Chapter 8
Field Recovery, Lab Methods, Data Records, Curation

Regional traditions of archaeological practice, local and national laws, and institutional requirements have encouraged a diversity of approaches to excavation, documentation, and curation. Some zooarchaeologists name their sites whatever they please; others must use a site designation system prescribed by a state or provincial government, historic preservation office, or national antiquities service. Some zooarchaeologists can chose whatever standard of documentation and curation they wish, while others must conform to contractual requirements of museums, government agencies, or archaeological societies. In the field, some zooarchaeologists use paper bags, others, plastic. Some zooarchaeologists use WindowsOS®, and some use MacOS®. Some zooarchaeologists must deposit a yearly report as a condition or continued permitting, and/or copies of their basic data and publications with a museum, government agency, or antiquities service, and some need not.

Some zooarchaeologists work in the field, directly supervising excavation and recovery of faunal remains. Others work primarily in field lab settings, analyzing assemblages produced by recent excavations. Yet others work with collections recovered earlier and deposited in museums and other research facilities after minimal or no analysis. Some zooarchaeologists have the power to direct how faunal remains are recovered and curated at the site. Some can at least interact with the project supervisor during excavation and suggest procedures that enhance recovery and conservation of faunal remains. Others working materials excavated earlier count themselves lucky to have reasonable copies of field notes and a living, mentally competent project supervisor to interview. Many zooarchaeologists – as others in their discipline – do archaeologies of archaeology, poring over scrappy, incomprehensible field notes, bemoaning lost proveniences, repairing (when possible) bones and teeth damaged by post-excavation "curation," and figuring out what, given all the missed opportunities at documentation, mishandled specimens, and shoddy archaeological follow-up, can defensibly be said about the materials at hand. Some zooarchaeologists have their analysis of collections truncated or permanently forestalled by political developments, as did Zeder (1991), when the Iranian Revolution blocked further access the Kur Basin materials she was studying.

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Over the years, I have encountered nearly all of these cases firsthand. Quite a few demonstrate that, though there may be several ways to do zooarchaeology right, some ways are just plain wrong. In *The Early Mesoamerican Village*, Kent Flannery (1976:1) quoted Sir Mortimer Wheeler as stating that the Near East was the "land of archaeological sin," to which Flannery responded, "Such a statement could have been made only by a man who had never worked in Mesoamerica." Most seasoned archaeologists will agree that, contrary to both these eminences' pronouncements, archaeological sins are truly transgressions without borders.

Rather than attempt to document the diversity of local, national, and regional approaches to handling archaeofaunal material, this chapter reviews considerations that should guide it, offering suggestions on minimum standards of conservation, documentation, and curation – in other words, how to avoid the worst occasions of archaeological sin.

8.1 Research Design and Data Collection

Zooarchaeologists designing their research at least intuitively grasp how their theoretical perspectives condition their definition of research problems and the data they collect as relevant to those problems. These stem from theoretically grounded arguments about humans, their contexts, decisions, and actions that one find most compelling and interesting – evolutionary ecology, behavioral ecology, interpretive archaeology, Marxist or feminist approaches, etc. This turn begs the question of what types of archaeofaunal data investigators working within any given intellectual model deem useful to addressing research problems, and how they juxtapose various datasets in their arguments. Other questions emerge in this inquiry: could the data and analytic methods used in the preferred paradigm be augmented or replaced by other data or methods? One other line of questions may be asked less often: would the way one plans to recover, curate, analyze, and document archaeofaunal remains allow other researchers to use your data for different analytic purposes? Would other researchers instead have to collect data from the same archaeofaunal sample from the beginning? If so, are there ways to avoid some such duplication of effort?

Many zooarchaeologists cannot design archaeofaunal data recovery from the inception of a field project. Persons working in cultural resource management (CRM) or heritage management projects must recover and analyze samples within specific time and budgetary frameworks, often under less than optimal research conditions. However, with good standards of collection and documentation, data produced in such contexts can and has been used in scholarly research and public education – the ultimate rationale for heritage protection activities. Some regional professional societies have agreed upon central research questions and the relevant data to be collected in all archaeological projects in the region, regardless of their nature, thus assuring minimal standards of data collection. Zooarchaeologists in heritage management contexts can assure their standards of documentation by noting the data used in the research literature relevant to their region.

Zooarchaeologists using museum collections frequently must deal with archaeofaunas that were imperfectly collected and documented by modern standards, and it may be tempting to consider these materials worthless because of their limitations. Having spent most of my career working with such collections, my viewpoint is that certain issues can be addressed using such collections, and the challenge is to design research around their potential. At the very least, these collections can serve as a kind of "preliminary archaeofaunal reconnaissance" for a region, and most can offer greater research potential. Lyman's long history of contributions to the paleobiogeography and historical ecology of various mammal species (e.g. 1986, 1988, 1991, 2004, 2007) exemplifies the potential of previously excavated collections, and Stiner (1990) offers a discussion and example of working with collections recovered early in the twentieth century.

8.2 Field to Lab: Primary Recovery and Curation

It is a truism that archaeologists destroy sites as they excavate them and therefore must document as thoroughly as possible the context and disposition of materials in their original locations. This section takes a zooarchaeological perspective on this aspect of archaeology.

