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Zooarchaeology and Historical Archaeology: Progress and Prospects

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This review assesses the development and current status of zooarchaeological research in historical archaeology. Analytical issues in recovery, identification, quantification and interpretation are discussed with particular reference to assemblages from historical sites. The results section summarizes the substantive contributions zooarchaeological studies of historical assemblages have made to our understanding of past diet, food production systems, social and cultural variation, and archaeological interpretations. The last four decades of research has provided a strong basis for future analyses that draw together diverse strands of zooarchaeological, historical, scientific, and anthropological evidence.

KEY WORDS: zooarchaeology; historical archaeology; faunal analysis; animal bone studies.

INTRODUCTION

This article reviews the development, practice, and results of zooarchaeological research in historical archaeology. Zooarchaeology, or faunal analysis, is the study of animal bones from archaeological sites. The study of animal bones from sites has become an established sub-discipline in archaeology with a large and growing literature (see O'Connor (2000) and Reitz and Wing (1999) for recent overviews). Zooarchaeologists studying historical faunal assemblages typically use many of the same methods and explore the same issues as zooarchaeologists studying assemblages from other time periods and locations. As a result, this review is not strictly limited to historical archaeology, but selectively incorporates other zooarchaeological studies. In particular, zooarchaeologists working with historic assemblages have much to gain from a broader reading of studies of Old World assemblages dominated by domestic animals. At the same time, the purpose

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is not to encompass the entire field of zooarchaeology, but to look primarily at the study of animal bones from historical sites. Thus this article highlights, to the extent possible, aspects of developmental history, methods, and questions that are unique to historical archaeology, with a particular emphasis on research results. The study of animal bone assemblages from historical sites, referred to here as "historical zooarchaeology," is sufficiently developed to have made some substantive contributions to our understanding of past diet, subsistence practices, and the development and characteristics of past agricultural and food production systems. Despite these accomplishments, the full potential of historical zooarchaeology is far from realized. Recent studies have established innovative directions for the future, creating opportunities for significant research that makes new contributions to our comprehension of the past.

THE DEVELOPMENT OF HISTORICAL ZOOARCHAEOLOGY

The growth of historical zooarchaeology has been shaped by the broader patterns of development of both zooarchaeology and historical archaeology. Bogan and Robison (1978, 1987) have compiled information on the history and development of zooarchaeology in Eastern North America. Jolley (1983) reviewed the state of historical zooarchaeology as of the early 1980s, and Deagan (1996) has incorporated an assessment of many historical zooarchaeology studies in her broader overview of environmental archaeology in historical archaeology. Together, these authors identify many of the important themes in the development of historical zooarchaeology.

Robison (1987), in his historical overview, recognizes three periods in the development of zooarchaeology in Eastern North America: a Formative Period (1860s–1951), a Systematization Period (1951–1969), and an Integration Period (1969–present). As he notes, the first researchers who can be considered full-time specialists in North American zooarchaeology, Paul W. Parmalee, Stanley J. Olsen, and John E. Guilday, emerged during the Systematization Period. In addition to analyses of prehistoric assemblages, all three of these men published early studies of historic assemblages (Guilday, 1970; Olsen, 1964a; Parmalee, 1960). The first published study of a North American historic faunal assemblage dates to 1960 (Parmalee, 1960), setting a start date for historical zooarchaeology (Jolley, 1983).

As historical archaeology grew during the 1970s, the number of analyses of animal bone assemblages from historic sites expanded. Deetz's (1977) attention to "small things forgotten" and interest in past foodways, and historical archaeology's attempts to reconstruct past lifeways helped establish faunal analysis in historical archaeology. Zooarchaeology also benefited from the greater attention to ecological and environmental issues that came with the cultural ecological emphasis of the "new archaeology." A scientific and cultural ecological approach came

into historical archaeology through people like Stanley South (1977), and influenced some of the 1970s and early 1980s studies of historic assemblages. Good examples are found in many of the historical zooarchaeology reports in the Conference on Historic Site Archaeology Papers, which South edited (Honerkamp, 1982; Miller, 1979; Miller and Lewis, 1978; Shapiro, 1979). During this period, historical zooarchaeology also benefited from the general expansion of historical archaeology that came with the rapid growth of cultural resources management studies.

In a very practical sense, historical zooarchaeology typically got done where people with strong interests in zooarchaeology worked with people digging historic sites. Charles Cleland, at Michigan State University, and the combination of Charles Fairbanks and Elizabeth Wing at the University of Florida, made great contributions to historical zooarchaeology, not just through their own work, but also through teaching students. Cleland's early research in historical zooarchaeology (Cleland, 1970) established directions for some of Terry Martin and Henry Miller's subsequent work (Martin, 1986, 1990, 1991a,b, 1979, 1984, 1988; Miller and Lewis, 1978). The program at Florida has had an even broader influence on the development of historical zooarchaeology, beginning with a string of student projects (Cumbaa, 1975; Honerkamp, 1982; Otto, 1977, 1984; Reitz, 1979), and continuing to this day through interdisciplinary field projects, which often include a strong environmental archaeology focus.

As the general subfield of zooarchaeology has become better established, the number of full-time zooarchaeologists has continued to grow. Many zooarchaeologists tend to concentrate on a specific time period or region. Some zooarchaeologists with a primarily prehistoric or Old World focus have studied North American historic assemblages (Crabtree, 1984; Crader, 1984b, 1989, 1990; Greenfield, 1992; Lyman, 1977, 1979, 1987b). These studies continue to make a real contribution to historical zooarchaeology, especially when they draw in new perspectives and approaches.

