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Introduction to *Zooarchaeological Method and Theory*: a Special Issue Honoring R. Lee Lyman

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Abstract The Society for American Archaeology presented R. Lee Lyman with the Fryxell award for Interdisciplinary Excellence in Zooarchaeology in 2011. Lyman has produced over 120 journal articles or book chapters, and four single-authored books on the topic, and this issue honors his contributions to zooarchaeological method and theory with six original pieces by his peers. Arguably, his greatest impact has been in the field of vertebrate taphonomy and the development of a means to measure density-mediated bone attrition, but of equal importance was emphasis in the discipline that unit selection, or what one measures, should be linked to a particular research question. Lyman's work has also stressed the importance of making zooarchaeology relevant to modern issues of conservation biology.

Keywords R. Lee Lyman · Zooarchaeology · Vertebrate taphonomy · Conservation biology · Quantitative methods

Introduction

This special issue honors the contributions R. Lee Lyman has made to the field of zooarchaeology. For over 35 years, Lyman has been making seminal contributions to a range of topics including taphonomy, quantitative methods, biogeography and paleoecology, predator/prey interactions, and conservation biology. When we learned in spring 2010 that he had been honored with the Fryxell Award for Interdisciplinary Excellence in Zooarchaeology, we developed plans for a symposium at the 2011 Meeting of the Society for American Archaeology (SAA) in Sacramento, California, soliciting abstracts from scholars whose work has been enriched by Lyman's theoretical and

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methodological approaches. The SAA session included 12 papers on a wide range of topics that revealed just how rich and varied Lyman's reach has been (Broughton *et al.* 2011; Butler and Elder 2011; Cannon 2011; Darwent 2011; Dobney 2011; Gifford-Gonzalez 2011; Nagaoka 2011; Marshall and Asa 2011; Outram and Evershed 2011; Schmitt and Lupo 2011; Schollmeyer and Driver 2011; Wolverton 2011). Six of these were expanded for publication in this special issue. Here, we summarize the core areas of Lyman's research and highlight links to these papers.

Research Productivity and Research Focus

By any measure, Lyman's publication record is staggering. Within just the subfield of *zooarchaeology*, at the time of this writing, Lyman had produced 101 peer-reviewed journal articles, 18 book chapters, 2 edited books, and 4 single-authored books (see Appendix for a complete list of Lyman's publications related to zooarchaeology along with citation frequency). Most of these works are single authored, and the journals in which he has published (Table 1) are the flagship journals in archaeology, paleontology, Quaternary science, and conservation biology. He has worked with 28 different coauthors on zooarchaeological themes—all of whom undoubtedly would agree that their research and writing were enhanced by their collaboration with him. As impressive as the above accounting is, it only pertains to Lyman's work in zooarchaeology. Lyman has had major impacts in other research areas, including evolutionary anthropology and the history of American archaeology. His publication list would nearly double if his contributions in these areas were included. We might also ask what his scholarly contribution might be if he had not served as department chair for over a decade.

Besides Lyman's prodigious output, another hallmark of his career is the wide range of topical themes to which he has contributed and which we consider here, along with the assembled papers.

Vertebrate Taphonomy

The Cambridge Press publication *Vertebrate Taphonomy* (Lyman 1994a) has, without a doubt, made Lyman's name synonymous with this field of research. The book is cited or referred to so frequently that it has affectionately been dubbed the "Taphonomy Bible." It is used as a text and reference for students and professionals in archaeology and paleontology. Even 18 years after publication, it is still the best resource available on the topic and as of this writing has been cited 1,194 times. *Vertebrate Taphonomy* exemplifies Lyman's encyclopedic command of the literature and his ability to write about a complex topic in a way that makes it accessible to a wide audience.

Among his many forays into taphonomy, Lyman has investigated the effects of fragmentation on identifiability and bone grease extraction, effects of volcanic explosive events on bones, bone weathering, actualistic study of owl pellets, and bone utility indices for marine mammals. Perhaps most important is his work establishing the importance of bone density in mediating bone preservation that he began as part of his doctoral research, which has had enormous implications for studies of ancient human subsistence, including distinguishing hunting from scavenging and models related to transport of body parts from kill sites to base camps. Although several scholars before

Table 1 Peer-reviewed journals in which Lyman has published between 1977 and 2012

