THE ROLE OF LITHIC RAW MATERIAL AVAILABILITY AND QUALITY IN DETERMINING TOOL KIT SIZE, TOOL FUNCTION, AND DEGREE OF RETOUCH: A CASE STUDY FROM SKINK ROCKSHELTER (46NI445), WEST VIRGINIA

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Analysis of lithic artifact data from Skink Rockshelter (44NI445) in central West Virginia indicates that stone quality and availability were important in determining how Native Americans differentially utilized tools at the site. In turn, tool function influenced lithic raw material selection. While local Kanawha chert was clearly preferred for projectile point and biface manufacture, non-local Upper Mercer chert was preferred for flake tool use. Skink Rockshelter lithic data do not support the original hypothesis of the paper, that expedient flake tool use would increase at the expense of curated tools in the Kanawha chert primary source area. Instead, individuals curated the comparatively high-quality Upper Mercer chert stone tools to the site and continued to use and retouch them, rather than replace them with tools produced from the inferior, but abundant, Kanawha chert. Curation of Upper Mercer flake tools, as well as projectile points, resulted in their markedly reduced sizes and higher Hafted Biface Reduction Index (HRI) measures compared to the local Kanawha chert tools.

While overlooked in most prior studies, retouch of stone tools is an important component of the wider technological organization strategy of mobile hunter-gatherers. Even though retouch is the main focus of this paper, the ultimate goal is to better understand the means by which hunter-gatherers achieved success in life with the help of stone. In that regard, retouching stone tools is but one facet of a broader risk-minimizing strategy to reduce the chance of failure and control future success, given uncertain future travel and subsistence realms.

This paper focuses on how lithic raw material availability and quality affect the degree of retouch on stone tools and overall toolkit size. The main hypotheses are that lithic raw material availability and quality were key factors in determining the size of the tool kit and the extent of tool retouch. In toolstone-rich settings, the size of curated toolkits and the degree of tool retouch may decrease in favor of expedient tool production using locally-abundant lithic raw materials. In toolstone-deficient environments, increased curated tool kit size and increased tool retouch likely reduced the risk of tool depletion during forager travel. These hypotheses on retouch versus replacement decisions are tested utilizing stone tool data from Skink Rockshelter (46NI445), a multi-component, stratified rockshelter in uplands of Nicholas County, West Virginia, as well as assorted other case studies.

Organization of Lithic Technology

The lithic technological organization literature is rife with examples showing the relationship between lithic raw material type and forager mobility and settlement patterns

(Andrefsky 1994a; Bamforth 1986; Binford 1979; Nelson 1991). Andrefsky (1994b) showed that prehistoric Native Americans of the Columbia Plateau and elsewhere used local lithic raw materials when they were of a high quality, workable morphology, and moderate-high availability. Archaeological sites in regions such as these invariably will contain high percentages of these local lithic raw materials. In the current paper, local lithic raw materials are defined as those occurring within bedrock or secondary deposits within 5-15 miles of a given archaeological site.

On the opposite end of the spectrum, if local lithic raw materials are scarce and/or of a low quality, then foragers will curate higher quality lithics with them in their travels. Archaeological sites in these areas will, thus, contain substantial amounts of these moderate-high quality lithic materials from 30 or more miles distant, considered here to be semi-local and non-local based on distance to source (Figure 1).

Applying previous models of forager mobility (Binford 1983; Sampson 1988; Mandryk 1993), I have suggested elsewhere that hunter-gatherers generally organize themselves within a three-tier mobility realm—local, semi-local, and non-local—given various subsistence and social factors (MacDonald et al. 2006; MacDonald and Hewlett 1999) (Figure 1). Given the uncertain travel realms, hunter-gatherers moved freely in and out of these three mobility realms according to their needs, whether they be somatic or reproductive.

By identifying the sources of trace lithic raw materials at sites, archaeologists can better understand hunter-gatherer travel and trade patterns within the semi-local and non-local realms. For example, many Folsom-period (ca. 10,900 to 10,200 BP) sites in the northern Plains of North America yield very small quantities of lithics from sources 100-

300 miles distant (MacDonald 1999). However, at the Bobtail Wolf Site in western North Dakota (Figure 2), the high quality local lithic raw material, Knife River Flint, was utilized to produce all types of tools (e.g., flake tools, bifaces, etc…), while other local and semi-local lithics were utilized comparatively sparingly, and non-local lithics from distant sources are rare-to-non-existent (Root 2000; MacDonald 1999). This example supports Andrefsky's (1994a, 1994b) supposition that locally-available lithic materials will be used for all types of lithic tool production activities when the materials are abundant and easily accessible.

Another Folsom site in the Plains—Shifting Sands in West Texas (Hofman et al. 1990)—also exemplifies Andrefsky's lithic technological organization predictions, but from the opposite end of the spectrum. At this site, nearly the entire lithic assemblage is comprised of non-local lithic raw materials—Edwards chert—with lesser amounts of local and semi-local materials. Because local and semi-local lithics were scarce and of a low quality, Edwards chert was imported by Folsom foragers in this toolstone-deficient environment.

Skink Rockshelter Background

Of course, many parts of the world—such as central West Virginia—fall in between these two extremes of lithic raw material use. Within the heart of the Kanawha chert primary source area, GAI Consultants investigated Skink Rockshelter during the fall and winter of 2002-2003 (MacDonald 2003) (Figures 3-4). Contrary to Knife River Flint in the northern Plains and Edwards chert in the southern Plains, Kanawha chert is generally considered to be a low-moderate quality lithic raw material in the Middle Atlantic and Appalachian regions of eastern North America. This dark gray marine flint is a member of the Pennsylvanian Kanawha Formation and occurs in an approximately 1,000 sq. mile basin in parts of Boone, Kanawha, Clay, Nicholas, Webster, and Fayette Counties, West Virginia (Reger 1921:227; Reppert 1978:3).

While it is of a generally low quality, Kanawha chert is nevertheless abundant and occurs in knappable form across the primary source area, as well as in secondary sources throughout alluvial drainages to the west and north. Because of its widespread availability, the stone was used throughout prehistory and is found in high percentages at sites in the primary source area and vicinity in central and western West Virginia (MacDonald and Cremeens 2005).

Excavations at Skink Rockshelter recovered nearly 30,000 lithics from two horizontally-stratified occupations (Figure 5; Table 1). The southern portion of the shelter contained evidence of multiple occupations during the Early Archaic (ca. 9,000-7,000 B.P.) and Late Archaic (ca. 5,500-3,800 B.P.) periods, while the northern portion of the shelter contained Late Woodland (ca. 1,500-1,000 B.P.) artifacts. The contrasting use of space at the shelter during the respective occupations was likely due to differential infilling from rock fall and colluvium (MacDonald and Cremeens 2005). As reflected in Table 1, Late Woodland-period (77.7% of artifacts) Native Americans used the site comparatively more intensively than their Early and Late Archaic-period (13.7% of artifacts) counterparts.