The 1980s saw the first zooarchaeologists who concentrate a significant portion of their work on historic period assemblages, including Elizabeth Reitz, Terrance Martin, and Joanne Bowen. Bowen helped to establish historical zooarchaeology by publishing an early piece that compared documentary and zooarchaeological evidence for animal husbandry at Mott Farm (Bowen, 1975). Part of the importance of this piece is that is was reprinted in Robert Schuyler's *Historical Archaeology* reader (Schuyler, 1978), and thus has a high visibility among historical archaeology students. Bowen has studied assemblages from historic sites in New England (Bowen, 1982, 1992, 1998; Brown and Bowen, 1998), and as director of the Zooarchaeology Laboratory at Colonial Williamsburg, has studied numerous assemblages from the Chesapeake. Her historic anthropological work on seasonality and agricultural practices (Bowen, 1988, 1990) has advanced the field by developing models for interpreting assemblages that differ markedly from

seasonality models employed by prehistoric zooarchaeologists. Bowen's seasonality work is complemented by Miller's zooarchaeological analyses (Miller, 1984, 1988), and Landon's research on seasonal slaughter practices (Landon, 1993, in press)

Terrance Martin, based at the Illinois State Museum (where Parmalee helped launch the zooarchaeology program), has studied a variety of historic assemblages from throughout the Midwest (Branstner and Martin, 1987; Martin, 1986, 1987, 1990, 1991b). Of particular importance are Martin's analyses of animal bone collections from French Colonial sites in the Midwest. These studies have greatly expanded our understanding of French subsistence practices, and the patterns of interaction between French colonists and Native Americans (Martin, 1986, 1991a,b).

Elizabeth Reitz at the Museum of Natural History of the University of Georgia has done more than any other individual to advance the subfield of historical zooarchaeology. Reitz has studied assemblages from throughout the Southeast, and has amassed a currently unmatched body of work in historical zooarchaeology (a partial sample of contributions includes Reitz, 1986a,b, 1987, 1991, 1994a,b; Reitz *et al*., 1985, 1987a,b, 1996; Reitz and Honerkamp, 1983; Reitz and Ruff, 1994; Reitz and Scarry, 1985; Reitz and Wing, 1999; Reitz and Zierden, 1991). One significant aspect of Reitz's work is that she employs a wide range of approaches. Her collaborative *Historical Archaeology* volume with Scarry worked at integrating faunal and botanical evidence with the historical and archaeological record in a synthetic fashion (Reitz and Scarry, 1985). She has also published many multi-site comparative analyses (Reitz, 1986a, 1987; Reitz *et al*., 1985; Reitz and Zierden, 1991), and one of few overview articles assessing accomplishments of historical zooarchaeology (Reitz, 1987). Reitz's work often includes experimentation with new analytical approaches (for example, Reitz and Ruff, 1994). In addition to her substantive contributions to our understanding of the past, Reitz's work has established a standard and direction for future studies.

Two additional points close the discussion of the development of historical zooarchaeology. Deagan (1996, p. 363) has noted that studies of zooarchaeological and other biological data from historic sites are most successful when they employ interpretive models developed for historical archaeology, rather than simply borrowed from prehistoric archaeology. As she describes, "one basic principle is that social environment and market variables are often more directly relevant to understanding subsistence strategies than are local environmental variables and their scheduling" (Deagan, 1996, p. 363). The development of these approaches over the last two decades suggests that historical zooarchaeology is beginning to mature and coalesce.

Finally, despite historical zooarchaeology's maturation, it has not really achieved Robison's final "Integration" phase, where zooarchaeological data is fully integrated into the body of archaeological reports, and used as a central part

of the archaeological interpretation (1987, p. 12). Zooarchaeologists too often receive collections after an excavation is complete, and without information necessary for a complete analysis (Emslie, 1984). Animal bone studies are frequently appended to site reports with little real integration, or published as separate studies. There are some notable exceptions to this pattern, studies where zooarchaeological data is integrated in a broader archaeological or anthropological interpretation (Ewen, 1991; Otto, 1984; Rothschild, 1990; Shackel, 1996; Walsh *et al*., 1997; Yentsch, 1994). Yet for an inherently interdisciplinary field like historical zooarchaeology, which draws together historical, anthropological, archaeological, environmental, and other sources of data, the issue of integration remains problematic. The most successful future studies will use some combination of multidisciplinary teams, project directors with an appreciation of the potential of different types of environmental analyses, and zooarchaeologists able to integrate multiple sources of data and apply them to the key interpretive issues in historical archaeology.

ISSUES IN ANALYSIS

The techniques used for identifying and studying animal bones are very similar across sites. In a simple sense, prehistoric and historic animal bone assemblages differ primarily in the range of species represented and the types of butchery marks left on the bones. However, as the bones are quantified and interpreted, greater differences begin to emerge between historical zooarchaeology and studies of assemblages from other time periods. This section provides a brief overview of some issues in assemblage recovery, identification, quantification, and interpretation. Methodological questions have been extensively discussed and debated in the broader zooarchaeological literature (examples include Grayson, 1984; Hesse and Wapnish, 1985; Klein and Cruz-Uribe, 1984; Lyman, 1982, 1987a, 1994b; Reitz *et al*., 1987a,b). Hence, this review is selective, focusing on analytical issues that are specific to historical zooarchaeology, areas where historical zooarchaeologists have failed to keep up with other zooarchaeologists, and areas where studies of historic bone assemblages have made a distinct contribution.

Taphonomy and Recovery

Zooarchaeologists have focused a great deal of attention on taphonomy, studying how bones get deposited and buried at sites, how they get destroyed, what conditions aid preservation, and how excavation practices pattern assemblages (Behrensmeyer and Hill, 1980; Binford, 1981; Bonnichsen and Sorg, 1989; Ericson, 1987; Gifford, 1981; Lyman, 1985 1987a,c, 1993, 1994b; Meadow, 1980; Shaffer, 1992; Shipman, 1981; Wheeler and Jones, 1989, pp. 64–78). While much

of this research focuses on interpretations of bone assemblages from the earliest sites, many of the conclusions are equally applicable to historic assemblages, as my own work has shown (Landon, 1992, 1996, pp. 33–57). All archaeological assemblages are, to differing degrees, subject to taphonomic processes.

An assemblage's taphonomic history influences taxonomic representation, skeletal part representation, age profiles, and many other aspects of assemblage patterning. One well-recognized effect is that of density-mediated attrition (Binford, 1981; Lyman, 1984, 1993). Simply put, when a bone assemblage is subjected to a destructive force, be it carnivore gnawing, weathering, soil compaction, or something else, the densest bones are the most likely to survive, while the least dense are the first destroyed. In these circumstances, taxa with fragile bones, skeletal parts that are less dense, and late fusing epiphyses (growing ends of bones) are disproportionately destroyed. In assemblage dominated by domestic animals, different slaughter ages for taxa could contribute to differential destruction, with implications for taxonomic representation. For example, if people usually slaughtered young pigs and older cattle, pigs' bones would be under-represented relative to cattle bones in assemblages subjected to density-mediated attrition (Landon, 1992, p. 353).

