Glimpses of the Past

Investigating settlement sites of prehistoric humans—stream proximity

— by Garrett Love

Introduction

Problem

Can the locations of sites where archaeological artifacts have been found teach us anything about early humans and their interactions with the environment? In particular, can geographic data be used to determine *which geographic features were important in the selection of settlement sites for prehistoric humans?*

In the same way that a crime scene investigator can sometimes piece together events in the recent past based on available evidence, an archaeologist can make deductions about patterns and events in the lives of humans in the distant past, based on the discovery of *artifacts*—objects or tools created, used, and left behind by those humans. Much can be learned from detailed observations of artifacts at a given archaeological site. There is, however, another level of analysis that can be considered by taking a larger perspective and considering similarities *between* different site locations where similar artifacts have been found. Such analysis not only elucidates how the patterns of prehistoric human behavior may have been influenced by the environment, but with enough information it may even be possible for researchers to identify sites where undiscovered artifacts may exist, marking them for future excavation or preservation.

This lab uses the capabilities of geographic information systems (GIS) to make a preliminary analysis of a set of archaeological site locations and to establish whether locations of particular prehistoric human activities may have been selected based on their proximity to a water source.

Location

Fayetteville, North Carolina

Keywords: archaeology; projectile points; end scrapers; slope; aspect; settlement patterns; chi-square; representative area; mask; ArcGIS Spatial Analyst for Desktop; merge; minimum bounding geometry; aspect; reclassify; environment settings

Time to complete the lab

Two to two and one-half hours

Prerequisites

This lab is intended for upper-class undergraduates who have a familiarity with the manipulation and presentation of point and polygon databases in ArcMap, both through the attribute table and layer properties. Students should also have a fundamental familiarity with statistical analysis.

Data used in this lab

- Point shapefiles of archaeological sites (locations of projectile point and end scraper artifacts)
- USGS digital elevation model (DEM) raster in TIFF format
- Polyline shapefile database of area streams
- Polygon shapefile of 100-meter buffer zones from persistent streams in the area
  - Geographic coordinate system: GCS_North_American_1983
  - Datum: D_North_American_1983
  - Projected coordinate system: NAD_1983_StatePlane_North_Carolina_FIPS_3200
  - Projection: Lambert Conformal Conic

Student activity

Ten thousand years ago, during an age identified by archaeologists as the "Early Archaic" (8000–6000 BC), migrating hunter-gatherer groups of humans would live and hunt in the region that is now central North Carolina. This study, done in the Sandhills region of south-central North Carolina just northwest of Fayetteville, replicates the findings from an analysis of archaeological site locations for two Early Archaic (8000–6000 BC) artifacts, although because of confidentiality concerns, simulated site locations have been provided in lieu of actual site locations. There are two types of artifacts associated with hunting activities that are commonly found in this region. "Projectile points" include spearheads and arrowheads used primarily as the tips of killing projectiles. "End scrapers" are formal tools associated with the processing of animal hides and are used to loosen and remove hair and to soften hides as part of the tanning process.

Archaeological sites are identified by the presence of multiple artifacts and provide evidence of the type of activity that occurred at the site in the past. It is a standard assumption that characteristics of the natural environment have an influence on the choices people make regarding their daily activities. For prehistoric peoples, the choice of location for activities such as

hunting, butchering, preparing hides, and settling would be influenced by such factors as the presence of game, the availability of water, the availability of tool resources such as stone and wood, and the adequacy of shelter. These factors in turn can be related to topographical variables such as elevation, slope, aspect, and distance from persistent river beds.

Some geomorphological processes (glaciation, tectonic activity, seasonal flooding) can result in relatively rapid topographical change and therefore substantial transformation in a 10,000-year time frame. Regions that are not subjected to these processes, however, can have a relatively stable topography (evidenced in part by the existence of preserved archaeological sites) and can sometimes use modern topography as a proxy for earlier conditions.

Projectile points (*left*) and End Scrapers (*right*), courtesy of the Research Laboratories of Archaeology, the University of North Carolina at Chapel Hill.
http://www.rla.unc.edu/archaeonc/.

The US Geological Survey provides information on modern streams and rivers in the United States to the public through the National Hydrography Dataset (http://nhd.usgs.gov/). Seasonal streams were eliminated from the dataset to establish a subset of locations with a longer history, and then a series of buffer zones were generated representing a range of distances "to the nearest stream" (source of water).

In this analysis, you have been provided with coordinate locations of archaeological sites identified by the existence of projectile point and end scraper artifacts, indicating that particular Early Archaic activities once occurred at these specific locations. You will make the assumption that if Early Archaic activities had *no* relationship to water sources, the representation of site locations in each of the stream buffers should be similar to the relative area encompassed within each buffer. For example, if 15 percent of the surface area in the region was within 100 meters of a stream, a "null hypothesis" stating that the archaeological sites are randomly distributed would lead to an *expectation* that roughly 15 percent of the sites would also occur, just by random

chance, within 100 meters of a stream. If the actual *observation* of data sites yields different representation within each stream buffer zone, and the difference is *significant* enough to demonstrate that the distribution was not likely to have been random, you will perhaps be able to draw some basic conclusions about the data.

In this lab, you will

- merge point datasets and establish a representative area using Minimum Bounding Geometry,
- use the Clip tool to establish area fractions from a polygon layer that fall within a clip polygon,
- use the Intersect tool applied to point features to sample data from a polygon layer, and
- apply a chi-square analysis to determine whether archaeological site locations have a statistically significant representation within a given proximity to a water source.

PREPARE YOUR WORKSPACE

You will be working with and generating a number of data files as part of this project, so it will be important to stay organized. If you do not already have a SpatiaLABS project folder, begin by creating one on your computer or storage device (e.g., My Documents\SpatiaLABS).

