LETTER

REPLY TO WESTAWAY AND LYMAN:

Emus, dingoes, and archaeology's role in conservation biology

Melinda A. Zeder[a,b,1], Tim Denham[c], Jon M. Erlandson[d], Nicole L. Boivin[e], Alison Crowther[f], Dorian Q. Fuller (傅稻镰)[g], Greger Larson[h], and Michael D. Petraglia[e]

In a curious comment on our PNAS Perspective (1), Westaway and Lyman (2) offer two Australian zooarchaeological case studies—one involving eggshells and the other dingoes—that they argue undercut one of our main points: that archaeological data and deep time perspectives have much to offer conservation biology. Neither example provides a specific substantive critique of our perspective: there are no dingoes in our article (1), no eggshells, and we mention the long and rich record of human management and alteration of Australian environments only briefly. Nor do we suggest that all archaeological assemblages can effectively inform current conservation biology efforts. Such datasets obviously vary in their quality and potential applicability to modern situations (3). When considered more closely, both of Westaway and Lyman's (2) case studies underscore rather than undercut the importance of archaeological and paleoecological data in conservation biology initiatives.

Westaway and Lyman's (2) first example, focused on the potential misidentification of directly dated eggshell fragments as belonging to the extinct flightless bird *Genyornis newtoni*, does not contradict our conclusion that Aboriginal burning practices had substantial impact on biodiversity in Australia (1). The taxonomic reassignment of the eggshell as a megapod (another large flightless bird that disappeared shortly after human arrival in Australia) (4) has no relevance for the original study's isotopically based inferences about the degree of dietary specialization of the extinct species versus the still extant emu (5). Nor does this new identification (if correct) have any bearing on the shift in emu diet detected in the original study at about 45 kya, which formed the basis for Miller et al.'s conclusions regarding the contribution of human firing to changes in vegetative composition. Far from weakening the central thesis of our article (1), the evidence regarding the intensity of human landscape manipulation and its impact on Australian biotic communities afforded by the recent studies cited by Westaway and Lyman (2) provides additional support for our point that the increasing number and effectiveness of archaeological methods over the past 20 y has greatly enhanced the ability to produce fine-grained reconstructions of human/environmental interactions and human foraging systems in Australia (e.g., ref. 6) and elsewhere.

Westaway and Lyman's (2) second case study, which considers proposals to reintroduce dingoes in Australia as a means of controlling exotic predators and maintaining indigenous biodiversity, also strongly supports the very issue at the heart of our paper (1): that archaeology can contribute key information needed in the formulation of conservation plans. Although the relative role of dingoes vs. humans in the loss of indigenous marsupial predators remains an open question, the relevant datasets needed to provide answers can only be obtained from the archaeological record.

Archaeologists and conservation biologists clearly must be aware of the limits of the archaeological record and its applicability to current day conservation efforts (3). Few would doubt this point or the ability of ever-larger datasets and high-resolution methods to address these limitations. The fact remains that these historical datasets are fundamental to attempts to understand both ecological systems and the role of humans in shaping them.

[a]Program in Human Ecology and Archaeobiology, Department of Anthropology, National Museum of Natural History, Smithsonian Institution, Washington, DC 20013; [b]External Faculty, Santa Fe Institute, Santa Fe, NM 87501; [c]School of Archaeology and Anthropology, College of Arts and Social Sciences, Australian National University, Canberra, ACT 0200, Australia; [d]Museum of Natural and Cultural History, University of Oregon, Eugene, OR 97403-1224; [e]Max Planck Institute for the Science of Human History, Jena D-07743, Germany; [f]School of Social Science, The University of Queensland, Brisbane, QLD 4072, Australia; [g]Institute of Archaeology, University College London, London WC1H 0PY, United Kingdom; and [h]Palaeogenomics & Bio-Archaeology Research Network, School of Archaeology, University of Oxford, Oxford OX1 3QY, United Kingdom

Author contributions: M.A.Z., T.D., J.M.E., N.L.B., A.C., D.Q.F., G.L., and M.D.P. wrote the paper.

The authors declare no conflict of interest.

[1]To whom correspondence should be addressed. Email: zederm@si.edu.

1 Boivin NL, et al. (2016) Ecological consequences of human niche construction: Examining long-term anthropogenic shaping of global species distributions. *Proc Natl Acad Sci USA* 113(23):6388–6396.
2 Westaway MC, Lyman RL (2016) The need to overcome risks associated with combining inadequate paleozoological records and conservation biology. *Proc Natl Acad Sci USA*, 10.1073/pnas.1609950113.
3 Wolverton S, Nagaoka L, Rick TC (2016) *Applied Zooarchaeology, Five Case Studies* (Elliot Werner Publications, Clinton Corners, NY).
4 Grellet-Tinner G, Spooner NA, Worth T (2016) Is the "*Genyornis*" egg a mihirung or another extinct bird from the Australian dreamtime? *Quat Sci Rev* 133:147–164.
5 Miller GH, et al. (2005) Ecosystem collapse in Pleistocene Australia and a human role in megafaunal extinction. *Science* 309(5732):287–290.
6 Bird DW, Bliege Bird R, Codding BF (2016) Pyrodiversity and the anthropocene: The role of fire in the broad spectrum revolution. *Evol Anthropol* 25(3):105–116.