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Testing for Paleoindian Aggregations: Internal Site Structure at Bull Brook

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Final Report for Period: 02/2007 - 01/2008

Submitted on: 04/30/2008

Principal Investigator: Robinson, Brian S.

Award ID: 0352918

Organization: University of Maine

Title:

Testing for Paleoindian Aggregations: Internal Site Structure at Bull Brook

Project Participants

Senior Personnel

Name: Robinson, Brian

Worked for more than 160 Hours: Yes

Contribution to Project:

Brian Robinson was employed through the University of Maine on the Alaska Research Project directed by Frederick H. West at the time that the NSF grant was awarded. In 2004 he was hired as assistant professor of Anthropology in the Climate Change Institute and the Anthropology Department, at which time emphasis was placed on increasing graduate and undergraduate student participation. Robinson is responsible for the overall organization of the project and for structuring the data base.

Name: Pollock, Stephen

Worked for more than 160 Hours: Yes

Contribution to Project:

Stephen Pollock is a geologist specializing in rock types of New England and the Northeast. He has traveled to lithic quarry sources in New England and New York. He assisted early but was later replaced by Heather Short.

Name: Burke, Adrian

Worked for more than 160 Hours: Yes

Contribution to Project:

Adrian Burke is an archaeologist who specializes in lithic material types in the Northeast and Midwest including Canadian sources. When the NSF proposal was submitted Adrian was at the University of Maine but subsequently moved to the University of Montreal.

Name: Kelley, Joseph

Worked for more than 160 Hours: No

Contribution to Project:

Joe Kelley is a Professor of Marine Geology at the University of Maine working with Peter Leach and Alice Kelley on the submergence history of the landscape adjacent to the Bull Brook site.

Post-doc

Name: Short, Heather

Worked for more than 160 Hours: No

Contribution to Project:

Heather got her PhD in geology at the University of Maine. She assisted Adrian Burke with geological descriptions of thin sections after Stephen Pollock was removed from the project.

Graduate Student

Name: Pelletier, Bertrand

Worked for more than 160 Hours: Yes

Contribution to Project:

Bert Pelletier is a graduate student in the Climate Change Institute. He has helped in field mapping at the Bull Brook site, collection management, and ArcGIS 9 mapping. Most of his work for me has been work study and volunteer effort.

Name: Ort, Jennifer

Worked for more than 160 Hours: Yes

Contribution to Project:

Jennifer Ort is a graduate student doing her Masters thesis on artifact and material type distributions within the Bull Brook site. She spent four months at the Peabody Essex Museum working on the catalog of 11,500 entries and well over 40,000 items.

Name: Leach, Peter

Worked for more than 160 Hours: No

Contribution to Project:

Peter Leach is a graduate student in the Climate Change Institute at the University of Maine where he is working on the geoarchaeology of submerged shell middens. Peter helped take and analyze sediment cores from the salt marsh adjacent to the Bull Brook Site

Name: Nelson, John

Worked for more than 160 Hours: No

Contribution to Project:

John Nelson was a graduate student in Geology at the University of Maine. He assisted with electrical resistivity testing of the Bull Brook site. He processed the data and gave preliminary interpretations. Two years later he died after a brief illness.

Undergraduate Student

Name: Cooper, Erica

Worked for more than 160 Hours: Yes

Contribution to Project:

Erica Cooper worked for several years as an undergraduate work study student and also for one month after she graduated. She transcribed part of the Bull Brook catalog, most of the original field notes, and she photographed approximately 30% of the Bull Brook artifact collection.

Technician, Programmer**Other Participant**

Name: Asch Sidell, Nancy

Worked for more than 160 Hours: No

Contribution to Project:

Nancy Ash Sidell is a paleobotanical consultant who works widely in the Northeast. She has thus far identified wood charcoal for three samples, searching for Pleistocene species to identify suitable samples for radiocarbon dating since the site is heavily bioturbated.

Name: Tossell, Melanie

Worked for more than 160 Hours: No

Contribution to Project:

Melanie Tossell was my primary contact at the Peabody Essex Museum for logistical aspects of working with the collection. She is a photographer who has documented the Bull Brook site excavations on film, unrelated to the NSF grant. She has now relocated, but will spend two weeks in Salem continuing with artifact photography.

Name: Eldridge, William

Worked for more than 160 Hours: Yes

Contribution to Project:

William Eldridge of Swampscot, Massachusetts is one of the original excavators and the principal record keeper and photographer from the Bull Brook site excavations of 1950 to 1970. He is now 90 years old and has been the driving force that made the present research possible. The research involves hundreds of hours of taped interviews working out details of excavations and record keeping. Bill also proofreads text on the site.

Research Experience for Undergraduates

Organizational Partners

University of Montreal

Adrian Burke moved from the University of Maine to the University of Montreal and was set up as a subcontractor through the University of Montreal, continuing as a geological consultant.

Peabody Essex Museum

The Peabody Essex Museum in Salem, Massachusetts owns the Bull Brook collection and has provided access and significant logistical support. They plan to make information about the site available on their website. They also provided their visiting scholars apartment for the use of Jennifer Ort for five weeks.

Phillips Academy, Robert S. Peabody Museum of Archaeology

Part of the Bull Brook collection and records are at the RSPM. The staff has been very helpful and contributed to the project in many ways.

Other Collaborators or Contacts

Frederick H. West is a former curator of Archaeology at the Peabody Essex Museum and was a primary supporter and colleague in research that lead to the current project. Mary Lou Curran served as the principal contact with the Peabody Essex Museum until she left the museum in 2005. Joseph and Nick Vaccaro are original excavators from the 1950s. Taped interviews were held with both. Nick passed away in 2004. Other excavators contributed prior to the current project. Douglas Jordan did his Harvard PhD on the Bull Brook Paleoindian site in 1960 and was an official collaborator on the project as a consultant regarding the early work, until he passed away in 2006.

Activities and Findings

Research and Education Activities: (See PDF version submitted by PI at the end of the report)

Findings:

Major Findings

When Bull Brook was discovered in the 1950s, archaeologists could not imagine how one could prove that multiple loci were occupied contemporaneously, in shallow, essentially nonstratified archaeological contexts. Although the avocational archaeologists recognized that the simple geometry of a circular settlement pattern was in itself powerful evidence, it took a change in emphasis in archaeology toward large scale spatial analysis and landscape archaeology to make the settlement pattern worthy of intensive investigation. The excavators succeeded in documenting the pattern sufficiently that it became the premier example of a large Paleoindian settlement, with some archaeologists accepting it directly, but the plan itself was not enough to test the implications of it. The next threshold of confidence required a thorough analysis of all existing records and the help of the excavators to knit the spatial evidence together. The result is that the simple geometry proved to be the result of intentional organization, becoming more highly structured when viewed more intensively, as it should be. The excavators recognized differences in activities, but they didn't ferret out more detailed spatial patterning. The simple circle proved to be concentric circles, with inner and outer activities, divided into spatial segments with varying lithic proportions. That these unsuspected patterns survived with loss of provenience of nearly 1/3 of the assemblage and through multiple episodes of cataloging, is a testament to the vigilance of the avocational archaeologists and to the pronounced nature of the specialized patterns. They are not subtle. They occur at other sites, but as Slobodin (1962:61-62) noted among the Gwich'in in the Yukon Territory, some social groupings become more in evidence, or more organized in 'large-group' camps. Bull Brook represents the maximum scale of organization, at least at the site level, and it is in such cases that hunter-gather organization is most visible. It is one of the lessons of science and understanding that what seems beyond proof from one perspective, may be the height of organization from another.

Training and Development:

Opportunities for Training and Development.

Most directly with regard to training, graduate and undergraduate students are participating in important aspects of the project. One Masters thesis will come from the project, with other students participating in field and laboratory work and report production.

Regarding public education, the current project represents a kind of research saga, with intensive reanalysis of excavations from 50 years ago spanning significant changes in archaeological theory and interests. One of the most popular aspects of the research in public presentations has been the forensic methods employed to fully integrate all of the sources of evidence (e.g., microscopic inspection of ink irregularities to

reconstruct rolls of color slides). The project and presentations contribute to the recognition of the potential for reanalysis of early archaeological research. This may not be new to archaeologists, but the message must be constantly conveyed to the public.

Outreach Activities:

Outreach Activities

This project benefits from a large number of superlatives. The site has been famous for many years. It is among the largest of Pleistocene occupation sites and potentially among the most organized. The project also involves intensive interaction between avocational archaeologists and academics, which is a popular theme. In short, it can be a captivating story.

The project has benefited from (and contributes to) a public promotional campaign organized through the Peabody Essex Museum and the Robert S. Peabody Museum, 'The Friends of Bull Brook.' November 22 is now registered by the State of Massachusetts as 'Bull Brook Day,' recognizing the contributions of the excavators, with archaeologists and politicians providing testimony. Melanie Tossell produced an educational film for use in schools. The NSF funded project serves as the 'expert witness' at public presentations and archaeological meetings. In turn, the promotional campaign helped facilitate municipal and institutional cooperation. At a meeting of the Eastern States Archaeological Federation in Fitchburg, Massachusetts the organizers sought to bring together avocational, professional and Native American interests. As the key note address, the Bull Brook site research found an enthusiastic audience including Tribal Preservation Officers from the Aquinnah Wampanoag and Narragansett tribes who are themselves developing networks with archaeological and local communities. The stage is well set for presentation of the final results.

Journal Publications

Pelletier, Bertrand G. and Brian S. Robinson, "Tundra, Ice and a Pleistocene Cape on the Gulf of Maine: A Case of Paleoindian Transhumance.", *Archaeology of Eastern North America*, p. 163, vol. 33, (2005). Published,

Pollock, S.G., Hamilton, N.D., and Boisvert, R., "Archaeological geology of two flow-banded spherulitic rhyolites in New England, U.S.A.: Their history, exploitation and criteria for Recognition.", *Journal of Archaeological Science*, p. , vol. , (2007). Submitted,

Robinson, Brian S. Jennifer C. Ort, William E. Eldridge, Bertrand G. Pelletier, Adrian L. Burke, "Paleoindian Aggregation at Bull Brook in Eastern Massachusetts", *American Antiquity*, p. , vol. , (2008). Submitted,

Robinson, Brian S. and William A. Eldridge, "Debating Bull Brook, 1965-1972", *Bulletin of the Massachusetts Archaeological Society*, p. 67, vol. 66, (2005). Published,

Books or Other One-time Publications

Robinson, Brian S., "Bull Brook and Debert: the Original Large Paleoindian Sites in Northeast North America.", (). Book, Accepted
 Editor(s): Confederacy of Mainland Mi'kmaq, Debert, Nova Scotia
 Collection: Debert Workshop Conference
 Bibliography: in preparation from the Debert Workshop, sponsored by the Confederacy of Mainland Mi'kmaq, Debert, Nova Scotia, October 20, 2005.