Journal title	Frequency
Advances in Archaeological Method and Theory	2
American Antiquity	7
American Anthropologist	1
American Midland Naturalist	3
Arctic and Alpine Research	1
Archaeology in Washington	1
Biological Reviews	1
Canadian Journal of Earth Sciences	1
Conservation Biology	2
Current Anthropology	4
Current Research in the Pleistocene	2
Environmental Management	1
Ethnoarchaeology	1
Evolutionary Anthropology	1
Historical Archaeology	2
The Holocene	2
Human Nature	1
International Journal of Osteoarchaeology	3
Journal of Anthropological Archaeology	4
Journal of Anthropological Research	1
Journal of Archaeological Method and Theory	1
Journal of Archaeological Science	12
Journal of California and Great Basin Anthropology	1
Journal of Ethnobiology	6
Journal of Field Archaeology	3
Journal of Mammalogy	2
Journal of Northwest Anthropology	2
Journal of Taphonomy	3
Journal of Wildlife Management	1
Journal of Zoology	1
Marine Mammal Science	1
Northwest Anthropological Research Notes	4
Northwestern Naturalist	1
Northwest Science	8
Palaios	1
Quaternary Research	6
Quaternary Science Reviews	1
Review of Archaeology	1
Science	1
Tebiwa	1
Ursus	1
Western North American Naturalist	1
World Archaeology	1

him had devised methods of measuring bone density and worked to assess its role in structuring skeletal element frequencies, Lyman provided a much needed analytic framework and introduced an accurate and reliable way to measure this property of bones.

Lyman's study on cervid bone (Lyman 1984, 1985) was used as a model for multiple bone density studies such as for marmots (Lyman *et al.* 1992) and seals (Lyman 1994a), salmon (Butler and Chatters 1994), turkey (Dirrigl 2001), hare (Pavao 1999), canids (Novecosky and Popkin 2005), camelids (Stahl 1999), sheep (Symmons 2005), and bison (Kreutzer 1992). Lyman's work also showed that bone weathering is not an accurate indicator of bone assemblage formation (Lyman and Fox 1989). His study of the "crispy elk," which was discovered after the eruption of Mount St. Helens, led to a new avenue: "volcanic" taphonomic research (Lyman 1984b, 1989b). His work has had direct application for modern forensic science investigations (Beary and Lyman 2012; Lyman 2002d, 2013). We do not think it is too much of an exaggeration to suggest that Lyman's relentless concern with taphonomy over his career has contributed to the fact that this area of study is fundamental to zooarchaeological method and theory today. All of the contributions to this volume consider taphonomic issues—either as a central part of their study or as an issue that requires attention on the path to larger questions.

Quantitative Methods

Following in the footsteps of his doctoral advisor and mentor, Donald Grayson, Lyman co-organized (with V. Butler) a special forum to discuss methodological standards in faunal analysis at the Society for American Archaeology in 1995, and he has brought new insights to questions of sampling and quantification (1994a, 1994b, 1994c, 2008a). Lyman has encouraged long and hard reflection about what we are measuring when we tally bones and has tried to reduce the squabbling over "which quantification unit is best" by emphasizing that unit selection should be linked to the research question. His most recent single-authored book, *Quantitative Paleozoology* (2008a), which builds on Grayson's (1984) *Quantitative Zooarchaeology*, has already become the "go-to" reference for zooarchaeologists. Here, Lyman presents a comprehensive discussion of the fundamental counting units used in the discipline as well as a critical analysis of the significant changes that have occurred in quantitative zooarchaeology over the past 25 years.

Central to zooarchaeological research is accurate identification of specimens within a faunal assemblage. If the identifications themselves are flawed, then any quantification and analysis that follow will simply amplify those errors. Described by some as zooarchaeology's "dirty little secret," Wolverton (this issue), a former doctoral student of Lyman, presents a strong case for providing detailed information on zooarchaeological methods (*cf.* Driver 1992). Attention to issues of internal validity and quality assurance in zooarchaeology are of particular concern when these identifications are used to assert changes in prehistoric hunting patterns or are applied to conservation biology.

Linked to both taphonomic research and issues of identification and quantification, Lyman has addressed the relationship between fragmentation and quantification and the relation between number of identified specimens (NISP) and MNE/MNI and studies of archaeological fauna from Missouri and Washington (Lyman and O'Brien 1987; Darwent and Lyman 2002), analysis of owl pellets (Lyman 1994b, 2012d; Lyman *et al.* 2001; Lyman and Lyman 2003; Lyman *et al.* 2003), and experimental research on boiling and grease extraction (Church and Lyman 2003). Building on

these research themes, Cannon (this issue) develops a mathematical model to better understand the relationship between fragmentation, identifiability, and NISP. As part of model testing, he designed "bone crushing" experiments to empirically track the effect of fragmentation rate on NISP and then used digital image analysis to measure specimen area, which he finds is both a fairly simple and valid way to measure fragmentation. Finally, Cannon's study steps back to the larger concern about why we care about quantification and taphonomy: If we want to compare NISP values from site A to those from site B, we must be able to control for fragmentation differences.

