Chapter 26
Doing Zooarchaeology Today and Tomorrow

Zooarchaeology is at an interesting juncture in its history. Archaeological faunal analysts have made great advances in method and practice over the last five decades, and intense debates continue on emergent topics. Much of this progress has depended upon tapping various kinds of knowledge derived from the contemporary world, from the biomedical literature to experiments to ethnoarchaeology and landscape taphonomy. Controversies over the meaning of long bone fracture outlines have subsided as bone structure and the mechanics of stress in bone as a material were understood. Debates over the respective roles of human selectivity versus bone mineral density in determining archaeofaunal element frequencies generated technologically aided techniques for calibrating the key variables of each, and methods for assessing the probabilities of one or the other influence as the dominant process. Intensive actualistic research has identified specific actors' effects on bone, thereby narrowing the range of possible processes, effectors, and actors involved in multi-agent accumulations. At some levels, the field has progressed toward greater knowledge.

26.1 Ongoing Issues in Zooarchaeological Inference

Some challenges abide, and new ones face us. As was the case with the biological sciences, zooarchaeologists initially sought to achieve reductionist explanations, emulating the classic example of the physical sciences, searching for few key process that account for the evidence under study, then stipulating simple determinative relationships between that evidence and a causal process. For zooarchaeology, as in some basic forms of biological research this works reasonably well, that is, at the level of what this book calls the action of causal processes, effectors, and actors. Even with these process-product relations, the clearest results may be produced by multivariate analysis, as appears to be the case with distinguishing trample marks from cut marks.

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The problem comes when trying to use these same straightforward procedures to use patterning in the archaeofaunal evidence to make broader inferences about human behavior in its social and ecological contexts. Some zooarchaeologists have been slow to shift from hoping for one or two lines of evidence, or a "magic number," will stand as a proxy for the complex operation of past human behaviors and adaptations. This book has made the case (Chap. 3, Sect. 3.5) that, for such targets of zooarchaeological analysis, considerable actualistically-derived evidence suggests that causation is probabilistic rather than determinative. In these cases, analogical inferences, while not so weak as formal analogies, individually lack the power of single-cause, determinative ones, and so do parallel cases in biological sciences. Yet, as Lyman and I both suggested many years ago, researchers can combine many such analogical inferences to gain some sense of the most probable circumstances that generated a set of evidence we have collected. In other words, the more interesting the question in zooarchaeology, the less likely it is that there will be a "magic number."

I do not advocate stepping back from rigorous scientific methods. Predictive models drawn from behavioral ecology have proved very fruitful in human ecology and some archaeological cases, with predictions phrased and assessed probabilistically. Instead, I simply urge zooarchaeologists to take seriously that we may be at a transition point from the process-product forms of inference that produced such progress in our field over the last 50 years and entering a zone currently being explored by biologists and paleontologists. This level of inquiry will call for analyses that use multiple, independent, and actualistically supported lines of evidence from archaeofaunas and their contexts, as well as judicious application of strong bodies of theory drawn from living biological systems (synecology, behavioral ecology, etc.). Mayr (1982) presented instances of complex inference in the biological sciences. Paleobiologists cited in Chap. 17 are tacking between contemporary landscape data and exploring paleontological data with multivariate methods. Wylie (1989) and Stahl (2002) have explored some of the "behind the scenes" inferential operations involved in archaeology. I suspect that many examples of what most would call "good archaeology," involve such complex analytical work with datasets, even when researchers don't stress the philosophical underpinnings of what they do, nor apply fancy multivariate analyses. Zooarchaeologists are dealing with outcomes of complex systems and seek to work with materials left them by time and taphonomy in ways that acknowledge the nature of the determinative "source side" processes (Wylie 1985). To address these issues, our analytic methods and models should probably be equally multivariate and complex.

One major question to consider is that of the scale of time over which archaeofaunal samples accumulated, and to match appropriate questions to these scalar levels, as do paleobiologists. Clearly if you know the date that Monticello was established as a plantation production system and the year that Jefferson died and most of his property, including its enslaved people, were sold to clear his debts, you can ask human-scale, even generation-scale, questions of the archaeofaunal sample. But if a paleontologist tells you the sample's resolution is around 150 years at best (Terry 2008), are the questions the same? What if your geoarchaeologist colleague tells you the best resolution of scale in a small Pliocene site is 2000 years (Stern 2008), what are the appropriate questions? Scale might be the first questions to be answered on a checklist for the next generation of zooarchaeologists. While this speculation may seem irrelevant to many working with Holocene foragers and pastoralists, when locales are repeatedly occupied, the interaction of time-averaging and archaeofaunal accumulation – sampling scale – should be considered. Those of us working in the last few score millennia have the luxury of being able to bracket site materials with radiocarbon and other dating methods, providing some of that resolution.