While the Late Woodland and Archaic site occupants differentially utilized space within the rockshelter, their lithic raw material use patterns were extremely similar

(Figure 6). Since Kanawha chert is widely available, but of a fairly poor-moderate quality, other semi-local and/or non-local materials were expected to occur in some quantity at Skink Rockshelter. As indicated in Figure 6, Upper Mercer chert from eastern Ohio occurs in fairly high percentages during both the Archaic (21.9%) and Late Woodland (24.6%) occupations, suggesting patterned movements and lithic raw material use in this region over much of the Holocene (MacDonald et al. 2006).

Upper Mercer chert derives from the Upper Mercer Limestone member of the Lower Pennsylvanian system within Coshocton, Perry, and Miskingham counties of east-central Ohio (Kagelmacher 2000). At its most proximate point, Upper Mercer chert primary sources are more than 85 miles northwest of Skink Rockshelter (see Figure 4). However, secondary sources of cobble Upper Mercer chert are likely present in far eastern Ohio and, perhaps, in western West Virginia, perhaps within 60 miles of the site. While the current paper focuses on retouch of stone tools at Skink Rockshelter, MacDonald and Cremeens (2005) and MacDonald et al. (2006) provide additional details regarding lithic raw material sources and their differential use at Skink Rockshelter during the respective Archaic and Late Woodland occupations.

Results

Analysis of stone tool data provides insight into the differential use of Kanawha and Upper Mercer cherts at Skink Rockshelter during the Archaic and Late Woodland occupations. Given its role in the curated toolkit, non-local Upper Mercer chert should have a higher ratio of retouched to utilized flakes, while the opposite would be expected for the local Kanawha chert. Upper Mercer chert tools were likely curated to the site and preserved in the toolkit via retouching, while Kanawha chert tools are more likely to appear as expedient utilized flake tools because of their simple replacement with widely available materials (Andrefsky 1994a; Bamforth 1986).

As shown in Figure 7, 23 Upper Mercer retouched flakes were recovered compared to only seven utilized flakes, for a ratio of 3.29:1 for the entire site assemblage. For Kanawha chert, 11 retouched flakes and eight utilized flakes were recovered, for a ratio of 1.38:1 for the entire site assemblage. Thus, as predicted, retouched flakes are more common for Upper Mercer than for Kanawha chert. However, unexpectedly, Upper Mercer chert from 60-90 miles northwest was arguably the preferred material for all flake tool use, including utilized flakes. Given its abundance on the landscape, Kanawha chert was predicted to dominate the flake tool assemblage; however, as these data show, the non-local Upper Mercer chert (n=30 flake tools) was selected for flake tool use more frequently than the local Kanawha chert (n=19 flake tools). As confirmed for several other sites discussed in this volume, tool function heavily influenced the lithic raw material selection of individuals at Skink Rockshelter.

The effects of retouch and hafted-biface reduction can also be factored into the evaluation of lithic raw material use variability and toolkit composition at Skink Rockshelter. Using methods defined in this volume and elsewhere (Andrefsky 2006), the hafted biface retouch index (HRI) was calculated for diagnostic Late Woodland and Archaic projectile points recovered from Skink Rockshelter (Figure 8). The formula utilized in the analysis is HRI = $\sum S_i/n$, where S is the sum of retouch indexes for the 16 projectile point segments (n). Since it is assumed that they traveled a longer distance within the forager's toolkits, the Upper Mercer chert projectile points should have a higher HRI than points produced from locally-available Kanawha chert.

The Skink Rockshelter projectile points (Figure 8) were largely produced from Kanawha chert (n=12), with a comparatively small number of points produced from non-local Upper Mercer chert (n=3) and semi-local Hillsdale chert (n=1). At its most proximate point, Hillsdale chert is found approximately 30-40 miles east of the project area near Lewisburg in Greenbrier County and near Mill Point in Pocahontas County (see Figure 4) (Brashler and Lesser 1990: 199).

For the purposes of increasing sample size, the non-local and semi-local chert projectile points (n=4) are grouped in this analysis. As predicted, the mean HRI for the Upper Mercer and Hillsdale chert projectile points is 0.578, compared to only 0.453 for Kanawha chert points (Figure 9). These HRI data support the hypothesis that projectile points produced from non-local (Upper Mercer chert) and semi-local lithic materials (Hillsdale chert) were curated and retouched more extensively than their counterparts produced from local materials (Kanawha chert).

Another measure of comparative lithic raw material use and tool retouch is size variation, including simple measures of weight and dimension. While detailed measures of retouch, such as HRI and other indices discussed in this volume, are more precise measures of retouch, dimensional and weight measures can be used as supplemental measures of lithic tool reduction.

Given the increased distance to their sources and accompanying higher degree of retouch, we should expect that tools produced from semi-local and non-local lithic raw materials—such as Upper Mercer chert at Skink Rockshelter—will have generally reduced sizes compared to their counterparts produced from local materials, such as Kanawha chert in this case.

In confirmation of these predictions, Upper Mercer retouched flakes are smaller on average—2.8 grams versus 13.8 grams—than Kanawha chert retouched flakes, suggesting their curation in toolkits for more extended periods (see Figure 7). For utilized flakes—flake tools used for expedient tasks showing no signs of retouch—Upper Mercer chert tools weigh 1.47 g versus 5.13 g for Kanawha chert tools.

Thus, individuals at Skink Rockshelter in central West Virginia continued to use and retouch Upper Mercer chert flake tools, generally to the point where they were no longer useful and were discarded at the end of their use lives. In contrast, Kanawha chert flake tools occur in reduced quantities, despite the material's local abundance. As would be expected, Kanawha chert tools generally were discarded much earlier in their use-life history, as revealed by their larger masses and decreased use-wear and retouch indexes compared to the non-local Upper Mercer chert artifacts. Native Americans at Skink Rockshelter gave preferential treatment to Upper Mercer chert for daily-task activities, retouching flake tools to the point of exhaustion before using Kanawha chert. Tool function clearly influenced the differential use of Upper Mercer and Kanawha cherts at the site.

As would be expected, the increased curation distance and the accordingly higher degree of retouch and reduction resulted in significantly smaller stone tools (e.g., utilized flakes, retouched flakes, bifaces, and cores) for Upper Mercer (mean stone tool weight=4.94) compared to Kanawha chert (mean stone tool weight=8.49) (Figure 10; also see Figure 7). In turn, stone tools produced from the non-local Paoli and Flint Ridge cherts from greater than 100-130 miles west (see Figure 4) occur in comparatively low mean weights (4.44 and 3.88 g). As reflected in Figure 10, regression analysis shows a strong and significant relationship between distance to source and mean stone tool weight for these four lithic materials at Skink Rockshelter (F=.004; df=3; r^2=0.99; $t\text{-}stat$=12.254; p=.001).