Biogeography and Paleoecology/Biology

Lyman's rich record of biogeographic and paleoecological research has been used to isolate the main factors that structure the distribution and abundance of animals, such as climate change or human-caused resource depression. His work has considered a wide range in taxa, including distributions of freshwater clams (Lyman1980b, 1984c), pygmy rabbits (1991c, 2004f), voles and mice (Lyman 1997; Lyman *et al.* 2001), gophers (Lyman 1983), mountain beavers (Lyman and Zehr 2003), noble martins (Lyman 2011c), mink (2007a), bears (1986b, 2008b, 2011b), foxes (Lyman 1991d, 2012c; Lyman *et al.* 2006), seals (Lyman 1988a; Lyman *et al.* 2002), and ungulate species, including white-tailed deer (Lyman 2006d), wapiti elk (Dixon and Lyman 1996; Harpole and Lyman 1999; Lyman 2004d, 2006c, 2010a, 2011b), pronghorn (Lyman 2007b), bison (Lyman 2004c; Lyman and Bassett 2004), moose (Lyman 2010d), bighorn sheep (Lyman 2009, 2010e), and mountain goats (Lyman 1988b, 1994d, 1995e, 1998a). Importantly, it was his impact on biology that led the University of Missouri to present Lyman the Chancellor's Award for Outstanding Research and Creative Activity in Biological Sciences (2001). As an archaeologist, not a biologist, this was an exceptional achievement.

Butchery Studies

For much of Lyman's long career, he has used cut marks and body-part representation to infer butchery patterns and, in turn, larger aspects of human behavior. This has led him to investigate socioeconomic and taxonomic differences in butchered faunas from historic (1977, 1987d) and prehistoric contexts (Lyman 1978, 1987a, 1991a, 1992b, 1995c, 2006b; Lyman *et al.* 1992; Savelle *et al.* 1996). In this issue, Lupo, Fancher, and Schmitt unpack a series of linked assumptions commonly made in butchery studies—that the number of cut marks and degree of bone fragmentation are linked to intensity of carcass processing, which in turn is linked to resource intensification (itself perhaps a sign of resource depression and dietary stress). The authors empirically test several of these assumptions through actualistic study of animal carcass processing by two different groups of Central African foragers characterized by different foraging efficiencies. Their study finds that cut mark frequency and bone fragmentation are not simple proxies for foraging efficiency and highlights the need for more work on the variable socio-environmental forces that affect how humans respond to resource depression and dietary stress.

Predator–Prey Interactions

Lyman (1987e) has weighed in on debates on early hominid scavenging *versus* hunting, has established vertebrate mortality profiles using modern "volcanic" data (Lyman 1987b), and has engaged in research on the effects of human predation on terrestrial game (Lyman and Wolverton 2002) and pinniped abundance and behavior (Lyman 1988a, 1989a, 1991a, 1992b, 1995a, 2003b, 2011a; Lyman *et al.* 1988). Lyman's debate with California archaeologists Bill Hildebrandt and Terry Jones (Hildebrandt and Jones 1992, 2002; Jones and Hildebrandt 1995) sparked doctoral dissertation projects (*e.g.*, Darwent 2001; Whitaker 2008) and led many to question long-held views by marine biologists that the historic patterns of marine mammal distribution reflect great time depth. Hildebrandt and Jones firmly believe that California coastal archaeology and the study of pinniped hunting would not have progressed without Lyman's influence (Hildebrandt, 2005, personal communication). As a testament to his impact, Lyman (2011a) provides the introduction to a recent book on human–pinniped interaction in the northeastern Pacific (see Braje and Rick 2011 and chapters therein). His influence on archaeological marine mammal research—especially pinnipeds—has been felt in coastal regions across the globe.

Two papers in this issue tackle predator–prey relationships. Working in the American Southwest with large data sets from three regions, Schollmeyer and Driver consider various factors that could explain variable artiodactyl relative abundance across site assemblages. Human-caused resource depression is widespread. Long-term resilience in artiodactyl populations seems to have been maintained by source–sink dynamics, with lightly human-populated hinterlands serving as source areas for game, which in turn were reduced from hunting in more densely populated areas. Broughton *et al.* study trends in genetic diversity in ancient California tule elk to estimate changing prehistoric population size, which is tied strongly to predation intensity. Focusing on bones from Emeryville Shellmound, they find a decline in mtDNA diversity after 1,600 BP coincident with the point at which taxonomic abundance indices suggest elk populations declined. The authors also use stable isotopes from these same bone samples to reconstruct climate trends, which they find do not account for declines in prey abundance after 1,600 BP, thereby supporting predation pressure as the cause for decreased tule elk populations and reduced genetic diversity.

