Comments/Rebuttals

Rebuttal Response: ''Disturbance to Surface Lithic Components of Archaeological Sites by Drill Seeding.'' *Rangeland Ecology & Management* 64:171–177

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We welcome the dialogue initiated by the rebuttal of Rust and Earl as an opportunity to discuss the concerns of both archaeologists and ecologists regarding the disturbances associated with rangeland management practices. We hope that in the process, unconfirmed opinions can be distinguished from empirical evidence, and therefore allow policy and its implementation to be aligned with sound, research-based principles. We stated in our article that cultural resources need to be considered and protected. Rust and Earl confirm that statement but misrepresent other aspects of our work.

Rust and Earl begin by stating that National Register Criteria typically would not call for avoidance of surface lithic scatters but later take us to task for ''misunderstanding'' the significance of lithic scatters. We intentionally designed our study to quantify effects of rangeland drill-seeding on surface lithic scatters precisely because they a) are a common feature, b) can remain undetected in a pedestrian survey, and c) are potentially subject to the direct effect of drill-seeding equipment. For the reasons that Rust and Earl ably explain, a preponderance of recorded sites are characterized—upon initial examination, at least—only by surface lithic scatters, whether they later are found to contain subsurface features or not. We infer from Rust and Earl's objections that surface lithic scatters are not intrinsically valuable, but that they serve as a marker of more important cultural sites. In contrast, our study considered surface lithic scatters as cultural sites in their own right but distinct from sites with additional archaeological features. At no point did we intend to imply that the direct effects we measured on surface lithics could be translated to other archaeological features. The ''risk to cultural sites'' to which we refer in the Management Implications section is indirect damage to sites, including potential for soil erosion and looting of artifacts following avoidance mitigation.

The National Register Criteria are implemented by agencies and interpreted by individuals. According to the BLM Handbook, 10 surface lithics within a 10-m diameter would qualify as an archaeological site; not unlike our study design. However, ''Archaeological discoveries which are less substantial … may be recorded as sites if a professional archaeologist believes they are important enough …'' (BLM Handbook H-8110 2002). Even in this first step in the process of adding a site to the National Register, great latitude is given to an individual interpretation of the importance of cultural resources relative to other valuable resources.

Experimental Design

Although we specified in the article that ''because of a shortage of suitable lithic pieces, lithic size was not an experimental factor,'' we acknowledged that effect will vary with lithic size and mass. Rust and Earl cite evidence of that effect from Odell and Cowan (1987) and Dunnell and Simek (1995), but this detraction is wholly irrelevant because in our study ''all lithic sizes were exposed to all treatments'' and the size of lithic flakes would not be a determining factor in a decision to reseed a site or not. Our data suggest only a trend that smaller lithics were more likely to be displaced unscathed, whereas larger lithics were more likely to sustain damage and remain in place, a conclusion that can be surmised from our *Discussion*. We disagree that our descriptions of the data presented in the study are insufficient. We included a description of sample size and materials (p. 172); cited specific numbers in our *Results* that allow the reader to back-calculate our sample size, and presented a scatterplot of all data in Figure 3.

Adverse Effects to Cultural Materials

Rust and Earl claim that significant sites with several different components have remained buried in a ''relatively stable context for thousands of years'' without specifying the context for this stability. Even if this claim could be substantiated, it is likely that extant perennial vegetation largely was responsible for such stability. Supposing that a fire has removed that stabilizing influence, and considering that the target seeding depth of rangeland drilling is less than one centimeter, we maintain that such stable sites will be affected less by reseeding than by unchecked erosion.

That Rust and Earl consider our reported values of lithic damage and displacement to be significant is a matter of interpretation. Our article addressed this matter with respect to surface/subsurface correlation. First, we presented published evidence that damage and displacement by natural processes meets or exceeds our reported values. In addition to the example cited in the article, here we present more references on the significance of bioturbation (Bocek 1986; Johnson 1990, 2002; Balek 2002; Van Nest 2002). Balek (2002) shows that even ''stable'' upland sites can be affected significantly by

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biomechanical processes and that artifacts " … can be sorted by size, become temporally mixed, and can be displaced laterally and vertically." Second, the common methods of collecting and analyzing archaeological data do not have sufficiently high resolution to be significantly affected by the amount of displacement demonstrated by our study. Quadrat provenance consists of recording the location of artifacts to a specified resolution, usually in the range of 1–10 m^2 and generally is used for higher-density populations. Point provenance consists of recording exact locations for each artifact and works best for low-density populations. Even when using point provenance, increasing the scale of a study arguably is more valuable than exact provenance, and the scale necessary to examine patterns will subsume slight movements (O'Connell 1993). In selecting a specific method of collecting data on site, the archaeologist seeks to collect the largest continuous area possible with necessary detail and accuracy. We maintain that the 15-cm mean displacement in our study is insignificant at the typical scale of analysis. In the next section, we will return to this point in light of the available literature.