Burke, Adrian L., "Paleoindian Ranges in Northeastern North America Based on Lithic Raw Materials Sourcing", (2006). Book, Published
 Editor(s): Céline Bressy, Ariane Burke, Pierre Chalard, and Hélène Martin,
 Collection: Notions de territoire et de mobilité: exemples de l'Europe et des premières nations en Amérique du Nord avant le contact européen.
 Bibliography: ERAUL 116 (Actes du Xe congrès annuel de l'Association Européenne des Archéologues, Lyon, 2004)

Web/Internet Site

Other Specific Products

Product Type:**Data or databases****Product Description:**

The final data base for the Bull Brook artifact collection will provide detailed descriptions, provenience records and historical context in Excel format with over 11,000 lines of data. This catalog is complete for provenienced artifacts and in progress for non provenienced artifacts.

Sharing Information:

We intend to make the entire catalog available by CD or through the Peabody Essex Museum Website.

Product Type:**Data or databases****Product Description:**

The geological thinsections and descriptions are the first to be produced from the Bull Brook site and will serve an important foundation for lithic comparative studies.

Sharing Information:

Publication of a book on
Bull Brook with possible internet access

Product Type:**Data or databases****Product Description:**

The geological thinsections and descriptions are the first to be produced from the Bull Brook site and will serve an important foundation for lithic comparative studies.

Sharing Information:

Publication of a book on
Bull Brook with possible internet access

Contributions

Contributions within Discipline:

This project was designed to identify characteristics of Paleoindian aggregation, contributing to understanding of Paleoindian social organization and providing variables that can be used to identify aggregation activities at other sites. While many general characteristics and alternative functions of social aggregation are known among hunter-gatherers, the Bull Brook site contributes patterning of specific practices that can be used to evaluate other Paleoindian sites. Project results indicate that the Bull Brook site represents an organized event, the largest in the Western Hemisphere during the Pleistocene. The circular settlement pattern incorporated specialized activities (including hunting preparations) that were directed toward the center of the circle. Strongly patterned activities have been recognized at other sites, but are here organized more explicitly in the context of large gatherings, in effect shining the social spotlight on participants. Raw material distributions suggest that segments of the ring represent different regional groups or mobility patterns, although major lithic sources (e.g., Hudson River Valley chert) appear to be abundant throughout the site. The history of the Bull Brook research is instructive because it was excavated in the 1950s before such large gatherings were considered 'anthropologically possible.' The research required development of methods to reconstruct the original site plan from still photography and home movies, among other records, expanding the level of interpretation that is possible for a site that was destroyed long ago.

Contributions to Other Disciplines:

The analytical techniques for recovery of spatial data are in some ways quite basic, but they have rarely been applied as intensively in archaeological studies. These methods and the degree of interaction and dependence on the original excavator's knowledge are widely applicable to other historical disciplines.

Contributions to Human Resource Development:

Research on the Bull Brook site and the earliest large social gatherings have a variety of appealing aspects that make the study ideal for educational purposes. The story of the site and the path of analysis includes of a series of improbable links and dedicated people. The story is a saga, but its impact will be increased when the science is adequately documented through the cooperative efforts of generations of investigators. Archaeology and cultural appreciation are part of anthropology, but the vehicles to convey these to the public need to be developed regionally and nationally. Tribal historians from some of New England's Native people expressed interest that the Bull Brook research linked the contributions of 'archaeological elders' with Native American heritage.

Contributions to Resources for Research and Education:

Archaeological research necessarily revisits the work of past investigators as ideas and interests change. The current research is a text book case of how great those changes can be, and the degree to which changing ideas require creative methods to secure the data in another form.

Contributions Beyond Science and Engineering:

The Bull Brook story has generated more popular enthusiasm than most. The story of the Bull Brook Boys and their quest. The Italian immigrants who made substantial contributions to Native American heritage. November 22 is Bull Brook Day in Massachusetts. All that is needed is the solid scientific foundation to build on the next level of enquiry and the popular story has genuine educational value. We believe we have secured that foundation with the assistance of the original excavators.

Categories for which nothing is reported:

Any Web/Internet Site

Activities and findings**Testing for Paleoindian Aggregation at Bull Brook:
Final Report (BCS 0352918)**

Brian S. Robinson, Adrian L. Burke and Jennifer C. Ort

Part 1: Introduction, Spatial Analysis and the Bull Brook Site Plan
Brian S. Robinson**Introduction**

The goal of the project “Testing for Paleoindian Aggregations” is to identify characteristics that distinguish large social gatherings (events) from less organized accumulations of activities spread over time. The Bull Brook site in Ipswich, Massachusetts yielded what is potentially the largest and most highly organized Paleoindian settlement plan in North America, but the value of the site for elucidating large-scale social gatherings was not recognized by professional archaeologists until decades after the site was salvaged by avocational archaeologists and destroyed by gravel pit operations. The avocational group did recognize the importance of the spatial pattern and their records provide the major sources of evidence.

The Bull Brook site has undergone decades of research, with the history of early work summarized elsewhere (Byers 1954, 1955; Eldridge and Vaccaro 1952; Grimes 1979; Grimes et al. 1984; Jordan 1960; Robinson and Eldridge 2005). The current project grew out of collaboration with Frederick H. West, Marylou Curran and others at the Peabody Essex Museum in Salem, Massachusetts. After the NSF grant was awarded the principal investigator changed from a research position to a tenure track professor at the University of Maine, greatly affecting research time and affording opportunities for graduate student research. Adrian Burke moved to the University of Montreal where he continued consulting on northern and western material types. Burke and geologist Heather Short undertook lithic source identifications, including work formerly allotted to Stephen Pollock. Jennifer Ort completed the enormous task of cataloging and classifying all artifacts and flakes coordinated with provenience documentation in the master Excel catalog, as part of her ongoing MS degree in the Climate Change Institute at the University of Maine. Bertrand Pelletier, graduate student assisted with ArcGIS mapping.

The project report is divided into four parts authored by their respective investigators. Part 1 (Robinson) covers the reconstruction and evaluation of the ring-shaped settlement plan and associated artifact assemblages. Part 2 (Ort and Robinson) focuses on identification of internal site structure based on artifact classes and raw material distributions. Part 3 (Burke) is a report on lithic source identifications. Part 4 (Robinson) provides additional data including new radiocarbon dates and discussion.

At the outset of the project, it was not known whether the combination of all three parts of the project would be needed to identify significant organizational characteristics. With completion of the project we conclude that each part of the project produced evidence of internal organization as reviewed below. The results strongly support the hypothesis that the ring-shaped settlement pattern represents a single organizational event. Furthermore, well-patterned internal structure provides evidence of social organization

and activity patterning that is recognizable in smaller Paleoindian sites, but in less-standardized configurations. These results should be widely applicable, providing new models with which to evaluate potential Paleoindian aggregation areas.

Reconstruction of the Site Plan and Landscape Analysis

Five of nine major participants in the 1950s excavations have contributed to the current research, helping to flesh out the records and to integrate them into a detailed chronological and spatial record of the excavations. Site reconstructions are based on a limited number of measured plans, augmented and checked by analysis of hundreds of still photographs, panoramas constructed from home movies, and aerial photographs. William Eldridge provided indispensable support in assimilating site records, mostly his own field records and photographs. This part of the project was successfully completed and yielded a revised site plan, the details of which are documented in detailed reports on each of the 42 loci. Methods employed and results are provided below, with excerpts from the report submitted for publication (pending acceptance).

Although the original published Bull Brook site plan is a critical document that preserved the organizational framework of the site, there was no written account of how it was produced and no published means to evaluate it. As reported elsewhere, scale errors and use of unmeasured plans precluded detailed analysis, resulting in the current project to entirely reconstruct the site plan. The most valuable single document in this effort was a plan of 15 loci that were accurately mapped by Bill Eldridge, Nick Vaccaro and Frank Vaccaro in January 1953 using 400 feet of cod line, a 50-foot tape and a large wood carpenter's square, providing the first evidence of an arc-like pattern (Bull Brook Records 468, hereafter BBR). The remaining loci were recorded in sketch plans and photographs. Three aerial photographs were obtained from the period of excavation (1952, 1954 and 1957) that were registered with GIS coordinates (ArcGIS 9.0) with the assistance of graduate student Bertrand Pelletier. The mapping problem involved finding ways to transfer small scale landmarks (trees, fence posts and open excavations) visible in still photographs and movies taken on the ground, to the aerial photographs in which larger scale landmarks were visible (large trees, buildings, utility poles).

A comprehensive catalog of records and photographs was developed (BBR), totaling at present 3,235 pages of field notes, labels, correspondence and photographs that yielded a detailed chronology of events. Hundreds of color slides were compiled and cross-referenced with field records to maximize the number of photographs of each locus, a process that would have been impossible without the direct participation of Eldridge. Kodak slide covers were not date-stamped in the early 1950s, but they had unique print irregularities and variations in frame numbers that allowed original film rolls to be reconstructed. We have 37 rolls of film taken between 1953 and 1959 with Eldridge's Balda Baldinette camera (50-mm lens), and 11 rolls from Tony Vaccaro's Wirgin Edina camera (43-mm lens). The angle-of-view of color slides from the two cameras is 39° and 42.5°, respectively (7% of the image was masked by slide covers). We also have Doug Jordan's photographs, including an important panorama taken October 30, 1953.

A breakthrough in mapping came with the analysis of Nick and Anna Vaccaro's 8-mm movies, taken between September of 1953 and April of 1958. The movies were digitized and frames stitched together into panoramas. The first film clip was a complete 360-degree panorama providing accurate angles-of-view for the entire film (18.6° per

digital frame). Measured angles were fit to visible landmarks on aerial photographs providing GIS coordinates for the photographer and intersecting lines of sight (ArcGIS 9.0). Five long panoramas (three from movies, one by Jordan and one by Eldridge) provided angles to dozens of landmarks. Intersecting angles were used to plot details such as fence posts, backdirt piles, trees and shrubs.

