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# Scale in the study of Indigenous burning

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All future environmental challenges are human–environmental challenges, so it behoves us all to learn from long-term successes (and failures) of coupled human–natural systems both in the past and today to inform contemporary management, ecological restoration and conservation[1]. On this point, I agree with a paper by Oswald et al.[2]. The authors assemble an impressive volume of charcoal, pollen and archaeological data from southern New England to evaluate a longstanding hypothesis that Native Americans managed New England landscapes with fire, thereby creating landscape heterogeneity, including open forests and meadows. However, because of the regional scale of their analysis, their synthesis is predisposed to reject this hypothesis irrespective of evidence within their records of human impact and fire management.

The authors approach Indigenous fire management at the regional scale—an area covering part or all of five US states. This study area was home to numerous Indigenous societies—at least 14 autonomous eastern Algonkian tribal groups around the start of the seventeenth century[3]. Not a single one of these communities would have exercised their land use at the ~65,000 km² regional scale represented by the distribution of palaeoecological coring locations. These populations practised a form of seasonal mobility to cultivate or harvest different resources at different times of year, referred to as "conditional sedentism"[3]. However, even with this form of central-place foraging and horticulture, most land-use activity would probably have been within 2–5 km of each settlement at any given time[4]. A regional analysis that presumes the same forms of landscape management and human impacts existed uniformly across this multi-state area is mismatched to the scale at which Native people lived. Therefore, this type of study is always likely to conclude 'no management' by Native people because it overlooks the sort of evidence that would show it. In the authors' Figs. 2a and 4a, it is clear that there is a great deal of heterogeneity in the charcoal records that is a product of variable local fire activity. Local comparisons of human history (from archaeology or ethnohistory) with local fire records (for example, macroscopic charcoal[5] from sedimentary deposits within the archaeological landscape) would be more relevant for assessing Native fire management[6]. Indeed, Oswald et al. acknowledge the correlation between human population peaks and local peaks in fire activity at some sites. However, many of the coring sites have no archaeological evidence (in northern Connecticut, Rhode Island and most of Massachusetts), and the areas with the densest palaeoecological coring locations (Cape Cod and Martha's Vineyard) have curiously little evidence for horticulture or wild-plant use, both activities that may have involved fire[7,8].

The study's conclusions were further predetermined by the averaging of charcoal, pollen and archaeological records across the entire region regardless of the spatial heterogeneity of those records. Doing so inherently emphasizes the shared variability between the records and therefore the driver that is common across that spatial scale, in this case a multi-state region. For Indigenous fire management to show up in this averaged record, variation in Native fire management would have to have been synchronized—across 14 or more tribal groups—and extensive enough to register in a large number of coring locations. This type of regional averaging prioritizes interpretations based on shared drivers (often climate, which has a larger, synchronized spatial imprint) and obscures heterogeneity in space and time that often characterizes Indigenous fire management[9]. The charcoal records used in Oswald et al. are quite variable and asynchronous, but this is lost in an average that changes relatively little over time. The palaeofire coring locations also appear to be spatially mismatched with the heterogeneous distribution of the 1,800 archaeological sites. Summing the total number of archaeological sites across the region gives the appearance of spatial homogeneity, but the maps tell a very different story. Mixing palaeoecological records that are unlikely to evince human management (no archaeology or other human proxy at the local scale) with some records that do evince human management by averaging would necessarily dilute the evidence for Native American management. Spatially and temporally relevant landscape connections between coring sites and archaeological landscapes are what is needed to assess Indigenous fire management[6,10] without dilution by regional averaging.

Furthermore, the study assumes that evidence of climate drivers in palaeofire records precludes evidence for human management, which is an outmoded dualism that assumes fire is exclusively 'natural' or 'cultural'[11]. Although some Indigenous fire-use buffers the impacts of climate variability[12,13], in other cases it can amplify or synchronize fire activity with climate[14]. Regional averaging of palaeofire records is always likely to emphasize climate because it is a driver that can operate synchronously at that broader spatial scale. The presence of that climate signal, however, is not de facto evidence that Native people were not managing fire within that region. In fact, Native fire management might be one of the reasons that the fire–climate linkage is so strong, especially in ignition-poor regions, such as southern New England[15].

This is not a sterile academic debate on proper methodology. Conclusions about histories of environmental management by Indigenous people have real-world consequences—see some of the political fallout from Tim Flannery's controversial environmental history of Australia, *The Future Eaters*[16]. One of the goals of the study by Oswald et al. was to have real-world impacts on conservation practice. However, it is precisely because studies such as this can impact contemporary practice as well as the Native communities connected to that land that we in the scientific community have the responsibility to take extreme care with the relevance of the evidence used to support a particular claim about Indigenous management or lack thereof. This is particularly true when the study in question conflicts with rich historical evidence of Native fire use[7,8].

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This is not to say that the research by Oswald et al. is incorrect. Certainly, their inference that the regional-scale ecological consequences of European colonization were qualitatively different at that scale than what came before is the best supported—but also the most understated—inference in the paper. My point is that the authors cannot have confidence that they are right or wrong in their conclusions about Native management because their methods have precluded the generation of relevant evidence to evaluate Indigenous land use at the scales at which people lived.

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## Competing interests

The author declares no competing interests.

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