Zooarchaeologists have recognized taphonomic effects for at least 30 years (Uerpmann, 1973, pp. 318–319); yet, historical zooarchaeologists still often attribute assemblage variation to differences in human behavior without considering the potential effects of recovery methods or taphonomic history. In a review of a large number of zooarchaeological studies of plantation sites, Reitz (1987) concluded that interpretations of socioeconomic variation could not be conclusively supported because of the potential contributions of taphonomic, environmental, archaeological, and other factors to assemblage patterning. Jolley (1983, p. 67) pointed out 20 years ago that "sample size, recovery methods, preservation factors, and modification of the faunal assemblage by natural and cultural factors" are rarely considered in studies of historic assemblages. Some progress has been made (see for example Crader, 1990; Rothschild and Balkwill, 1993), but not enough. Given our growing understanding of taphonomic processes, we have reached the point where interpretations of animal bone assemblages that ignore the effects of taphonomic processes on assemblage patterning must be considered incomplete. This is not to suggest that taphonomy become an end in itself, but rather that the effects of taphonomic processes be delimited so that stronger interpretations about past human behavior can be made. This can be accomplished through a careful consideration of excavation practices, depositional context, taxonomic representation, body part representation, and bone surface modifications.

Identification and Recording

Laboratory analysis of animal bones can include recording a series of different attributes (Clason, 1972; Grigson, 1978; Klein and Cruz-Uribe, 1984; Reitz *et al*.,

1987a,b; Reitz and Wing, 1999). At the most basic level, the skeletal part and taxon are identified. This involves the comparison of archaeological specimens with skeletons in comparative collections and published references (Balkwill and Cumbaa, 1992; Gilbert *et al*., 1981; Gilbert, 1980; Gustafson and Brown, 1979; Hillson, 1992; Olsen, 1964b, 1968; Schmid, 1972). Many of the North American identification atlases are aimed at prehistoric assemblages, and European atlases often include more domestic animals (Amorosi, 1989; Hillson, 1992; Prummel, 1987; Schmid, 1972). European researchers have described criteria to distinguish sheep and goats bones, which are very similar (Boessneck, 1970; Payne, 1985; Prummel and Frisch, 1986). Anatomy books such as Sisson and Grossman (1953) can also be useful aids, although no published reference substitutes for an adequate comparative collection.

Driver (1992) has reviewed many of the underlying assumptions in classification and identification and discussed some important problems that are relevant to historical zooarchaeology. One point he makes is that our knowledge of a time period and the presumed distribution of species often leads to identifications that are not, in fact, supportable on the basis of the bones alone. This can include identifying undiagnostic fragments to a species we have identified from other skeletal elements or otherwise assume to be present, and assuming species historically held their present range. As O'Connor has noted (1996, p. 10), the latter practice might keep us from ever reinterpreting past animal ranges.

Driver is correct that we must be cautious in identification and more explicit about the criteria used to separate closely related taxa. In historic assemblages, the problem of sheep and goat distinction is well known, but there are other distinctions that are equally problematic. Few researchers report on criteria used to distinguish rats (*Rattus rattus* and *R. norvegicus*), pigeons (*Ectopistes migratorius* and *Columba livia*), and domestic dogs from other canids, even though these distinctions are both difficult and frequently made. More explicit identification is not just better research, but could potentially also make a significant contribution to archaeological interpretation. For example, defining clear skeletal criteria to distinguish wild and domestic turkeys could increase the interpretive value of turkey bones from historic sites.

There are a variety of other attributes that can be recorded for each bone specimen, including symmetry (side of the body), fusion state of the epiphyses, and weight. Zooarchaeologists have developed criteria and recording protocols for skeletal part and portion (Gifford and Crader, 1977), weathering (Behrensmeyer, 1978), burning (Crader, 1984a; Shipman *et al*., 1984), other bone surface modifications (Fisher, 1995), tooth eruption and wear (Grant, 1982), other means of age and sex determination (Wilson *et al*., 1982), and bone measurements (von den Driesch, 1976). Several researchers have defined specific criteria for distinguishing different types of butchery marks in historic assemblages (Crader, 1990; Graf, 1996; Landon, 1996, pp. 58–95; Lyman, 1977; Reitz and Scarry, 1985, pp. 84–86).

There is, at present, little consistency in analyses of historic assemblages as to what gets recorded and reported. The questions being investigated will, at times, determine the attributes recorded. However, closer attention to skeletal part representation and butchery marks would seem warranted. The well-established standards for bone measurements (von den Driesch, 1976), tooth eruption and wear (Grant, 1982, reprinted also in Hillson, 1986), and other age and sex determination criteria (Armitage, 1982; Driver, 1982; Grigson, 1982) also could be beneficially applied in studies of historic assemblages, especially assemblages dominated by domestic mammal remains. These attributes have a long history of use by European researchers to interpret stock rearing and animal husbandry practices (Higham and Message, 1969; Uerpmann, 1973), topics worthy of further attention in historical archaeology. Meaningful use of these observations requires a large sample size (Crabtree, 1990, pp. 183–184), and their interpretive value will improve as a larger body of descriptive work is generated.

Quantification

The topic of quantification is central to zooarchaeology and has been extensively discussed (Binford, 1981; Casteel, 1977; Cruz-Uribe, 1988; Fieller and Turner, 1982; Grayson, 1979, 1984; Lyman, 1979, 1987b, 1994a; Watson, 1979; White, 1953; Wing and Brown, 1979). Traditionally, much of the focus on quantification has been directed at estimating taxonomic abundance and interpreting the relative dietary importance of different taxa. As Lyman (1994a, pp. 48) has noted, more recent quantitative terms and units entered zooarchaeology with the growth of taphonomic studies, and are designed to measure taphonomic effects or identify taphonomic processes. These emphases are not mutually exclusive, and it is desirable to take a taphonomic approach to understanding taxonomic abundance.

