Modeling Archaeological Sites and Forest History on Cedar Mesa, SE Utah*

R.G. Matson  
Professor Emeritus  
University of British Columbia  
rgmatson@shaw.ca

William D. Lipe  
Professor Emeritus  
Washington State University  
lipe@wsu.edu

Sept. 12, 2017

Introduction
Producing a model that successfully predicts archaeological site densities over a large area of more than 1,000,000 acres which had diverse prehistoric adaptations and diverse environments is an extremely difficult task. Recently such an attempt has been done for the Monticello BLM area (SWCA 2016). With the difficulties in mind, it is not surprising that this attempt has aspects which can be shown to be incorrect for specific areas. This is the case for the Cedar Mesa area within the Bears Ears NM according to existing high quality archaeological information which is largely publicly available. The “sensitivity” maps produced (in particular Fig. 8-4, 5 and 8) are significantly in error for Cedar Mesa where we have worked together since 1970. These maps (Figure 1, 8-5) show the spine of the mesa, along Utah 261, being an area of low site density, while our work has demonstrated that this area is, instead, the environment of highest site density. Many of our publications and reports have so argued, beginning in 1971, when planning the Cedar Mesa project [CMP] (Lipe and Matson 1971), progress reports (Matson and Lipe 1975; 1978) and final summary (Matson, Lipe and Haase 1988) and detailed monograph available online (Matson, Lipe and Haase 1990) as well as many more specialized reports, MA theses and PhD dissertations (see Matson, Lipe and Haase 1988 and Lipe and Matson 2009) for lists). These publications include several in the last few years, Morin and Matson (2015), Lipe et al. (2016), Matson, Lipe and Curewitz (2016), and Lipe (2014).

One way of showing the difference between the predictive modelling and the actual site densities is to use a site definition used by the predictive modelling and compare it with the Cedar Mesa Project equivalent(s). We chose to use to compare the “Prehistoric Open sites with Features” (Figure 1, Fig. 8-5) predictive modelling class using the combination of Basketmaker II (BM II), Basketmaker III (BM III), and Pueblo II-III (PII-III) habitation site classes we developed for our research as the Cedar Mesa equivalent as this appeared to be the closest fit. These three kinds of habitations sites, by definition, are always “Prehistoric”, almost always “Open” and either have significant features visible on the surface, or are inferred to have pithouses present.

Doing this and plotting the site densities per quadrat to three different elevation classes results in Figure 2, “Cedar Mesa Density of ‘Prehistoric Open Sites with Features’.” One can see that this figure is essentially reversed from that shown by the predictive modelling (Figure 1

* This paper was delivered at the 14th Biennial Conference of Science & Management on the Colorado Plateau & Southwest Region at Flagstaff, Sept. 11-14, 2017.
Fig. 8-5) for this area, with the spine of the mesa having a density of four times of that of the 5600-6000 ft. elevation band on the flanks of the mesa. Such a startling difference obligates a brief discussion of how this Figure 1 was derived and thus, the Cedar Mesa Project sampling scheme.

The Cedar Mesa Project.  

The Cedar Mesa Project (CMP) sampling universe was based on Lipe’s experience working in SE Utah. His experience led him to believe that the “Anasazi” farming adaptation would be captured on by the elevations of 5600 ft. and 6800 ft. and that the “drainages” made natural units of some integrity. We therefore designed a sampling universe along those lines, including the canyons, by drawing lines at canyon mouths across from the neighboring 5600 ft. contours, as seen in the Figures 2 and 3. This scheme inclosed an area of about 800 square kilometers, or approximately 200,000 acres.

We randomly selecting 5 of the 20 drainages, as shown on Figure 3. We random sampled each of the five drainages at a 7% rate, using quadrats 400 metres on a side, resulting in samples sizes in each drainage ranging from 9 quadrats to 22 and a total of 76 in all.

We not only surveyed the quadrats, but mapped and completely collected almost every site. The maps provided a way of setting up collection grids and collection locations so that almost every object can be located to within 1 metre or so of its original location. Specific forms (published in Matson et al. 1990) were also filled out for the botanical, physiographic and cultural information. Summaries for each quadrat and site are available on-line as part of Matson et al. 1990.
The production of the CMP Sensitivity Figure
We simply totalled up the habitation sites for the three periods (BM II, BM III and PII-III) for each quadrat for Figure 2. The three bands illustrated on the Figure 2 was produced by dividing the 1200 ft. elevation range into three 400 ft. groups. The 5600-6000 ft. group included 17 quadrats, with a mean of 0.765 sites of this class per quadrat and a median of 0.
Actually only 5 of the 17 quadrats had any “Prehistoric Open Sites with Features” in them.