8.2.1 Sedimentary and Spatial Context

Reading the taphonomic history of an archaeofaunal sample, whether archaeological or paleontological, requires as much information as possible about their contexts of origin. The sedimentary matrix can testify to the range of chemical and mechanical processes affecting bones during and after deposition. Sediments can aid identifying archaeofaunal remains' relation to subtle features that may have structured human traffic and activity (Binford 1987), especially in sites lacking preserved architecture. As demonstrated by micromorphological research at the Neolithic site of Çatalhöyük (Matthews et al. 1996), it can also be informative in constructed environments.

Analysis of intrasite spatial relations of bone specimens is a time-honored practice, especially in sites inferred to result from a single occupation. Classic examples are the bison kill-butchery sites of the North American plains. At Olsen-Chubbuck (Wheat 1967, 1972), the Horner Site (Frison and Todd 1987), and other such occurrences, piece-plotting individual elements or articulated body segments permitted a step-by-step narration of the trapping, killing, and subsequent systematic primary butchery of bison. Parallel research into details of processing sometimes employs piece-plotting and refitting bone element fragments across a site, as was done at the Pliocene site of FxJj20, East Lake Turkana, Kenya (Bunn et al. 1980). Todd (1987) took the spatial approach further, combining precise spatial plots of elements and

body segments with a detailed metrical and morphological matching of bilaterally symmetrical bones of the bison body, permitting reconstruction of the disassembly of individual animals. Enloe and David (1992) pursued a parallel analytic approach at the Magdalenian reindeer hunters' encampment of Pincevent in the Seine River basin not far from Paris; by "refitting" individual animals, they were able to trace the social subdivision of animal carcasses among the excavated dwellings (Chap. 25). Waguespack (2002) investigated the nature of carcass subdivision and sharing with this strategy at a historic Nunamiut Inuit campsite (Chap. 25). All such analyses were done before Total Station Mapping (TSM), which speeds spatial documentation of three-dimensional coordinates.

Such meticulous spatial analyses of archaeofaunas are possible only under certain circumstances of preservation and deposition. A preponderance of skeletal elements must be identifiable and measurable and deposited over a relatively short span. Other cases do not permit a piece-plotting approach to analysis. Midden deposits from villages, towns, and cities can contain tens to hundreds of thousands of specimens, potentially representing hundreds of individual animals, parts of which may have been redistributed and discarded on a citywide scale and often were reworked by later construction in ancient times. These occurrences require other spatial documentation strategies. Commonly, specimens may be documented only to excavation unit or to feature (e.g. Zeder 1991). This involves trading off precision of spatial detail against gaining a larger sample, and being able to search for robust patterning in a large dataset.

I analyzed the archaeofauna from a site with very dense artifact and bone concentrations, the Holocene pastoralist-hunter Prolonged Drift (SAES coordinate number GrJi1), excavated in central Kenya in 1969 (Gifford et al. 1980). From about 18 m^2, excavators recovered over 165,000 bone specimens and more than 220,000 lithic and ceramic specimens (Fig. 8.1). Investigators began by piece-plotting all specimens, but, to make any headway at all in exploring the extent and boundaries of the accumulation, they switched to documenting each specimen's location to the quarter-m^2 by 5 cm vertically. They traded off point-provenience data analyses against obtaining a sense of the spatial scope of activities creating the deposit.

8.2.2 Influence of Recovery Methods

Another, parallel trade-off is that between excavation time and comprehensive recovery of small specimens. Recovery of microfauna, smaller fish, amphibians, reptiles, birds, and mammals requires very small screen size (≤3 mm or 1/8 in) to sieve excavated matrix, as well as wet screening and/or flotation methods. Experimental studies have demonstrated that recovery of taxa can be strikingly different with different mesh sizes (Davis 1987; Payne 1972). Screen sizes larger than 1/8″ (4 mm) result in substantial losses of elements from smaller species or from smaller individuals of vertebrates of variable sizes (Payne 1972; Shaffer 1992; Stahl

Fig. 8.1 Bones, obsidian and other debris in a quarter m^2 at the Kenyan site of Prolonged Drift (GrJi1), near Lake Nakuru, Kenya (Photograph by the late Glynn Isaac and in possession of the author.)

1992, 1996; Shaffer and Sanchez 1994; Nagaoka 1994; James 1997; Zohar and Belmaker 2005). Reitz and Wing (2008: 154–156) give an excellent example of this problem. In the early Spanish archaeofaunal sample from St. Augustine, Florida, using 6 mm (~1/4″) mesh screen would recover a just under 16,000 specimens, with mammals comprising over 87%. Using 3 mm mesh would recover another 1960 specimens, in which mammals comprised only 1% of the assemblage and fishes nearly 97%. Reitz and Wing (2008:148–150) also report that flotation is the only strategy for obtaining very small fish species, and that taxonomic abundances can be skewed substantially by size-selective recovery. For representative recovery of archaeofaunal taxa, quite a small screen size is thus optimal.