1 Create a SpatiaLABS folder under your My Documents folder.

2 Create a Data folder under the SpatiaLABS folder.

COLLECT AND EXAMINE DATA

First, you will download and extract data from the data.zip file.

1 Download *GotPdata.zip*.

2 Extract GotPdata.zip to your workspace (e.g., My Documents\SpatiaLABS\Data).

Now you will view the data to confirm extraction before moving on to the analysis.

3 Start ArcCatalog.

4 Examine the Data folder. There should be one raster dataset (*GlimpsesArea*), two point shapefiles (*EndScrSites* and *ProjPtSites*), one polyline dataset (*NHD_streams*), and one polygon dataset (*Per_Stream_Buffers*).

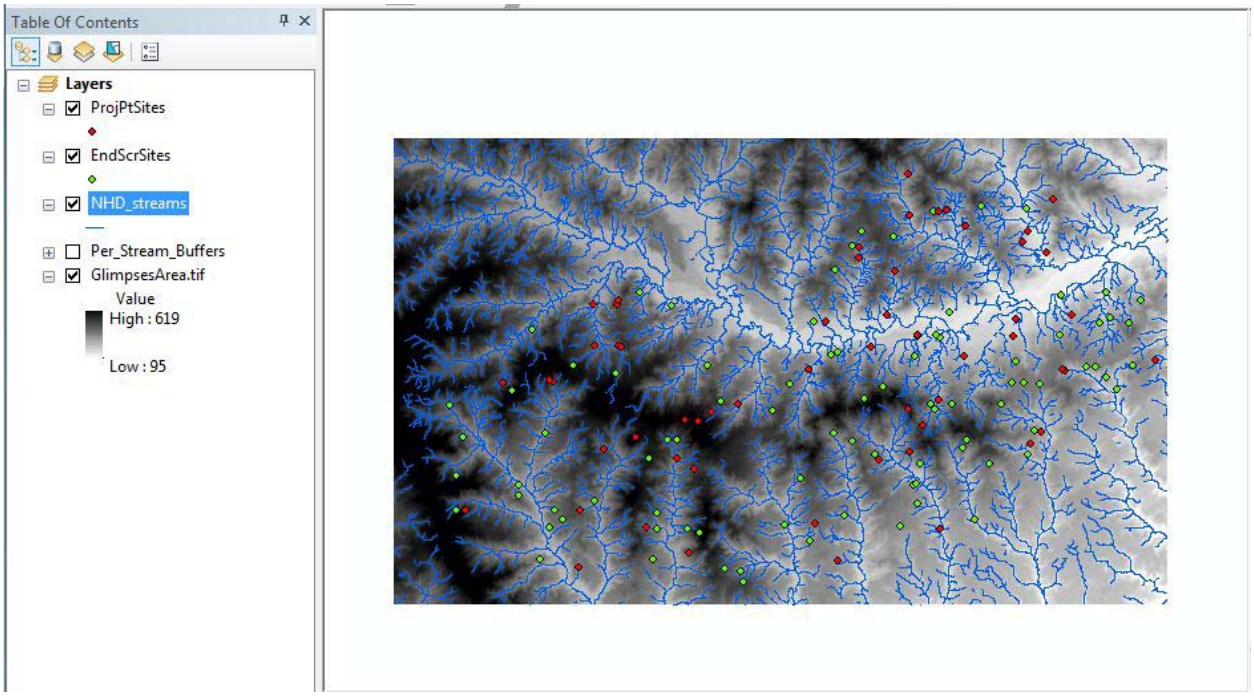
ESTABLISH A REPRESENTATIVE AREA

1 Start ArcMap.

2 Add each of the five datasets as layers.

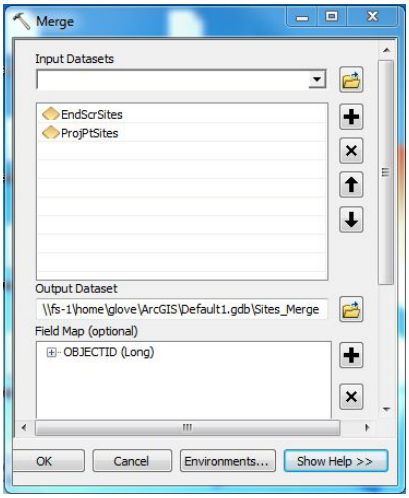
3 Organize and modify the symbology of the layers so that the elevation, stream location, and archaeological site data is visible on one map.

Question 1: *Based on initial visual inspection, do either of the sets of site locations appear to be associated with a particular distance from streams? Which of the two appears to have the greatest association?*



DEFINE THE STUDY AREA

To compare characteristics associated with a set of spatial points to the general characteristics of the surrounding area, it is necessary to first define the boundaries of that area. Many datasets are defined over a rectangular extent, but the boundaries of that rectangle may not be relevant to a particular analysis and may include features that, if included, would confound the analysis (for example, including an area of "ocean" in an analysis of land-based features). You will need to define a polygon that represents the boundaries of a local area *where Early Archaic artifacts have been found*.



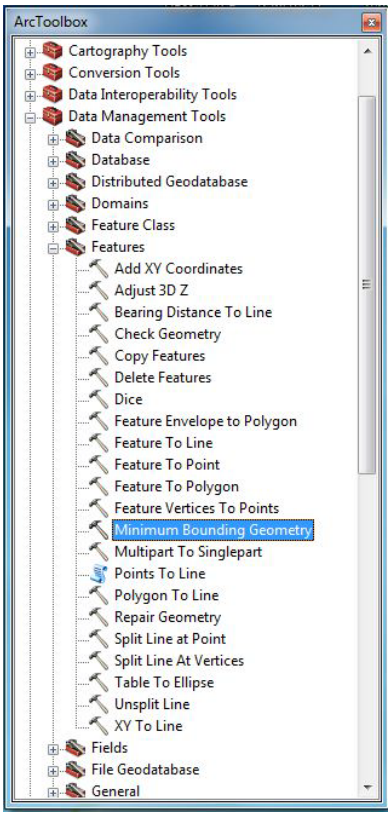
Merge point locations into a single dataset

1 On the main menu, click *Geoprocessing » Merge* to open the *Merge* dialog box.

2 Select both the *ProjPtSites* and *EndScrSites* datasets as *Input Datasets*. Choose an appropriate name (e.g., ***Sites_Merge***) and save location for *Output Dataset*.

