Assessing Contemporary Human Activity at Sites in the Anasazi Archeological District, San Juan National Forest: A Quantitative Approach

Ralph J. Hartley
National Park Service, rhartley4@unl.edu

Anne M. Wolley Vawser
Midwest Archeological Center, anne_vawser@nps.gov

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Introduction

The rate at which a place of prehistoric activity incurs change to its material and spatial integrity is enhanced by modern human activities. Change due to processes of the non-human environment can be monitored, measured, and to some extent, made predictable. Use of a place of prehistoric activity by modern humans can, in many cases, alter if not destroy remains that have been assigned public value. It is the assigned value to some prehistoric material items that contributes to the probability of non-research oriented digging for the purpose of acquiring artifacts, often called "looting" or "pot-hunting". Procuring these items for a market that fluctuates through time and geographically has been a phenomenon in the Four Corners area of the northern Colorado Plateau for over a century. Sites with architectural remains are those most commonly looted. Predicting, however, what particular sites, under what social and economic conditions have been or will be looted is sometimes difficult. Archaeologists have invested considerable effort in categorizing prehistoric sites in this area based on architectural or situational variables for the purpose of deriving functional generalizations about use of the place (Schlanger and Orcutt 1986). It is likely these same fundamental surface features and characteristics of a site help determine its vulnerability to looting.

For over ten years, more than 1600 archaeological sites were recorded along an approximately 15km length of the Dolores River valley in southwest Colorado in preparation for the river's impoundment as McPhee Reservoir and associated projects. The Dolores Archaeological Program (DAP 1978-1985) resulted in the subsurface testing or excavation of 101 of these sites. This area, currently listed on the National Register of Historic Places as the Anasazi Archaeological District, is managed by the San Juan National Forest.

Change to the landscape surrounding the reservoir has been extensive since the late 1970s. The increase in human activities in this area has potentially increased the probability of places of prehistoric activity being altered either as a function of their location on the newly sculpted landscape or by the nature of assumed artifactual material embedded in the site.

In June of 2003 thirty-two sites were relocated, mapped with a Global Positioning System (GPS) and information concerning their condition recorded (Figure 1). These sites were chosen from a list of 56, designated by the USFS under three priority categories relative to their on-going or potential contemporary human impact. The Anasazi Archaeological District constitutes an ideal environment in which to study the effects of diverse contemporary human activities on prehistoric sites that, in addition to being highly dense, vary greatly in the type of material remains and site morphology readily observable to modern visitors.

The purpose of this study is to: (I) assess whether associations exist between a set of characteristics of a prehistoric site observable on the ground surface and evidence of modern human activities at that place; (II) ascertain how evidence of subsurface "looting" varies with characteristics of the site that reflect varied prehistoric activity; and (III) assess the vulnerability of sites to contemporary human activities during exposure after periods of inundation.

Approach and Method

Analyses of data compiled from observations made between 1972 and 2003 at 29 of the 32 archaeological sites located were conducted with exploratory procedures that are amenable to establishing predictions susceptible to being evaluated and revised with additional data collection. Three sites (5MT5072; 4564; and 5071) were eliminated from quantitative analyses