However, such methods are time- and labor-intensive and sometimes rendered difficult if not impossible in the field clayey soils or lack of sufficient water for wet-screening or flotation. Like paleoethnobotanists and other archaeologists seeking microdebris, zooarchaeologists must trade off loss of that level of recovery for the excavated site as a whole against a set of controlled samples recovered for later, fine screening. These normally are time-honored methods of core or column sampling (Casteel 1970; Hester et al. 2009) that remove the entire contents of either a rectilinear subunit of a regular excavation unit (column) or an augured core of specified part of a unit or feature. These samples are subdivided by vertical provenience and can be wet-screened with 2 mm or even smaller-gauge screen or floated for total recovery of the sample contents in another setting (see also Lyman 2005). We received such an archaeofaunal flotation sample from a recently excavated site just north of the Monterey Bay, California. Sorting these under binocular microscope, the doctoral student and archaeoichthyologist Cristie Boone (Albion Environmental) isolated many bones of sardine- and herring-sized fishes, which had never before

been reported from coastal sites in southern San Mateo County (Gifford-Gonzalez et al. 2006).

The core/column technique also requires that a sampling strategy be devised. Input from zooarchaeologists is helpful in designing appropriate strategies, as random sampling may not be optimal for specimen recovery. Parallels exist in other archaeobiological fields: based on their understanding of plant processing practices, paleoethnobotanists have developed tactics for sampling diverse locales for macrobotanical remains. Features such as hearths, storage pits, and threshing floors are often slated for sampling in agricultural settings (Dennell 1974; Pearsall 1989; Reddy 1997). Sampling for smaller faunal remains can be guided by similar expectations, including the simple prediction that very small bone and other faunal debris may be recovered from substrates near hearths and other food preparation areas (see Chap. 15). Lyman (2012) cautioned that experimentation showed that screen size should be selected with prior estimates of local microfaunal bone size in designing recovery strategy.

8.2.3 Cleaning

Cleaning of faunal materials involves multiple risks of bone surface modification or other forms of specimen damage. Brushing dirt-covered bones with stiff-bristled brushes can add surface modifications to bone in the form of pseudo-cut mark scratches (Bromage 1984). Water or additives such as dilute detergents may affect specimen integrity or complicate their use in dating or ancient DNA (aDNA) analysis. Other forms of cleaning have their risks. Preparators' tools used to remove concretions can mark bone in ways that mimic ancient human intervention (Shipman and Rose 1983; White and Toth 1989). If poorly managed, dilute acids intended to remove concretions from bone surfaces can dissolve those surfaces as well. Ultrasonic baths can remove concretions and dirt but involve some risk to delicate specimens, as can air scribes. Probably the most common risk during cleaning is loss of provenience. In field situations and laboratories with multiple workers, protocols are required to assure consistent association of provenience data with as specimens move through cleaning.

8.2.4 Preservation and Conservation

Preserving organic materials as they come out of the ground is among the most variable of field recovery problems. Depending on the chemistry of the sedimentary contexts from which they are excavated, bones, shells, scales, and other animal remains may resist degeneration or be very vulnerable to distintegration. Use of stabilizing media and cleaning procedures should be rethought in light of recent developments dating and genomic analysis. Radiocarbon determinations on bone

and shell require that at least some of an archaeofaunal sample be protected from contamination by modern carbon. Matisoo-Smith and Horsburgh (2012) recommended that specimens slated for aDNA not be washed.

Bones in intermittently and constantly moist, acidic environments may have lost most of their calcium apatite, with only remnant collagen, which is vulnerable to disintegration on drying. Special tactics are required on-site to conserve them. At the Mesolithic site of Star Carr (Clark 1954), a vacuum chamber was used to perfuse with preservative and stabilize red deer bones recovered from an acidic peat bog. Soil processes and other pre- and post-depositional taphonomic may leach collagen and calcium from bones rendering them more fragile than fresh bone. Clayey soil can filter into cracks in bones, and subsequent wetting of the sediments can cause the clay to expand in the cracks, in essence exploding them in the matrix and presenting challenges to recovering them as integral units. Other specimens may be encrusted in calcium carbonate concretions or other chemical precipitates to the point that taphonomic modifications to the bone surfaces and cannot be documented until the deposits are removed.

Recounting many methods for coping with these and other site-specific conservation problems is beyond the scope of this book. Readers should see Hester et al. (2009) for an introduction, as well as online information on preservatives and their solvents by Hamilton (1999). Conservation in the field should avoid tactics that will obscure the morphology and surface modifications to elements, consistently and pervasively alter their chemistry, or otherwise stand in the way of later laboratory analysis. To paraphrase the well-known medical ethic, when trying to preserve a specimen, the field crew should first, do it no harm.

Some specimens do require stabilization in the field, but permanent preservatives should be avoided. These may obscure the bone surface's traces of human and nonhuman actors, and removing them involve toxic chemicals and possible loss of the original bone surface. I had to abandon seeking all but the grossest bone surface modifications in a sample of nearly 5000 identifiable specimens from one early East African pastoralist site because a polymethacrylate emulsion had been liberally applied in the field to nearly every specimen when most still had considerable soil, roots, and even tiny obsidian flakes on their surfaces. Efforts by lab technicians in the Kenya National Museum and myself in 1990 to find a solvent for the layers of preservative and dirt were fruitless, and some of the chemicals we used were probably neurotoxic. From Hamilton's (1999) webpage on adhesives and consolidants, I now know that we'd have experienced more solvent success, had we added toluene, a toxic aromatic hydrocarbon, to our already dangerous cocktail. Acetone softened but did not dissolve the preservative layer. When I tried to gently peel the gummy preservative layer off specimens, the outer layer of bone came off with it, and I desisted. I decided that this assemblage could testify only to less fine-grained levels of processing activities. The same assemblage presented other related problems: field technicians unschooled in osteology had used the preservative as glue, sometimes joining bits from different elements and species. If one cannot dissociate such them in the lab, one is literally stuck with specimens of albeit momentarily amusing but problematic hybridity.