Lyman (1994a, pp. 37–38) distinguishes three types of quantitative units: (1) observational units, which are empirically based and directly measurable; (2) derived units, which result from mathematical manipulation of fundamental observations; and (3) interpretive units, which are structured to measure some abstract or theoretical concept. Observational and derived units are fairly common in historical zooarchaeology, while interpretive units have received relatively less use. Lyman (1994a, p. 47) also notes that increased understanding of taphonomic processes has changed the status of some quantitative units. For example, early interpretations of the number of identified specimens (NISP) as a straight proxy for taxonomic abundance are now recognized as flawed.

The most common quantification units currently used in historical zooarchaeology are (1) NISP, the number of identified specimens; (2) bone weight, the total weight of some collections of specimens; (3) MNI, the minimum number

of individuals necessary to account for some collection of specimens; (4) meat yield, an estimate of the total meat available, calculated by multiplying MNI times a usable meat estimate; and (5) biomass, an estimate of body weight based on an allometric relationship between bone weight and body weight (Reitz *et al.*, 1987a,b). NISP and bone weight are both observational units. MNI is a derived unit because of the differences among researchers in the criteria used to calculate this number. Meat yield and biomass are both interpretive units, used as proxies for relative dietary importance of different taxa. The best historical zooarchaeology reports tend to use several different types of quantitative units simultaneously, often contrasting them with each other.

One underlying problem with meat yield and biomass estimates is that neither fully considers the implications of skeletal part representation in an assemblage. This is obvious for meat weight estimate derived from MNIs, but less so for biomass estimates. The allometric relationship between bone weight and biomass is based on whole individuals (Reitz and Wing, 1999, p. 228), and does not consider the variation in the density of body parts. Strictly speaking, the biomass estimated from 100 g of pig femora is the same as that from 100 g of pig teeth, even though usable resources from these body parts would not be the same. Lyman (1979) suggests tying skeletal part representation to specific butchery units, generating meat yield estimates based on butchery unit representation. Huelsbeck (1991) takes a similar tack, arguing that quantification should be based on the meat unit acquired by the consumer. Though Lyman uses historic sources to derive butchery unit meat weights for domestic animals, his approach has not been widely applied to historic assemblages.

Several studies of historical assemblages have taken slightly different approaches to quantification. Rothschild (1989) measured diversity in faunal assemblage from New York City and St. Augustine, Florida, to assess the effects of urbanization. Faunal diversity decreased through time in New York, perhaps as a result of environmental change. Faunal assemblages from St. Augustine were more specialized in the early periods than the later periods. While her interpretive conclusions remain preliminary, she demonstrated that diversity measures could be a useful way to characterize historic faunal assemblages.

Breitburg (1991) has worked on assessing the relative value of different measures of taxonomic abundance. Drawing on data from a series of historic assemblages he has studied throughout Tennessee, Breitburg compares taxonomic abundance measured through NISP and MNI to documented numbers of individuals (DNI) derived from historical sources. His statistical analysis shows that MNIs generated from the faunal analysis provide, on the whole, a closer match with the historical DNI than do NISP numbers. This study shows one way historical documentation can be used, in conjunction with archaeological data, to help resolve methodological questions in zooarchaeology.

As this discussion suggests, most of historical zooarchaeologists' attention to quantification focuses on issues of taxonomic representation and the relative dietary contribution of taxa. While these emphases have merit, the future development of historical zooarchaeology requires additional attention to other quantitative variables. The emphasis on taphonomy has introduced a whole new series of quantitative units in zooarchaeology, few of which have penetrated into historical zooarchaeology. While traditional quantitative units tend to measure taxonomic attributes of assemblages, more recently developed quantitative units tend to measure "non-taxonomic attributes of faunal remains within a taxonomic category, such as abundances of different skeletal parts or frequencies of butchery marked bones" (Lyman, 1994a).

This type of shift in quantification emphases is necessary for the continued maturation of historical zooarchaeology. There is much to be gained from attempts to more explicitly record, quantify, and interpret butchery mark frequencies (Crader, 1990; Graf, 1996; Landon, 1996; Lyman, 1977; Szuter, 1991). Similarly, more detailed analysis of skeletal part representation increases the interpretive value of assemblages, especially those dominated by remains of domestic mammals. For example, Reitz and Zierden (1991) used log plots, with specimen counts standardized against anatomical representation in a single animal, to look at cattle body region representation across a series of sites. Another approach to skeletal part representation is to calculate minimum numbers of elements (MNE) (see for example Crader, 1990), and use MNE and MNI numbers to generate percentage survival or the analogous percentage recovery rates (Crader, 1984a; Landon, 1996; Legge and Rowley-Conwy, 1991). One of the main advantages of percentage survival rates is that this measure has been used in actualistic studies that assess differential survival of skeletal elements (Binford, 1981; Brain, 1980), providing a basis for interpretation. Additional work to improve methods of quantifying and reporting skeletal part representation is key to increasing our ability to make comparisons among assemblages that go beyond simply taxonomic abundance.

Interpretation

We can categorize historical zooarchaeology reports is in terms of their organization and goals: (1) site reports, with a primary emphasis on description of an assemblage; (2) interpretive or integrative site-based analyses, which in addition to describing an assemblage offer more detailed interpretation, drawing in other historical, environmental, or archaeological data; (3) comparative analyses of multiple assemblages, either diachronic or synchronic; and (4) overviews that assess method or theory in the subfield. As with many taxonomies, the categories overlap and have a subjective component. In most early studies, researchers produced descriptive site reports. As archaeologists developed the analytical skills

necessary for faunal analysis the nature of the reports shifted, and zooarchaeologists began to produce more interpretive and comparative reports. All types of reports offer valid, albeit different, contributions to the field. Comparative and highly interpretive analyses are only possible with a foundation of descriptive work.

We can also categorize historical zooarchaeology reports in terms of their interpretive emphases. The traditional emphases of prehistoric zooarchaeology are diet, subsistence practices, environmental reconstruction, and paleoeconomy. Early studies in historical zooarchaeology mirrored these interests, focusing on dietary and subsistence practices. Some researchers also investigated broader questions about reconstructing agricultural and other subsistence systems. Environmental reconstruction is relatively new in historical zooarchaeology, but has begun to appear, for example in studies of urban environments (Mrozowski *et al.*, 1989; Rothschild, 1989).