The next group, 6000-6400 ft., included 29 quadrats and has a mean of 1.17 and a median of 1 site per quadrat. Eighteen of these quadrats had habitation sites. The final group (6400 - 6800 ft.) consisted of 30 quadrats, with a mean of 3.1 and a median of 3 “habitation” sites per quadrat. An impressive 28 out of 30 quadrats had at least 1 “habitation” site.

These figures make it clear that the “spine” of the mesa is the portion with the highest density of the most significant sites the reverse of the predictive model (Figure 4 [18x3 side by side]). The only significant caveat is that many of our CMP limited activity sites do have “features” and so, at least, would also fit the draft report site class but those sites have a similar elevation distribution as the habitation sites (Matson et al. 1988).

Extension of Cedar Mesa Pattern?
As disturbing as the maps (SWCA 2016:Fig. 8-4, -5 and -8) showing the spine of Cedar Mesa as an area of relatively low site density are, the depictions of relatively high site densities in low-lying arid regions south and southwest of Cedar Mesa and outside of our sampling frame in the same figures are more so. Showing significant site numbers in areas such as Valley of the Gods at elevations below 5000 ft. are errors. We know from a recent conference that there isn’t any significant site density there.

The contract work closely related to the CMP reported in Lipe, Matson and Powers, 1977 allow us to expand Figure 2. This project included non-collection quadrat surveys in two areas (Figure 4), the Pine and Dripping Canyons, to the west of the Cedar Mesa Project sampling universe and the Slickhorn area, between Hardscrabble and West Johns, mostly within the sampling universe, but a drainage that was not sampled by CMP. These quadrat surveys used the same quadrat size, approximately the same sampling rate and survey procedures as the CMP.

In the Slickhorn area, the 23 quadrats produced 23 sites. All but two of the total 23 Slickhorn components were classified as BM II sites and the other two as Pueblo II-III. Very few of the 23 sites, if any, would be considered “habitation” sites.

The Pine-Dripping Canyon survey gives rather different information from the 24 quadrats surveyed. All are outside the Cedar Mesa Project sampling universe and can be used to estimate the number of sites in the area between Cedar Mesa and the Red House Cliffs. Sixteen quadrats were in the elevation band between 5600 and 6000 ft. and only three possible habitation sites, all BM II, were located giving a mean of 0.19 per quadrat. The other eight quadrats between 6000 and 6400 ft. produced 11 possible habitation sites, giving a mean of 1.4, close to the 1.17 produced by the CMP for this elevation band. Four of these were BM II and 7 PII-III. No quadrats had an elevation greater than 6400 ft.

It is clear that the area west of the Cedar Mesa sampling universe, east of the Red House Cliffs and south of the 5600 ft. contour line to the San Juan River will have very few sites, and most of those will be BM II Limited Activity Sites (Figure 5). The elevation between the 6000 and 6400 ft. will be similar to the same elevation band on Cedar Mesa, as shown by the Pine Dripping Canyon quadrat survey. with likely slightly more than one habitation site per quadrat.

There remains the band above 6400 ft. between the northwest edge of the CMP defined project area and Natural Bridges National Monument. Although the Extension survey did not cover any of this area, it is also immediately adjacent to the Upper Grand Gulch drainage,
which was sampled during the CMP. Nine quadrats were surveyed there and all were between 6400 and 6800 ft., producing an average 2.33 “Prehistoric Open Sites with Features” per quadrat. Either this figure, or the overall CMP 6400-6800 ft. figure of 3.1 sites, indicate that
band between Upper Grand Gulch and Natural Bridges is a high density area.

Thus we can legitimately produce Figure 5 showing the ‘extension’ of the elevation bands to the west and northwest of the CMP project area, showing three levels of site density, with an implied fourth, the area below 5600 ft. with an expected site density of far less than half of that between 5600 and 6000 ft. The 5600-5800 ft. band in the Cedar Mesa sampling frame averaged only .18 habitation sites per quadrat.

