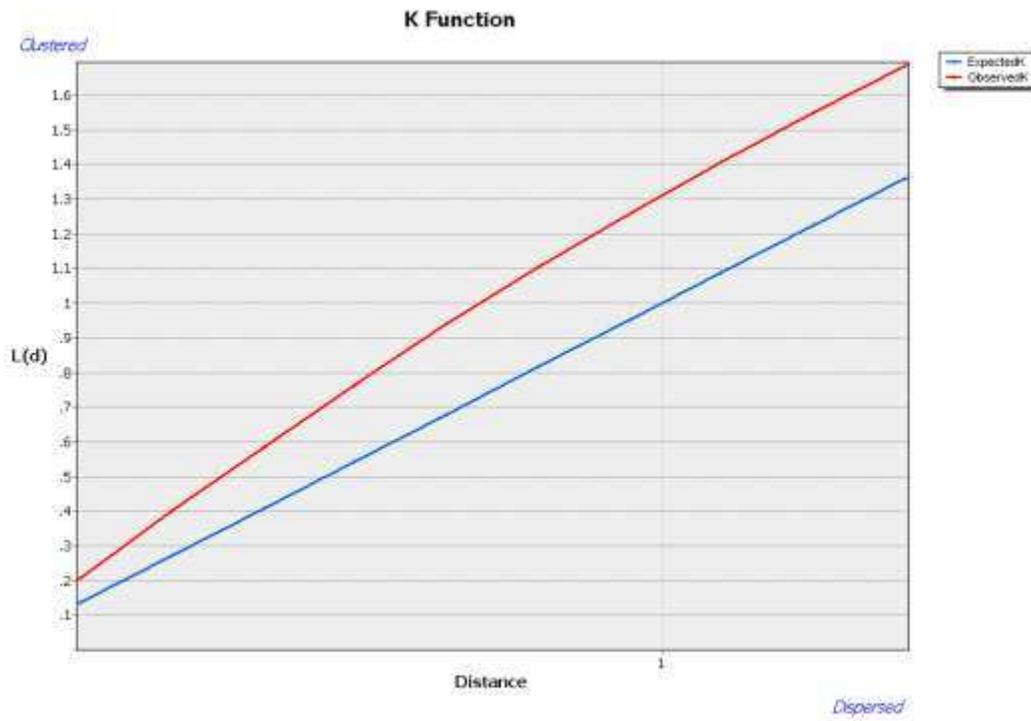


Figure 7.4.6: Graph of Ripley's K function analysis illustrating that the observed distribution is likely the result of a clustered distribution.

7.4.4 A2: Horizontal Distribution: Recoveries by Level

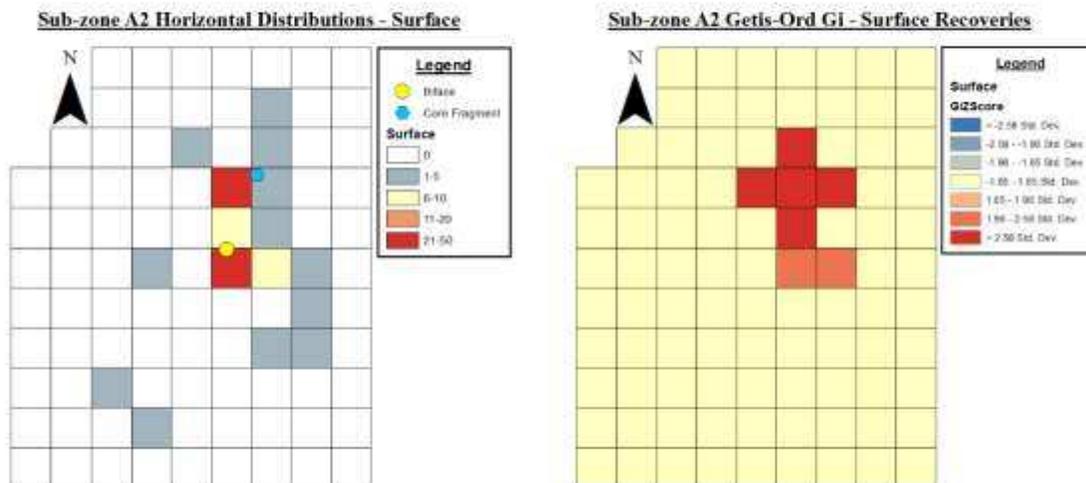
Artifact distributions by level indicate a high degree of clustering located within the central area of the sub-zone (Figure 7.4.7). As excavation levels progress, the densest artifact concentrations transition from the upper right of the cluster area, towards the bottom left. Re-assessing original field excavation notes suggest that some differences in the amount of organic overburden may be responsible for changes in level designation of artifacts, as different excavators/ excavation floors resulted in varying placements of datum strings. This could result in some variations as to when artifacts would have been encountered. Overall, greatest artifact concentrations occur within levels 2-4.

7.4.5 A2: Horizontal Distribution: Recoveries by Material Type

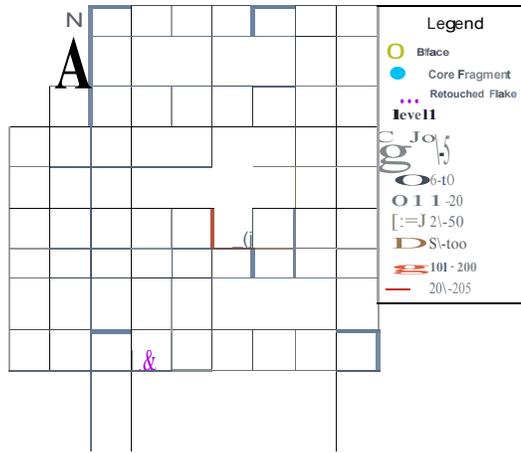
Materials recovered from sub-zone A2 included taconite, gunflint silica, siltstone, chert, quartz, mudstone, and amethyst (Figure 7.4.8 A-G). In sub-zone A2, the use of siltstone, chert, quartz, and amethyst appears to have been extremely limited. While most of these recoveries appear to come from within the area of artifact clustering, chert debitage generally occurred towards the north of the sub-zone.

Taconite recoveries were the most prominent within sub-zone A2, and cluster strongly within the centre. The highest proportion of taconite artifacts were recovered in the northeast of this central cluster. Meanwhile, gunflint silica recoveries occur along the northern portion of the high density cluster zone.

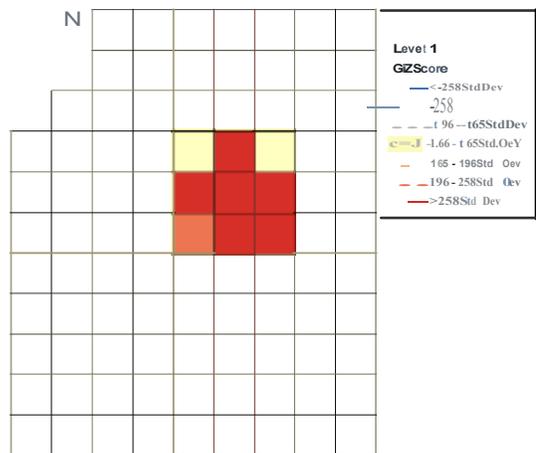
A2: Horizontal Distribution of Artifacts by Level



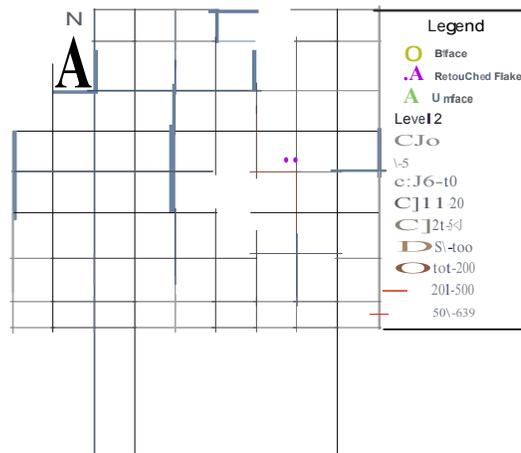
Sub-zone A2 Horizontal Distributions - Level II



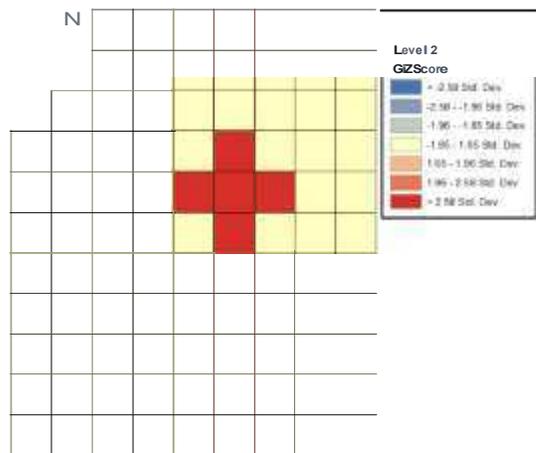
Sub-zone A2 Getis-Ord Gi - Level II Recoveries



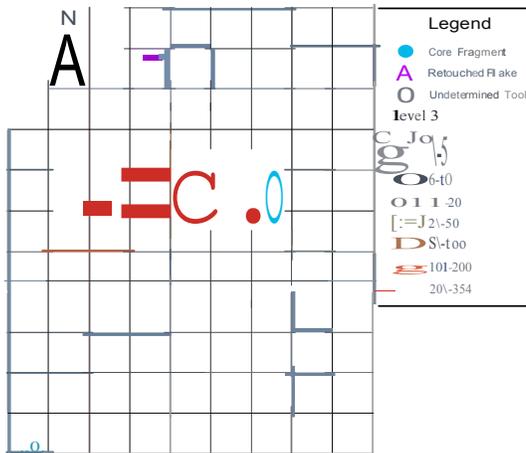
Sub-zone A2 Horizontal Distributions - Level 3



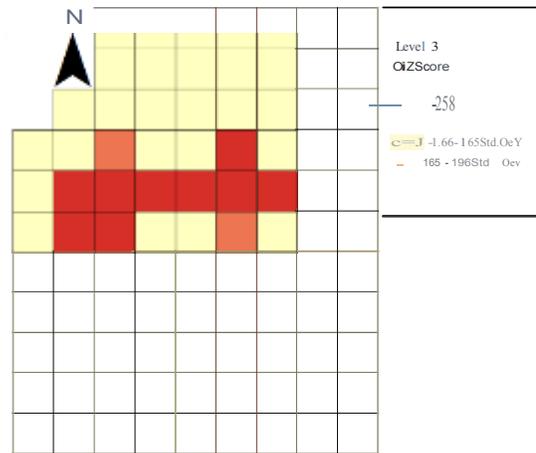
Sub-zone A2 Getis-Ord Gi - Level 2 Recoveries



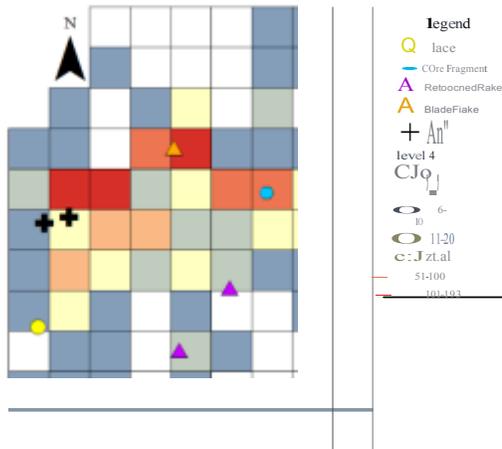
Sub-zone A2 Horizontal Distributions- Level 3



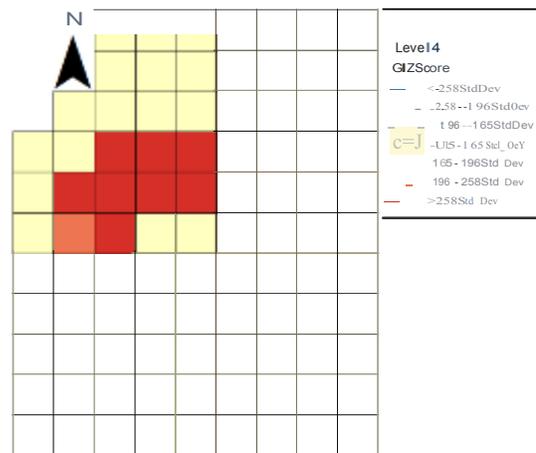
Sub-zone A2 Getis-Ord Gi -Level 3 Recoveries



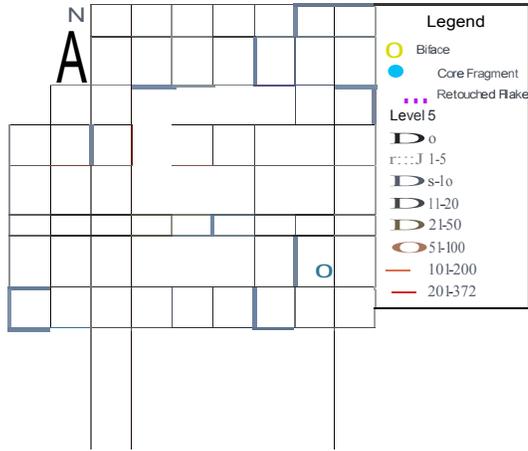
Sub-Zone A2 Horizontal Distributions - Level 4



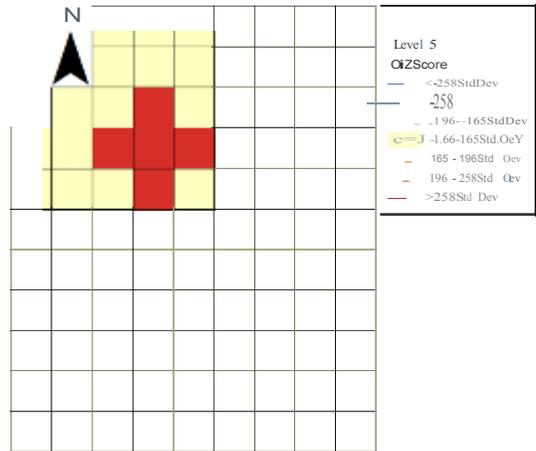
Sub-zone A2 Getis-Ord Gi -Level 4 Recoveries



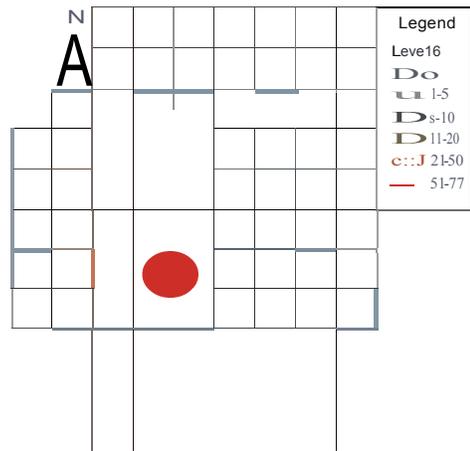
Sub-zone A2 Horizontal Distributions- Level 5



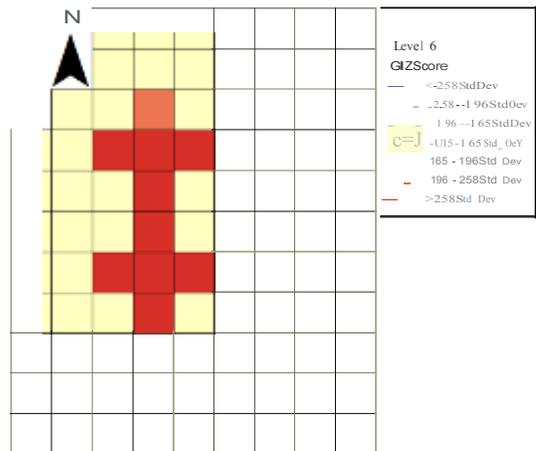
Sub-zone A2 Getis-Ord Gi - Level 5 Recoveries



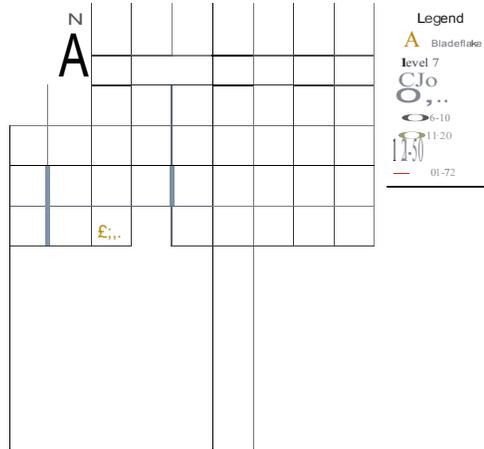
Sub-zone A2 Horizontal Distributions- Level 6



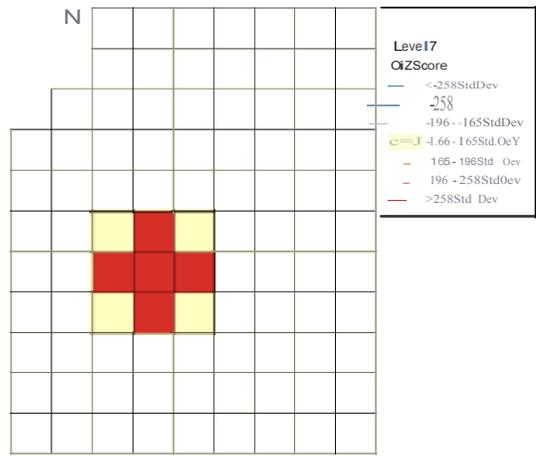
Sub-zone A2 Getis-Ord Gi -Level 6 Recoveries



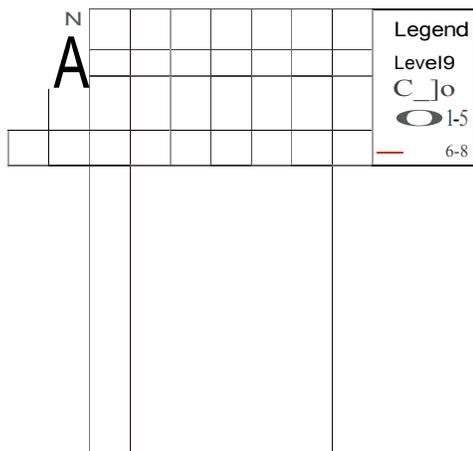
Sub-Zone A2 Horizontal Distributions - Level 7



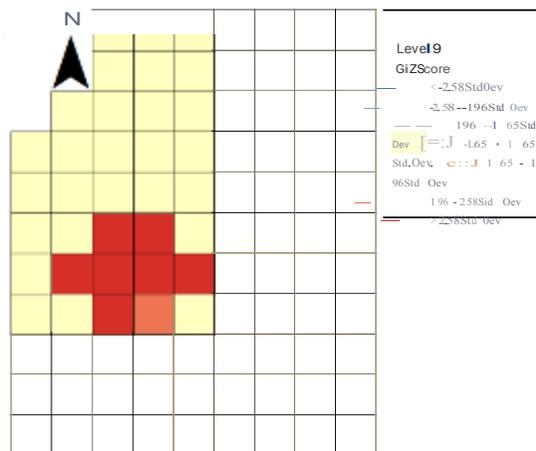
Sub-zone A2 Getis-Ord Gi -Level 7 Recoveries



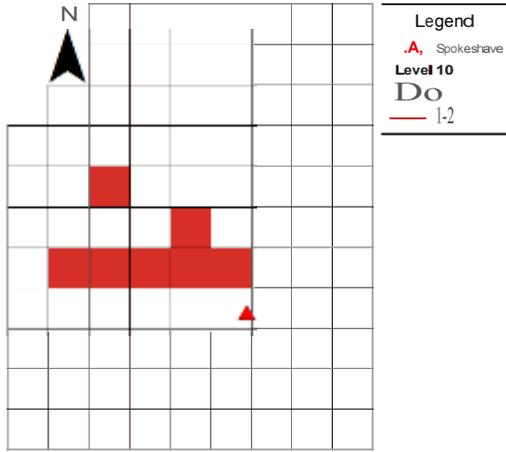
Sub-zone A2 Horizontal Distributions - Level 9



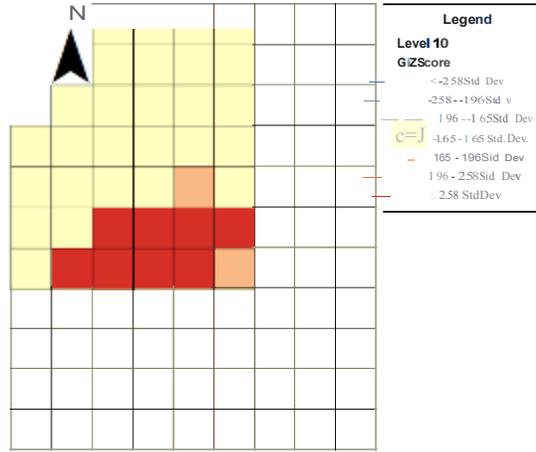
Sub-zone A2 Getis-Ord Gi -Level 9 Recoveries



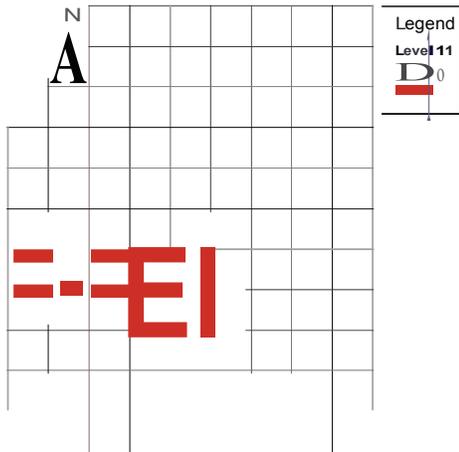
Sub-zone A2 Horizontal Distributions- Level10



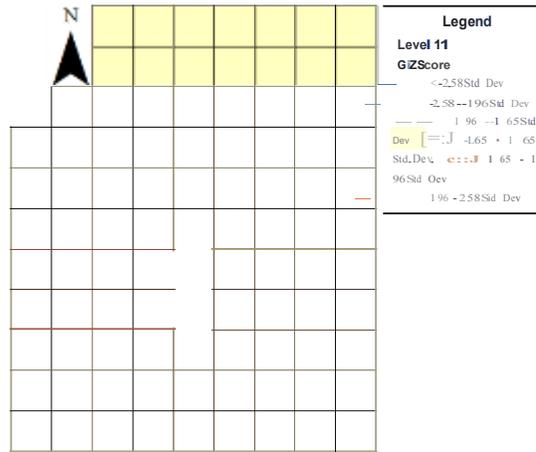
Sub-zone A2 Getis-Ord Gi - Level10 Recoveries



Sub-zone A2 Horizontal Distributions - Level 11



Sub-zone A2 Getis-Ord Gi - Level11 Recoveries



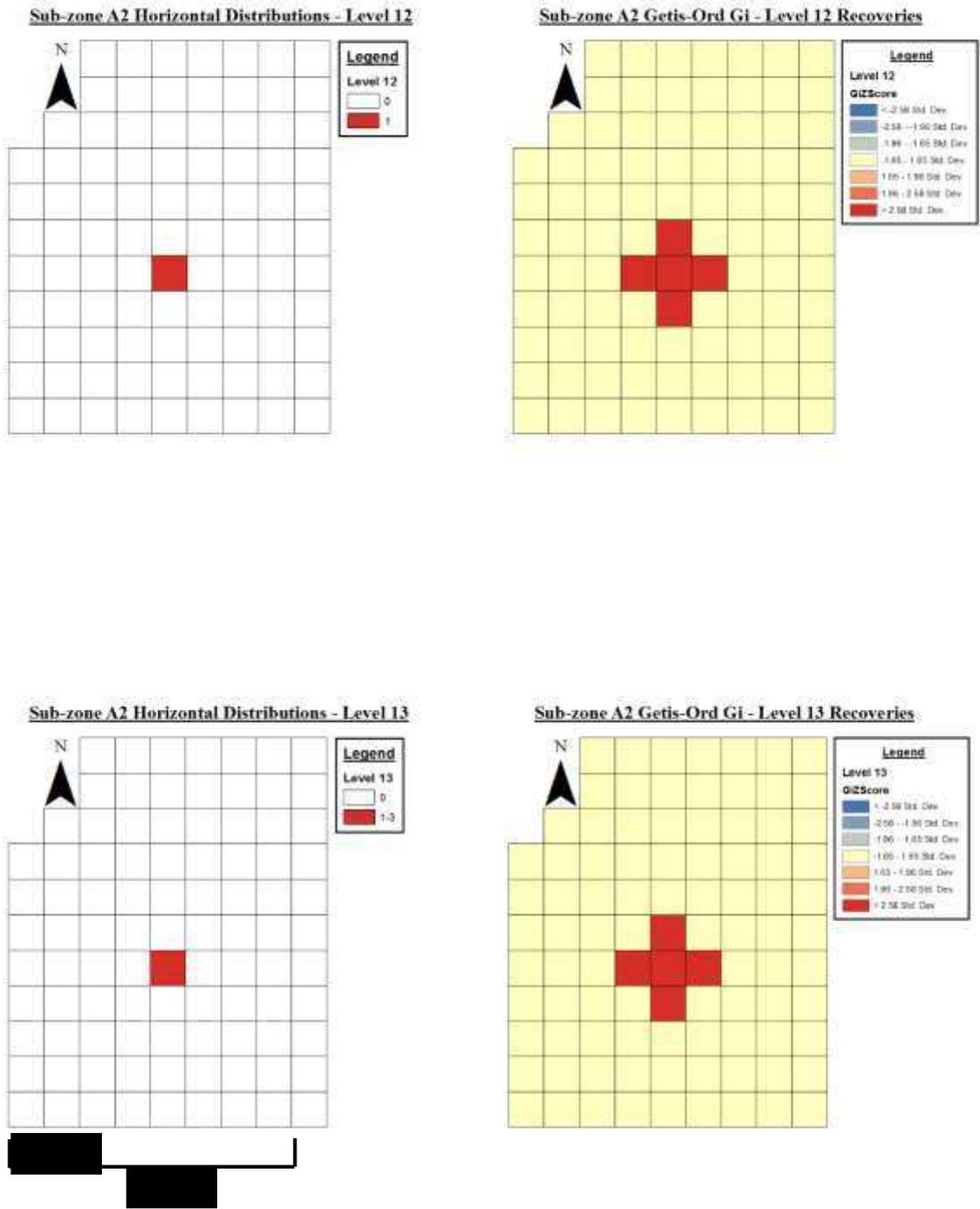
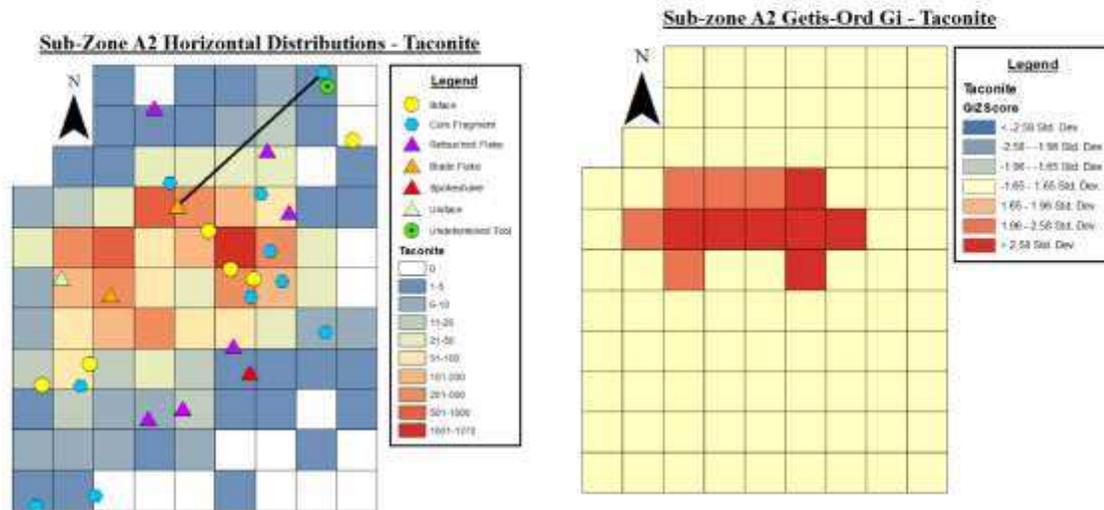
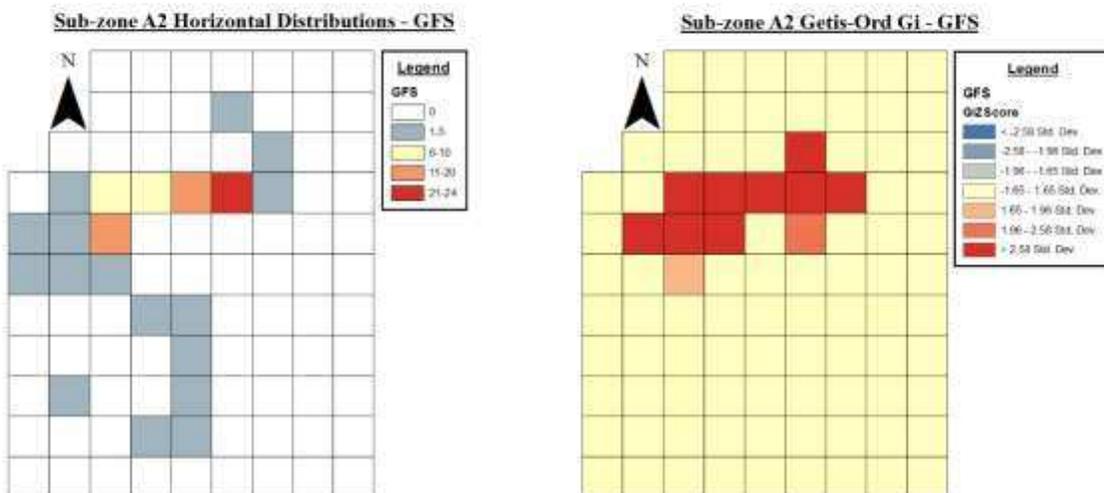


Figure 7.4.7: Sub-zone A2 artifacts by level – Frequency and Getis-Ord G_i .

A2: Artifact Distributions by Material

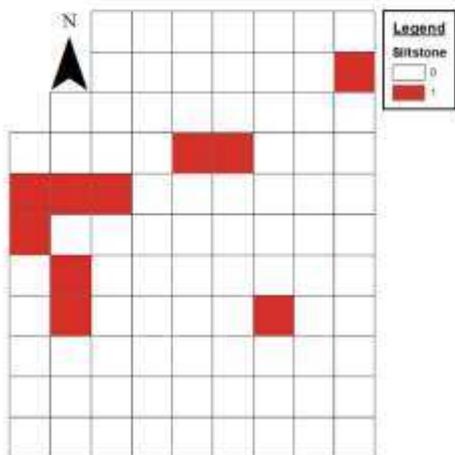


A

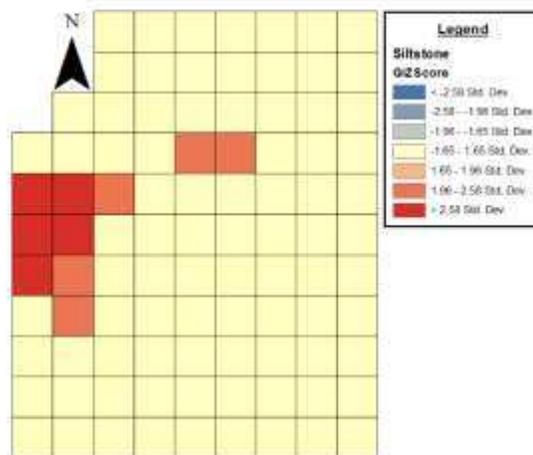


B

Sub-zone A2 Horizontal Distributions - Siltstone

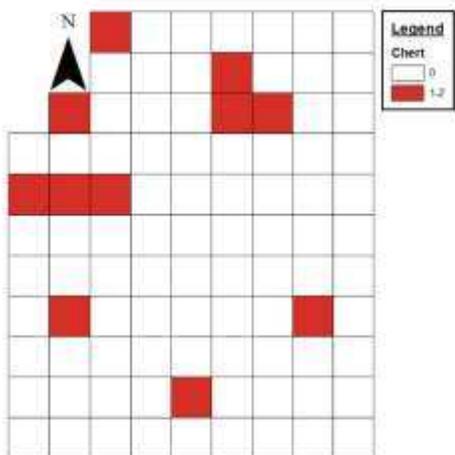


Sub-zone A2 Getis-Ord Gi - Siltstone

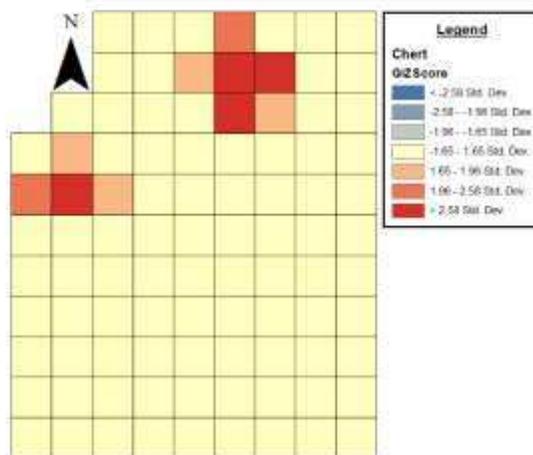


C

Sub-zone A2 Horizontal Distributions - Chert

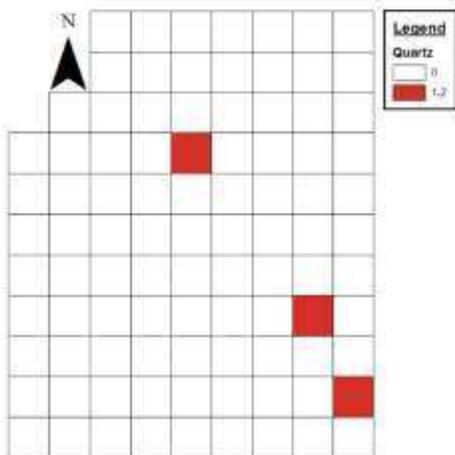


Sub-zone A2 Getis-Ord Gi - Chert

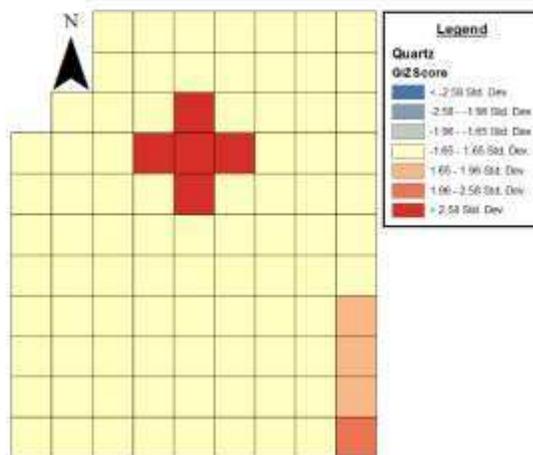


D

Sub-zone A2 Horizontal Distributions - Quartz

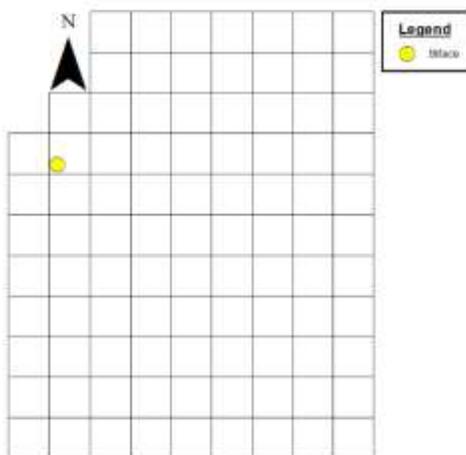


Sub-zone A2 Getis-Ord Gi - Quartz

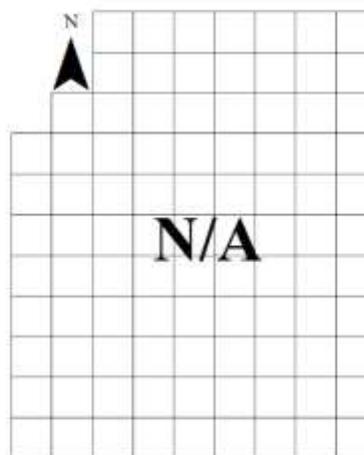


E

Sub-zone A2 Horizontal Distributions - Mudstone



Sub-zone A2 Getis-Ord Gi - Mudstone



F

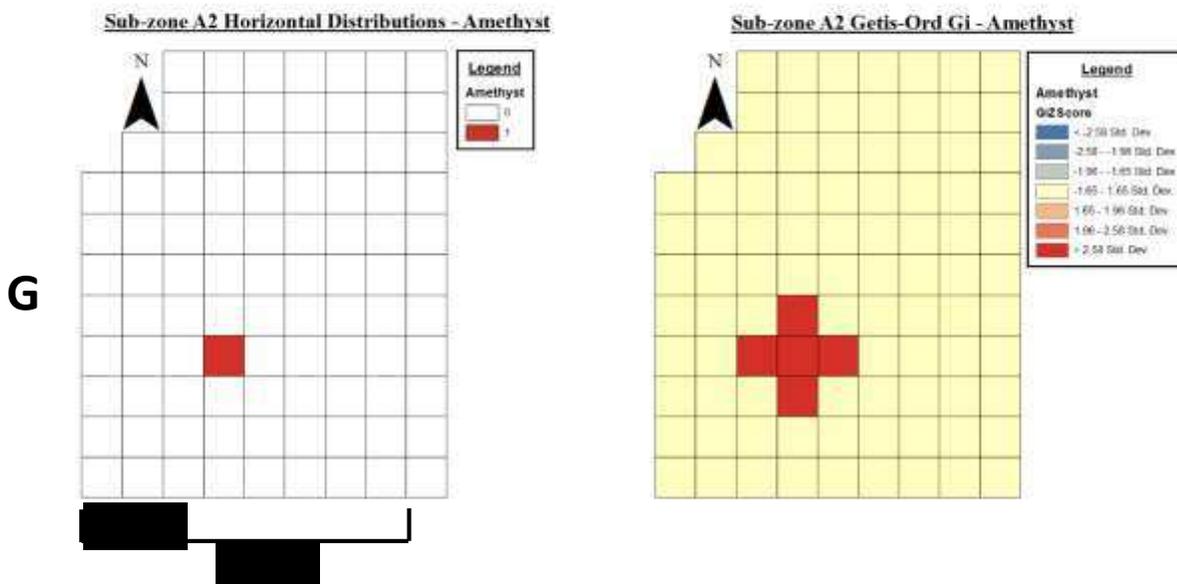


Figure 7.4.8: Sub-zone A2 artifact distributions by material type. A) Taconite, B) Gunflint Silica, C) Siltstone, D) Chert, E) Quartz, F) Mudstone, and G) Amethyst.

7.4.6 A2: Horizontal Distribution: Debitage

Initial observations of all mapped debitage by quadrat frequency reveals a circular shaped lithic distribution with a relatively low frequency zone in the centre (Figure 7.4.9). This observed patterning was further explored by segmenting the sub-zone and plotting the concentrations of artifacts per quadrat (Figures 7.4.10). This cross section analysis further supported the observed ring-shaped distribution. It should be noted, however, that high artifact frequencies do not form a full circle, as the lower right side appears to exhibit a lower recovery frequency. In order to better illustrate this, a kernel density contour map was generated using artifact frequencies (Figure 7.4.11). This shows areas of highest recovery (e.g. hot-spots identified through Getis-Ord G_i), with the

relatively low recoveries in the cluster centre as well as lower right. Debitage clustering was further explored through the mapping and analysis of debitage size and type.

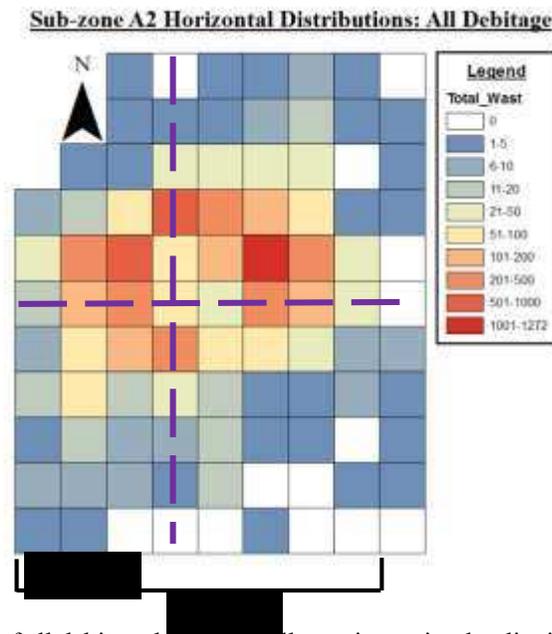


Figure 7.4.9: Distribution of all debitage by quadrat illustrating a circular distribution of materials. Segmenting discussed in figure 7.4.10 indicated by dashed lines.

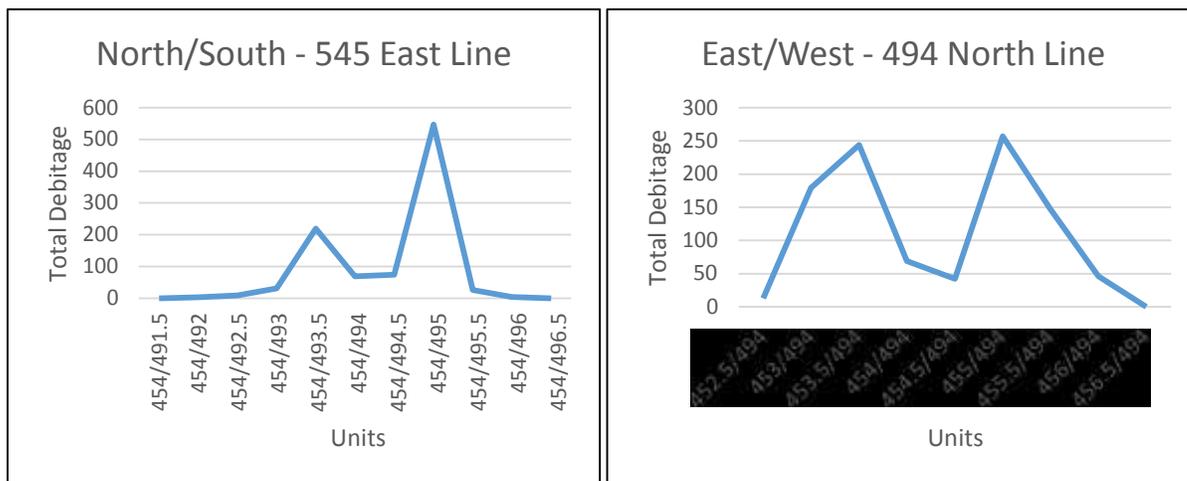


Figure 7.4.10: Results of sub-zone cross-section. A) North/South artifact frequencies, B) West/East artifact frequencies.

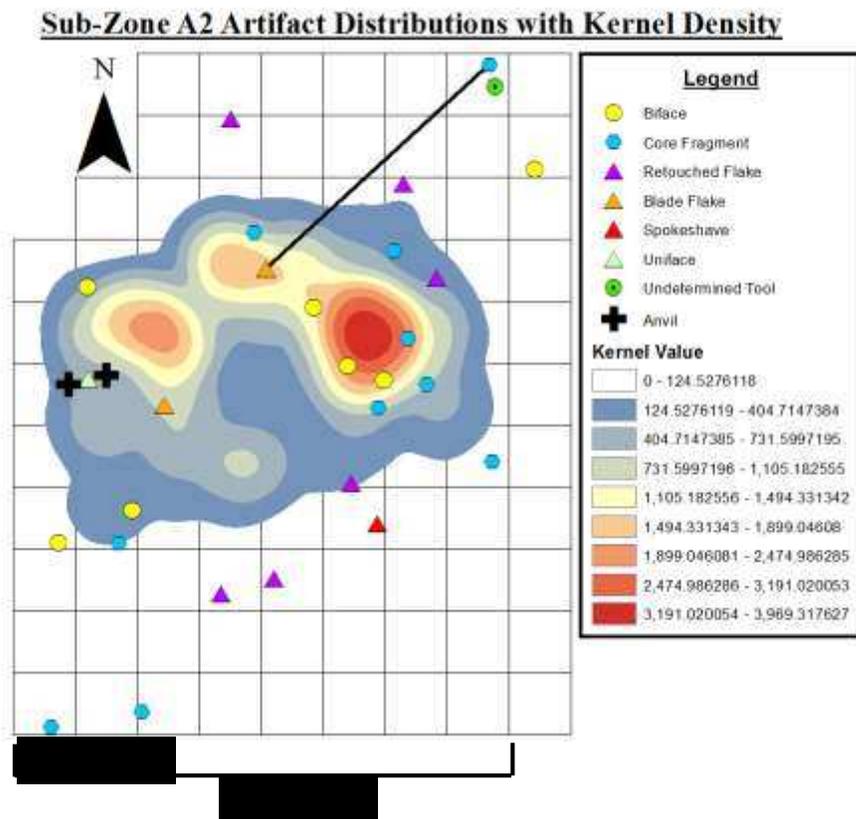


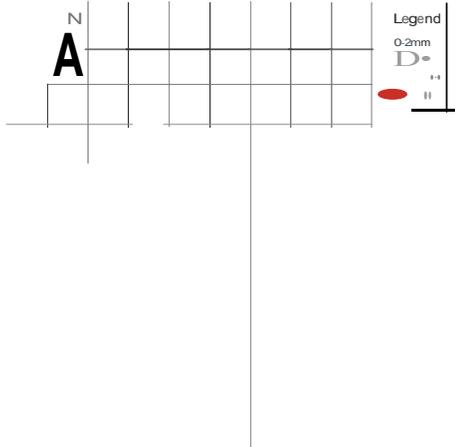
Figure 7.4.11: Kernel density of sub-zone A2 artifact distributions.

Debitage Size

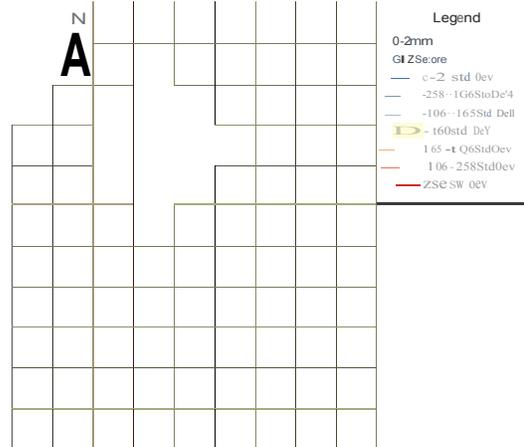
The distribution of debitage by size can be seen in Figure 7.4.12. Overall, debitage distributions by size cluster within the high recovery zones previously identified. There is some distinction between primary clustering within this zone, as there appears to be a split between the west and east cluster areas. In the left side of the cluster, there is a tendency for higher clustering of very small debitage (0-2mm and 2-6mm) and very large debitage (50+mm). Meanwhile, mid-range debitage size categories (6-12mm, 12-25mm, and 25-50mm) appear to occur in higher frequencies towards the eastern cluster area. It can also be observed that debitage clustering in the west is closely related to the location of recovered anvil stones.

