Coupling Biological Activity and Geomorphic Processes in Archaeological Site Formation

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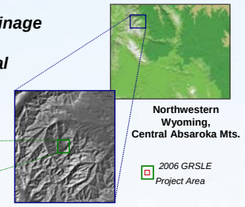
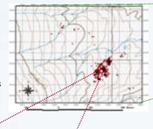
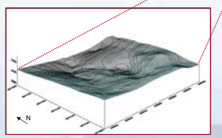
In archaeology, burrowing organisms are associated with site disturbance, particularly the loss of stratigraphic integrity. While capable of artifact translocation, fossorial activity, coupled with geomorphic processes, can also preserve archaeological resources. Additionally, since suitable habitat for subsurface dwellers is bound by specific ecological parameters, can the intensity of former occupation can indicate past environmental conditions? At a high altitude site in Wyoming, sediment displaced by *Thomomys talpoides*, the northern pocket gopher, is redistributed into alpine sag ponds, burying cultural material. Research begun in 2006 examines the impact of pocket gopher activity in conjunction with physical processes of sedimentation on archaeological site context.

GREYBULL RIVER SUSTAINABLE LANDSCAPE ECOLOGY PROJECT (GRSLE)

The GRSLE project area is located in the Greybull River drainage basin, part of the Greater Yellowstone Ecosystem in northwestern Wyoming. Prior to GRSLE little archaeological research had been conducted in the remote, little accessed tributaries of the Greybull. To date, over 225 previously unrecorded sites have been documented.





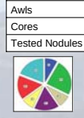


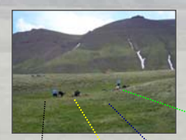
Site 48PA2874

Site 48PA2874 (3100m), is located in a hummocky alpine parkland dotted with shallow, ephemeral ponds. The site overlooks the Big Horn Basin to the east.

48PA2874 is distinguished from other local sites by the shear number of pieces of chipped stone, the density of artifacts, the diversity of tools, and the presence of spatially discrete artifact concentrations. The site covers over 1000 by 1000m. Temporally diagnostic projectile points indicate this multi-occupation site has over 10,000 year of human use.

ARTIFACT SUMMARY	
Flakes	2267
Worked Flakes	16
Bifaces	20
Projectile Points	23
Scapers	10
Awls	3
Cores	4
Tested Nodules	7





Test Excavation
Is there buried cultural material at the site?

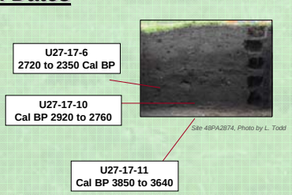
Test units were excavated around a small alpine sag pond. The pond was surrounded by both active and inactive pocket gopher mounds. One unit, was placed upslope of the dry pond, the other unit, another at the cusp of the dry sag pond.

U27: The 'Pond' Unit
Unit U27 contained 64 pieces of chipped stone in 4.2m³ of excavated sediment

T26: Unit Up-slope of the Pond
Unit T26 contained 395 pieces of chipped stone in 2.32m³of excavated sediment

Radiocarbon Dates

Charcoal samples from U27, the unit in the pond and down-slope of the pocket gopher mounds, were radiocarbon dated. The radiocarbon dates and the amount of sedimentation accumulation from where the sample was collected will be used to evaluate a model predicting erosion rates from pocket gopher mounds.



Sample	Ground Surface (m)	Sample Elevation	Radiocarbon Date (cal BP)	Sediment Accumulation
U27-17-6	3098.215	3097.771	2720 to 2350	0.444
U27-17-10	3098.140	3097.653	2920 to 2760	0.487
U27-17-11	3098.140	3097.080	3850 to 3640	1.060

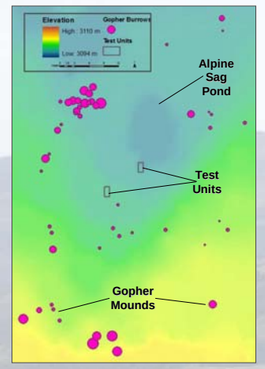
POCKET GOPHERS AND ARCHAEOLOGICAL SITE FORMATION

While often considered a disturbance to archaeological sites, researchers studying alpine environments in the Greybull River watershed propose sediment ejected by gopher activity has overtime been redistributed by physical processes and resulted in burying cultural material.

To investigate this proposal researchers combined data on:

- **Pocket gopher mounds: location and volume of sediment**
- **Fine grained topographic information**
- **Used a GIS-based erosion model to predict the path and amount of deposition**


Photo by L.C.Todd



To investigate the impact of pocket gopher activity on the site locations and sediment characteristics of active and inactive burrows were documented in a 0.35 hectare area surrounding an alpine sag pond.