The use of movie panoramas provided a key to mapping open areas of the site as described elsewhere (Robinson et al. nd), but one quarter of the site was in a fenced wooded area, requiring other methods. Individual color slides were successfully employed to map locations in the woods (including Loci 24, 25 and 27) matching a small number of key landmarks and a larger number of distinctive trees. This process was, in fact, rather arduous, but once identified, the photographer's location, the bearing of the left side of the image and angle-of-view provided a permanent reference that can be built upon and refined (Fig. 1). Photographs exist for all except one locus in the woods (21) and further refinement is possible.

Photograph analysis also provided a means to evaluate the integrity of each locus. Spatial relationships plotted with GIS locations were used to confirm that different loci excavated over a period of years were, in fact, separate. Locations of 26 loci are accurately mapped while 10 have good relative positions yielding a revised plan of 36 loci. The confidence level associated with the location of each locus is documented pointing out areas where further refinement is desired, but the relative positions are often well documented in sketch plans and photographs allowing more confident spatial analysis than was previously possible. Five loci were eliminated from the original 40; Locus 8 was minimally recorded and probably overlapped with Locus 41 or 9, Loci 17 and 42 had ambiguous records and few artifacts, and Loci 30 and 40 were recorded as bulldozed secondary deposits. Locus 38 was excavated after 1959 and only recently added. The rationale for all of these modifications are provided in the detailed locus report.

The extent of archaeologically testing and surface collecting was documented as part of the landscape analysis (Fig. 2) to account for spaces inside and outside of the ring-shaped configuration. Surfaces stripped for loam removal provided excellent surface coverage, often after an area had been test pitted and excavated, although stripping was also a method of discovery in some cases. Although the conditions were by no means ideal, the extensiveness of exploration (3.1 hectares of stripped surface) and the absence of evidence for prior disturbance (Paleoindian artifacts were concentrated below the plow zone) provided unusually complete coverage compared to the degree of disturbance at some other large Paleoindian sites (MacDonald 1968; Gramly 1982).

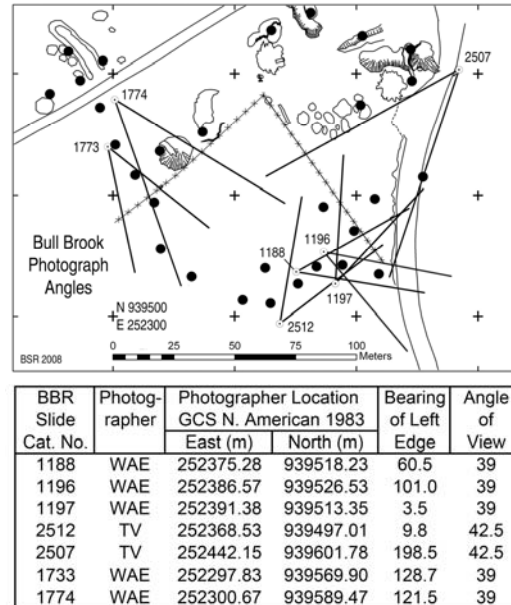


Figure 1. Graphic and coordinate locations of color slides. Large dots are loci.

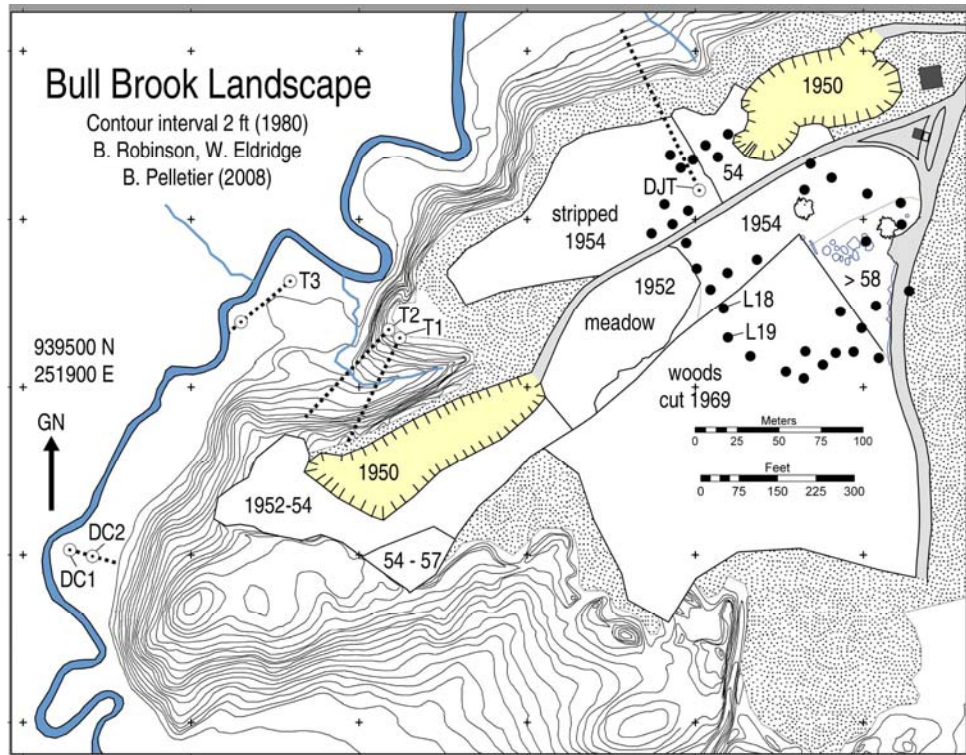


Figure 2. Landscape features at the Bull Brook site, showing locations of Dutch cores (DC1, DC2), resistivity transects (T1 - T3), and Douglas Jordan's survey transect (DJT). Years represent episodes of site destruction by sand and gravel operations.

Emphasis was placed on identifying topographic and hydrologic features that may have influenced the configuration or placement of the Paleoindian occupation. Byers (1954:343) observed that the “surface of the land shows differences in elevation that could not have amounted to more than 5 feet over the entire area.” Hartshorn (1969:174) described the landform as “an almost isolated flat-topped plain” referred to as a “kame plain or a kame delta.” These general observations were made when most professional archaeologists considered the ring-shaped pattern to be coincidental, and fine-grained influences on the form of the settlement pattern were of less interest.

Important aspects of topography west of the Paleoindian occupation area were destroyed by sand pit operations between 1948 and 1952, prior to the earliest aerial photographs or still photographs of the site. One feature (a spring fed erosional gully) still exists (Fig. 2, marked by test areas T1 and T2). This feature (currently 80 m long, 50 m wide, 8 m deep) was too small to be recorded on the Ipswich, Massachusetts 7.5 minute quadrangle map (3 m contour interval), but is accurately shown on an important two-foot interval photogrammetric map produced in 1980 and contributed to the project by the sand pit owners in 2004 (Fig. 2).

Related to the gully, William Eldridge described a low meadow covered by bluets in the spring, located toward the west side of the Paleoindian occupation. At first it was unclear whether this wet area (lower by about a foot) was inside or outside of the ring-shaped area, an important problem although as Harold Borns noted (personal communication, 2005) it is unclear that a landform marked by a patch of bluets would

have been significant in the Younger Dryas cold period. The gully and spring were well known landmarks to the excavators, with one full-channeled gouge of the Early to Middle Archaic period recovered on the bank near the head of the gully. Bill Eldridge and Nick Vaccaro said that this drainage pattern originated from the direction of Loci 18 and 19 (Fig. 2). According to Eldridge there was a distinct iron-stained strip exposed on the surface of dense sediments, after 10 to 15 feet of sand was removed between these loci and the gully. When the site plan was assembled with GIS locations, combined with the earliest sketch plans of the site representing conditions in 1950 and 1952 (BBR 2326, BBR 469), the respective observations came together. The meadow was a low area southwest of Loci 18 and 19. It did not intrude into the center of the circle (Fig. 2). The iron-stained channel below the meadow likely represents a depression in the dense sediment level (clay?) that marked the bottom of the sand pit operations (now largely refilled). This subsurface depression, originating near the west edge of the Paleoindian occupation, drained a major portion of the landform into the spring fed gully, with spring waters originating 3 – 5 m (10 to 15 ft) below the adjacent sand banks. This and other smaller springs (one north of the Paleoindian occupation and east of Jordan's survey transect (Fig. 2, DJT) were observed to run through the winter.

Modest field work at the Bull Brook site was accomplished during this project with the permission of the sand pit owners. The work was done with University of Maine graduate students including the late John Nelson, Bert Pelletier, Peter Leach and Jennifer Ort, in consultation with Joseph Kelley (School of Marine Sciences, University of Maine). Nelson contributed electrical resistivity testing on three transects across the gully and in the marsh. Resistivity works in salt water saturated soils, in contrast to ground penetrating radar. The resultant profiles show measurements of resistance in ohms, showing variably sharp transitions. Transects 1 (Fig. 3) and 2 show the transition between the dry upper sands (red zone, > 8000 ohms on August 12, 2004) and the denser basement sediment (dark blue ca. 20 - 70 ohms). The contact is preserved at the terrace edges and may have been dissected toward the center of the gully. The large centrally located blue area may be a remnant of the original dense strata or perhaps an earlier channel fill from the period before sea level rose. Importantly, the denser sediment level appears to be only about four meters thick across the profile, underlain by a layer of higher resistance (200 – 900 ohms), even though water-saturated. This apparent transition back to coarser sediments may account for a reference to a geological core taken in the bottom of the sand pit at Bull Brook which reported 30 feet of sand in a 75 foot deep core (Sammel 1962 in Hartshorn 1969:174). Unaltered gray marine clay is reported east of the sand pit (Hartshorn 1969:174). In Transect 1, the highest recorded elevation is 12.46 meters (arbitrary benchmark), with the high salt marsh surface at 2.3 meters in the adjacent marsh. The original terrace edge crested at 12.0 m (39.3 ft) above the marsh surface near Locus 6 on the northwest side of the Paleoindian occupation (Jordan profile, described below), two meters higher than the terrace edge preserved in T1. The spring fed gully was probably present in late Pleistocene times, given that it represents a major subsurface drainage pattern on the landform.