A2: Horizontal Distribution of Debitage by Size

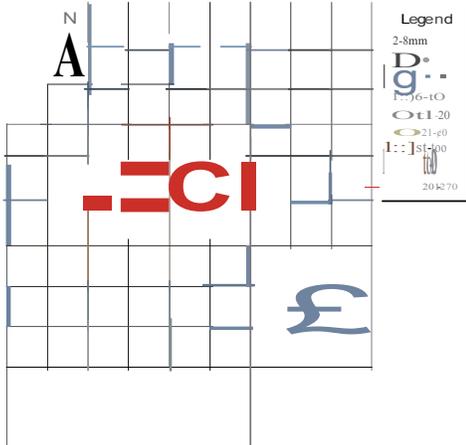
Sub-Zone A2 Horizontal Distributions: 0-2mm



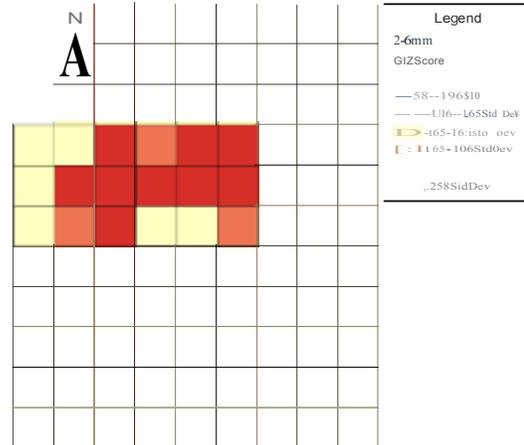
Sub-Zone A2 Getis-Ord Gi Results: 0-2 mm



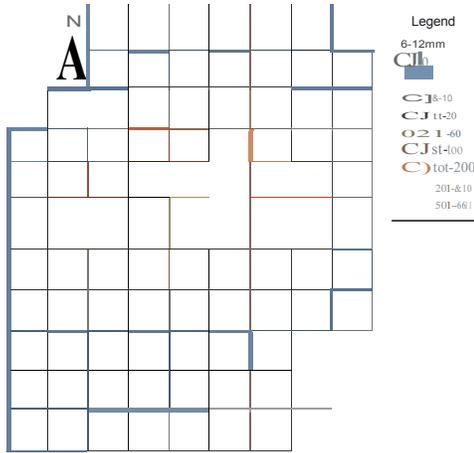
Sub-Zone A2 Horizontal Distributions: 2-6mm



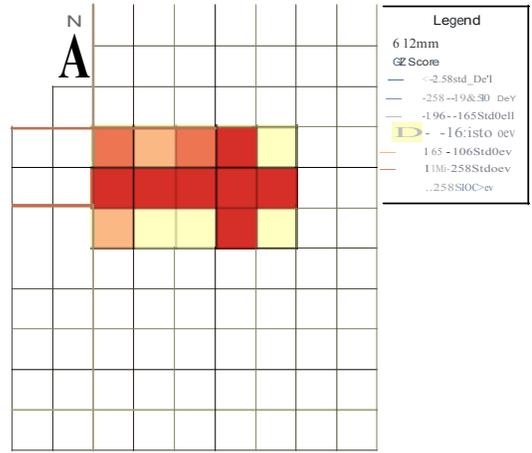
Sub-Zone A2 Getis-Ord Gi Results: 2-6mm



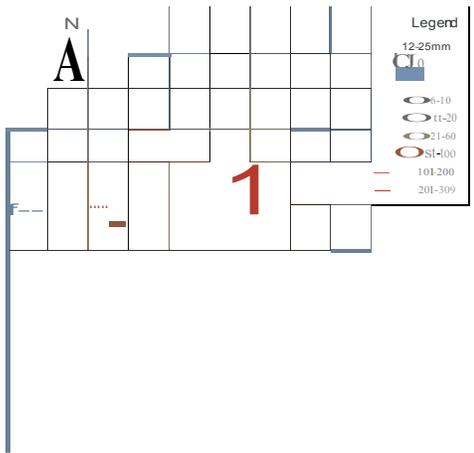
Sub-Zone A2 Horizontal Distributions - 6-12mm



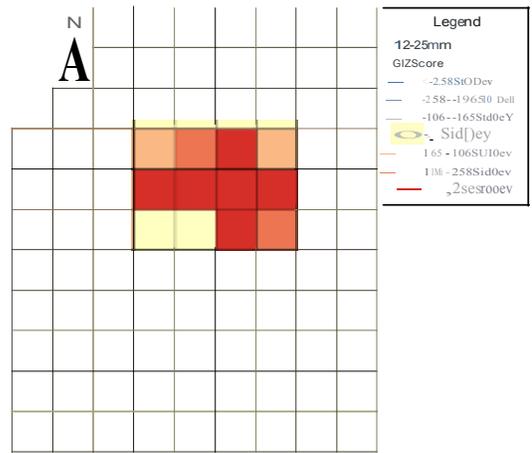
Sub-Zone A2 Getis-Ord Gi Results - 6-12mm



Sub-Zone A2 Horizontal Distributions: 12-25mm



Sub-Zone A2 Getis-Ord Gi Results: 12-25mm



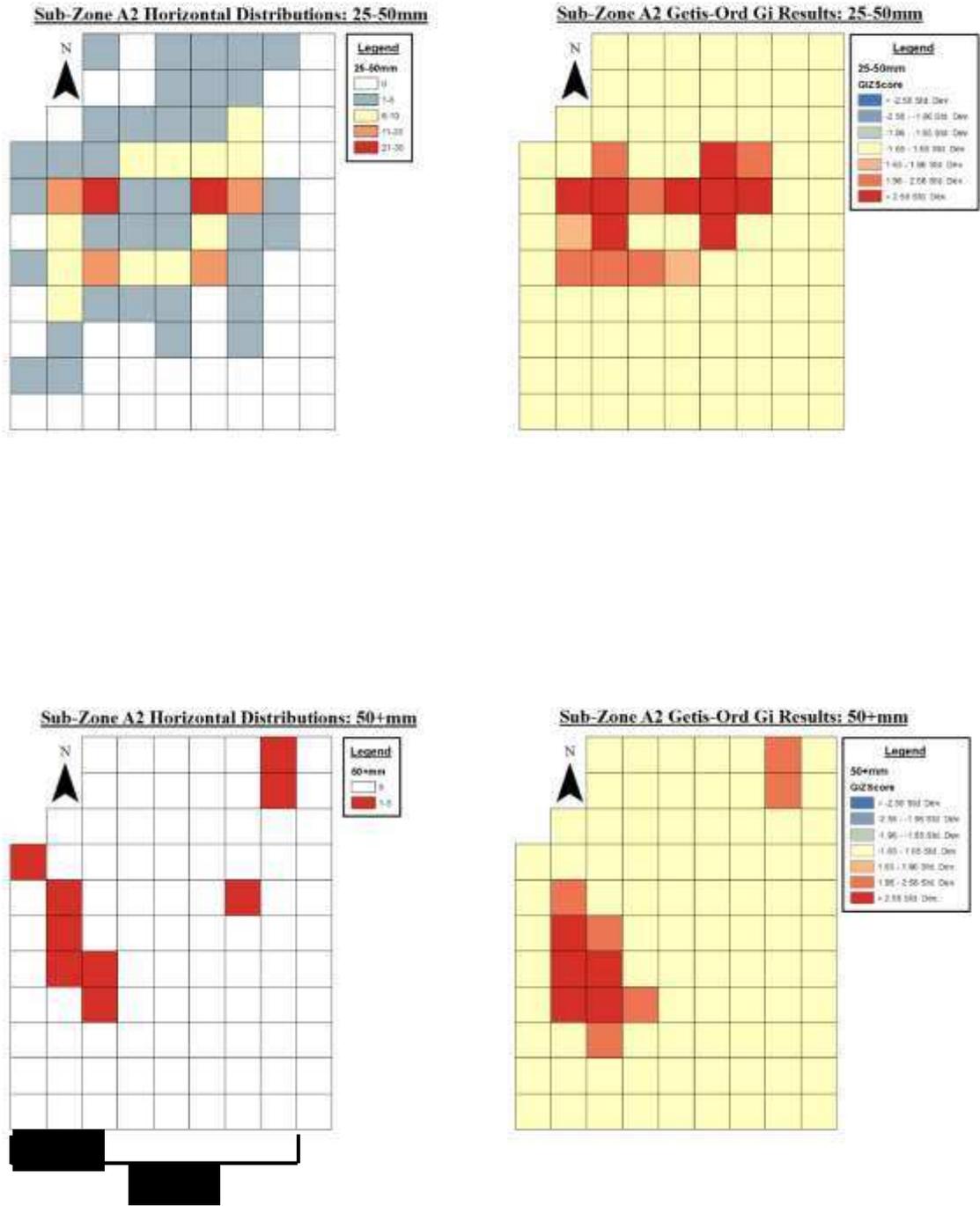
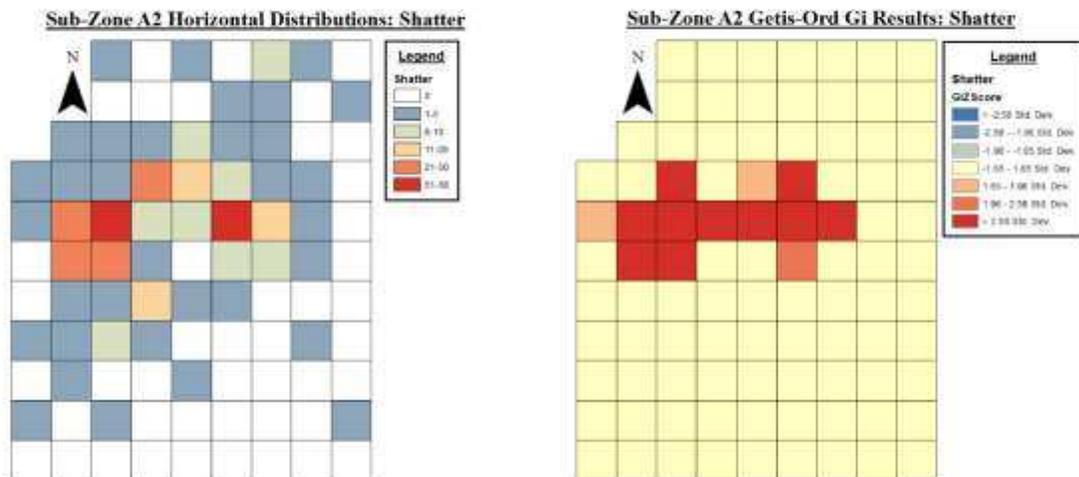


Figure 7.4.12: Distributions of sub-zone A2 debris by size.

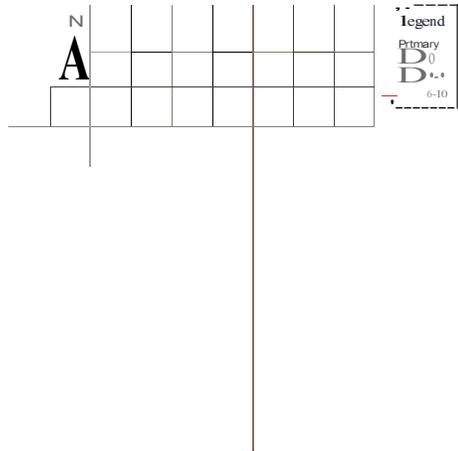
Debitage Type

Similar to debitage size, the distribution of debitage by type exhibits a split distribution within the primary cluster area. Primary, secondary, and undetermined flakes exhibit a stronger distribution within the eastern portion of the cluster, while tertiary flakes and shatter are predominantly located within the west (Figure 7.4.13). This pattern is also observed when comparing concentrations of debitage vs. microdebitage (Figure 7.4.14). Again, the location of anvil stones appears to occur in relation to western debitage clustering.

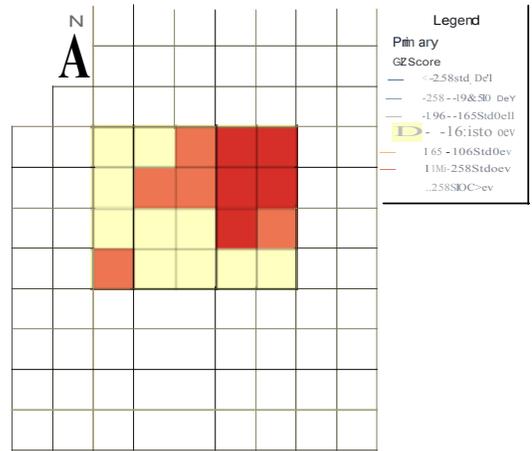
A2: Horizontal Distribution of Debitage by Type



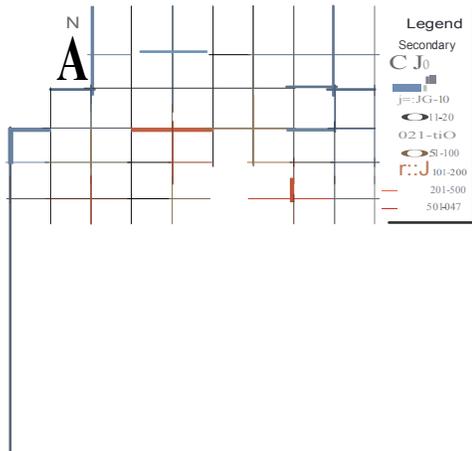
Sub-Zone A2 Horizontal Distributions - Primary Debitage



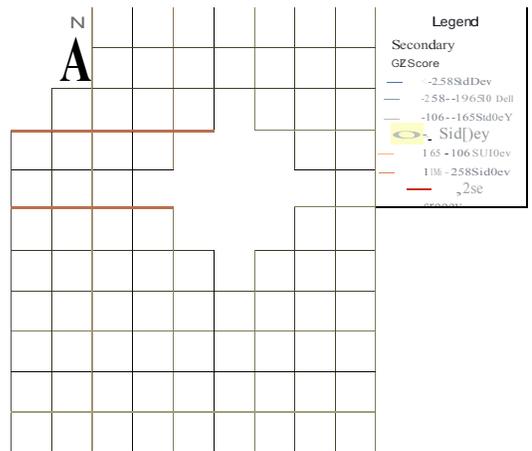
Sub-Zone A2 Getis-Ord Gi Results: Primary Debitage



Sub-Zone A2 Horizontal Distributions - Secondary Debitage



Sub-Zone A2 Getis-Ord Gi Results: Secondary Debitage



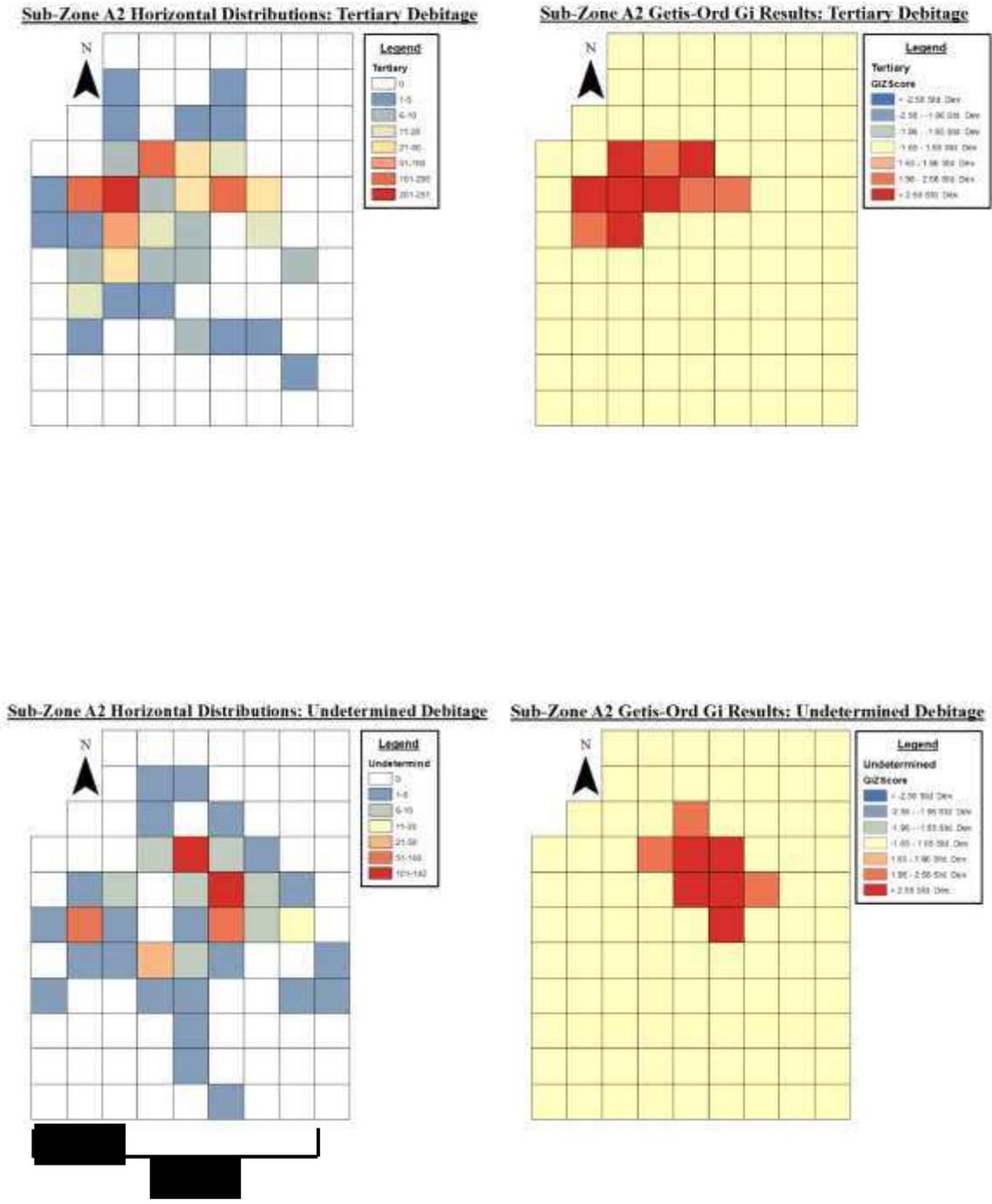


Figure 7.4.13: Distribution of sub-zone A2 debitage by type.

A2: Horizontal Distribution of Debitage vs. Microdebitage

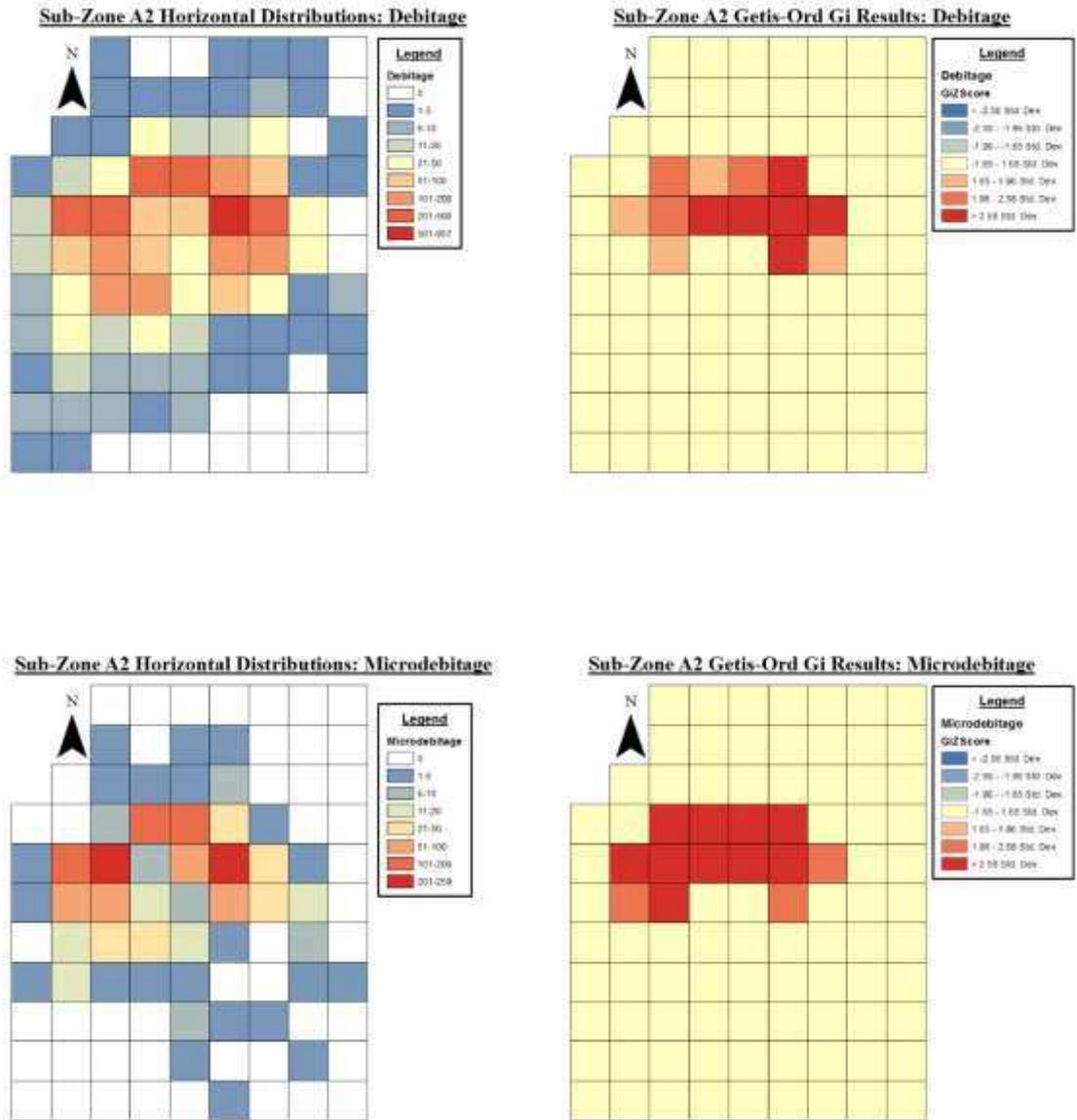


Figure 7.4.14: Distribution of sub-zone A2 debitage vs. microdebitage.

7.4.7 A2: Horizontal Distribution: Tools

A variety of tools were collected from within sub-zone A2 (Figure 7.4.15). Of the recovered tools, three main classes stand out: cores, bifaces, and retouched flakes.

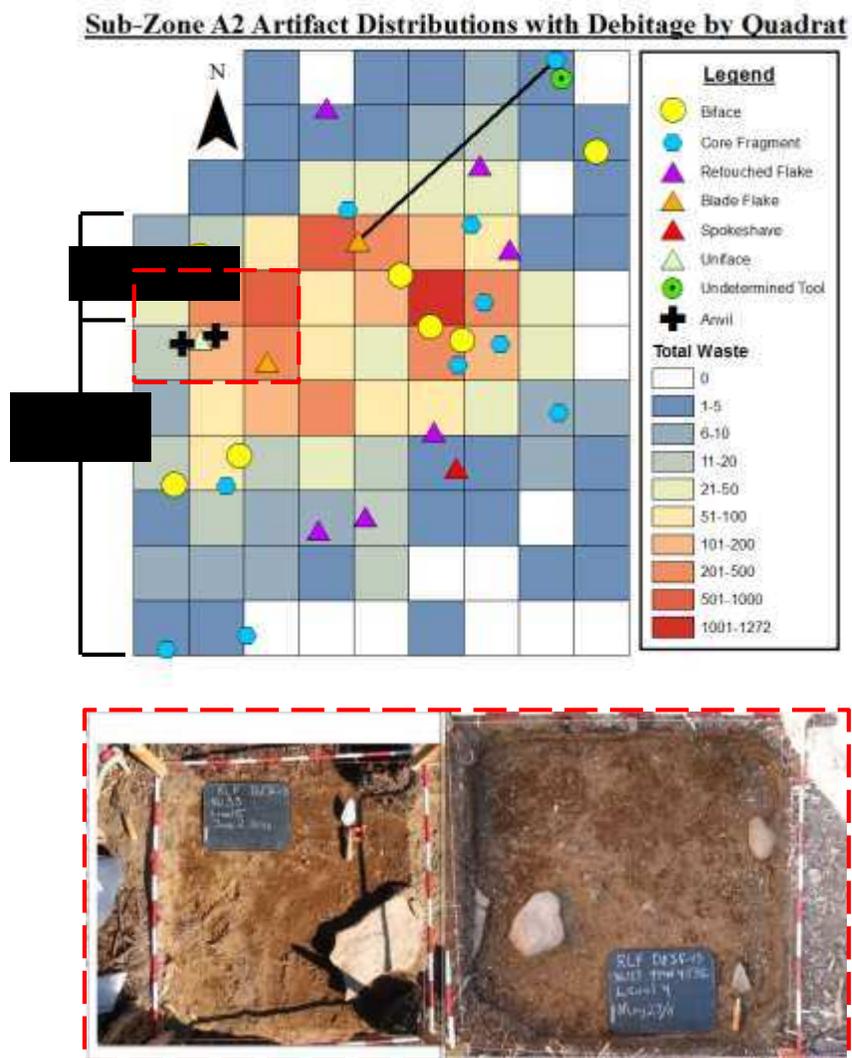


Figure 7.4.15: Distribution of all sub-zone A2 tools with total debitage by quadrat. Field photos of anvil stones inset (Photos by S. Hamilton and C. Surette).

Cores

The distribution of cores by cortex type is illustrated in Figure 7.4.16. The distribution by cortex type does not suggest any specific pattern (due to low recovery numbers), however, general distribution patterns exhibit a correlation between core

location and debitage hot-spots. This is particularly apparent near the highest lithic recovery zone in the eastern portion of the cluster. It can also be observed that core recoveries are limited to the periphery of these lithic recovery zones.

Sub-zone A2 Horizontal Distributions: Core Cortex Type

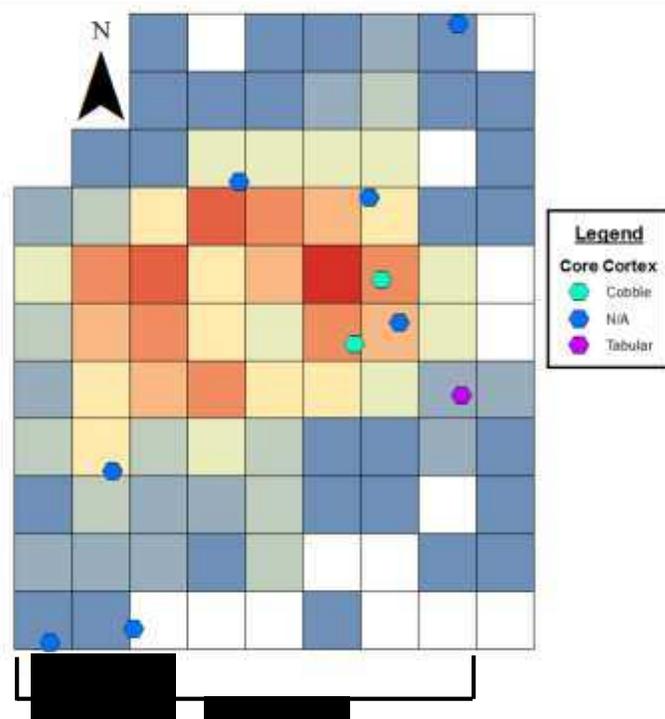
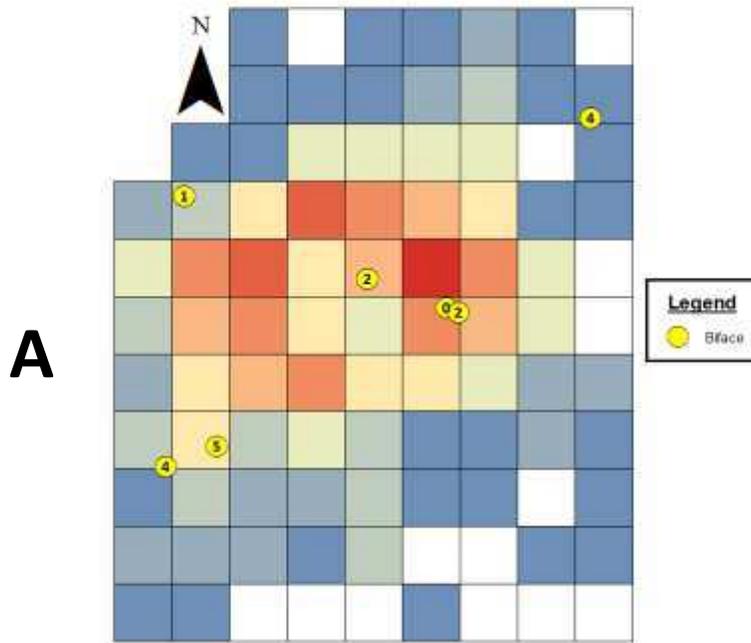


Figure 7.4.16: Distribution of sub-zone A2 cores by cortex type.

Bifaces

Biface distributions in sub-zone A2 follow a similar pattern to cores, being limited to areas outside high debitage concentrations (Figure 7.4.17). Bifaces located closer towards the centres of these high debitage areas are also of earlier production stages, representing either blanks or roughly edged pieces.

Sub-zone A2 Horizontal Distributions: Bifaces by Recovery Level



Sub-zone A2 Horizontal Distributions: Bifaces by Stage

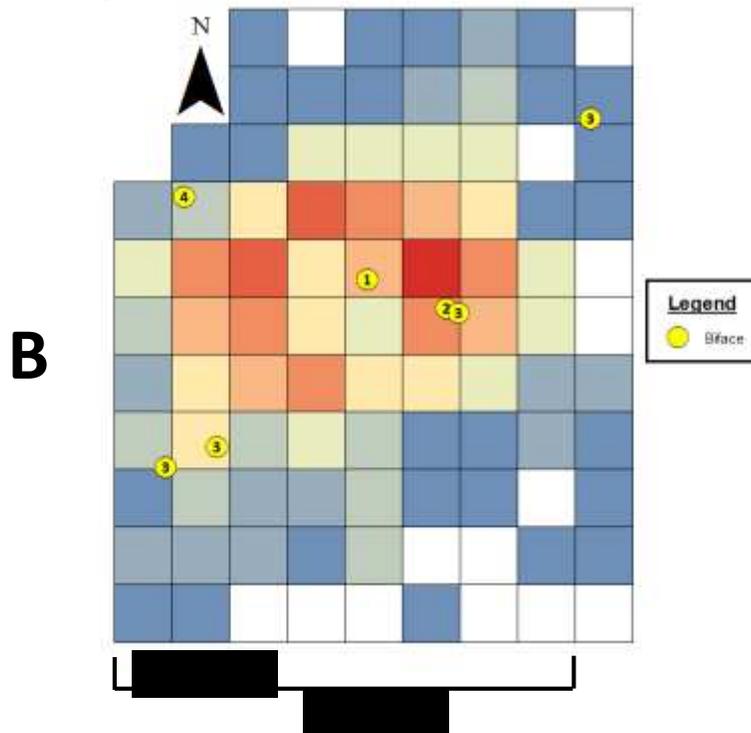


Figure 7.4.17: Distribution of sub-zone A2 bifaces by level (A) and stage (B) – Level and stage indicated by numbers within yellow circles.

Retouched Flakes

Retouched flakes were mapped by their designation of either intentional or incidental in order to see if there was a patterned distribution (Figure 7.4.18). No clear pattern could be detected, however, and the overall distribution of artifacts followed a similar pattern to that observed for cores and bifaces. The distribution of retouched flakes appears to be limited to the periphery of the debitage cluster.

Sub-zone A2 Horizontal Distributions: Retouched Flake Type

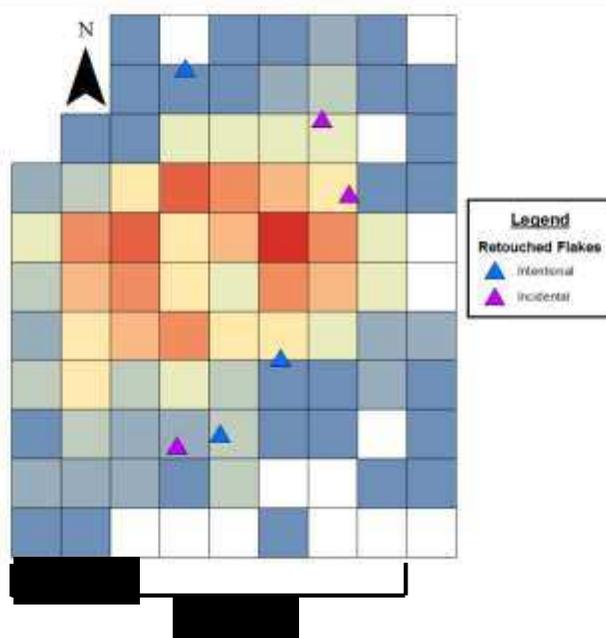


Figure 7.4.18: Distribution of sub-zone A2 retouched flakes by intentional or incidental flaking.

Tool Refits

One artifact refit was recovered from sub-zone A2 (see Figure 7.4.15). This consisted of a blade flake that refit to its original core. As this refit represents a tool item detached from a core, the observed distance (~2m) could be the result of transport for use during site occupation.

General Tool Distribution

The distribution of all recovered tools can be seen in Figure 7.4.15. In general, tool clustering appears to occur in correlation with observed debitage distributions. Of interest in this distribution is the continued pattern of limited tool recoveries from within the centre of debitage clustering. As well, there is a strong association with recovered anvil stones and high density debitage recoveries.

7.4.8 A2: NSG Results

The results of the NSG survey indicate an area of high magnetic anomalies within the centre of artifact clustering (Figure 7.4.19). When compared with kernel density results, the areas of highest readings occurs roughly within the central cluster area of low artifact recovery, while the lowest readings are associated with high artifact concentration zones (see Figure 7.4.11). The implications of this association will be discussed further in Chapter 8.

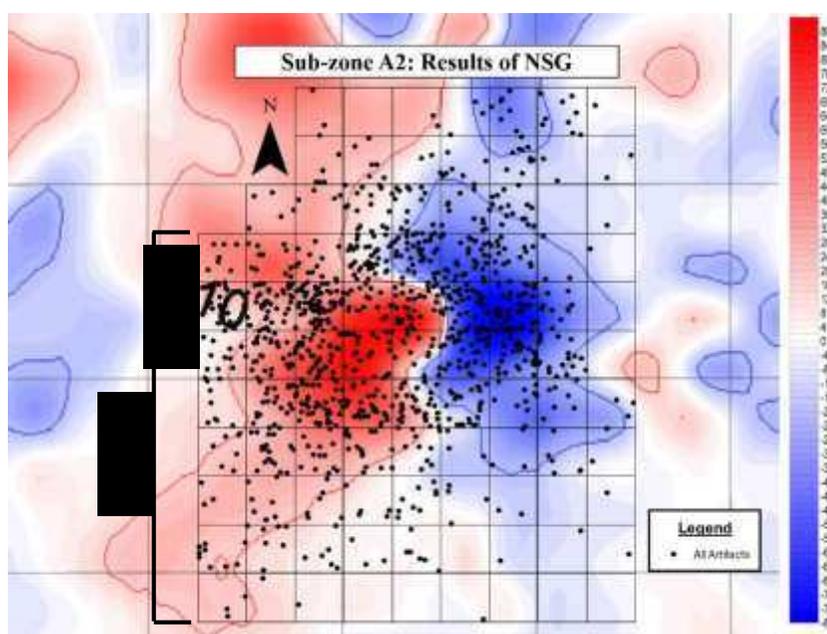


Figure 7.4.19: NSG results for sub-zone A2. High magnetic anomalies can be seen in correlation with voids in artifact concentrations and high recovery frequencies.

7.5 *Sub-Zone: B1*

Sub-zone B1 consisted of a relatively small lithic cluster within 36 50 x 50cm quadrats (Figure 7.5.1). It is located near the centre of the site excavation area, just below the 238 metres above sea level (masl) topographic line. The southern portion of this area overlaps with sub-zone B2. It was noted within excavation notes that the quadrat of highest artifact recoveries within this sub-zone (452N/488E NW) was between two units with tree stumps.

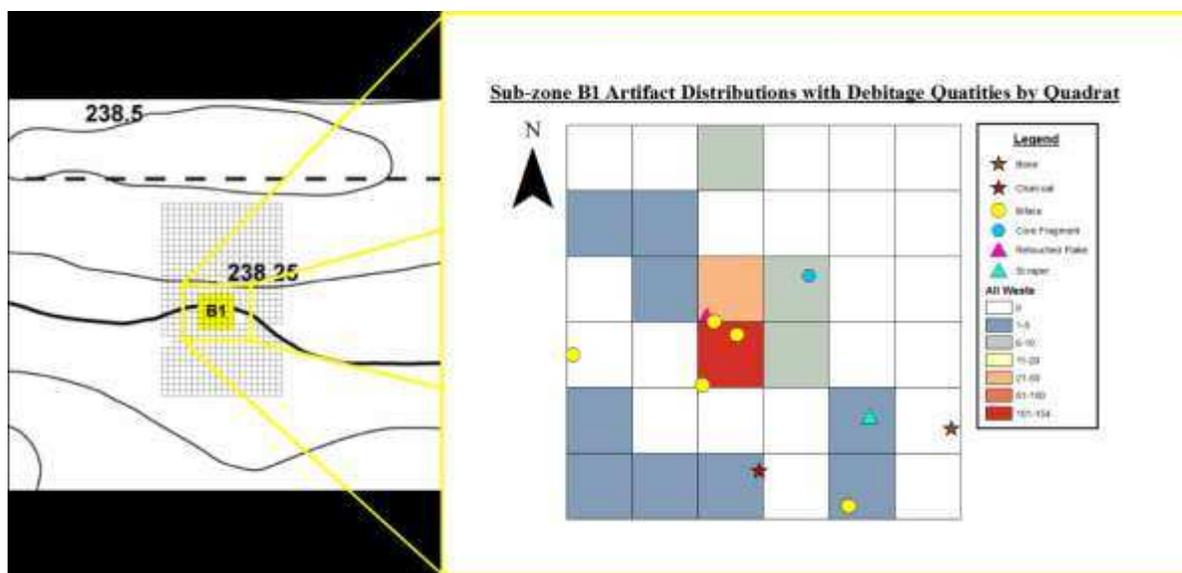


Figure 7.5.1: Sub-zone in relation to topography with a close up of sub-zone B1 illustrating all tool recoveries with total debitage by quad.

7.5.1 *B1: Artifact Recoveries*

Sub-zone B1 yielded 251 artifacts, including eight tools. Tool recoveries included one core, five bifaces, one retouched flake, and one scraper (Table 7.5.1). Debitage recoveries consisted of 222 pieces, which were further analyzed by size, type, and material (Figures 7.5.2-7.2.4). Other artifact recoveries included 20 fragments of charcoal

(shared with sub-zone B2), and one faunal item recovered from level 2 (5-10cm below surface).

Table 7.5.1: Sub-zone B1 tool recoveries

B1: TOOLS	
TYPE	Frequency
CORE	1
BIFACE	5
RETOUCHED FLAKE	1
SCRAPER	1

Table 7.5.2: Debitage frequencies by size.

B1: DEBITAGE	
SIZE	Frequency
0-2MM	0
2-6MM	12
6-12MM	64
12-25MM	100
25-50MM	43
50+MM	3

Table 7.5.3: Debitage frequencies by type.

B1: DEBITAGE	
TYPE	Frequency
PRIMARY	5
SECONDARY	195
TERTIARY	0
UNDETERMINED	11
SHATTER	11

Table 7.5.4: Debitage frequencies by material.

B1: DEBITAGE MATERIAL	
TYPE	Frequency
TACONITE	217
GFS	5

7.5.2 *B1: Vertical Distribution*

Vertical artifact distributions illustrate that artifact recoveries occur primarily in Level 4, with few recoveries occurring above and below this depth (Figure 7.5.2). Assessing this distribution by artifact size reveals a similar pattern (Figure 7.5.3). This distribution differs from other sub-zones where primary recovery zones occur within the Level 3 range. Excavation notes for units 489N/452E and 488N452E indicate the

presence of tree stumps along either side of the high artifact recovery zones. These tree stumps could explain the differences observed in average artifact recovery levels.

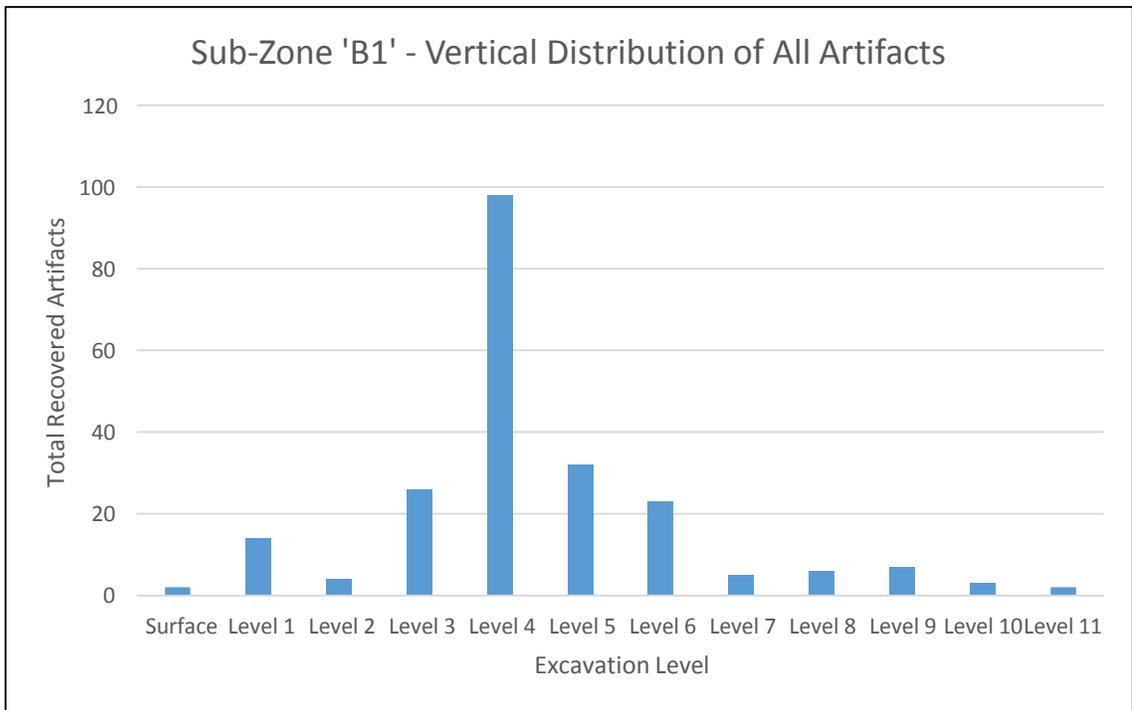


Figure 7.5.2: Total artifact recoveries by level for sub-zone B1.

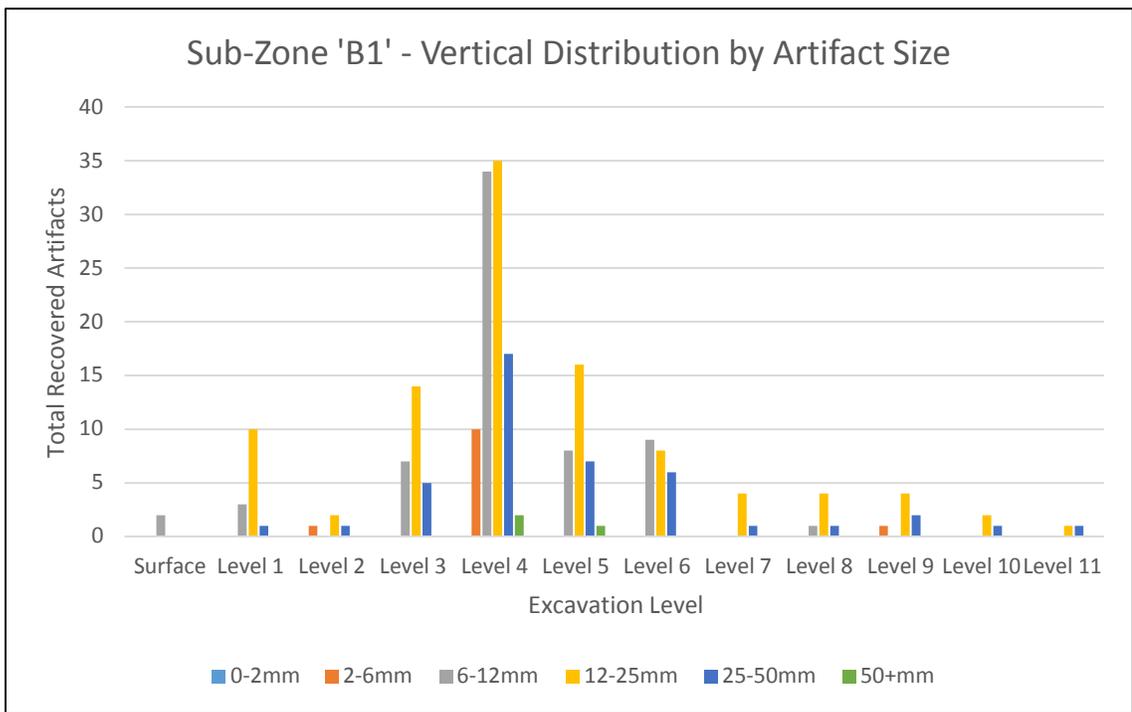


Figure 7.5.3: Total artifact recoveries by size and level.

7.5.3 B1: Horizontal Distribution: General

The results of statistical analysis for artifact clustering indicate that the distribution in sub-zone B1 is not the result of random chance (Figures 7.5.4-7.5.6). Both nearest neighbour and Getis-Ord G_i^* indicate that there is a less than 1% likelihood that the observed artifact distribution is random.

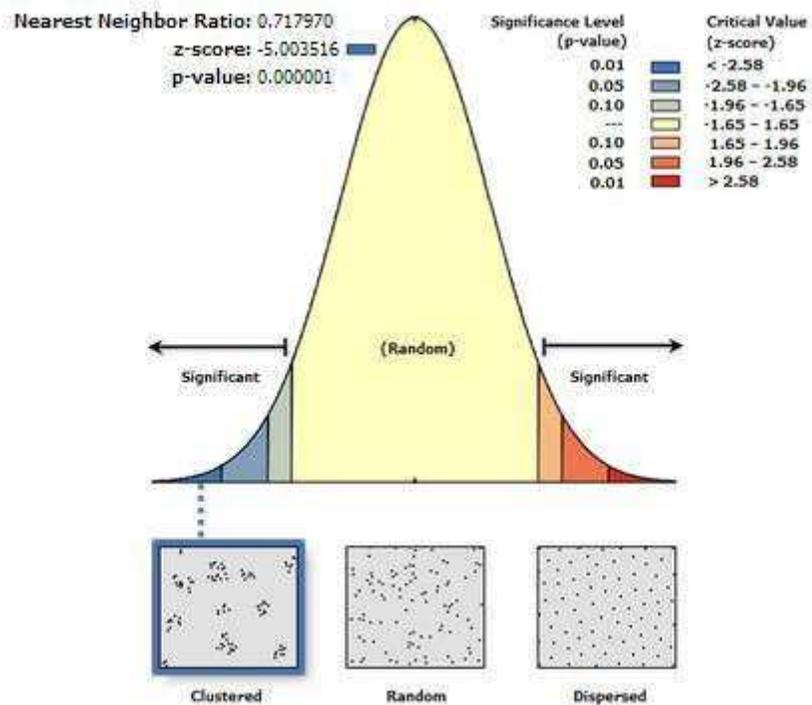


Figure 7.5.4: Results of nearest neighbour analysis indicating that at a z-score of -5.003516 there is a less than 1% chance that the observed distribution is the result of random chance.

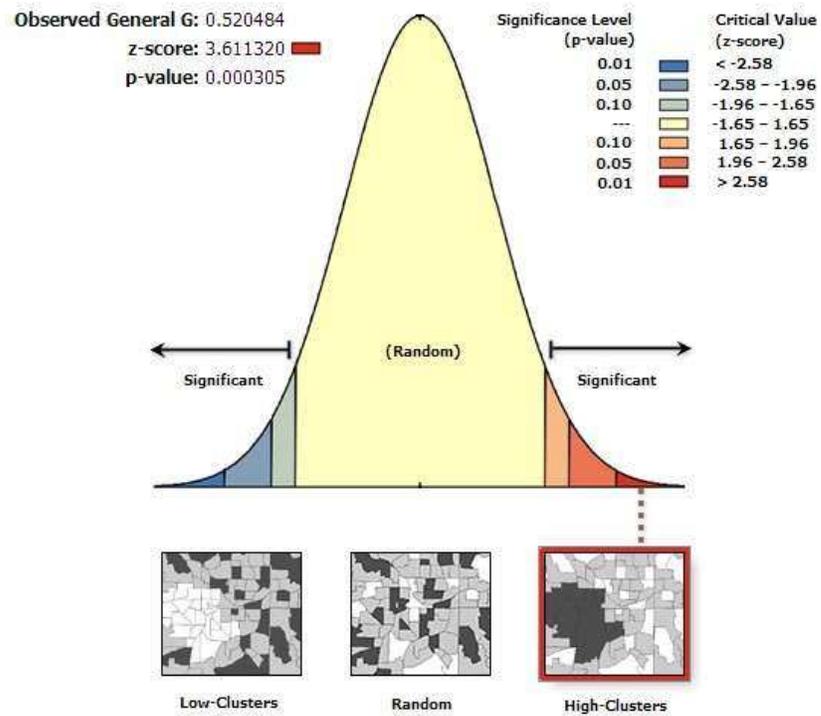


Figure 7.5.5: Results of Getis-Ord G_i analysis indicating that at a z-score of 3.611320 there is a less than 1% chance that the observed distribution is the result of random chance.

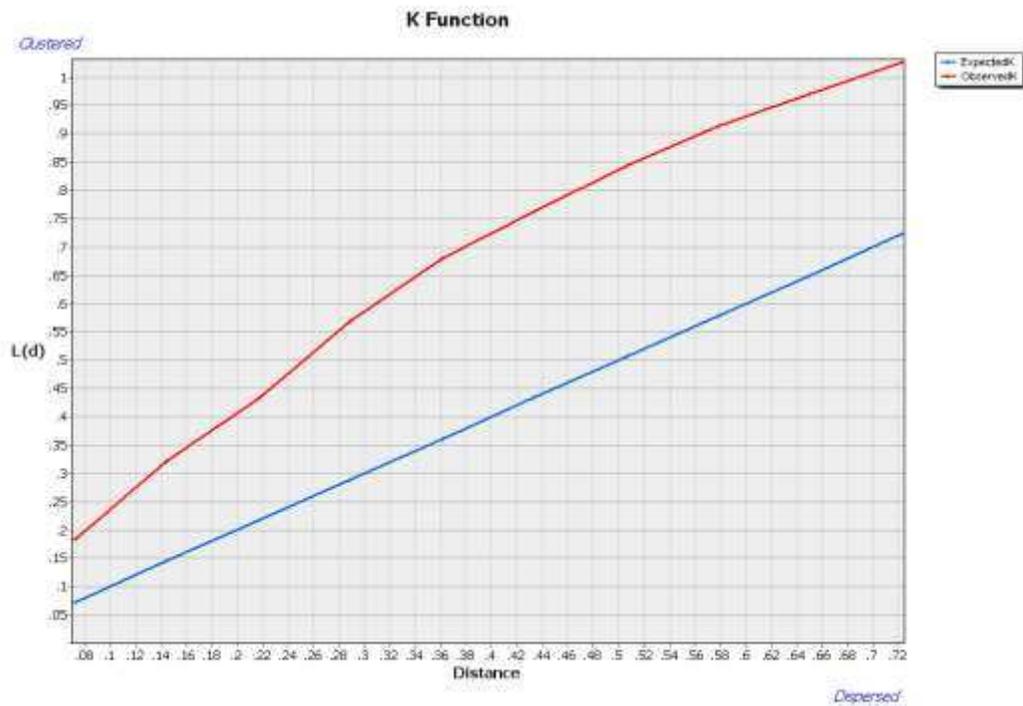


Figure 7.5.6: Graph of Ripley's K function analysis illustrating that the observed distribution is likely the result of a clustered distribution.

7.5.4 B1: Horizontal Distribution: Recoveries by Level

The distribution of artifacts by level indicate that artifact recoveries occur primarily in one central location with little variation (Figure 7.5.7).

7.5.5 B1: Horizontal Distribution: Recoveries by Material Type

Only two different material types were collected from sub-zone B1: taconite and gunflint silica. Taconite was the most common, being concentrated within the middle of the sub-zone (Figure 7.5.8 A). Lesser amounts were recovered along the southern portions of the sub-zone where it borders with sub-zone B2. Gunflint silica recoveries were extremely limited, and appear to be distributed randomly (Figure 7.5.8 B).

7.5.6 B1: Horizontal Distribution: Debitage

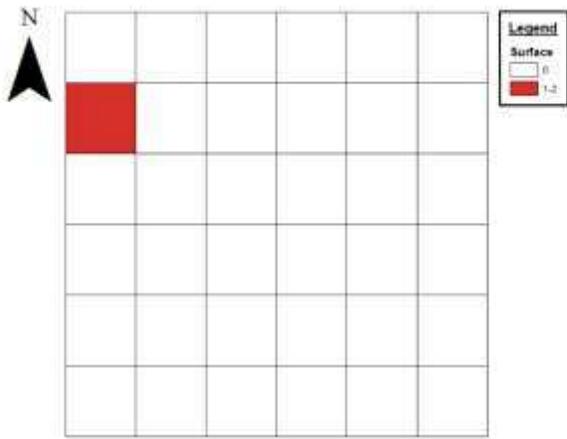
The distributions ofdebitage by both size (Figure 7.5.9) and type (Figure 7.5.10) follow a similar pattern of distribution concentrated within the centre of the sub-zone. All recoveries are highly clustered within the northwest quadrant of unit 488N/452E.

7.5.7 B1: Horizontal Distribution: Tools

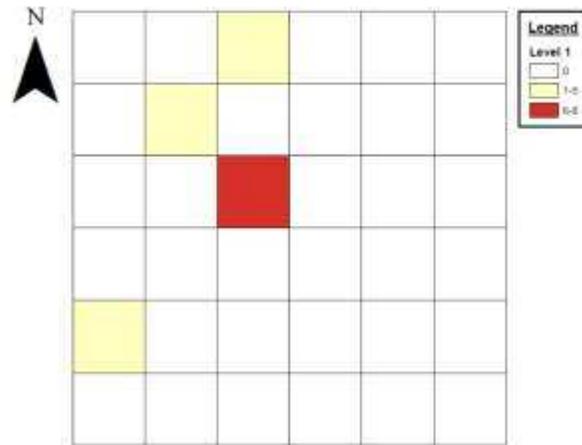
Tools recoveries from sub-zone B1 occur generally within the area of highdebitage recovery in the sub-zone centre (Figure 7.5.11). However, two bifaces and one scraper occur along the periphery of this cluster in areas of little to nodebitage recovery. It is not possible to make inferences regarding biface distributions by stage due to limited recoveries (Figure 7.5.12).