We also remind the reader that we aligned our experimental lithics to maximize mechanical contact with the rangeland drill disks. Lithic damage data therefore are exaggerated by as much as an order of magnitude, because as little as 10% of the soil surface is contacted by the disk. As we reported in the article, the total mechanical disturbance to the soil surface was 71 and 75% for the 30.5 cm and 20.3 cm disk spacing, respectively; this value includes the area contacted by the disks as well as the adjacent cast-disturbed area. By the same token, the probability and distance of lithic displacement also is exaggerated.

The Archaeological Literature

We presented two schools of thought in surface/subsurface correlation, and we placed Horobik and Parkisons (2008) in the second group, with data indicating that surface collections are not necessarily representative of subsurface collections. Similarly, we did not construe the findings of Lewarch and O'Brien (1981) as a recommendation to plow over archaeological sites, and nowhere do we make such an implication. We simply presented their paper as evidence that it is possible to account for lithic displacement, and that directional disturbances are easier to account for than less-predictable forces.

By citing Nance and Ball (1981), we intended to illustrate that in context of the literature, the authors' chosen range of grid sizes (1–12 m^2) effectively brackets a typical grid size of 5 or 6 m^2. Although the data did show that smaller grid size yielded better accuracy, it is clear they are identifying cost-to-benefit ratios. Their data give the archaeologist an idea of how much the data can benefit relative to the increased "cost" of smaller grid units. Although higher resolution in data collection usually is better, a modest improvement in data parameters might not justify a large increase in cost resources. A 1-m^2 grid is the low end of the spectrum and rarely is used until site excavation. Finally, we note that the smallest tested grid size is still larger than our mean displacement value.

Rangeland Seeding Options and Avoidance

Rust and Earl allege that we assume drill seeding to be the only method of reseeding and avoidance–mitigation as the only option to protect archaeological sites. They recommend getting past "the cheapest and quickest" methods and considering the needs of both resources. First, we assert that we have presented empirical data and evidence from the literature that addresses both archaeological and ecological resource concerns. The negative environmental impacts of minimal vegetative cover are indisputable. Inadequate revegetation results in resource degradation, decreases site potential, incurs intensive soil loss, fosters weed proliferation, and increases risk of wildfire occurrence. Second, this issue is more complex than "archaeology versus ecology." All resources are limited, and we must maximize efficiency for preserving the vegetation, soil, ecosystem, and archaeological resources. We cannot ignore time, effort, and money as constraints in the management of these sites. For example, we estimate—with information obtained from the BLM under the Freedom of Information Act—that archaeological clearance for 12 140 ha of the 2007 Milford Flat Fire in southern Utah cost $1 million, or about $82 ha^{-1}. Drill seeding ensued at a cost of $27 ha^{-1}. The per-hectare expense of a proposed treatment and the number of hectares that can be treated are inversely proportional. Alternative methods for range recovery could have been considered had the archaeological clearance not consumed 75% of the budget, and all to mitigate for a method of revegetation we view as innocuous to most nonfeatured cultural sites. The sobering reality is that many rangelands go untreated because of rigid archaeological requirements, and therefore place both ecological and cultural resources at higher risk of deterioration. The revegetation methods that Rust and Earl deride as "the cheapest and quickest" have proven cost-effective and efficient.

Although avoidance can be a problem for archaeological sites, it is of secondary concern. In the Milford Flat scenario, the number of hectares reseeded was limited by the cost of archaeological clearance, and re-establishment of vegetation likely was reduced by the associated time delays. Because government agencies are accountable for damage resulting from their interventions, the default response has historically been a Class III archaeological inventory—described by the BLM Handbook (2002) as "continuous, intensive, and complete." This expensive and time-consuming approach attempts to prevent direct damage to cultural resources, but ignores the potentially tremendous damage to cultural and ecological resources resulting indirectly from the absence of perennial vegetation on the site. To counterbalance the tendency to reduce and delay revegetation efforts, agencies also should be accountable for damage resulting from neglect or dereliction. Current guidelines already allow that " … a Field Manager may waive inventory for any part of an Area of Potential Effect when … the nature of the proposed action is such that no impact can be expected on significant cultural resources" (BLM Handbook H-8110, 2002). We propose a more judicious use of various levels of archaeological inventory, particularly for range treatments that are shown to be benign. Prompt and effective treatment protects not only the ecological integrity of the landscape but also extant archaeological resources until there is enough time and money to adequately record and survey them.

We did not undertake this study to consider our findings within a fixed structure of legal requirements, but rather intended it to be the seminal project in obtaining data upon which we can sensibly base range management practices and, if necessary, adapt policy and law. Confronting long-held misconceptions can be uncomfortable, but we believe our study does exactly what Rust and Earl advocate for in their conclusion: to "get past stating concerns" and "consider the potential effects of various treatments on cultural resources and determine what types of activities can be expeditiously authorized." Our study is unique because rangeland management practices have not been studied widely relative to the impact on cultural sites, but we believe our data indicates that rangeland drill seeding is a practice that could be "expeditiously authorized" in many cases on western rangelands. Regardless of when emergency response plans are created, they are more valuable when based on evidence rather than assumption. We renew our call for additional studies to quantify effects of rangeland treatments so data can be used to improve protection for range resources—including cultural resources—in light of long-term results and the interdependency of multiple resources.

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