SwitchBack: A Geographic Information System (GIS) Model of Past Human Movement Across a Northwest Wyoming Landscape

Courtney Hurst [1,2,3], Peter Barry[1], Chris Kinneer[2], Lawrence Todd[2]

Colorado State University Fort Collins Colorado 80524

Forestry, Rangeland, Watershed Stewardship Department (1), Department of Anthropology (2), Graduate Degree Program in Ecology (3)

Contact Information: Courtney Hurst damdigr@lamar.colostate.edu

Introduction and Background

Predictive Modeling in Archaeology

In *Quantifying the Present and Predicting the Past,* Kohler defines archaeological predictive models as a "simplified set of testable hypotheses based…on empirical correlations, which at a minimum attempts to predict the loci of past human activities resulting in the deposition of artifacts or alteration of the landscape." Inductive reasoning of these predictive models uses specific environmental composition of the archaeological landscape to create the model (Wandsnider 1998:90). GIS technology has already been utilized in archaeological predictive modeling (Allen et al. 1990; Judge and Sebastian 1988; Watkins 2000).

SwitchBack

Switchback was developed using a set of rules for acceptable trail gradients. In developing the program this way it "forces" it to consider grades greater than the least grade. Grade is analyzed in three directions; 45° left and right of the cardinal direction of interest and in the direction of interest (Figure 2). SwitchBack analyzes the grade diagonally across three raster cells at 45° to the user-specified cardinal axis, and the three cells in the straight ahead direction; compares the three grades, and chooses the lesser grade as optimum. When grades are equal in all directions, the program continues in the previous direction for a number of cells determined by the mean grade. The program then assigns a grade value of 1 thru 14 to the chosen corridor on a congruent raster map for a distance of one to three cells, depending on the grade of the corridor. The variable distance "walked" during each iteration allows for longer sections across steeper grades. This process is repeated until the end of the DEM is reached in the cardinal direction (Figures 1).

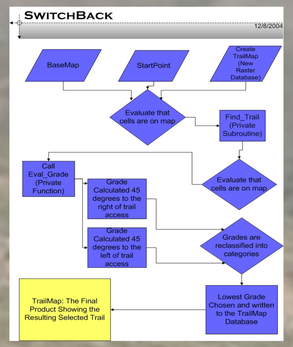

Figure 1: SwitchBack Program Flowchart.

Figure 2: SwitchBack User-Interface.

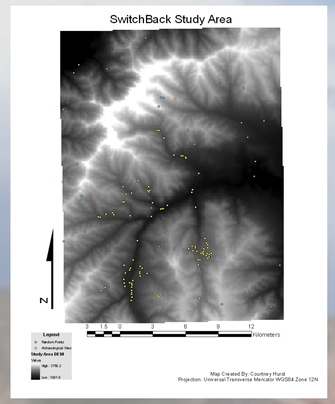

Figure 3: SwitchBack Study Area. The spatial arrangement of archaeological sites and random points

Field crew investigating a SwitchBack trail.

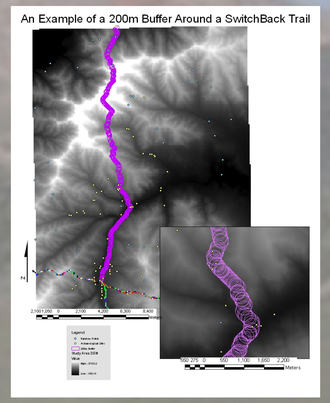

Figure 4: An example of a 200m buffer of a SwitchBack Trail started from an archaeological site.

Methods

Study Area DEM

The study area Digital Elevation Model (DEM) served as the raster value source for the SwitchBack program. Using ArcGIS 9.0, the four DEM's that constitute the study area were "sewn" together using Spatial Analyst's raster calculator *mosaic* function. The study area DEM was then converted into ASCII file format.

Archaeological Site Start Points

Ninety-six archaeological site locations were imported into ArcGIS 9.0 from the GRSLE Excel database file after conversion to a dBase IV (DBF IV) file format. Selecting each site individually, the point location of the site was converted to a raster grid format using the Spatial Analyst *feature to raster* operation. Each of these files were then converted into ASCII format.

Random Start Points

The four bounding UTM coordinates of the study area DEM were determined, and the values of these coordinates were used as the limits for the random UTM Northings and Eastings. The random numbers were generated using Microsoft Excel's random number generator. Thirty random points were obtained through the following equation: RAND()*(b-a)+a. Once the Excel file was created, the file was imported into ArcGIS 9.0, and the random points rasterized and converted to ASCII file format.