Zooarchaeology is by no means limited to issues of subsistence practices or environmental reconstruction. One valuable aspect of animal bone studies is their potential to provide insight into many of the broader issues that interest historical archaeologists. In historic contexts, it is useful to view bones as part of a comprehensive system of food production, preparation, distribution, consumption, and disposal. As Gumerman (1997) has shown, all of these stages are intertwined with a society's political economy and its patterns of social differentiation, creating opportunities to study these topics. There is growing recognition of the potential uses of faunal data to elucidate trade, ethnicity, social differentiation, the development of political complexity, and aspects of cultural change (Clark, 1987; Crabtree, 1990; Crabtree and Ryan, 1991; Gumerman, 1997; Hudson, 1993, pp. 181–272; Zeder, 1988, 1991).

Connecting counts of fragmented bones and teeth to complex cultural questions requires an interpretive translation that draws on biological, archaeological, historical, ethnographic, or other sources of information. This becomes especially important in interpretations of social variation and the symbolic meaning of food (Gumerman, 1997, pp. 109–111; Hall, 1992). In historical zooarchaeology, our understanding of the archaeological and historical context of an assemblage often includes detailed information about the function of a site, the people that occupied it, when it was occupied, and the basic nature of subsistence practices. This can extend to detailed information about the social, economic, occupational, ethnic, or religious background of a household, all of which increases the interpretive potential of bone assemblages. Often, the challenge in these situations is to develop an interpretation that does more than simply reiterate what we already know about a site.

General contextual knowledge helps build frameworks for interpretation. For example, Schulz and Gust (1983) used historic data on butchery practices and prices of beef cuts to develop relative price ranks for cuts of beef, allowing us to connect observations of beef bones in an assemblage to historic categories

of price-ranked butchery units. Yentsch, despite disliking the scientific aspects of historical zooarchaeology, successfully interprets zooarchaeological data, primarily by drawing on detailed contextual information—contemporaneous bone assemblages, historical information about meat prices and availability, and ethnohistorical information about African foodways (Yentsch, 1994). A scientific and rigorous approach to faunal analysis does not in any way preclude interpretive studies. On the contrary, attempts to address more theoretically complex issues will only succeed when well supported by carefully crafted and rigorous analyses.

RESULTS

The subfield of historical zooarchaeology is sufficiently developed to have made some substantive contributions to our understanding of the past. This section reviews some of these contributions, organizing them thematically around four frequently interrelated topics: (1) diet and subsistence practices; (2) animal husbandry and food distribution; (3) social and cultural variation in foodways; and (4) archaeological interpretations. These categories overlap, and many studies contain information about more than one topic; these categories primarily help organize the discussion. Given the rapid expansion in the number of studies of historic assemblages, it is impossible to review them all. It is, however, possible to get a sense of what has been accomplished, and what questions remain for future research.

Diet and Subsistence Practices

The broad rubric of diet and subsistence practices encompasses studies of the relative dietary importance of different domestic and wild taxa, the technologies employed in raising, capturing, and processing animals, seasonal variation in the uses of different food sources, and a series of related topics. Most studies in historical zooarchaeology include some assessments of diet and subsistence practices, even when these serve as a precursor to other interpretations. A clearer understanding of past dietary practices is one area where historical archaeology has greatly augmented and altered our picture of the past. This is especially true for our conception of Colonial Period diet and the diet of both enslaved and free African-Americans. One interesting topic researchers have addressed is how British, French, Spanish, and African people altered or maintained their traditional dietary practices in the new environments of North America. This relates to general questions about colonial adaptation, the transplantation of cultural traditions, and the patterns of interaction with indigenous populations, all of which are important emphases in the historical archaeology of colonialism (for an interesting South African example see Schrire, 1992). The effects of colonial interaction on

the subsistence and foodways of post-contact Native Americans in the periods after contact remain understudied, though this situation has been changing some recently (Lapham, 2002; Kuhn and Funk, 2000).

Excavations at Jamestown, the first permanent English settlement in the colonies, have recovered information about the first years of the settlement, including "The Starving Time" of 1609–1610, when the colony was almost lost due to severe food shortages. Bowen and Andrews' (2000, p. 3) analysis of faunal remains from this earliest period of settlement show that the colonists relied much more heavily on wild animal foods in the first years than they did even 10 years later. The natural resources of the Chesapeake initially allowed the colonists greater access to prized wild foods, such as sturgeon, porpoise, and wild birds. However, as the food shortage took hold during 1609, the colonist also began to consume undesirable or taboo animals such as dogs, rats, mice, vipers, musk turtles, and horses (Bowen and Andrews, 2000, pp. 7–20). Arrival of additional supply ships in 1610 saved the colony, but not before many had starved or succumbed to illness. While the history of this period is well know, Bowen and Andrews analysis provides the first scientific and zooarchaeological insights into food consumption during "The Starving Time."

The later periods in the Chesapeake are much better known. Miller's (1984, 1988) multi-site comparative analysis of assemblages from the 17th- and early-18th-century Chesapeake provides our best understanding of colonial British subsistence practices. In this region, as in most early colonial settings, the adaptation to a new environment and the development of the colony's economic and settlement system contributed to changes in dietary practices. The traditional importance of sheep in the British diet did not transfer to the Chesapeake, and cattle and swine became, respectively, the two most important domestic sources of meat. Wild animals such as deer, small mammals, wildfowl, turtles and fish, played an important role in the early colonial diet. The differential availability of these wild food resources, in combination with the yearly agricultural cycle, contributed to strong seasonal variation in food consumption.

Miller interprets the primary differences in this overall pattern as due not to economic variation among planters, but to the changes through time. In the second half of the 17th century the importance of deer, fish, and other wild foods in the diet decreased significantly, while the proportion of beef and pork in the diet rose. As the contribution of wild food resources declined, the diet became more uniform, with less seasonal variation in the types of meat consumed. Ultimately, a distinctive regional dietary pattern developed that was different from contemporaneous British practices. As Miller acknowledges, his broad overview includes little material from the poorest households or from slave or servant quarters. While more recent work has expanded our understanding of animal husbandry and agricultural production in the Chesapeake (Walsh *et al*., 1997), there is still potential for additional research on sites within the region to elucidate more fully the dietary variation that occurred within plantations,

and between different groups of people in the Chesapeake's highly stratified society.