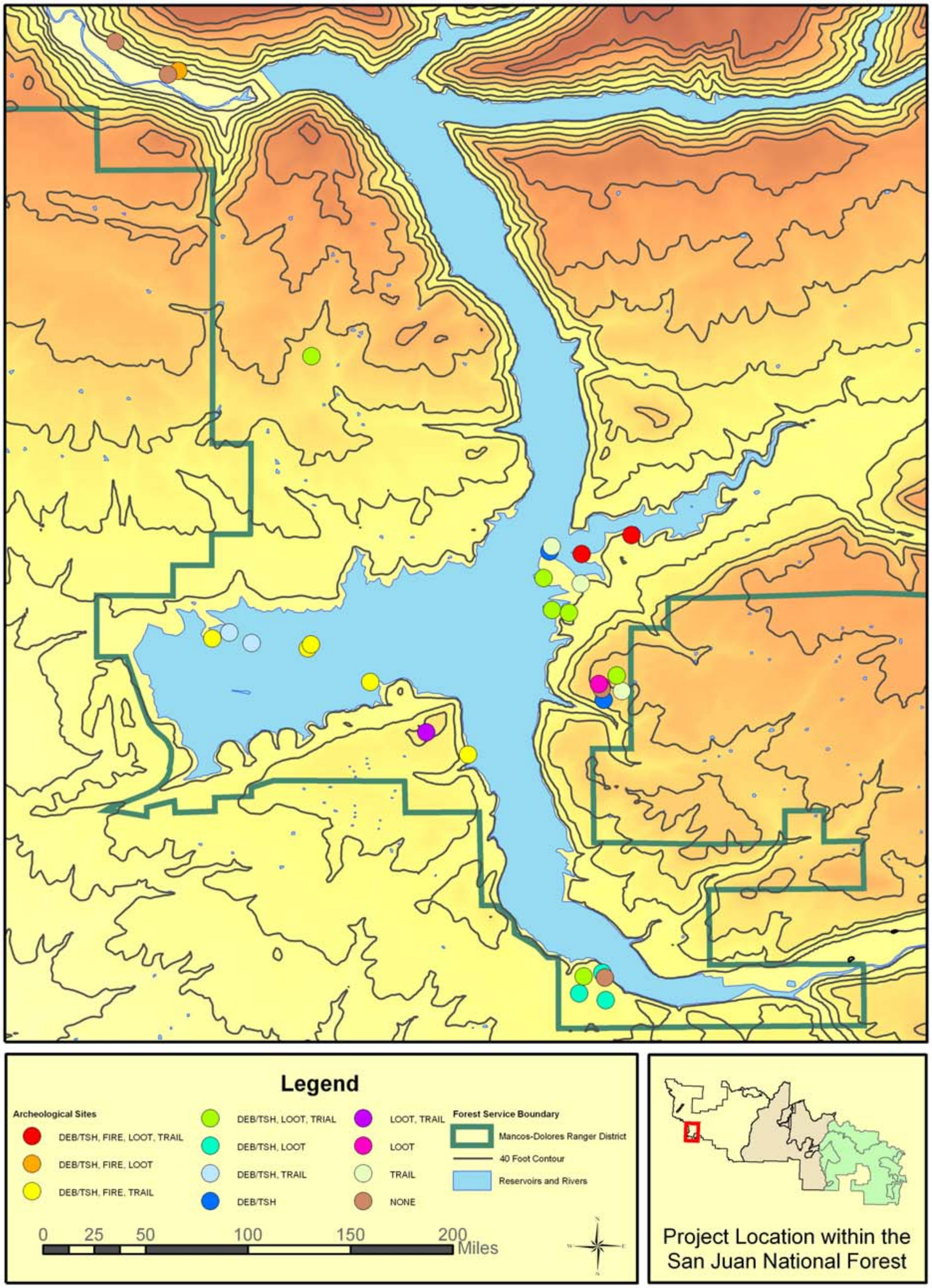

Figure 1. Overview of the McPhee Reservoir area and the Anasazi Archeological District. Sites examined are color coded by the types of impacts observed.

due to the nature of their historic non-Native American occupation and use. This small data set was subjected to what Carr (1985:30-34; 1987:219-224) has called constrained exploratory data analysis (Table 1). That is, specific behavioral phenomena of interest in the realm of contemporary adverse impact to the integrity of the archaeological remains frame assumptions that underlie the search for patterning. Although the analytic procedures employed may make results appear superfluous the goal of these analyses is to construct testable predictions oriented toward gaining insight into where and how contemporary visitors use prehistoric sites in the environment resulting from and surrounding McPhee Reservoir. Moreover it is suggested that the analytic framework pursued here can be used with expanded data and with refined categorical variables.

Table 1. Frequency of modern activities at a site by prehistoric features.

	CHARACTERISTICS				
ACTIVITY	RM	RS	PS	AS	RSH
DEB/TSH	13	4	8	15	2
FIRE	4	2	2	4	1
LOOT	14	4	8	14	1
TRAIL	14	5	6	16	0

Two sets of categorical variables are used in these analyses. Units of analysis are binary. Evidence of human activity at a site in the contemporary or recent historic period was categorized as:

DEB/TSH – Miscellaneous debris and trash resulting from human activity in proximity of prehistoric features or remains (Figure 2).

FIRE – The remains of fire hearths presumed to having been used during brief visits to the site (Figure 3).

LOOT – Pits hand dug in the site by non-archaeologists for the purpose of acquiring artifacts (Figure 4).

TRAIL – Foot trails or two-track roads used by four-wheel drive or ATV vehicles within a site boundary (Figure 5).