Create the representative area polygon

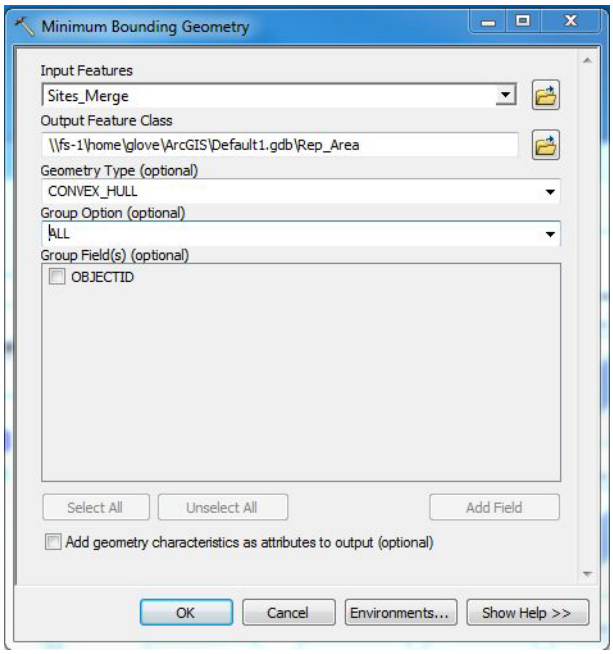
1 Open *ArcToolbox* and activate the *Minimum Bounding Geometry* tool located at *Data Management Tools » Features » Minimum Bounding Geometry*.



2 Your new *Sites_Merge* shapefile of points should be selected for *Input Features*.

3 Choose an appropriate name (e.g., ***Rep_Area***) and save location for *Output Feature Class*.

4 Select *CONVEX_HULL* for *Geometry Type* and *ALL* for *Group Option*.



5 Click *OK* to create a minimum bounding geometry.

Question 2: *What are the other Geometry Type options? Which of these others might be a suitable option for your selection of representative area?*

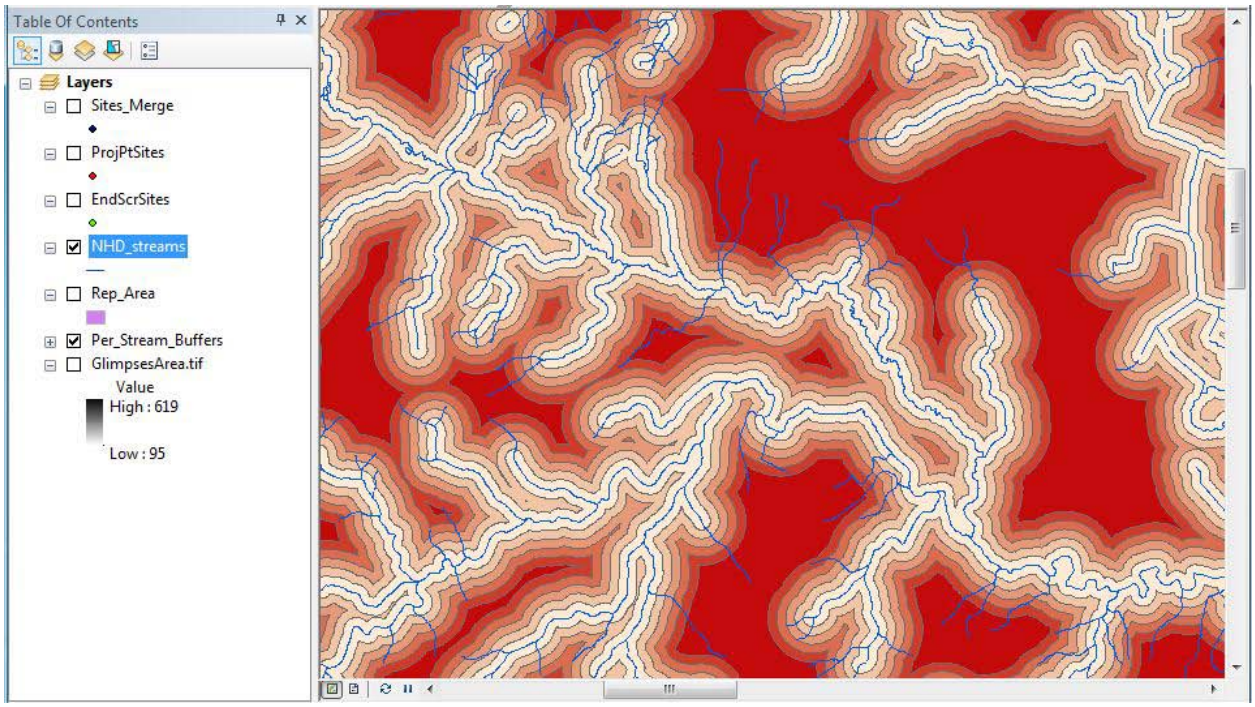
VISUALIZE

1 Organize your layers and adjust the transparency of the representative area ('Rep_Area') layer so it can be visualized along with the elevation, stream location, and archaeological site data. Export a copy of this map for your instructor.

2 You may want to save your map document at this point, if you haven't already done so.

DETERMINE COUNT OF SITES NEAR STREAMS

1 Turn off all layers except the stream layer and display the *Per_Stream_Buffers* layer along with the stream layer. Zoom in on some portion of the data and observe the relationship between these two layers.