Such complications can be avoided by cleaning specimens better in the field and by stabilizing only those that truly need it with water-soluble preservatives. Mistakes made in the field can literally be dissolved in the lab. Wheat (1972) stabilized the Olsen-Chubbuck bison bones in the field with a dilute solution of Borden's Elmer's Glue®, then produced from casein, a dairy product, which he reported could later be removed by soaking specimens in water. Aside from appreciating the irony of applying a bovine-derived preservative to wild bovine bones, readers are advised that, several decades ago, Elmer's Glue-All® shifted to a polyvinyl alcohol resin emulsion. While the manufacturer cites water as a solvent (Hamilton 1999), some of us have found the glue to be less water-soluble than anticipated.

It is relatively straightforward to develop field procedures that avoid many such problems if zooarchaeologists can communicate with persons excavation and initial curation in the field, if they themselves cannot be involved directly. Protocols for recovering and handling faunal remains can be developed and circulated to minimize damage to vertebrate remains.

8.2.5 Provenience Information Management

Once archaeological specimens are recovered from their sedimentary contexts, initially cleaned, and stabilized, they are grouped and handled according to protocols that can vary from one excavation – or one zooarchaeologist – to another. The traditional practice of putting everything from an excavation unit level in one bag labeled with provenience information and storing it for sorting and analysis at a later date is still common. But field labs, where preliminary sorting and initial analysis and data transcription take place, are now more common. Project-specific trade-offs again present themselves. Costs of fielding and providing analytic facilities to a set of specialists may sometimes be justified and other times not. Likewise, having only semi-skilled workers sort and bag finds from excavation units into material categories (ceramics, lithics, bones, shells, etc.) must be weighed against the risks of inadvertent damage to delicate remains during sorting or transport.

8.2.6 Labeling

Whatever the distance from the field to the lab, information regarding specimens' source coordinates must travel with them. Provenience data may be applied to the specimens themselves, be attached to specimens by paper tags that ride with them inside bags, be written on the outsides of paper or plastic bags, or even attached via scanning tags. In the U.S., some federal government agencies, state agencies, or state historic preservation offices recommend curation standards for the end products: acid-free paper products, plastic bag thickness, specific forms, electronic database formats, and so forth. These standards can be met, at a relatively low cost, in

much of the developed world but are much more difficult for even major institutions in less developed countries to meet. I personally believe that foreign researchers in such regions have an ethical obligation to support the long-term curation and maintenance of the collections they use by investing in upgrading their physical curation to reasonable standards.

A longstanding tradition in archaeology favors applying provenience or catalogue numbers directly to specimens. However, this may not be advisable for specimens to be analyzed for bone surface modifications. A taphonomic corollary of Murphy's Law predicts that the only cut mark or other diagnostic trace of an actor on a specimen will invariably be transected by a neatly lettered specimen number, often written on a thick application of white paper correction fluid and topped off with a layer of clear nail polish. If a specimen is large enough, one can prudently avoid loss of provenience by writing catalogue numbers on it, a task best done by someone who knows enough about zooarchaeology to avoid bone surface modifications. In elements so small, or so modified, that writing on them would seriously compromise recoverable taxonomic and taphonomic information, provenience information is best attached on a tag or card associated with the specimen.

In my lab, we lacked the person-power to directly label thousands of specimens from a variety of excavators. Each potentially identifiable specimen received a specimen card with a randomly assigned catalogue number (produced by an automatic number stamper) and its own resealable bag. Printed on the specimen card are all the data fields that will eventually be entered into the site database. Starting with provenience data, the card accumulates progressively more information (Fig. 8.2). Less identifiable and nonidentifiable specimens are grouped in bag lots (Chap. 9).

8.3 Specimens into Data: Analytic Considerations

The next phase of zooarchaeological analysis is usually to sort and identify specimens to the greatest level of specificity possible, and to record bone surface modifications and other types of postmortem modifications.

8.3.1 Element and Taxonomic Identification

For final taxonomic identification, faunal analysts normally opt to work with comparative bone specimens rather than simply with drawings or other representations of animal remains (Parmalee 1985). As noted earlier, this is due in part to the fragmentary nature of zooarchaeological specimens, in which only a small segment of an element may be present. Identification is therefore sometimes a matter of seeking out a range of probable elements and species and then carefully searching for the closest possible morphological or metrical match.