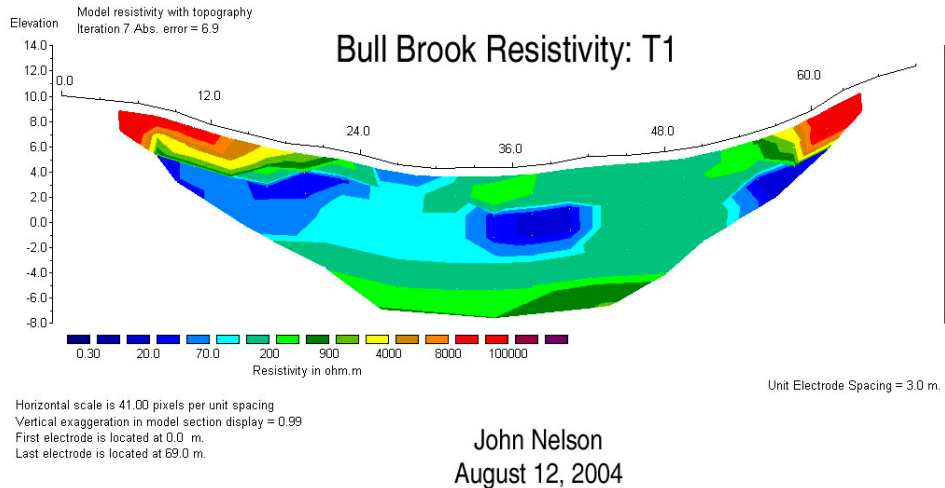


Figure 3. Resistivity profile at Transect 1 through gully. By John Nelson.

The precise character of the terrace edge opposite the Paleoindian site was recorded by Doug Jordan in his field book in late 1953, just as the region was being cleared for stripping (Fig. 4). With GIS locations for this profile and adjacent loci, it is shown that Locus 6, the outermost locus toward the western slope, was situated at or just east of the crest of the terrace, with the rest of the settlement pattern located east of the terrace crest on a gentle one percent slope. On the far eastern edge of the settlement pattern, approximately 1/5 of the loci occupied a steeper eastern slope occupying depression about a 10 ft deep (3 m), on a 5 to 10 % eastern slope. Thus, 80% of the circular settlement plan is situated on a featureless one-percent eastern slope, with about 20% of the eastern edge draped into an eastern depression. There is no evidence of topographic or hydrologic variation within the central area of the settlement plan.

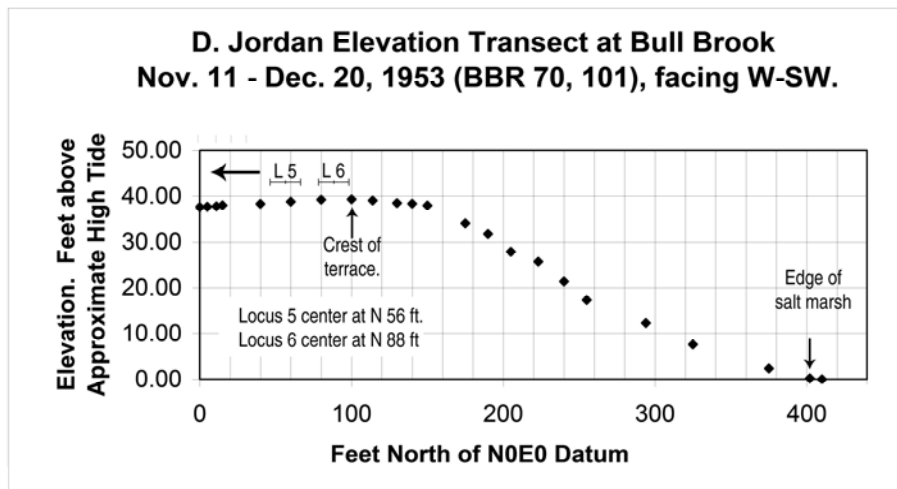


Figure 4. Douglas Jordan's surveyed profile of the west bank of the landform (facing S-SW) showing the position of Loci 5 and 6. The left-hand arrow points toward the center and opposite side of the Paleoindian settlement pattern. Each dot on the slope is a measured elevation. Shown vertically exaggerated.

Finally, two Dutch cores were taken at the narrow portion of the salt marsh between the steep slopes of Jewett Hill to the west (not shown) and the 40 foot (12 m) knob at the southwest end of the landform. The work was done with Peter Leach and Jennifer Ort on February 22, 2007 with permission of the Ipswich Conservation Commission. The salt marsh narrows to 50 m. at the core locations (Fig. 2, DC1 and DC2), marking the end of a steep-sided funnel that opens toward the ocean. It is speculated that the funnel might have served as a trap for caribou moving from the coast and perhaps from Jeffreys Ledge which would have been an island at the time (Pelletier and Robinson 2005). Dutch core 2 was the most informative with a depth of 2.5 m. This core produced 1.26 meters of salt marsh peat overlying 40 cm stiff grey silt clay, followed by 35 cm of bedded fine to coarse sand with organics and 50 cm of silt loam. A small twig from 181 cm deep in the core yielded at date of 4790 +/- 40 (Beta 240632, Cal BC 3630 – 3360, 95% probability), indicating the overlying stiff clay is associated with Late Holocene sea level rise. Intact bottom deposits were not found.

In summary, the location of the Bull Brook settlement plan was pinpointed on the glacial landform during the NSF funded project, demonstrating errors of over 100 m in previously published plans. This allowed a more detailed investigation of topographic and hydrologic variables, with no evidence that the ring-shaped pattern was controlled by these factors beyond the edge of the landform itself. Large flat areas extending well beyond the circular pattern were extensively surface hunted, yielding later Holocene stone and pottery artifacts, but without Paleoindian artifacts between Bull Brook and Bull Brook II, a smaller cluster of loci located to the south and reported elsewhere (Grimes et al. 1984). More topographic reconstruction is possible with photogrammetry.

Ring Structure and Assemblage Evaluation

The revised Bull Brook site plan reproduces the ring-shaped pattern of the original, but with a more symmetrical, slightly pear-shaped outline and new evidence of internal segmentation (Fig. 5). For example “Segment A” (Fig. 5, left) has 11 loci, seven of which (between Loci 7 and 18) form a 72-m long straight line with locus centers separated by 13 to 17 m. Assuming an average locus diameter of five meters, this represents spacing of 8 to 12 meters between loci. Using this straight line as an axis, Locus 10 is on the outer rim of the ring and Loci 9, 14 and 15 are on the interior. Moving clockwise, Loci 5, 4, 1 and 3 are in a line (center points separated by 9 to 15 m) with Locus 6 on the outside and Locus 2 on the inside. This group is truncated by the early sand pit where some data (loci) may have been lost. These two segments are separated by 24 m between the centers of Loci 7 and 5. It is of considerable importance and also quite remarkable (given these were the first areas excavated) that the locations of all of the loci in these two segments are reliably plotted. This was largely possible because of the measured plan of 13 loci produced by Eldridge in 1953, overlapping with the area covered by the movie panoramas. The most accurately plotted areas are also the most clearly structured. Other segments are also apparent, but include less accurately plotted loci (Segments C and D). There is some spatial evidence beyond the final plan, allowing Locus 20 to be lumped with Segment D, while Locus 19 is ambiguous. Segments C and D could be separated into two smaller segments, but they are consistent with the better defined segments and are employed here as tentative organizational units for distributional analysis. The segments resemble the plans of smaller Paleoindian sites

that occur as straight or arc-like configurations, providing models for exploring social organization. The revised ring pattern has a length of 164 m (from the centers of Loci 6 to 36) and a width of 130 m (from Loci 22 to 35).

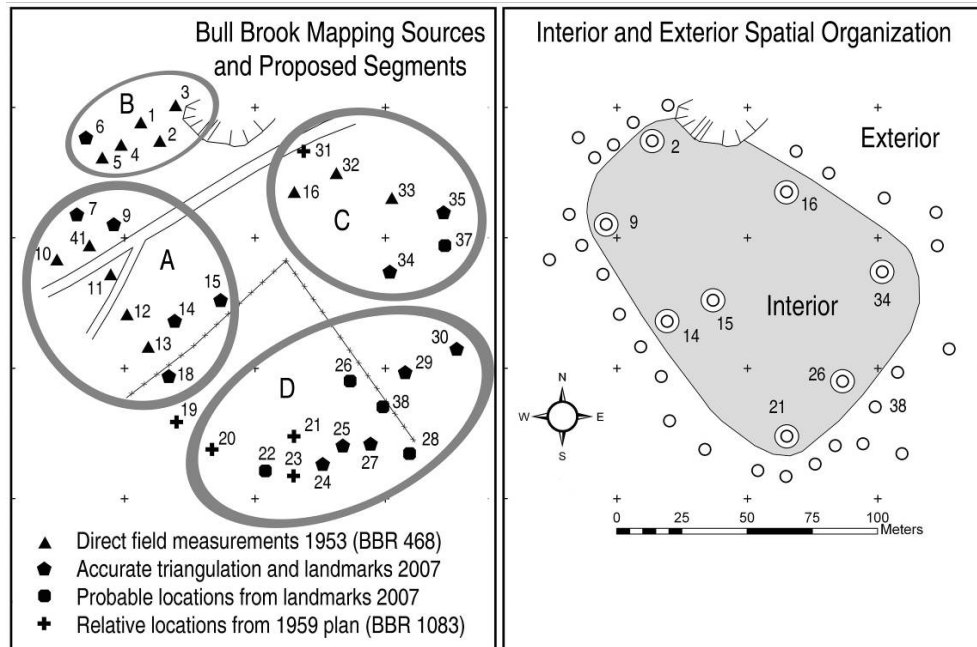


Figure 5. Proposed segments and interior/exterior organization of the Bull Brook loci.

The linear segments and relatively clear circular outline allow further separation into interior and exterior portions of the circle as described above for Segments A and B. Following this trend, there is a well-defined outer zone of 28 loci, distinguished from eight inner loci (Fig. 5, right). This distinction provides two very large samples of artifacts to test whether outer and inner loci represent different activities. It should be noted that the potential for differing interior and exterior activity patterning did not arise solely from an interest in geometry. Bill Eldridge's field records clearly distinguished three loci (15, 22 and 34) as different from others based on the high concentration of bifacial drills. These loci were situated toward the inner part of the circular pattern on the original published version of the Bull Brook site plan, suggesting a possible pattern. However, the only artifact frequencies published or known at the time (Grimes et al. 1984) did not include any of these loci and the distribution of other artifact frequencies was unknown. Thus, the spatial analysis provided both the breakdown by segments around the ring, and the distinction between interior and exterior, for use as organizational groups for the distributional analysis.

