Using an Archaeological Predictive Model to Design Sample Surveys Following Forest Fires

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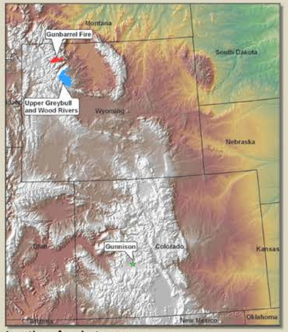
ABSTRACT

Given the massive acreages burned annually in the forests of the western United States, there is a need to mitigate the associated impacts to the archaeology of the region. The main impacts are physical destruction of heritage resources and accelerated looting made possible by increased ground visibility. While this destruction is clearly defined and predictable, systematic mitigative approaches are lacking. The first step toward this post-burn mitigation is the identification of heritage resources through surface surveys. This poster outlines an approach to defining survey areas using an archaeological predictive model that is both systematic and flexible to budgetary limitations.



Location of project areas

Post-burn inventories of previously documented sites resulted in a dramatic increase in site areas.

Numbers of artifacts also sharply increased after the burn.

Mean artifact length decreased slightly on average as a result of the increased post-burn visibility.

Not surprisingly, most of the artifacts documented after the burn were in burned patches.

Artifacts that were once shielded from view by a thin sheet of vegetation and detritus were exposed.

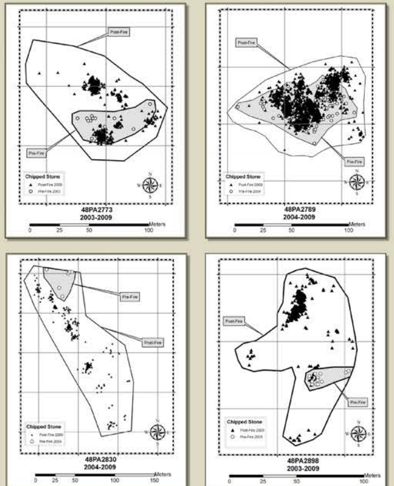
The Little Venus fire area became a hotspot for looting. No funding was made available to offset these anticipated adverse affects.

Looter training on Federal land in 2007, following the Little Venus Fire

Introduction

The Little Venus Fire burned 34,000 acres in the Upper Greybull watershed of Wyoming in 2006. This area has been sample surveyed every year since 2002 by a Colorado State University field school, and sites have been revisited following the burn.

The burn literally changed our view of the archaeological record:



Sites before and after burning

Data showing pre- and post-burn differences

SITE	AREA (m^2) PRE-FIRE	AREA (m^2) POST-FIRE	AREA (m^2) % INCREASE	NUMBER OF ARTIFACTS PRE-FIRE	NUMBER OF ARTIFACTS POST-FIRE	NUMBER OF ARTIFACTS % INCREASE
48PA2750	81	615	659	20	92	360
48PA2773	1599	7491	368	39	639	1538
48PA2789	3493	7417	112	349	1747	401
48PA2797	697	1686	142	50	232	364
48PA2830	1059	13865	1209	6	264	4300
48PA2898	411	6255	1422	17	461	2612
		Average:	652		*Average:*	1596

SITE	MEAN ARTIFACT LENGTH (mm) PRE-FIRE	MEAN ARTIFACT LENGTH (mm) POST-FIRE	MEAN ARTIFACT LENGTH (mm) CHANGE	POST-FIRE CONTEXT # in BURNED PATCH	POST-FIRE CONTEXT % IN BURNED
48PA2750	13.9	15	1.1	84	91.3
48PA2773	15.8	8.9	-6.9	463	72.5
48PA2789	14.1	11.8	-2.3	1561	89.4
48PA2797	7.3	9.4	2.1	216	93.1
48PA2830	N/A	15	N/A	236	89.4
48PA2898	N/A	9.7	N/A	451	97.8
		Average:	-1.5	*Average:*	88.9

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In 2008, the Gunbarrel Fire burned over 60,000 acres west of Cody. The fire was allowed to burn and was hailed as a wildland fire use success story. The Shoshone National Forest received the 2008 Chief's Award for Sustaining Forests and Grasslands.

Yet again, the prehistoric heritage resources within the forest are in danger of being looted as a direct result of the fire.

$11.2 million was spent to control the Gunbarrel fire. At $164 per acre, this was cheaper than prescribed burns, which typically cost $200 per acre on the Shoshone National Forest.

A cost share agreement is being worked out between Dr. Todd of GRSLE and the Shoshone National Forest to fund a sample survey. The Gunbarrel sample survey will be guided by the predictive model developed for the area (outlined below).

Upper Greybull Predictive Model

First, a predictive model was built using data from the upper Greybull watersheds within the Shoshone National Forest. The total modeled acreage is 274,625 acres.