As with stone tools, the entire class of debitage should also be expected to vary by size measurements given the fall-off from distance to source, with the assumption being that the tools traveling the longer distances will be smaller due to retouch and reduction and produce accordingly smaller debitage. In this regard, mean weight for debitage is 0.58 grams for Upper Mercer chert and 0.85 g for Kanawha chert. Debitage produced from the non-local Flint Ridge and Paoli cherts weigh less than 0.5 grams each. As Figure 11 shows, regression analysis indicates a significant and strong relationship between distance to source and mean flake size for the five materials with known source locations in relation to Skink Rockshelter (F=.03; df=4; r^2=0.83; $t\text{-}stat$=6.045; p=.009).

Summary and Conclusion

The main hypotheses of this paper were that, in toolstone-rich settings, the size of the curated toolkit and the degree of tool retouch will decrease in favor of expedient tool use using abundant local lithic materials. However, analysis of data collected at Skink Rockshelter in the heart of the Kanawha chert primary source area in central West Virginia suggests that other factors also contribute to tool kit size and the degree of retouch.

Results of excavations at Skink Rockshelter indicate that Upper Mercer chert flake tools are more abundant than Kanawha chert flake tools, even though Kanawha chert is far more abundant at the site as a whole due to its local availability. Apparently, tool function influenced lithic raw material selection for Native Americans at Skink Rockshelter. As shown in Figure 12, while Kanawha chert represents 68 percent of all artifacts at the site, as well as 50 percent of bifaces, it represents only 37 percent of unifacial tools. In comparison, Upper Mercer chert represents only 24 percent of artifacts and 34 percent of bifaces, but nearly 60 percent of flake tools.

These stone tool data reflect a significant difference in lithic raw material use based on tool function and tool type (x^2=8.24, *df*=1, *p*<.005); as such, they do not support one of the original hypotheses of the paper, as reviewed above, that Kanawha chert would dominate all stone tool categories due to its ubiquitous availability near Skink Rockshelter. As discussed above and elsewhere (MacDonald and Cremeens 2005; MacDonald et al. 2006), these patterns of lithic raw material and tool use emerged during the Early Archaic period and continued until the Late Woodland period at Skink Rockshelter, suggesting patterned Native American land-use and lithic technological organization for much of the Holocene.

Overall, the Skink Rockshelter data clearly indicate that raw material quality was important in determining how Native Americans differentially utilized tools at the site. In turn, tool function affected raw material selection for daily-task activities, with individuals selecting non-local Upper Mercer chert for flake tool use and locally-available Kanawha chert for biface manufacture. As Andrefsky (1994b) suggests, simple abundance of a given lithic material does not guarantee its use for all activities. As reflected by data from Skink Rockshelter, the overall quality of the lithic material will significantly affect stone tool production activities at a given site.

As such, Skink Rockshelter lithic data do not support another of the original hypotheses of the paper, that expedient flake tool use would increase at the expense of curated tools in the Kanawha chert primary source area. Instead, individuals curated the comparatively high-quality Upper Mercer chert tools to the site and continued to use and retouch them, rather than immediately replace them with tools produced from the inferior, but abundant, Kanawha chert. Curation of the Upper Mercer tools resulted in their markedly reduced sizes and higher HRI measures compared to the local Kanawha chert tools. Accordingly, the size of the curated tool kit (60 Upper Mercer chert stone tools) was extremely similar to that of the locally-produced tool kit (63 Kanawha chert stone tools). These data refute the hypothesis that the size of the curated tool kit would be reduced due to the local availability of Kanawha chert. The preference for Upper Mercer chert in daily-task activities influenced curation strategies of site occupants.

Data from Skink Rockshelter effectively reveal the impact of lithic raw material quality and tool function on tool-production and lithic raw material selection decisions of prehistoric Native Americans in central West Virginia. While its low quality did not dissuade users from producing bifaces and projectile points from Kanawha chert, individuals clearly believed they could not completely rely on the inferior material for use as retouched and utilized flakes in other daily-task activities. Instead, Native Americans carried stone tools produced from Upper Mercer chert to Skink Rockshelter to minimize the risks of relying upon the low quality Kanawha chert. Tool function, thus, significantly altered lithic raw material curation patterns. As is typical of hunter-gatherer populations (Torrence 1989), such risk-minimization efforts likely cost little, but provided ample comfort to individuals with uncertain travel plans and even more uncertain access to high-quality lithic raw materials.

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Table 1. Skink Rockshelter artifact summary by component.

Component*	Debitage	Biface	Uniface	Core	Other	Pottery	Total	%
Archaic	4038	12	5	18	0	0	4073	13.7
LW	22853	69	44	91	5	41	23103	77.7
Buffer	2547	7	5	5	0	1	2562	8.6
Total	29438	88	51	114	5	42	29738	100.0
Percent	99.0	0.3	0.2	0.4	0.01	0.1	100.0	---

*Archaic includes Early and Late Archaic artifacts (9,000-3,800 BP); LW includes Late Woodland artifacts (1,500-1,000 BP); Buffer Area includes artifacts from test units separating the two horizontally-stratified Archaic and Late Woodland components.

Figure captions

Figure 1. Schematic three-tier model of hunter-gatherer travel patterns.

Figure 2. Location of archaeological sites discussed in text.

Figure 3. Skink Rockshelter, West Virginia. View south.

Figure 4. Location of Skink Rockshelter (46NI445), Nicholas County, West Virginia, in relation to regional lithic raw material sources.

Figure 5. Differential use of space over time at Skink Rockshelter.

Figure 6. Lithic raw material use in Archaic and Late Woodland occupations, Skink Rockshelter.

Figure 7. Ratio of retouched to unifacial tools and weights for Upper Mercer and Kanawha chert flake tools, Skink Rockshelter.

Figure 8. Skink Rockshelter projectile points.