The distributional analysis is clearly dependent on the integrity of the artifact assemblages in each locus and considerable effort was put into documenting the history of collection and cataloging. This entails methods used by the group of excavators and the record keeping of individual excavators, drawing on the detailed site chronology developed for this project. The earliest limited cataloging was done in 1952, followed by Doug Jordan's invaluable catalog of approximated 3500 provenienced artifacts (1959), followed by the more exhaustive catalog of the Peabody Essex Museum begun in 1978.

Through all of these episodes, the basic unit of provenience was the individual collector-lot, preserving names of the finders and episodes of recovery for most of the collection. Collector-lots thus provide the key to evaluating provenience, rather than the content of each lot. For this project, collector-lots were evaluated independently from the artifact descriptions themselves, with every provenienced collector-lot evaluated and recorded in the detailed locus descriptions. There were few, but some significant changes from the PEM catalog. Approximately 30% of the collection is excluded from the spatial analysis due to disturbance or insufficient documentation.

Part 2: Artifact and Lithic Raw Material Distributions

Jennifer Ort and Brian Robinson

Small artifact loans were initially made to the University of Maine during the early part of the project, but most of the work was conducted at the PEM, totaling over four months of full time cataloging and analysis. Ort was responsible for both technological descriptions and assigning material type designations based on a comparative collection that was prepared in advance and developed over time. Virtually every artifact was viewed with a 7 - 30 power stereoscope. The entire assemblage of provenienced artifacts and flakes was analyzed. The remaining artifacts were thoroughly evaluated with regard to provenience, and those attributed only to the Bull Brook site in general or to "Early Bull Brook" (roughly the northern half of the site) are still in the process of being classified and photographed. Artifacts from the first 15 loci were photographed on both sides, in addition to all bifaces, drills, flute flakes and selected other material.



Figure 6. Bull Brook artifacts: a, fluted point; b, uniface flakeshaver; c, endscraper; d, graver; e-h, drills; i, side scraper. Photographs by Erica Cooper courtesy of RSPM (a, i) and PEM (b - h).

Artifact frequencies from 6 loci (n = 508) were previously published (Grimes et al. 1984:167). New artifact totals include 5,215 Paleoindian tools and 36,597 flakes from 36 loci. Statistical analysis was conducted on 2,543 of the more regular tool forms, averaging 70 flaked stone artifacts per locus (Table 1). Bifaces include 54 nearly complete fluted points (Fig. 6a), 42 fluted bases and 186 fragments or preforms. Paleoindian drills are rare except on large sites such as Bull Brook and Vail (Gramly 1982). Bull Brook drills have carefully prepared S-shaped bits for rotation in one direction (Fig. 6e-h). Other artifacts include unifacial flakesavers (limaces, Fig. 6b, Grimes and Grimes 1985), endscrapers (Fig. 6c), gravers (Fig. 6d) and wedges (*pièces esquillées*). Table 1 also lists frequencies of flakes and flute flakes.

Bull Brook Artifact Frequencies Separated by Interior and Exterior Loci

Bull Brook Category	Interior Loci			Exterior Loci		Site Total Count	Six Biface Dominated Loci	
	Count	Z-score	% of Site Total	Count	Z-score		Count	% of Site
Loci Included	8		22%	28		36	6	17%
Artifacts Included in Statistical Analysis								
Flakeshaver	81	8.46	64%	45	-5.00	126	79	63%
Drill	48	7.12	70%	21	-4.21	69	44	64%
Biface	127	6.31	45%	155	-3.73	282	97	34%
Endscraper	203	-5.03	18%	910	2.97	1,113	61	5%
Wedge	75	-3.12	18%	339	1.84	414	40	10%
Graver	32	-2.42	17%	157	1.43	189	15	8%
Side scraper	93	0.24	27%	257	-0.14	350	59	17%
Total	659		26%	1884		2,543	395	16%
Flakes and Flute Flakes								
Flakes	17,169		47%	19,306		36,475	16,807	46%
Flute flakes	103		84%	19		122	108	89%

Table 1. Bull Brook artifact frequencies separated by interior and exterior loci. Z-scores show negative and positive correlations for each set, with absolute values of Z > 2.58 significant at .01. Frequencies for the six biface-dominated loci at right.

Analysis of the seven most regular artifact classes indicates that differences between the interior and exterior are not coincidental (chi square = 274, df = 6, p = .0000). Z-scores and percentages show four artifact classes that are most strongly contrasted. The eight interior loci have 26% of all artifacts, but 70% of flakesavers, 64% of drills and 45% of bifaces, with only 18% of endscrapers. The interior also produced 84% of the flute flakes, a finishing touch in the production of fluted points.

When loci are ordered by proportions of the two most strongly contrasting sets of artifacts (endscrapers representing one set, bifaces, flakesavers and drills the other), endscraper proportions decline gradually, followed by an abrupt change with six loci dominated by the biface group (Figure 7). The biface-dominated loci include five of the eight interior loci (Fig. 8, Loci 2, 16, 34, 26, 21) and one exterior locus (38). In contrast, five of six loci with the highest proportion of endscrapers are on the exterior, clustered in Segment A (Fig. 8). The proportions of artifact types in the six biface-dominated loci contrast strongly with the remainder of the site (Table 1). Although it is not surprising that the biface-dominated loci had high numbers of flute flakes, it is notable that they included 89% of all the flute flakes as compared to only 34% of bifaces. Biface

reduction and especially flute removal were specialized activities, while the products of biface production are well distributed around the site. The six loci included only 5% of endscrapers and 8% of the gravers (Table 1). Side scrapers are evenly distributed on the interior and exterior. The distinctive character of these loci is emphasized by even spacing around the interior edge of the settlement, supporting the hypothesis that the circular plan represents an organized event (Figure 8).

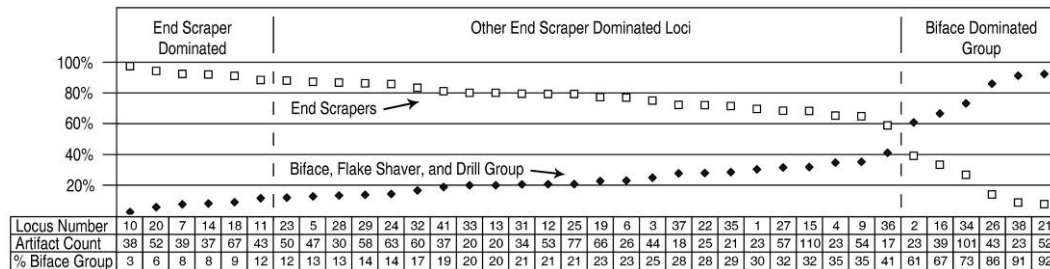
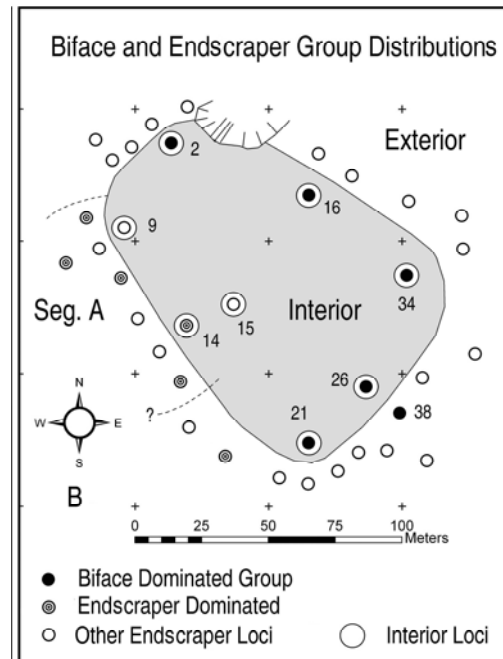


Figure 7. Loci ordered by the proportion of endscrapers compared to the proportion of bifaces, flakeshamers and drills combined. Artifact counts represent the total of those classes of artifacts.

Figure 8. Position of six loci in the biface-dominated group (with the highest proportion of bifaces, flakeshamers and drills) and six loci dominated by endscrapers.



Two of the remaining interior loci (9 and 15) also have high proportions of bifaces, and Locus 15 has the fourth highest number of drills (n = 6) and the eighth highest number of flakeshamers (n = 8). Segment A has the highest proportions of endscrapers compared to other segments, but within Segment A, Loci 9 and 15 have the highest proportions of biface group artifacts. Thus all of the interior loci share characteristics of the biface group except Locus 14, although there is some variation in relative proportions of artifacts in segments of the circular pattern.

The strongly contrasting activities, between interior and exterior loci were then compared to the distributions of material raw materials. The lithic categories are described more fully below, with only major, recognizable categories employed for the distributional analysis. It was proposed at the outset of this project that distributional patterns of artifact type would be different from those of raw materials if the ring-shaped settlement pattern was comprised of different regional groups.

Inner and outer ring characteristics may vary with different cultures, but... ethnographic examples cited... suggest that outer ring activities may be appended to the social group of the inner ring segment. In a hypothetical case, this could mean that inner and outer rings show contrasts in activities and artifact frequencies, while different segments around the circumference of the ring have greater contrasts in raw material sources and regional styles. (Robinson 2003)

Comparative Collection #	Material Description	State	Segment A		Segment B		Segment C		Segment D		Total
			Cnt	%	Cnt	%	Cnt	%	Cnt	%	
1125	PA jasper	PA	278	52%	49	33%	102	37%	258	39%	687
3001	red/grey-red Munsungun	ME	61	11%	22	15%	46	17%	126	19%	255
5547	black/gray mottled, WAH	NY	163	30%	56	38%	87	32%	195	30%	501
6869	rhyolite tan/weathered	?	26	5%	14	9%	30	11%	37	6%	107
308	rhyolite NH	NH	6	1%	7	5%	8	3%	17	3%	38
2961	red sedimentary	?	4	1%	1	1%	3	1%	22	3%	30
Total			538		149		276		655		1618

Table 1. Frequencies of selected material types, with relative proportions of these types from each of four site segments at Bull Brook. The grand total excludes only Locus 19 from the site total.