Question 3: *How are these two layers related?*

Question 4: *Why do the buffer zones surround only some of the streams?*

Question 5: *How would you generate the buffer zone layer if it were not provided?*

CALCULATE AREA WITHIN EACH BUFFER RANGE

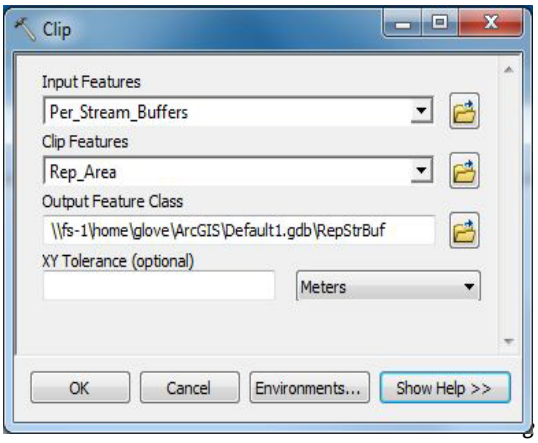
Every part of the representative area can now be classified based on distance from a permanent stream, and the amounts in each classification can be compared based on the area associated with each.

Use vector data to determine area fractions for each buffer zone within the representative area.

1 On the main menu, click *Geoprocessing » Clip* to open the *Clip* dialog box.

2 Select *Per_Stream_Buffers* for *Input Features* and use the representative area polygon for *Clip Features*.

3 Choose an appropriate name (e.g., ***RepStrBuf***) and save location for *Output Feature Class*.



4 Open the attribute table of the new feature class and record the area of each buffer zone in units of 10,000 m^2 in table 1 below.

5 Calculate the fraction of the representative area that falls within each buffer range and record it in table 1 as well.

Table 1. Area fractions

Buffer range (m)	Area (x 10,000 m^2)	Area fraction, A_f
0–100		
100–200		
200–300		
300–400		
400–500		
500+		
Entire		1.00

Question 6: *If 500 raindrops were to fall randomly on the representative area, estimate the number that would land at a distance between 200 and 300 meters from a stream.*

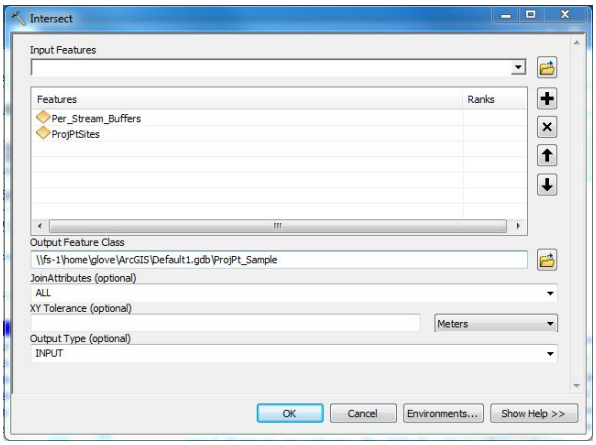
Question 7: *If the archaeological sites with projectile points are randomly distributed in the area, what number would you expect to find in this same 200- to 300-meter buffer zone?*

DETERMINE *OBSERVED* STREAM BUFFER DISTANCES FOR SITE LOCATIONS

Point features can be used to sample associated spatial data from a polygon layer by executing a spatial intersection of the two layers. Use this functionality to determine the buffer zone association of each archaeological site.

1 On the main menu, click *Geoprocessing » Intersect* to open the *Intersect* dialog box.

2 Select *ProjPtSites* and *Per_Stream_Buffers* for *Input Features*. Select an appropriate *Output Feature Class* location and name. Use option *ALL* for *JoinAttributes* and *INPUT* for *Output Type*. Click *OK*.



3 Repeat steps 1 and 2 for the *EndScrSites* locations. Save your map document.

4 View the attribute table of one of the new point feature classes. You should note that each of these points now has a *Buffer* attribute.

5 Use these new datasets to generate a count of Projectile Point Sites and End Scraper Sites associated with each stream buffer level. You can facilitate the count by sorting the data according to the *Buffer* attribute, and then highlighting the rows corresponding with each buffer range category. Record the counts in table 2 below.

Table 2. Observed site counts

Buffer range (m)	Proj point count (PP)	End scraper count (ES)
0–100		
100–200		
200–300		
300–400		
400–500		
500+		
Entire		

Question 8: *What ArcGIS tool could you use to determine the above information using the sites point layer and the stream polyline layer, but not the buffer zone polygons?*

CHI-SQUARE ANALYSIS

In any probabilistic system, it is always theoretically *possible* for two characteristics to align in such a way that they appear to be associated, even if they are independent and there is no basis for a relationship. The goal of a statistical analysis is to consider the possibilities associated with random chance, to quantify these random elements in terms of probability, and then to establish a level of *confidence* in the observed relationship by demonstrating that the pattern would be an *improbable* result in an independent, unrelated system.

The next step in the analysis of the archaeological sites is to establish a test statistic that quantifies the difference between characteristics *observed* at the actual sites and what would be *expected* if the same number of sites were randomly distributed in the representative area. Pearson's chi-square statistic compares the frequencies for observed and expected occurrences distributed over *n* categories (*n* = 6, in this case). The probabilities associated with the statistic can be approximated by the chi-square distribution with *n* - 1 (or five) degrees of freedom (df).

CALCULATE CUMULATIVE CHI-SQUARE STATISTIC FOR EACH ARTIFACT TYPE

1 Copy the projectile point counts from table 2 and record as *Observed Freq* (observed frequency) values in table 3 below. Sum to verify the total number of projectile point sites (PP_{tot}).