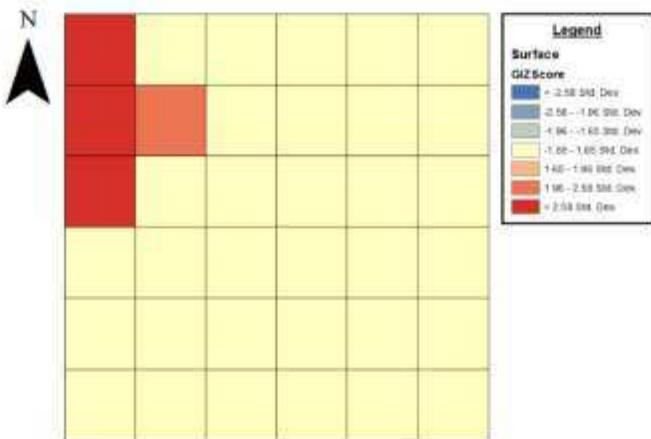
Sub-zone BI Horizontal Distributions - Surface Recoveries



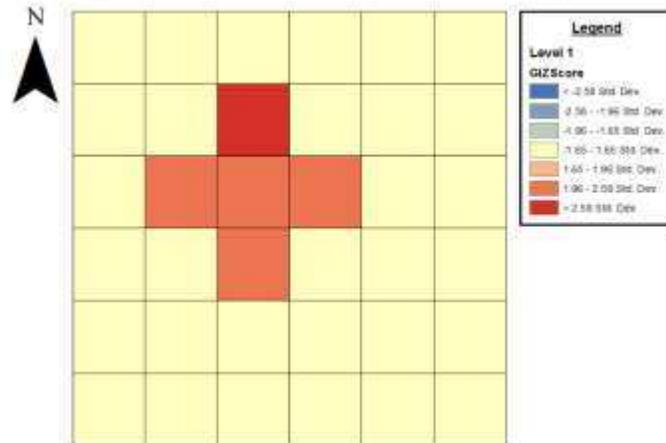
Sub-zone BI Horizontal Distributions - Level 1 Recoveries



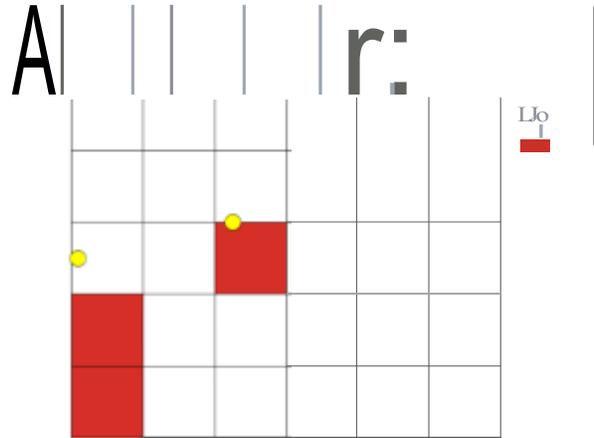
Sub-zone BI Getis-Ord Gi - Surface Recoveries



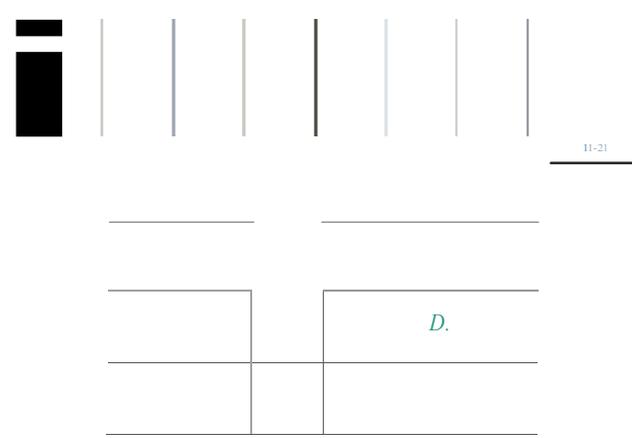
Sub-zone BI Getis-Ord Gi - Level 1 Recoveries



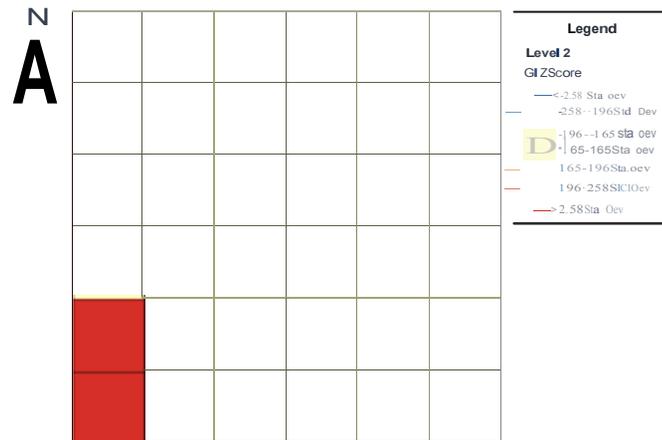
Sub-zone B1 Horizontal Distributions- Level 2 Recoveries



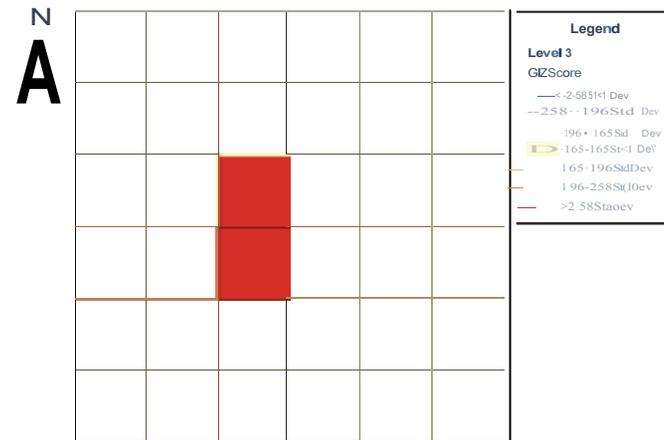
Sub-zone B1 Horizontal Distributions - Level 3 Recoveries



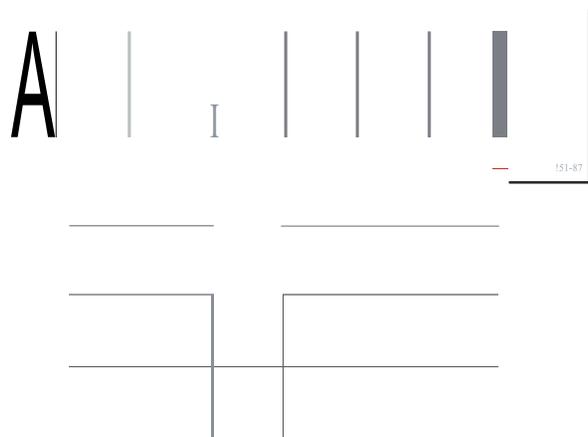
Sub-zone B1 Getis-Ord Gi - Level 2 Recoveries



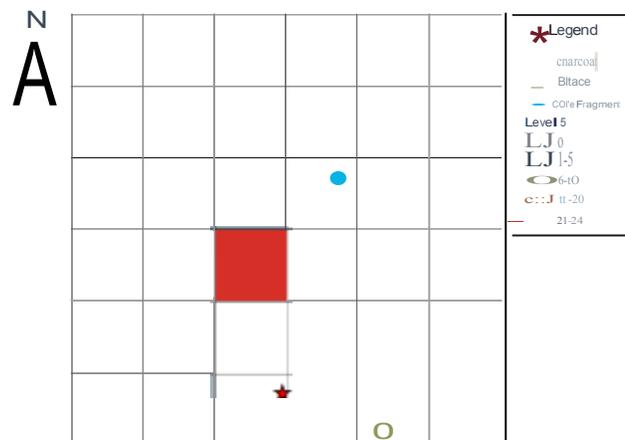
Sub-zone B1 Getis-Ord Gi - Level 3 Recoveries



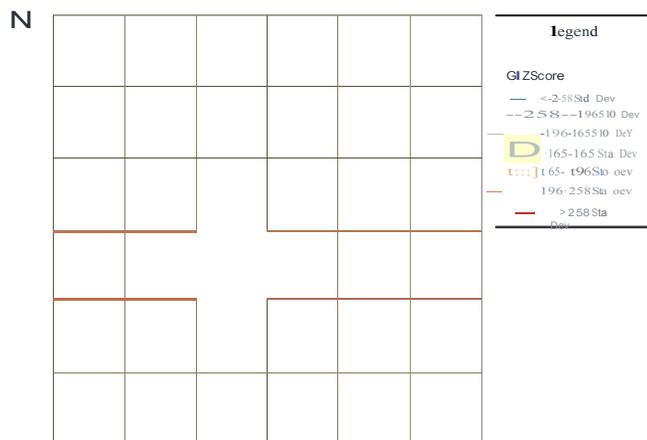
Sub-zone BI Horizontal Distributions - Level 4 Recoveries



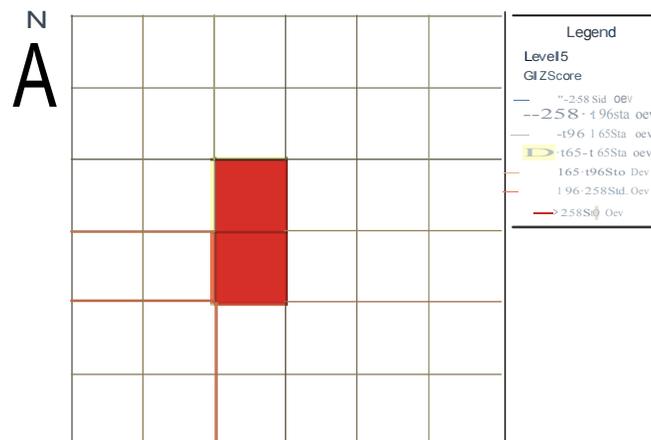
Sub-zone BI Horizontal Distributions - Level 5 Recoveries



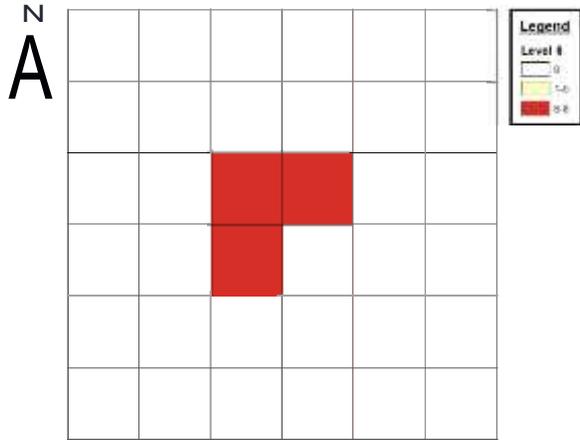
Sub-zone BI Getis-Ord Gi - Level 4 Recoveries



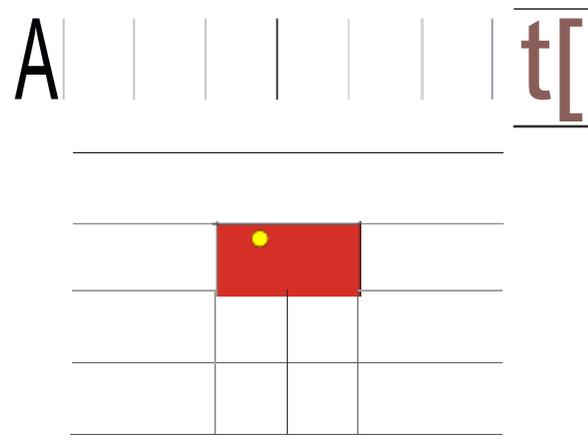
Sub-zone BI Getis-Ord Gi - Level 5 Recoveries



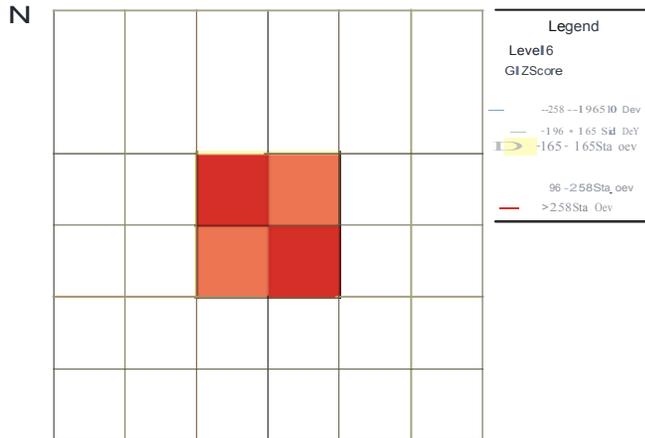
Sub-zone BI Horizontal Distributions - Level 6 Recoveries



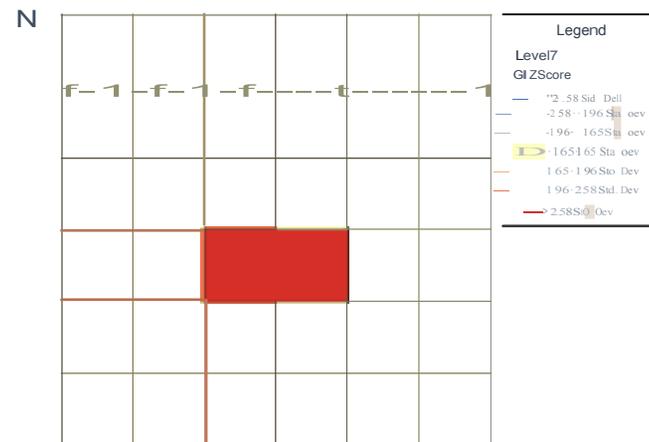
Sub-zone BI Horizontal Distributions- Level 7 Recoveries



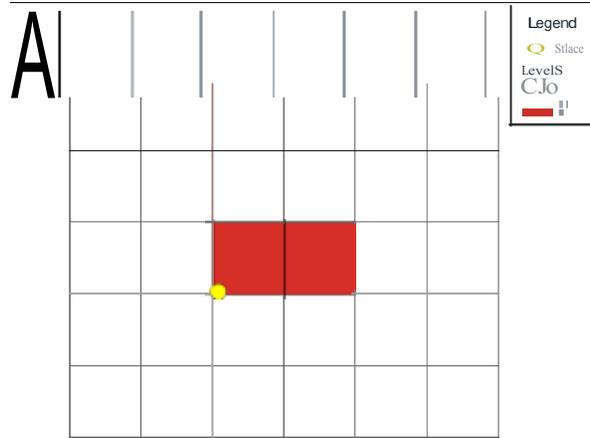
Sub-zone BI Getis-Ord Gi- Level 6 Recoveries



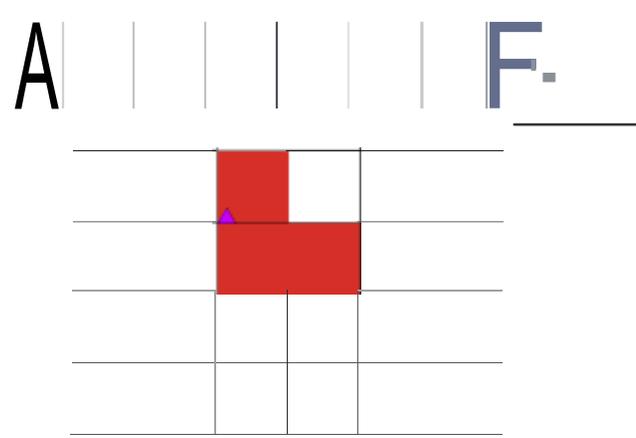
Sub-zone BI Getis-Ord Gi- Level 7 Recoveries



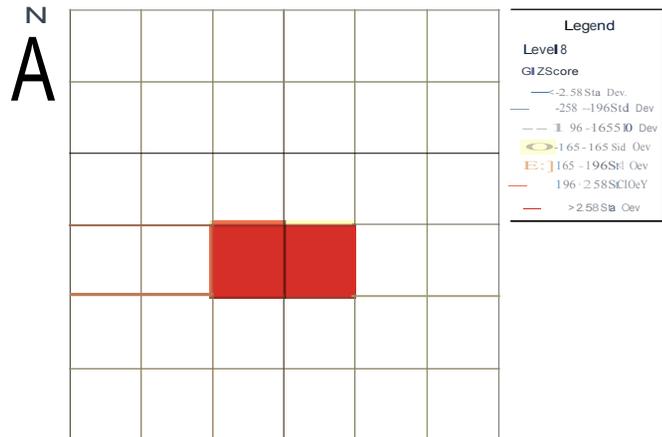
Sub-zone B1 Horizontal Distributions - Level 8 Recoveries



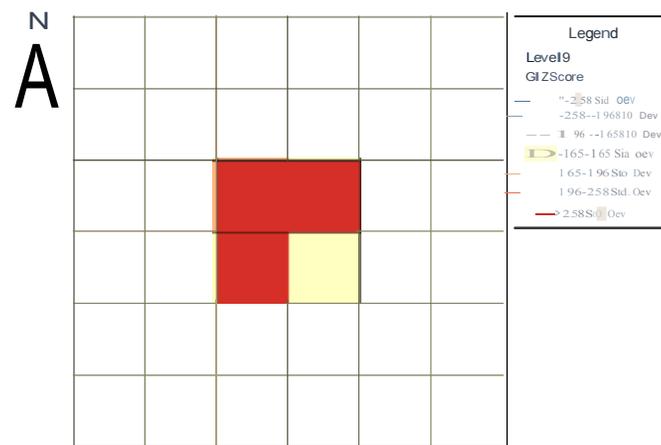
Sub-zone B1 Horizontal Distributions - Level 9 Recoveries



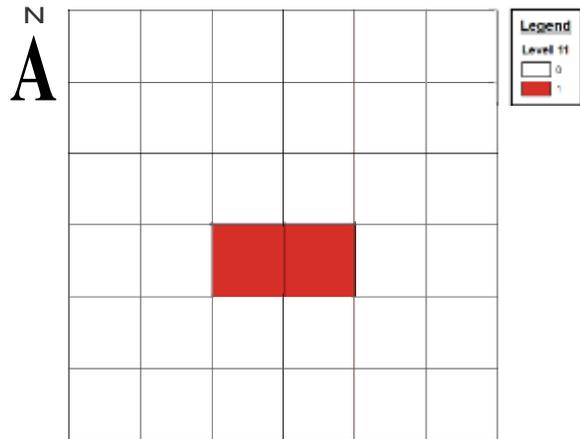
Sub-zone B1 Getis-Ord Gi- Level 8 Recoveries



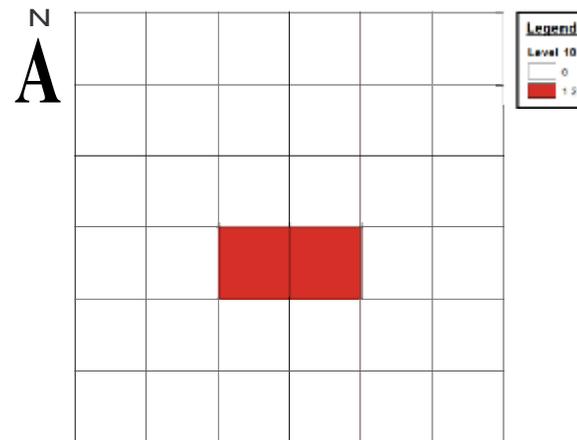
Sub-zone B1 Getis-Ord Gi- Level 9 Recoveries



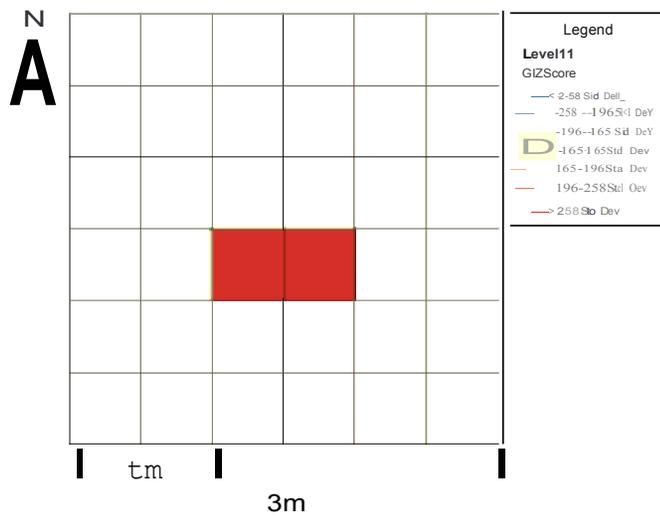
Sub-zone BI Horizontal Distributions - Level11 Recoveries



Sub-zone BI Horizontal Distributions- Level10 Recoveries



Sub-zone BI Getis-Ord Gi* - Level11 Recoveries



Sub-zone BI Getis-Ord Gi* - Level10 Recoveries

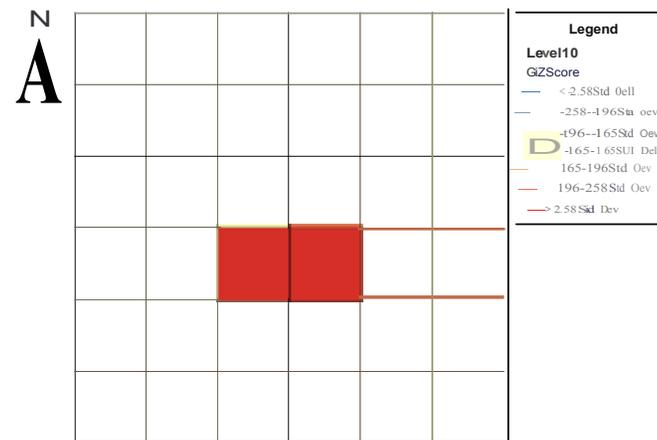
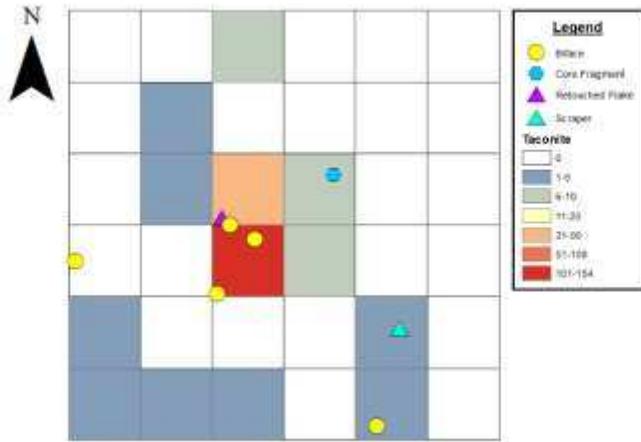


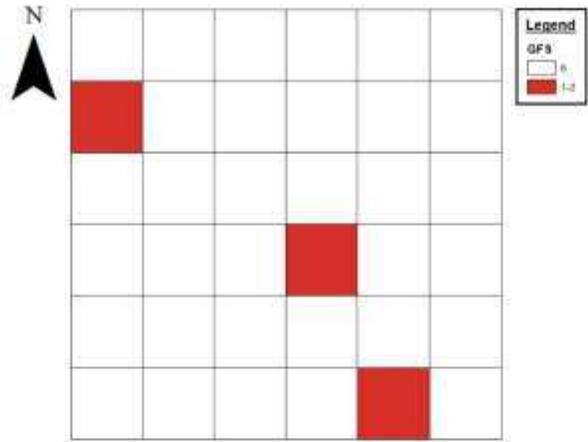
Figure 7.5.7: Distribution of sub-zone BI artifacts by level. This shows that locations of high frequency artifact recoveries remains constant.



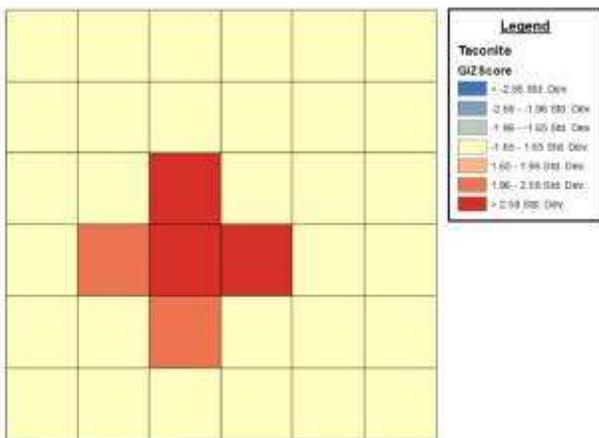
Sub-zone B1 Horizontal Distributions - Taconite



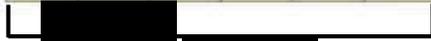
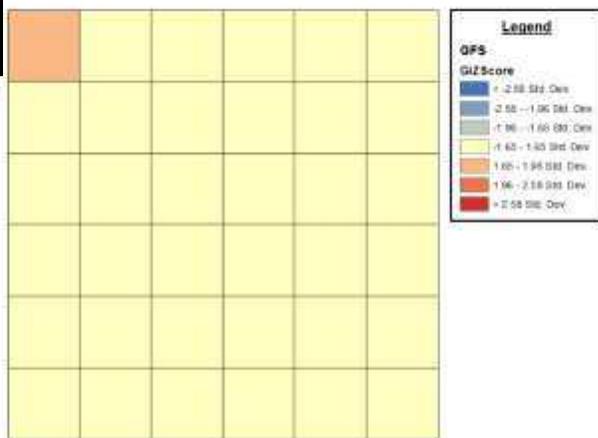
Sub-zone B1 Horizontal Distributions - GFS



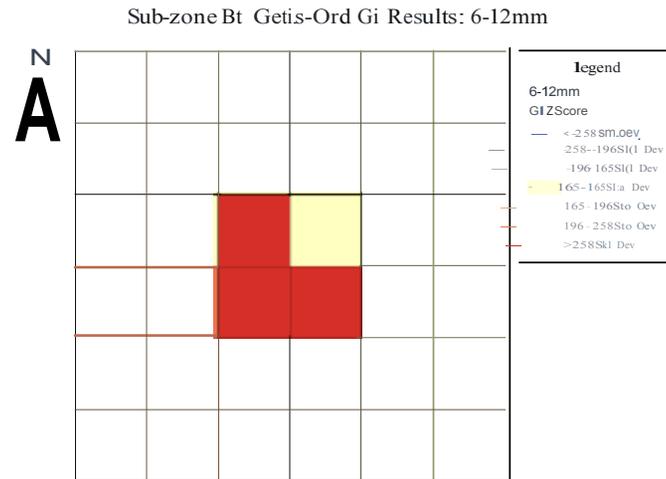
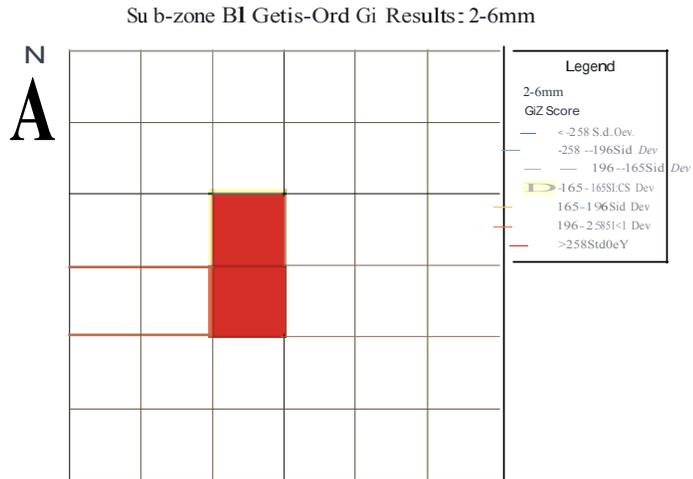
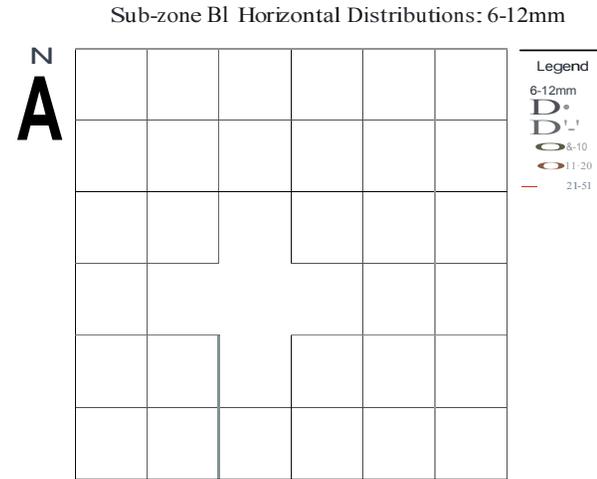
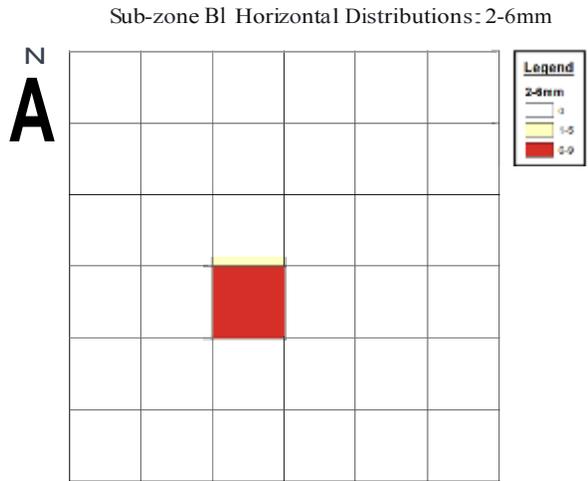
Sub-zone B1 Getis-Ord Gi - Taconite

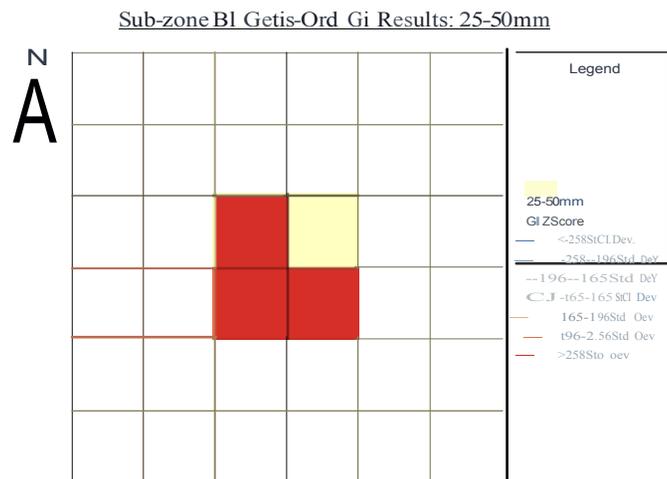
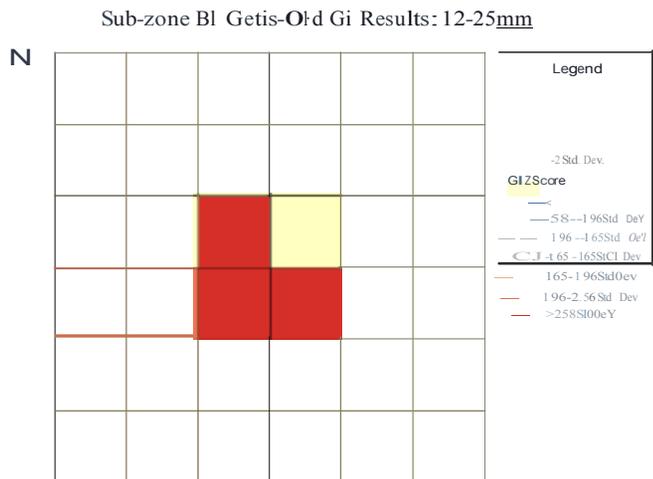
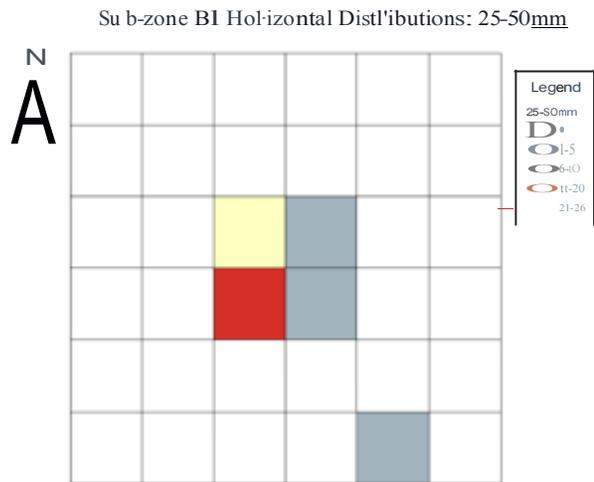
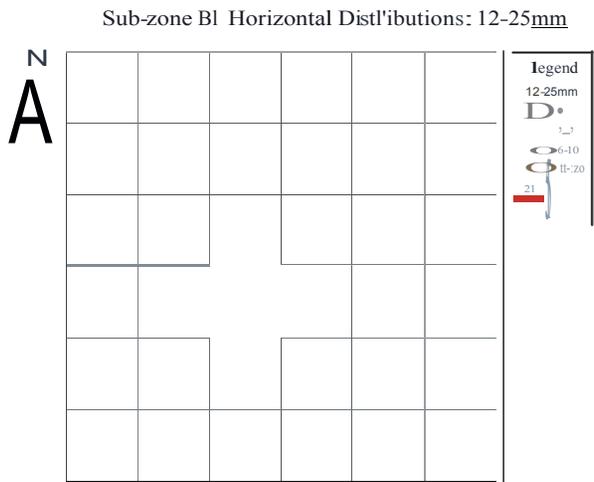


Sub-zone B1 Getis-Ord Gi - GFS

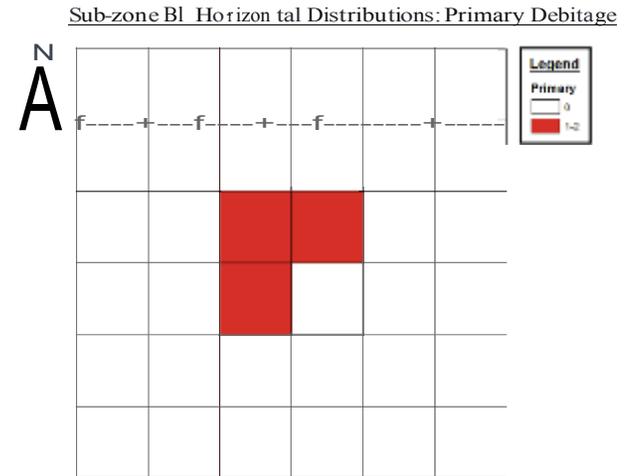
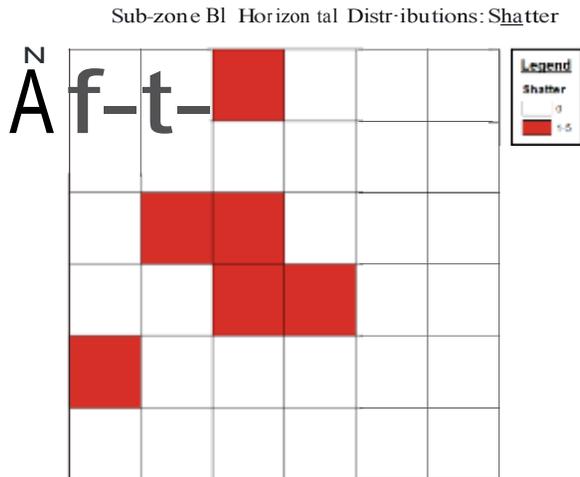
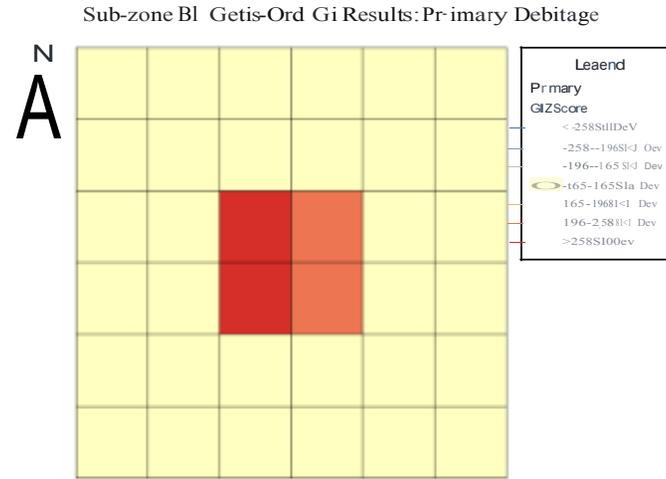
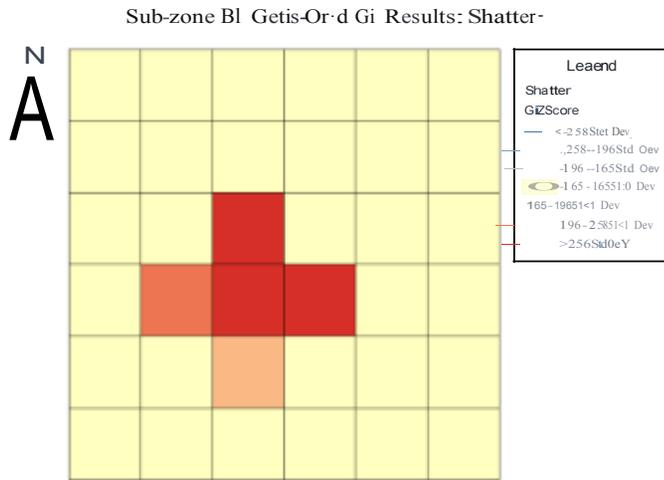


BI: Horizontal Distribution of Debitage by Size

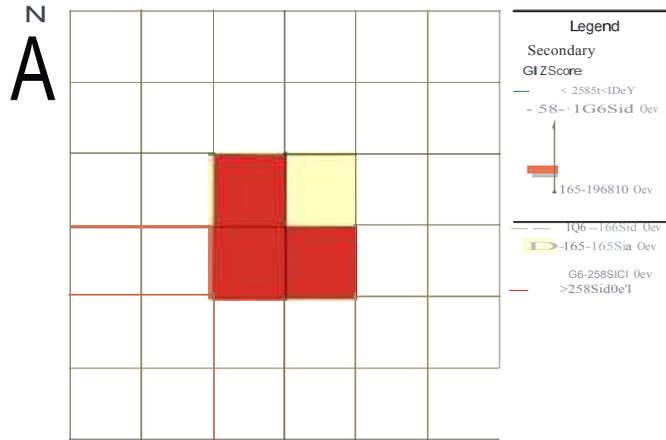




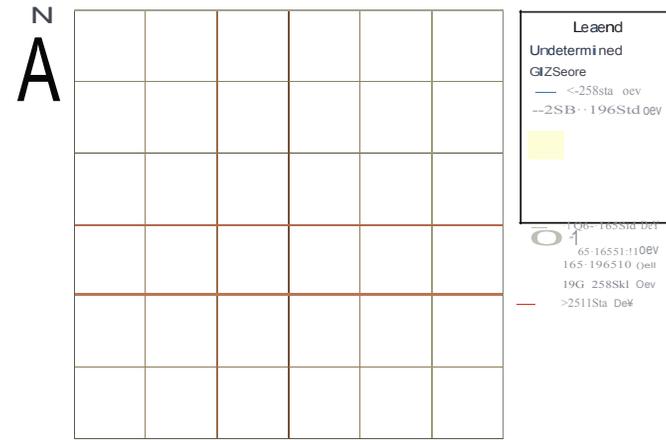
B1: Horizontal Distribution of Debitage by Size



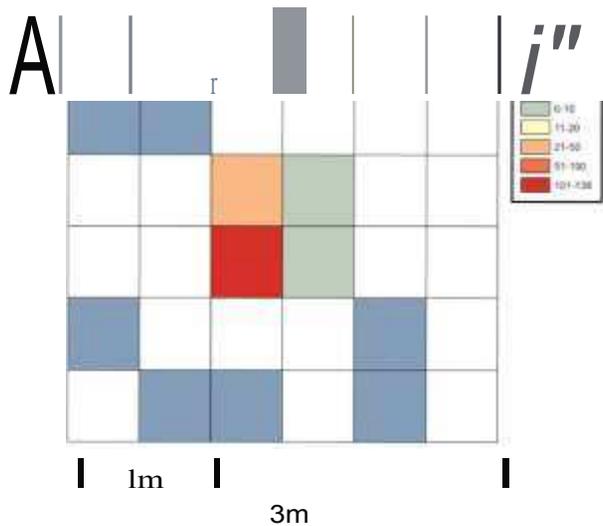
Sub-zone B1 Getis-Old Gi Results: Secondary Debitage



Sub-zone B1 Getis-Old Gi Results: Secondary Debitage



Sub-zone B1 Horizontal Distributions: Secondary Debitage



Sub-zone B1 Horizontal Distributions: Undetermined Debitage

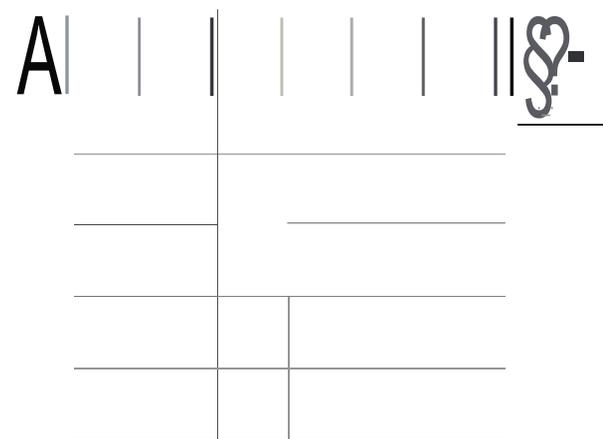


Figure 7.5.10: Distribution sub-zone B1 debitage by type.

Sub-zone B1 Artifact Distributions with Debitage Quantities by Quadrat

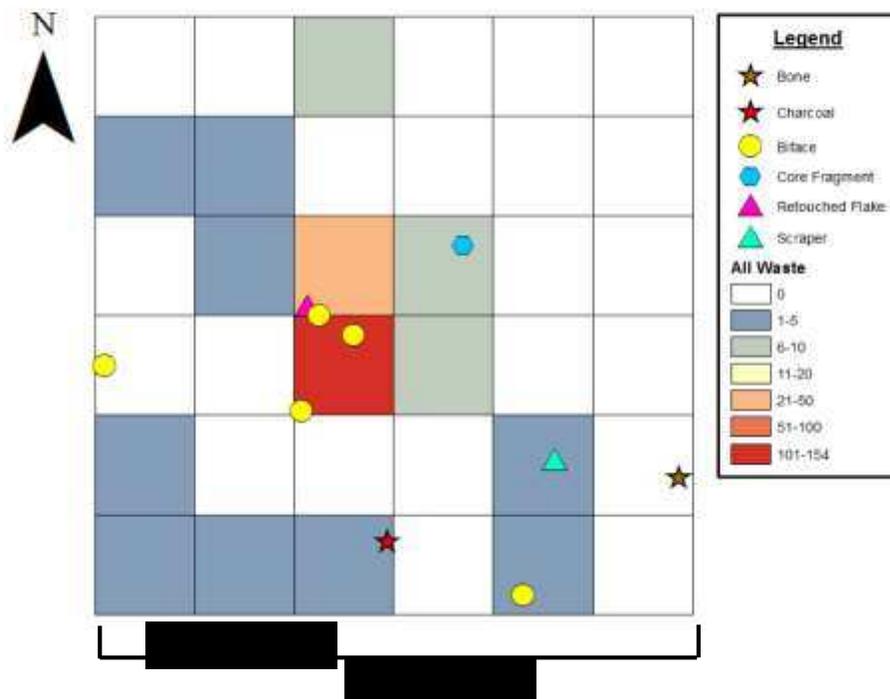


Figure 7.5.11: Distribution of sub-zone B1 tools with total debitage by quad.

Sub-zone B1 Horizontal Distributions: Bifaces by Stage

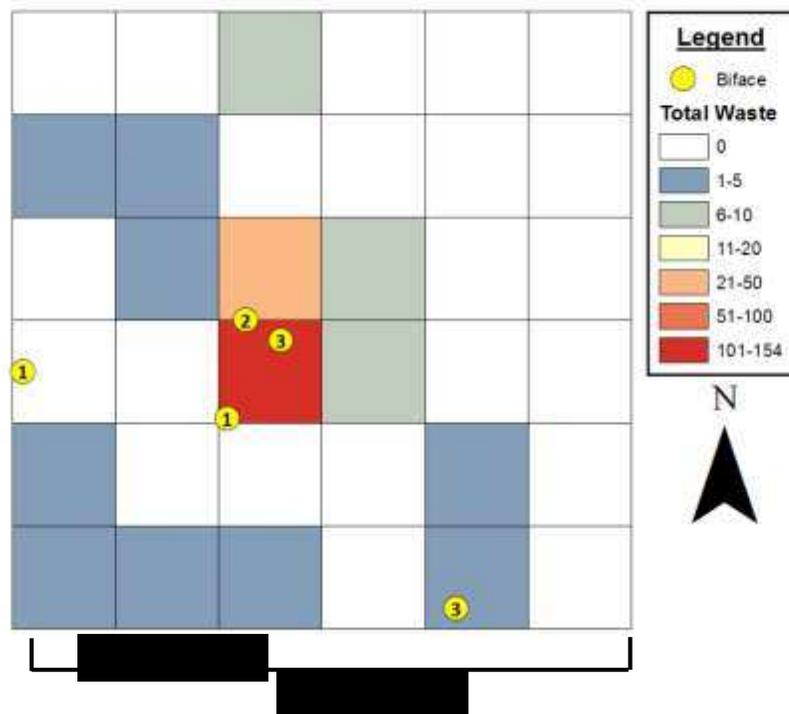


Figure 7.5.12: Sub-zone B1 biface distributions by stage.

7.5.8 B1: NSG Results

NSG results do not appear to indicate any substantial anomalies within sub-Zone B1 (Figure 7.5.13). However, a slightly higher reading does occur within the lower mid-section of the sub-zone.

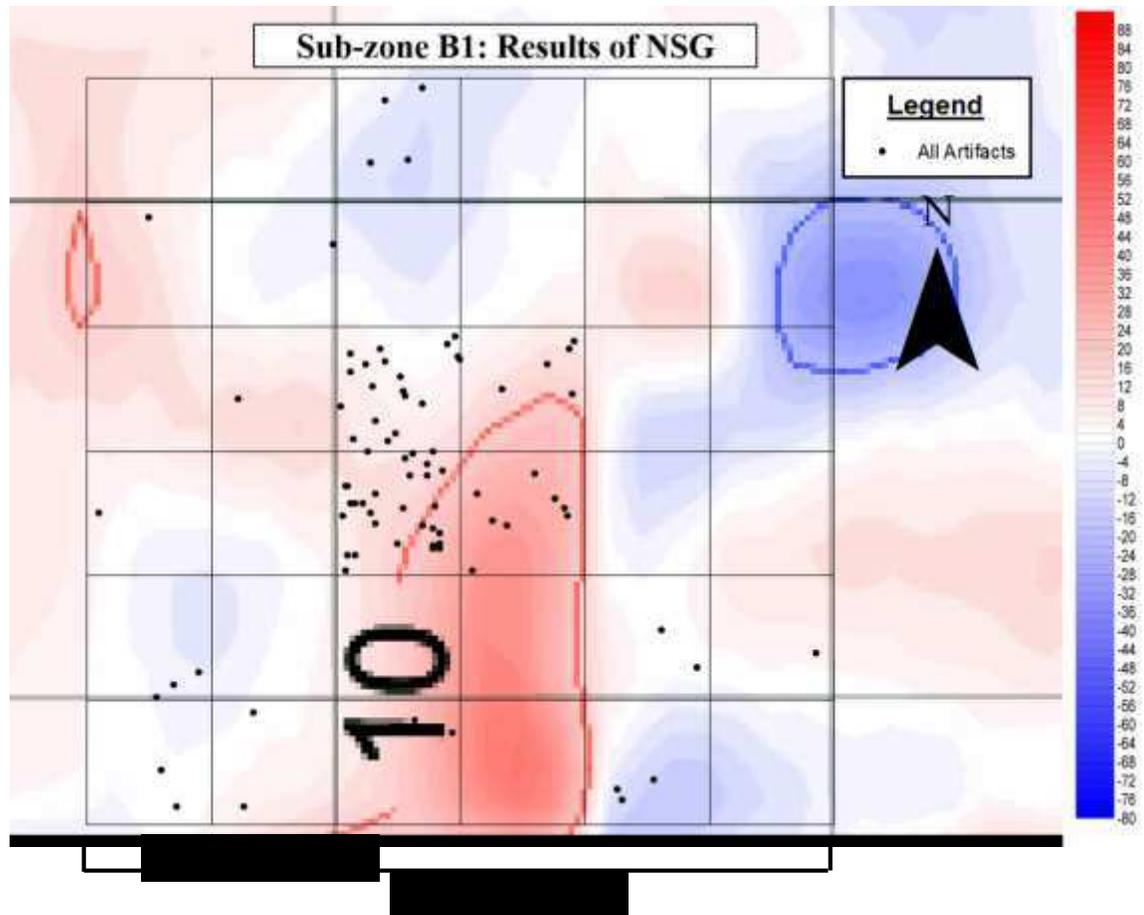


Figure 7.5.13: NSG results for sub-zone B1.

7.6 Sub-Zone: B2

Sub-Zone B2 covered the largest lithic cluster within the southern portion of the RLF site. This sub-zone consisted of 96 50 x 50cm quadrats within a crescent shaped distribution (Figure 7.6.1).

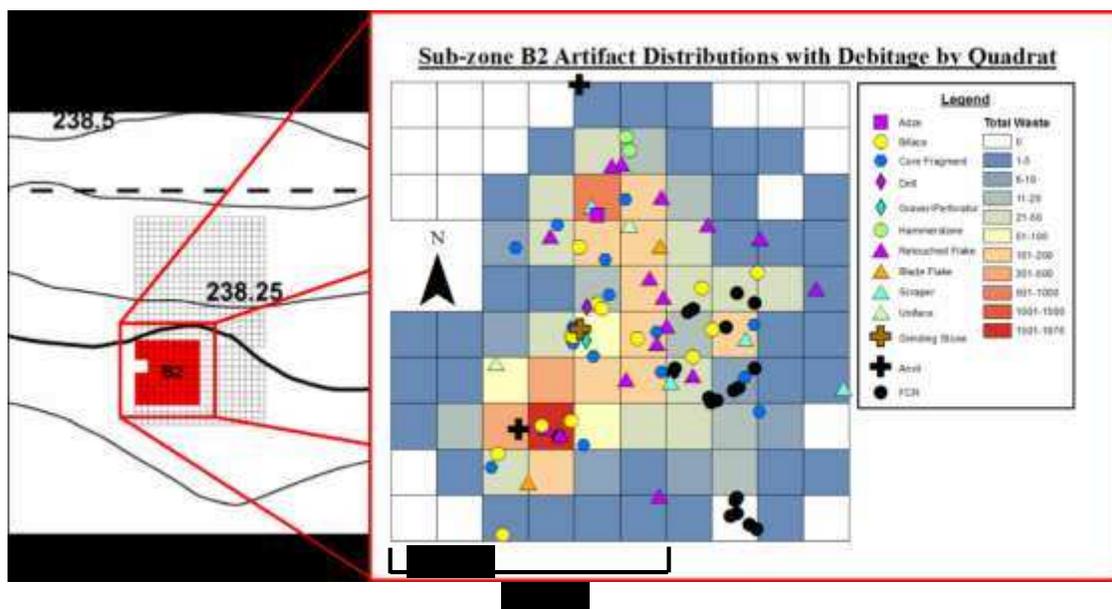


Figure 7.6.1: Sub-zone in relation to topography with a close up of sub-zone B2 illustrating all tool recoveries with total debitage by quad.