The “Dolores Archaeological Program Site Form” (1982) on which archaeological sites were initially recorded, or in some cases re-recorded, during pedestrian survey include a “Site Type” general descriptive checklist (Orcutt and Goulding 1986). Each site recorded was described as being characterized with one or more of the following five descriptors:

Figure 2. Debris and trash are visible (left) at this campsite near a historic dugout (5MT4564). Note the use of beach areas exposed by low water in the background.

Figure 3. Recent campfires were evident at many of the sites around the recreation area (5MT2320).

Figure 4. Evidence of looting at sites in the form of looters pits (left) and trash such as this shovel (5MT4450).

Figure 5. Several sites were impacted by off road vehicle use as evidenced by tracks or vegetation damage (5MT2204).

RM – Rubble Mound
RS – Rubble Scatter
PS – Pitstructures
AS – Artifact Scatter
RSH – Rockshelter (Figure 6)

An additional category, "Other", was available to field recorders but not applicable to analyses used in this study.

Additionally, evidence of human activity was observed in relation to rates of inundation/exposure for sites within the high water line of the McPhee Reservoir. Elevations of relocated sites visited at low water were determined by evaluating several data sources. The GPS unit used to record site locations and features (Trimble Pathfinder Power Pro), while providing horizontal accuracy of plus or minus 50 centimeters, provides much less vertical accuracy, so the GPS elevation along could not be used to determine site elevations. However, by using the horizontal accuracy of the GPS data to plot the sites a fairly accurate elevation was determined. The current Digital Elevation Model (DEM) data represents the pool level rather than the pre-reservoir topography. Ten foot contour maps from the pre-reservoir period of 1984 were obtained from the Bureau of Reclamation and were digitized and used to create an elevation model of what is current the lake bottom. The site locations were also compared to the current Digital Raster Graphic (DRG) which is the georeferenced topographic map of the area. This map shows some elevation data for the lake bottom as well. All of these measurements were compared to determine the site elevations. Measurements of annual high and low pool elevations for the McPhee Reservoir were obtained from the US Bureau of Reclamation for 1984 through 2003. This data was compared to site elevation to determine rates of exposure and inundation.

Figure 6. One of several rockshelters with evidence of prehistoric use (5MT2383).

Results

I. Examining questions of association about characteristics of a site that result from prehistoric activities [CHARACTERISTICS] and the observable results of contemporary activity [ACTIVITY] at that place was initially conducted using correspondence analysis as an exploratory relational procedure (SPSS 11.5 and SYSTAT 10.2)[1]. Evaluation of full input data suggests low variation in the data set where total inertia is .028 ($\chi^2 = 3.88$, $df = 12$, $p = .986$) (Table 2). Figure 7 shows the plot of the correspondence analysis (CA) of the two variables using the symmetrical normalization method. The first two dimensions of the correspondence table explain 96.72% of the 2.8% of the variation explained by the model. Keeping in mind that correspondence is not association and that correlation between site characteristics and contemporary activities is weak some generalizations about the categories of variables can be made nevertheless. Trails and two-track roads [TRAIL] and fire hearths [FIRE] contribute the greatest percent of inertia (variance) to Dimensions 1 and 2 respectively, whereas, not surprisingly given the content of the sample of sites, rockshelters [RSH] account for the greatest inertia of the column points in Dimension 1. The presence of rockshelters in this data set is an outlier that contributes to the tightly clustered points in the symmetrical normalized plot, making interpretation difficult. The existence of observable pitstructures (PS) and scattered rubble (RS) are explained best by the principal components model (squared correlation .975 and .973 respectively). The lower left quadrant is defined by "looting" [LOOT], differentiated from observed debris and trash [DEB/TSH] and pitstructure [PS] as a site feature in Dimension 2, where 18.3% of the total inertia is represented.

Table 2. Correspondence diagnostics for CHARACTERISTICS and ACTIVITY.

	Quality[a]	Mass[b]	Inertia[c]	Dimen.1[d]	Dimen.2[d]
DEB/TSH	.923	.307	.005	.802	.121
FIRE	.993	.095	.010	.745	.248
LOOT	.738	.299	.002	.048	.690
TRAIL	.997	.299	.012	.917	.080
RM	.728	.328	.001	.722	.006
RS	.973	.109	.003	.000	.973
PS	.975	.175	.003	.207	.768
AS	.693	.358	.002	.691	.002
RSH	.999	.029	.020	.996	.003

[a] A proportion of variance statistic indicating how well a point is represented by the first two dimensions.
[b] Marginal proportion of the variable used to weight the point profile when computing point distance.
[c] A variance measure of the distance from the average weighted by its mass.
[d] Proportion of inertia accounted for by each axis as a squared correlation.