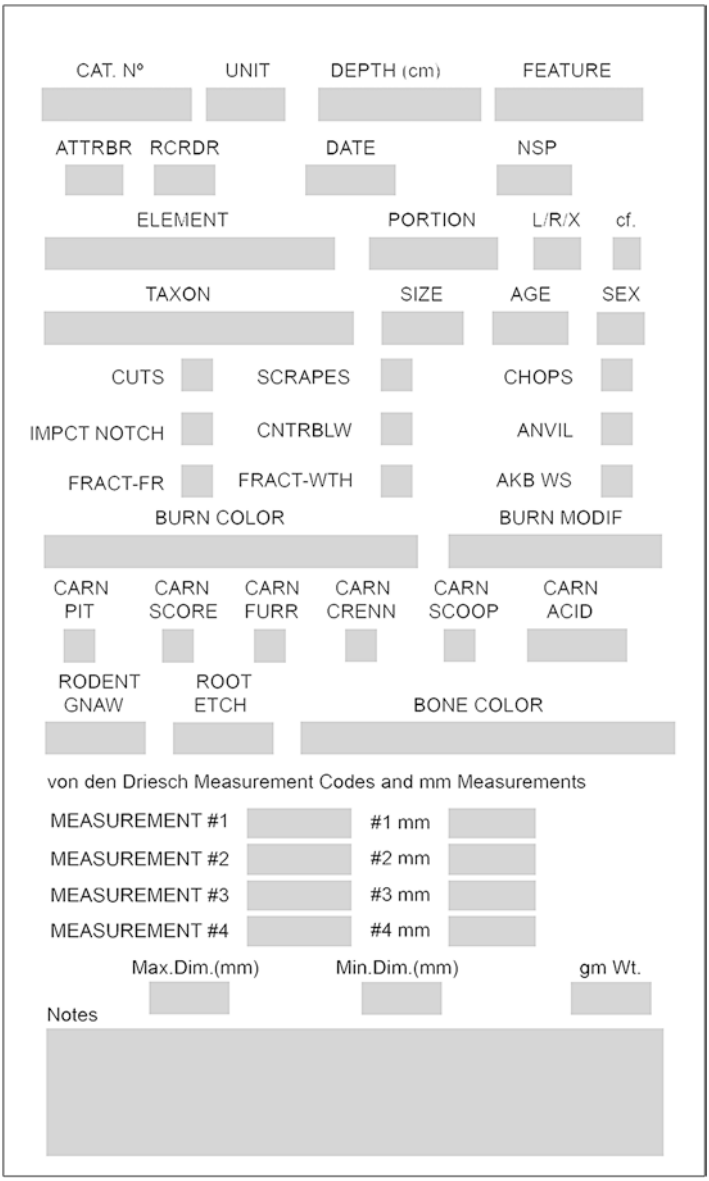

Fig. 8.2 Example of data card placed in bags with specimens in Gifford-Gonzalez zooarchaeology laboratory through 2012. Card is filled in successively as analysis proceeds, and data entry is made into virtually identical fields. See text for details

If more than one similar-sized species of a given zoological subfamily, family, or order possibly exists in a sample, one must refer to comparative specimens from all such species to make final taxonomic diagnoses. For some closely related and commonly encountered species, such as domestic animals, either morphological or metrical distinctions are described in the literature, as is the case with sheep and goats (Payne 1969; Prummel and Frisch 1986; Rowley-Conwy 1998; Boessneck 1969; Zeder and Lapham 2010; Zeder and Pilaar 2010). However, in many cases, zooarchaeologists may have to establish their own reference criteria, again on the basis of comparative specimens of known species.

Zooarchaeologists must sometimes build their own reference collections, either because comparative collections in museums or other institutions are too distant to consult regularly or because no comparative collections exist for the species in question. Agricultural stations and colleges, local markets, road kills, local inhabitants in areas where hunting is common, and beachcombing can provide animal bodies, although collectors should fully inform themselves about applicable laws and collecting permits. Preparation of animal bodies into comparative specimens requires no specialized equipment but requires knowledge of and adherence to health and safety standards, as well as knowledge of how different types of bone respond to heat or enzymatic treatment. Preparations can range in palatability from a carefully dissecting a poached salmon dinner to the grisly maceration or boiling operations that can make members of the zooarchaeological community outcasts at home and abroad.

Regarding taxonomic identification, Butler and Lyman (1996) made several recommendations for zooarchaeological reports. While analysts need not describe the basis of their identifications of common species, they should present their rationale for taxonomic ascription in the case of a rare species, or of new criteria for identification of closely related or rare species. They present conventions for such descriptions derived from the paleontological and zoological literature, involving morphological and metrical descriptions of distinctive dental, cranial, or postcranial osteological features of the species in question. Excellent zooarchaeological examples can be found in Grayson (1984).

I recommend keeping a lab log or diary, preferably digital, used by everyone working on an assemblage, to record important observations on specimens or decisions about how and why to record certain data. This might include such novel taxonomic ascriptions as discussed by Butler and Lyman. I also record unusual modifications for which no data field exists in my database, but which are recorded in the "Notes" section of individual specimen cards and the database. Any major decision made during analysis that affects descriptive variables (e.g. adding another color category from the Munsell® system to the database) is recorded, with its rationale, as well as informal notes on redundancies in types of modification of a given taxon or element. Because every assemblage differs, any given analysis may require modifications to data fields or variables employed. In working with the Adrar Bous, Niger, early pastoral (c. 5000–2500 B.C.) archaeofauna, I noted the dissolution of dentine from bovid teeth, to the extent that the tooth enamel sometimes collapsed upon itself, something I had never seen in more than 30 East African archaeofaunas

(Gifford-Gonzalez and Parham 2008). After documenting about 25 such specimens in the "Notes" field of specimens cards and our FileMaker® database, I decided this was such a common and interesting occurrence as to justify creating a new data field, "Dentine Loss," so that I could record this aspect of the assemblage on a simple qualitative scale, from "none" to "extreme." The decision and the variables settings went into the Adrar Bous lab log, and text from the log was later incorporated into the final write-up of the assemblage. The effort invested in writing a clear methodological rationale for a new procedure in the log pays off sometimes months or years later, when this can often be copied directly into the methods section of a monograph chapter or journal article.