The area to the south and southeast of Cedar Mesa to the San Juan river has also been filled in as a very low density area. That does not mean that there are not important sites there (The Lime Creek Clovis site, for example) but that the site density is very low.

![Figure 5. “Extended” CMP Sensitivey Map.](image)
Origin of the “Cedar Mesa Pattern”? 

We complete this section with a more inferential issue, what is producing the Cedar Mesa site distribution? First, this pattern is produced by rainfall dry farming, known best today in the bean and winter wheat farming areas between Monticello and Cortez. For rainfall dry farming you need sufficient precipitation, enough warm days and a deep, absorbent soil. On Cedar Mesa one has an sandy aeolian soil that stores water well. It is not, though, evenly distributed on the mesa. Elevation is not the most sensitive environmental variable we found; instead the amount of dense Pinyon-Juniper in a quadrat was (Figure 6). Like elevation, the presence of abundant Pinyon-Juniper is also a proxy measuring precipitation and temperature, but it also occurs only on deeper soil, the other critical variable. This was the adaptation for 1100 years on Cedar Mesa, the differences, including the hiatuses and the various settlement patterns were probably as much due to changing climate as anything else.

We are not objecting to producing sensitivity maps. We in fact developed a linear regression model using elecvation and percent Dense PJ that works well with elevations up to 6800 ft. It is also consistent with the CMP based site densities. This equation is shown at the bottom of Figure 6.

Flood water and slope runoff farming is important in some of the larger washes east of Cedar Mesa, e.g. Comb adjacent to Cedar Mesa and further east in the Butler, Cottonwood and Recapture Washes, and Montezuma Creek. Brooks’ (1975) MA on Horse Flats, to the northwest of Cedar Mesa, shows that flood water farming was important (probably in combination with dry farming) there, and Milk Ranch Point to the northeast shows dry farming, but not at the same time that Cedar Mesa was occupied. So this simple model is very good for Cedar Mesa, and many other places, but others, some quite nearby, are very different.

After critiques from us and many others a revised modelling scheme was recently developed and the large MFO area divided into a number of areas, one called “Cedar Mesa”. Unfortunately (Figure 7) it has a new set of problems, showing abundant sites where none exist.

Modelling Conclusions

The attempts to modelling “sensitivity” in the greater Cedar Mesa region are failures, grossly inaccurate. In spite of long existing information about the site distribution in this area, much of it published in peer review literature and with detailed information available on line for more than a decade, it was not used in developing or testing the models. Is this a failure of archaeological infrastructure, where the expertise to do this kind of work and the needed local knowledge falls between academic, bureaucratic and contract archaeology? Or as others have suggested, is it the results of decades underfunding of management units, so that the crucial information is lost in backlogs never digitized and thus invisible when needed? In any event, one fears the results if the sensitivity maps are ever used.
Linear Regression Model

\[ \text{n of habitation sites} = -7.32 + 0.0238 \times (\% \text{ Dense PJ}) + 0.001254 \times (\text{Elev in ft.}) \]

\[ r^2 = 0.368 \]

Example, 5600-5800 ft, actual n of habitation sites is 0.18, predicted 0.22

Figure 6. Elevation and % Dense PJ of CMP Pueblo II-III Habitation quadrats (from Matson et al. 1990 Fig. XI-1,3) and Linear Regression Model.
Encroachment of Pinyon and Juniper
Land managers seem to agree that Pinyon and Juniper are invading the highly valued environments that produce grass. Looking beyond the strangely military language, “invade”, “encroachment” noted by Bryan Hockett it is apparent that much PJ has been there for a very long time. In 1973 Lipe planted a corn plot on Cedar Mesa slashed and burned the previous year (Figure 8). As part of this experiment he sent sections of the wood from the plot and from a nearby surveyors line recently cut (1970) to be tree-ring dated and some 100 were.

From time to time we have taken photos (Figure 9) of the plot and mapped what was present. The photos show almost no “rejuvenation”. The PJ that has come back with two exceptions was from stumps that were not killed when cut and burned. The two exceptions were one pinyon seedling and one juniper seedling, seen in Figure 10. Neither made it. Not much encroachment going on here in 45 years.