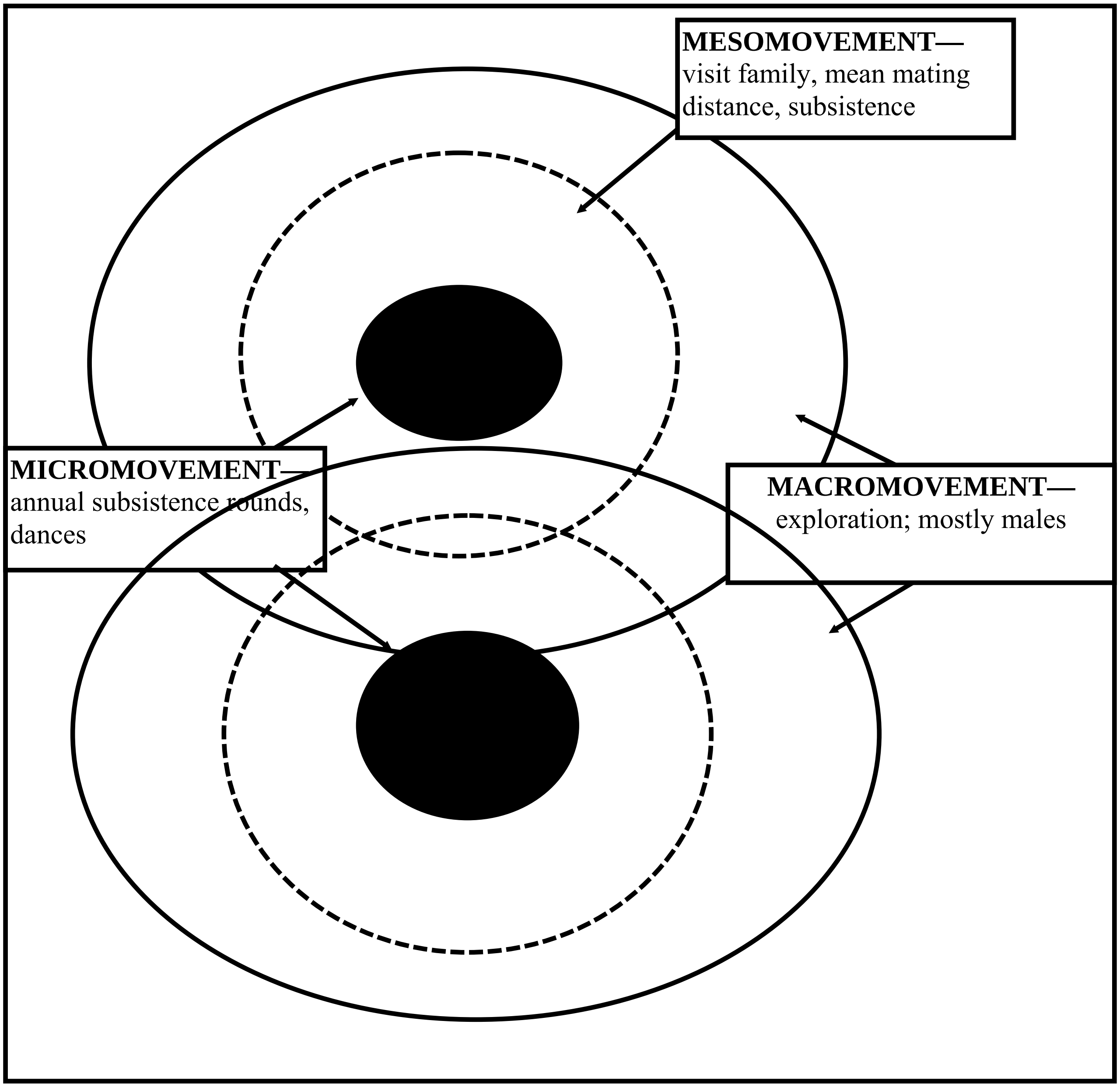
Figure 9. Comparison of hafted biface retouch index (HRI) for Kanawha Chert and Upper Mercer/Hillsdale chert projectile points, Skink Rockshelter.

Figure 10. Differential size of stone tools based on distance to lithic material source, Skink Rockshelter.

Figure 11. Differential flake size based on distance to source, Skink Rockshelter.

Figure 12. Differential lithic raw material use based on percentages of lithics, unifaces, and bifaces, Skink Rockshelter.

Figure 1. Schematic three-tier mobility model of hunter-gatherer travel patterns.



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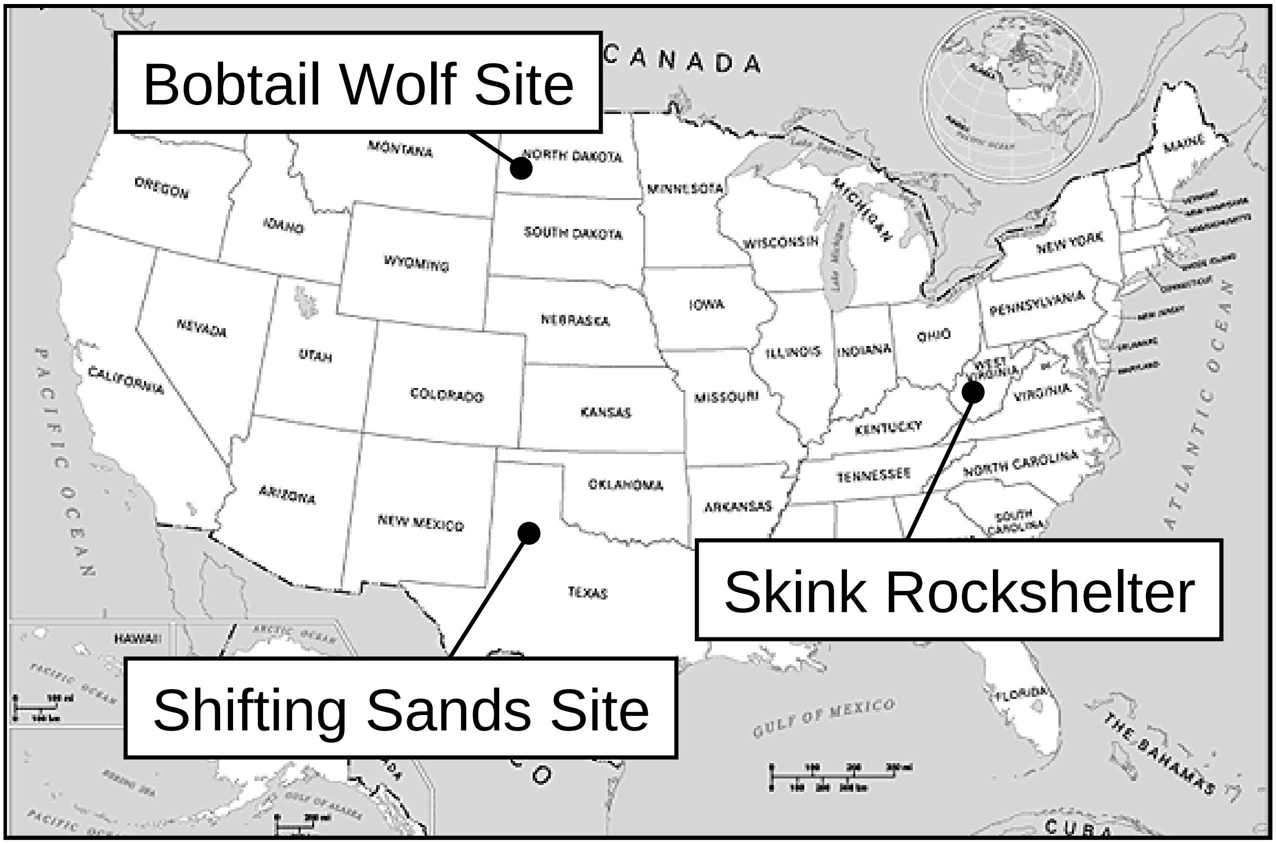