Table 3. Projectile point chi-squared

Buffer range (m)	Observed freq PP	Expected freq $A_f * PP_{tot}$	Test statistic $(Obs-Exp)^2 / Exp$
0–100			
100–200			
200–300			
300–400			
400–500			
500+			
(Sum)			

2 Multiply each area fraction from table 1 by the projectile point total PP_{tot} and record as *Expected Freq* (expected frequency) values. Round to the nearest tenth and sum to verify an equal total.

3 For each category, calculate the corresponding *Test Statistic* contribution and sum for the cumulative chi-squared statistic.

4 Repeat steps 1 to 3 for end scraper data and record in table 4.

Table 4. End scraper chi-squared

Buffer range (m)	Observed freq ES	Expected freq $A_f * ES_{tot}$	Test statistic $(Obs-Exp)^2 / Exp$
0–100			
100–200			
200–300			
300–400			
400–500			
500+			
(Sum)			

Determine probability associated with cumulative chi-square statistic

1 Find a table of chi-square values in the back of a statistics textbook or on the Internet. These tables generally display critical values of the chi-square distribution that correspond to particular "significant" probabilities (e.g., 10%, 5%, 1%, 0.5%, 0.1%), usually organized by column in the table. Each row in the table corresponds to the "degrees of freedom" parameter of the distribution.

2 Consider, as an example, a chi-square value of 11.0 in a system with four degrees of freedom. From most tables, you should be able to find a chi-square value of 9.49 corresponding to 4 df and a significance level of 0.05 (5%) and a chi-square value of 13.28 corresponding to 4 df and a significance level of 0.01 (1%).

3 The value of 11.0 is greater than the 5% critical value of 9.49, meaning that "the observed data was among the possible combinations that would be observed in a completely random system only 5% of the time." There is less than 5% *significance* in the hypothesis that the observed data is random and 95% *confidence* in stating that "the data was *not* randomly generated" (possibly leading to the conclusion that the data demonstrated a statistically relevant relationship).

4 Use a table and determine whether either or both of the chi-square statistics demonstrate a significance level of 10%.

5 Results from a statistical analysis will often include a *p-value*, which is the probability directly associated with the test statistic. The chi-square value of 11.0 is roughly halfway between the critical values (9.49 and 13.28), so a similarly rough estimate for the associated p-value might be 3% (halfway between 5% and 1%). The calculated p-value is 0.0266, which can be interpreted as "a random system would generate a larger value of the test statistic (representing a greater deviation from the 'expected') only 2.66% of the time."

6 Using a chi-square calculator from the Internet or using a chi distribution function in a spreadsheet, find the p-values for projectile points and for end scrapers.

Question 9: *Do the locations of projectile point and/or end scraper archaeological sites demonstrate a relationship to distance from a stream? Write a clear conclusion, citing your significance level and p-values.*

Question 10: *Which buffer ranges contributed most to the chi-square statistic? Were these buffer ranges over- or underrepresented? What additional insight does this give you about the site locations?*

Question 11: *What factors might lead early people to choose locations near a stream for their daily activities?*

Question 12: *What factors might lead early people to choose locations away from a stream for their daily activities?*

Question 13: *Which artifact type would more likely be associated with actual settlements, projectile points or end scrapers?*

Question 14: *How could this analysis be improved?*

Question 15: *Was proximity to a stream an important geographic feature in the selection of settlement sites for prehistoric humans?*

References

National Hydrography Dataset
http://nhd.usgs.gov/

University of North Carolina—Research Laboratories of Archaeology of NC
http://www.rla.unc.edu/archaeonc/

Nanney, M. M. "Investigating Environmental Variables Influencing Early Archaic Archaeological Site Locations on Ft. Bragg Military Reservation, North Carolina: A GIS Approach to the Study of Prehistoric Human-Environmental Interaction." MS thesis, North Carolina Central University, Durham, NC, 2011.

Bona, L. 1994. "Volume 3: Methodological Concerns. A Report Prepared for the Ontario Ministry of Natural Resources." Lakehead University: Center for Archaeological Resource Prediction. Thunder Bay, Ontario.

Butzer, K. 2008. "Challenges for a Cross-disciplinary Geoarchaeology: The Intersection Between Environmental History and Geomorphology." *Geomorphology* 101: 402–11.

Gibbon, G. Updated 2005. "Archaeological Predictive Modeling: An Overview." *The Minnesota Model*. http://www.mnmodel.dot.state.mn.us.

Irwin, J., and W. Culpepper. 2000. "Prehistoric Land Use in the North Carolina Sandhills." 57th Annual Meeting Southeastern Archaeological Conference (SEAC) 2000.

Kvamme, K. 1990. "One-Sample Tests in Regional Archaeological Analysis: New Possibilities, Through Computer Technology." *American Antiquity* 55 (2): 367–81.

Leigh, D. 2008. "Late Quaternary Climates and River Channels of the Atlantic Coastal Plain, Southeastern USA." *Geomorphology* 101: 90–108.

Moore, C., and J. Irwin. 2002. "Pine Barrens and Possum's Rations: Early Archaic Settlement in the Sandhills." Southeastern Archaeological Conference (SEAC) 2002.

Weisstein, E. n.d. "Chi-Squared Test." From MathWorld—a Wolfram web resource.
http://mathworld.wolfram.com/Chi-SquaredTest.html.

Submit your work

Submit your answers to questions 1 through 15, along with the data tables 1 through 4, to your instructor.

Credits

Images

Projectile Points and End Scrapers, courtesy of the Research Laboratories of Archaeology, the University of North Carolina at Chapel Hill.

Sources of supplied data

GotPdata\EndScrSites.shp, created by author.

GotPdata\GlimpsesArea.tif, image courtesy of US Geological Survey, Department of the Interior/USGS.

GotPdata\NHD_streams.shp, courtesy of National Hydrography Dataset, **nhd.usgs.gov.**

GotPdata\Per_Stream_Buffers.shp, created by author.