Reitz's work on Spanish subsistence in the Southeast also shows how traditional practices were altered in the New World. The initial period of colonization saw major dietary change for the Spanish colonists. Attempts to directly transplant Iberian practices failed. Spanish livestock did not all thrive in the new environment, and domestic pigs, cattle, and chickens comprised only a small proportion of the diet. The greatest change was in the marked increase in the use of wild animals, which were hunted, fished, or acquired by trade with local Native Americans. Of particular importance were deer, gopher tortoises, sharks, sea catfishes, drums, and mullets. As with the pattern in the Chesapeake, the pattern for Spanish Florida changes through time. Early-18th-century Spanish diet in St. Augustine still includes a diverse array of taxa, but compared to 16th-century sites the importance of wild food resources drops significantly, while the dietary importance of domestic mammals increases (Reitz, 1991, p. 69).

In many ways, the early Spanish subsistence practices in the Florida differ only subtly from contemporaneous Native Americans. The Spanish colonists apparently altered their diet to local resources and practices, borrowing heavily from Native American practices. Interestingly, the Native American diet does not seem to have undergone the same degree of change. Post-contact mission site bone assemblages vary little from pre-contact Native American bone assemblages, suggesting Native Americans altered their traditional food practices little. The single exception is a minor change in the fish species consumed due to adoption of some Spanish fishing technology. This comparison of Spanish and Native American diets and dietary change raises interesting questions about processes of culture change and interaction that could be addressed in future studies.

French subsistence practices seem to have changed more than the British, but less than the Spanish. Cleland's (1970) comparative analysis of British and French assemblages from Fort Michilimackinac shows that the British diet was almost entirely traditional domestic mammals–based, while the French incorporated more wild mammals, birds, and fish into their diet. The British apparently relied on their superior trade networks to supply the fort, while the French had greater interaction and trade with Native Americans. However, even the French at the fort never had a diet that emphasized fish and other wild foods as much as local Native Americans. Scott's (1985, 1991, 1996) work on additional materials from Fort Michilimackinac has clarified and expanded our understanding, showing that the British at the fort, while relying heavily on domestic animals, ate more wild animals than British further to the east. Additionally, while the diet of French at Michilimackinac incorporated more wild animals than French settlements further to the east, it still included more domestic animal meat than the most isolated French settlements.

Martin's (1986, 1988, 1991b; Jelks *et al*., 1989, pp. 75–108, 112–117) analysis of faunal assemblages from Fort Ouitenon and the Laurens Site shows that the French adopted more aspects of Native American subsistence practices at more isolated outposts. The Laurens Site, which had a relatively well-established French population, had a faunal assemblage that was dominated by domestic animals. Biomass calculations suggest that two-thirds of the meat consumed came from the domestic animals. Fort Ouitenon, an isolated outpost with a smaller French population and a larger Native population, shows a very different pattern. Here the biomass calculation suggests that less than one-third of the meat consumed derived from domestic animals, with the bulk of the diet from wild animals, primarily deer. The collection from Fort Ouitenon also contains modified turtle carapaces, bone and antler tools, and birds apparently collected for their feathers, all of which have parallels at contemporaneous Native American sites. The variation that appears to exist among French sites could be further explored with additional samples, increasing our understanding of patterns of interaction between French and Native peoples.

Researchers have studied African-American subsistence and tried to assess how African dietary practices were altered or maintained in the environments of the New World. Ferguson has argued that, at least for some of the South Carolina coastal plantations, there was a strong degree of continuity in African foodways (Ferguson, 1992), though faunal data was not a central part of his argument. Yentsch (1992) also argues for a strong African influence on Colonial Chesapeake fishing practices. In plantation contexts it remains unclear what degree of choice slaves had in their diet, and how much their dietary pattern was forced on them by others. Reitz (1994b) studied the faunal assemblage from the 18th-century free African site of Gracia Real de Santa Teresa de Mose (Fort Mose), north of St. Augustine in Spanish Florida. Contemporaneous assemblages from St. Augustine and the Nombe de Dios Native American village provided comparative data. Consumption of domestic animals at Fort Mose was much greater than at the Native American village, but less than at St. Augustine. The pattern of wild animal use is virtually identical to that at the Native American village, with an emphasis on estuarine resources that could be captured with relatively simple techniques. No specifically "African" elements of the subsistence pattern are visible from the bones, although this does not preclude the continuation of African traditions in food preparation or consumption.

More is known about African-American diet from studies of slave quarter faunal assemblages. As Singleton notes (1991, p. 171), "The study of food remains has perhaps contributed more to the amplification of written records on slave living conditions than any other archaeological resource." Evidence at many plantations shows slaves used wild food resources to augment rations issued by the planters. On coastal plantations, the use of estuarine resources, fish, turtles, and aquatic mammals, was particularly important. More interior plantations also used many

wild resources, primarily birds and small mammals (Reitz *et al*., 1985, p. 185). Many of the wild taxa represented in slave quarter assemblages could have been caught with traps, nets, or snares in some combination of purposeful and opportunistic collecting (McKee, 1987, p. 38; Reitz *et al*., 1985, p. 184). While there is no real indication of specifically African dietary choices, the consistent use of wild resources shows a conscious effort to supplement insufficient plantation food rations.

Beef and pork were the two most important sources of meat issued in plantation rations. Specific quantities are difficult to judge, especially since some preserved pork was distributed boneless, but beef appears to have been equally or more important than pork on some plantations (Reitz *et al*., 1985, p. 169). Slaves were typically given lower-quality cuts, possibly reusing some bones for soup after they had been stripped of most meat for the planter's table (McKee, 1987). At Monticello, there is good evidence for variation in the cuts of meat issued to specific slaves. Crader (1984b, 1989, 1990) compared faunal assemblages from three contexts at Monticello. Two come from buildings used as slave dwellings and one comes from a dry well filled with trash from the plantation house. The material from one of the slave dwellings, building "O," contains bones of meaty cuts of pork that appear from the butchery marks to have been prepared as roasts rather than in stews or soups (Crader, 1990). This pattern is quite different from the other slave dwelling assemblage, and more in line with the plantation house assemblage. Future studies of faunal assemblages from slave quarters will increase our understanding of dietary variation both within and among plantations, thus enhancing our ability to interpret cultural aspects of subsistence practices.