26.2 New Methods, Practical Continuities

New technological developments and opportunities for applying zooarchaeological knowledge call for a reordering of priorities and practices in zooarchaeology, at least among researchers investigating diet, domestication, and ancient biogeography and synecology. However, rather than replacing zooarchaeology, stable isotope, zooMS, and genomic research augment it. These can enable zooarchaeologists to pursue topics that focus more on human ecology and social relations. However, even if one aspires to isotopic or ancient DNA analysis, one has to know how to identify specimens to analyze – or work with someone who can. I learned this lesson in working on bone stable isotopes and ancient DNA, when these methods called the taxonomic identifications into question. In one case, two "coyote" specimens had isotopic values that fell into the range of sea otters: a check of the specimens revealed that they were marginally identifiable fragments that could just as readily sort with *Enhydra* and should never have been included in the sample drawn (the case for zooMS!). When selecting *Callorhinus* specimens from the Moss Landing Hill site collection for aDNA analysis, amidst the many unequivocally female and young-of-the-year I sent what I thought were a few rare male specimens, only to learn that they were male California sea lions. These humbling experiences prove that there is no substitute for accurate taxonomic identification based on osteological markers – and that one should be conservative with fragmentary specimens.

I would venture one generalization that applies nearly universally to zooarchaeology: sophisticated quantitative analyses such as Terry's (e.g. 2007, 2008) work with micromammals can be done, as she states, only because of the detailed data collection, documentation, and publication by an entire generation of researchers. Morin et al. (2016) stress that their relatively high levels of inter-analyst agreement resulted from months of dogged work by each volunteer. There may scarcely be a zooarchaeology lab in the world where afternoon conversation has not turned to that fantasy machine, with its little conveyer belt carrying individual specimens in for instant 3-D outline scanning for overlap assessment and osteometrics, then on to the instant zooMS platform for a quick read on taxonomy, printing the data code card, automatic bagging, etc. But in the meantime, after the tea or coffee break, we have our work before us. Table 26.1 points to at least some of the considerations zooarchaeologists should take into account when approaching their analyses.

Table 26.1 Zooarchaeological analysis in several challenging steps, relevant chapters in text are given in parentheses

I. Think
A. What do you want to investigate?
1. Subsistence (a) *Predation on wild species* (b) *Herd management* (c) *Role of domesticates in farming systems* (d) *Urban supply chains for animal foods* (e) *Non-archaeofaunal resources required to distinguish these*
2. Household food supply (a) *Butchery/selective transport (if applicable)* (b) *Culinary processing modes, energetics* (c) *Modes of disposal* (d) *Non-archaeofaunal resources required to distinguish these*
3. Inter-household sharing or lack thereof (a) *Intrasite activity areas* (b) *Carcass refitting* (c) *Taxonomic differences among houses* (d) *Feasting vs. everyday consumption patterns of modification, discard* (e) *Non-archaeofaunal resources required to distinguish these*
4. Differential animal acquisition, processing, or consumption (a) *As diacritical markers of gender* (b) *As diacritical markers of rank* (c) *As diacritical markers of class* (d) *Non-archaeofaunal resources required to distinguish the above*
5. Long-term site function history
6. Diachronic, regional-scale changes in any of above
7. Animal biogeography and evolution (a) *Climate change effects* (b) *Invasive species* (c) *Non-archaeofaunal resources required to document these*
II. What is the nature of your sample or samples?
A. Stratified site, single component?
B. Excavation by arbitrary or lithologic levels?
C. Was some archaeofauna recovered according to features?
D. When was your sample recovered?
E. Faunal recovery practices at time of excavation? 1. Screened or not screened 2. If screened, what was mesh size - effects on taxonomic representation? 3. Are there column samples, flotation samples? 4. Total sample of site/level, partial sample - how much? 5. Effects of curation practices on archaeofaunal sample
F. How will any of the above affect the composition of the archaeofaunal sample?
G. Given your knowledge of such biases, what classes of data do you deem most relevant to collect?