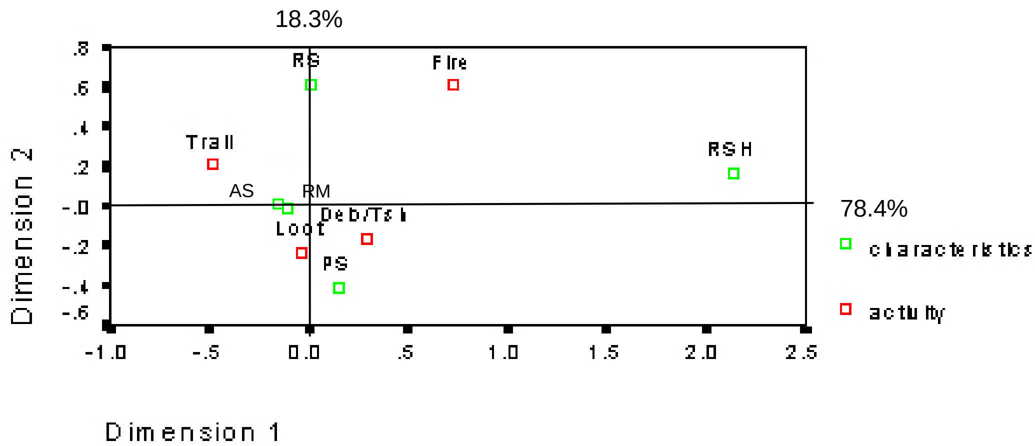

Figure 7. Correspondence analysis of prehistoric site characteristics with recent human activities (1^{st} and 2^{nd} axis).

II. Evidence of subsurface digging for the purpose of looting artifactual material was observed at fifteen (52%) of the 29 sites used in this analysis. Association between characteristics and features of a site and the presence of past looting is presented in Table 3. Sites situated in rockshelters [RSH] are eliminated from these analyses due to the definition as a topographical situation in the landscape rather than a human induced modification to the place. With this information an assessment was conducted using binary logit analyses to establish predictions concerning what site features increase the probability of subsurface looting at a site (Table 4). While Models I and II do not differ significantly they do reflect the results of relational data represented in the correspondence analysis. The existence of rubble scatter [RS] at a site does not contribute to an increase in the probability that a site will undergo subsurface looting.

Table 3. Relationship between subsurface looting and site characteristics.

	χ^2	*df*	*p*	Cramer's V
RM	8.62	1	.003	.545
RS	.109	1	.742	.061
PS	10.31	1	.001	.596
AS	3.72	1	.054	.358

Table 4. Logit Models of Contribution of Site Features to Subsurface Looting.

	Model I		Model II		Model III	
	Coefficient	T-statistic	Coefficient	T-statistic	Coefficient	T-statistic
RM	2.050	1.661	2.079	1.692	2.079	1.722
RS	-0.267	-0.193	-	-	-	-
PS	15.985	.023	15.915	.022	16.203	.023
AS	1.176	.904	1.204	.928	-	-
	LR=18.254, *df*=4, *p*=.001 MFR^2=.454 Total Correct=.756		LR=18.216, *df*=3, *p*=.000 MFR^2=.453 Total Correct=.757		LR=17.254, *df*=2, *p*=.000 MFR^2=.430 Total Correct=.732	

Note: Dependent Variable = LOOT
LR = Likelihood-ratio statistic
MFR^2=McFadden's rho squared (refer to endnote #2)
Total Correct = Proportion successfully predicted as a ratio of the sum of the diagonal elements to the total number of observations

III. Eleven of the 32 sites located in 2003 have been subject to inundation (Figure 8) as determined by high pool elevations (Table 5) and site elevation (Table 6). All of these places have been subjected to human activities during periods of exposure (Figure 9) Ten sites showed evidence of foot trail or two-track road use. Nine of the sites contained debris or other trash and five contained modern fire hearths, indicating intensive use of beaches by campers and boaters (Figure 10). Other impacts observed include the use of ATVs and pulling boats or individual watercraft up on to beach areas. In one case, rubble from a roomblock was being used to anchor boats and was carted off for use in fire rings. Evidence of subsurface looting was not documented at most of these sites and is less likely to be observed due to the redeposition of sand and silt during inundation.