8.4 Data to Database: Recording Information from Specimens

Most zooarchaeologists use computers to create and manipulate archaeofaunal databases. Rapid advances in hardware and software capabilities, especially personal computers, Total Station mapping, prompt-based data input systems, relational databases, and sophisticated plotting and graphing capabilities impel the continued emergence of new systems of recording and managing zooarchaeological data. It is most prudent, therefore, to avoid discussing specific systems that will soon be outdated and concentrate instead on what data management should do relative the ultimate goals of zooarchaeological analysis.

Systems for managing zooarchaeological data are numerous and widely published, and the best advice I can give is to examine a range of these systems and their flexibility before either committing to one in particular or trying to devise one's own. Early examples include Meadow's "Bonecode" (1978), Campana and Crabtree's "Animals" system (1987), Klein and Cruz-Uribe's (1984) database system, that developed by myself and Crader (Gifford and Crader (1977); Gifford-Gonzalez and Wright 1986) and subsequently adapted to other settings (Parker and Kaczor 1984). The cloud-based Ossobook archaeofaunal database (http://xbook.vetmed.uni-muenchen.de/wiki/OssoBook), developed by a consortium of German and Swiss institutions, permits interassemblage comparison as well as recording. Readers are also referred to Reitz and Wing's (2008: 153–250) discussion of their primary and secondary data recording methods.

Minimally, a system should permit entry of specimens' data without having to physically pre-sort specimens by provenience, osteological or taxonomic order. A good system will be easy to use at the inputting end, using menus for the element and Linnaean names recorded on specimen tags, thereby minimizing keystroke errors and allowing less zooarchaeologically skilled people to do data entry. It should readily produce osteologically or taxonomically ordered tables, without involving additional human inputs of element and taxon names, and facilitate estimates of basic zooarchaeological counting units (Chap. 10).

Marean, Cleghorn, and other former members of Marean's Arizona State University laboratory developed a FileMaker® database format that is now widely used (Fig. 8.3). It offers visual templates of elements of various taxa to facilitate logging the osteological landmarks preserved on individual specimens. These in turn engage with an Excel®-based pivot table estimation of number of identifiable specimens (NISP) and minimum number of individuals (MNI), abundance measured to be discussed in Chap. 10. The advantages of a system that incorporates osteological landmarks will be discussed further in Chap. 10,

I created a custom FileMaker® relational database with lookups for the element, portion, and taxon numeric equivalents for originally developed by Gifford and Crader (1977) to produce osteologically and taxonomically logical sorts of large datasets. The data entry view uses pull-down menus that allow persons with little familiarity with osteology or animal systematics to enter data from lab specimen cards (Fig. 8.4). Sorts and tallies of NISP can be run in the application, and tab-delimited data can be exported for statistical analysis and other aggregation. The database structure lacks the built-in landmark system of the Marean et al. database structure. As the case with other FileMaker® products, the database is compatible with WindowsOS® and MacOS® operating systems, and it has also been adapted to Microsoft Access®.

8.4.1 Data and Specimen: A Necessary Relationship

One other form of data control has seldom been discussed in zooarchaeological publications: associating data generated from a specimen with the specimen itself in its permanent curation and storage location. In most sciences, the standard by which scholarly research is judged is its replicability. Publications of research results are supposed to present enough information about materials and methods that another researcher can reproduce the experiment and compare results of the original with their own replication. It allows a researcher's results to be checked and inferences drawn from those findings to be assessed by the community of practitioners.

Today, zooarchaeologists can post their datasets on a number of institutional or nonprofit websites, which is a great step forward toward ensuring access to information and a certain level experimental replicability. However, doing so does not permit other researchers to assess the accuracy of the initial element, portion, side, and taxon determinations, age estimates, observations on taphonomic modifications, metrical data gathered, and any other determinations made by the archaeofaunal analyst. This is the first step in assuring experimental replicability, and in many scientific fields, even new ones, well known standard procedures are followed and are expected to be stated explicitly in scholarly articles. Thus far, no such standards exist across zooarchaeological practice, despite the fact that simple *and* more technologically sophisticated methods for doing so exist. In zooarchaeology, other researchers seldom attempt a wholesale re-analysis of a faunal assemblage on which another has worked. However, one's *specimen identification and descriptions of*