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Table 26.1 (continued)

H. How accessible to future researchers will this collection be in the future? Will it be in jeopardy of neglect or destruction? (Chap. 8) 1. If so, can you collect more data than relevant to your immediate research, post in digital repository?
III. Preliminary choice of relevant quantitative units NISP, MNI, MNE, NDE, butchery units, etc. (Chaps. 10, 18, 20, 21, and 22)
A. Given your knowledge of recovery biases and the data you wish to collect, what are the most prudent and effective measures of abundance?
B. How do your methods for recording portion of elements represented affect your options for estimating derived measures of abundance? (Chap. 10) 1. Will you use fractional, overlap, or landmark methods to estimate this?
C. Which options preserve the most flexibility for shifting measures on the basis of what you learn during analysis? 1. e.g. Extreme fragmentation of specific taxa or body segments
IV. How and where will you archive your data for others to check and use in further research?
A. Consult digital repositories e.g. ADS (U.K.), Open Context, tDAR, other institutional systems regarding: 1. Formats required or advised 2. Embargo terms 3. Fee structure
B. Choose a repository 1. Will this affect your data collection methods? How?
V. Primary data collection
A. Select methods for recording data (Chap. 8) 1. Does the physical repository have standard required formats? 2. Will you keep a data tag or card with the specimens? 3. In what form (hand-lettered field form, printed label, barcode, QR)
B. What format will you use for data recording and structuring? 1. Database type (e.g. flat vs. relational, etc.) 2. Database format 3. How do the above choices affect the accessibility to your findings by other researchers?
C. How do your decisions affect comparability with other researchers' data?
VI. Sorting, identification, and attribute recording (Chaps. 8 and 9)
A. Will sorts be done by only you, or by a group under your supervision 1. How will you use persons of different levels of expertise? 2. How will you check output of different sorters?
B. Initial sort into differing levels of identifiability 1. Sort quickly, with minimal reference to comparative samples 2. Keep alert for distinctive features to follow up later
C. Secondary sorts and definitive identifications 1. Determine/record attributes 2. Consider metrical data pertinent to research questions, record 3. How will you report your identifications of rarer taxa

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Table 26.1 (continued)

D. Sample extraction for any other pertinent data, e.g.: 1. Tooth sectioning 2. Annular growth sectioning fish otoliths 3. Stable isotopic analysis of teeth or otoliths 4. aDNA 5. zooMS
E. Keep a log of your day-to-day analytic decisions that affect data recorded, digital data fields, variables, etc.
VII. Data structuring and exploration
A. Taxonomic data 1. Are recovery methods likely to have affected taxonomic representation? (Chap. 8) 2. If analyzing a subsample of a larger assemblage, how have you established that your sample is representative of the larger aggregate? (a) *e.g. Sampling to redundancy, etc. tactics* (Chap. 22) 3. How will you report and document unique species or interspecific differences (Chap. 9)
B. Element and portion frequencies – within and between taxa. (Chaps. 18, 20, and 21) 1. Does exploration of frequencies (e.g. histograms, x-y plots, simple statistical tests etc.) reveal strong biases away from original representation of elements in the body? 2. Do these correlate with bone mineral density indices? 3. Do these correlate with nutritional utility indices? 4. What factors may have created this structure in your data (selective transport, in situ destruction by humans, carnivores, etc.)? 5. Consult data on modification attributes, site context, sedimentology.
C. Modification attributes (Chaps. 11, 12, 13, 14, 15, 16, and 17) 1. Does the site's geological/geomorphic context relate to occurrence of attributes, e.g.: (a) *Relation of sedimentary matrix to abrasion through geologic action, trampling,* (b) *Does geomorphology suggest locality was good carnivore lair site, etc.)?* 2. How do cut, chop, and scrape marks reflect processing behaviors? 3. How do patterns of thermal alteration reflect processing and/or disposal behaviors, site formation? 4. How do fracture patterns reflect processing behaviors, nonhuman modifications, site formation processes? 5. Knowing what you now do about assemblage composition, will refits of broken bones or carcass refitting repay the time, in terms of information relevant to questions you propose to investigate? 6. How do traces of carnivore, rodent, root, etc. modification reflect site formation? 7. How do patterns of weathering and or other geological forms of bone modification reflect site formation? (a) *Span of time over which bone accumulated* (b) *Degree of impact of the processes on small/delicate bones, etc.?*
D. How may the above patterns of representation and modification affect analyses based on element frequencies (e.g. age profiles derived from dentitions of different-sized animals vs. selective transport, interspecific variations in NISP, etc.)? 1. Are there other exploratory methods you can use to narrow or define these possibilities? 2. Note how you will discuss this in your write-up in your log
E. Double-check whether any of the patterning in your data might depend upon the quantitative units used or methods of aggregation (Chap. 18)
VIII. Go back to your original research questions and goals: think again