7.6.1 B2: Artifact Recoveries

A total of 5,461 artifacts were recovered from sub-zone B2. This included 63 tools (frequency = 67). A breakdown of tools by type can be seen in Table 7.6.1. Tool recoveries were further analysed by core cortex type (Table 7.6.2), biface stage (Table 7.6.3), and retouched flake type (Table 7.6.4).

Debitage recoveries consist of 5,315 total pieces. These were further broken down by material, type, and size (Tables 7.6.5 – 7.6.7 respectively). Other recoveries included FCR (n = 52), charcoal (n = 20), and miscellaneous items (n = 7).

Table 7.6.1: Sub-zone B2 tool recoveries by type.

Note: Bracketed number represents total without refitted artifacts

B2: TOOLS	
TYPE	Frequency
CORE	17
BIFACE	14 (15)
ADZE	1
DRILL	1
ANVIL	2
GRAVER/PERFORATOR	1
GRINDING STONE	1
HAMMERSTONE	2
RETOUCHED FLAKE	16 (17)
BLADE FLAKE	2
SCRAPER	4 (5)
UNIFACE	2 (3)

Table 7.6.2: Sub-zone B2 core frequencies by cortex type.

B2: CORES	
CORTEX	Frequency
N/A	10
COBBLE	4
TABULAR	3

Table 7.6.3: Sub-zone B2 biface frequencies by stage following Bennett (2015). Note: this includes adze and drill recoveries.

B2: BIFACE	
STAGE	Frequency
N/S	0
1	1 (2)
2	8
3	5
4	0
5	1
6	1

Table 7.6.4: Breakdown of sub-zone B2 retouched flakes by either incidental or intentional flaking.

B2: RETOUCHE FLAKES	
INTENTIONAL	10 (11)
INCIDENTAL	6

Table 7.6.5: Sub-zone B2 debitage by material.

B2: DEBITAGE	
MATERIAL	Frequency
TACONITE	4583
GFS	701
SILTSTONE	9
CHERT	4
QUARTZ	5
AMETHYST	2
OTHER	11

Table 7.6.6: Sub-zone B2 debitage by type.

B2: DEBITAGE	
TYPE	Frequency
PRIMARY	112
SECONDARY	3829
TERTIARY	165
UNDETERMINED	835
SHATTER	374

Table 7.6.7: Sub-zone B2 debitage by size grade.

B2: DEBITAGE	
SIZE	Frequency
0-2MM	0
2-6MM	1026
6-12MM	2452
12-25MM	1384
25-50MM	427
50+MM	26

7.6.2 *B2: Vertical Distribution*

The vertical distribution of artifacts from sub-zone B2 exhibit highest recovery frequencies in levels 2, 3, and 4, with peak densities in level 3 (Figure 7.6.2). Exploring artifact distributions by size produces a similar distribution with the exception of 2-6mm debitage, which occurs in greatest frequencies around level 2 (Figure 7.6.3).

It was noted that recovery outliers existed within sub-zone data. A single flake was recovered from excavation level 16 in the Southwest quad of unit 485N/451E. Further inquiry determined that the flake likely fell into the unit during profile trenching,

as there were no other artifact recoveries above or below. As such, this level was removed from the study of this sub-zone.

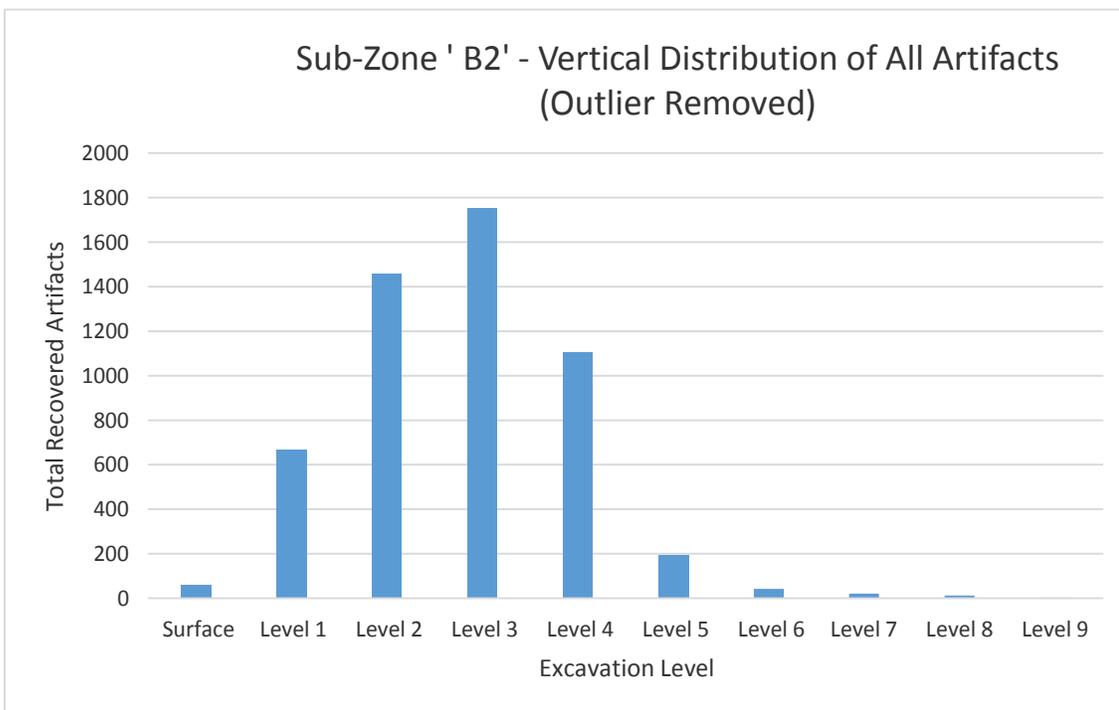


Figure 7.6.2: Total recoveries by level for sub-zone B2.

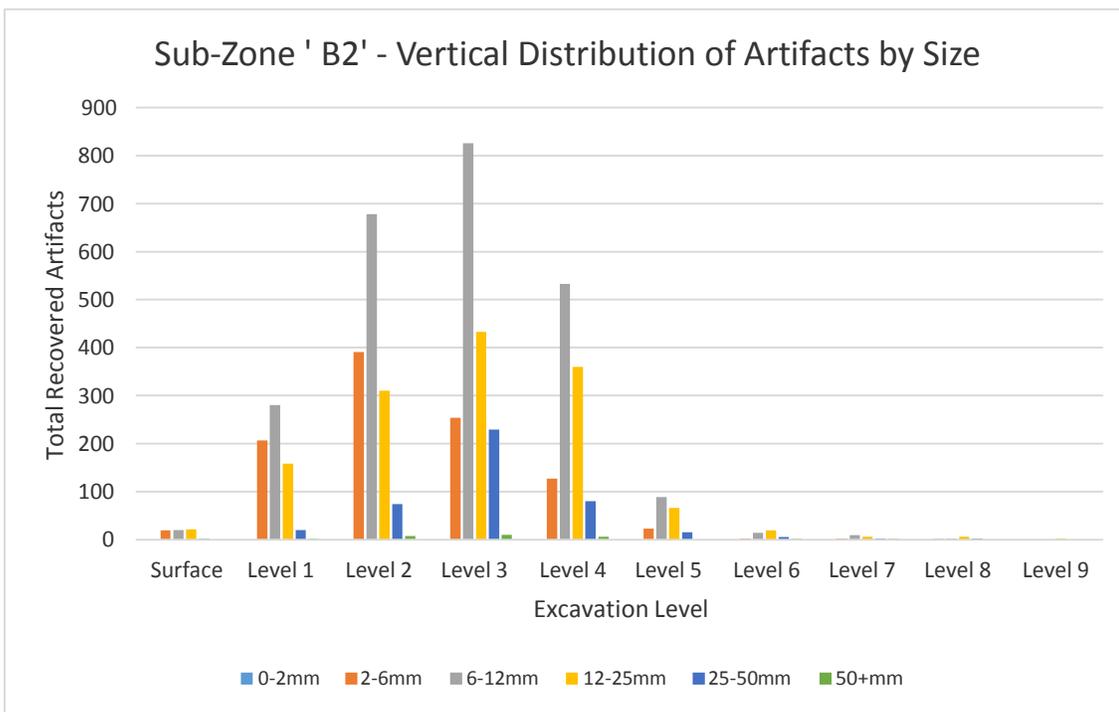


Figure 7.6.3: Sub-zone B2 total recoveries by size and level.

7.6.3 B2: Horizontal Distribution: General

Statistical clustering tests indicate that the observed artifact distributions are highly clustered (Figures 7.6.4 - 7.6.6). The results of both nearest neighbour and Getis-Ord G_i^* indicate that there is a less than 1% chance that the observed artifact distribution could be the result of random chance.

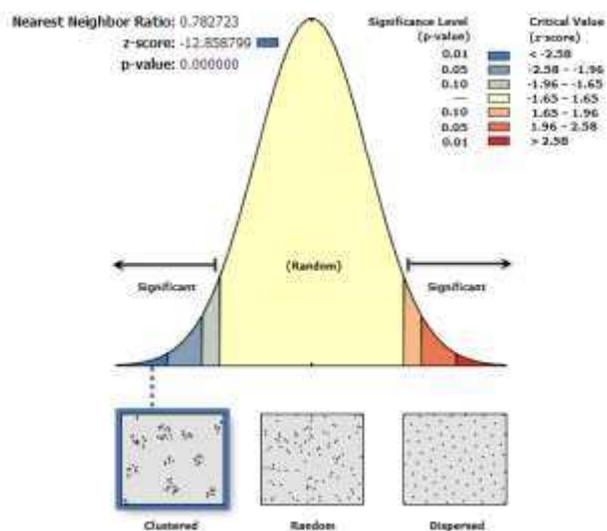


Figure 7.6.4: Results of nearest neighbour analysis indicating that at a z-score of -12.858799 there is a less than 1% chance that the observed distribution is the result of random chance.

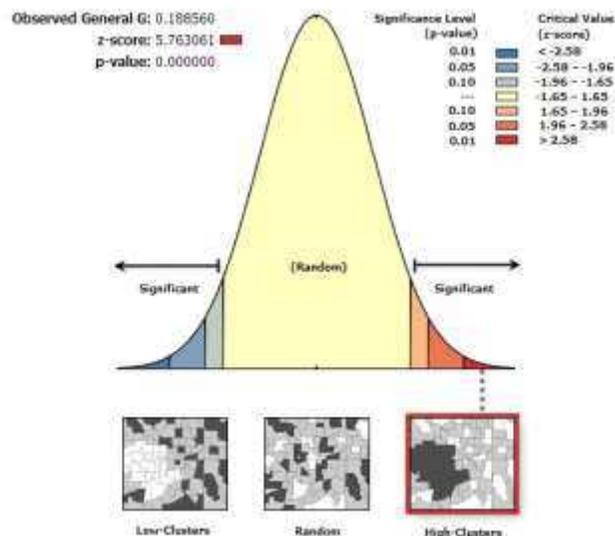


Figure 7.6.5: Results of Getis-Ord G_i^* analysis indicating that at a z-score of 5.763061 there is a less than 1% chance that the observed distribution is the result of random chance.

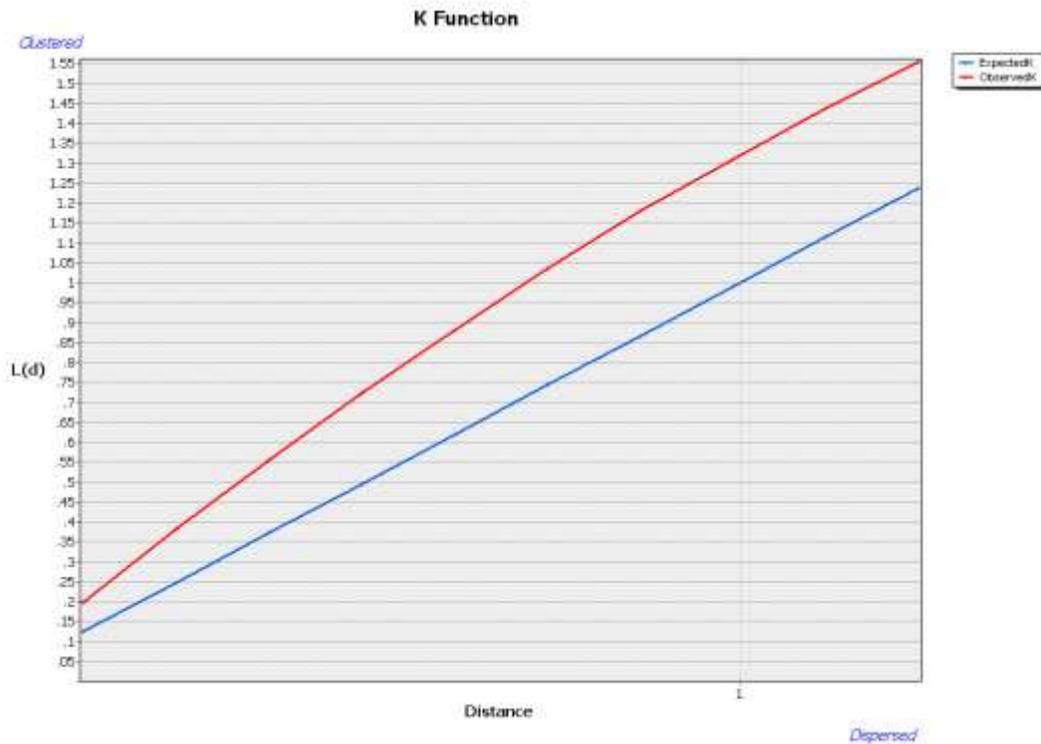


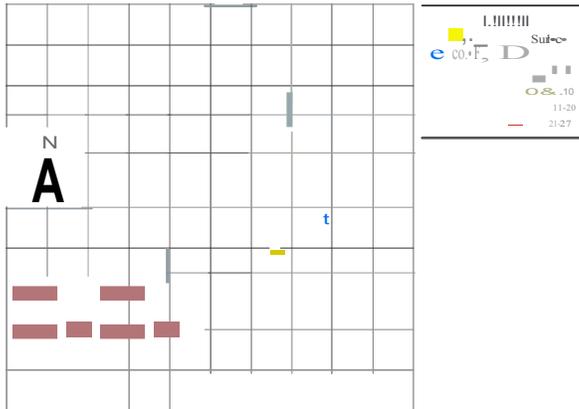
Figure 7.6.6: Graph of Ripley's K function analysis illustrating that the observed distribution is likely the result of a clustered distribution.

7.6.4 B2: Horizontal Distribution: Recoveries by Level

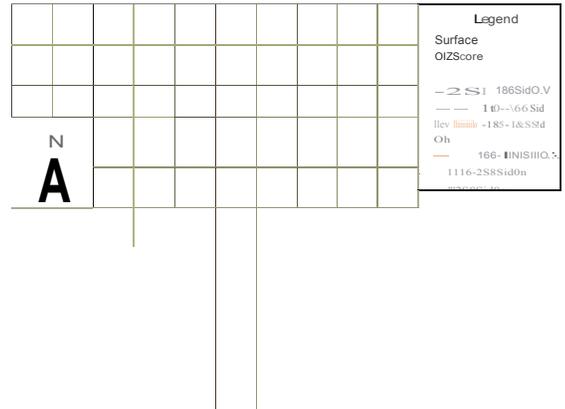
Artifact recoveries by level in sub-zone B2 indicate that highest artifact recoveries remain constant over two cluster areas; one in the north and one in the south (Figure 7.6.7). Clustering remains concentrated within these areas until Level 6, where concentration then tend towards areas of FCR recovery. Recoveries of FCR in sub-zone B2 come from between Levels 2 and 6, while tool recoveries range from surface collected materials to Level 8.

B2: Horizontal Distribution of Artifacts by Level

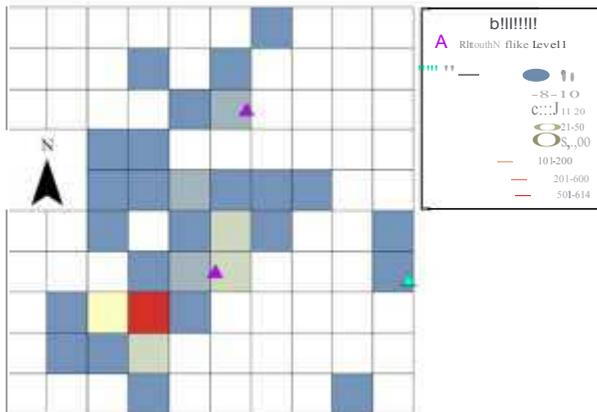
Sub-zone 82 Horizontal Distributions- Surface Recoveries



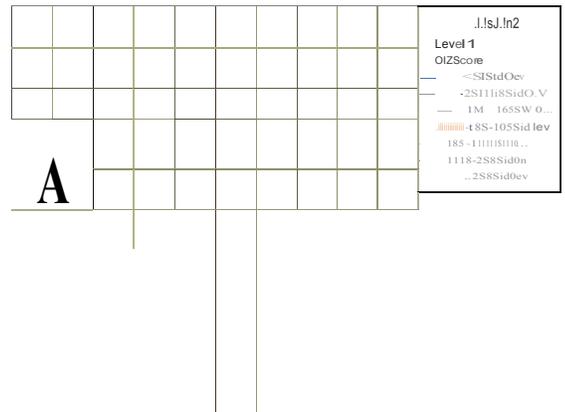
Sub-zone B2 Getis-Ord Gi Results- Surface Recoveries



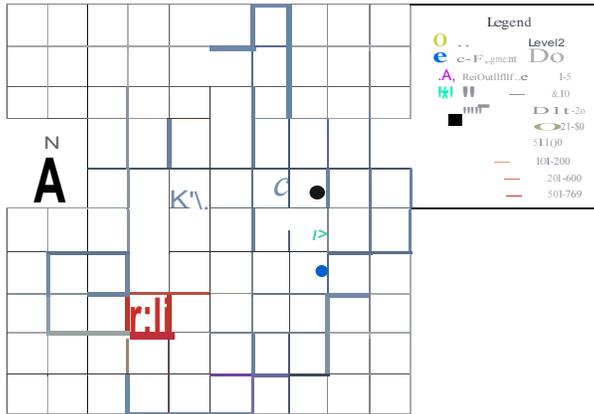
Sub-zone B2 Horizontal Distributions - Level I Recoveries



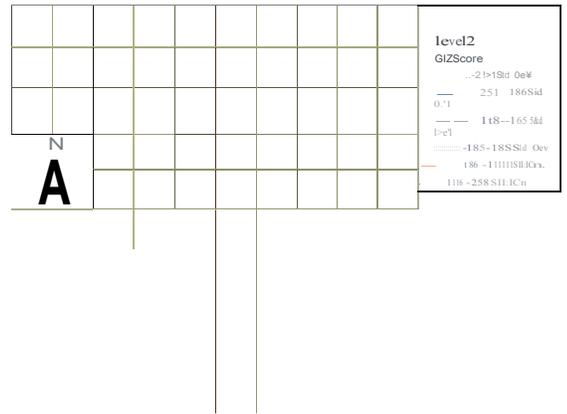
Sub-zone B2 Getis-Ord Gi Results- Level I Recoveries



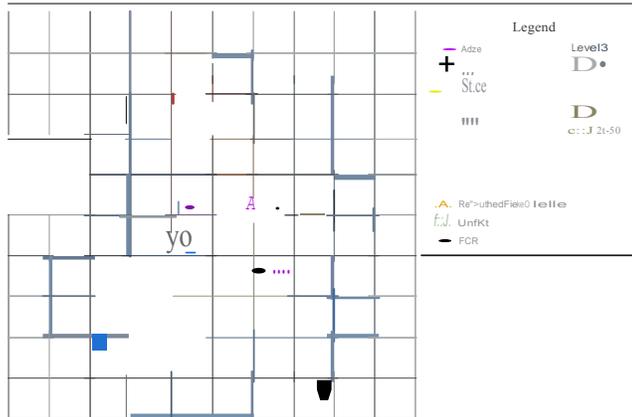
Sub-zone 82 Horizontal Distributions - Level 2 Recoveries



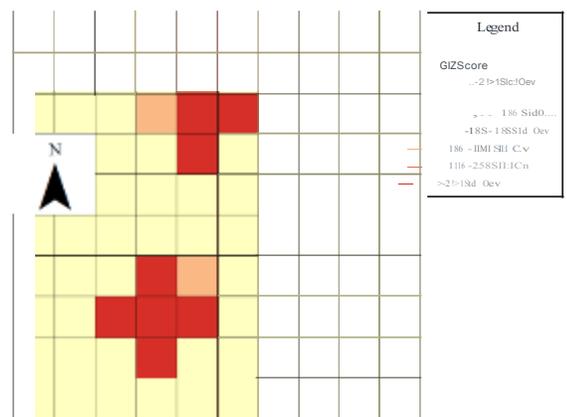
Sub-zone B2 Getis-Ord Gi Results - Level 2 Recoveries



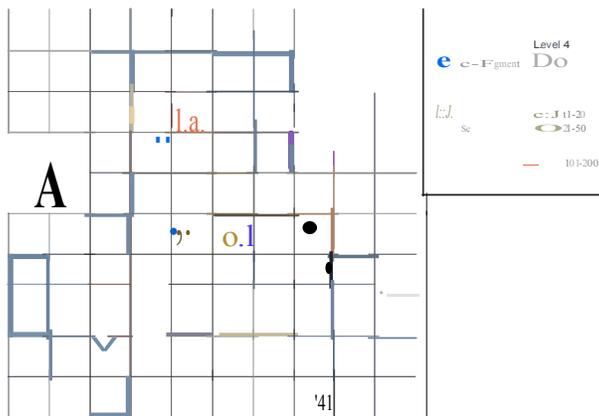
Sub-zone B2 Horizontal Distributions - Level 3 Recoveries



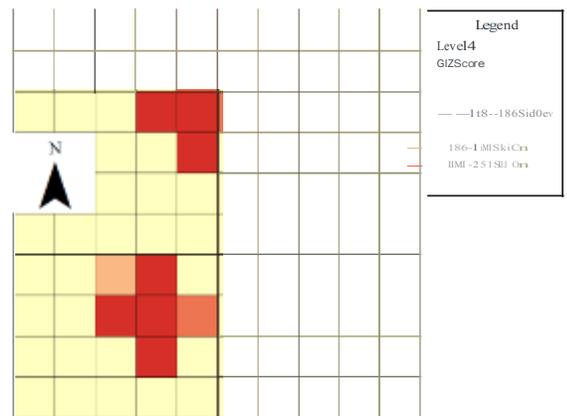
Sub-zone B2 Getis-Ord Gi Results - Level 3 Recoveries



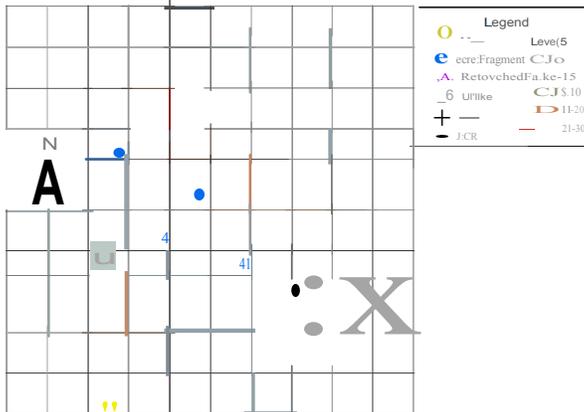
Sub-zone B2 Horizontal Distributions - Level 4 Recoveries



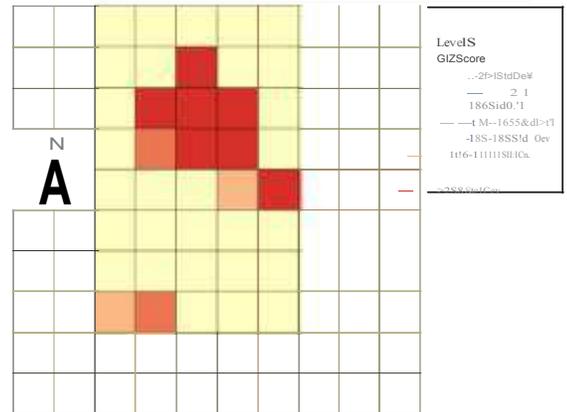
Sub-zone B2 Getis-Ord Gi Results - Level 4 Recoveries



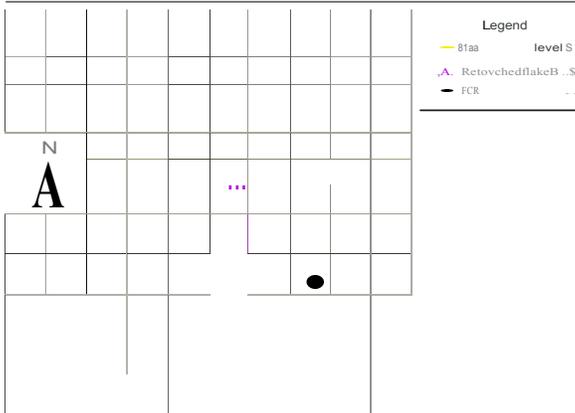
Sub-zone 82 Horizontal Distributions - Level 5 Recoveries



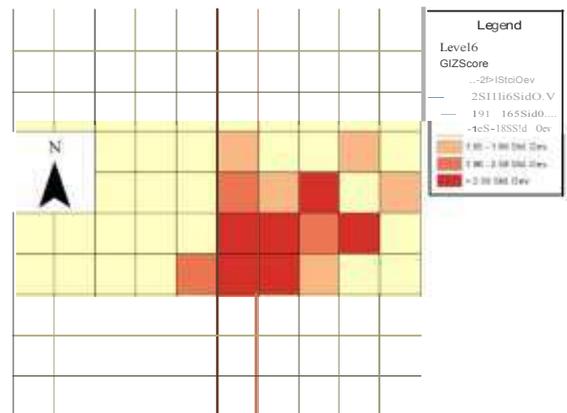
Sub-zone B2 Getis-Ord Gi Results - Level 5 Recoveries



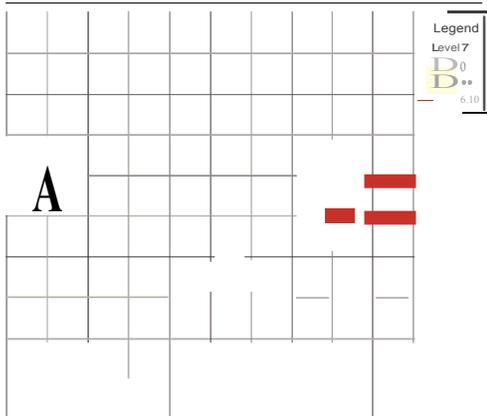
Sub-zone B2 Horizontal Distributions - Level 6 Recoveries



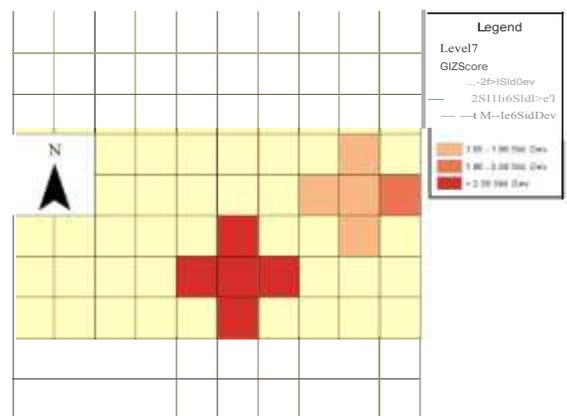
Sub-zone B2 Getis-Ord Gi Results - Level 6 Recoveries



Sub-zone B2 Horizontal Distributions - Level 7 Recoveries



Sub-zone B2 Getis-Ord Gi Results - Level 7 Recoveries



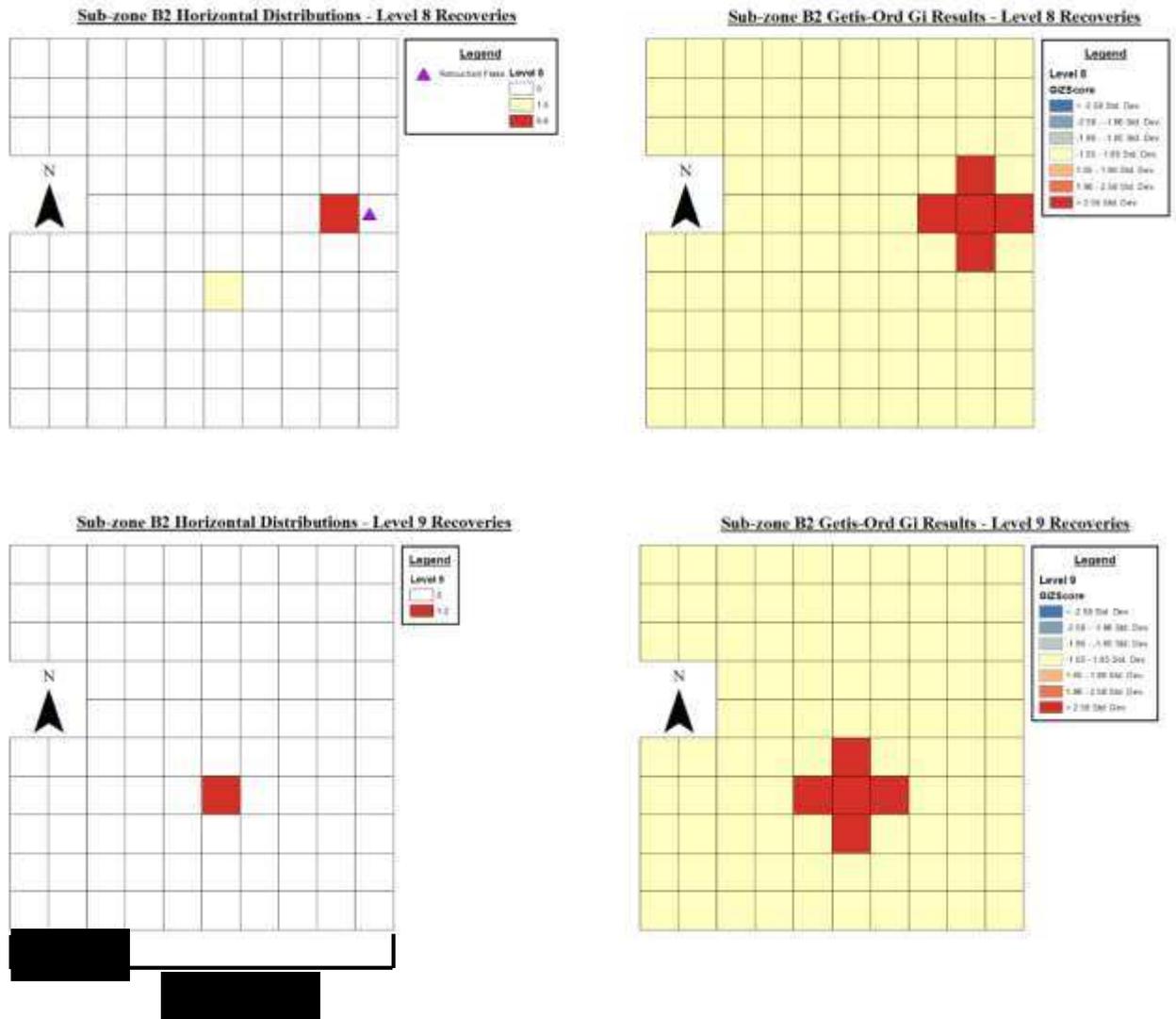


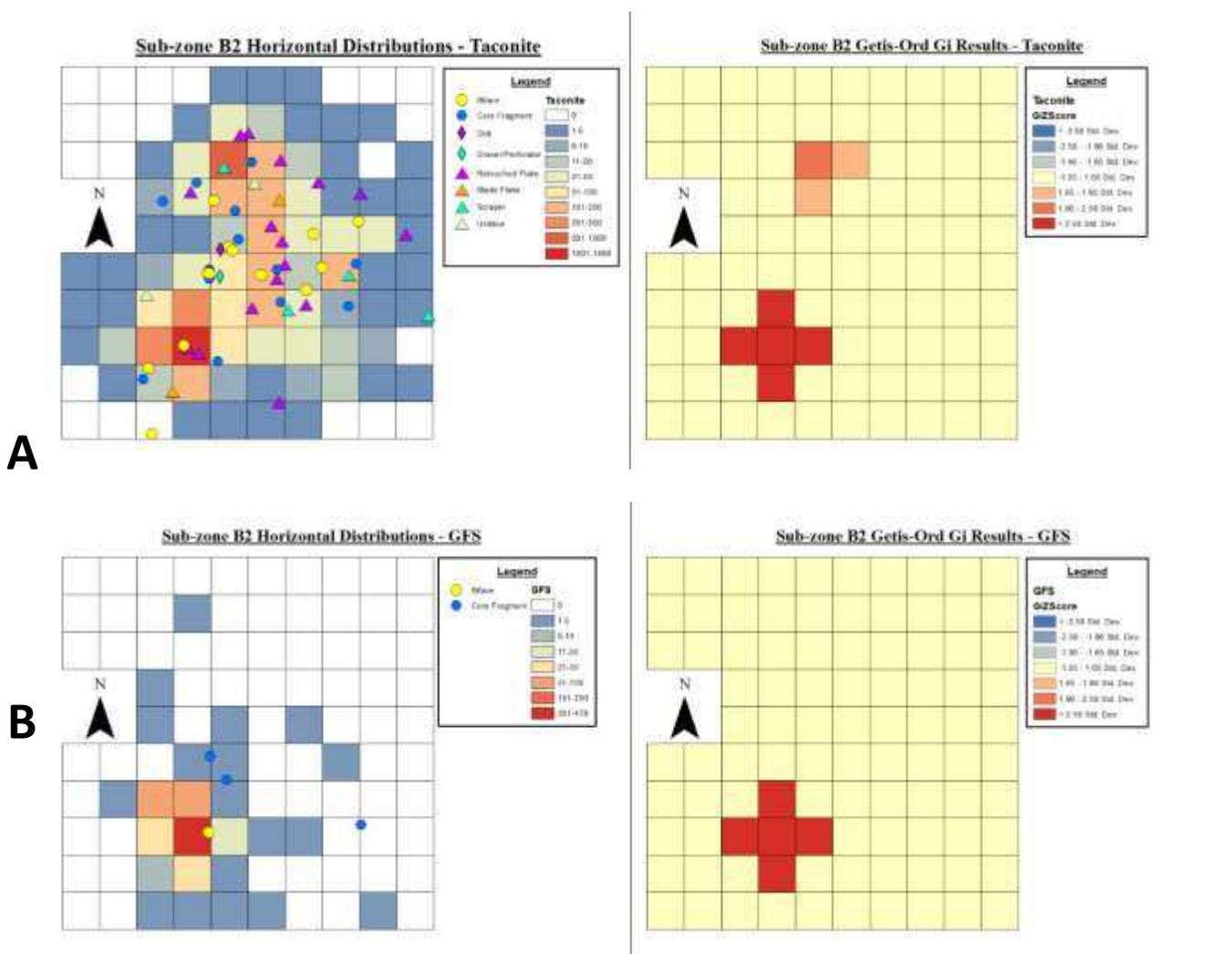
Figure 7.6.7: Distribution of sub-zone B2 artifacts by level indicating two primary clustering areas.

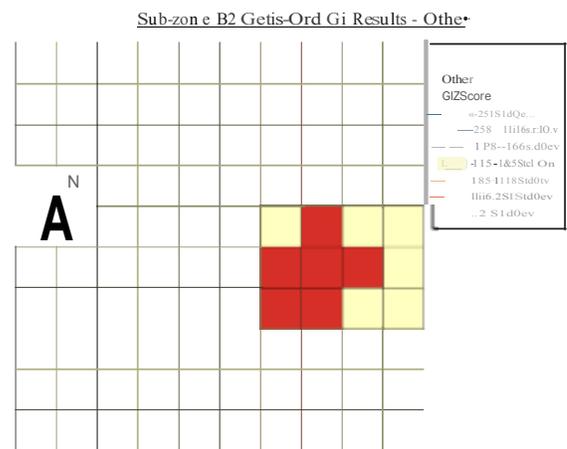
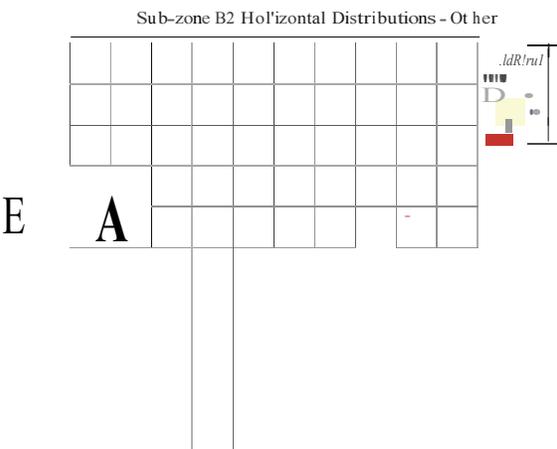
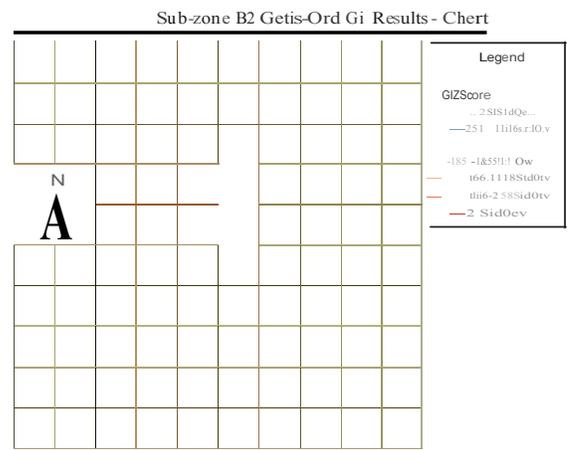
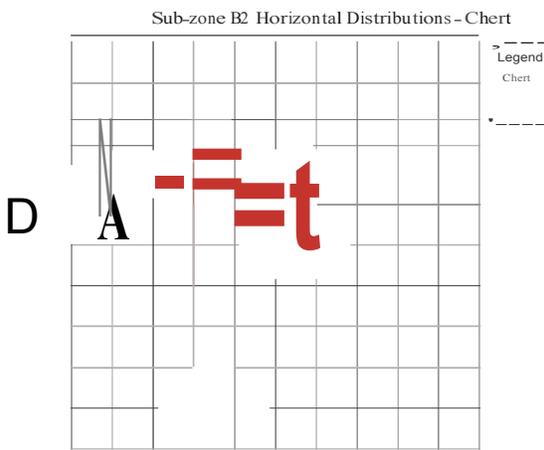
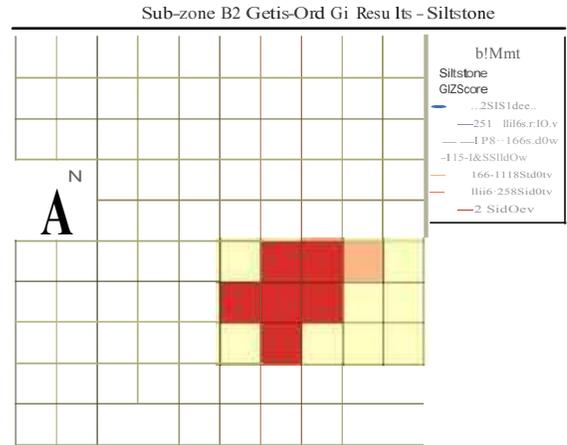
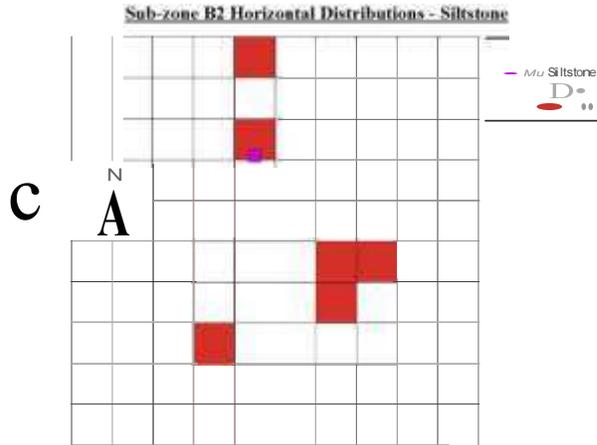
7.6.5 B2: Horizontal Distribution: Recoveries by Material Type

The material types recovered from sub-zone B2 included taconite, gunflint silica, siltstone, chert, ‘other’, quartz, and amethyst (Figure 7.6.8 A-G). Recovered in extremely low frequencies, the distribution of chert, quartz, and amethyst loosely coincide with high artifact recovery zones previously identified. Siltstone and ‘other’ material recoveries however were more closely distributed near FCR recoveries.

Taconite and gunflint silica represented the highest frequency of recoveries by material. The distribution of taconite within sub-zone B2 occurred in highest amounts within the two previously identified cluster locations, with lower recovery rates distributed in-between. Meanwhile, the distribution of gunflint silica cores and debitage were highly clustered within the south. There are limited distributions of this material in other areas of the subzone.

B2: Horizontal Distribution of Artifacts by Material





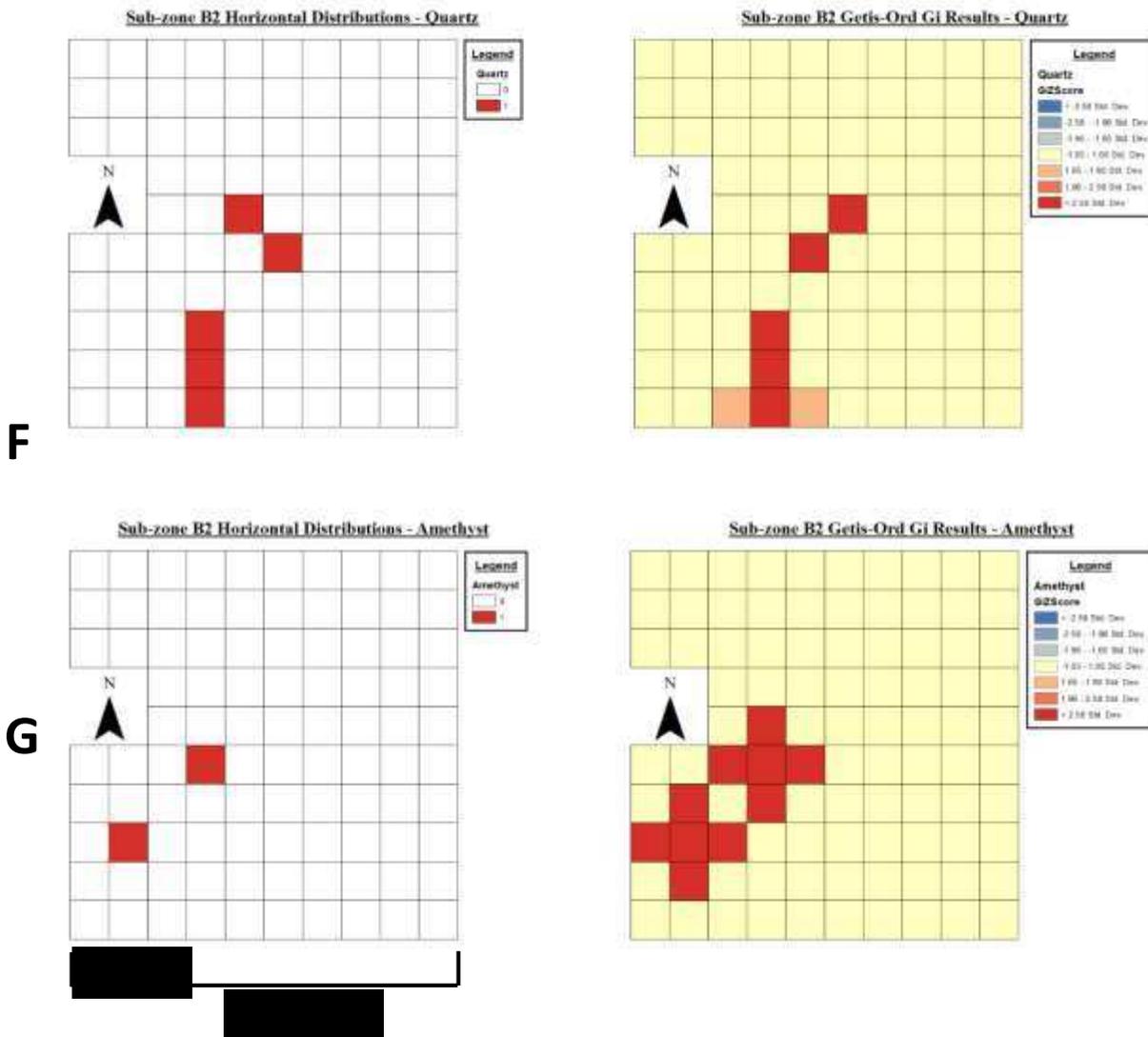


Figure 7.6.8: Distribution of sub-zone B2 artifacts by materials type: A) Taconite, B) Gunflint silica, C) Siltstone, D) Chert, E) 'Other', F) Quartz, and G) Amethyst.

7.6.6 B2: Horizontal Distribution: Debitage

The overall distribution of debitage within sub-zone B2 clearly exhibits the presence of two high density recovery locations with a lower frequency area bridging the two clusters (Figure 7.6.9). Debitage distributions were further analysed by debitage size and type in order to further investigate this pattern.

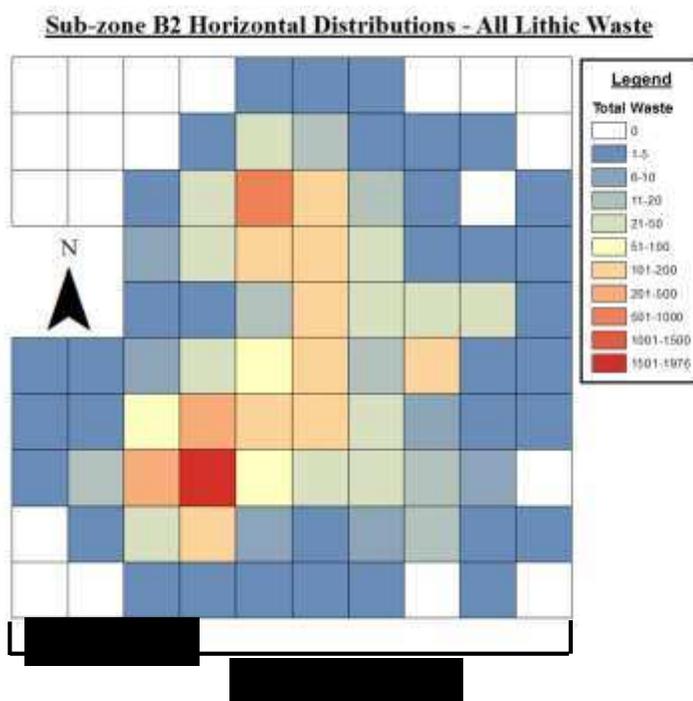


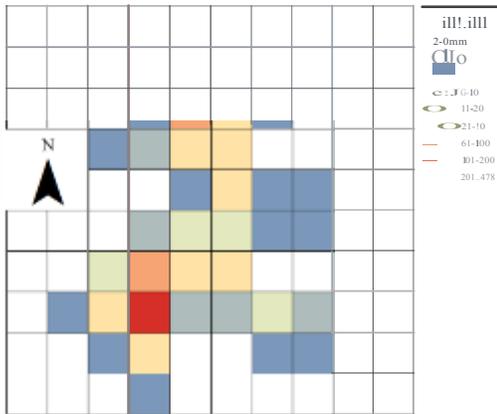
Figure 7.6.9: Distribution of all sub-zone B2 debitage by quadrat showing two primary cluster locations with lesser debitage frequencies occurring in between.

Debitage Size

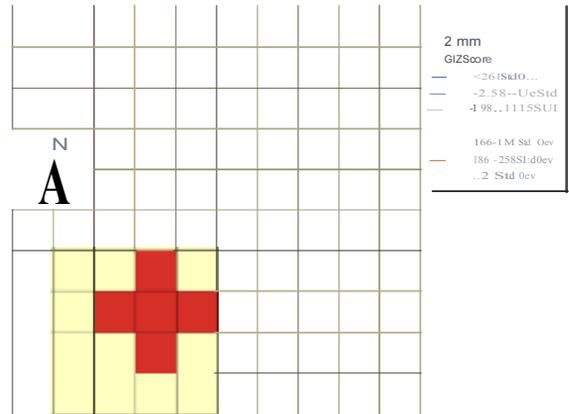
Artifact distributions by size are shown in Figure 7.6.10. The distribution of various debitage size grades maintains significant clustering in the same relative locations. However, there is an observed difference between the size compositions of those clusters. In the southern cluster zone, there appears to be a higher recovery of debitage within the 2-25mm size range, while the northern cluster yielded a greater number of large debitage between 25-50mm.