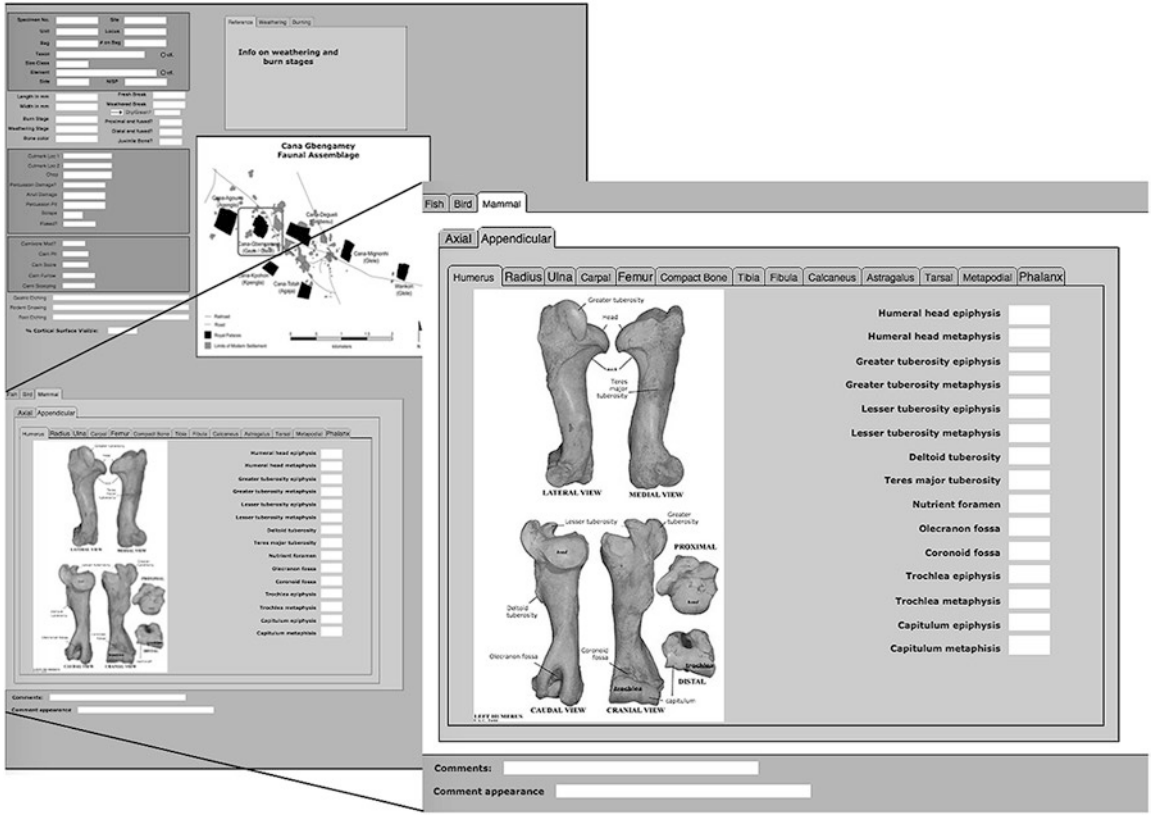

Fig. 8.3 Illustration of an example the Marean-Cleghorn FileMaker® recording system recording Anneke Janzen's analysis of the Cana Gbengamey (Bénin) archaeofauna, with the landmark section enlarged for clarity (Illustration by the author, database used with permission of Curtis Marean and Anneke Janzen.)

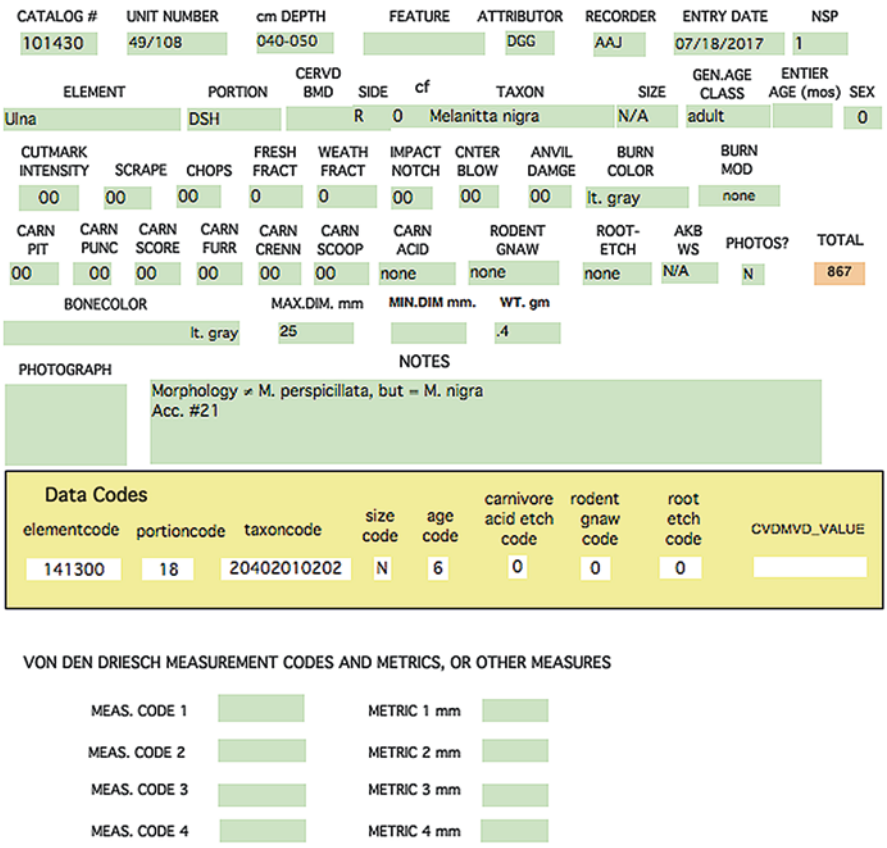

Fig. 8.4 Screen shot of the author's FileMaker® relational database. Data fields correspond to those in Fig. 8.2. Fields in the "data codes" box are automatically reported numeric equivalents of element, portion, and taxon identification entries, according to Gifford and Crader (1977), plus numeric equivalents for some identification fields that facilitate anatomically and taxonomically logical sorts of entries. For elements too fragmentary to measure, von den Driesch fields are left blank (Illustration by the author)

taphonomic evidence should be readily accessible to assessment by others. Gobalet (2001) recommends that faunal reports stipulate the reference collections used for species attributions and the location of permanent storage of the collection analyzed – as a means of assuring the "experimental replicability." See also Butler and Lyman remarks in Chap. 10.