Documentation of Pocket Gopher Burrows

Pocket Gopher Data Summary	
Area Investigated	0.35 ha
Total Borrows	53
Active Burrows	17
Inactive Borrows	34
Unspecified Activity	2
Volume of Disturbed Sediment	309 liters
Artifacts in Mounds	115

RECORDED ATTRIBUTES
- *Volume sediment/rocks*
- *Mound L/W*
- *Evidence of current activity*
- *Chipped stone collected*
- *Sediment analysis of active/inactive mounds*

Winter Gopher Activity


Photos by L.C.Todd

Determining seasonality: ***Gophers create 'soil cores' when tunneling beneath snow. These tunnels and burrows are abandoned after snowmelt, therefore researchers could determine active vs. inactive mounds.***

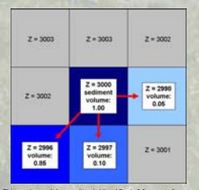
Particle Size Analysis

Are there differences in % sand, silt, and clay in active and INACTIVE burrows?

YES! T-tests indicate the percentage of clay found in actively occupied rodent burrows is varies significantly from the percentage of clay in burrows abandoned for a minimum of one season. Percentages of sand and silt did not differ significantly. This could support the proposal that in the project area fine particulate matter in rodent burrows has overtime eroded and potentially been redistributed into the sag pond.

Predicting Erosion

How the model works...



This erosion model was written in Visual Basic 6.0 as part of NR521, an advanced GIS modeling class. Dr. Denis Dean (denis@cnr.colostate.edu) developed the model for the California Transportation Department as part of a larger project predicting landslide susceptibility of hill slopes.

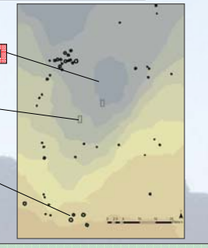
The model predicts the path of erosion by comparing elevations adjacent to a given starting point. The starting point (cell in dark blue on diagram) is linked to a number representing the volume of material available for erosion. The model evaluates the elevation of the neighboring cells and moves a user defined percentage of total volume into a specified number of cells. The program then uses the same method to evaluate the cell containing newly moved material. The model terminates when either there are no neighboring cells with lower elevation or there is no more sediment to transfer.

EROSION MODEL: PREDICTING THE PATH AND ACCUMULATION OF SEDIMENT

Inputs to the Model

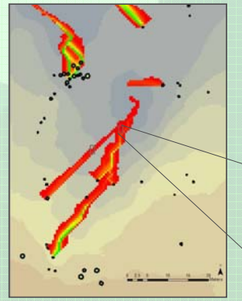
Starting points
Gopher mound locations and associated sediment volume

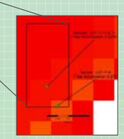
Elevation
From fine grained topographic data collected in field



Results of the Model

The predicted path of material eroding from the gopher burrows moves toward the ephemeral pond and the test excavation units. The model indicates sedimentation did occur from where the radiocarbon dates were obtained.





Radiocarbon Dated Sample	Predicted Accumulation (liters)
U27-17-6	0.276014
U27-17-10	0.027085
U27-17-11	0.027085

Sedimentation Calculation and Comparison with Radiocarbon Dates

- Use the value of raster cell overlaying area where radiocarbon date obtained
- Multiply volume of sediment by the number of years indicated by the radiocarbon date
- Divide resulting volume of sediment by area of cell (50 x 50cm=2500cm²)

Sample	1 Year Predicted Deposition	Maximum Radiocarbon Date	Predicted Accumulation in X years	Actual Deposition	Difference (cm)
U27-17-6	276.01 (cm³)	2720	300.3	44.4	255.9
U27-17-10	27.085	2920	31.635	48.7	-17.06
U27-17-11	27.085	3850	41.71	106	-64.289

Liters of sediment converted to cubic centimeters

The Predictive Capability of the Erosion Model?

The model over-predicted sediment accumulation at sample U27-17-6 and under-predicted accumulations for U27-17-10, 11

Possible reasons
-Very slight differences in elevation may result from measurement errors rather than actually representing the ground surface. These small, millimeter-sized differences greatly impact the functioning of the model as the algorithm terminates if a neighboring cell with a lower elevation is not encountered.
- Model assumes steady state conditions- Climatic conditions influence the amount of sediment transported by rain, snow, and wind, as well as determine the presence, placement, and density of gopher populations.
-There are many other sediment inputs to the system, therefore having a too low predicted amount of accumulation may not be a problem, however the over-sedimentation predicted for sample U27-17-6 can not be explained.

Site 48PA2874, Photo by L. Todd