B2: Horizontal Distribution of Debitage by Size

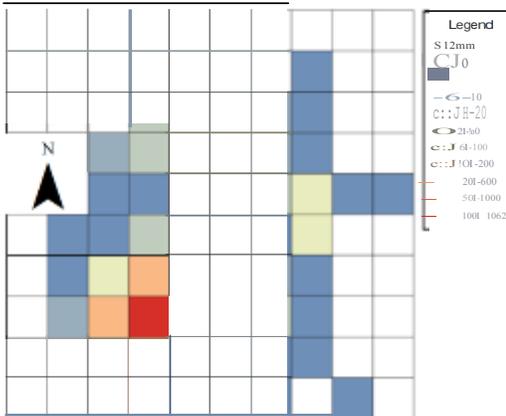
Sub-zone 82 Horizontal Distributions: 2-6mm



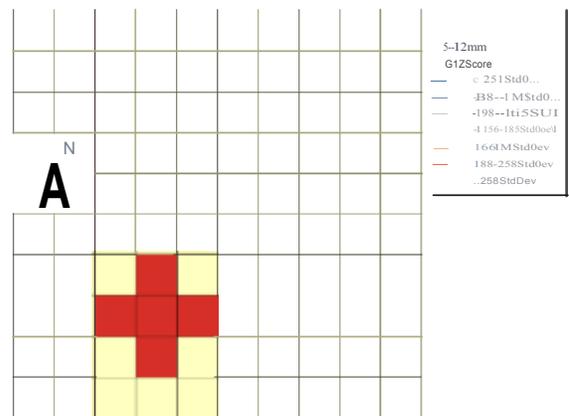
Sub-zone B2 Horizontal Distributions: 2-6mm



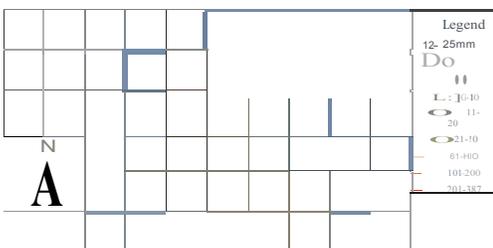
Sub-zone 82 Horizontal Distributions: 6-12mm



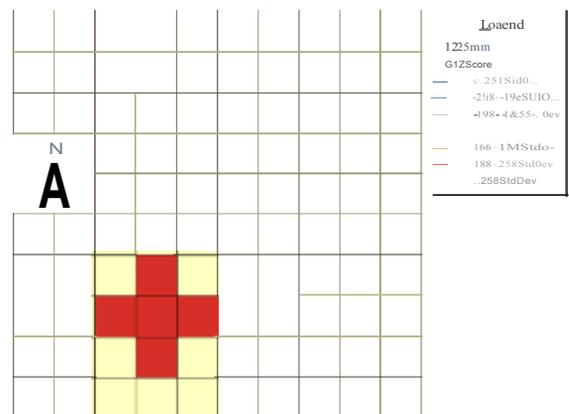
Sub-zone B2 Horizontal Distributions: 6-12mm



Sub-zone 82 Horizontal Distributions: 12-25mm



Sub-zone B2 Horizontal Distributions: 12-25mm



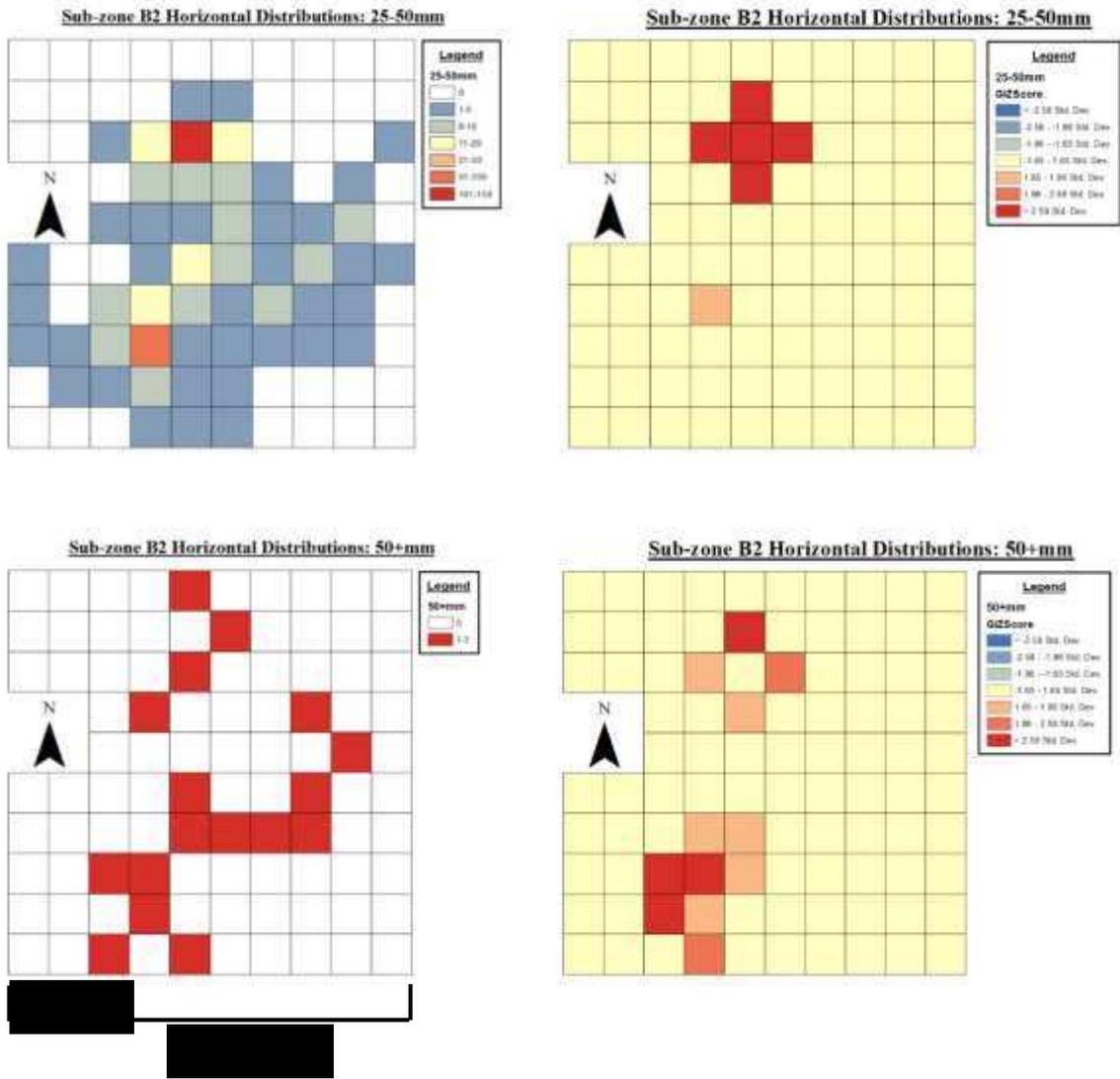
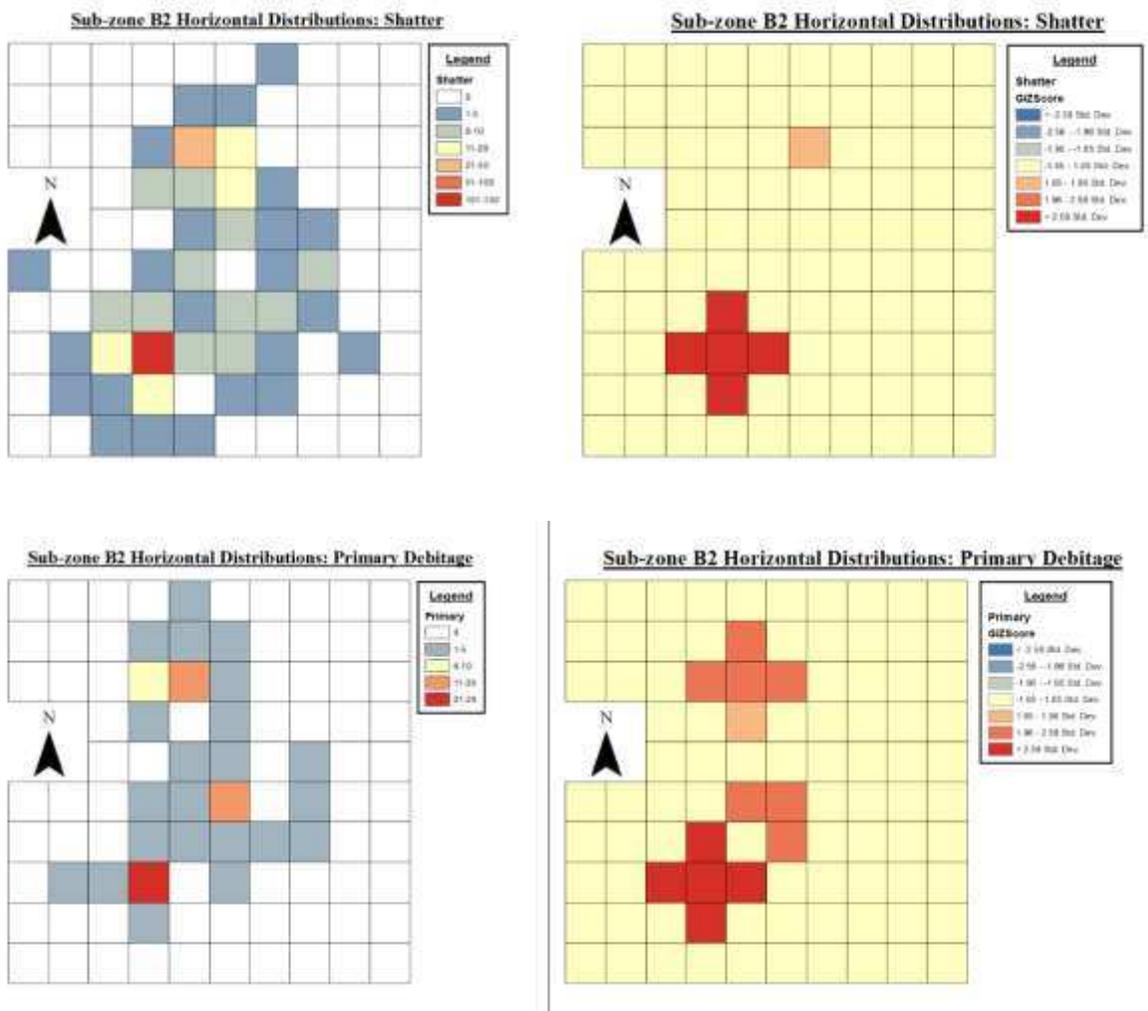


Figure 7.6.10: Sub-zone B2 debris distributions by size.

Debitage Type

Similar to debitage size distributions, the location of debitage by type coincides directly with high recovery locations (Figure 7.6.11). Highest concentrations for all debitage types occurs within the southern cluster location, while there is a slight split between northern and southern clusters regarding primary debitage hot-spots.

B2: Horizontal Distribution of Debitage by Type



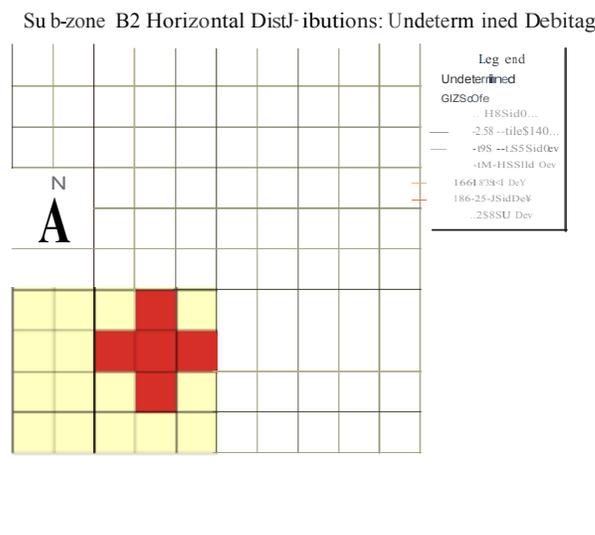
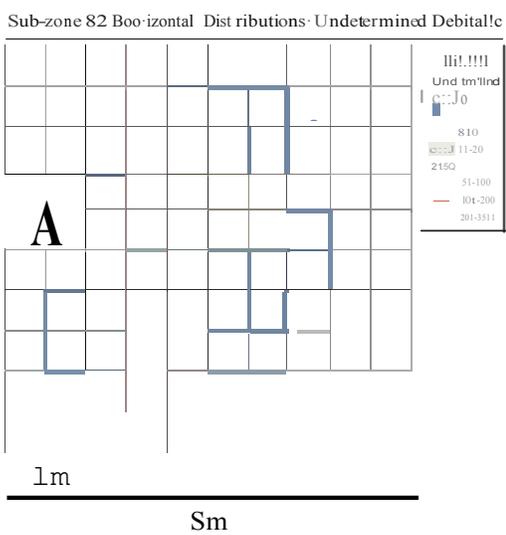
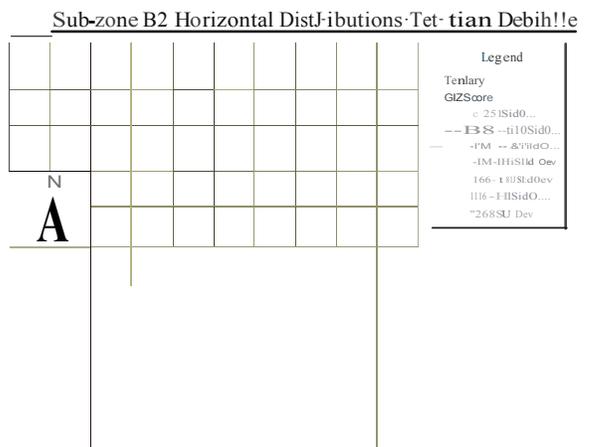
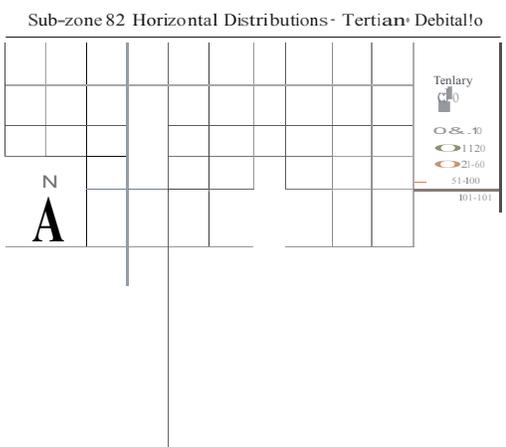
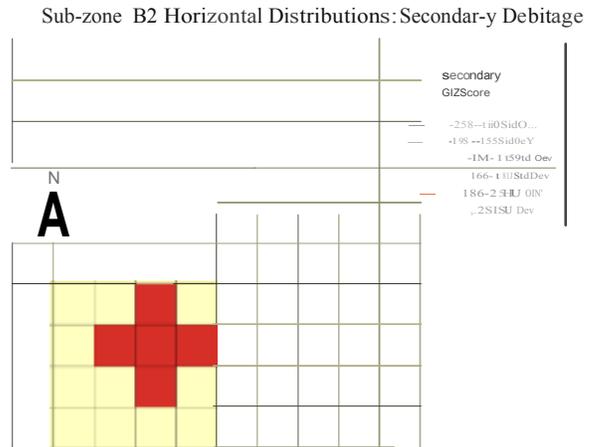
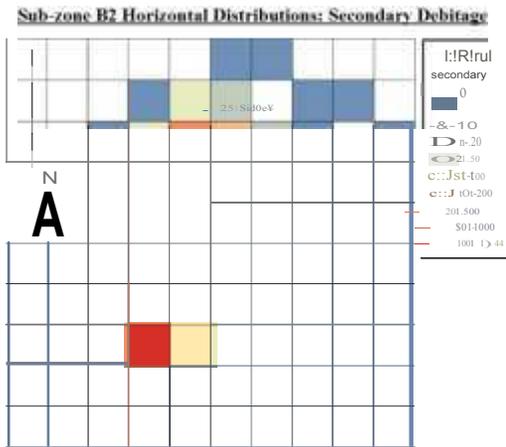


Figure 7.6.11: Sub-Zone B2debitage distribution by type.

7.6.7 B2: Horizontal Distribution: Tools

The distribution of all tool recoveries from sub-zone B2 can be seen in Figure 7.6.12. These recoveries were further analyzed by cores, bifaces, retouched flakes, FCR and charcoal distributions, and general tool distributions.

Cores

Similar to other sub-zones, the mapping of cores by cortex type does not appear to reveal any form of significant clustering. It can be noted though that the general distribution of cores occurs between the areas of highest debitage recoveries (Figure 7.6.13), with the highest concentration of cores occurring near the recovered grinding/anvil stone.

Bifaces

Bifaces from sub-zone B2 are located primarily within the areas between high debitage recoveries, similar to the distribution of cores. Assessing the distribution by stage and level does not appear to exhibit any distinct pattern (Figure 7.6.14 and Figure 7.6.15). While there may be a tendency for later stage bifaces to occur closer to the northern cluster area, this is not a direct association.

Retouched Flakes

Distributions of retouched flakes by either intentional or incidental flaking does suggest that there is a stronger distribution of intentionally retouched items within the

vicinity of FCR clustering (Figure 7.6.16). The distribution of incidental retouched items in contrast does not appear to exhibit any patterning.

Tool Refits

There are two tool refits within sub-zone B2. One consists of a broken core fragment made of gunflint silica while the other is a broken taconite core fragment. There is little separation between the two taconite pieces both vertically and horizontally. The gunflint silica cores are also within close proximity, being separated by only one vertical level and less than 50cm horizontally.

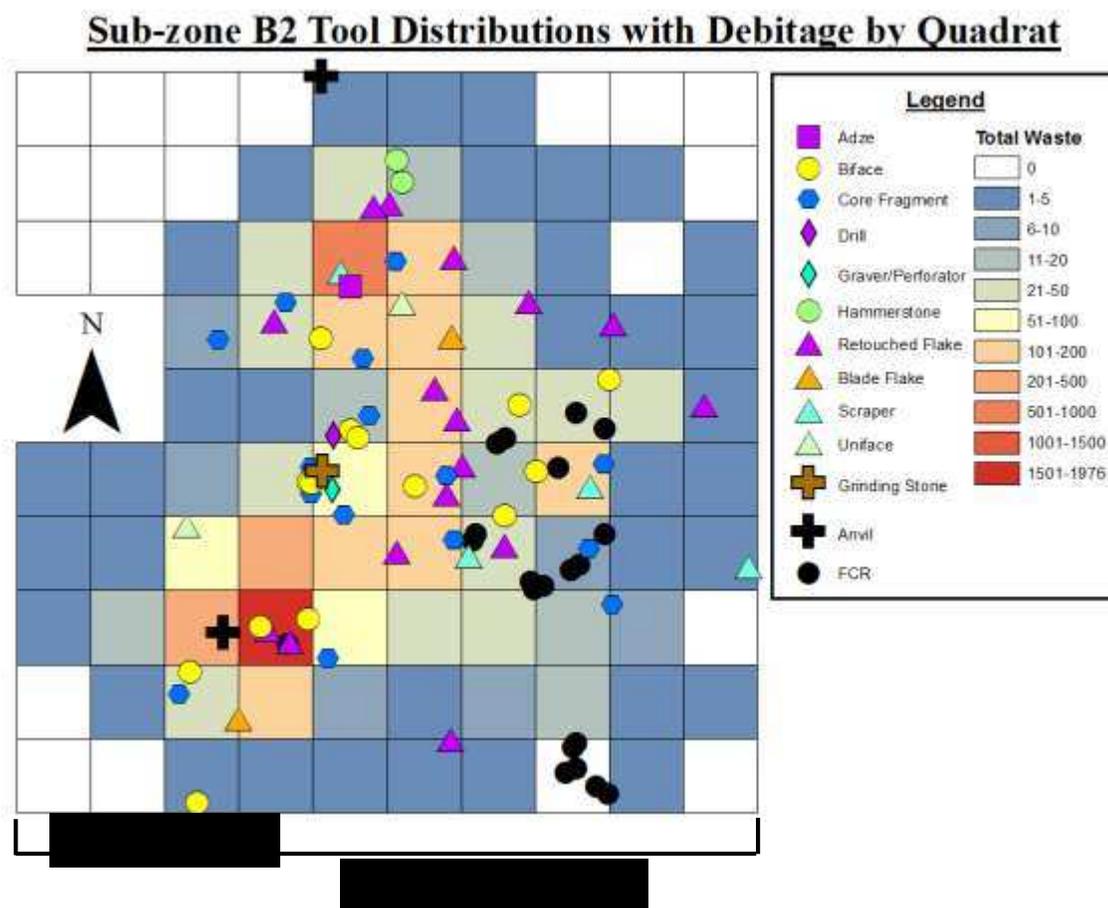


Figure 7.6.12: Distribution of all tools in sub-zone B2 with total debitage recoveries by quadrat.

Sub-zone B2 Horizontal Distributions: Core Cortex Type

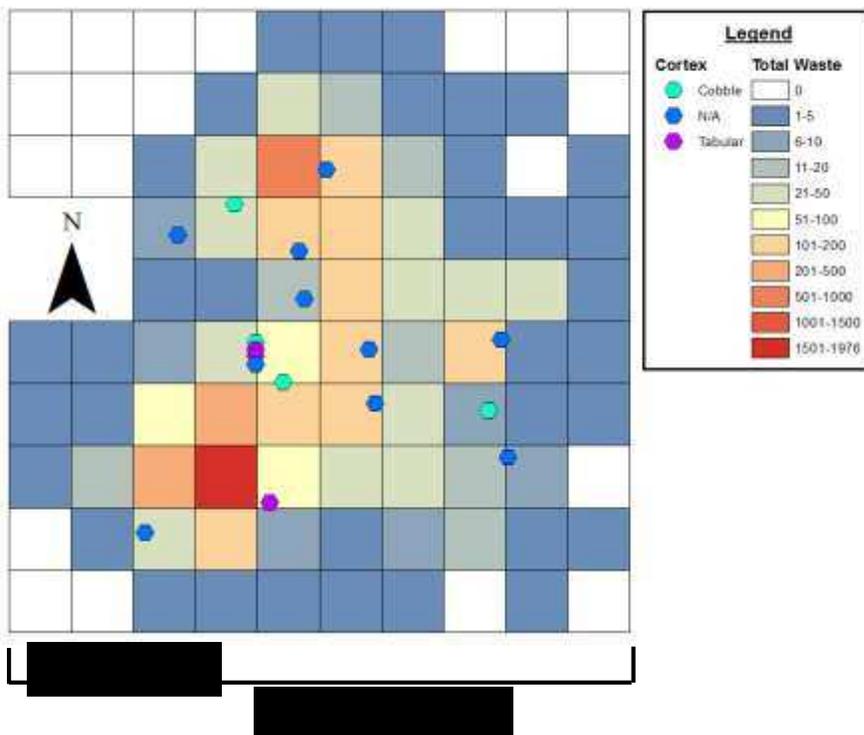


Figure 7.6.13: Distribution of sub-zone B2 cores by cortex type and level.

Sub-zone B2 Horizontal Distributions: Bifaces by Level

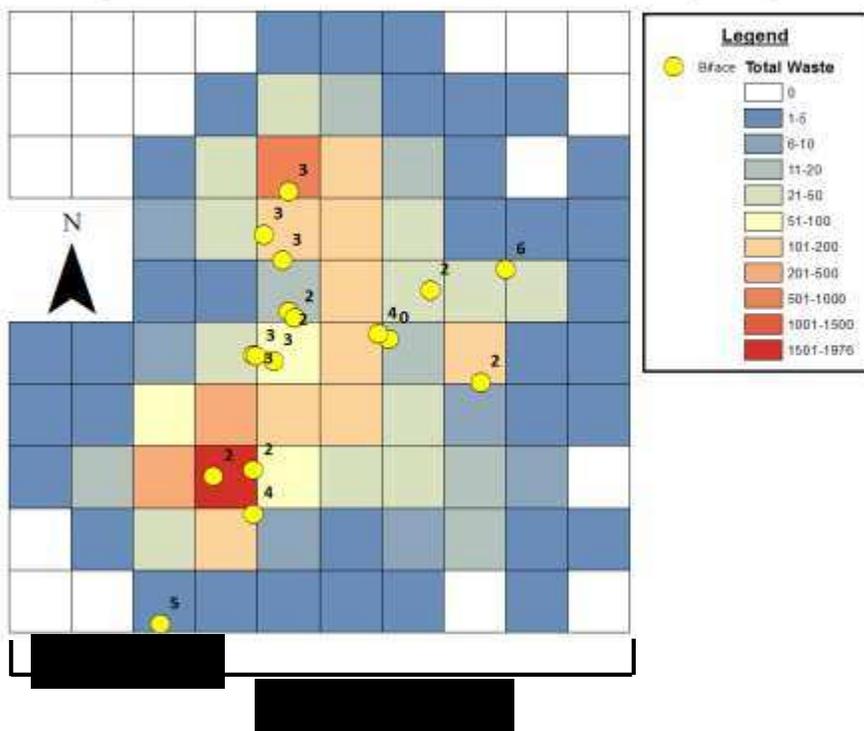


Figure 7.6.14: Distribution of sub-zone B2 bifaces by recovery level.

Sub-zone B2 Horizontal Distributions: Bifaces by Stage

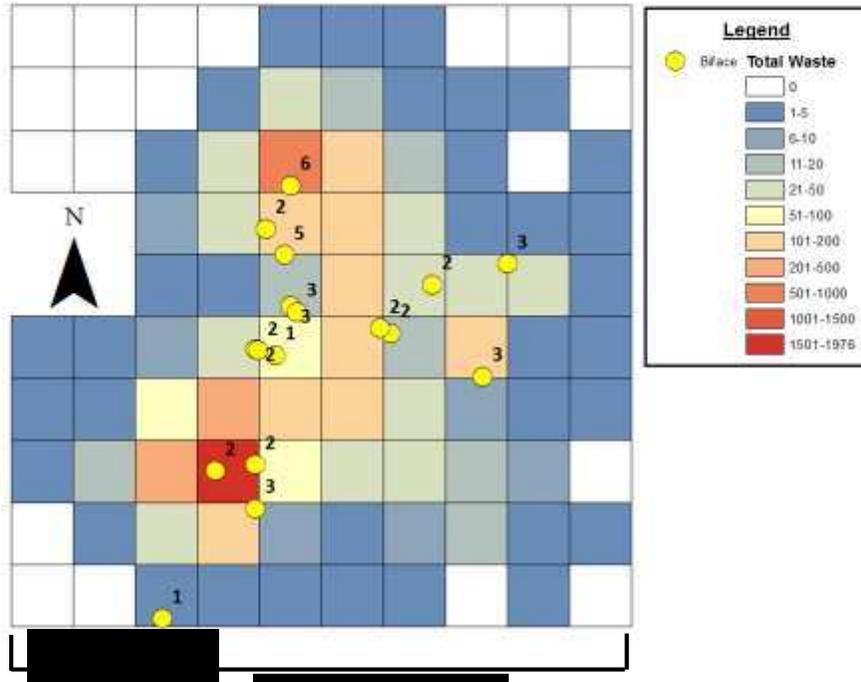


Figure 7.6.15: Distribution of sub-zone B2 bifaces by stage.

Sub-zone B2 Horizontal Distributions: Retouched Flake Type

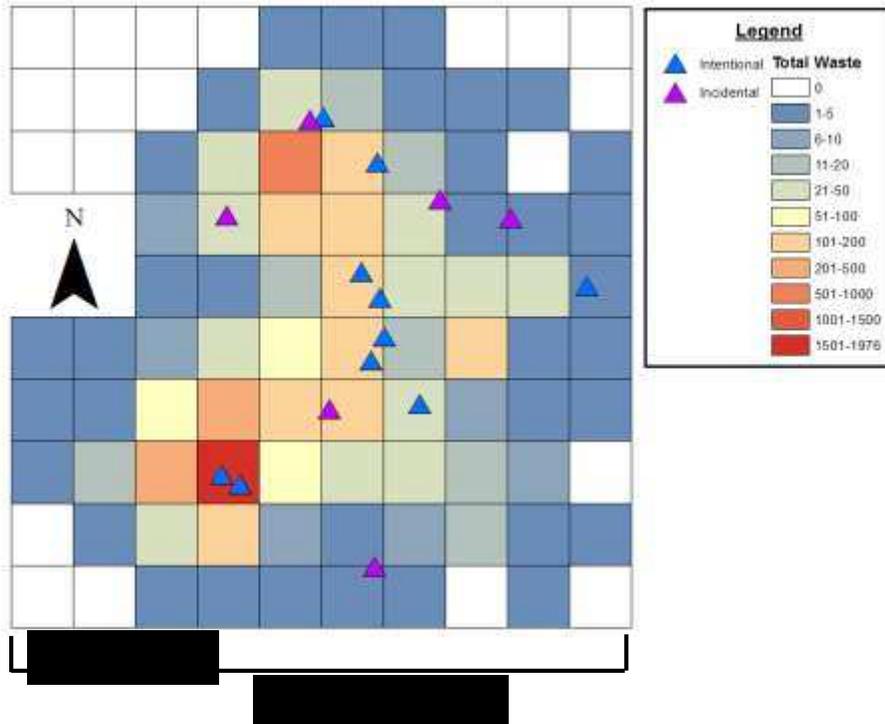


Figure 7.6.16: Distribution of retouched flakes by intention vs. incidental flaking.

FCR and Charcoal Distributions

There are two clusters of FCR within subzone B2. Cluster 1 consists of a dispersed grouping of FCR fragments towards the middle of the sub-zone, while cluster 2 is a dense cluster of fragments contained within one quadrat (Figure 7.6.17).

Cluster 1 contains primarily small sized FCR fragments (25-50mm), with two larger FCR pieces in the 50+mm size range (combined mass of 261.2g). Cluster 2 consists of one large FCR piece (over 50+mm, 5000+ g), with a number of smaller FCR fragments that likely broke off of this larger item during transportation.

Charcoal recoveries from sub-zone B2 were recovered from level 5 in the upper northeast area. Artifact recoveries from within this area are minimal, and no FCR was noted for this portion of the sub-zone.

General Tool Distribution

Other tool recoveries from sub-zone B2 included scrapers, unifaces, blade flakes, a graver/perforator, hammerstones, and three anvil stones. The distribution of all recovered tools occurs in close association with high concentrations of debitage. Many tools were recovered from between the two primary cluster zones.

The location of anvil stones in sub-zone B2 vary in their relation to debitage and artifact frequencies (see Figure 7.6.12). The southernmost anvil stone is located within the centre of highest debitage recovery, while the northern most anvil stone does not appear to have any direct relation to reduction activities. The central grinding stone/ anvil is located where debitage recoveries are lower, however, there are a number of tool recoveries within the immediate area.

Distributions of scrapers and unifaces in sub-zone B2 appear to be relatively dispersed, while still occurring within general artifact cluster areas.

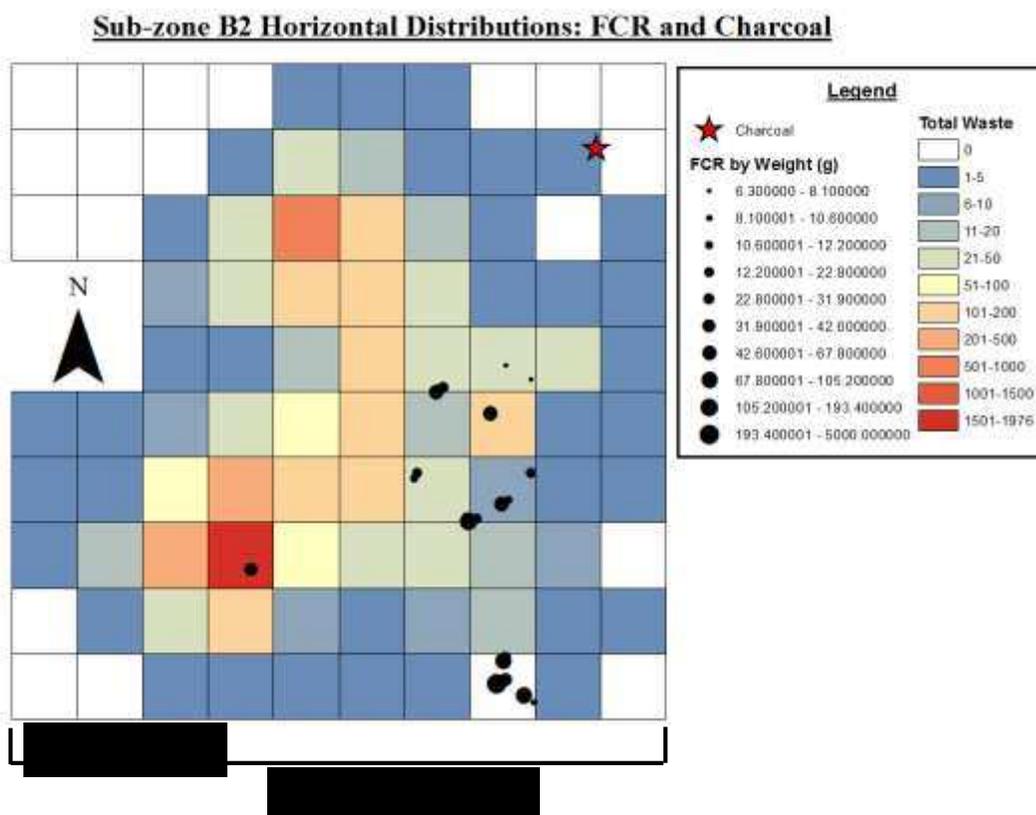


Figure 7.6.17: Distribution of FCR and charcoal recoveries from sub-zone B2.

7.6.8 B2: NSG Results

There are no significant magnetic anomalies contained within sub-zone B2 (Figure 7.6.18). Along the eastern border there is a strong magnetic anomaly that extends east towards sub-zone B4. This will be discussed further in section 7.8.

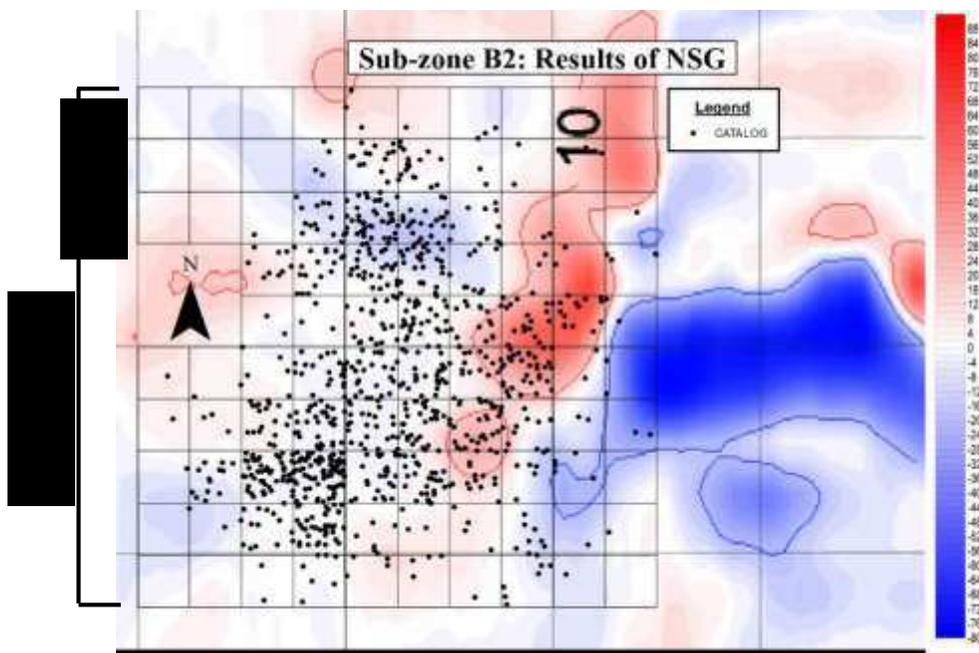


Figure 7.6.18: Results of NSG for sub-zone B2.

7.7 Sub-Zone: B3

Sub-zone B3 consists of a relatively small cluster within the southern extent of the RLF site (Figure 7.7.1). In total, this sub-zone contains 30 50 x 50cm quadrats. There is some overlap along the northern edge of this area with sub-zone B2.

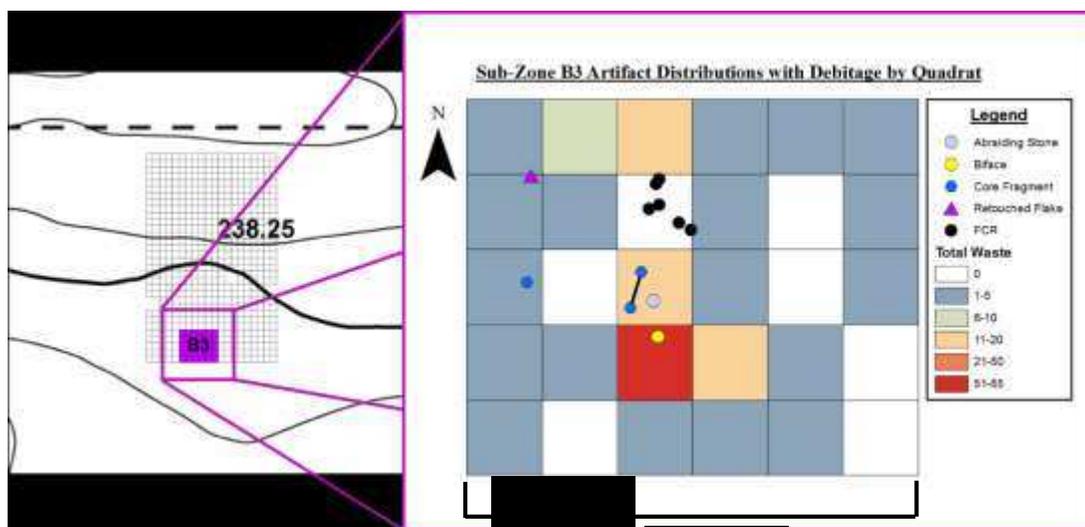


Figure 7.7.1: Sub-zone in relation to topography with a close up of sub-zone B3 illustrating all tool recoveries with total debitage by quad.

7.7.1 B3: Artifact Recoveries

A total of 171 artifacts were recovered from sub-zone B3, including three cores (frequency = 6), one biface, one retouched flake, one abrading stone, and 17 pieces of FCR (Table 7.7.1). Debitage recoveries for this sub-zone include 145 pieces, which were further divided by size, type, and material (Tables 7.7.2-7.7.4).

Table 7.7.1: Sub-zone B3 tool recoveries.

B3: TOOLS	
TYPE	Frequency
CORE	3 (6)
BIFACE	1
RETOUCHED FLAKE	1
ABRADING STONE	1

Table 7.7.2: Sub-zone B3 debitage frequencies by size.

B3: DEBITAGE	
SIZE	Frequency
0-2MM	0
2-6MM	23
6-12MM	60
12-25MM	48
25-50MM	12
50+MM	2

Table 7.7.3: Sub-zone B3 debitage frequencies by type.

B3: DEBITAGE	
TYPE	Frequency
PRIMARY	2
SECONDARY	103
TERTIARY	13
UNDETERMINED	11
SHATTER	16

Table 7.7.4: Sub-zone B3 debitage frequencies by material.

B3: DEBITAGE	
MATERIAL	Frequency
TACONITE	138
GFS	7

7.7.2 B3: Vertical Distribution

The vertical distribution of artifacts in sub-zone B3 centre around Level 3 (Figure 7.7.2). This distribution is mirrored by all artifact size ranges (Figure 7.7.3). Second highest frequencies occur in Levels 4 and 2 respectively.

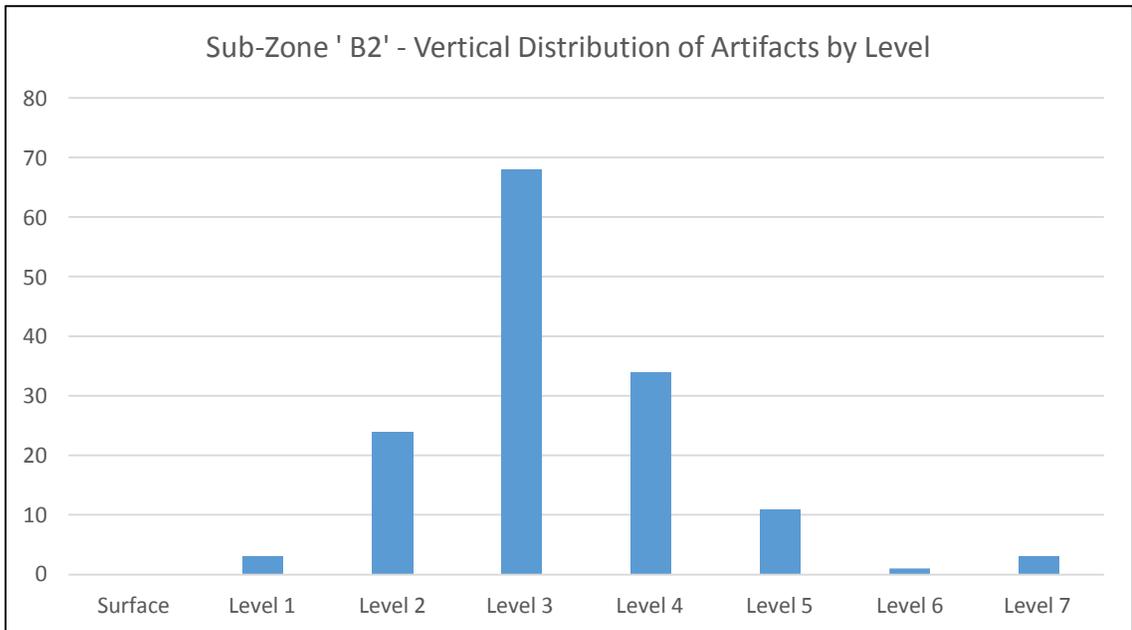


Figure 7.7.2: Sub-zone B3 total artifact recoveries by level.

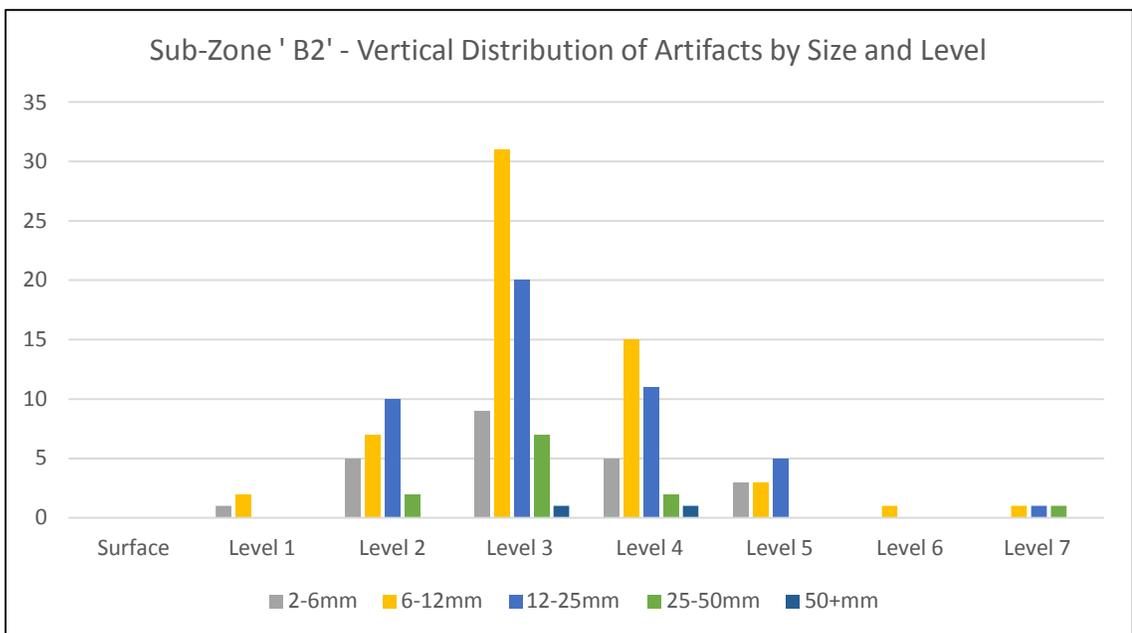


Figure 7.7.3: Sub-zone B3 artifact recoveries by size and level.

7.7.3 B3: Horizontal Distribution: General

The results of statistical clustering analysis for sub-zone B3 yielded conflicting results. While both Getis-Ord G_i and Ripley's K suggest that the placement of artifacts exhibits a clustered distribution, nearest neighbour analysis suggests that the observed artifact locations are random in nature (Figures 7.7.4-7.7.6). Differences between these tests may be the result of differing methods, as nearest neighbour utilizes location but not frequency, whereas Getis-Ord G_i utilizes cell frequencies. Furthermore, nearest neighbour assesses the distance between the nearest single point rather than multiple point locations.

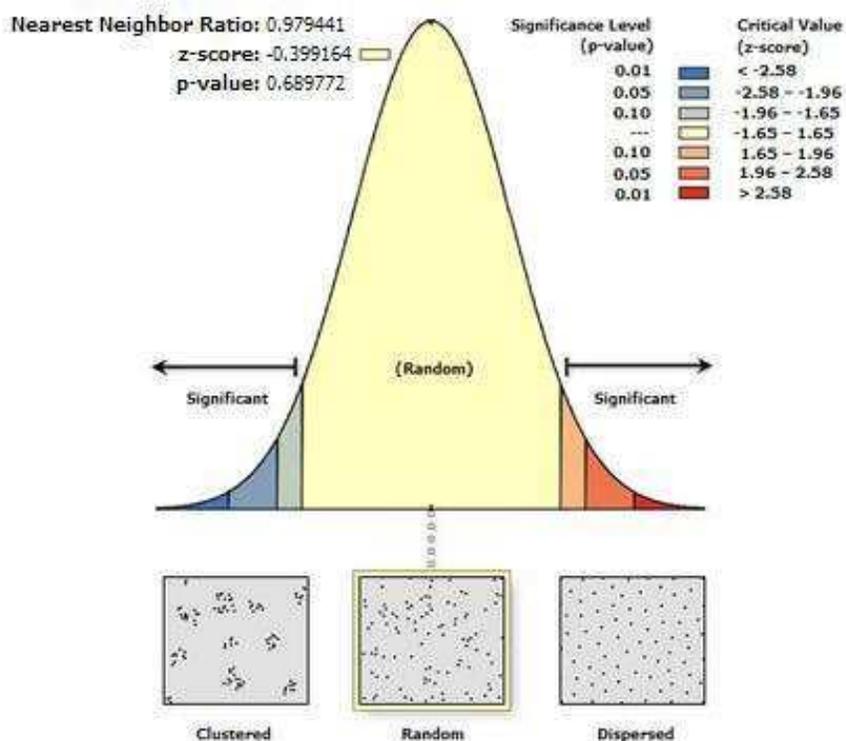


Figure 7.7.4: Results of nearest neighbour analysis indicating that at a z-score of -0.399164 the observed pattern varies little from that of a random distribution.

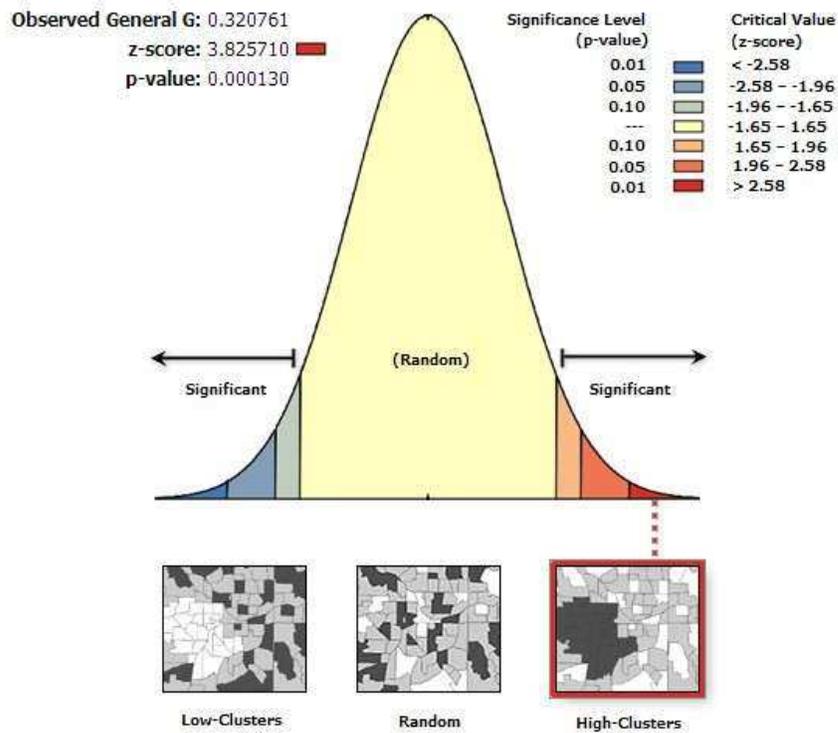


Figure 7.7.5: Results of Getis-Ord G_i^* analysis indicating that at a z-score of 3.825710 there is a less than 1% chance that the observed distribution is the result of random chance.

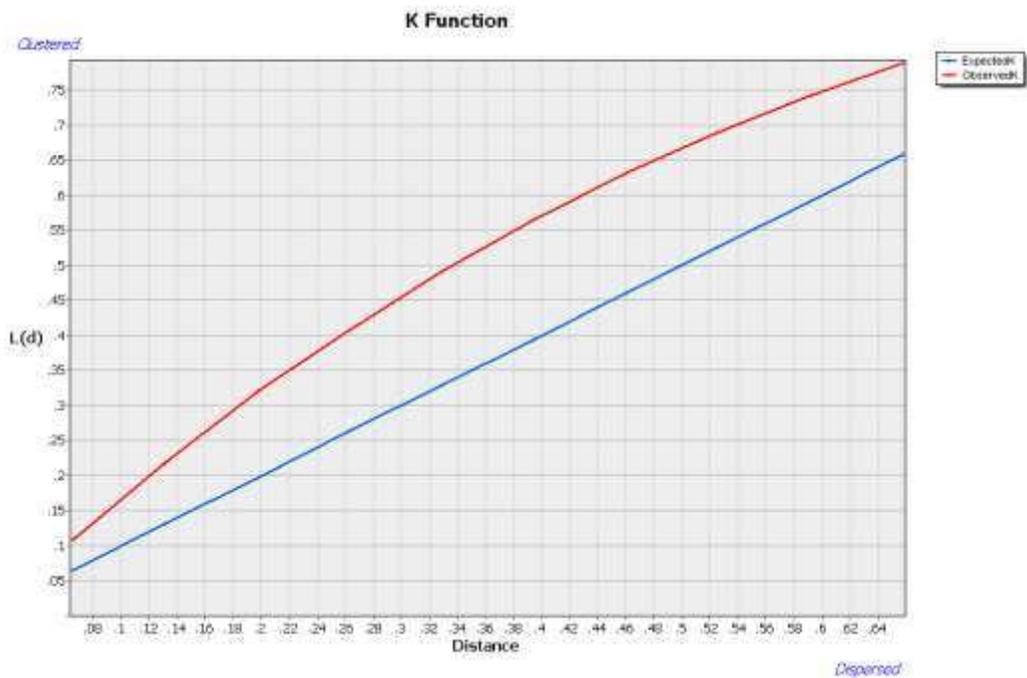
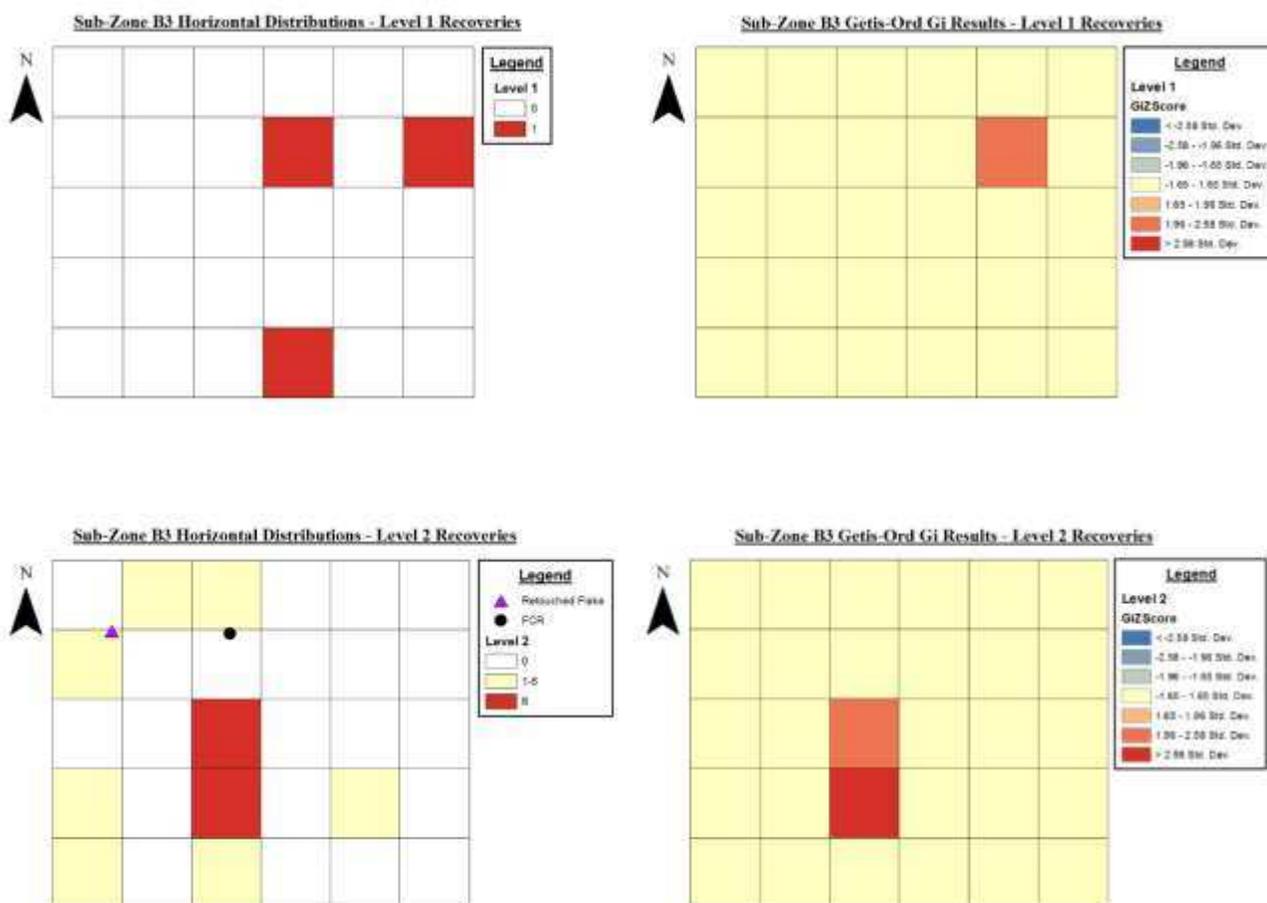


Figure 7.7.6: Graph of Ripley's K function analysis illustrating that the observed distribution is likely the result of a clustered distribution.