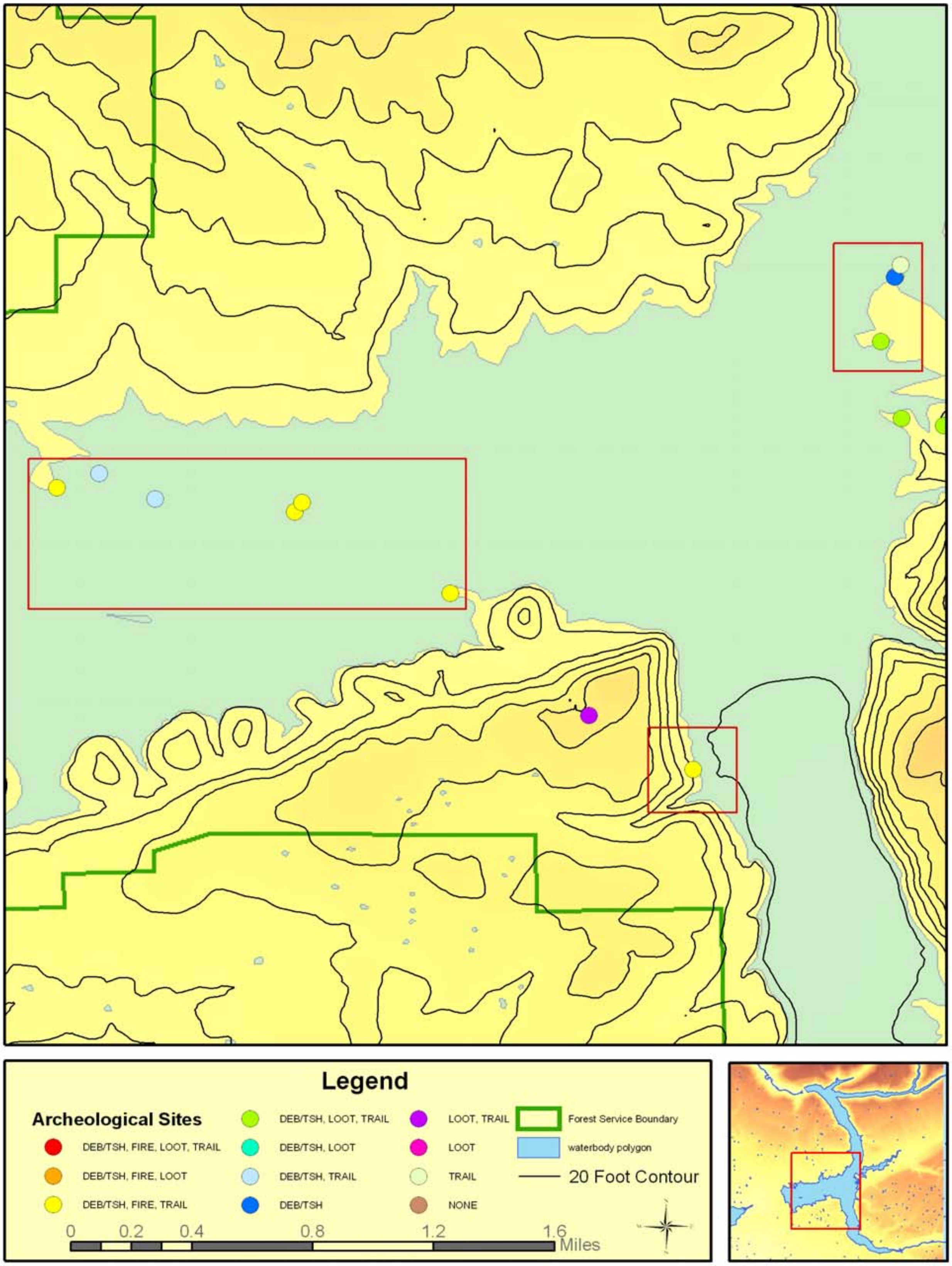

Figure 8. Sites visited in 2003 that have been subject to inundation. Sites are color coded by the types of impacts observed.

Table 5. Annual high and low pool elevation and content, McPhee Reservoir, Colorado.