The lithic material distributions are here charted according to Segments A – D (Table 2 and Figure 9). The more distinctive varieties of known lithic sources as identified by Burke were selected. Only tools are included in these counts. Although there was a learning curve involved with material identification, the first 17 loci were rechecked with photographs, and the materials selected here are among the more obvious. It is emphasized that these percentages do not represent the relative importance of different lithic sources. Munsungun chert, for example is only represented by the homogeneous reds and red/gray variants. Other color varieties are known but are difficult to identify in the hand samples, such as the abundance of grey cherts as discussed by Burke below. Jasper, on the other hand, is nearly completely represented as it is easier to identify. Jasper comprised 18% of all tools from Segment A and 13% of all tools from Bull Brook. The frequencies represent varying proportions of distinctive types within each segment, for the purpose of identifying variations between the segments.

To some degree we had anticipated or hoped for more strongly contrasting patterns between the segments, representing clear regional contrasts. This is clearly not the case, with the major material sources distributed throughout all of the segments. This may be one of the more important observations of the distributional study. Nonetheless there are subtle differences between the segments that may represent a more realistic picture of groups who use a wide geographic range, exploiting the same lithic source areas. Differences may represent specific routes and timing, in addition to exchange (Curran and Grimes 1989). Without being able to quantify site totals at present, we

suspect a stronger component of Hudson Valley chert, following Burke, than reported in recent years.

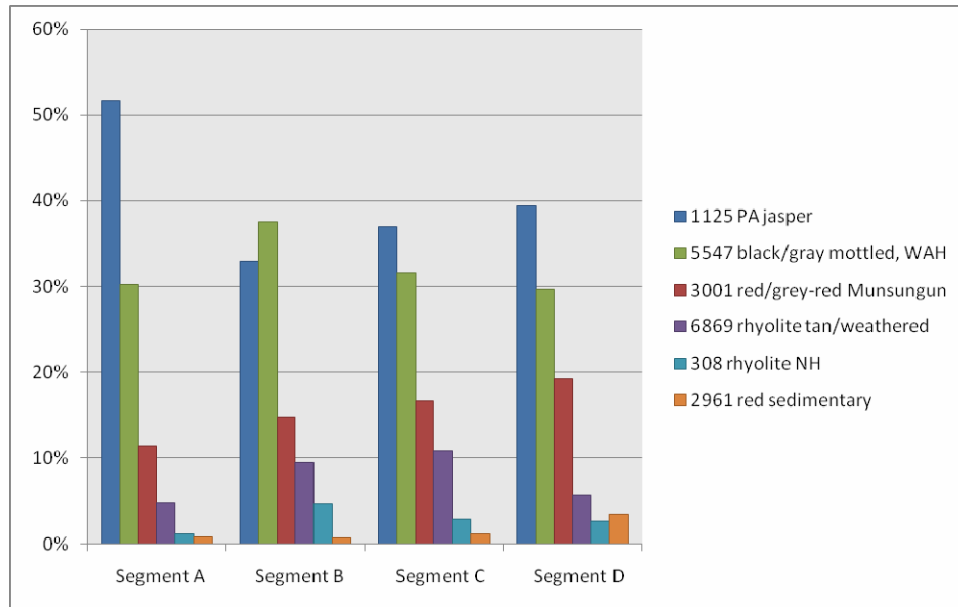


Figure 9. Relative proportions of selected material types from Bull Brook segments

Distributional analysis of Bull Brook artifacts demonstrated stronger than expected contrasts in tool types between interior and exterior loci revealing important new information of activity organizations. Material analysis demonstrates a greater degree of homogeneity in major segments of the Bull Brook circle, but still with variations, as Burke’s lithic analysis below contributes to resolving territories of lithic exploitation.

Part 3: Lithic Source Analysis Adrian L. Burke

Lithic raw material identification was conducted in two interrelated parts or stages. Early in the project the Bull Brook collection was inspected at the Peabody Essex Museum by Adrian Burke, Steven Pollock and Brian Robinson, for the purpose of constructing a comparative collection. The initial collection of 65 specimens is referred to as Comparative Collection A. It included multiple specimens of each of the major material types, including burned and unburned specimens of red and yellow-brown jasper, for example. This collection was used by Jennifer Ort throughout her analysis to assign comparative numbers to the rest of the collection. With more thorough review, Ort selected an additional 36 specimens referred to as Comparative Collection B. Thirty-five Bull Brook specimens were thin sectioned by Burnham Petrographics, with permission of the Peabody Essex Museum. Three of the thin sectioned pieces were from Comparative Collection B. The distributional analysis required lumping of smaller variations into major material classes. This necessarily limited utility of some material

groups, such as homogeneous gray chert, for specific source identification. This was unavoidable since time and distance precluded analysis of the whole collection by multiple individuals. Thus the distributional analysis is based on major identifiable groups, with finer description and analysis limited to the Comparative Collections and thin sections.

Methods and Problems

The sourcing of the lithic materials from the Bull Brook site was carried out by Dr. Adrian L. Burke, with the help of Dr. Heather A. Short for the thin section petrography. An initial macroscopic analysis led to the identification of two general categories: 1) a small percentage of coarse-grained, igneous rocks probably of local origin and primarily in the form of large flakes, debris and fractured cobbles, and 2) a large percentage of fine-grained, siliceous rocks of regional, and extra-regional (exotic) origin making up most of the tools and debitage in the collection. Burke focused on the latter category in part due to the importance of these materials in the Bull Brook collection, in part to answer the initial project research questions, and in part due to a lack of knowledge and experience on the part of Burke with the prehistoric use of the igneous rocks of southern New England (cf. Hermes and Ritchie 1997; Strauss 1989; Strauss and Murray 1988). While this project was conceived of as a truly interdisciplinary research project, and the PI and collaborators were constantly in communication throughout, the sourcing sub-project was de-coupled from the larger research project in order to maintain a certain objectivity with regards to the ultimate assignments of archaeological lithic materials to known or presumed geologic sources. Therefore, after helping to choose the archaeological lithic raw material comparative collection (ALRMCC) from among the Bull Brook artifacts themselves, Burke then proceeded independently with the geoarchaeological side of the project by first putting together a geologic lithic raw material comparative collection.

The geologic lithic raw material comparative collection (GLRMCC) was chosen to be as comprehensive and inclusive as possible for two reasons. First, a geoarchaeological approach to sourcing lithic raw materials must include all potential sources in order not to exclude or overlook any potential geologic source and thus prejudice the archaeological interpretations based on the results (Church 1994). Archaeological raw materials often have more than one geologic look-a-like, but these are seldom considered by archaeologists. Second, Paleoindian groups in northeastern North America are generally recognized as having exploited very large territories annually and generationally, on the order of hundreds of linear kilometers (Burke 2006; Curran and Grimes 1989; Ellis 1989; Gramly 1988; Storck and Bitter 1989). This means that the potential geologic catchment is huge and therefore the geoarchaeological study had to adjust the scale of analysis to this truly regional scale (Figure 10). Fortunately, Burke had already worked at this larger scale for other projects in the Northeast (Burke 2000, 2003), and his geologic lithic raw material reference collection housed at the Département d'Anthropologie of the Université de Montréal already included most of the raw materials under consideration. Complete lists and descriptions for the two comparative collections are available and will be published.

The GLRMCC for the Bull Brook project comprised hand samples from all known Early Paleoindian quarries within the greater Northeast, such as the well known Munsungun (ME) and West Athens Hill (NY) chert quarries, and the Hardyston jasper

quarries (PA). Other sources known to have been used during the Early Paleoindian period but for which no strictly Paleoindian quarries have been found to date include Cheshire/Dalton quartzite (VT), Jefferson and Mt. Jasper rhyolite (NH), and chert/chalcedony/jasper from Minas Basin (NS). I also included Late Paleoindian quarries that may have been used during the Early Paleoindian, for example Sheguiandah quartzite (ON) and Cap Chat chert (QC). Several important Paleoindian quarry sources from the southern Great Lakes were also added to the GLRMCC (e.g., Onondaga chert [NY/ON] and Collingwood or Fossil Hill chert [ON]). The larger reference collection also included materials from greater distances used during the Early Paleoindian period such as Knife River Flint (ND). The GLRMCC was clearly weighted towards the northern glaciated regions due to Burke’s personal research experience and the Université de Montréal reference collection used. However, we did have at our disposal an important collection of Ohio cherts (e.g., Upper Mercer and Plum Run) as well as many other “exotic” materials used in North America (DeRegnaucourt and Georgiady 1998; Kagelmacher 2001). Finally, a few “enigmatic” sources were included in the GLRMCC because they could have been used or at least they raised serious questions about look-alikes (Limerock jasper [RI] and Saugus jasper or rhyolite [MA]).

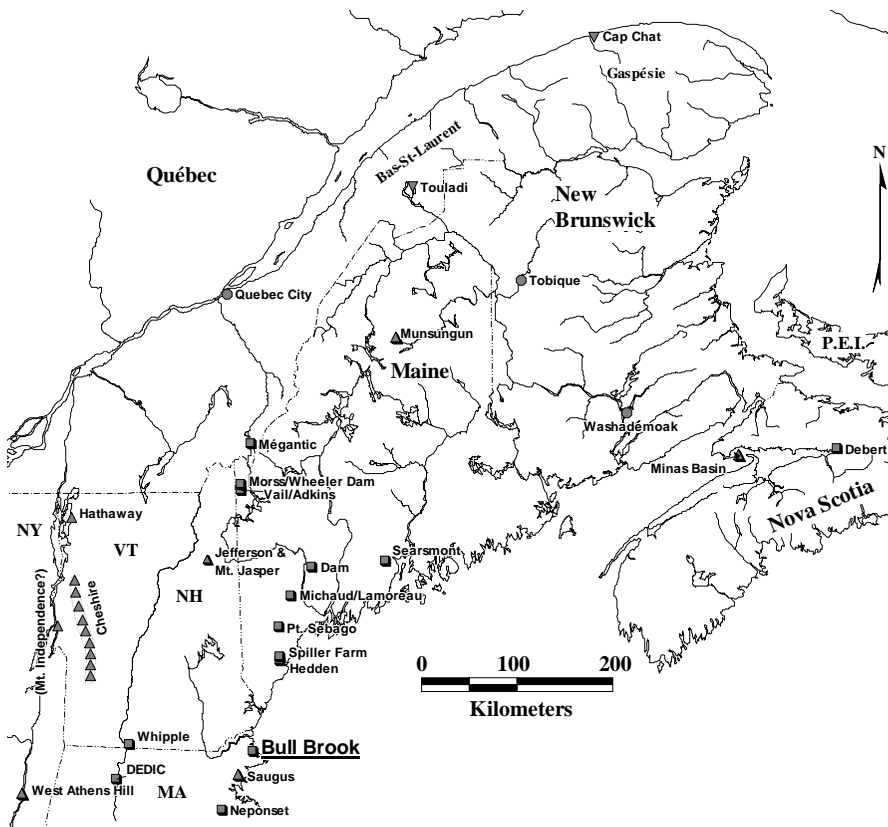


Figure 10. Eastern New York, New England, Southeastern Quebec and the Maritimes. Squares are early Paleoindian sites, triangles are known Early Paleoindian quarries, upside down triangles are Late Paleoindian quarries with no Early Paleoindian evidence, circles are other known quarries that will be considered as potential sources.