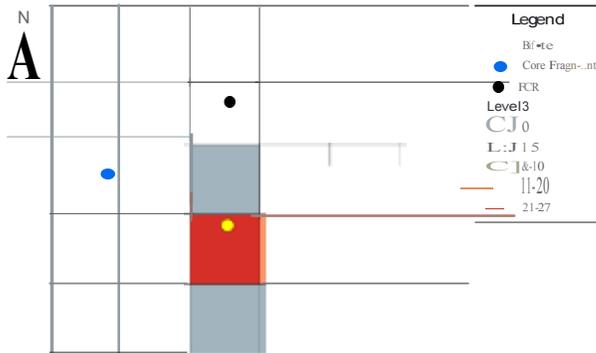
7.7.4 B3: Horizontal Distribution: Recoveries by Level

Artifact recoveries by level generally exhibit clustering towards the centre of the sub-zone (Figure 7.7.7). It should be noted though, that through all levels there is a consistent horizontal dispersal of debitage in low frequencies.

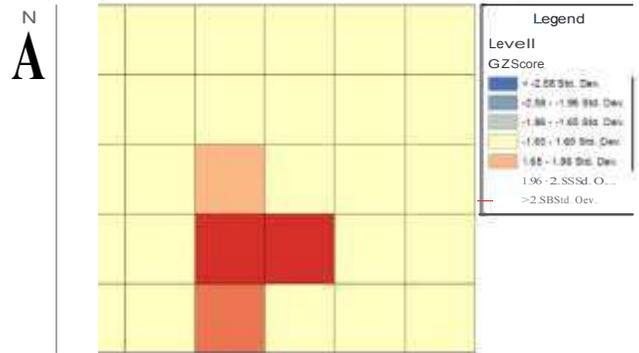
B3: Horizontal Distribution of Artifacts by Level



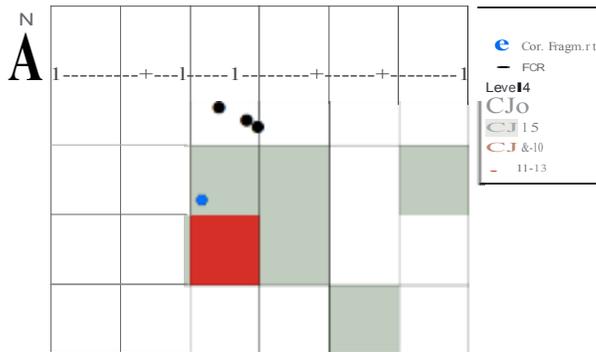
Sub-Zone B3 Horizontal Distributions - Level 3 Recoveries



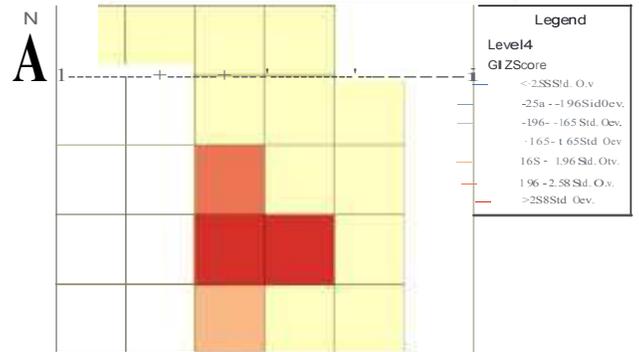
Sub-Zone B3 Getis-Ord Gi Results - Level 3 Recoveries



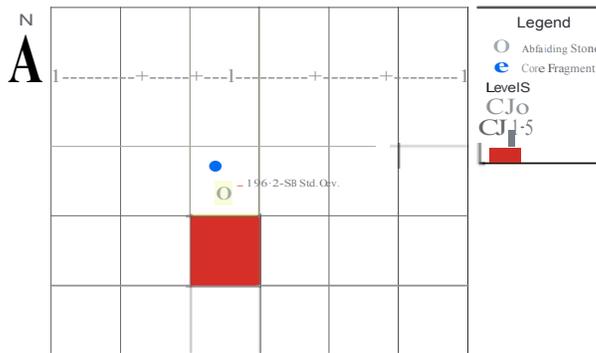
Sub-Zone R3 Horizontal Distributions - Level 4 Recoveries



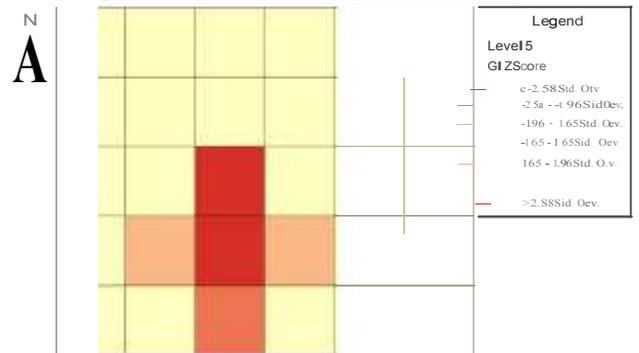
Sub-Zone R3 Getis-Ord Gi Results - Level 4 Recoveries



Sub-Zone R3 Horizontal Distributions - Level 5 Recoveries



Sub-Zone R3 Getis-Ord Gi Results - Level 5 Recoveries



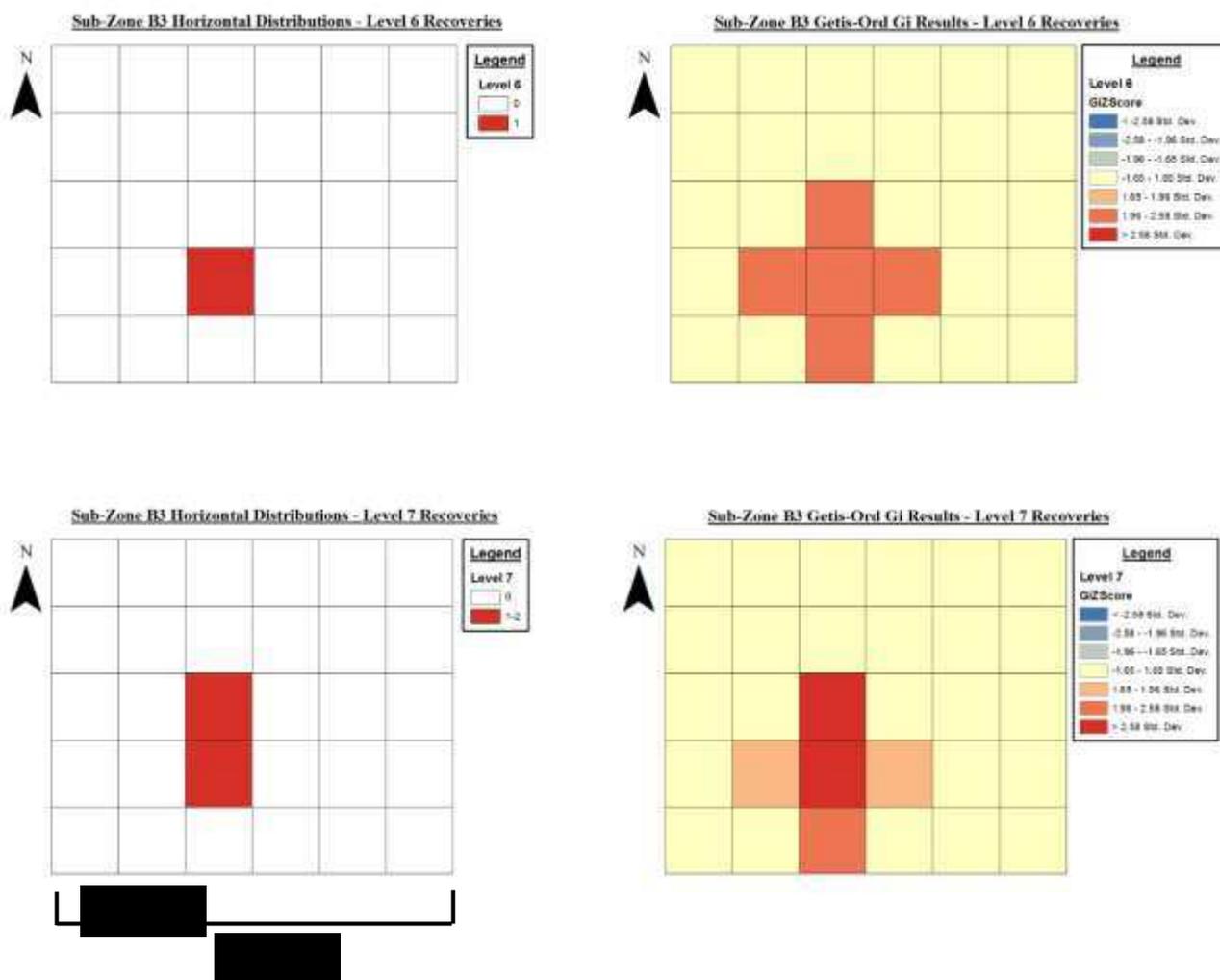


Figure 7.7.7: Sub-zone B3 artifact recoveries by level.

7.7.5 B3: Horizontal Distribution: Recoveries by Material Type

Material types recovered from sub-zone B3 were limited to taconite and gunflint silica. Gunflint silica artifacts appear to be randomly dispersed (Figure 7.7.8 B) while taconite, being the primary recovery material within B3, follows the same dispersal patterns observed in level distributions (Figure 7.7.8 A).

B3: Horizontal Distribution of Artifacts by Level

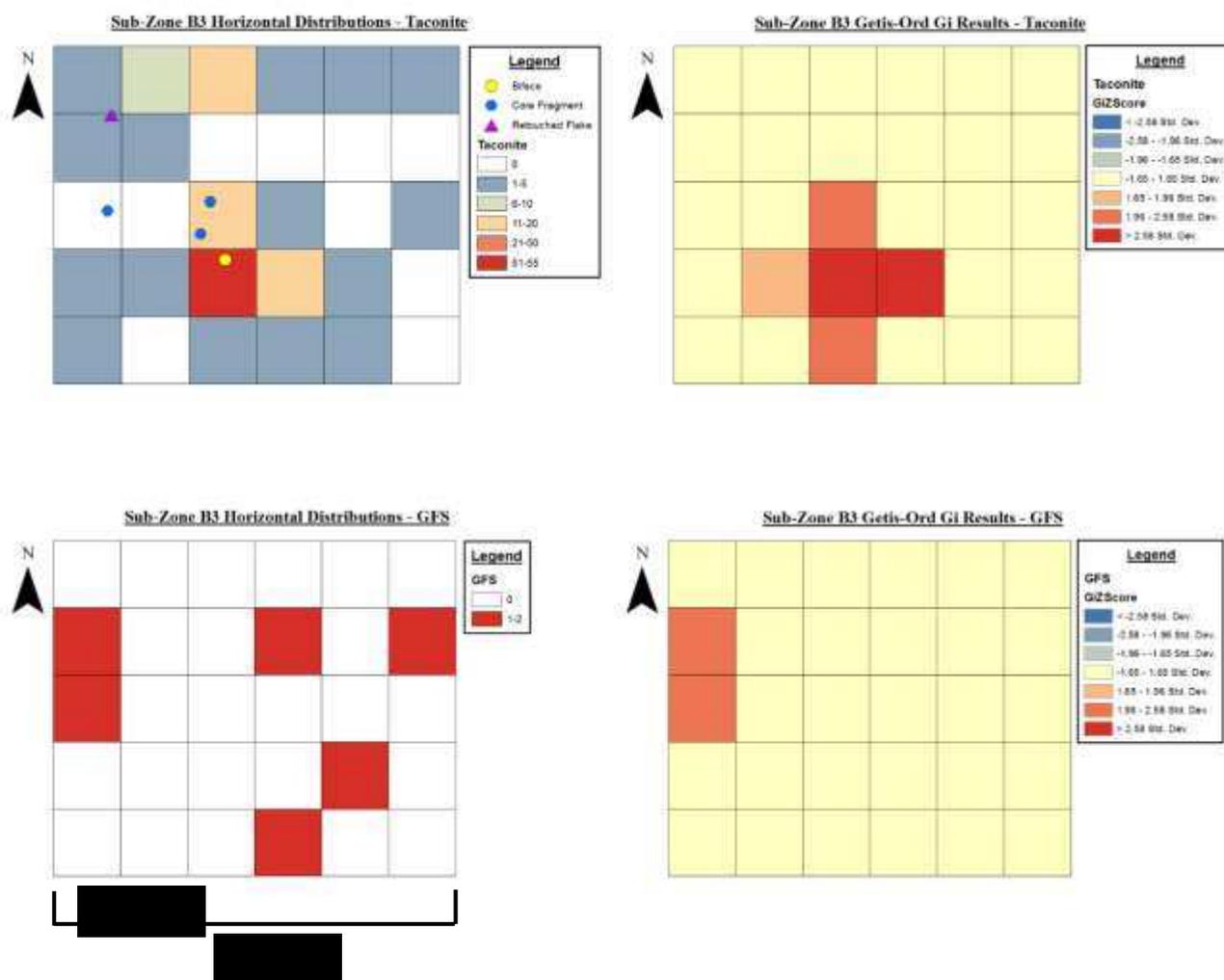
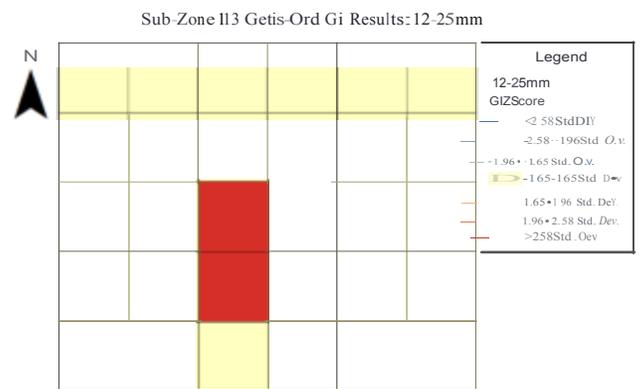
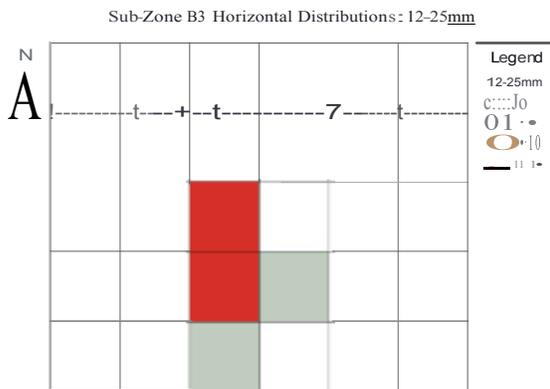
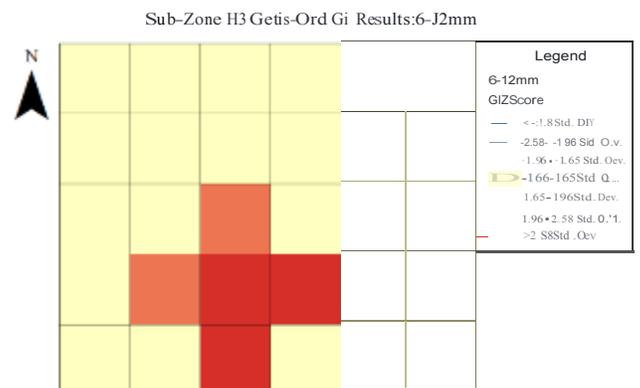
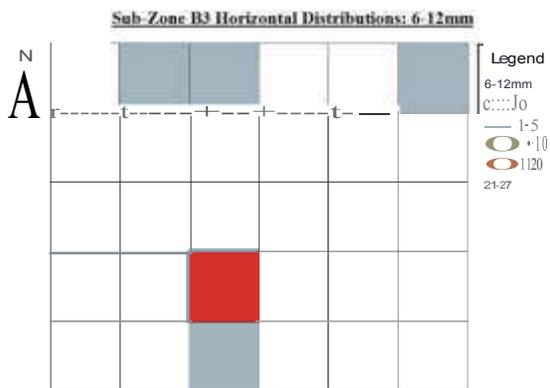
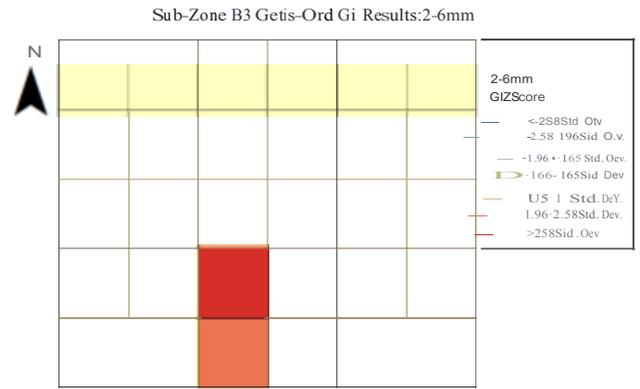
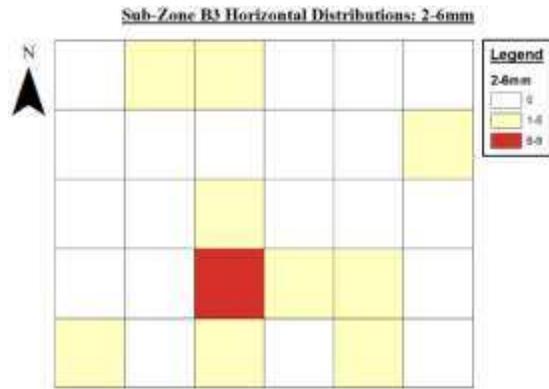


Figure 7.7.8: Sub-zone B3 artifact distributions by material: A) Taconite, and B) Gunflint silica.

7.7.6 B3: Horizontal Distribution: Debitage

The distribution of debitage by size and type follow similar patterns as previously discussed for level distributions, with main concentrations occurring within the centre of the sub-zone (Figures 7.7.9 and 7.7.10). There is little variation between debitage size and type in regards to the primary concentration areas.

B3: Horizontal Distribution of Debitage by Size



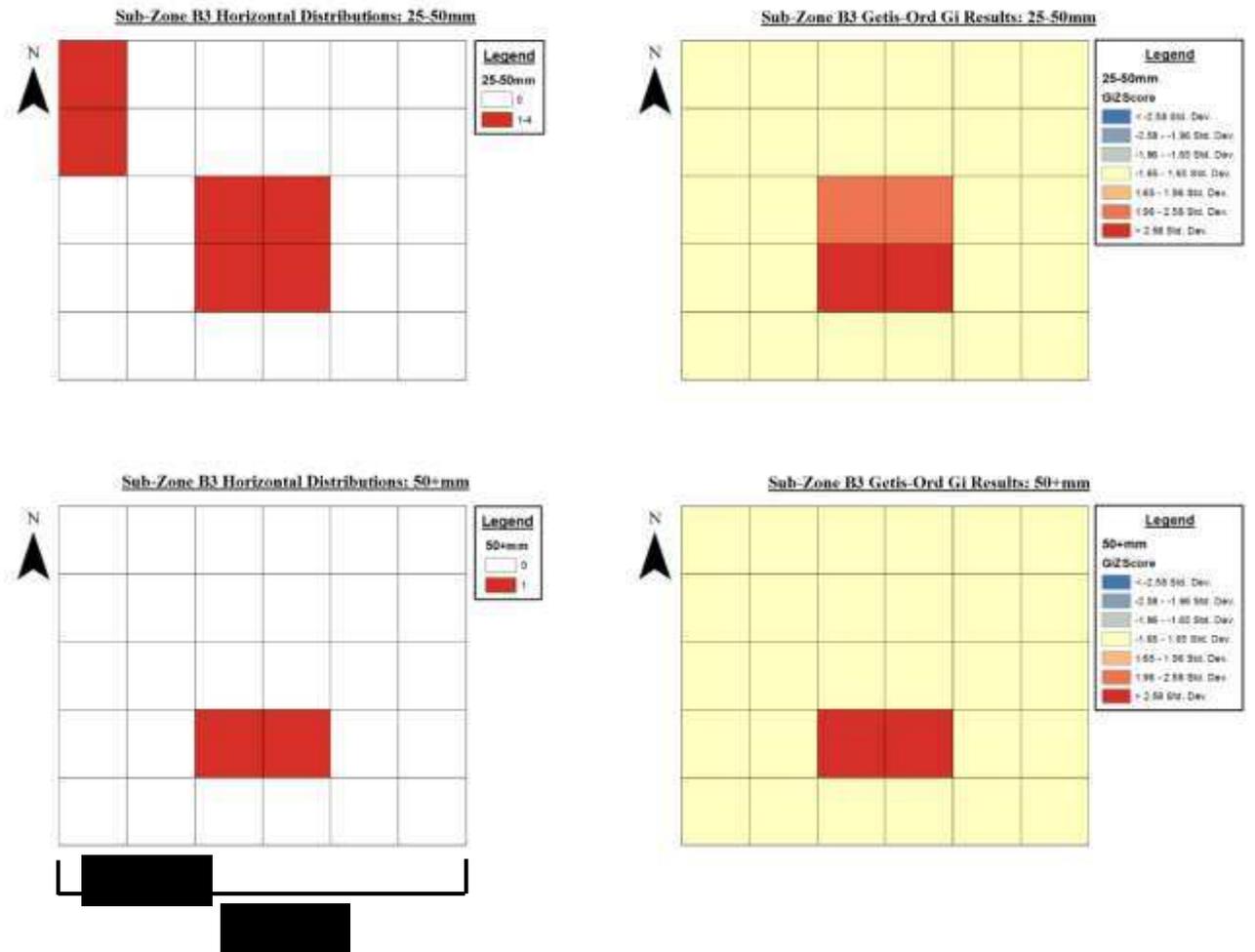
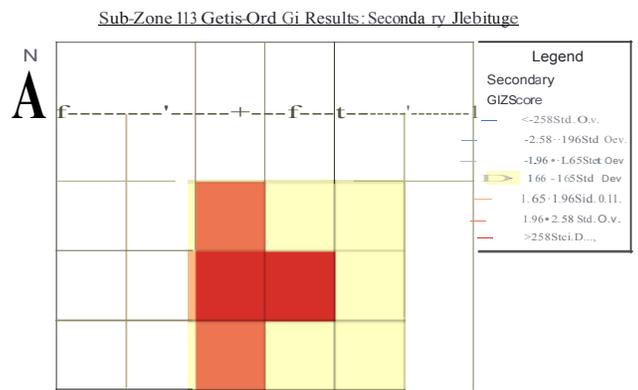
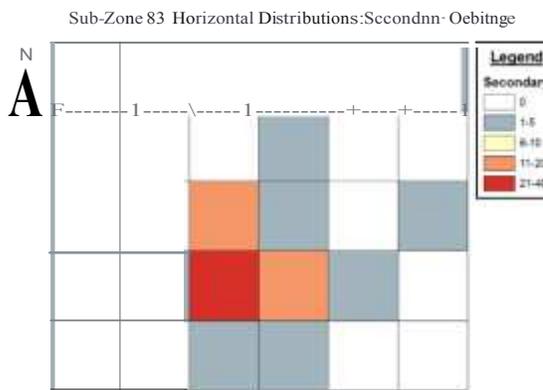
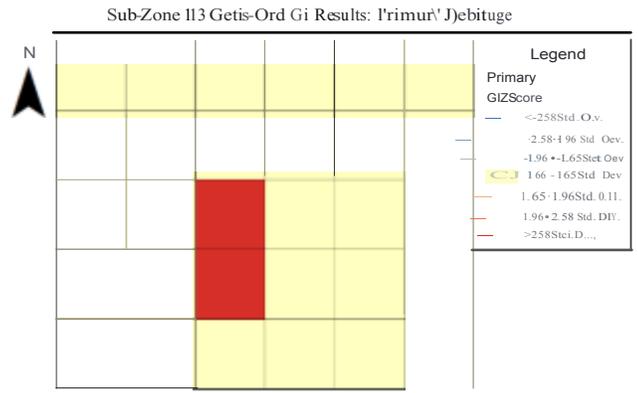
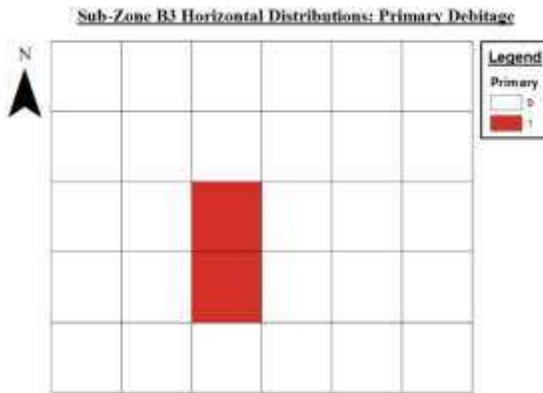
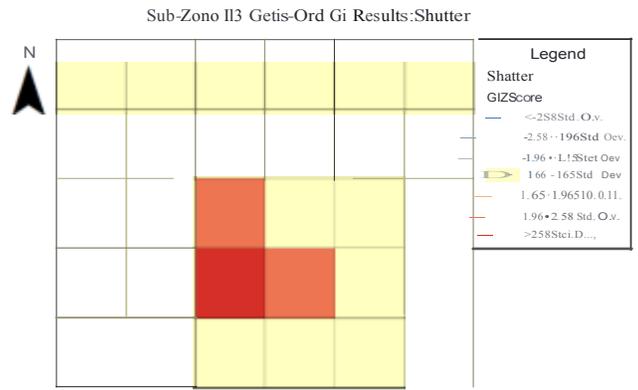
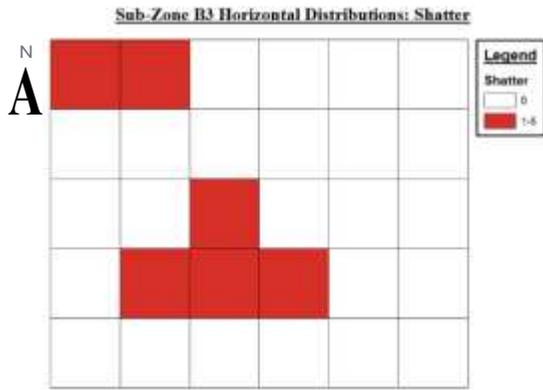


Figure 7.7.9: Sub-zone B3 debris distribution by size.

B3: Horizontal Distribution of Debitage by Size



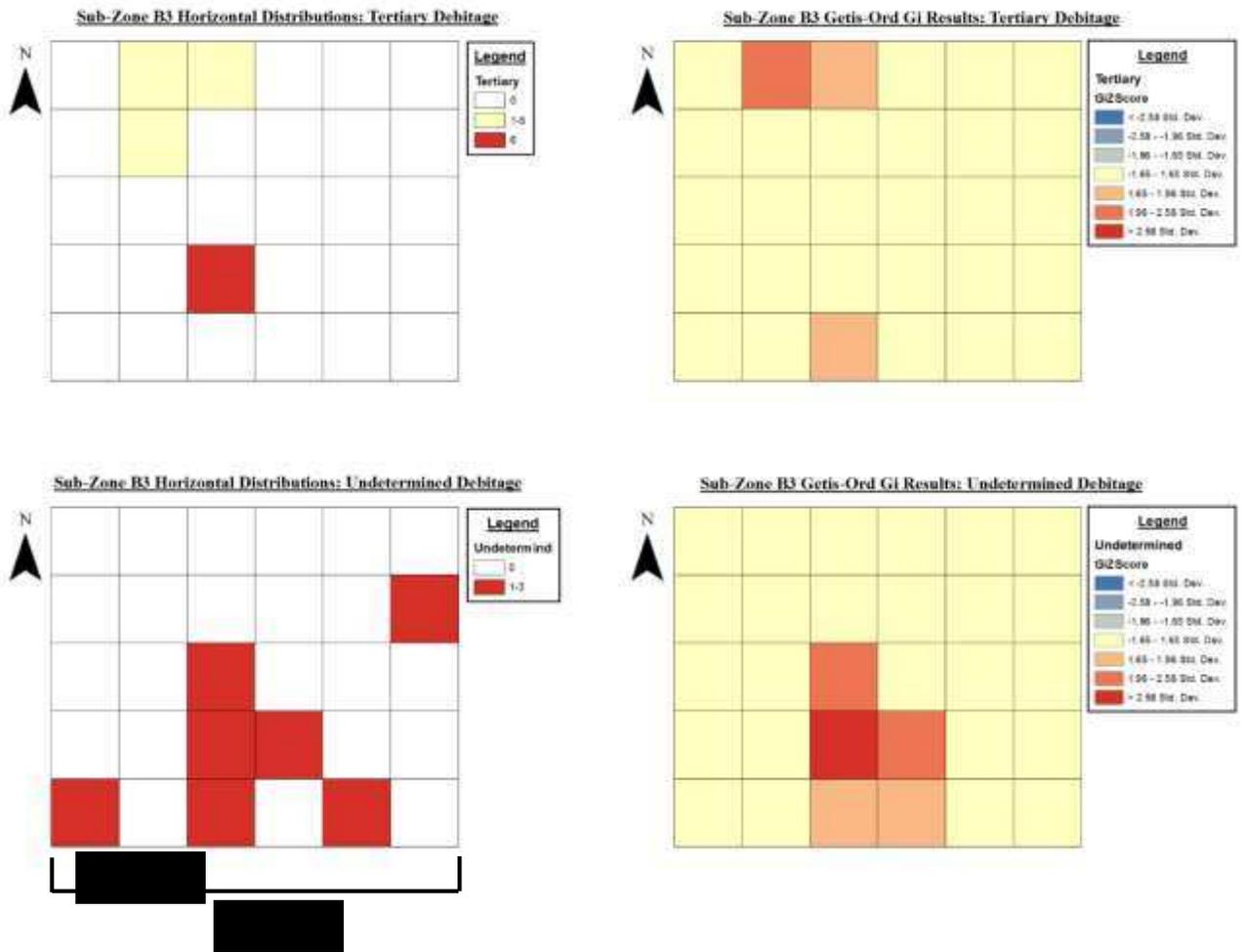


Figure 7.7.10: Sub-zone B3 debitage distribution by type.

7.7.7 B3: Horizontal Distribution: Tools

There were limited tool recoveries from sub-zone B3. Artifacts that were recovered exhibit a general association to high artifact frequency areas within the centre of the sub-zone (Figure 7.7.11). One outlier is the recovered retouched flake, however, this appears to exhibit incidental retouching. This sub-zone also includes the recovered FCR cluster discussed in section 7.6. This cluster consists of one large fragment with a number of smaller secondary pieces that likely broke off from the original item.

One artifact refit was recorded for sub-zone B3. This consisted of a core re-fit from within the same quadrat and within one level of each other (levels 4 and 5).

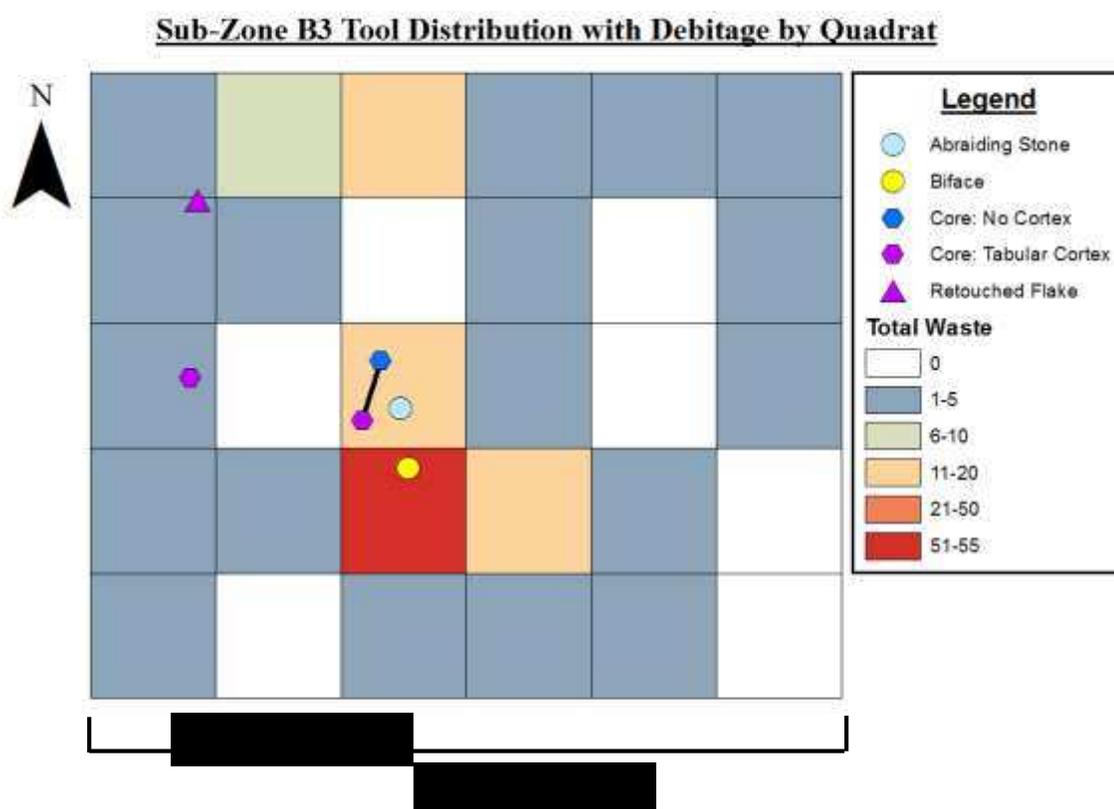


Figure 7.7.11: Sub-zone B3 tool recoveries with totaldebitage by quadrat.

7.7.8 B3: NSG Results

Sub-zone B3 does not appear to have any significant magnetic anomalies (Figure 7.7.12). It does occur just south of an extended anomaly that stretches between subzone B2 and B4.

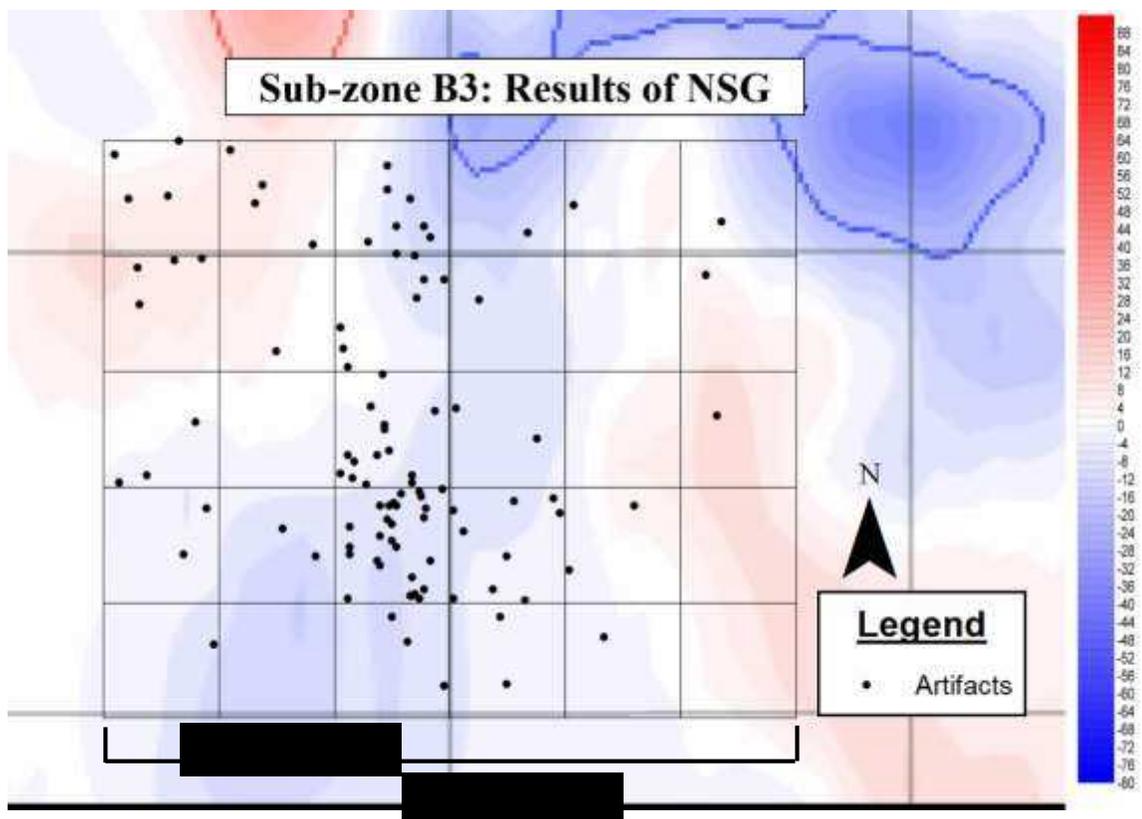


Figure 7.7.12: Results of NSG survey for sub-zone B3.

7.8 Sub-Zone: B4

Sub-zone B4 covers a relatively small and localized cluster of artifacts within the southeastern portion of the RLF site (Figure 7.8.1). This is the smallest sub-zone within this study, consisting of only 20, 50 x 50cm quadrats.

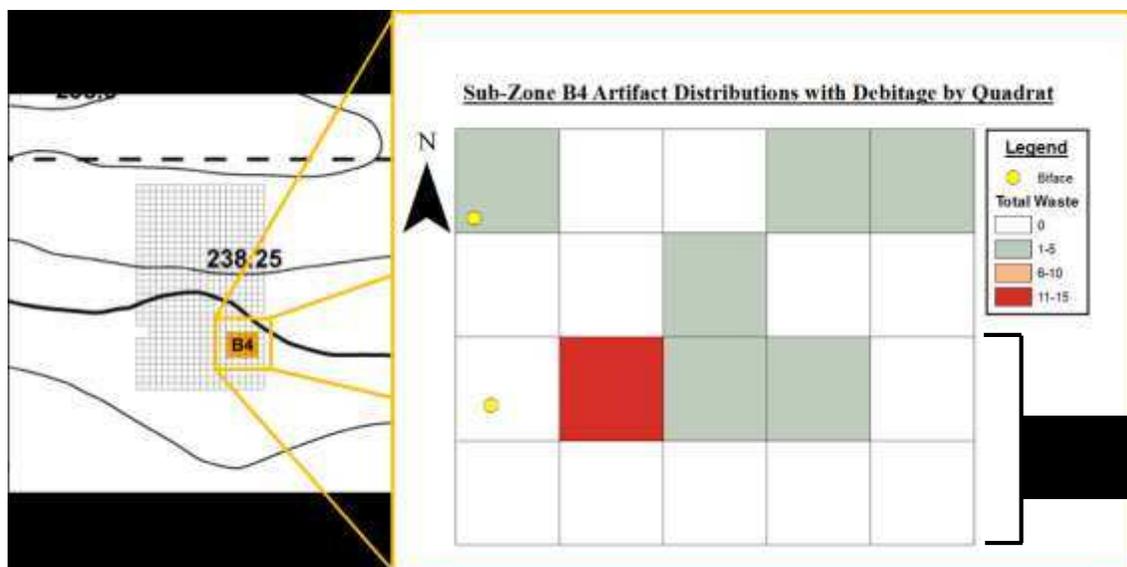


Figure 7.8.1: Sub-zone in relation to topography with a close up of sub-zone B4 illustrating all tool recoveries with total debitage by quad.

7.8.1 B4: Artifact Recoveries

A total of 26 artifacts were recovered from sub-zone B4. Of this, 2 bifaces were recovered (frequency = 3). Biface recoveries consisted of one stage 2 biface made of taconite recovered from level 8, and one stage 3 biface made of gunflint silica recovered from the excavation surface. These represent the only tool recoveries from this subzone.

Debitage recovered from sub-zone B4 included 22 artifacts, of which the majority were siltstone (Tables 7.8.1-7.8.3). Further assessment of the artifact catalog indicated that these siltstone recoveries may not represent culturally modified materials. As such, further analysis was conducted. This revealed that, while this material has been used to produce tools on other sites (e.g. Mackenzie 1, Figure 7.8.2-A), the artifacts from RLF may not be the result of cultural modification (Figure 7.8.2-B, C). Re-fitting broken fragments suggests that rather than fracturing through percussion, it is more likely that these objects broke along natural faults within the material. This leaves six flakes of other

materials within the sub-zone, of which three exhibit water rolling that may suggest natural pebbles. The final artifact recovery consisted of one chert pebble cataloged as ‘other’ and is likely natural.

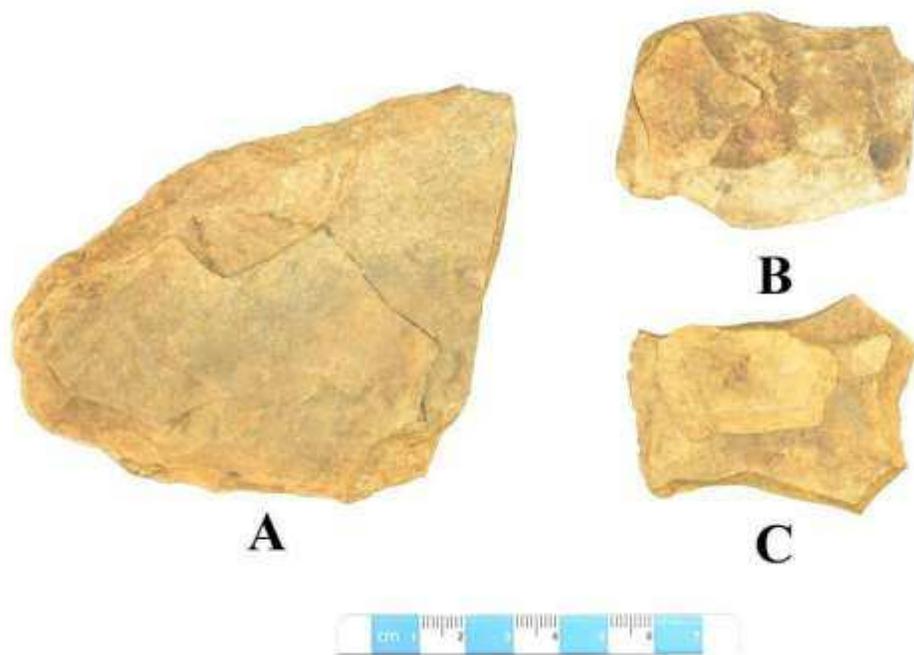


Figure 7.8.2: Siltstone artifact recoveries from the Mackenzie 1 (A) and RLF (B and C) sites. Flake refits from items B and C do not appear to exhibit cultural modification, but rather natural fracturing.

Table 7.8.1: Sub-zone B4 debitage frequency by size.

B4: DEBITAGE	
SIZE	Frequency
0-2MM	0
2-6MM	1
6-12MM	4
12-25MM	9
25-50MM	6
50+MM	2

Table 7.8.2: Sub-zone B4 debitage frequency by type.

B4: DEBITAGE	
TYPE	Frequency
PRIMARY	6
SECONDARY	11
TERTIARY	1
UNDETERMINED	0
SHATTER	4

Table 7.8.3: Sub-zone B4 debitage frequency by material.

B4: DEBITAGE	
MATERIAL	Frequency
TACONITE	2
GFS	2
SILTSTONE	16
CHERT	2

7.8.2 *B4: Vertical Distribution*

The vertical distribution of artifacts within sub-zone B4 does not follow the pattern exhibited within other sub-zone areas (Figures 7.8.3 and 7.8.4). Artifact clustering within B4 is spread primarily between levels 2-5, with level 5 yielding the greatest number of recoveries. Removing siltstone debitage from the vertical distribution of artifacts does not change this varied distribution, as one taconite biface was recovered from level 8.

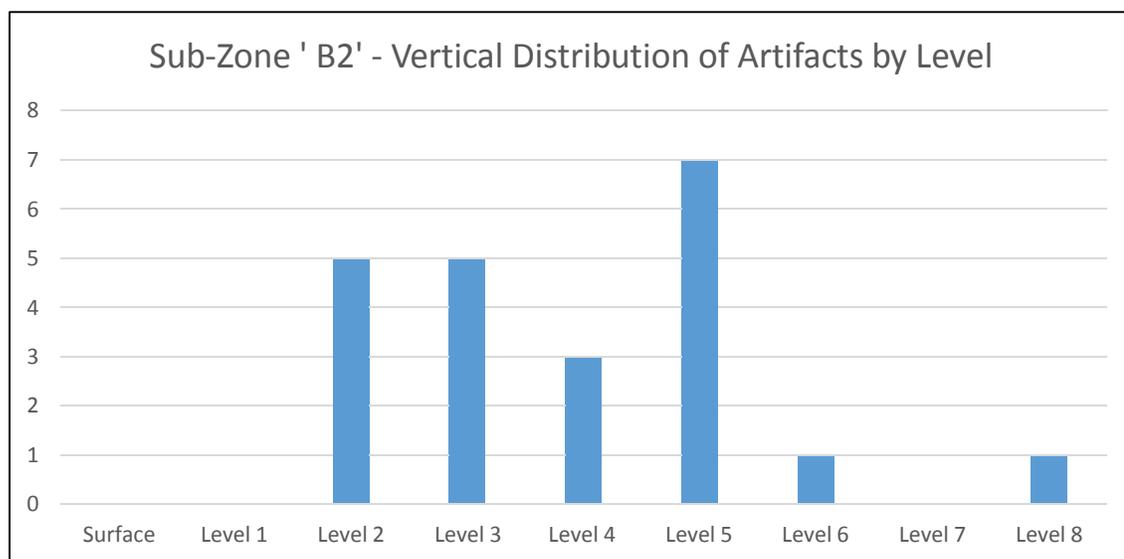


Figure 7.8.3: Sub-zone B4 artifact frequencies by level.

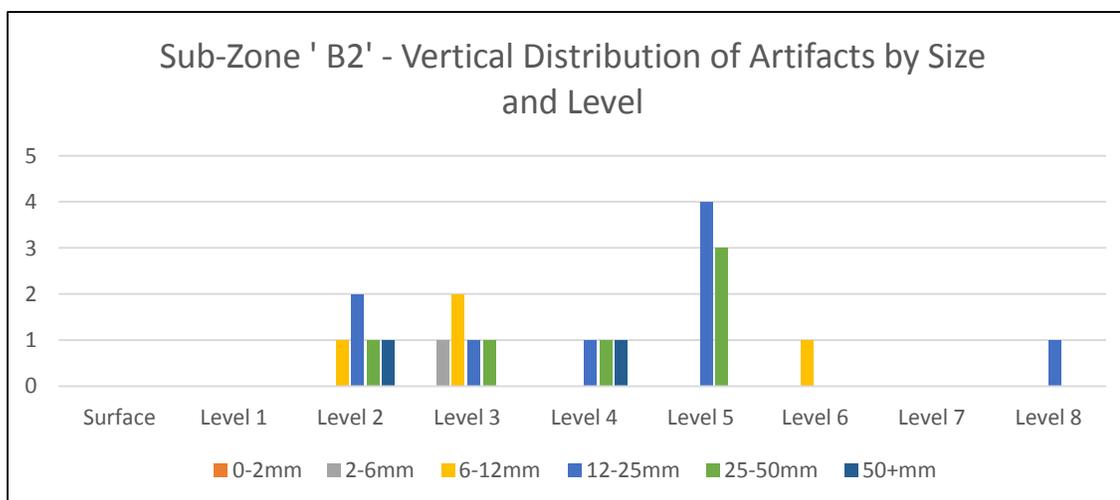


Figure 7.8.4: Sub-zone B4 artifact frequencies by size and level.

7.8.3 B4: Horizontal Distribution: General

The results of both nearest neighbour and Getis-Ord G_i^* tests indicate that the observed distribution of artifact in sub-zone B4 is the result of random chance (Figures 7.8.5 and 7.8.6). Conversely, Ripley's K analysis suggests that some clustering is occurring, likely associated with dense siltstone concentrations (Figure 7.8.7).

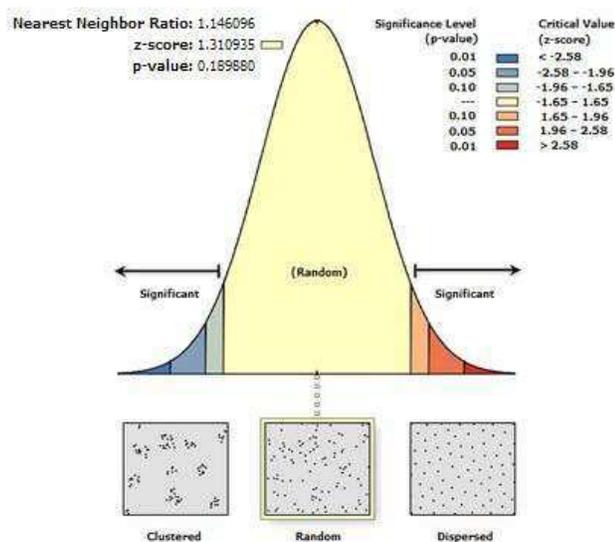


Figure 7.8.5: Results of nearest neighbour analysis indicating that at a z-score of 1.146096 the observed pattern varies little from that of a random distribution.