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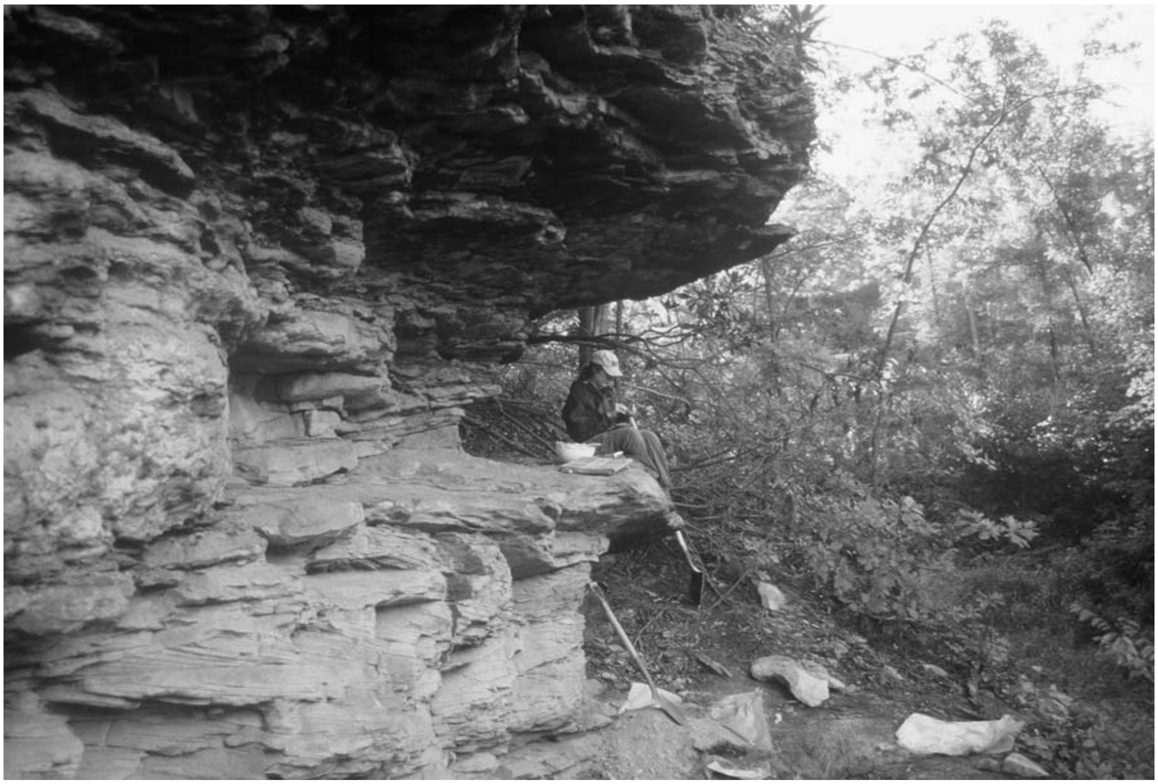


Figure 4. Location of Skink Rockshelter (46NI445), Nicholas County, West Virginia, in relation to regional lithic raw material sources.

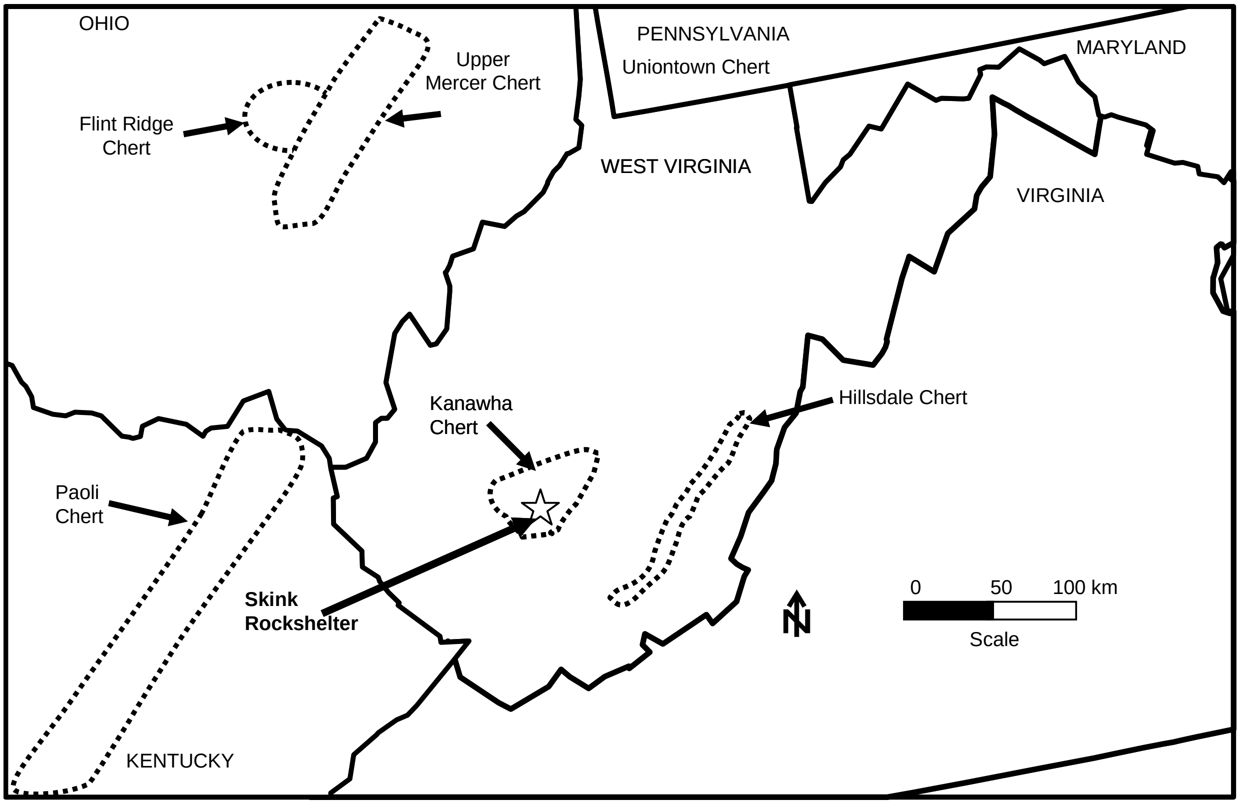


Figure 5. Differential use of space over time at Skink Rockshelter.