Conservation Biology and Applied Zooarchaeology

Over the past ~15 years, Lyman has worked to transfer results from zooarchaeology to conservation biology. Lyman co-organized (with K. Cannon) in 2002 the first symposium at the SAAs on the application of zooarchaeology to issues of conservation biology. His influential article on applied zooarchaeology and its relevance to wildlife management (1996) built on his biogeographic and paleoecological research, and ultimately led to three books on the use of zooarchaeology in conservation biology (Lyman 1998a; Lyman and Cannon 2004; Wolverton and Lyman 2012). He tirelessly pushes zooarchaeologists to view their work as critical to modern wildlife-management decisions (*e.g.*, Lyman 1994, 1998, 1999, 2002).

Contributors to this special issue have answered Lyman's call. Schollmeyer and Driver's study would help justify maintaining game-source areas for dwindling game populations in parts of the American West. Broughton *et al.*'s study highlights the range and changing genetic diversity in pre-European contact tule elk populations, whose numbers may have been reduced to as little as one mating pair in the nineteenth century. Marshall and Asa's paper focuses on African wild asses, which face an extremely high chance of extinction in the wild. This is mainly an ethological study of wild ass in captivity, designed to understand the domestication process of donkey, a close relative to ass. Answering the question, "what kept the wild ass 'wild,'" however, may help conservation biologists design policy to sustain this species into the future.

Professional Service and Teaching

Lyman has contributed much to the wider academic community by serving as a symposium discussant or invited speaker on nearly two dozen occasions. He currently serves as an associate editor for the *Journal of Human Evolution*, *Journal of Taphonomy*, and *Northwest Science*, and formerly was coeditor for *ArchaeoZoology*. Another core contribution Lyman makes to the profession is through peer review. A truly exceptional and supportive colleague, Lyman is always available to review grant proposals and drafts of manuscripts for publication, and he consistently shares his data with his students and colleagues. To quote one of his peers: "there is no one I would rather send my paper drafts to than he" (William Hildebrandt, 2005, personal communication). Others have indicated that Lyman's thoughtful and fair critiques helped them take their research to a new and improved level.

Aside from his annual teaching load that always includes introduction to archaeology, and alternating graduate and undergraduate courses in zooarchaeology and archaeological history, theory, and method, Lyman has served as the major professor for half a dozen doctoral students, a dozen-plus master's students, and an equivalent number of undergraduate honors students and McNair Scholars. He has fostered these students by providing them with faunal samples and helping to produce their first articles. Lyman's students have worked on zooarchaeological research and undertaken independent field studies in such places as the High Arctic (Darwent 2001, 2004), Missouri (Wolverton 2001, 2005; Wolverton and Lyman 1998), Oregon (Lyman *et al.* 1988), Syria (Loyet 1999), and Washington (Dixon and Lyman 1996; Harpole and Lyman 1999; Lyman and Zehr 2003); and on topics related to taphonomy and forensic science (*e.g.*, Beary and Lyman 2012; Church and Lyman 2003; Darwent and Lyman 2002; Lyman and Fox 1989; Lyman *et al.* 1992a). Two of these students have gone on to tenure-track positions at the University of California, Davis, and the University of North Texas. They are now advising the next generation of zooarchaeologists who proudly follow in the lineage of Donald Grayson and Lee Lyman.

Summary

Overall, Lyman's emphasis on explicit interpretative models and his rigorous approaches to analysis have directed scholars to become clearer about their research

questions, to operationalize abstract concepts with measurable units, and to consider the range of factors (taphonomic, environmental, cultural) that could be responsible for patterns in the bone record. Zooarchaeologists have been most directly influenced by his work, given the close connection, but because bone records are critical to larger questions in archaeology as relates to cultural and biological evolution, his work has greatly influenced the field of archaeology generally. Finally, Lyman has always sought to make ancient bone records relevant to Quaternary science and more recently conservation biology, demonstrating the enormous range of research and wildlife management-related questions that archaeofaunas can address.

Some colleagues and students have joked that Lyman must not sleep or that he has some curious affliction: how else to account for his near superhuman scholarly achievements? We are not sure where his productivity comes from. We will simply be thankful that it was zooarchaeology that received so much of his scholarly attention.

Appendix

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