GotPdata\ProjPtSites.shp, created by author.

Instructor resources

This lab takes a practical social science problem and integrates the use of multiple data manipulation techniques with the application of a standard statistical technique (chi-square analysis). It should be an appropriate midsemester example for an undergraduate geospatial statistics course.

Analysis and visualization tools

The lab is written with the presumption that students will be using ArcGIS 10 with an ArcGIS for Desktop Advanced license.

Lesson notes and comments

ESTABLISH A REPRESENTATIVE AREA

As mentioned in the introduction, because of confidentiality concerns, simulated site locations have been provided in lieu of actual site locations. The simulated sites were chosen to maintain the original extent of the data and to approximately maintain the stream proximity distribution observed in the original data. This unfortunately means that additional analysis using other characteristics will not be possible with these site locations.

The elevation raster data in the DEM is not really a necessary piece of this lab but is important for the analysis in the companion lab, *Glimpses of the Past: Investigating settlement sites of prehistoric humans—slope and aspect*, which focuses on surface aspect. In this example, it provides some visual context for the stream and site location data.

Question 1: *Based on initial visual inspection, do either of the sets of site locations appear to be associated with a particular distance from streams? Which of the two appears to have the greatest association?*

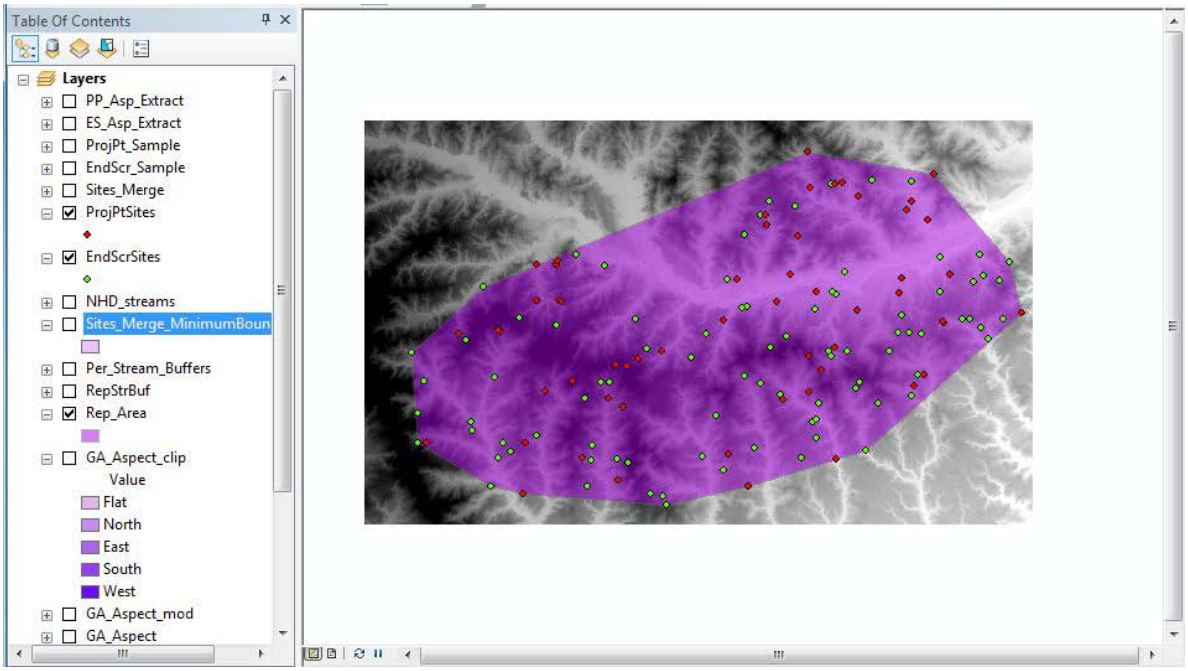
Answer: Answers will vary. In a visualization of the full region (see the lab graphic), everything seems "close" to one of the streams, which occupy much of the visualization at this scale. Students may note that a few of the projectile sites, most notably in the left center of the study area, are located at the highest elevations, conspicuously distant from a stream bed.

Define the Study Area

Question 2: *What are the other Geometry Type options? Which of these others might be a suitable option for your selection of representative area?*

Answer: The other *Geometry Type* options are *RECTANGLE_BY_AREA*, *RECTANGLE_BY_WIDTH*, *CIRCLE,* and *ENVELOPE*. Reference the ArcGIS 10 *Help* for pictorial illustrations. Arguments can be made for any of the options, but only *CONVEX_HULL* and *ENVELOPE* stay within the bounds of the available data. *CONVEX_HULL*, *ENVELOPE,* and *CIRCLE* all require an ArcGIS for Desktop Advanced license to use.

Visualize



Representative area polygon generated from *Minimum Bounding Geometry » Convex Hull*.

Determine Count of Sites Near Streams

Question 3: *How are these two layers related?*

Answer: The buffer polygons in the polygon layer represent distance zones located at 100 m intervals from the nearest stream polylines, although only for a subset of the NHD streams.

Question 4: *Why do the buffer zones surround only some of the streams?*

Answer: Observant students may discover from the stream attribute table that the streams are differentiated by a field *FCode*, which has three distinct values. Shallow/seasonal streams with FCode 46003 were not included in the generation of the buffer polygons. Streams with FCodes 46006 and 55800 were included. As mentioned in the student activity introduction, seasonal streams were eliminated from the dataset to establish a subset of locations with a longer history.

Question 5: *How would you generate the buffer zone layer if it were not provided?*

Answer: There is a *Multiple Ring Buffer* tool located in the *ArcToolbox » Analysis Tools » Proximity* toolbox. It would need to be applied to a selection of the streams with FCode <> 46003. Note that it is a time-intensive process, which is why the already processed polygon layer is provided.