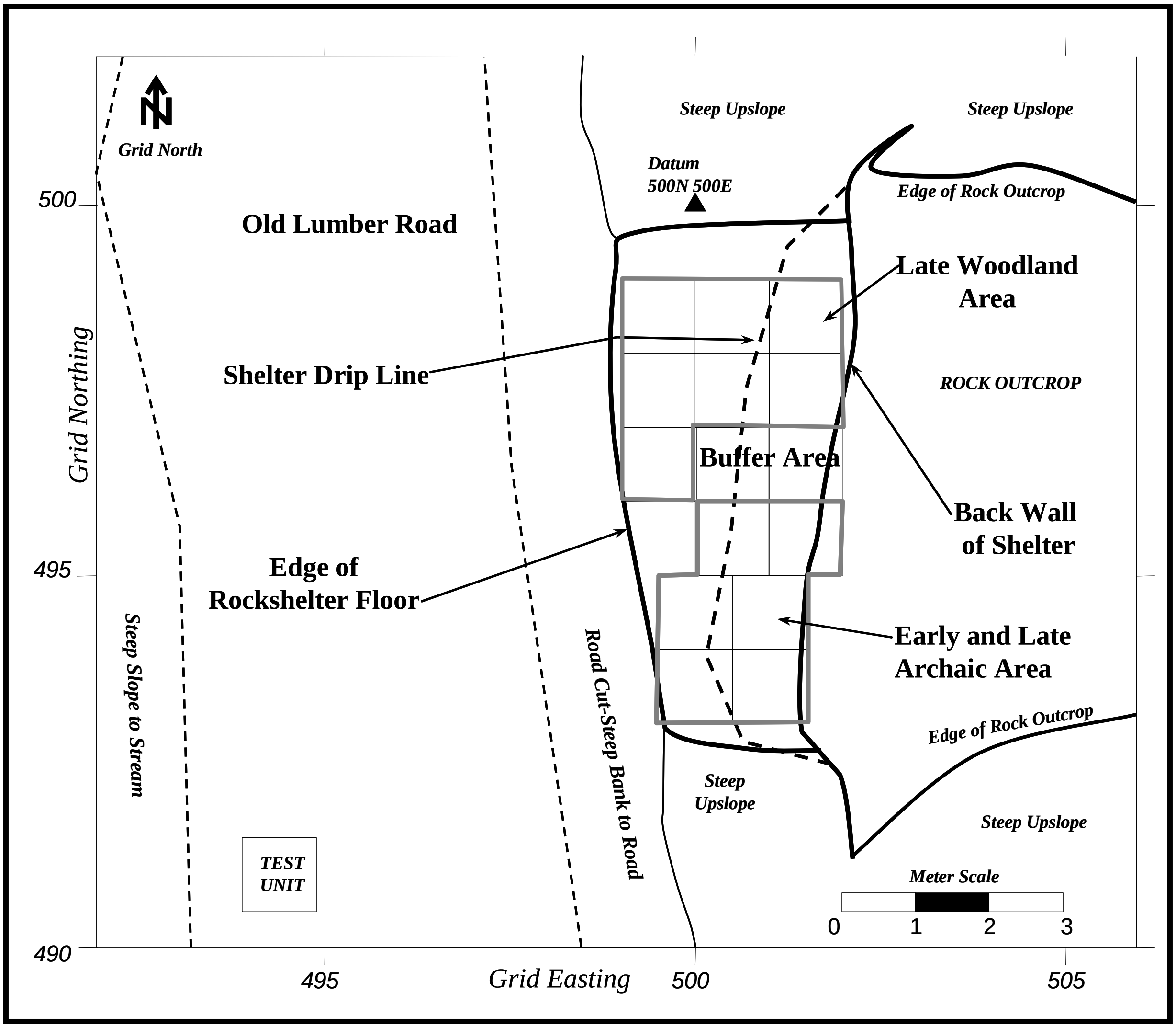


Figure 6. Lithic raw material use in Archaic and Late Woodland occupations, Skink Rockshelter.

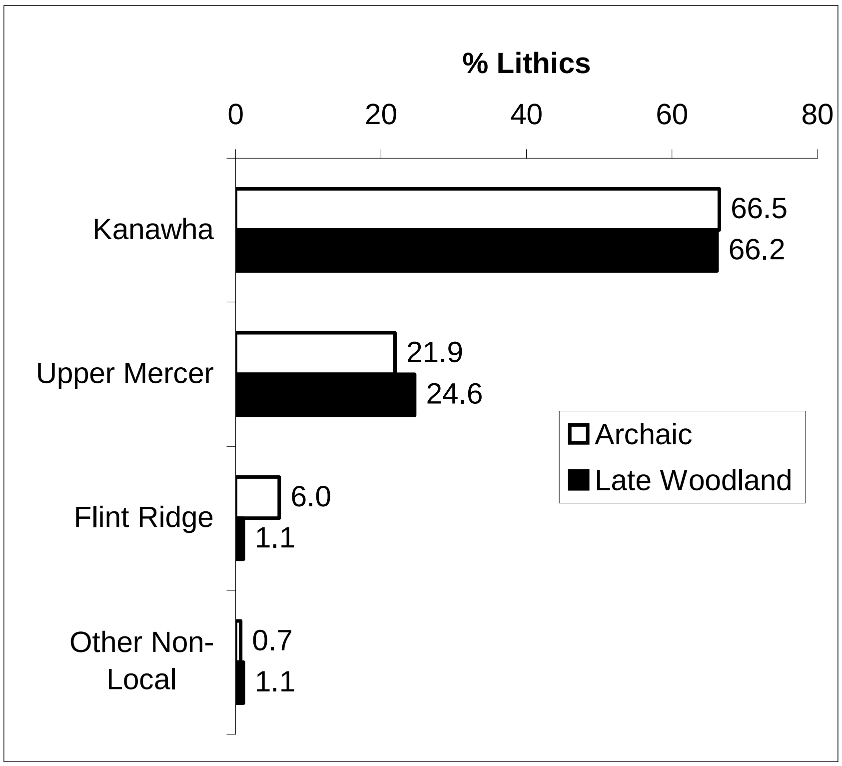


Figure 7. Ratio of retouched to unifacial tools and weights for Upper Mercer and Kanawha chert flake tools, Skink Rockshelter.