Based on Burke's previous geoarchaeological work and that of many colleagues in the region (Black and Wilson 1999; Eley and Bitter 1989; Luedtke 1992; Pollock, et al. 1999), it was clear that macroscopic and low-power microscopic characteristics (e.g., color, luster, translucency, texture or grain size, weathering patterns, visible fossils) could be used reliably to identify distinctive lithic raw materials such as Pennsylvania jasper, Onondaga chert, or some of the Munsungun cherts. On the other hand, our experience also forced us to be very conservative in identifying raw materials macroscopically, especially since most of the Bull Brook artifacts were weathered. Several sources of good quality grey chert are found in the Northeast and were used extensively throughout prehistory. These cherts are difficult to distinguish in hand sample, even for the most experienced archaeologist (Calogero 1992). For this reason, 35 artifacts were thin sectioned and analyzed using a petrographic microscope (full descriptions will be published in the future). These thin sections were compared to thin sections made for all of the GLRMCC samples. In addition, a limited number of geochemical analyses were carried out on geologic and archaeological samples in order to confirm macroscopic and petrographic source identifications (neutron activation analysis, non-destructive X-ray fluorescence, & scanning electron microscopy of polished thin sections).

The GLRMCC was then confronted with the reality of the Bull Brook collection and the ALRMCC. The fundamental challenge is that the fine grained siliceous raw materials used to make stone tools can be hard to identify macroscopically, especially when weathered. Cherts of various shades of grey pose the biggest challenge since they make up a large part of the Bull Brook artifacts. Some macroscopic characteristics such as laminae, burrows, brecciation, radiolarian fossils, and micro-stylolites did help us to identify specific sources. However, many cherts had to be classified under the provisional rubric "consistent with", while many others remained at the level of "grey chert". Few of the grey cherts could be assigned a secure geologic source. Maroon-burgundy-red cherts were also a problem in macroscopic identification. Other materials seemed straightforward such as Cheshire quartzite or Pennsylvania jasper, but the possibility of look-a-likes remains (Sheguiandah quartzite and Limerock jasper). Thin section petrography was able to resolve some of these 'grey' areas but does not ultimately resolve the flaws in the macroscopic identification since it is still possible that some of the materials identified to one source but not thin sectioned are in fact from another source. The thin section petrographic analysis, however, remains important to the geoarchaeological dimension of the Bull Brook project as it allows us to precisely describe the lithology of each of the lithic raw materials that were used and these remain for future comparison.

Lithic Identification Results

Based on careful macroscopic and low power microscopic (30x) comparison of archaeological materials with the GLRMCC, supported by thin section petrography and limited geochemical analyses, Burke was able to confirm the presence on the Bull Brook site of several lithic raw materials. In addition, some of the materials in the ALRMCC could be tied more securely to known geologic sources, while others were tentatively assigned. This is important because the detailed descriptions of the characteristics of the Bull Brook materials comprising the ALRMCC can be used in the future on other Paleoindian sites. Munsungun chert from northern Maine is present at Bull Brook. This

is not surprising as it was already noted by other archaeologists and detailed by geologist Stephen Pollock (Pollock 1987b; Pollock, et al. 1999; Pollock, et al. 1995). Jefferson and Mt. Jasper rhyolites (NH) are also present at Bull Brook. Once again, this is simply a confirmation of what other archaeologists and geologists had noted previously (Boisvert 1999; Bradley 1998; Pollock, et al. 1996). Grey-green radiolarian chert from the Hudson Valley (NY) consistent with the chert from the West Athens Hill Paleoindian quarry (Funk 1973, 2004) is also present at Bull Brook. This is a new result, at least in terms of modern petrographic studies, although Bull Brook cherts have been attributed to different major sources in the past, including those related to West Athens Hill or Normanskill chert (Byers n.d.:10). We are forced to “reconsider again” the social relationships and territories of the Bull Brook occupants.

The cherts from the Hudson Valley are not always easily distinguishable from the grey varieties of Munsungun, even in thin section. With the help of Heather Short, we were able to find some characteristics, however, that can help to tell these apart (radiolaria and fossil hash densities, chlorite mineral presence, structures such as stylolites or layering, localized brecciation, late stage veins with chalcedony). More importantly, these recurrent petrographic characteristics can be tied to the macroscopic characteristics visible in hand samples such as the radiolaria, laminae, or brecciation.

The artifacts made of yellow-brown-caramel jaspers found at Bull Brook do indeed match the jaspers known from the Hardyston formation in Pennsylvania (e.g., Macungie quarries), both in hand sample and thin section. Thin section petrography allowed us to eliminate the Limerock (RI) jasper source as the source for jasper at Bull Brook. Limerock jasper contains tourmaline minerals and orientations of quartz axes not found in Pennsylvania jasper, and the colliform patterns so typical of PA jasper (deformed original detrital grains surrounded by hematite) are not present in the Limerock hand samples or thin sections.

Although the majority of gray cherts cannot now be attributed to a particular source based on visual comparison with the comparative collection, each of the major sources had distinctive varieties that are more or less confidently identifiable in hand specimens and associated with the thin section identifications. The red/brown and red/gray Munsungun chert (ALRMCC 2881, 3001), coarsely mottled black on grey WAH chert (5547), Pennsylvania Jasper (1125), New Hampshire rhyolite (308) that were sufficiently abundant in the collection to undertake distributional comparisons, in addition to other distinctive materials that were not identified to source.

Perhaps just as interesting and noteworthy are the materials that appear to not be present at Bull Brook. We have found no evidence of cherts from the Champlain Valley (NY/VT). Neither the limestone replacement cherts (Mt. Independence/Clarendon Springs) nor the shale melange cherts (Hathaway) are present (Burke 1997). This is interesting because at the Late Paleoindian site of Reagan these materials seem to be present (Ritchie 1953), and because Pollock has identified these materials at the Michaud site in Maine (Pollock 1987a). Cheshire quartzite is also absent. This material is never common on Paleoindian sites but it is present at the Whipple site (NH) which is not far from Bull Brook (Curran 1984). Onondaga chert does not seem to be present, nor are any of the well known cherts from the Great Lakes, but of course we have to be cautious since there may be small flakes of this material in the hundreds of weathered flakes identified simply as grey chert. Two thin sections contain bryozoans and other fossils,

and lack the extensive chlorite mineralization of West Athens Hill chert (#6443 & 7904). These may very well be cherts from the limestone contexts in the southern Great Lakes (Eley and Bitter 1989). While most of the raw materials come from considerable distances, none of the truly “exotic” materials that did travel enormous distances during the Paleoindian period seem to be present (e.g., Knife River Flint) (Tankersley 1991).

Other materials raise interesting questions. Saugus rhyolite or jasper has been directly associated with Early Paleoindian fluted points (Grimes et al. 1984:168) but does not appear to be present on the site. The thin sections we have of this material do not match the thin sectioned artifact. Once again we need to be cautious with weathered dull red cherts and fine grained igneous rocks. Flakes of this material may have been classified macroscopically simply as “red chert” during analysis. Geochemical analyses should be able to resolve this issue. None of the Quebec lithic sources are present at Bull Brook. This is perhaps not surprising given that at the Cliche-Rancourt Paleoindian site (QC), materials from Maine and New Hampshire dominate the assemblage (Chapdelaine 2004). None of the fine grained silicates from Minas Basin (NS) that are so dominant at the Debert Paleoindian (MacDonald 1968) site have been identified at Bull Brook. A few highly translucent orange-red pieces (microcrystalline quartz and chalcedony with hematite) may be from the Maritime Provinces (e.g., Tobique, Washademoak, Minas Basin), but they could easily come from minor local sources in Massachusetts or elsewhere in Southern New England.

The geochemistry aspect of the sourcing project is not complete at the writing of this report. While neutron activation analysis (NAA) was initially thought to be critical to the sourcing project, Burke quickly came to the realization that the intra-source chemical variability in sources such as Munsungun and West Athens Hill were so great as to require a major geochemical characterization campaign involving several hundred analyses (cf. Malyk-Selivanova, et al. 1998). A few geologic samples of West Athens Hill chert, Munsungun chert, and NH rhyolite were submitted to the SLOWPOKE reactor at the Polytechnique de Montréal for NAA, where Burke and Chapdelaine had already run dozens of samples of Northeast cherts (Burke 2000, 2003; Burke and Chapdelaine 2006; Chapdelaine and Kennedy 1999). The NAA analyses helped to establish the presence of useful trace and rare earth element patterns that appear to be diagnostic of different Northeast Appalachian cherts; however, we need to run many more samples before this can be used to accurately source the cherts from Bull Brook. Non-destructive X-ray fluorescence (XRF) analysis is still ongoing. All of the flakes making up the comparative collection that fit in the XRF instrument will eventually be analyzed. Non-destructive XRF analysis of archaeological samples is a less precise and accurate technique than NAA or ICP-MS, but it should allow us to separate out major categories such as igneous (rhyolites, felsites) versus sedimentary (cherts) materials that are ‘hiding’ in the weathered red and grey flakes and tool fragments. This could lead to the identification of the Saugus source for example. Finally, some preliminary analyses were carried out using scanning electron microscopy (SEM) of polished thin sections. This provided some very promising results for distinguishing the Appalachian cherts using elemental raster maps. Unfortunately the technique remains time consuming and requires destructive polished thin sections to be made which greatly reduces the analytical sample.