The situation for enslaved Africans and African-Americans in the North appears to be slightly different, though the archaeological research on slave sites in the North is admittedly far less developed. In general, wild animal foods appear to be must less important in the diet in the North. At the Royall House in Massachusetts and Sylvester Manor in New York, both wealthy households that contained slaves, the faunal assemblages are strongly dominated by the remains of cattle, pigs, and sheep, with few wild animals present (Newman and Landon, 2002; Sportman, 2003). At the Carr Site in Rhode Island, the early-19th-century household of an African-American tenant farmer, heads, hocks, and feet of cattle, pigs, and sheep dominate a very small faunal assemblage (Landon, 1997a). The small size of the assemblage and the predominance of low-meat parts together might reflect the diet or a poor household that included little meat. While more assemblages need to be studied, the pattern of intensive use of wild animals seen in the South does not seem to hold in the North. This might reflect broader pattern of regional variation, as most Euroamerican assemblages in the North show a strong emphasis on domestic animals for food.

Our knowledge of subsistence practices in the West is much more limited, especially for the colonial sites. Archaeologists have studied the effects of Russian

and Spanish colonial contact on Native American diet (Lightfoot *et al*., 1998; Spielmann, 1989), but have not given as much attention to the colonists themselves. Snow and Bowen (1995) report on a series of pre-1680 Spanish colonial contexts in Santa Fe, New Mexico. Their study shows a clear dietary emphasis in Santa Fe on meat from domestic livestock, predominantly mutton and beef. This is a clear contrast both to local Native American sites and to Spanish colonial sites in the Southeast, suggesting the value of additional studies of southwestern Spanish zooarchaeological assemblages. This work could likely make an important contribution if it was framed by broader questions about colonialism and culture contact in the Southwest.

More is known about later 19th-century sites in the West, as American expansion spawned new forts, trading posts, and mining camps across the region. Several studies have examined zooarchaeological collections from these sites, emphasizing a variety of issues including the connections to food provisioning networks (Crass and Wallsmith, 1992), local butchery practices (Szuter, 1991), and social variation within communities (Schmitt and Zeier, 1993). Several interesting studies have also investigated subsistence practices among overseas Chinese in the West, both at mining sites and in urban areas (Gust, 1993; Langenwalter, 1980; Longnecker and Stapp, 1993). The general impression is that overseas Chinese maintained aspects of their traditional food practices, including a preference for pork and poultry and their use of Chinese cleavers in butchery. Of course, their ability to eat a traditional diet was subject to both constraints of the food supply systems (Longnecker and Stapp, 1993) and to the economic situation of different Chinese communities (Gust, 1993).

The final topic considered under diet and subsistence studies is seasonality. Seasonality is an important concept in prehistoric zooarchaeology, especially in cultures where seasonal resource use practices are coupled with seasonal settlement patterns. In these situations, determining season of site use becomes an important goal of faunal analysis. Seasonality is often given less attention in sedentary agricultural societies. Davidson (1982) suggests the possibility of identifying seasonal holiday foods in bone assemblages. Shapiro (1979) and Miller (1984, 1988) have both looked at seasonal variation in diet by identifying and quantifying animal resources is short-term deposits. Both identify similar patterns, with domestic mammals most important during the late fall and winter, and more fish and wild fowl incorporated in the diet during spring and summer. Bowen (1988; Walsh *et al*., 1997, pp. 178–180) has taken a slightly different approach, using documentary information on the exchange of products to define seasonal use of different foods. I have extended Bowen's work by using tooth cementum increment analysis to test her models of seasonal slaughter of domestic mammals, and to see if urban markets altered seasonal slaughter patterns (Landon, 1991, 1993, in press). This work supports Bowen's rural patterns and shows that domestic animal slaughter followed a strongly seasonal pattern. Further, it suggests that Colonial

towns followed a rural slaughter cycle. Although results to date are limited, the potential of seasonality studies seems great.

Animal Husbandry and Food Distribution

Historic faunal assemblages often contain many domestic animal bones, and often these can be studied to gain insight into past animals husbandry practices. The uses of animals for draft, dairy, food, or other purposes can often be interpreted from age data, butchery patterns, and skeletal part representation (e.g. Payne, 1973). Bowen (1975) combined animal bone data with historical information to interpret animal husbandry at Mott Farm in Rhode Island. Jacob Mott's probate inventory listed 73 sheep, 21 cattle, and 10 pigs, while the bone assemblage contained pigs and cattle in roughly equal numbers, and only half as many sheep. The difference in relative representation, in combination with age data, suggests the uses of the animals. The Mott's raised pigs for food and slaughtered them young, raised sheep primarily for wool and for sale, and raised cattle for dairy products and for meat.

Miller (1984) also uses age data to interpret animal husbandry practices. He notes a shift in the ages of cattle represented in 17th- and early-18th-century assemblages in the Chesapeake, with later sites containing greater numbers of older cattle. Miller attributes this shift to an increased use of cattle for draft purposes, which resulted from land clearing and greater use of roads. Reitz (1986b; Reitz and McEwan, 1995) interprets the uses of animals at Puerto Real, Haiti, from both taxonomic and skeletal part representation. Cattle dominate the assemblage from one area of the site in particular, Locus 39, likely a reflection of successful cattle production for hides and other trade products. The cattle skeletal part representation supports this interpretation, with bones from the carpus and tarsus disproportionately over represented. Some of the bones are residential food refuse, but the bone scrap and the cattle carpals and tarsals are likely refuse from skinning and meat preservation that was subsequently used for making tallow and other by-products (Reitz, 1986b, p. 327).

One component of examining the uses of animals is studying the trade and exchange of live animals and meat. Taxonomic representation, skeletal part representation, age data, and butchery patterns can all help elucidate these issues. Klippel and Falk (2002) identified the remains of Atlantic cod in the wreck of the 19th-century steamboat *Bertrand*. This fish was being taken up the Missouri River as part of the ship's cargo, a reflection of the developed trade in preserved fish. Seventeenth-century Dutch shipments of barreled beef sometimes excluded the head, metapodials, and phalanges (van Wijngaarden-Bakker, 1984), though 19th-century American shipments of barreled pork could include a full range of skeletal parts (Hattori and Kosta, 1990). In his study of Brimstone Hill Fort on St. Kitts, Klippel (2001) noticed that cattle head and foot elements

are under-represented in the collection. He interpreted this as a sign of barreled beef imports, a conclusion he supported with stable isotope data showing some cattle raised in non-tropical temperate environments (Klippel, 2001, p. 1195).