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Table 26.1 (continued)

A. Which issues of those you originally defined can you defensibly address, given what you now know about the nature of the assemblage? 1. What arguments can you make to link significant patterns in your data with the past processes you set out to investigate
B. Are there other topics and questions that analysis of the archaeofaunal data suggest to you at this point?
IX. Report your findings
A. Select the appropriate outlet(s) for your results, according to topics, theory, and methods mobilized in your research
B. Strive to be intelligible, despite all the specialized jargon 1. Select and produce appropriate tables, charts, illustrations to support your arguments and inferences, given outlet type and standards
C. Chose a way to present as much of your basic data as possible, so that others can evaluate your inferences and use your data for comparative purposes 1. How much and what data will be included as in-text tables, appendices 2. How much can be included as digital supplemental materials in your target journal or monographic series? 3. How much will you place in accessible form in a digital repository as soon as possible?
D. Send your draft to your most critical zooarchaeological colleague 1. Revise per colleague's suggestions
E. Ask an archaeological colleague who is *not* a zooarchaeologist to read your revision and suggest changes for broader circulation 1. Revise again, as needed
F. Submit your revision 1. Revise per reviewer comments
X. Prepare your base data for upload to your selected digital repository, as needed
XI. Take a well deserved break.

Many years ago, Grayson (1981) stressed that explicit and detailed documentation of archaeofaunal materials underlies all advanced analyses. This is not intended to discourage, but rather to encourage, the painstaking labor involved in basic research in zooarchaeology. It pays off, it not in your own hands, then in those of others. Several stable repositories for digital archaeological data are available today. I am preparing my own archaeofaunal data with documentation for deposit at one of these, with the hope that others can work with them productively.

26.3 Conclusion

Recalling my graduate student days at UC Berkeley, when my professors encouraged me to take up "archaeological faunal analysis," I am deeply impressed by the amount of knowledge that a few visionary notions – and a staggering amount of hard, tedious work by many researchers all over the world – have produced since then. However, writing this book has also brought me back to what David Clarke

(1973) called "critical self-consciousness," that tipping point from the self-congratulatory, "Look how much we know," to the realistic and humbling recognition of, "Look how much we don't know." But rather than letting this be a cause for despondency, I trust that, "how much we don't know" presents a challenge to push a little further into clarifying ambiguities and reducing our ignorance.

I encourage zooarchaeologists to slog through some morass of ambiguity in archaeofaunal interpretation, rather than going for a virtually impregnable case study on a banal topic to publish in a flagship journal – what Lewis Binford (personal communication, 1979) once called, "twirling and pirouetting." Our narratives, the stories about the human past we tell from our data, must be scientific, not in the sense of appealing to some sacred body of theory but in the sense of being explicit about one's methods and systematic in the pursuit of clarity (Lyman 2008). A casual perusal of *Science* or *Nature* shows that articles in other disciplines often devote 50% of page space to detailing materials and methods. Some zooarchaeological articles follow this model, but a distressing number of ostensibly data-grounded zooarchaeological pieces do not disclose what was deemed unidentifiable, how or why counting units were chosen, or other salient methodological details. It's not science if you can't replicate the exercise.

We are now have the third generational cohort of zooarchaeological researchers entering the field and are seeing how their work builds upon – if only to challenge – those of the founding generation and their students. As one of that first cohort, I stated at the beginning of this book that my best wish was not that it be a definitive, final statement on zooarchaeology, but rather that it offer a framework for arranging and mobilizing the constant stream of new information in this lively and growing field. I also said that I hoped to assemble, as well as I could, a kind of methodological and conceptual toolkit for getting on with zooarchaeological research. It is with those intentions that I have written it, and I hope that this will be useful to my colleagues, present, and future.

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