A product-focused approach demands design of analytic and data storage systems that reveal as much as possible about individual specimens' histories and, ultimately, about the redundancies and aggregate patterning in our assemblages. The simplest way to assure this is to attach the same data that goes into a research database to a bag, tag, card, or even a digital code that remains with the specimen and links to an online database. Other researchers can thus spot-check the competence of another researcher on a case-by-case basis.

However, some zooarchaeologists simply dump each specimen back with others into a unit/level bag once they have recorded their data. It's certainly quicker to toss specimens back into their original bags than to record the data twice, once on a record that remains with the specimens and once in a database. However, whether or not done with that intention, it disguises the researcher's first steps in producing a dataset. Other scientists are left to accept or reject the validity of published observations or even posted datasets on faith.

Basic data attached to the specimens themselves are not only a form of ethical practice but also as a form of insurance against the loss of digital records or unexpected truncation of analysis. I am not the only researcher to have had a computer stolen during fieldwork: the phrase "portable laptop" takes on a whole new meaning after a mugging. In my case, the data on its hard drive were backed up elsewhere, now quite feasible with "cloud" based storage technologies. However, in the worst-case scenario, aggregate site data could have been reconstituted from the specimen tags in the museum collections because I had made a practice of recording all information on them. Archaeologists also may die long before they expect to, leaving their analyses incomplete. In the case my mentor, who passed away at age 47, each archaeological specimen he analyzed had the same information attached to it as were in his interim notes at the time of his death. Under the difficult infrastructure conditions that exist in some parts of the world, functional computers or even a reliable electrical supply may not be assured to museum collections managers and curators or visiting researchers wishing to check a site's archaeofaunas. In such cases, specimen data cards themselves can be hand-sorted to produce summary archaeofaunal tabulations.

As curator of our local archaeology archives, I have had to cope with the problem of missing identification data. The zooarchaeological sub-contractor for several development-related mitigation project collections deposited with our archives chose to write only the animal genus on specimen tags, despite presenting site report summary tables that included Minimum Number of Individuals. That statistic would have required knowing the element identification and from which side of the vertebrate body a bilaterally symmetrical element derived (Chap. 10). To make this collection useful to visiting researchers, graduate students, and myself, I re-identified over 5000 such "previously identified" specimens to element, portion, and side, essentially redoing the analysis. This is not really what I had in mind when I advocated "experimental replication" in zooarchaeological analysis.

In my own laboratory, we have experimented with two data recording approaches for specimen cards. The first was filling values into preprinted cards data fields on that match fields in our FileMaker® database (Figs. 8.2 and 8.3). When all the fields are filled and definitive identifications are checked, these data are entered into the database. The second involved making less formal notes on relevant data on blank acid-free cards, entering these data into the database, and then printing a self-adhesive label to put on the blank side of each card, which presented all the information in a neatly typed format. Since less skilled lab interns do most of the data entry, I have opted to use the defined-field data card shown in Fig. 8.2, since it allows them to relate the hand-written data in each card's fields to fields with pull-down menus

in the FileMaker® database. Another approach is now possible: printing a digital code such as a Universal Product Code (UPC or barcode) or a Quick Response (QR) code that can be inserted with a specimen and linked to institutional computers or online databases. When inserted with a specimen, these would allow anyone with a smartphone to access individual specimen data, or perhaps call for a print of a dataset. Some of us older traditionalists may prefer the legibility of a paper label, but this is a quicker means of attaching data to specimens. In the developing world, this is a realistic alternative for museum and curation facility management, as one can expect technologically savvy staff. Mobile phone and tablet use has surged where landlines never existed, and people in the global South used apps for online banking well before it became widespread in the global North.

8.5 Lab to Archive: Curation Considerations

Having served as curator of our university's central coastal California archaeology collections for about 40 years, I am aware of the value of well-curated materials to visiting researchers or students working on specific projects. Few zooarchaeological texts have discussed this matter, and Reitz and Wing's (2008) discussion of curation is in an appendix. Sullivan and Childs (2003) noted the longstanding tendency of field archaeologists to regard repositories as "dumps" rather than the repositories of well-prepared materials, whether analyzed or unanalyzed, that have future research functions.

For zooarchaeological materials, just as for other artifactual materials, data attached to specimens are essential to the curation and further research, as well as being *the* fundamental bases of experimental replicability in zooarchaeology. Practices acceptable when the goal of archaeofaunal analysis was a list of species may now be inappropriate for detailed, product-focused taphonomic analyses of bone surface modifications. We now have technological infrastructure to facilitate such practices at relatively low cost and time investment, and thus have little excuse not to build in experimental replicability from the ground up.

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