Trail Generation and Analysis

Thirty archaeological sites were chosen randomly using the statistical program SPSS. These sites and the random points were then used as a start points for trail generation in each of the four directions (Figures 2 and 3). Once the trails were generated, each trail was buffered at a distance of 200 meters. A count was made of the number of sites and random points within 200m of each individual trail (Figure 4).

Sites				
	North-South	East-West	South-North	West-East
Archaeological Start Points	62	83	169	73
Random Start Points	64	46	21	39
Random Points				
	North-South	East-West	South-North	West-East
Archaeological Start Points	6	6	5	20
Random Points	4	10	21	12

Table 1: The Number of Archaeological Sites and Random Points within 200m of SwitchBack Trails by Direction and Starting Point.

Field crew enjoying a break at the end of a SwitchBack Trail.

Results

In three of the four directions, trails started from archaeological sites (AT) encountered more archaeological sites than the trails initiated from random points (RT). The number of archaeological sites encountered by AT trails in the South-North direction was the greatest of any direction (Table 1). By comparison only 21 archaeological sites were encountered in this direction from trails begun from random points (Figure 5). Nearly twice the number of archaeological sites were within 200m of the East-West and West-East trails initiated from AT points than those begun from RT points (Table 1 and Figure 5).

In the East-West and South-North directions, RT trails encountered more random points within 200m of the trails than AT trails (Table 1 and Figure 6). In the South-North direction, approximately four times the number of random points were within 200m of RT trails than AT trails. In the East-West direction nearly twice the number of random points were within 200m of trails initiated from RT points (Table 1 and Figure 6).

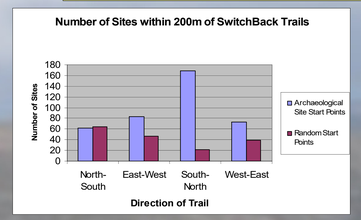

Figure 5: Number of Sites Within 200m of SwitchBack Trails

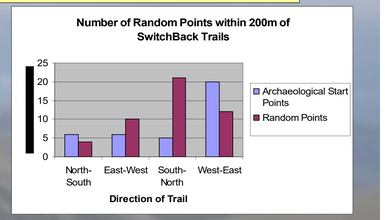

Figure 6: Number of Random Points Within 200m of SwitchBack Trails

Discussion

Human movement is assumed to be non-random, but rather directed by external and internal variables. This study was an initial evaluation of the ability of the SwitchBack program to model human movement based on landscape gradient. The proxy for human movement in this experiment was the number of archaeological sites encountered within 200m of the SwitchBack trails. In particular, the South-North direction was of interest because it covered more of the study area than the other directions. This was due to the spatial clustering of sites in the southern portion of the study area (Figure 3). The trails in this direction had the potential to encounter sites in the cluster as well as those in the northern portion of the study area. In the South-North direction AT trails encountered the most archaeological sites of any direction, whereas the RT trails encountered least number of archaeological sites of any direction. This result and the overall results indicate the ability of SwitchBack to predict human movement when known archaeological sites are used as start points and the variable of landscape gradient is considered. If SwitchBack was not able to model some aspect of human movement and gradient was not an important variable to movement patterns, then the results of the AT trails and RT trails would be expected to be similar.

Future Directions

Future Experiments of the SwitchBack Program include:

- Determine the number of sites of the same time period linked together by SwitchBack trails
- Create corridors of SwitchBack trails within the landscape and survey them
- Compare the site density along trail corridors as compared with the surrounding area
- Determine if there multi-component sites along the trail corridors and if they occur in a higher density than in the surrounding area
- Compare SwitchBack trails with GPS data of modern day human movement across the same landscape

References

Allen, K.M.S., S.W Green, E.B.W Zubrow, editors
1990 *Interpreting Space: GIS and Technology.* Taylor and Francis, England

Judge, W.J. and L. Sebastian
1988 *Quantifying the Present and Predicting the Past: Theory, Method, and Application of Archaeological Predictive Modeling.* United States Department of the Interior, Bureau of Land Management, Denver, Colorado.

Kohler, T.A.
1988 Predictive Locational Modeling: History and Practice. In *Quantifying the Present and Predicting the Past,* edited by W.J. Judge and L.Sebastian, pp. 19-53. United States Department of the Interior, Bureau of Land Management, Denver, Colorado.

Wandsnider, L.
1998 Regional Scale Processes and Archaeological Landscape Units. In *Archaeology: Measuring Time, Space and Material,* edited by A.F Ramenofsky and A. Steffen, pp. 87-103. University of Utah Press, Salt Lake City, Utah.

Watkins, R.
2000 *GIS Predictive Models, The Siteless Approach, and Ground Stone: A Test Case from the Uinta Mountains, Utah.* Master's Thesis, Department of Anthropology, University of Wyoming

63rd Annual Plains Anthropological Conference 2005 Edmonton, Canada