CALCULATE AREA WITHIN EACH BUFFER RANGE

Below is the attribute table for the clipped buffer polygon layer *RepStrBuf*. Note that the *Buffer* field represents the high end of the distance range, with the exception of buffer value 600, which includes all distances greater than 500 meters. Answers for the table 1 area fractions follow.

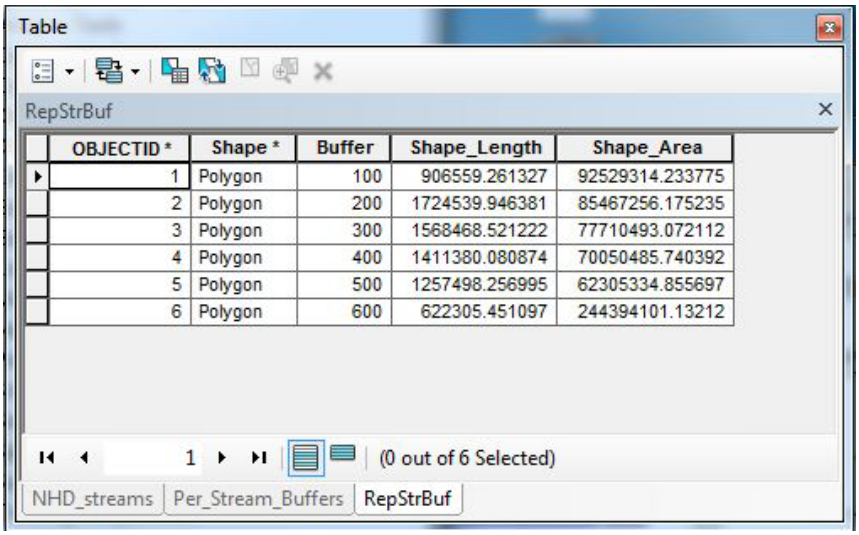


Table 1. Area fractions

Buffer range (m)	Area (x 10,000 m^2)	Area fraction, A_f
0–100	9253	0.146
100–200	8547	0.135
200–300	7771	0.123
300–400	7005	0.111
400–500	6231	0.099
500+	24,439	0.386
Entire	63,246	1.000

Question 6: *If 500 raindrops were to fall randomly on the representative area, estimate the number that would land at a distance between 200 and 300 meters from a stream.*

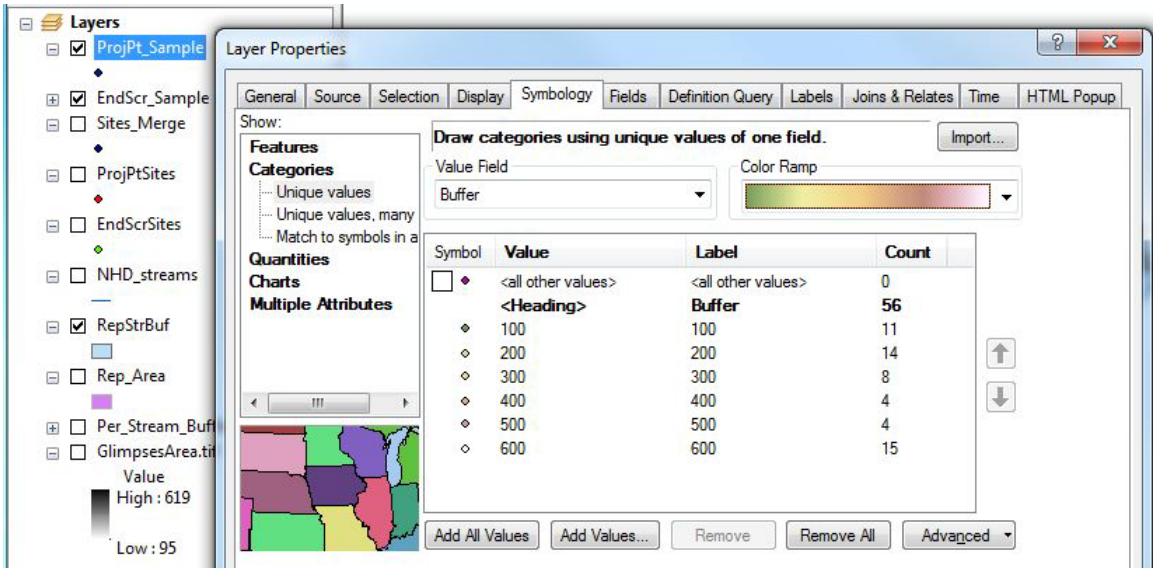
Answer: 500 * .123 = 62

Question 7: *If the archaeological sites with projectile points are randomly distributed in the area, what number would you expect to find in this same 200- to 300-meter buffer zone?*