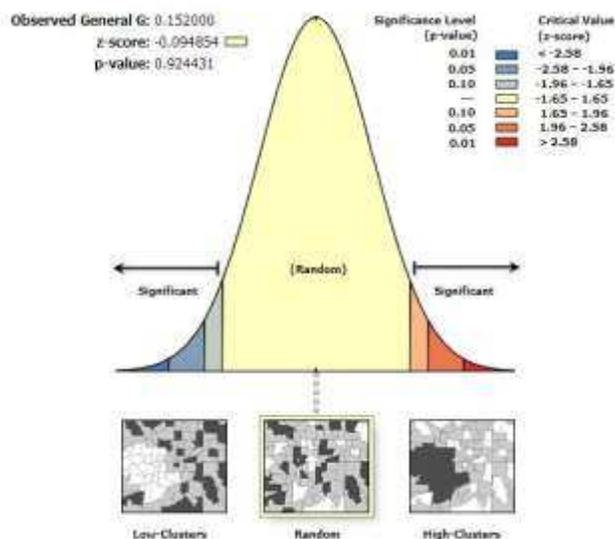


Figure 7.8.6: Results of Getis-Ord G_i analysis indicating that at a z-score of -0.094854 the observed pattern varies little from that of a random distribution.

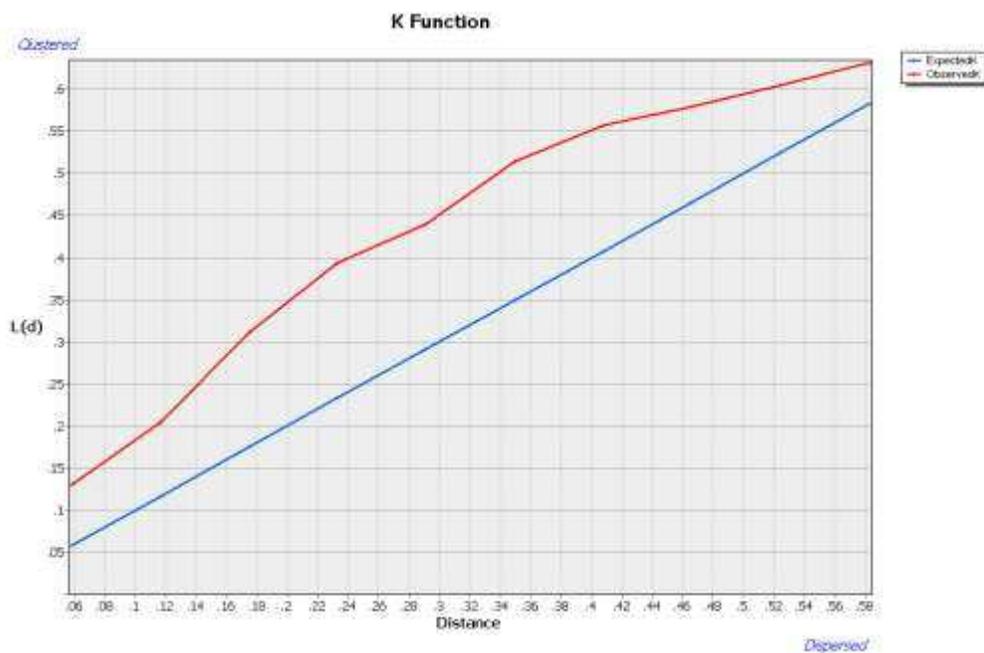


Figure 7.8.7: Graph of Ripley's K function analysis illustrating that the observed distribution is likely the result of a clustered distribution.

7.8.4 B4: Horizontal Distribution: Recoveries by Level

The distribution of recoveries by level varies greatly. However, all siltstone artifacts are recovered from within the same quadrat (Figure 7.8.8). As artifact recoveries were limited within this sub-zone it was determined that the application of Getis-Ord G_i^* was not necessary.

7.8.5 B4: Horizontal Distribution: Recoveries by Material Type

The limited artifact recoveries from sub-zone B4 inhibits the application of material distribution studies, however it can be noted again that all siltstone recoveries occur within the same quadrat (Figure 7.8.9).

7.8.6 B4: Horizontal Distribution: Debitage

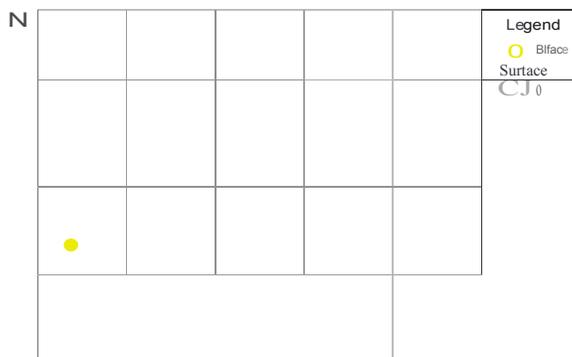
The distribution of debitage follows a similar pattern as illustrated in distributions by level and material. There does not appear to be any patterned distribution of debitage by size and type aside from the concentrations of siltstone within a single quadrat.

7.8.7 B4: Horizontal Distribution: Tools

There does not appear to be any correlation between the two recovered bifaces in sub-zone B4, as one was recovered from a surface context while the other was recovered from level 8 (35-40cm below surface) (Figure 7.8.10).

B4: Horizontal Distribution of Artifacts by Level

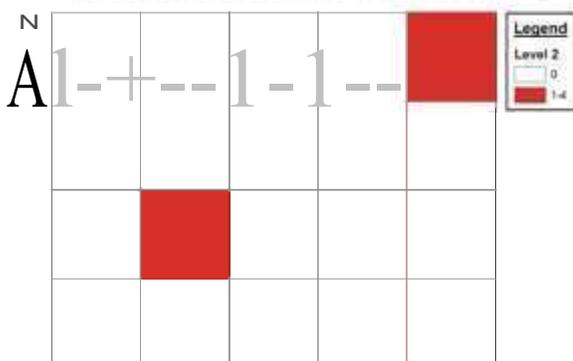
Sub-Zone B4 Horizontal Distribution - Surface Recoveries



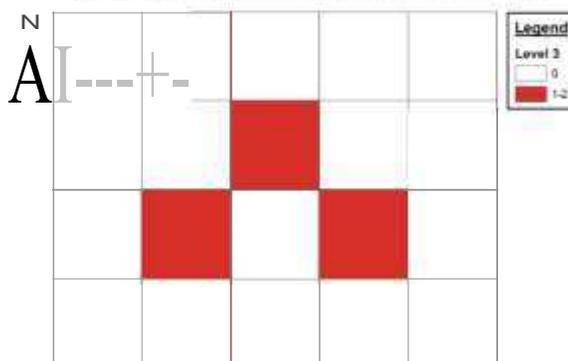
Sub-Zone B4 Horizontal Distribution - Level 1 Recoveries



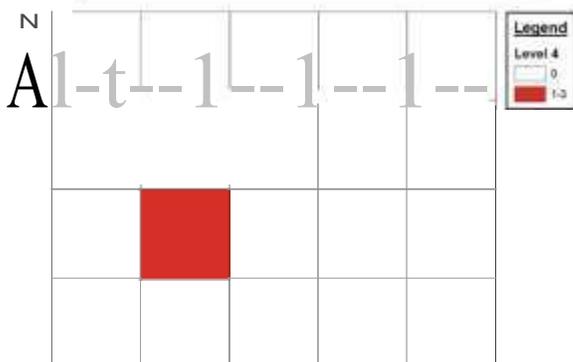
Sub-Zone B4 Horizontal Distribution - Level 2 Recoveries



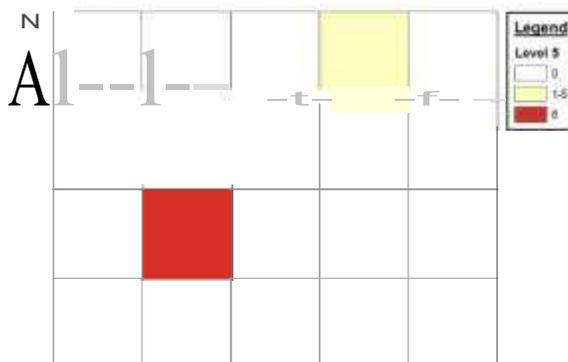
Sub-Zone B4 Horizontal Distribution - Level 3 Recoveries



Sub-Zone B4 Horizontal Distribution - Level 4 Recoveries



Sub-Zone B4 Horizontal Distribution - Level 5 Recoveries



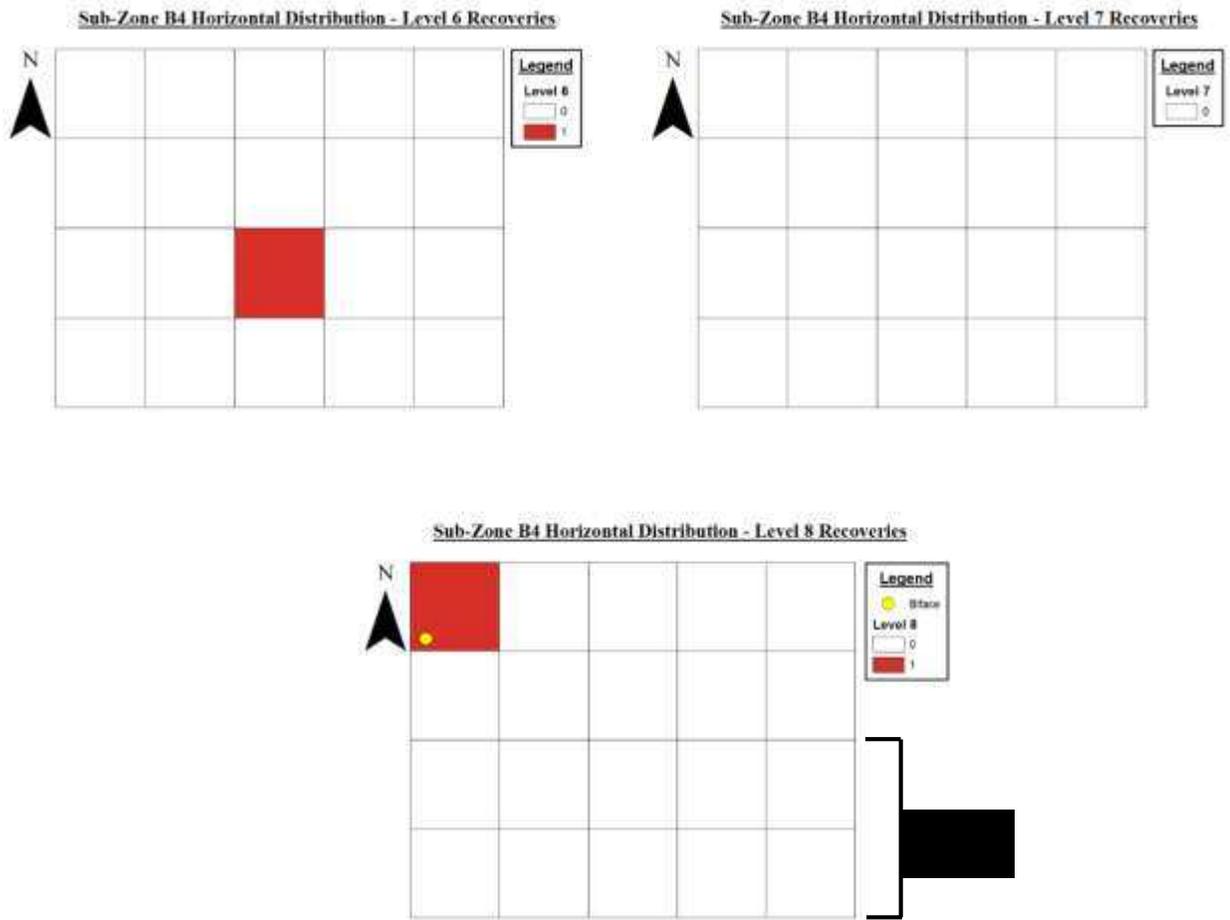


Figure 7.8.8: Distribution of sub-zone B4 recoveries by level.

B4: Horizontal Distribution of Artifacts by Material

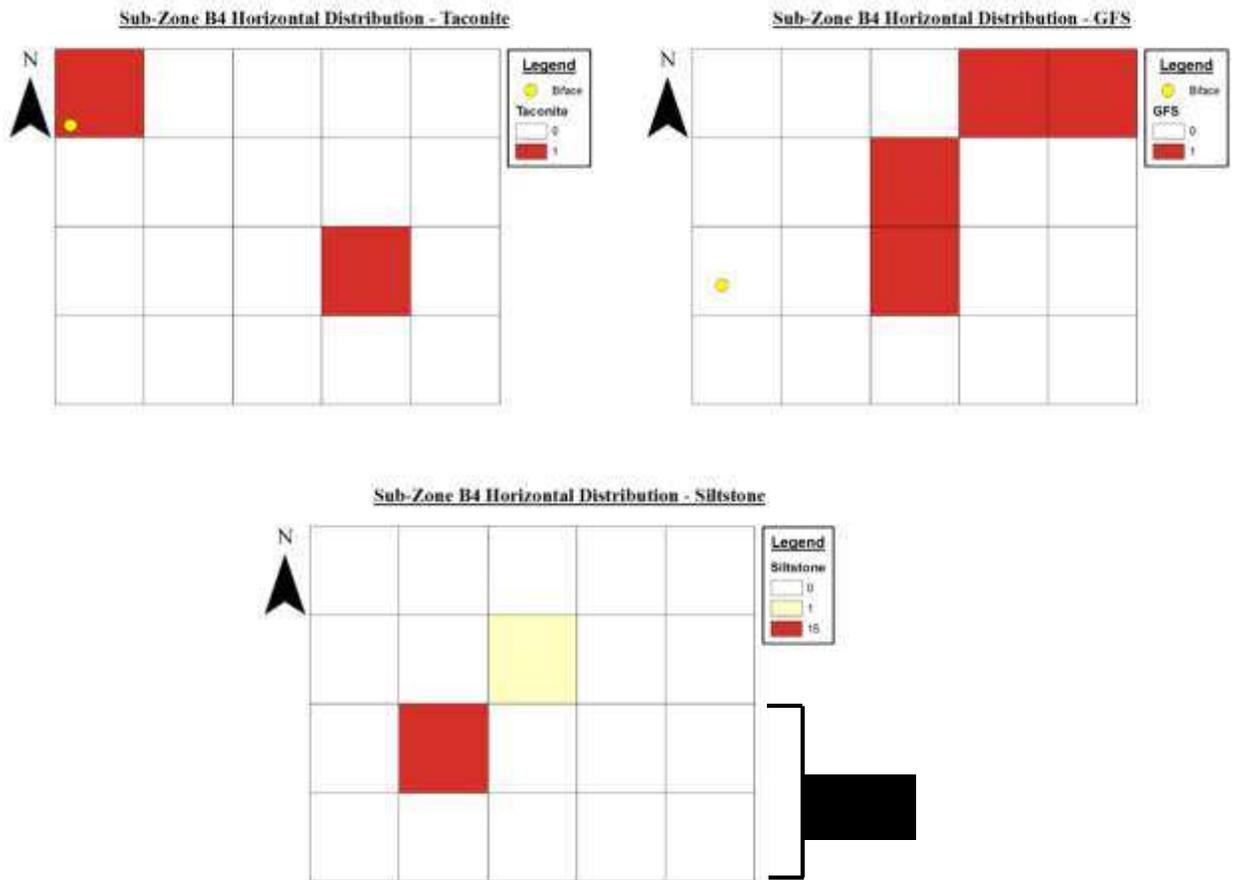


Figure 7.8.9: Distribution of sub-zone B4 recoveries by material type: A) Taconite, B) Gunflint silica, and C) Siltstone.

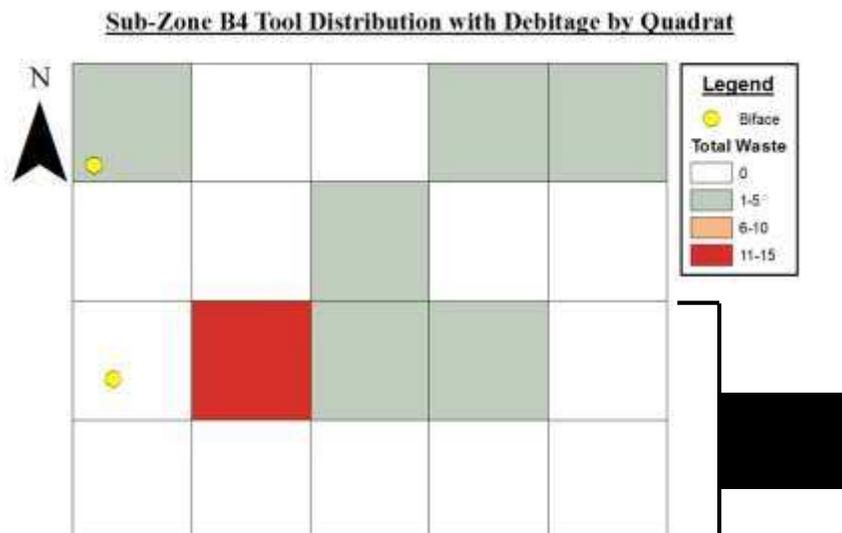


Figure 7.8.10: Sub-zone B4 tool distributions with total debitage by quadrat.

7.8.8 B4: NSG Results

There does appear to be a strong NSG anomaly recorded for area B4. This consists of an elongated high and low reading area that extends into the sub-zone from the west (Figure 7.8.11). The limited recovery of artifacts however inhibits interpretations regarding cultural association.

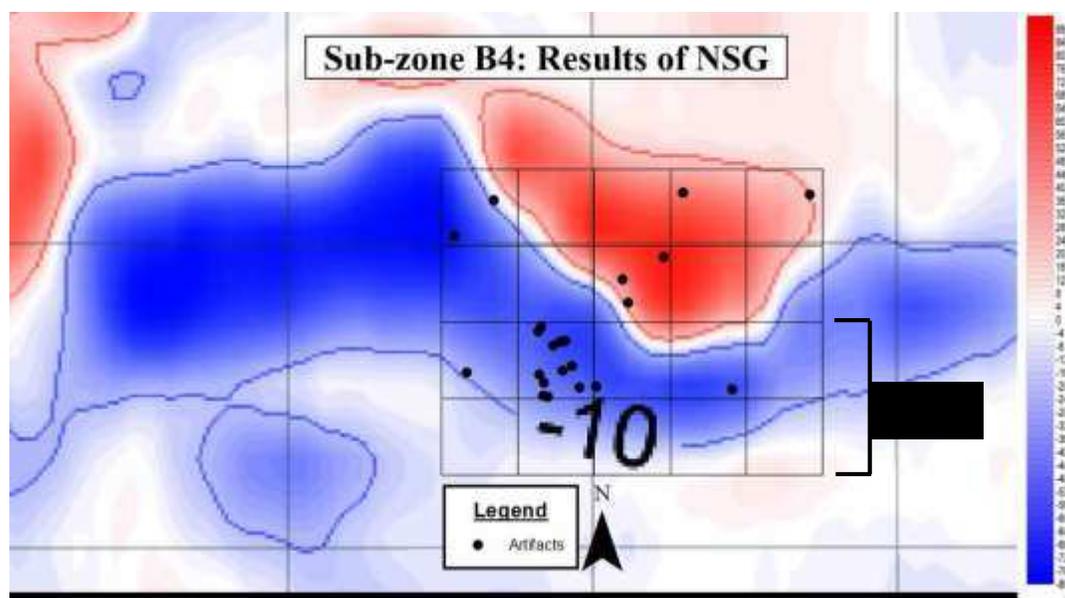


Figure 7.8.11: Results of NSG survey for sub-zone B4. The presence of magnetic anomalies can be seen spreading into the sub-zone from the west.

Chapter 8

Site Interpretations

8.1 *Introduction*

The results presented in Chapter 7 provide the foundation from which interpretations of site use and organization are based. This chapter presents interpretations for individual sub-zones as well as the larger zone 'A' and 'B' areas, leading to hypotheses regarding activity areas and overall site function.

8.2 *Disturbance Processes at the RLF Site*

Although the effects of mechanical tree removal and stacking have already been discussed, it is not the only observable disturbance process at the RLF site. The analysis of artifact distributions by level for all sub-zones indicates that vertical movement of artifacts has occurred, likely as a result of pedoturbation and cryoturbation (Schiffer 1987; Wood and Johnson 1978).

Despite this, the primary artifact distribution peaks in levels 2-4, with greatest quantities in level 3 (Figure 8.2.1). The observed unimodal distribution suggests a comparatively simple depositional sequence, and is consistent with the RLF being a single component site, or possibly multiple occupations with limited soil accumulation between occupation events. It is proposed that slight variations observed within some sub-zones (e.g. sub-zone B1) may be the result of tree stumps offsetting initial excavation datum placement and providing differing amounts of organic overburden. However, limitations in vertical recovery control due to 5cm arbitrary level excavations may have

distorted any subtle variations that may have existed within vertical artifact distributions resulting in an oversimplification of the observed pattern.

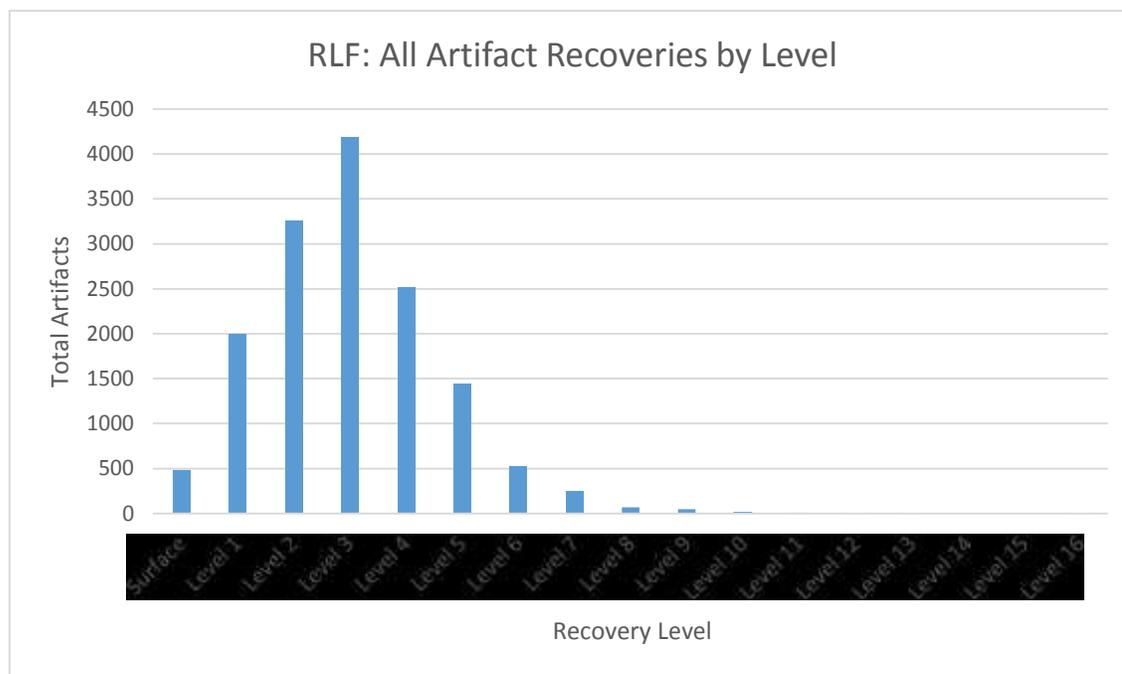


Figure 8.2.1: Vertical distribution of all artifact recoveries by level.

8.3 *RLF Site: Sub-Zone Interpretations*

The following sections (8.3.1-8.3.6) explore site use interpretations for each sub-zone based on observed artifact composition and distributions.

8.3.1 *Sub-Zone A1*

While surface disturbance has resulted in the horizontal displacement of artifacts within sub-zone A1, it is still possible to propose sub-zone activity. After removing surface and level 1 recoveries from the analysis, three lithic clusters are apparent within the sub-zone (Figure 8.3.1).

Sub-Zone A1 Artifact Recoveries from Levels 2-10

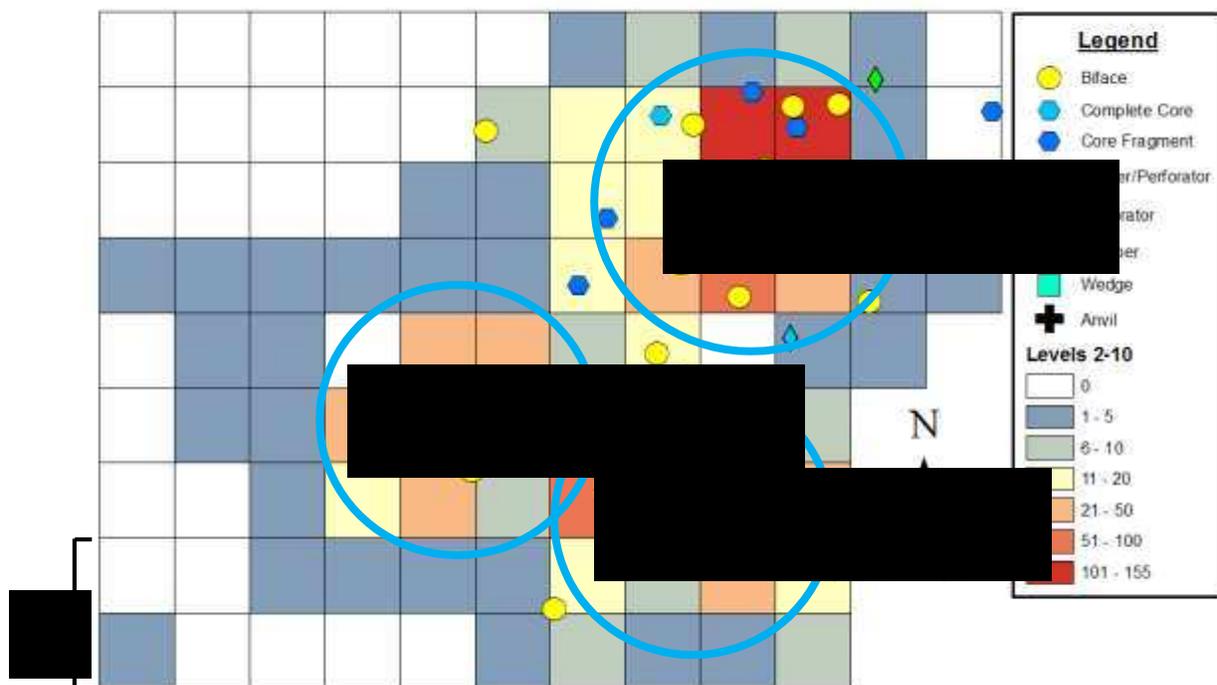


Figure 8.3.1: Artifact distributions for sub-zone A1 indicating the presence of three distinct cluster areas. Note: Surface and level 1 recoveries removed.

Consideration of debitage by size and type shows very little variation between clusters A1-A and A1-B. This differs from cluster A1-C. A separation in debitage size is observed with larger waste occurring to the west and the smaller waste to the east. However, debitage of all sizes for A1-C overlap within a general cluster zone.

With all flake types and sizes occurring in relatively confined spatial distributions, it is proposed that these clusters represent *in-situ* lithic reduction activities. The limited recovery of small waste flakes (<6mm or tertiary reduction flakes) compared to larger debris suggests that this reduction activity was focused more towards the early stages of tool production rather than tool finishing. This interpretation is supported by the recovery of a larger than expected number of broken early stage biface fragments and cores.

An alternate explanation for the clusters in sub-zone A1 is that they represent periodic cluster discard (Gibson 2001). This alternative hypothesis is based on the number of broken and fragmentary bifaces and cores relative to the amount of recovered debitage (~1 biface for every 119 debitage flakes recovered). However, this could be explained by disturbance removing some flakes from the sub-zone. As well, the initial stage/size of the lithic piece prior to beginning bifacial reduction would directly affect the number of recovered flakes, as late stage bifaces (~ stage 3) would require less flake removal in order to reach a cache stage. Unfortunately the interpretation of sub-zone A1 as representing a lithic dumping area cannot be properly investigated due to a lack of refitting analysis of recovered debitage (Bamforth et al. 2005).

The presence of the anvil stone within sub-zone A1 does not appear to directly relate to any of the high density artifact clusters, and is more strongly associated with artifact clusters in sub-zone A2. Furthermore, the limited variety in recovered tool types does not allow for interpretations of activity beyond stone tool production.

Based on the observed spatial distribution and composition of clusters in sub-zone A1, it is proposed that the production of cache/preform stage bifaces accounts for all three distinct areas. Taconite appears to be the primary material employed, although modest recoveries of gunflint silica in clusters A1-A and A1-C suggests it was also utilized for tool production.

8.3.2 *Sub-Zone A2*

Artifact distributions within sub-zone A2 are concentrated to form a ring-shaped pattern, with two primary depositional areas in the west and east (Figure 8.3.2). The

distribution of lithics within this clustering area does not exhibit any signs of horizontal size sorting and are therefore interpreted as representing *in-situ* deposits.

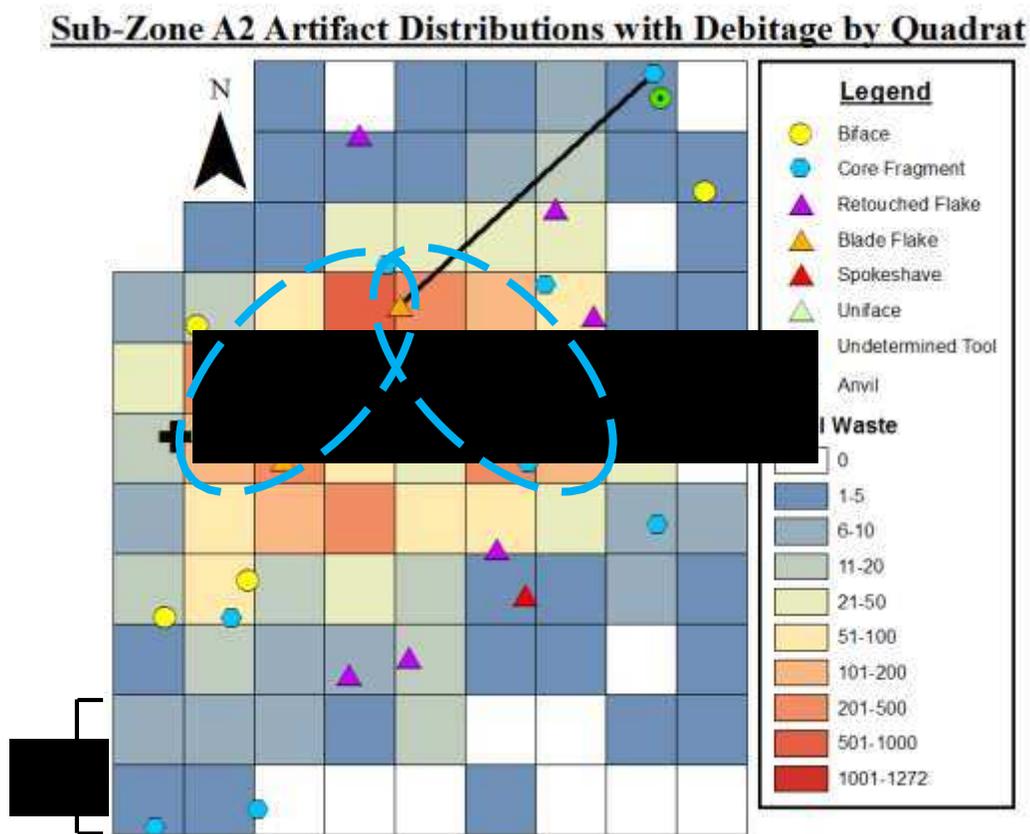


Figure 8.3.2: Artifact distributions for sub-zone A2 with two primary cluster areas indicated.

Ring shaped distributions have been linked through ethnoarchaeological observation to activities being performed around a central hearth (Binford 1983). This interpretation is supported by relatively low artifact recoveries (Bamforth et al. 2005) and distinctive magnetic anomalies emanating from the proposed central hearth area (Figure 8.3.3). This is further supported by distributions of potlidded artifacts concentrating near areas of greatest magnetic anomalies, as these artifacts may have resulted from heating in a hearth and were subsequently dispersed (Figure 8.3.4).

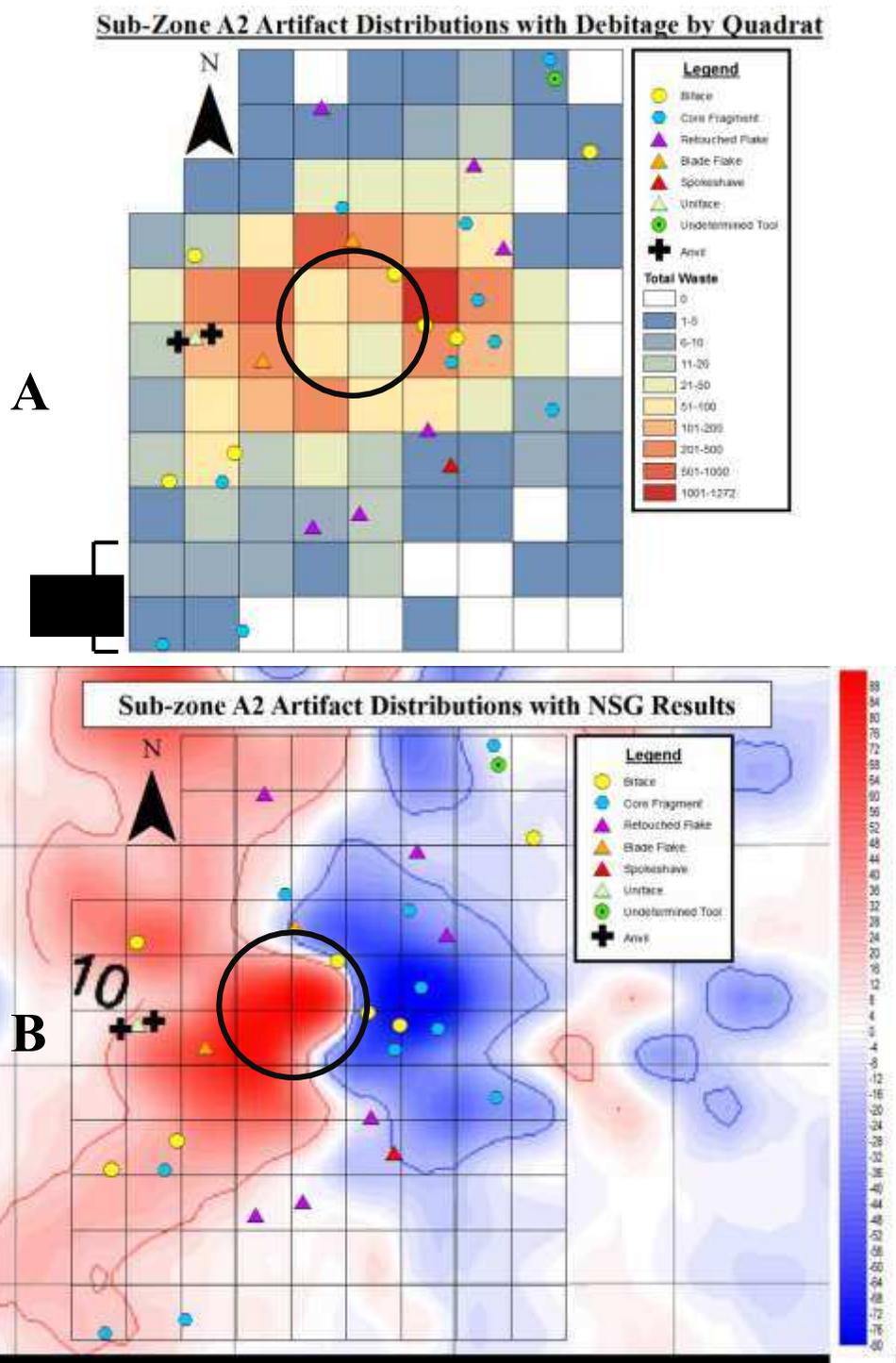


Figure 8.3.3: Proposed hearth location with A) artifact distributions, and B) Magnetic results from NSG.

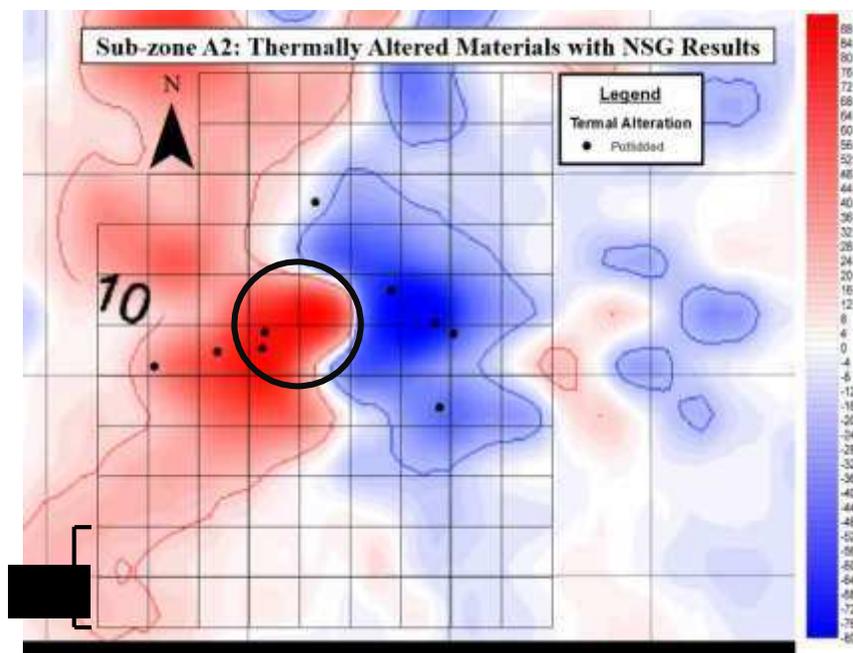


Figure 8.3.4: Distribution of potlidded artifacts with results of NSG. Proposed hearth location indicated by black circle.

While Binford (1983:158) asserted that these ring (or doughnut) shaped distributions occur almost exclusively with open-air hearths, similar patterns (exhibiting a confined distribution, expedient maintenance activities, and a lack of distinctive drop-toss displacement zones) could occur within short-term shelters. As it is not possible to definitively suggest whether a structure was associated with sub-zone A2, two interpretations must be considered.

Firstly, it can be proposed that the distribution of lithic debris in sub-zone A2 took place around a central hearth in an open-air environment, with at least two primary work zones being represented. The smaller of these two clusters (Figure 8.3.2-A2-A) involved the primary reduction of materials using the observed anvil stones, with a secondary focus of biface production. This is indicated by the high frequencies of shatter and small fragmentary debitage. Meanwhile, the primary cluster (Figure 8.3.2-A2-B) suggests activities related to the reduction of suitable material into bifaces/preforms. This is

indicated by the greater frequency of mid-sized flakes and directly associated biface fragments. It is proposed that the lack of an identifiable toss-zone is the result of limited spatial resolution in debitage data, and a limited spacing between the drop and toss zones areas during site use. The observation that tool recoveries generally occurred back from primary debitage distributions could represent a possible toss-zone, however this is not certain.

The second interpretation is similar to the first, however these activities are interpreted as having occurred within a structure, limiting the spatial distribution of debris until after the structure had been removed (Figure 8.3.5). In this interpretation, dense artifact concentration areas are interpreted as representing Type 1 cluster discard (Gibson 2001:74), in which flint knappers within a confined structure were performing lithic reduction tasks and periodically collected and dumped large quantities of mixed debris into a side dump area. This results in areas of extremely high lithic concentration. The use of type 1 cluster discard could help to explain the lack of toss-zone distributions as well as areas of highly mixed debitage recoveries in both high density recovery quads.

One might argue that flint knapping within a structure is unlikely given that it generates a great deal of sharp debris. However, if it can be proposed that some form of floor covering was being used and preventative maintenance kept harmful debris in a defined area, then this is not an improbable interpretation. It can also be speculated that if lithic reduction occurred within a structure just prior to camp abandonment then there would not be a need to worry about debris build-up. Furthermore, suggesting that debris from flint knapping would have made the structure uninhabitable assumes that all structures functioned as living spaces. Given the placement of the RLF site on the

beaches of proglacial Lake Minong it is possible that a structure might have been used to provide shelter and warmth during a task that requires a significant amount of manual dexterity.

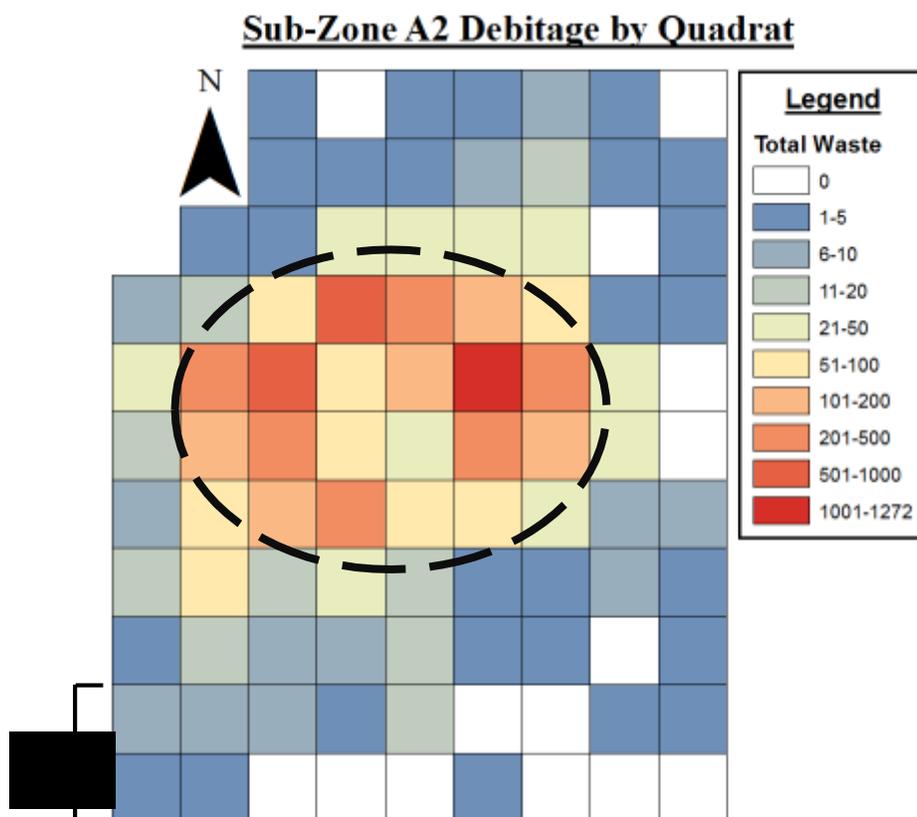


Figure 8.3.5: Debitage distributions for sub-zone A2 with proposed structural elements indicated based on the confined distribution of lithic artifacts.

The presence of scraping tools within sub-zone A2 suggests activities beyond lithic reduction. However, the limited and dispersed nature of these tool recoveries inhibits interpretation.

It is proposed that lithic distributions within sub-zone A2 represent at least two lithic reduction work stations oriented towards a hearth. Given the confined nature of lithic distributions and interpreted lithic maintenance activities within these clusters, it is proposed that some form of structure may have been present. However, this interpretation

must remain speculative as it is equally possible that the observed distribution is the result of limited spatial resolution, blurring patterns attributed to open-air activities.

8.3.3 Sub-Zone B1

The vertical and horizontal distribution of debitage recoveries by size and type indicate that limited post-deposition size sorting has occurred. This suggests that materials are likely minimally displaced aside from vertical movement.

The tightly clustered nature of debitage, biface, and core recoveries suggests that sub-zone B1 represents either a very brief lithic reduction event or, more likely, a type 3 lithic dumping area (Gibson 2001). This is based primarily on the highly clustered nature of debris within a 50x50cm quad, with little to no artifact recoveries from adjacent units. This interpretation remains tentative in light of the limited spatial resolution of recovered debitage, tree root activity, and a lack of debitage refit analysis.

8.3.4 Sub-Zone B2

Sub-zone B2 is interpreted as containing two distinct flint knapping areas, with a central area of undetermined activity (Figure 8.3.6). These flint knapping areas are interpreted to represent *in-situ* production activity based on the co-occurrence of all debitage sizes and types, the dispersal around central 'hot-spots', and the clustered distribution of similar raw material types (e.g. Gunflint Silica). This interpretation is also supported by the presence of extensively used anvil stones near cluster B2-B as well as hammer stone recoveries near cluster B2-A. The presence of fragmentary early stage bifaces, and limited recovery of fine scale debitage and finished formal tools suggests

that the primary function of these reduction areas was the production of bifaces suitable for caching.

This sub-zone also yielded a significant variety of lithic tools suggesting that activity was not limited to bifacial reduction. The high frequency and concentration of re-touched flakes, scrapers, and unifaces suggest that some form of cutting or scraping related activities were being performed within the central area of this sub-zone (see Figure 8.3.6-B2-C). The co-occurrence of re-touched flakes in high concentrations around FCR fragments further suggests some form of craft activities. If the FCR distribution derives from a hearth, then the re-touched flakes may represent a range of domestic activities. Alternatively, if the FCR was relocated to the area, they could have functioned as weights for activities such as hide working (Gibson 2001).

While no magnetic anomalies similar to sub-zone A2 were recorded in direct relation to the FCR clusters, there is an observed magnetic anomaly to the east. This occurs as an elongated magnetic anomaly spreading east-west just beyond sub-zone B2 (Figure 8.3.7). While a direct association cannot be made, it is possible that the readings are the result of hearth related activities near the sub-zone B2 FCR clusters, and the elongation of NSG reading a result of data collection.

Overall, sub-zone B2 is interpreted as representing at least two primary lithic reduction zones, with cutting/scraping activities, possibly related to either butchering or hide-working, occurring in a central area. Based on artifact dispersion and lack of relative artifact confinement, activities within sub-zone B2 are interpreted as occurring in an open-air environment away from built structures.

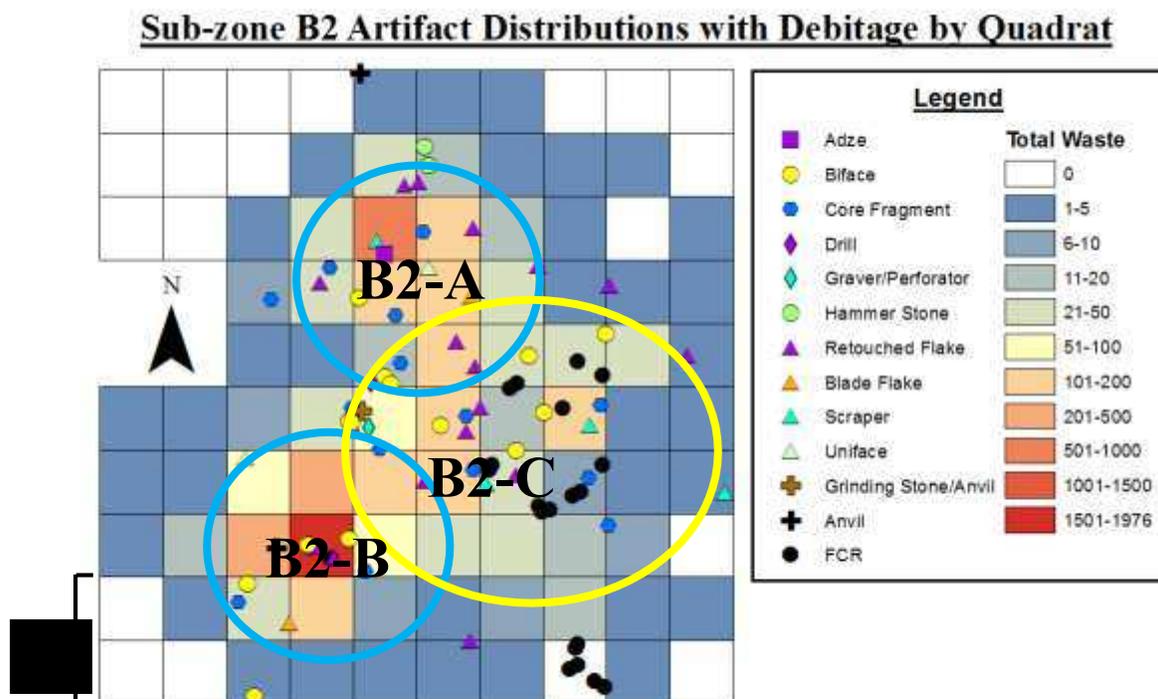


Figure 8.3.6: Artifact distributions for sub-zone B2 with areas of proposed lithic reduction (B2-A and B2-B) and secondary cutting/scraping activities (B2-C).

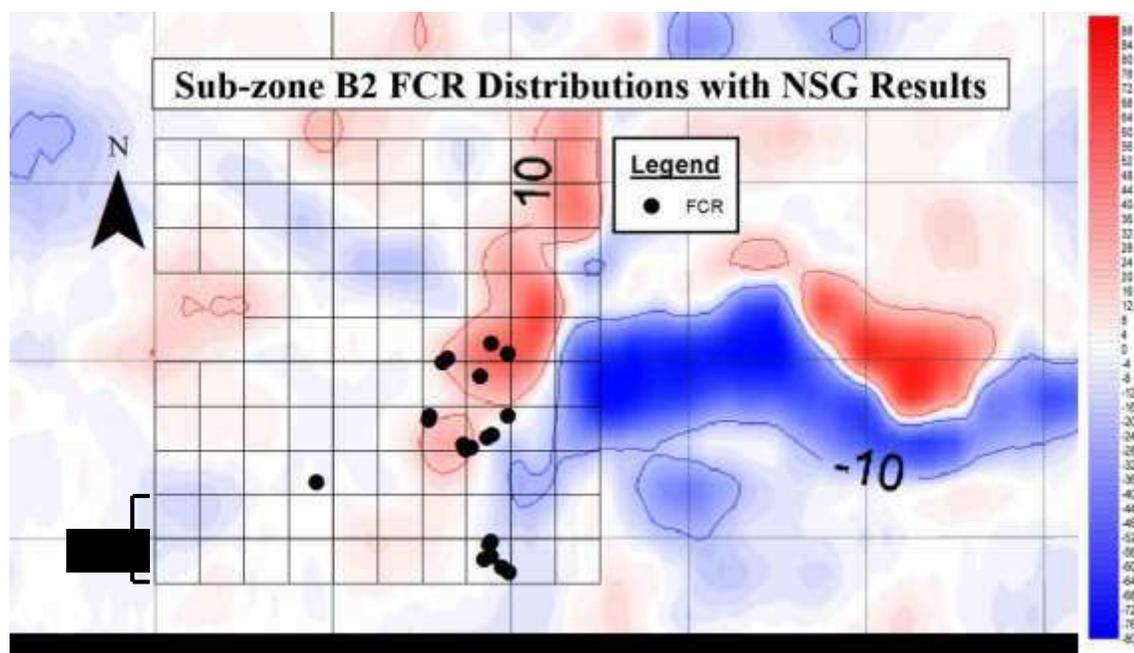


Figure 8.3.7: Location of sub-zone B2 artifacts in relation to NSG results.