Conclusions: Lithic Identification

There remains a gap between the GLRMCC and the Bull Brook collection and ALRMCC, primarily in terms of the degree of confidence that we can attach to the macroscopic identifications. In an ideal world, all archaeological materials would be subjected to (destructive?) geochemical analyses and these results compared to the visual identifications. This is clearly not possible and was never the intent of the researchers. On the other hand, the thin section petrography and the detailed description and comparison of geologic materials from known quarry source areas has strengthened the macroscopic identifications and provides in some cases clear and reproducible results in terms of distinguishing certain raw materials (e.g., Hudson Valley chert, Pennsylvania jasper). Thin sectioning is destructive and also limits the number of archaeological samples we can analyze but it remains a powerful tool and it has been extensively used in the Northeast (Calogero 1991; LaPorta 1996; Lavin and Prothero 1992; Lavin 1983; Prothero and Lavin 1990; Wray 1948). While further geochemical analyses would definitely help to further strengthen macroscopic identifications, we believe that for the moment not enough baseline comparative data exists to accurately evaluate intra and inter-source variability even for the Hudson Valley cherts alone (Hammer 1976; Jarvis 1988; Luedtke 1992). Pennsylvania jasper has been extensively analyzed geochemically (Hatch and Miller 1985), but in the end, our thin section petrography seemed to indicate that visual identification of the Bull Brook materials was probably correct most of the time. And, while the thin section sample was small (35 total artifacts), it may be telling that a majority of the cherts (N=21) were securely or tentatively assigned to West Athens Hill, suggesting that in fact the New York cherts may be more important than we initially thought.

Part 4: Radiocarbon Dating and Discussion

Brian Robinson

The spatial analyses in Parts 1 and 2 provide substantial evidence that the ring-shaped settlement pattern at Bull Brook represents an organized event. Choice of land forms, situation of the circular pattern across a limited portion of the landform, concentric patterning of activities with contrasting inner and outer patterns, and visible segmentation within the ring-shaped pattern correlated with contrasting raw material distributions. Perhaps uniquely, high concentrations of otherwise rare artifact forms (drills and flakesavers) may only occur at large social gatherings such as Bull Brook and the Vail Site (Gramly 1982), providing a signature that is visible even in limited excavations. Part 3 makes substantial progress toward identifying lithic sources. In all of these cases we have worked to establish significant foundations, recognizing further refinement and testing of additional patterns is needed. There is much more to be done to fit Bull Brook into the regional landscape at the scale that lithic transport suggests. There is additional work to be done with faunal analysis, adding context and distributional analysis to the previous identifications of caribou and beaver (Spiess et al. 1998). Although additional faunal analysis was not part of the current research proposal (research is ongoing), the calcined bone samples entered unexpectedly into another substantial problem in Northeastern Paleoindian studies, radiocarbon dating.

Numerous samples of charcoal were collected at Bull Brook in part because one of the early participants, Frederick Johnson, was a major player in the development of radiocarbon dating. Charcoal samples were carefully collected, but repeated efforts to date Bull Brook charcoal by gas counting methods yielded dates between 9300 +/- 400 and 5440 +/- 160 B.P. (Byers 1959; Grimes 1979:113). Although some of these dates could represent mixed samples partly of Paleoindian origin, recent AMS dates on individual charcoal fragments suggest that the early Holocene dates are likely correct. Part of the present proposal was to continue the search for the right piece of charcoal, enlisting Nancy Asch Sidell to search for Pleistocene wood charcoal, recognizing the problems of demonstrating cultural context. During this and previous projects Sidell (correspondence 1995, 2006) identified charcoal samples from multiple locations (Loci 6, 11, 16, 24, 32 and 34) yielded *Pinus strobus* (white pine), *Pinus* sp., *Quercus* sp. (white oak group), *Quercus* sp. (red oak group), and one hazelnut shell, but no *Picea* sp. (spruce). Spruce was prominent in the Bull Brook area through to the end of the Younger Dryas period at circa 10,100 radiocarbon years B.P. or 9800 cal B.C. (McWeeney 1994; Newby et al. 2005). The lack of spruce charcoal and multiple Early Holocene radiocarbon dates from Bull Brook suggest that much of the charcoal likely originated from Early Holocene forest fires, (Jacobson and Dieffenbacher-Krall. 1995),

Newly developed methods for dating burned or calcined bone provided an alternative method for dating Bull Brook. The method dates structural carbonate in the crystal lattice of bio-apatite (calcium phosphate) with good agreement between bone and charcoal dates (Lanting et al. 2001) and between laboratories (Naysmith et al. 2007). Two samples of calcined long bone from Bull Brook were dated at Beta Analytic with permission of the Peabody Essex Museum. A date of 10,410 +/- 60 B.P. (Beta 240629, 10,700 – 10,100 Cal B.C., 2 σ) was obtained on four shaft fragments (1.7 g) from a large bone sample that contained both caribou and beaver. A second date of 10,380 +/- 60 B.P. (Beta 240630, 10,670 – 10,040 Cal B.C., 2 σ) was obtained on three shaft fragments (1.2 g) associated with caribou bone from Locus 22. The two calcined bone samples yielded 0.28% and 0.16% carbon respectively with laboratory procedures running normally (personal communication, Ronald Hatfield 2008). Although further testing is needed, these are the first potentially reliable radiocarbon dates from Bull Brook.

The new dates represent the more recent end of the Gainey/Bull Brook phase (Curran 1999; Ellis and Deller 1997; Newby et al. 2005), falling in the later half of the Younger Dryas period. At this time there was a glacial re-advance in northern Maine, in areas of open tundra (Borns et al. 2004), while northeastern Massachusetts was open coniferous/deciduous forest (Newby et al. 2004:150). Different reconstructions of caribou migration behavior and exploitation have been offered (Curran and Grimes 1989; Dincauze 1993; Newby et al. 2005). The maximum low stand of sea level (55 to 60 m below present) occurred approximately 10,500 – 11,000 radiocarbon years ago (Barnhardt et al. 1995). At this time Jeffreys Ledge (now a submerged fishing bank four kilometers east of Bull Brook) would have been a large island extending nearly 40 km into the Gulf of Maine. If the timing and environment are right, this ephemeral island may have been a caribou refuge with a predictable fall migration to the wooded mainland, in the direction of Bull Brook (Fig. 2, inset) (Pelletier and Robinson 2005).

These are among the many avenues of research that remain. The present research was more narrowly focused on identifying archaeological signatures of aggregation at the

Bull Brook site. In contrast to simple clusters that can grow by agglutination and that may defy efforts to identify internal organization, ring-shaped settlements incorporate different aspects of planning. The size of the circle depends on the number of participants when the settlement is planned, which influences the choice of meeting places (Grøn 1991; Yellen 1977:130). Even spacing between loci in the most accurately mapped segments (A and B) also suggest planning and social norms. The almost exclusive focus of specialized biface production and fluting activities on the inner circle establishes an orientation toward the center of the social group, facing those across the circle. At smaller sites, linear segments may be aligned parallel to a terrace edge, with specialized biface production loci facing outward over a lake of distant landscape (McDonald 1968; Ellis and Deller 2000). This is the opposite orientation from that at Bull Brook, yet similar organizational rules may have been operating at different scales.

The interpretation of the loci themselves is an important but sometimes distracting problem. It is important to remember that “house-sized” well-bounded Paleoindian artifact concentrations were discovered at Bull Brook before they were recognized as a typical Northeastern pattern (Curran 1984; Spiess et al 1998). Concentrations of bone within them likely represent surface hearths, with artifacts and bones bioturbated to greater depths. It has also been proposed that Bull Brook may be a winter occupation in the Younger Dryas cold period (Curran and Grimes 1989; Pelletier and Robinson 2005), giving even more incentive for working indoors. That does not mean that all Paleoindian artifact concentrations are habitation loci, but rather that habitation loci with artifacts on the inside are probably one standard variation. It would be very important to be able to designate the loci at Bull Brook as habitation loci because habitations are as close as we will likely get to identifying households. Even with this designation, it may be that the specialized activities that took place on the interior of the circle are communal spaces rather than households. If this were the case, then we could propose that the Bull Brook event may have consisted of at least 29 households (including Locus 14) and perhaps as many as 36 if the specialized interior locations were also lived in. Indeed we present this as a reasonable hypothesis. It is equally important, however, to note that if the Bull Brook loci cannot be demonstrated to be habitation loci, reducing them to generalized activity areas, it does not in any way detract from the conclusion that Bull Brook represents an organized event, because the activities are just as strongly patterned regardless of what they represent.

We emphasize that the designation “organized event” carries with it a number of possible variations. We suggest that the circular settlement pattern itself was an organized affair, but we cannot necessarily reduce it to a single season. Individual loci could have been reoccupied for a small number of years without changing the pattern if done in the context of the original event. One or a few loci could represent isolated fortuitous placements that did not disrupt the overall pattern sufficiently to be detectable. On the other hand if it is accepted that the overall pattern is organized, it was an unusually large or rare event of the kind that may not have been repeated regularly. Our conclusion that Bull Brook represents an organized event includes these caveats.

Things would have been different if archaeologists had known in the 1950s what they suspect now. But as it was, the excavators explicitly recorded data that could be used to reconstruct spatial patterns in the future. The potential value of the site took decades to recognize and it is always more work to do things after the fact. The excavators

recognized differences in activities, but they didn't ferret out more detailed spatial patterning. The simple circle proved to be concentric circles, with inner and outer activities, divided into spatial segments with varying lithic proportions. That these unsuspected patterns survived, with loss of provenience of nearly 1/3 of the assemblage and through multiple episodes of cataloging, is a testament to the vigilance of the avocational archaeologists and to the pronounced nature of the specialized patterns. The specialized activities are not subtle. They occur at other sites. But as Slobodin (1962:61-62) noted among the Gwich'in in the Yukon Territory, some social groupings become more in evidence, or more organized in "large-group" camps. Bull Brook represents the maximum scale of organization, at least at the site level, and it is in such cases that hunter-gather organization is most visible.

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