Factors Influencing Radiocarbon Date Patterns in Southern Wyoming

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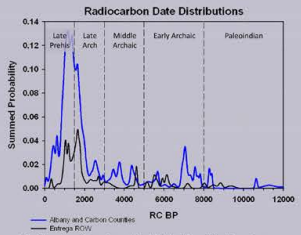
INTRODUCTION

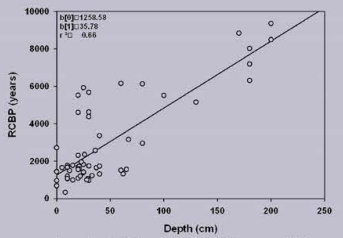
Building chronologies is a challenging but fundamentally important task in archaeology. The main lines of evidence used for organizing prehistory in southern Wyoming include stratigraphy, diagnostic artifacts (primarily projectile points), and radiocarbon date frequencies. Here we focus on the use of radiocarbon date frequencies in particular, in part because of the treatment the topic has received recently (Surovell 2007; Surovell, et al. 2009). We approach the problem as a general issue relating to the distribution, preservation, and recovery of archaeological materials. We evaluate the roles of behavioral variation, feature visibility, excavation bias, and taphonomy in the interpretation of radiocarbon date frequency diagrams. These issues are investigated as part of SWCA Environmental Consultants efforts to assess the long term cumulative effects of linear disturbances in a 233 by 2 mile buffer zone along the Rex/Entrega pipeline in Southern Wyoming (Seddon et al. 2005). This area has been central to some foundational efforts in chronology building (Metcalf 1987; Thompson and Pastor 1995).

Map of project area showing path of the Wyoming portion of the Entrega/REX pipeline. Information on radiocarbon dates, cultural material, and subsurface tests were collected from this area.

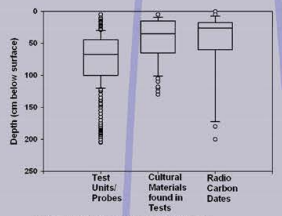


Profiles of radiocarbon date distributions like these have been especially important for the development of chronologies in Southern Wyoming (Metcalf 1987). Recent work has shown that similar patterns are seen in noncultural datasets and that taphonomy alters date patterns.

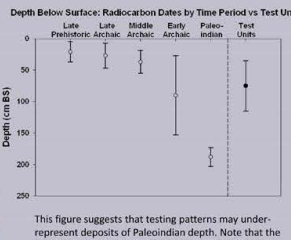
Dated features are frequently discovered in settings like this, a bladed right-of-way. Clearly, there is a lot more disturbance in the bladed surface than in the trench itself, which likely biases discovery toward the upper 30 – 50 cm, or toward recent/shallower finds. However, we could not find clear evidence for this bias in our analysis.



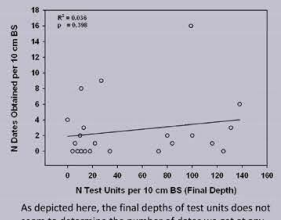
Across the pipeline's path, depth and RC age are positively related (thankfully). This furthers the concern that investigation strategies biased toward discovering shallower (younger) dates could also bias the RC date curve.



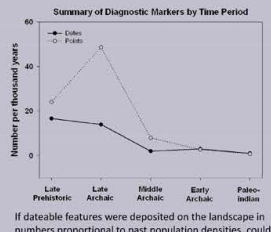
Do we dig deep enough often enough?
- the distributions of depths for all shovel tests, cultural materials found in them, and radiocarbon dates from within the pipeline buffer.



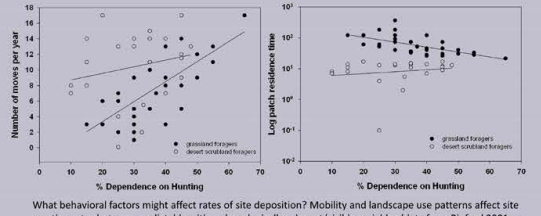
This figure suggests that testing patterns may under-represent deposits of Paleoindian depth. Note that the error bars are based on 1 standard deviation but the actual distributions are not normal (see fig to left).