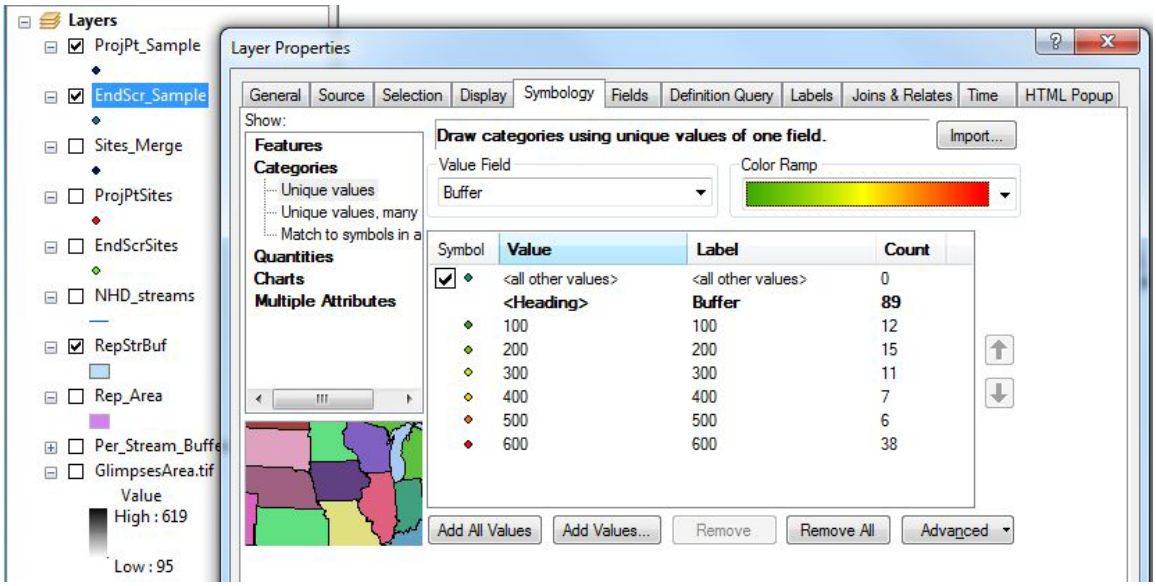
Answer: 56 * .123 = 7

DETERMINE OBSERVED STREAM BUFFER DISTANCES FOR SITE LOCATIONS

Counts for each buffer zone category can be easily generated on the *Symbology* tab under *Layer Properties*, here showing *Categories* using *Unique values* and selecting *Buffer* for *Value Field*.



Projectile point category counts by 100 m buffer zones.



End scraper category counts by 100 m buffer zones.

Table 2. Observed site counts

Buffer range (m)	Proj point count (PP)	End scraper count (ES)
0–100	11	12
100–200	14	15
200–300	8	11
300–400	4	7
400–500	4	6
500+	15	38
Entire	56	89

Question 8: *What ArcGIS tool could you use to determine the above information using the sites point layer and the stream polyline layer, but not the buffer zone polygons?*

Answer: The *Near* tool (*ArcToolbox » Analysis Tools » Proximity » Near*) applied with the points as input features and an appropriate selection of streams as the near features would append a "near distance" field to the points layer that could then be agglomerated into buffer zones. This would actually be a better method if there were an interest in repeating the analysis for different buffer ranges.

CHI-SQUARE ANALYSIS

CALCULATE CUMULATIVE CHI-SQUARE STATISTIC FOR EACH ARTIFACT TYPE

Table 3. Projectile point chi-squared

Buffer range (m)	Observed freq PP	Expected freq A_f * PP_{tot}	Test statistic $(Obs-Exp)^2$ / Exp
0–100	11	8.2	0.96
100–200	14	7.6	5.47
200–300	8	6.9	0.18
300–400	4	6.2	0.78
400–500	4	5.5	0.42
500+	15	21.6	2.04
(Sum)	56	56	9.85

Table 4. End scraper chi-squared

Buffer Range (m)	Observed freq ES	Expected freq $A_f * ES_{tot}$	Test statistic $(Obs-Exp)^2 / Exp$
0–100	12	13.0	0.08
100–200	15	12.0	0.73
200–300	11	10.9	0.00
300–400	7	9.9	0.83
400–500	6	8.8	0.87
500+	38	34.4	0.38
(Sum)	89	89	2.90

DETERMINE PROBABILITY ASSOCIATED WITH CUMULATIVE CHI-SQUARE STATISTIC

Projectile points: p = .080 (significance < 10%) End Scrapers: p = .716

Question 9: *Do the locations of projectile point and/or end scraper archaeological sites demonstrate a relationship to distance from a stream? Write a clear conclusion, citing your significance level and p-values.*

Answer: Although the statistical evidence is not particularly strong (only 10% significance, where 5% or 1% would be much stronger), there is reason to believe that projectile point locations are not randomly distributed, but instead exhibit some relationship to the distance from stream beds (p = 0.08). However, there is not sufficient evidence to make a similar claim about end scraper site locations (p = .72).

Question 10: *Which buffer ranges contributed most to the chi-square statistic? Were these buffer ranges over- or underrepresented? What additional insight does this give you about the site locations?*

Answer: Projectile point locations were overrepresented in the 100-meter to 200- meter buffer range and underrepresented in the range above 500 meters. This would indicate some preference level for the 100-meter to 200-meter range that may require further justification and study.

Differences in representation in the end scraper locations are not large enough to draw any conclusions.

Question 11: *What factors might lead early people to choose locations near a stream for their daily activities?*

Answer: People need water for their own daily consumption and for use in cleaning and manufacturing (pottery, sharpening of tools, and so on). Game and other life will also be located in areas accessible to a water source, as will particular types of food and resource-supplying vegetation. Flowing water can also be used for removal of wastes.

Question 12: *What factors might lead early people to choose locations away from a stream for their daily activities?*

Answer: Wet areas harbor insects and other breeding pests, and water draws predators as well as game. Steep stream banks are not always suitable for habitation, although more level areas in close proximity might be subject to flooding.

Question 13: *Which artifact type would more likely be associated with actual settlements, projectile points or end scrapers?*

Answer: Answers will vary. Both artifact types would be kept at settlements but used elsewhere. Projectile points might be left behind at hunting grounds and often served a dual purpose as cutting knives. Tanning is a messy and dirty process—scraping and other activities associated with tanning may have occurred at sites away from settlements.

Question 14: *How could this analysis be improved?*

Answer: Securing data that could identify prehistoric water sources (as opposed to modern ones) should improve the results if there is truly a relationship. Additional details about each site (other artifacts found, other characteristics) might lend additional insight that could categorize finds with more detail. Additional data from similar regions could strengthen the analysis as well.

Question 15: *Was proximity to a stream an important geographic feature in the selection of settlement sites for prehistoric humans?*

Answer: Answers will vary, depending on how students interpret the 10% significance and whether they believe projectile points (which demonstrated a potential relationship) or end scrapers (which did not) are more strongly associated with settlement sites.