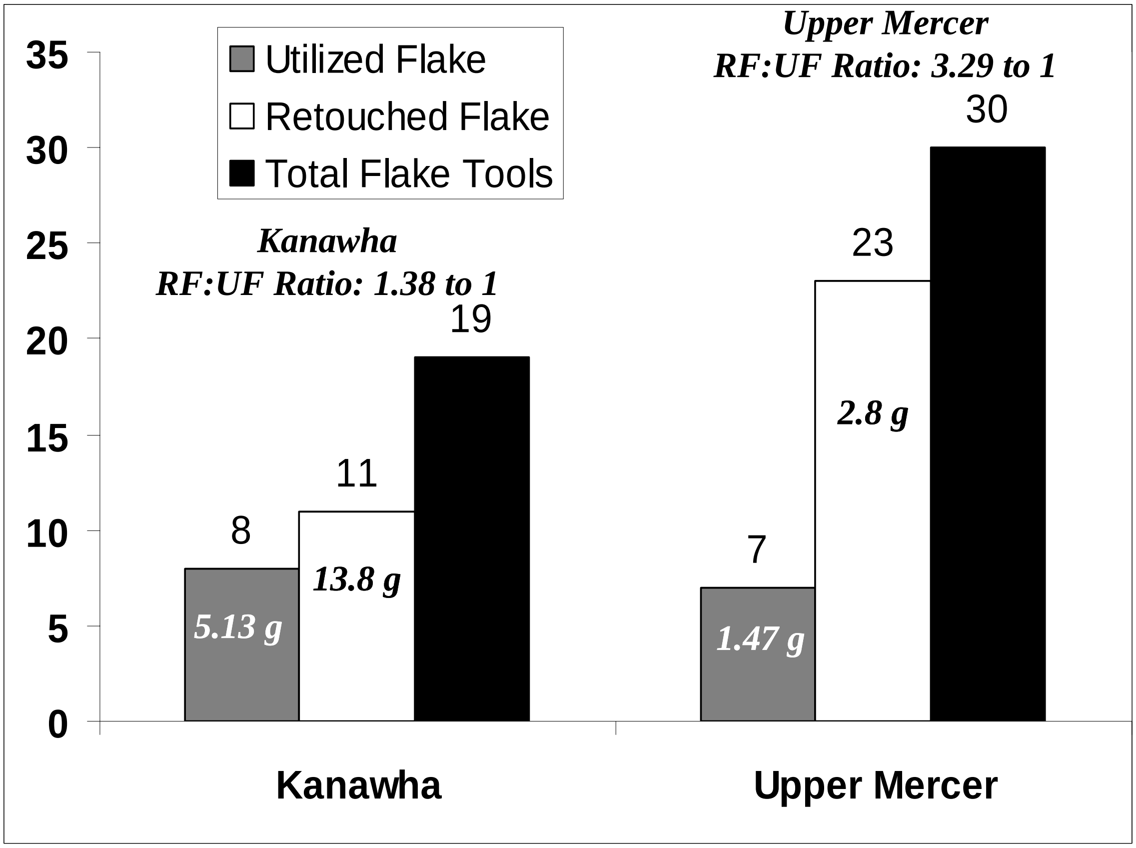
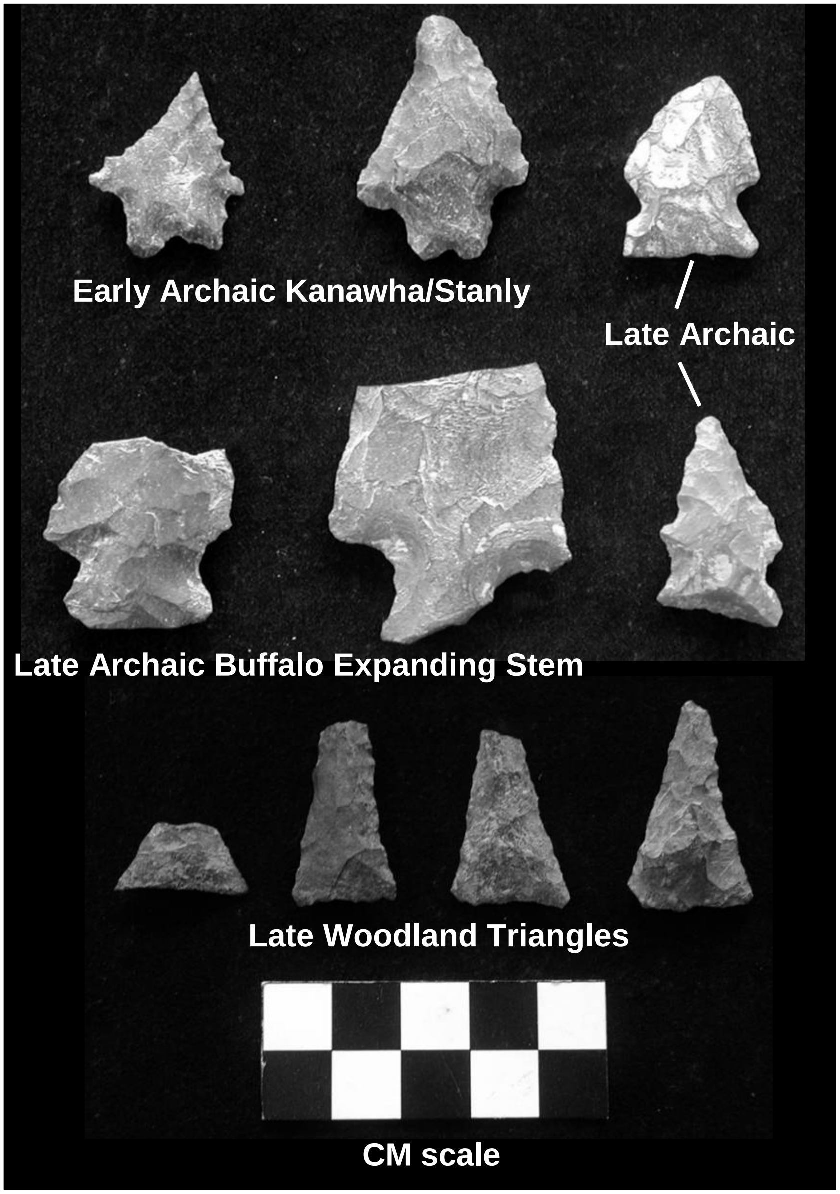


Figure 8. Skink Rockshelter projectile points.



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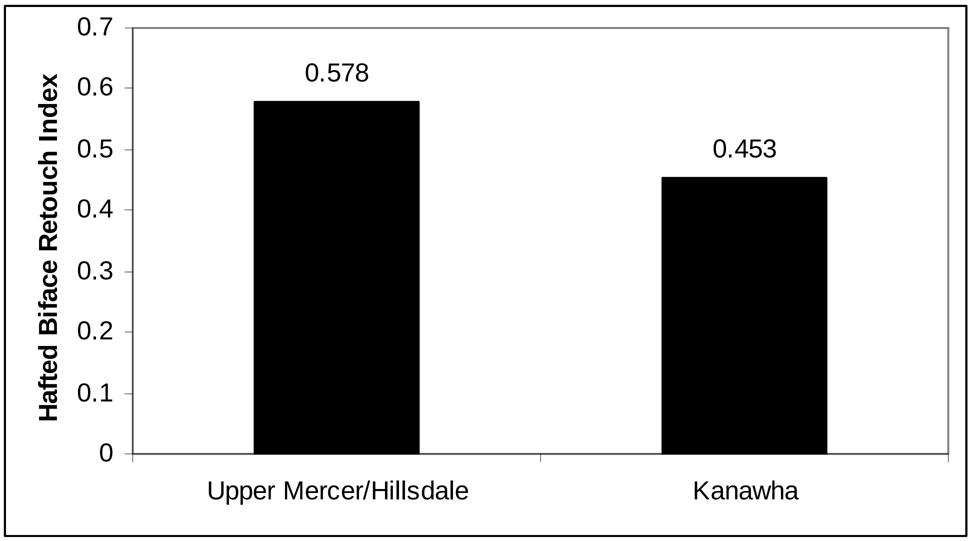

Figure 10. Differential size of stone tools based on distance to lithic material source, Skink Rockshelter.