8.3.5 Sub-Zone B3

Similar to sub-zone B1, distributions in B3 consist of a tight cluster of lithic artifacts. Distributions of debitage types and sizes all concentrate within the one small cluster area separated from cluster B2 by an area of low recoveries. The presence of core fragments and a broken early stage biface is suggestive of a brief lithic reduction event during which the biface broke and the knapper abandoned the area. Due to limited spatial resolution it cannot be determined if this is the result of *in-situ* lithic production or type 3 cluster discard.

The cluster of FCR located in sub-zone B3 represents one large fragment with smaller secondary fragments. This may be the result of either use as a heated stone removed from fire, or dumping after use within a hearth. It does not appear to be directly associated with deposition of artifacts in B3, although this cannot be ruled out.

Overall sub-zone B3 is interpreted as representing the remains of a relatively brief lithic reduction episode during which biface production failed and the knapper moved away from the area.

8.3.6 Sub-Zone B4

Re-analysis of material recovered from this zone suggests that siltstone objects are not the result of cultural manipulation, and therefore sub-zone B4 does not appear to represent an area of cultural activity. While some biface fragments were recovered from this area, the fact that they were separated by a significant vertical depth suggests that they are not directly related. The extremely limited and un-patterned debitage

distributions rule out the possibility that sub-zone B4 represents lithic production activities. The presence of an intense magnetic reading during NSG survey may represent an event no longer visible within the archaeological record, however, this cannot be explored further.

8.4 Overall Site Function and Organization

While lithic reduction activities were conducted in all areas of the RLF site, there is a distinct difference in the nature of deposits between zones A and B (Figure 8.4.1).

Zone A is interpreted as representing intense lithic reduction activities occurring around a central hearth (sub-zone A2) with a number of smaller lithic clusters to the west likely reflecting independent biface production activities. The hearth centred activities of sub-zone A2 exhibit characteristics that may indicate the presence of a shelter. If this interpretation is correct, then it can be proposed that zone A may contain a structure associated with the observed lithic reduction activities. This structure could have functioned as either a habitation area where flint knapping occurred as a secondary activity, or as a structure utilized primarily for flint knapping in order to protect the site occupants from the elements.

The southern section of the site, zone B, contained evidence of both intensive lithic reduction activities, and butchering/hide working activities suggested by the higher frequency of retouched flakes, scrapers, and unifaces. The dispersed artifact distribution suggests that these activities were more likely conducted in an open-air setting.

The observed separation of zones A and B by a slight rise in elevation, as well as observed differences in artifact distribution patterns, suggests that the separation of these

activity areas occurred intentionally. This separation may have functioned to locate the built structures further back from the beach, possibly within a more wind protected area. Meanwhile the messier activities associated with tool recoveries from sub-zone B2 could be conducted in a more open site area towards the active beach front.

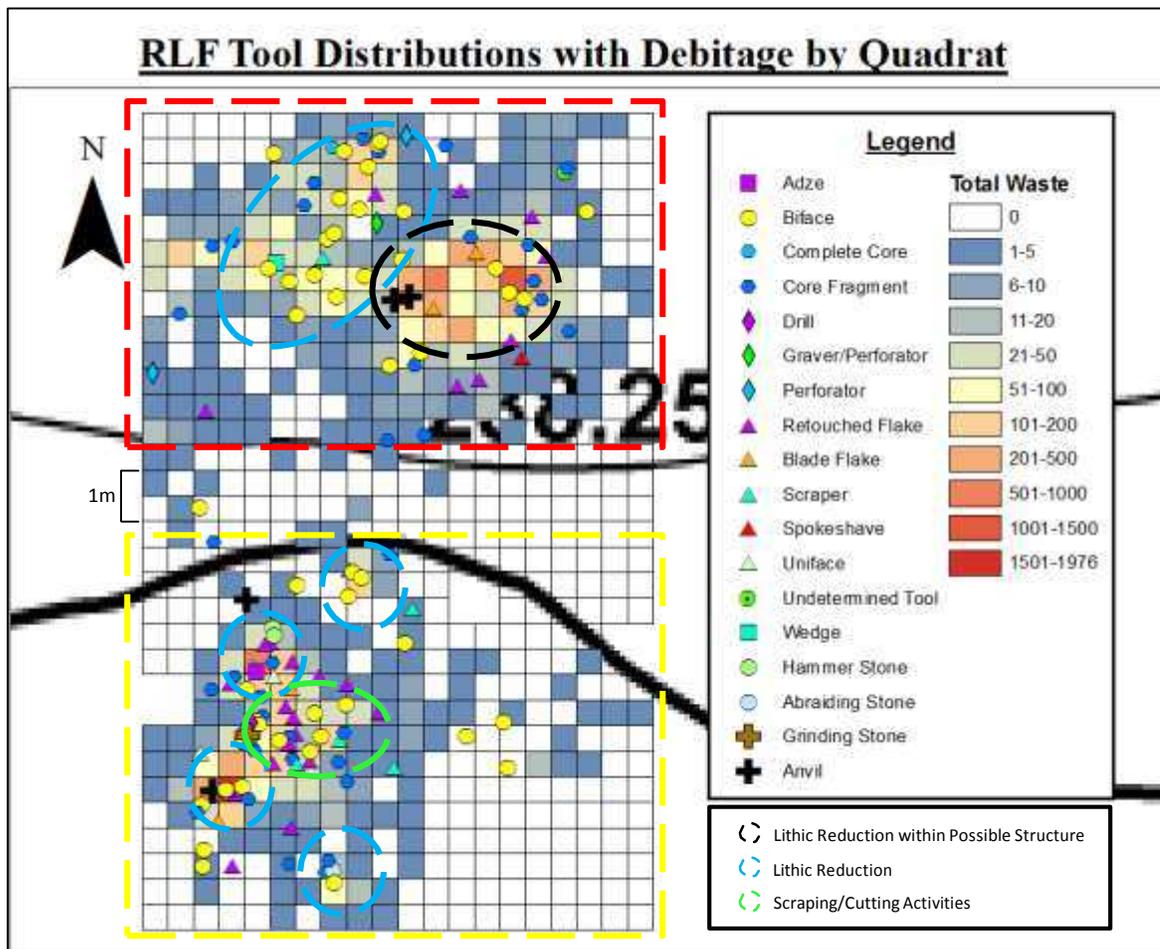


Figure 8.4.1: Distribution of activities within the RLF site in zones 'A' (red) and 'B' (yellow) with topographic contours represented by black lines.

Despite this separation, it can be proposed that the primary observable function of the RLF site was the manufacture of cache stage bifaces from both cobble cores collected locally and bedrock derived cores that may have been transported to the site. The lack of

cortical material on most RLF site recoveries indicates that at least some form of primary testing or reduction was conducted elsewhere. This reduction objective provides a snapshot of the cognitive reduction techniques employed by Lakehead Complex peoples (Bennett 2015) wherein site inhabitants are producing Stage 4/5 bifacial blanks for later finishing elsewhere. The implications of this will be further discussed in Chapter 9.

Chapter 9

Discussion

9.1 *Introduction*

The interpretation of activities undertaken at the RLF site have important implications for understanding Lakehead Complex site use and organization, as well the study of small scale lithic sites within the boreal forest as a whole. This chapter explores how the results of this spatial analysis affect the current understanding of Lakehead Complex culture, and provides commentary on how archaeologists could consider approaching the excavation and analysis of these smaller boreal forest lithic sites. Furthermore, it will discuss any limitations observed within the presented research and offer suggestions as to how future studies could best avoid and mitigate the encountered shortcomings.

9.2 *The RLF Site and the Lakehead Complex*

As previously discussed, few Lakehead Complex intra-site spatial investigations have been conducted (See Chapter 3), making it difficult to compare RLF to a wide range of sites. However, the interpretations proposed for the RLF site are similar to many regional sites in regards to general site composition and basic function. Of the currently excavated sites classified under the Lakehead Complex, the RLF site is most similar to the Naomi site (DcJh-42) and the Biloski site (DcJh-9).

Both the Naomi and Biloski sites are interpreted as being oriented towards the production of cache stage bifaces for transportation and refinement elsewhere (Adams

1995; Hinshelwood and Webber 1987). These interpretations are based primarily on the recovery of large quantities of fragmentary and failed early stage bifaces with few other tool recoveries. Comparing biface recoveries from Naomi and Biloski to those identified for the RLF site reveals a similar distribution of biface stages, with the exception that Naomi exhibits a greater abundance of stage 4 bifaces and an under-representation of stage 2 bifaces (Figure 9.2.1, Table 9.2.1).

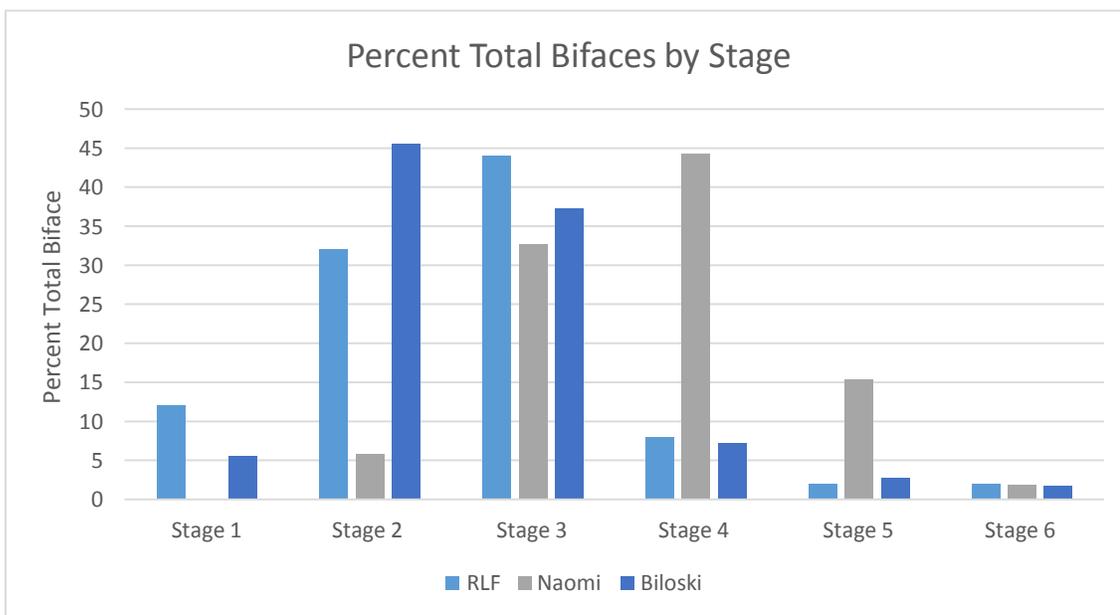


Figure 9.2.1: Percent total bifaces by stage for the RLF (DdJf-13), Naomi (DcJh-42), and Biloski (DcJh-9) sites (Adams 1995; Hinshelwood and Weber 1987).

Table 9.2.1: Comparison of biface recoveries by stage for the RLF (DdJf-13), Naomi (DcJh-42), and Biloski (DcJh-9) sites (Adams 1995; Hinshelwood and Weber 1987).

	RLF (DDJF-13)		NAOMI (DCJH-42)		BILOSKI (DCJH-9)	
	Total	% Total	Total	% Total	Total	% Total
STAGE 1	6	12.00	0	0.00	10	5.56
STAGE 2	16	32.00	3	5.77	82	45.56
STAGE 3	22	44.00	17	32.69	67	37.22
STAGE 4	4	8.00	23	44.23	13	7.22
STAGE 5	1	2.00	8	15.38	5	2.78
STAGE 6	1	2.00	1	1.92	3	1.67
TOTAL	50	100	52	100	180	100

It was proposed by Fox (1975) that littoral sites, such as Naomi and RLF, were chosen primarily for resource acquisition, with a secondary focus on lithic reduction activities. The Naomi site supports this hypothesis, as its location would not have been directly beneficial for tool production but rather the exploitation of food resources from adjacent wetlands (Adams 1995). The RLF site supports this hypothesis as well, as its location does not appear to coincide directly with either bedrock or cobble lithic sources. Therefore, all materials at the RLF site would have had to be transported to the site. As such, the RLF site location may have been selected based on its proximity to stream sources, well drained beach sediments, and placement back from the active beach front rather than its functionality as a lithic reduction area. However, aside from the butchering/hide working activities proposed for sub-zone B2, there is little direct evidence suggesting activities other than lithic tool production. This is similar to the observations made by Adams (1995) regarding the Naomi site assemblage. It is proposed that these sites may have functioned primarily as biface production stations, and that site location was chosen based on the immediate availability of resources during the brief occupation period.

The RLF site therefore represents a distinct Lakehead Complex site type at which biface production for transportation and later finishing was conducted as a primary activity during a relatively brief occupation, similar to the Naomi and Biloski sites. This differs markedly from quarry sites such as Cummins (DcJi-1) and hunting/occupation sites like Brohm (DdJe-1) and Mackenzie 1 (DdJf-9) in regards to debitage and tool composition.

Aside from these broad generalizations of site type, it is difficult to compare the intra-site organization of the RLF site to others within the Lakehead Complex. This is due to the general lack of detailed intra-site analyses.

The presence of distinctive knapping zones utilizing anvil stones as identified at the Naomi site (Adams 1995) is also seen in the RLF site. Aside from this however, little spatial similarities can be discussed beyond the presence and use of distinctive knapping locations (e.g. Adams 1995; Halverson 1992; Hinshelwood and Webber 1987). Interpretations derived from the RLF site analysis will help form the basis through which further intra-site comparison can be established.

9.3 Implications for the Study of Small Scale Sites in Northwestern Ontario

It is common that higher level archaeological research focuses on sites that yield large quantities of artifacts. This results in smaller lithic sites generally being subjected to cursory investigation. The interpretive resolution of the RLF site spatial data, coupled with its apparent brief occupation, was of primary importance for the ability to draw conclusions regarding site use and activity areas. With relatively modest lithic recoveries, the effects of post-depositional artifact movement did not heavily impact spatial resolution allowing for activity area interpretation. This is a unique characteristic of small scale sites, as spatial resolution on large/multi-component Boreal forest lithic sites are heavily affected by post-depositional disturbance, blurring distinctions in artifact distributions between multiple occupations.

Furthermore, the study of small scale sites, in regards to their intra-site organization and function, provide an opportunity to identify under-represented aspects of settlement systems and clarify the archaeological signatures of activity areas. While these larger sites are invaluable for the information that can be derived regarding the material culture and cognitive behaviours of past populations, the repeated nature of occupation limits their interpretability at an occupational level (see exception McCulloch n.d.). Smaller, more discrete sites, while yielding limited artifact recoveries, can begin to answer questions of site organization and occupation.

Unfortunately, the identification and documentation of smaller, more interpretable sites, is negatively impacted even in the early stages of archaeological investigations as a result of the methods required during site survey activities (Adams 1995). It is common for archaeological test-pit surveys during CRM investigations in Ontario to employ a 5m x 5m transect during initial site investigations. Given the small spatial footprint of the lithic knapping areas identified within the RLF site, consistently locating these discrete activity areas during 5m test pit surveys is unlikely. This results in smaller, more interpretable sites, being missed. However, expanding upon this standard to increase the number of test-pits within a survey area will directly impact the ability for archaeologists to effectively survey large areas within the allotted time and budget requirements. This leaves the difficult question of how one can both effectively locate small scale lithic sites while maintaining efficiency. Providing a solution to this will take the collective effort of the archaeological community and is beyond the scope of this paper.

What is clear is that the RLF site illustrates the importance of studying these smaller lithic sites, as it has yielded an interpretable distribution of lithic artifacts in large

part due to its discrete and limited occupation history. Spatial studies utilizing small scale lithic sites help to form an interpretive base through which large or repeatedly occupied Lakehead Complex sites can be compared.

9.4 Study Limitations, Concerns, and Future Directions

As with all archaeological research, it is important to acknowledge the limitations present. Understanding these weaknesses helps to address questions that arise, and propose ways through which they may be overcome in future research. The primary limitations encountered during the RLF site analysis were a result of either the nature of CRM derived data sets, the inherent biases of archaeological spatial analysis, or the interpretive limitations associated with base level artifact identification and analysis. The following sub-sections address the concerns associated with these limitations and provide comments on how to best adapt future spatial studies in order to alleviate any observed shortcomings.

9.4.1 Spatial Analysis and CRM Derived Samples

The overwhelming majority of archaeological investigations conducted within Northwestern Ontario today are driven by development rather than academic research. As such, CRM standards and procedures are directly responsible for the accessibility and condition of much of the data that is available for research. While many of the shortcomings observed within this thesis are a direct result of the policies imposed upon CRM archaeologists, they illustrate the difficulties in finding the balance between efficiency and data quality within the consulting world.

Limitations that result from CRM derived data are primarily associated with the scale of spatial resolution available. The excavation of units by 50cm quadrats and arbitrary levels meant that debitage data was batch catalogued by area, rather than by direct location. This limits the ability to identify fine scale patterning within debitage distributions that may represent unique or spatially distinct site activities by blurring together groups of artifacts (Figure 9.4.1).

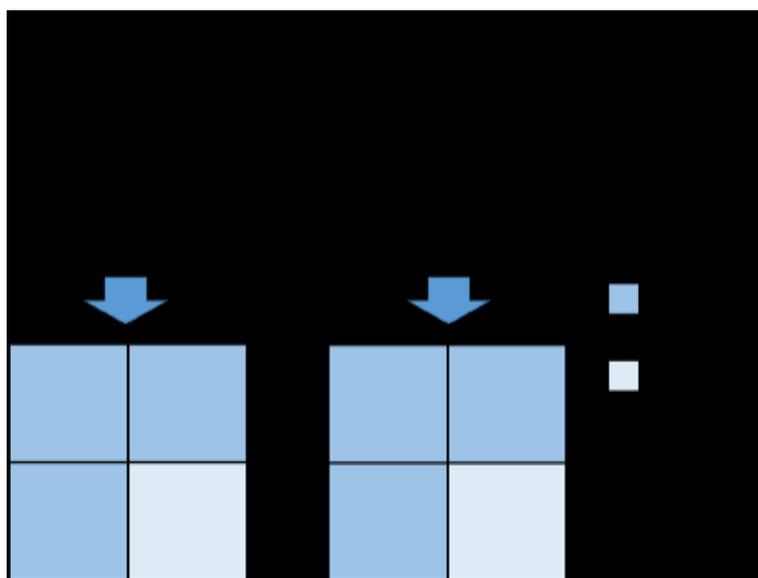


Figure 9.4.1: Idealized diagram illustrating the effects of batch cataloguing of artifact resulting in the blurring of fine scale debitage patterning in a 1x1 m unit.

While the use of batch cataloguing may limit fine scale interpretability, it does provide alternative benefits. Given the likelihood that post-deposition movement will displace artifacts (Bowers et al 1983; Schiffer 1987; Wood and Johnson 1978), the use of batch cataloguing allows the researcher to look beyond the individual artifacts in order to see the greater overall pattern. This reduces the possibility of falsely interpreting displaced artifacts. The use of batch cataloging also allows for a greater site area to be excavated, yielding a better overall site interpretation. However, the scale of the quadrats

used for batch cataloging must be chosen carefully to both maintain efficiency while also providing an appropriate amount of detail. Utilizing excavation units that are too large will result in the blurring or blending of artifact distributions, while too fine a scale will reduce the ability to excavate large site areas within the allotted excavation resources (Figure 9.4.2).

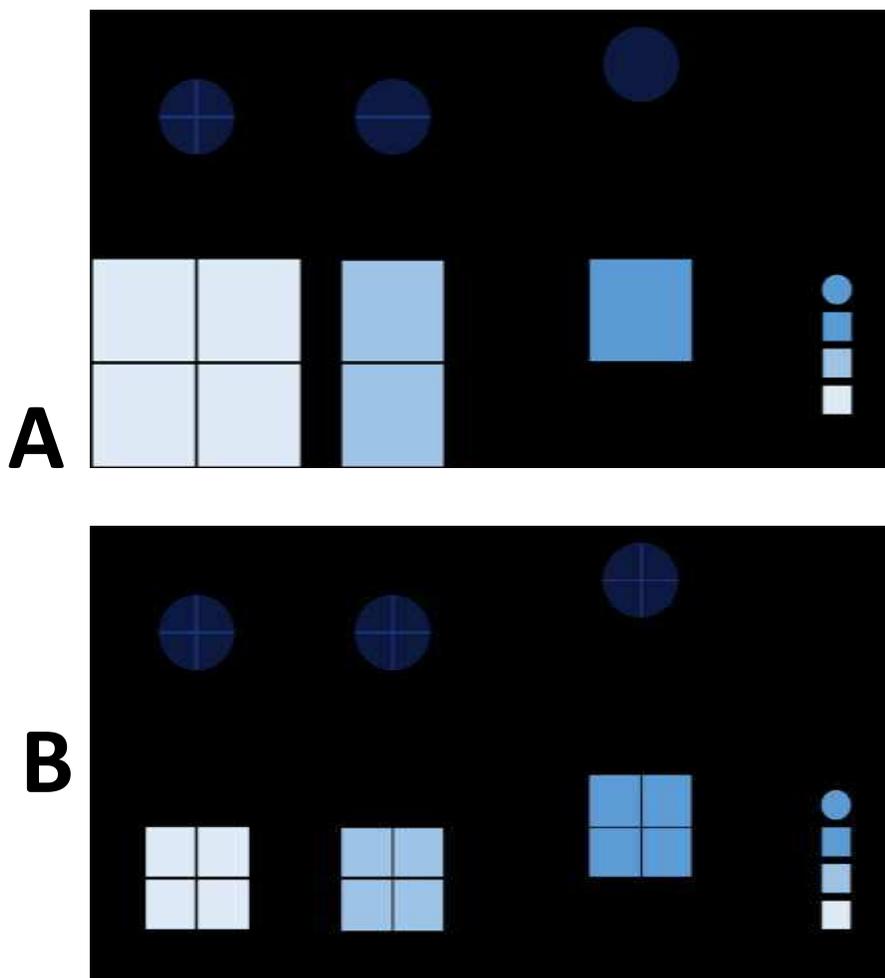


Figure 9.4.2: Diagram illustrating the effects of quadrat size on the spatial interpretability of artifact distributions. While reducing quadrat size further to 25x25 cm would improve the spatial resolution of patterning, the time required would double. This would limit the ability to excavate large areas of a site, reducing the overall site picture.

Further difficulties in spatial interpretability were encountered while attempting to determine whether concentrated lithic scatters were the result of *in-situ* production or secondary dumping activities. Utilizing sequences of artifact refitting may be able to distinguish these different depositional processes as an *in-situ* production event will yield long sequences of material refits while lithic dumping activities will not (Bamforth et al. 2005). Given the resource sensitive nature of CRM investigations, this form of time-intensive interpretation could not be employed for this analysis. Although the inability to perform a debitage refit analysis hindered the current study, it can be applied to future spatial analyses if conducted prior to initial spatial interpretations.

While many of the shortcomings observed within this thesis occur as both direct and indirect results of the constraints imposed upon consulting archaeologists, CRM excavations still prove promising for future spatial distribution studies. The RLF site analysis has shown promise for the use of NSG in CRM investigations, as it provides a method for identifying areas of significant archaeological potential in a Boreal forest setting prior to excavation. While this method is not currently a mandatory practise, it does prove feasible within the scope of a mitigation project. Furthermore, the use of properly scaled excavation quadrats (despite a loss of fine scale spatial resolution) allow for the interpretation of artifact distributions across a larger site area. The capability for CRM excavations to provide data suitable for higher level analysis is a direct result of the ability to balance time, scale, and resources. Finding this balance will provide an overall site impression, while maintaining enough fine scale data to interpret site organization and activity distribution.

9.4.2 Comments on Spatial Analysis in Archaeology

While utilizing spatial statistics aids in limiting researcher bias, they are not able to provide interpretations regarding the site activities responsible for an observed distribution. To accomplish this, one must utilize examples from both ethnoarchaeological and archaeological studies. Although these do provide valuable case studies through which the observed patterns can be compared, they also expose the research to the various personal opinions of the one interpreter. This is especially true when interpreting sites where only lithic artifacts remain.

On sites with poor organic preservation, it is difficult to identify hearths and/or structures that would have provided anchors for site activity. As such, one must rely on the various models/hypotheses available for the identification of artifact distributions resulting from hearth-related activities (Binford 1983; Gibson 2001; Stevenson 1986, 1991). While these models are very useful in providing generalized trends in formation processes, they do not account for subtle variations in site use that may have occurred between different populations due to environment, site location, group size/composition, or other unknown variables. Furthermore, with limited organic preservation even basic interpretations of site use are based solely on the morphological characteristics of stone tools. This makes comparisons in site formation different between sites (e.g. hearths used for food, warmth, light, hafting, and etc. will exhibit different characteristics that may not survive in the Boreal forest). As such, interpretations cannot be used to provide a direct series of events for a site, and must instead focus on generalized scenarios of site-use and organization based on all possible lines of evidence.

It is an unfortunate reality of spatial analyses that researchers can never truly eliminate all elements of research bias. Without a direct understanding of how or why past populations utilized their site space it is not possible to eliminate any feasible site scenarios. Therefore, it is important in any spatial interpretation to present all possible scenarios that could have resulted in the observed artifact distribution. In doing so, one is able to offer conclusions regarding site formation processes while providing the reader with alternative scenarios through which they can critically assess the results.

9.4.3 *Improving Activity Area Interpretability*

As stated previously (section 9.4.2), the application of spatial studies to sites yielding only lithic artifacts pose difficulties for the accurate interpretation of site function. Alternative archaeological studies can help to alleviate this issue by providing a more comprehensive understanding of tool use, and thus site activity distributions. Incorporating micro-fossil, residue, and use-wear analyses into spatial studies would allow for a more direct understanding of the organization and distribution of various activities. When applied to sites yielding little to no organic remains this can serve to expand and diversify the site catalog by function/use.

9.5 *Summary*

The limited number of intra-site spatial studies conducted for Lakehead Complex sites impedes in-depth comparisons regarding site organization and use. However, the similarities observed between the Naomi (DcJh-42) and the Biloski (DcJh-9) sites suggest that the RLF site is representative of a short term occupation at which cache stage

bifaces were produced for transport and refinement elsewhere. Similar to the Naomi site, the location of RLF does not appear to have been selected based on lithic reduction activities, but rather for the exploitation of the surrounding environment.

The similarities between the RLF and Naomi sites suggest a distinct site type where lithic reduction formed the primary function, despite its littoral setting away from available lithic sources. This supports the idea that Lakehead Complex littoral site locations were chosen primarily for resource availability despite primary observable site function.

The conclusions and spatial interpretations gathered from the RLF site analysis illustrates the importance of studying these small and seemingly unimportant lithic sites as they have the ability to provide interpretable patterns of activity. However, as is evident within this thesis, the proper documentation and analysis of these sites is needed in order to interpret lithic distributions. While data derived from CRM excavation does allow for interpretations of site use and organization, the spatial resolution and laboratory procedures do not permit in-depth interpretations regarding the nature of observed activity clusters. Future studies should strive to improve both the quality of spatial data collected in the field, as well as apply multiple forms of artifact analyses such as debitage refitting, micro-fossil analysis, residue analysis, and use-wear studies in order to better interpret activity area functions.

Chapter 10

Conclusion

It is common in archaeology to focus research on sites that yield either unique or significant recoveries. This is especially true in regards to the Late Paleoindian sites of Northwestern Ontario. The multi-occupational, sometimes multi-component, nature of these larger sites means that they often yield a variety of tool forms from which morphological and technological studies can be based. However, these frequently occupied sites are often subjected to poor taphonomic conditions (such as slow soil accumulation, highly acidic soils, and heavy pedoturbation), making it nearly impossible to distinguish distinct signatures of site use and organization at a settlement level. The inability to address long-standing questions of site-use and settlement patterns, has resulted in a gap in the current understanding of how Lakehead Complex populations organized themselves within their lived space. In order to fill this void, research regarding site-use could greatly benefit from a focus on small scale lithic sites such as RLF. These smaller sites, while generally unassuming in nature, provide the best opportunities to answer questions of intra-site organization. Their single-component, and sometimes single-occupation, history means that issues of taphonomy and preservation will be less detrimental towards archaeological signatures of activity areas.

While past studies have sought to address the nature of artifact distributions on Lakehead Complex sites (e.g. Adams 1995), they relied primarily on visual interpretations of piece plotted artifact maps. This thesis moves beyond visual inspection, addressing the intra-site organization of activities at the RLF site through the application of spatial analytical techniques and ethnoarchaeological and archaeological comparison.

The use of both spatial statistics and case study comparisons has enabled the critical assessment of observed artifact distributions in light of site disturbance and formation processes. This methodology aided in the identification and interpretation of six distinct lithic activity clusters within the RLF site (see Figure 8.4.1).

These cluster areas suggest that the primary function of the RLF site was the production of cache stage bifaces that would have been transported away for further refinement elsewhere. Biface production occurred in distinct flint knapping areas, with some evidence for hearth centred activity occurring in both the north and south of the site. There is also some evidence to suggest that a structure may have been associated with a hearth centred artifact distribution in the northern area of the site. Meanwhile, the southern portions of the site exhibited evidence of possible secondary activities oriented towards tasks that involved cutting and scraping, possibly hide working or butchering. The distinction between different areas of site activity allowed for the interpretation of various site-use zones that appear to have been chosen in order to distribute different activities within the site as a whole.

While the limited application of intra-site spatial analyses have restricted the comparative discussion between other Lakehead Complex occupations, similarities in basic site type and objectives are observed between the RLF and Naomi sites (Adams 1995). Both sites demonstrate that the primary observable activity was the production of bifaces suitable for caching, which represents a distinct facet within the cognitive production chain identified by Bennett (2015). Sites such as RLF and Naomi demonstrate the importance of producing cache stage bifaces that would have provided blanks for a

variety of different formal tools; a trait illustrated in the extensive cache recovered from the Crane site (Ross 2011).

Due to the lack of Lakehead Complex intra-site studies, the RLF site analysis is an important case study through which future spatial analyses can be compared and contrasted. It has demonstrated the significance of small scale lithic sites in regards to their spatial interpretability and ability to address questions that larger, more intensively occupied sites cannot. With the ability to clearly identify the archaeological signatures of various site activities on Lakehead Complex sites, we can begin to develop a picture of how Late Paleoindian populations within the region functioned at the household level.

Furthermore, the RLF site analysis has been able to evaluate the feasibility and effectiveness of applying intra-site spatial analyses to data sets obtained through CRM excavations. Despite limitations regarding fine scale interpretability, the ability to effectively segment excavation units into quadrats of a sufficient size provided enough spatial resolution to make informed and confident interpretations of debitage distribution patterns. These compromises in data resolution illustrate the importance of finding a balanced approach while conducting CRM projects, so as to ensure that excavations are able to provide both a holistic view of the site itself, as well as sufficient fine scale resolution to differentiate and interpret site activity areas.

An additional benefit of the RLF site analysis were the results gained from NSG survey conducted prior to excavation. While NSG survey is not a standard practise in the CRM community, it enabled the identification of possible hearth features that would have otherwise gone unnoticed. The identification of hearth features is invaluable when developing interpretations of site use, especially within Boreal forest sites where most

features do not survive in the archaeological record. The success of NSG in regards to the spatial analysis of the RLF site helps to validate both the use of remote sub-surface testing in the Boreal forest, and the value it can add to the spatial analysis and study of sites recovered through salvage excavations.

Overall, the RLF site study represents one of the first true applications of intra-site spatial analysis on a Lakehead Complex site (see also McCulloch n.d.). Utilizing both spatial analytical techniques and ethnoarchaeological and archaeological case studies, multiple distinct flint knapping activity areas were identified. These knapping areas suggest a site activity focused towards the production of cache stage bifaces. Further spatial patterning, correlated with NSG results, was able to provide evidence for the possible presence of a built structure and hearth focused activities. The many similarities observed with the Naomi site (Adams 1995) suggests a distinct site type where primary activities are the production of transportable biface blanks (Bennett 2015), despite being far removed from lithic sources. Additionally, the RLF site provides a case study into the application of spatial analysis utilizing CRM derived data sets, which represents the dominant form of archaeological investigation in Northwestern Ontario. Of primary importance, the intra-site spatial analysis of the RLF site provides a starting point from which questions of Lakehead Complex site use and organization can begin to be answered, enhancing our understanding of the people who occupied Northwestern Ontario over 9,000 years ago.

Chapter 11

References

- Adams, N. 1995. *A Preliminary Report on an Archaeological Excavation at the Naomi Site (DcJh-42) Thunder Bay, Ontario*. (W.P. 621-89-00, Northwest Region). Report Prepared for the Ontario Ministry of Transportation. P223-026-2009
- Andrefsky Jr., W. 1998. *Lithics: Macroscopic Approaches to Analysis*. Cambridge University Press. New York, New York
- Andrefsky Jr., W. 2001. *Lithic Debitage: Context, Form, Meaning*. The University of Utah Press. Salt Lake City, Utah
- Bamforth, D.B., Becker, M., and Hudson, J. 2005. Intrasite Spatial Analysis, Ethnoarchaeology, and Paleoindian Land-Use on the Great Plains: The Allen Site. *American Antiquity* 70(3):561-580
- Bennett, G. 2015. *Late Paleoindian Biface Manufacture: A Case Study from the Mackenzie I Site (DdJf-9) near Thunder Bay, Ontario*. Master's Thesis. Department of Anthropology. Lakehead University
- Binford, L.R. 1978. Dimensional Analysis of Behaviour and Site Structure: Learning from an Eskimo Hunting Stand. *American Antiquity* 43(3):330-361
- Binford, L.R. 1983. *In Pursuit of the Past: Decoding the Archaeological Record*. Thames and Hudson. New York, New York
- Bouchard, S. *n.d.* Unpublished Master's Thesis. Department of Anthropology. Lakehead University
- Björck, S. 1985. Deglaciation Chronology and Revegetation in Northwestern Ontario. *Canadian Journal of Earth Sciences* 22:850-871
- Bowers, P.M., Bonnicksen, R., and Hoch, D.M. 1983. Flake Dispersal Experiments: Noncultural Transformation of the Archaeological Record. *American Antiquity* 48(3):553-572
- Boyd, M., Teller, J. T., Yang, Z., Kingsmill, L., and Shultis C. 2012. An 8900-Year-Old Forest Drowned by Lake Superior: Hydrological and Paleoecological Implications. *Journal of Paleolimnology* 47:339-355

- Breckenridge, A. 2007. The Lake Superior Varve Stratigraphy and Implications for Eastern Lake Agassiz Outflow from 10,700 to 8,900 yBP (9.5-8.0 ^{14}C ka). *Paleogeography, Paleoclimatology, Paleoecology* 246:45-61
- Breckenridge A., Lowell, T. V., Fisher, T.G., and Yu, S. 2010. A Late Minong Transgression in the Lake Superior Basin as Documented by Sediments from Fenton Lake, Ontario. *Journal of Paleolimnology* 47(3):313-326
- Carr, C. 1984. The Nature and Organization of Intrasite Archaeological Records and Spatial Analytic Approaches to their Investigation. *Advances in Archaeological Method and Theory* 7:103-222
- Carr, C. 1991. Left in the Dust: Contextual Information in Model-Focused Archaeology. In *The Interpretation of Archaeological Spatial Patterning*. Edited by Kroll E.M. and Price, T.D. Pp.221-256. Plenum Press. New York, New York
- Cook, R. *n.d.* Unpublished Master's Thesis. Department of Anthropology. Lakehead University
- David, N., and Kramer, C. 2001. *Ethnoarchaeology in Action*. Cambridge University Press. New York, New York
- Dawson, K.C.A. 1983. *Prehistory of Northern Ontario*. Thunder Bay Historical Museum. Guide Publishing and Printing, Thunder Bay, Ontario
- De Smith, M.J., Goodchild, M.F., and Longley, P.A. 2007. *Geospatial Analysis: A Comprehensive Guide to Principles, Techniques, and Software Tools*. Troubador Publishing. Leicester, UK
- Dyke, A.S. 2004. An Outline of North American Deglaciation with Emphasis on Central and Northern Canada. In *Quaternary Glaciations-Extent and Chronology, Part II: North America*. Edited by Ehlers J. and Gibbard, P.L. Vol 2b Pp. 373-424. Elsevier, Amsterdam
- Dyke, A.S., Andrews, J.T., Clark, P.U., England, J.H., Miller, G.H., Shaw, J., and Veillette, J.J. 2002. The Laurentide Innuitian Ice Sheets during the Last Glacial Maximum. *Quaternary Science Reviews* 21:9-31
- Enloe, J.G., David, F., and Hare, T.S. 1994. Patterns of Faunal Processing at Section 27 of Pincevent: The Use of Spatial Analysis and Ethnoarchaeological Data in the Interpretation of Archaeological Site Structure. *Journal of Anthropological Archaeology* 13:105-124
- Farrand, W.R. and Drexler, C.W. 1985. Late Wisconsinan and Holocene History of the Lake Superior Basin. In *Quaternary Evolution of the Great Lakes*, Edited by Karrow, P.F. and Calkin, P.E. Geological Association of Canada Special Paper 30

- Fiedel, S.J. 1987. *Prehistory of the Americas*. Cambridge University Press. New York, New York
- Fiedel, S.J. 1996. Blood from Stones? Some Methodological and Interpretive Problem in Blood Residue Analysis. *Journal of Archaeological Science* 23:139-147
- Fiedel, S.J. 1999. Older Than We Thought: Implications of Corrected Dates for Paleoindians. *American Antiquity* 64(1):95-115
- Fisher, T. 2003. Chronology of Glacial Lake Agassiz Meltwater Routed to the Gulf of Mexico. *Quaternary Research* 59:271-276
- Fox, W.A. 1975. The Palaeo-Indian Lakehead Complex. In *Canadian Archaeological Association Collected Papers, Research Report 6* March 1975, Edited by Nunn, P. Pp.29-53. Ontario Ministry of Natural Resources, Historic Sites Branch
- Fox, W.A. 1977. The Trihedral Adze in Northwestern Ontario. In *Collected Archaeological Papers*. Edited by Melvin, D.S. Pp. 113-126. Ontario Ministry of Culture and Recreation Archaeological Research Report 13
- Fox, W.A. 1980. The Lakehead Complex: New Insights. *Data Box Research Manuscript Series*. Historical Planning and Research Branch, Ontario Ministry of Culture and Recreation, Pp. 1-22
- Gaffney, C. 2008. Detecting Trends in the Prediction of the Buried Past: A Review of Geophysical Techniques in Archaeology. *Archaeometry* 50(2):313-336
- Gibson, T.H. 1986. Magnetic Prospection on Prehistoric Sites in Western Canada. *Geophysics* 51(3):553-560
- Gibson, T.H. 2001. Site Structure and Ceramic Behaviour of a Protohistoric Cree Aggregation Campsite. *BAR Archaeopress Series V. 947*. British Archaeological Reports
- Gillings, M. and Wheatley, D. 2005. Geographic Information Systems. In *Handbook of Archaeological Methods Volume 1*. Edited by Maschner, H.D.G. and Chippindale, C. AltaMira Press. Lanham, Maryland
- Gregg, S.A., Kintigh, K.W. and Whallon, R. 1991. Linking Ethnoarchaeological Interpretation and Archaeological Data: The Sensitivity of Spatial Analytical Methods to Postdepositional Disturbance. In *The Interpretation of Archaeological Spatial Patterning*. Edited by Kroll E.M. and Price, T.D. Pp. 149-196. Plenum Press. New York, New York

- Halverson, C. 1992. *The 1991 Excavations of the Simmonds Site (DcJh-4): A Late Palaeo-Indian Site on the Current River*. Conservation Archaeology Report. Ontario Ministry of Citizenship and Culture, Northern Region No. 30. Thunder Bay, Ontario
- Healan, D.M. 1995. Identifying Lithic Reduction Loci with Size-Graded Macrodebitage: A Multivariate Approach. *American Antiquity* 60(4):689-699
- Hinshelwood, A. 1990. *Brohm Site Archaeological Project: 1987*. Conservation Archaeology Report. Ontario Ministry of Citizenship and Culture, North Central Region No.27. Thunder Bay, Ontario
- Hinshelwood, A. 2004. Archaic Reoccupation of Late Palaeo-Indian Sites in Northwestern Ontario. In *The Late Palaeo-Indian Great Lakes*. Edited by Jackson L.J. and Hinshelwood, A. Pp. 225-250. Canadian Museum of Civilization, Mercury Series, Archaeology Paper 165.
- Hinshelwood, A. and Weber, E.
1987 *Testing and Excavation of the Ozbolt Property, Part of the Biloski Site (DcJh-9), a Late Palaeo-Indian Archaeological Site, Thunder Bay, Ontario*. Conservation Archaeology Report. Ontario Ministry of Citizenship and Culture, North Central Region No. 25. Thunder Bay, Ontario
- Hodgson, T. *n.d.* Unpublished Master's Thesis. Department of Anthropology. Lakehead University
- Julig, P.J. 1994. *The Cummins Site Complex and Paleoindian Occupations in the Northwestern Lake Superior Region*. Ontario Archaeological Reports 2. Ontario Heritage Foundation. Toronto, Ontario
- Julig, P.J., McAndrews, J., and Mahaney, W.C.
1990 *Geoarchaeology of the Cummins Site on the Beach of Proglacial Lake Minong, Lake Superior Basin, Canada*. In *Archaeological Geology of North America Centennial Special Volume 4*. Edited by Lasca N.P. and J. Donahue. Geological Society of America. Boulder, Colorado
- Kent, S. 1984. *Analyzing Activity Areas: An Ethnoarchaeological Study of the Use of Space*. University of New Mexico Press. Albuquerque, New Mexico
- Kingsmill, L. 2011. *Middle Holocene Archaeology and Paleoenvironments of the Thunder Bay Region, Lake Superior Basin*. Master's Thesis, Department of Anthropology. Lakehead University
- Koetje, T.A. 1994. Intrasite Spatial Structure in the European Upper Paleolithic: Evidence and Patterning from the SW of France. *Journal of Anthropological Archaeology* 13:161-169

- Kroll, E.M. and Isaac, G.L. 1984. Configurations of Artifacts and Bones at Early Pleistocene Sites in East Africa. In *Intrasite Spatial Analysis in Archaeology*. Edited by Hietala, H.J. and Larson, P.A. University of Cambridge Press. New York, New York
- Kroll, E.M. and Price, T.D. 1991. *The Interpretation of Archaeological Spatial Patterning*. Plenum Press. New York, New York
- Kuehn, S.R. 1998. New Evidence for Late Paleoindian-Early Archaic Subsistence Behaviour in the Western Great Lakes. *American Antiquity* 63(3):457-476
- Kvamme, K.L. 2005. Terrestrial Remote Sensing in Archaeology. In *Handbook of Archaeological Methods Volume 1*. Edited by Maschner H.D.G. and Chippindale, C. AltaMira Press. Lanham, Maryland
- Kvamme, K.L. 2006. Magnetometry: Nature's Gift to Archaeology. In *Remote Sensing in Archaeology: An Explicitly North American Perspective*. Edited by Johnson J.K. University of Alabama Press. Tuscaloosa, Alabama
- Larson, G. and Schaetzl, R. 2001. Origin and Evolution of the Great Lakes. *Journal of Great Lakes Research* 27:518-546
- Lavachery, P. and Cornelissen, E. 2000. Natural and Cultural Patterning in the Late Holocene Deposits of Shum Laka Rock Shelter, Cameroon. *Journal of Field Archaeology* 27(2):153-168
- Leverington, D.W., and Teller, J.T. 2003. Paleotopographic Reconstructions of the Eastern Outlets of Lake Agassiz. *Canadian Journal of Earth Sciences* 40:1259-1278
- Loope, H. M. 2006. *Deglacial Chronology and Glacial Stratigraphy of the Western Thunder Bay Lowland, Northwest Ontario, Canada*. Master's thesis, Department of Geology, University of Toledo
- Lowell, T. V., Fisher, T. G., Hajdas, I., Glover, K., Loope, H., and Henry, T. 2009. Radiocarbon Deglaciation Chronology of the Thunder Bay, Ontario Area and Implications for Ice Sheet Retreat Patterns. *Quaternary Science Reviews* 28:1597-1607
- MacNeish, R.S. 1952. A Possible Early Site in the Thunder Bay District, Ontario. *National Museum of Canada Bulletin* 120:23-47
- Markham, S. 2012. *Projectile Point Assemblage Variability at the Paleoindian Mackenzie I Site, near Thunder Bay, Ontario*. Master's Thesis, Department of Anthropology. Lakehead University

- McCulloch, B. *n.d.* Unpublished Master's Thesis. Department of Anthropology. Lakehead University
- Mills, T. 2009. *A GIS Based Approach to the Spatial Analysis of the Fincastle Bison Kill Site (DIOx-5)*. Master's Thesis. Department of Geography. University of Lethbridge
- Moyes, H. 2002. The Use of GIS in the Spatial Analysis of an Archaeological Cave Site. *Journal of Cave and Karst Studies* 64(1):9-16
- Mulholland, S.C., Mulholland S.L., Peters, G.R., Huber, J.K., Mooers, H.D. 1997. Paleo-Indian Occupation in Northeastern Minnesota: How Early? *North American Archaeologist* 18(4):371-400
- Newman, M. and Julig, P. 1989. The Identification of Protein Residues on Lithic Artifacts from a Stratified Boreal Forest Site. *Canadian Journal of Archaeology* 13:119-132
- Norris, D. 2012. Current Archaeological Investigations in Ontario: The Discovery of and Preliminary Information Regarding Several Paleoindian Sites East of Thunder Bay. *Minnesota Archaeologist* 71:45-59
- Phillips, B.A.M. 1993. A Time-Space Model for the Distribution of Shoreline Archaeological Sites in the Lake Superior Basin. *Geoarchaeology* 8:87-107
- Quigg, J.M. 1978. Tipi Rings in Southern Alberta: The Lazy Dog Site. *Archaeological Survey of Alberta Occasional Paper No.8*. Alberta Culture Historical Resource Division. Edmonton, Alberta
- Quigg, J.M. 1986. Ross Glen: A Besant Stone Circle Site in Southeastern Alberta. *Archaeological Survey of Alberta Manuscript Series No.10*. Alberta Culture Historical Division. Edmonton, Alberta
- Rigaud, J.P. and Simek, J.F. 1991. Interpreting Spatial Patterns at the Grotte XV: A Multiple Method Approach. In *The Interpretation of Archaeological Spatial Patterning*. Edited by Kroll, E.M. and Price, T.D. Pp. 199-220. Plenum Press. New York, New York
- Ross, W. 1995. The Interlakes Composite: A Re-Definition of the Initial Settlement of the Agassiz-Minong Peninsula. *The Wisconsin Archaeologist* 76:244-268
- Ross, W. 2011. The Crane Site: An Example of an Individual (?) from the Prehistoric Record. In *Visual Arts in the North, Lakehead University Centre for Northern Studies, Occasional Paper #20*, Edited by P. Vervoot
- Saarnisto, M. 1974. The Deglaciation History of the Lake Superior Region and its Climatic Implications. *Quaternary Research* 4:316-339

- Schiffer, M.B. 1975. Archaeology as Behavioural Science. *American Anthropologist*. 77(4):836-848
- Schiffer, M.B. 1987. *Formation Processes of the Archaeological Record*. University of New Mexico Press. Albuquerque, New Mexico
- Shultis, C. 2012. *Quaternary Sedimentology East of Thunder Bay, Ontario; Implications for Five Paleoindian Sites*. Master's Thesis. Department of Geology. Lakehead University
- Steinbring, J. and Buchner, A.P. 1980. The Caribou Lakes Complex: A Provisional Definition. In *Directions in Manitoba Prehistory*. Edited by Pettipas, L.F. Pp. 25-35. Association of Manitoba Archaeologists and the Manitoba Archaeological Society. Winnipeg, Manitoba
- Stevenson, M.G. 1986. *Window on the Past: Archaeological Assessment of the Peace Point Site, Wood Buffalo National Park, Alberta*. Studies in Archaeology, Architecture and History. National Historic Parks and Sites Branch, Parks Canada, Environment Canada. Ottawa, Ontario
- Stevenson, M.G. 1991. Beyond the Formation of Hearth-Associated Artifact Assemblages. In *The Interpretation of Archaeological Spatial Patterning*. Edited by Kroll E.M. and Price T.D. Pp. 269-299. Plenum Press. New York, New York
- Teller, J.T. 1985. Glacial Lake Agassiz and its Influences on the Great Lakes. In *Quaternary Evolution of the Great Lakes Special Paper 30*, Edited by Karrow, P. and Calkin, P. Geological Association of Canada
- Teller, J.T., Boyd, M., Yang, J., Kor, P.S.G., and Fard, A. 2005. The Alternative Routing of Lake Agassiz Overflow during the Younger Dryas: New Dates and a Re-evaluation. *Quaternary Science Reviews* 24:1890-1905
- Teller, J.T. and Clayton, L. 1983. *Glacial Lake Agassiz (Vol. 26)*. Geological Association of Canada: St. John's, Newfoundland
- Teller, J.T. and Leverington, D.W. 2004. Glacial Lake Agassiz: A 5000 yr History of Change and its Relationship to the $\delta^{18}O$ Record of Greenland. *Geological Society of America Bulletin* 116(5-6):729-742
- Teller, J.T. and Thorleifson, L.H. 1983. The Lake Agassiz-Lake Superior Connection. In *Glacial Lake Agassiz*, Edited by Teller, J.T., and Clayton, L. Pp: 261-290. Geological Association of Canada Special Paper 26
- Thoms, A.V. 2008. Ancient Savannah Roots of the Carbohydrate Revolution in South-Central North America. *Plains Anthropologist* 53:121-136

- Vaquero, M. and Pastó, I. 2001. The Definition of Spatial Units in Middle Palaeolithic Sites: The Hearth Related Assemblages. *Journal of Archaeological Science* 28:1209-1220
- Waters, M.R., and Stafford, T.W. 2007. Redefining the Age of Clovis: Implications for the Peopling of the Americas. *Science* 315:1122-1126
- Wheatley, D. and Gillings, M. 2002. *Spatial Technology and Archaeology: The Archaeological Applications of GIS*. Taylor & Francis. New York, New York
- Wood, W.R. and Johnson, D.L. 1978. A Survey of Disturbance Processes in Archaeological Site Formation. *Advances in Archaeological Method and Theory* 1:315-381
- Yellen, J.E. 1977. *Archaeological Approaches to the Present: Models for Reconstructing the Past*. Academic Press. New York, New York
- Yu, S., Colman, S.M., Lowell, T.V., Milne, G.A., Fisher, T.G., Breckenridge, A., Boyd, M., and Teller, J.T. 2010. Freshwater Outburst from Lake Superior as a Trigger for the Cold Event 9,300 Years Ago. *Science* 328:1262-1266
- Zoltai, S.C. 1965. Glacial Features of the Quetico-Nipigon Area, Ontario. *Canadian Journal of Earth Sciences* 2:247-269