Date	High Elevation (feet)	High Elevation (meters)	Live Storage (acre-feet)	Low Elevation (feet)	Low Elevation (meters)	Live Storage (acre-feet)
2003	6890.16	2100.12	248,654	6858.41	2090.44	159,461
2002	6879.53	2096.88	214,719	6856.55	2089.88	155,336
2001	6914.39	2107.51	339,777	6876.33	2095.91	205,330
2000	6921.95	2109.81	372,009	6880.33	2097.12	217,120
1999	6924.46	2110.58	383,150	6894.84	2101.55	264,865
1998	6924.18	2110.49	381,896	6892.24	2100.75	255,773
1997	6924.35	2110.54	382,657	6892.46	2100.82	256,533
1996	6921.12	2109.56	368,441	6888.56	2099.63	243,335
1995	6924.25	2110.51	382,282	6895.79	2101.84	268,308
1994	6924.32	2110.53	382,595	6895.00	2101.60	265,496
1993	6924.20	2110.50	382,058	6905.59	2104.82	304,670
1992	6924.38	2110.55	382,864	6903.71	2104.25	297,471
1991	6921.05	2109.54	368,616	6888.03	2099.47	241,458
1990	6906.97	2105.24	309,911	6887.11	2099.19	238,423
1989	6924.25	2110.51	382,167	6899.40	2102.94	281,262
1988	6923.82	2110.38	379,380	6909.60	2106.05	320,280
1987	6923.40	2110.25	378,375	6902.64	2103.92	293,310
1986	6902.84	2103.99	294,065	6857.39	2090.13	157,098
1985	6857.34	2090.12	156,987	6775.44	2065.15	39,182
1984	6782.06	2067.17	44,933	6698.00	2041.55	1,426

Data provided by US Bureau of Reclamation, 2004.

Table 6. Sites visited during 2003 that have been inundated, first inundation, frequency of exposure, and impacts.

Site	Elevation of Site	Year of first inundation	Number of years inundated[a]	Number of years exposed[b]	Impacts
5MT2190	6910	1987	14	20	DEB/TSH, FIRE, TRAIL
5MT2202	6910	1987	14	20	DEB/TSH, TRAIL
5MT2204	6900	1986	16	16	DEB/TSH, TRAIL
5MT2215	6900	1986	16	16	TRAIL
5MT2246	6895	1986	16	13	DEB/TSH, FIRE, TRAIL
5MT4514	6890	1986	17	20	DEB/TSH, FIRE, TRAIL
5MT4546	6890	1986	17	20	DEB/TSH, FIRE, TRAIL
5MT4564	6922	1987	10	20	DEB/TSH, FIRE, TRAIL
5MT5072	6920	1987	13	20	DEB/TSH
5MT5154	6920	1987	13	20	TRAIL
5MT7499	6921	1987	13	20	DEB/TSH, LOOT, TRAIL

[a] The number of years in which the site was covered by water for some portion of a given year, 1984 through 2003.

[b] The number of years that the site was exposed above water at some time during a given year, 1984 through 2003.

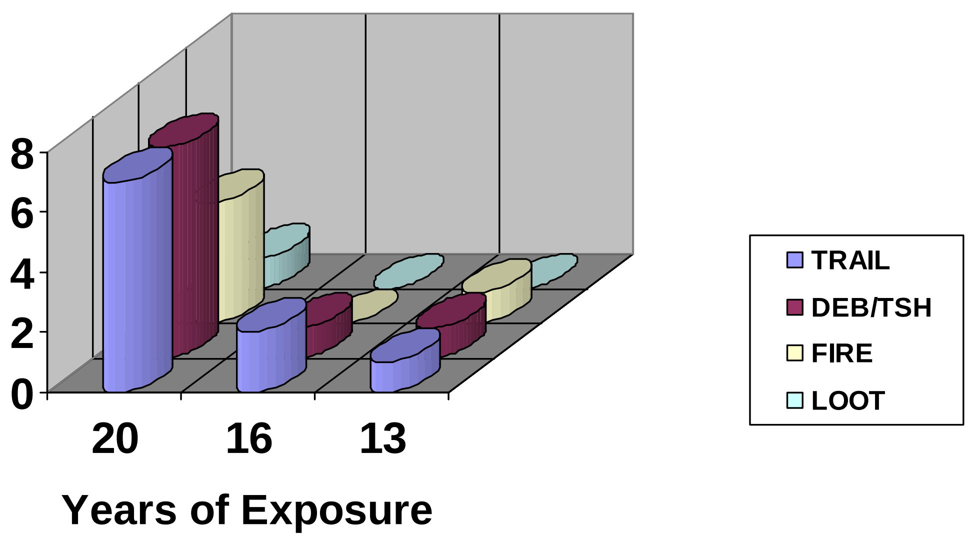

Figure 9. Number of sites with impacts by years of exposure.