The age profiles of the 100 dated samples look like this (Figure 11). The median and average ages are in excess of 200 years, and the third quartile is nearly 300
Figure 8. Todie “Slash and Burn Plot” 1973

Figure 9. Todie S/B Plot photographed at different years and 1992 map of plot.
years. Only 3 were less than 50. Since many of these trees were junipers with centers that had decayed, these are underestimates of the actual age of the trees. The oldest one is more than 450 years old with the first counted ring being laid down in 1491.

The Todie plot is in a good, deep soil area at about 6560 ft. in elevation, but not in anyway untypical of that elevation on Cedar Mesa. This is the lower end of the most densely occupied part of Cedar Mesa as discussed in the first section of this paper. We expect similar results elsewhere at similar elevations on Cedar Mesa.

![Figure 10. Juniper and Pinyon Seedlings in 1992](image)

Figure 11. Histogram of trees from Surveyor’s Line and Todie S/B Plot.
This is a very slowly regenerating woodland. The failure of the single juniper and pinyon seedlings to survive the middle 1990s may be the result of climate change, but even if they survived, the message they give us would be the same. In 1972, the well-known plant ecologist, Jack Major, cored some small PJ that appeared to be “encroaching” into the sagebrush flats and was surprised to see how many rings there were in the spindly specimens. The dates of the PJ recovered subsequently were not surprising. If “encroachment” is to be used, it would be more appropriately be used in terms of modern day harvesting of these old trees.

Pinyon-juniper forests sometimes burns as happened recently on Mesa Verde N.P. In our experience on Cedar Mesa (now jointly over 100 years) this is not a problems as lightning caused fires self-limit their extent to no more than several dozen trees. Thinning trees to lower fire risk does not make sense in this environment, although this may change if extensive beetle kill reoccurs.

General Conclusion

In the last 150 years our ability to understand our surroundings has greatly exceeded our ability to put this new knowledge to good use. The vast increase in understanding the nature of archaeology and the distribution of archaeological remains and past environments that came into being with the “New Archaeology” introduced more than 50 years ago is not being integrated into land management practices. In particular the relevant local information seems often to have been ignored. The data we obtained in the CMP (1972-1975) was first summarily published in 1978 (Matson and Lipe 1978), not quite four decades ago. The quadrat elevations and percent dense PJ data used in the first part of this paper are from tabulations dated 1982.

The issues about the PJ were raised in public meetings with land managers in the 1970s. Much has changed for the better since then, but we appear to have a serious problem in locating the appropriate knowledge and information when it is needed for practical applications.

References cited.

Brooks, Dan
1975 Prehistoric Soil and Water Control in the American Southwest: A Case Study.

Fast, Natalie
2012 How Great were Cedar Mesa Great House Communities, A.D. 1060-1270?

Haase, William R.
1983 Pueblo II and Pueblo III Settlement Patterns on Cedar Mesa, Southeastern Utah.

Lipe, William D.
2013 Old-Growth Pinyon-Juniper Woodlands and Archaeology on Cedar Mesa:
Characteristics and Management Concerns. Available at WSU: Research Exchange, Cedar Mesa Project.
Lipe, William D. (editor)

Lipe, William D., R. Kyle Bocinsky, Brian S. Chisholm, Robin Lyle, David M. Dove, R.G. Matson, Elizabeth Jarvis, Kathleen Judd, and Brian M. Kemp

Lipe, William D. and R. G. Matson

Lipe, William D. and R. G. Matson

Lipe, William D., R. G. Matson, and Margaret Powers

Matson, R. G., and William D. Lipe

Matson, R. G., and William D. Lipe

R. G. Matson, William D. Lipe and Diane Curewitz
2016 Dynamics of the Thirteenth-century Depopulation of the Northern San Juan: The View from Cedar Mesa. *Kiva* 80(3&4):324-349.

Matson, R. G., William D. Lipe, and William Haase
Matson, R. G., William D. Lipe, and William Haase
1990 Human Adaptation on Cedar Mesa, Utah, Revised edition. Available at:
https://circle.ubc.ca/handle/2429/47011

Morin, Jesse, and R.G. Matson

SWCA Environmental Consultants
2016 (July) Class I Cultural Resource Inventory of Lands Administered by the Bureau of Land Management, Monticello Field Office (Draft).

SWCA Environmental Consultants
2017 (July) Class I Cultural Resource Inventory of Lands Administered by the Bureau of Land Management, Monticello Field Office (Draft).