Second, the equations built using these data were applied to the Gunbarrel fire area.

To build the Greybull model, the 310 sites and 86,737 acres of nonsites (including slopes of over 30 degrees) were converted to 10 m grid cells. These were split into two random samples to build and test model.

The sites and nonsites were tagged with 13 environmental variables:

- aspect
- average productivity
- land cover type
- path distance (incorporating elevation) to stream orders 1-6, 2-6, 3-6, and 4-6
- path distance to water bodies
- relative elevation within 100 m and 1000 m
- slope
- soil
- surface geology

Stepwise logistic regression selected two environmental variables as significantly contributing to site placement:

- path distance to stream orders 1-6
- slope

site probability = 1 / (1 + [-5.56586812732334 + 0.00379719610476491*P16 + 0.24901346893509*SLOPE}])

Greybull Model Accuracy

- ✓ 93 % of the site cells and 97% of the nonsite cells were correctly predicted.
- ✓ Model predicts 96 % of the sites in 25 % of the project acreage.
- ✓ Kvamme's (1988:329) gain statistic = 0.74

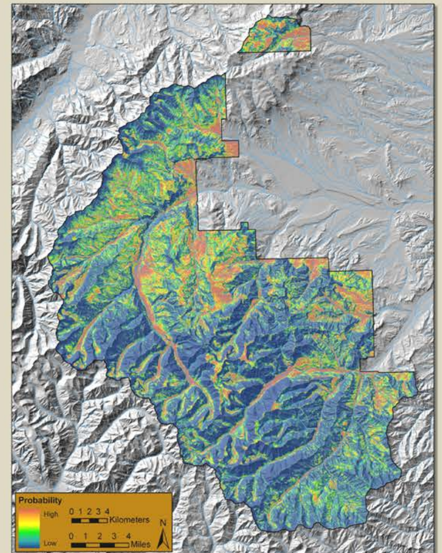
Gain = 1 – (% of area predicted to contain sites / % sites within the predicted site area).

Modeling the Gunbarrel Area

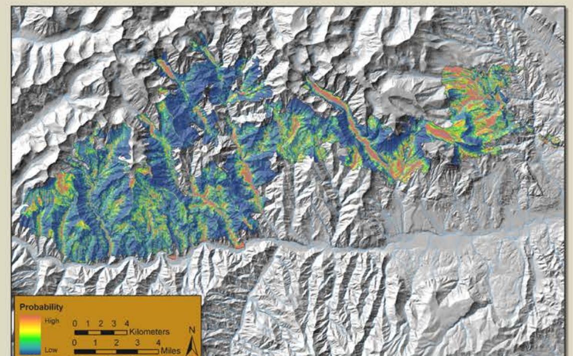
Applying the model to the Gunbarrel area results in a variety of options for sample surveys, depending on the funding. These choices can be guided by the acreage associated with the probability values, which range from 0 (low) to 1 (high). To avoid sampling a large amount of small areas, areas less than 5 acres were removed:

Range of model outputs

	Greybull					Gunbarrel			
Minimum Probability	Acreage	% Acreage	# Sites	% Sites	Gain	Acreage	% Acreage	Survey cost @ $20/acre	% of total expenditures
0	274625	100.0	310	100.0	0.00	61381	100.0	$1,227,620	9.9
0.1	134468	49.0	308	99.4	0.51	25484	41.5	$509,680	4.4
0.2	104765	38.1	304	98.1	0.61	18407	30.0	$368,140	3.2
0.3	85871	31.3	298	96.1	0.67	14343	23.4	$286,860	2.5
0.4	71691	26.1	294	94.8	0.72	11462	18.7	$229,240	2.0
0.5	59461	21.7	286	92.3	0.77	9182	15.0	$183,640	1.6
0.6	48644	17.7	266	85.8	0.79	7192	11.7	$143,840	1.3
0.7	38462	14.0	253	81.6	0.83	5461	8.9	$109,220	1.0
0.8	27881	10.2	235	75.8	0.87	3959	6.4	$79,180	0.7
0.9	15541	5.7	193	62.3	0.91	2335	3.8	$46,700	0.4
0.95	8370	3.0	147	47.4	0.94	1172	1.9	$23,440	0.2



Upper Greybull Predictive Model



Gunbarrel Predictive Model

Conclusions

Allowing wildland fires to burn is good for the forest, but bad for the heritage resources. Post-burn sample surveys should be funded as a part of standard mitigation procedures. Predictive models should guide these surveys, because they can have replicable methods and definable accuracies. Model acreages can be used to establish survey goals and costs. Building the models for management areas prior to fires would ensure rapid mobilization, and would minimize information lost from the predictable looting within burned areas.

GRSLE 2009
GREYBULL RIVER SUSTAINABLE LANDSCAPE ECOLOGY