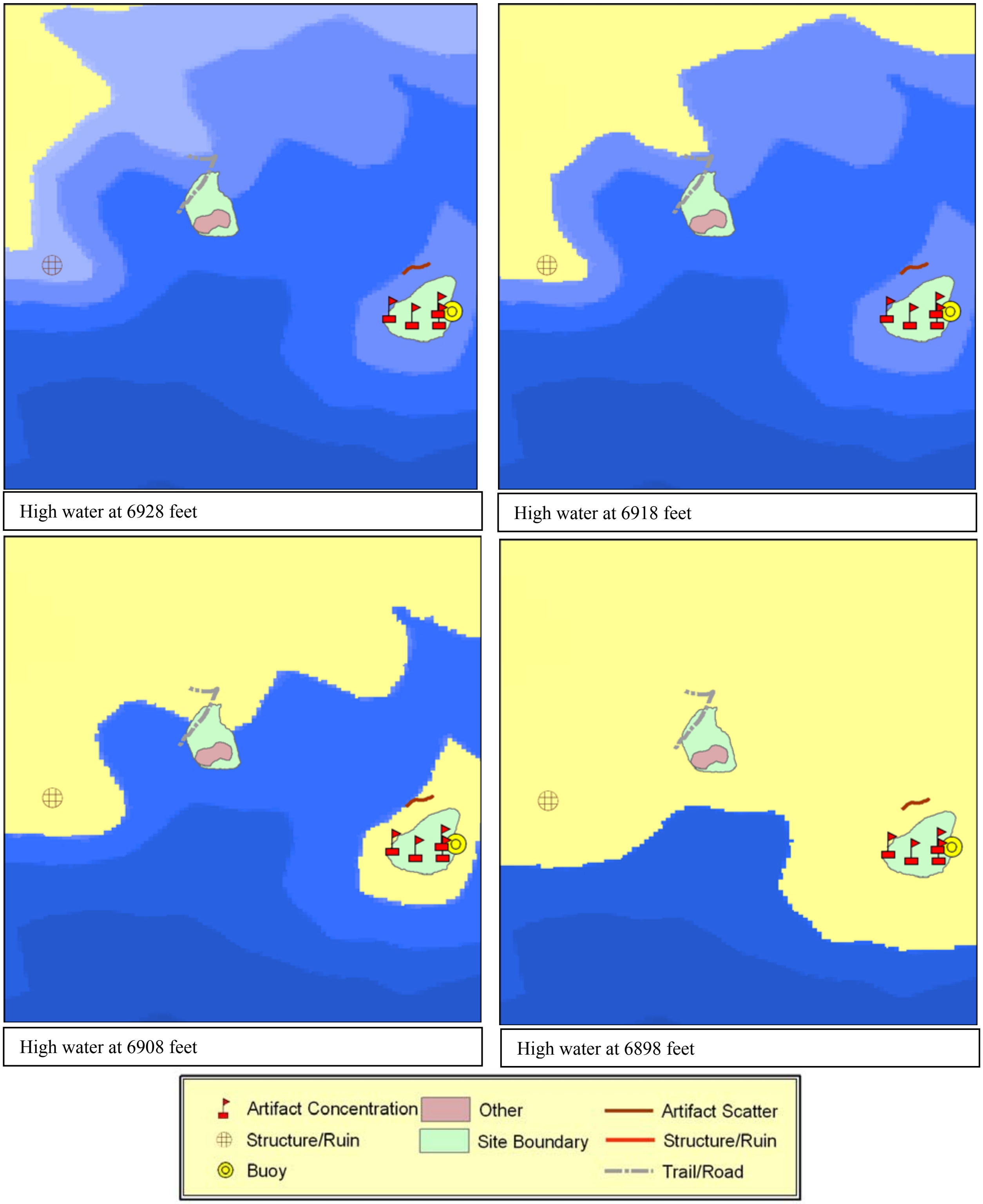

Figure 10. As the reservoir pool elevations drop, sites are exposed along beach areas that are popular for camping and shore use by boaters. While ATV use is not permitted on these exposed beaches, there was extensive evidence that vehicles had been in these beach areas. At the site on the far right, the double yellow circle indicates the location of an anchored buoy used to warn boats of shallow water

Discussion

Assessment of the condition of archaeological sites in the Anasazi Archaeological District is made, for the most part, relative to observations and information collected by those researchers documenting the sites during the pedestrian survey component of the Dolores Archaeological Program. Our knowledge of 95% of the 1600 sites in the District is limited to this information base. Since the DAP period ended in the mid-1980s, land-use of the area, although spatially varied, has undergone rapid change relative to the century prior to reservoir and associated development. The threat of illegal looting continues to be a problem, enhanced potentially by the overall increase in use of the area as well as by the broad spectrum of the population attracted to an environment available for public recreation.