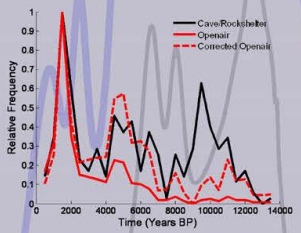
As depicted here, the final depths of test units does not seem to determine the number of dates we get at any given depth. But look again at the photo of the bladed right-of-way (upper right of poster) – do you still think this probably biases us toward shallower features?



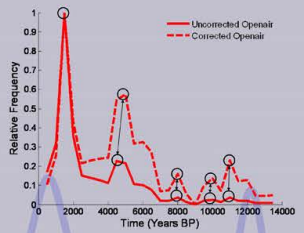
If dateable features were deposited on the landscape in numbers proportional to past population densities, could the same be true of other diagnostic markers? What factors might affect the production and loss of points by time period and are these factors more or less difficult to address than those affecting the deposition of dateable features?



What behavioral factors might affect rates of site deposition? Mobility and landscape use patterns affect site creation rates but vary predictably with archaeologically relevant/visible variables (data from Binford 2001 – see also Kelly 1995). Here we see that hunting and environment type condition mobility and residence. Which of these potential records would be more conspicuous after millenia?

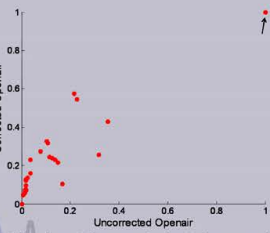


Attention to the problems associated with interpreting demographic signals from RC date profiles has increased recently due to the work of Surovell and colleagues, who have also developed a method for correcting taphonomic bias based on the geological destruction of volcanic terrestrial sediments. The result of the terrestrial deposit decay correction is shown. The corrected openair dates are closer to the less-biased cave/rockshelter record. The data encompass the study area (redrawn from Surovell et al. 2009).

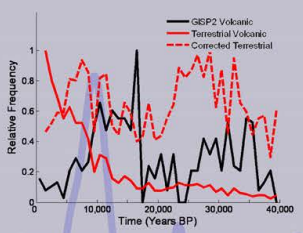


uncorrected			corrected		
rank	year	prop	rank	year	prop
1	1500	1.00	1	1500	1.00
2	4500	0.23	2	5000	0.57
3a	11000	0.04	3	11000	0.23
3b	8000	0.04	4	8000	0.16
4	10000	0.02	5	10000	0.14

How does this alter our perception of prehistoric demography and chronology in southern Wyoming? Without the correction, peaks 3 and 4 appear equal.



While taphonomic bias can greatly alter RC date patterns, the corrected and uncorrected date sequences are correlated (Surovell et al. 2009).
With influential point removed (indicated with arrow):
Spearman's r = 0.87 and Pearson's r= 0.76.
The correction changes our understanding of the pattern - consider the magnitudes of the shifts in the peaks in the figure to the left – but the relative order of peaks is similar.



The volcanic records used to make the terrestrial deposit correction function (Surovell et al. 2009). Like the archaeological case, volcanoes have a true underlying 'demographic' signal, but unlike archaeology this signal is well-preserved in GISP2 ice cores. Note that the correction seems to more closely align the openair archaeology dates with the caves/rockshelters (see figure, far left, bottom) than it does the record of terrestrial volcanics with the GISP2 volcanic record.

FINAL THOUGHTS

Interpreting archaeological data is usually (always) challenging.
As food for thought, we offer the perspective of Metcalf (1987):

"The assumption here is that the frequency of dates can be interpreted as reflecting general trends in intensity of occupation, but differential preservation and differential discovery potential will obscure actual levels of intensity of occupation. So, it might be valid to say the area was more or less intensively utilized from one millennium to the next, but invalid to directly compare population levels between millennia separated by thousands of years."

ACKNOWLEDGEMENTS

Our interest in this topic was sparked largely by two pioneering papers published in JAS by Surovell and colleagues. These papers not only identified and defined the problem, but proposed a potential solution. Todd also provided us with some of the data from their paper, which we reproduce here. Judson Finley provided valuable consultation about the interpretation and use of radiocarbon date data. David Byers provided critique and suggestions for analysis. We thank Larry Todd for encouraging us to wonder about such things. Lastly, we thank all the hard working archaeologists who dug all those test units that we have the nerve to so nonchalantly summarize in mere box plots.

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