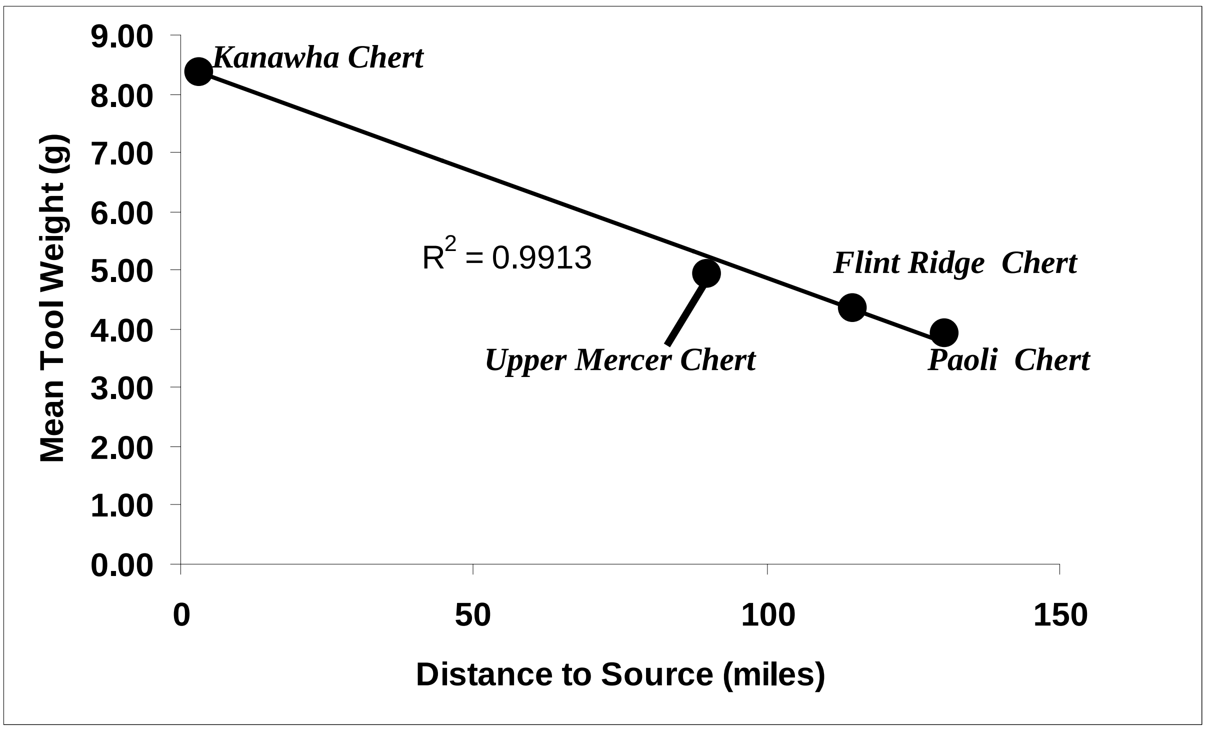

Figure 11. Differential flake size based on distance to source, Skink Rockshelter.

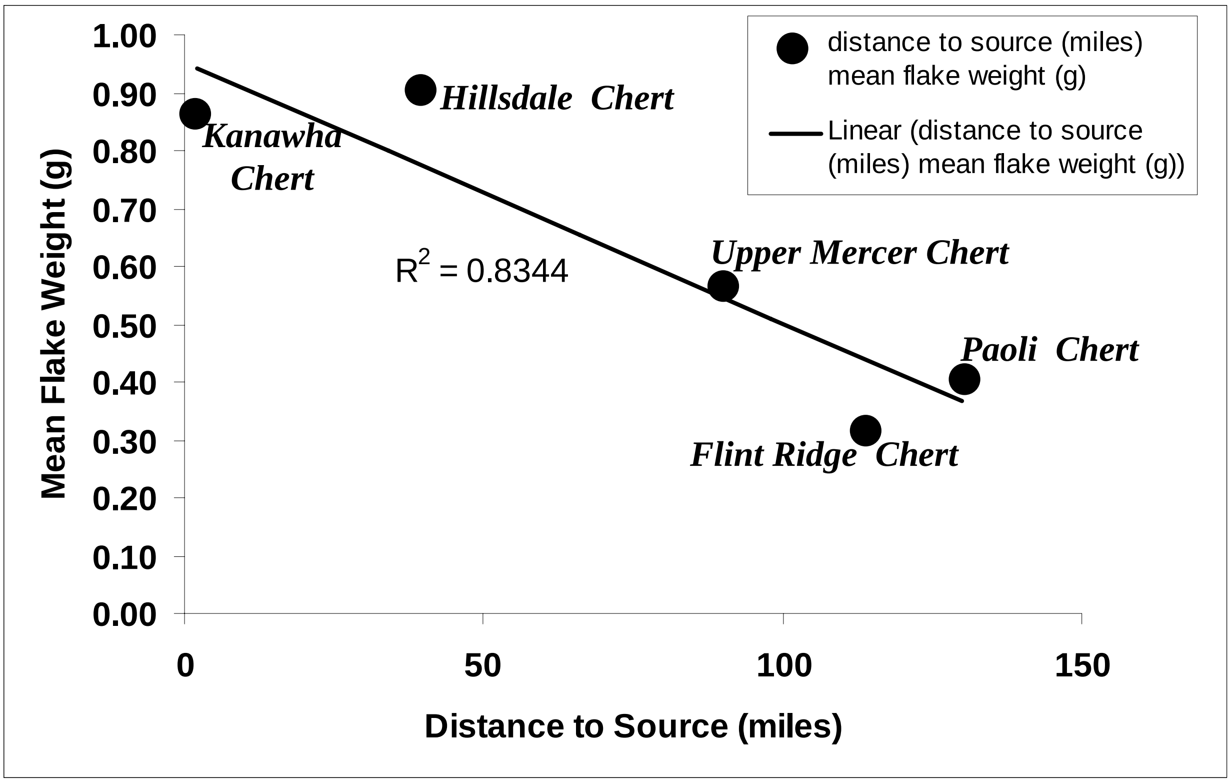

Figure 12. Differential lithic raw material use based on percentages of lithics, unifaces, and bifaces, Skink Rockshelter.