Despite the crude measures available for this study, results suggest that prehistoric sites with architectural remains designated as pitstructures and rubble mounds are most vulnerable to looting. This observation offers little insight to both professional and amateur archaeologists familiar with this environment. But the quantitative approach used here does offer a means by which to not only retrodict behavior but to predict vulnerability to site disturbance through illegal activities. In addition to site descriptors, other variables of interest to this problem will be the situation of the site on the landscape, that is, its topographical context as well as its proximity to human induced alterations to the environment such as roads, campgrounds, lakeshore, etc. It could also be predicted, for example, that an increase in frequency of modern fire hearths and trash at prehistoric sites is associated with proximity to these kinds of landscape variables.

The small number of rockshelters examined in this study affected the utility of the initial phase of the analysis. An expanded data set would benefit from a representative sample of rockshelter sites, especially due to their vulnerability to subsurface looting and potential archaeological significance. Graffiti was also observed at two of these sites (Figure 11). Documenting and analyzing the results of this activity can reveal use of the landscape at an operational scale and under socio-economic conditions not otherwise available (Hartley and Vawser 2002).

Sites denuded of vegetation and exposed by periodic and seasonal drops in reservoir level are subject to various kinds of human activities that contribute to their destruction beyond that of consistent inundation. As the water recedes wave action can enhance erosional processes, a phenomenon well acknowledged at sites along the shores of Lake Mead and Lake Powell. For example, a site that was initially recorded (1972) in the McPhee flood pool as a small artifact scatter eroding from the edge of a knoll has been exposed by erosion of surface deposits. The site was described as a small concentration of material on the northwest side of the knoll with few artifacts on top of the knoll. When the site was revisited during low water in 2003 few artifacts were found along the northwest side of the knoll but an abundance of cultural material was observed on top of the knoll. It is possible that soil from what was the top of the knoll is being redeposited on the side of the knoll, burying cultural material that was once observed there, while materials that were initially buried on the top of the knoll are now being exposed. The opportunity to document this gradual destruction can be valuable for land-managing agencies that oversee reservoirs throughout the western and plains states. The mapping of features and exposed artifacts in one meter diameter units, subsurface testing, and artifact collection can offer not only the salvage of a doomed cultural resource but also quantitative data with which to make predictions concerning the rate of destruction in reservoir contexts (Chapman, Fletcher and Thomas 2001).

Some sites with archaeological remains are found to have mature pinyon or juniper trees growing within architectural features (Figure 12). Due to soil quality and drainage this vegetation was, until recently, thriving. The current drought and beetle (*Dendroctonus ponderosae*) infestation has, in some cases, caused these trees to die, leaving a dense fuel load on or within the ruins. These same environmental factors increase the chances of fire. Deadfall concentrated in this feature may, according to research conducted by Buenger (2003), increase the potential peak temperature and duration of fire resulting in thermal damage to a variety of artifact material types. It is recommended that architectural sites in pinyon-juniper forest environments undergo inspection and where necessary dead brush be cleared from these features.

Figure 11. Graffiti in rockshelter (5MT2381).

Figure 12. Drought has resulted in heavy fuel loads (inset – 5MT6870) in and around some structures where previously thriving pinyon and juniper trees grew in and around features (see upright slabs in foreground -5MT6799).

End Notes

[1] Correspondence analysis serves to explore the relational structure of rows and columns of a contingency table. The method, increasingly used in archaeology, allows for the factoring of categorical variables and displaying them in a space that maps their geometric association in two dimensions (Blasius 1994; Baxter 1994; Shennan 1997). The amount of data compiled for this study and the limited number of categories make the visual inspection of the table adequate but the appeal of representing the table graphically in two dimensions enhances comparison with results of subsequent log-linear analysis. These techniques, as noted by Lebart (1994:177), "are generally intended to discover something, and not to prove anything."

[2] A convenient means by which to compare models is with computation of a pseudo-R^2. Several different measures are available that transform the likelihood-ratio statistic, measuring the strength of association between 0 and 1. McFadden's measure (MFR^2) is deemed one of the more reliable measures (Windmeijer 1995; Long 1997:104-105; Crown 1998:117).

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