Differential taxonomic representation at urban and rural sites can also provide information about urban markets, and the differential availability of products in urban and rural areas. Reitz (1986a) found that urban or rural site location had an overarching effect on assemblage composition in the Southeast. Similarly, in comparing urban and rural assemblages in Michigan, Mudar (1978) found that early-19th-century households in Detroit ate much less wild meat than the residents of the rural Filbert Site. Reconstructing urban food supply and exchange systems has been an important component of my own work (Landon, 1993, 1996, 1997b). In my study of Colonial Boston, I compared assemblages from two rural farms and two urban sites to characterize urban–rural differences and describe urban food distribution systems. Analysis of taxonomic representation, skeletal part representation, butchery practices, and age and seasonal slaughter patterns shows some urban–rural differences. Urban residents ate more mutton and lamb, more seafood, and fewer wild mammals. Urban butchers sometimes removed cattle feet early in the butchery process, and urban residents sometimes preferentially purchased meaty limb portions of carcasses. In most ways, however, the urban and rural assemblages are striking more for their similarities than their differences. The structural transformations that ultimately separated Bostonians from traditional agrarian practices did not begin until the end of the 18th century, and did not fully take hold until the early-19th century.

Many studies of urban assemblages recognize the importance of food marketing systems and work to interpret the nature of markets, how they changed through time, and how households interacted with market systems (Bowen, 1992, 1998; Bowen and Manning, 1994; Burk, 1993; Henn, 1985; Henry, 1987a). A good example is Henry's (1987a) study, in which she proposes an urban subsistence pattern for turn-of-the-century Phoenix, Arizona. This urban pattern is based on purchase of professionally butchered meats and commercially prepared foodstuffs, with household access to and choice of goods structured by their social class and ethnic traditions. Other studies complement this research. Bowen (1992) found little clear ethnic differences in urban assemblages from the African Meeting House and Narbonne Sites in Massachusetts, suggesting that urban markets structured the assemblages more than any other factor. Henn (1985) has studied the "urban foodchain" in New York, and cautions that differential refuse disposal habits, consumption of boneless cuts of meat, and reliance on non-market resources might hinder our ability to make accurate interpretations. With our broadened understanding of the nature of urban market systems, future studies can better explore how individual households interacted with markets, evaluating "when and how the transition to full dependence on commodity purchases occurred in urban contexts" (Henn, 1985, p. 208).

Social and Cultural Variation in Foodways

Researchers studying historic faunal assemblages often focus on how socioeconomic status and ethnicity pattern food consumption, and thus bone refuse at sites. In stratified and pluralistic societies these are important topics to study. As Deagan points out, studies by Mudar and Otto helped establish these research emphases, and "few similarly oriented studies since then have advanced that work significantly" (Deagan, 1996, p. 365). Mudar (1978) compares six assemblages from early-19th-century trash pits in Detroit, examining differences between French and non-French households and between households of different economic status. French households ate more mutton, turkey, goose, and pigeon than non-French households. Wealthy households consumed more pork than poorer households; however, specific price-ranked beef cuts were not purchased in a pattern that clearly correlated with either ethnicity or economic situation.

Otto's (1984) study compares faunal remains from the planter's kitchen, overseer's house and a slave cabin at Cannon's Point Plantation, a sea-island cotton plantation off the Georgia coast. He examines how the patterning of the archaeological assemblages reflects the known status differences of the wealthy white planter, the hired white overseer, and enslaved African-Americans. The remains of wild animals dominate all of the assemblages. The slaves and the overseer both consumed many fish, reptiles, and small mammals that would have been caught in the creeks, marshes, and woods immediately surrounding the plantation. The planter's assemblage contains a greater diversity of wild food resources, including fish and turtles caught by slave fishermen in habitats away from immediate vicinity of the plantation. The planter also had first pick of the domestic stock of the plantation, eating more and better cuts of beef. Butchery and ceramic vessel form data also suggest that the planter ate more roasts served on platters, while the overseer and slaves ate more stews and one-pot meals from bowls. Part of the strength of Otto's study is its skillful combination of multiple strands of archaeological and historical evidence. In this regard it continues to provide a valuable model for future studies.

Since Mudar's price ranking of beef cuts, many researchers have collected historical information about the relative prices of different types or cuts of meat to interpret animal bone assemblages in terms of the cost of the meat and the purchasing patterns represented (Henn, 1985; Henry, 1987b; Landon, 1987a; Milne and Crabtree, 2001; Rothschild and Balkwill, 1993; Schulz and Gust, 1983; Singer, 1985, 1987; Yentsch, 1994). Some of this research has expanded our ability to characterize urban dietary variation. Milne and Crabtree (2001) studied a series of assemblages from 1840s working-class households in New York's Five Point's Neighborhood, including that of a rabbi, a carpenter, and a brothel. Despite differences among the assemblages, they all are dominated by inexpensive cuts of pork and beef and large quantities of local fish. This pattern differs strongly from

that of middle-class households, which consumed few local fish and much more poultry (Milne and Crabtree, 2001, p. 44).

In one early and influential study of costs of meat and dietary variation, Schulz and Gust (1983) use historical data on butchery practices and prices to develop a relative ranking of beef cuts. They use this ranking to compare four Sacramento assemblages from markedly different economic situations: a jail, two taverns, and a posh hotel. The relative representation of different price-ranked cuts of beef clearly followed the pattern of the relative economic rank of the assemblage, with more high-priced cuts at the hotel and more low-priced cuts at the jail.

Schulz and Gust's article stimulated additional research, and many studies followed that offer improvements to their approach, or delineate problems with interpretations of socioeconomic status. Lyman (1987b) suggests more rigor in defining "socioeconomic status," and Lyman (1987b) and Huelsbeck (1989) propose measures of cost-efficiency as an alternative way to rank beef purchases and investigate purchasing patterns. Henn (1985) and other researchers point out the potential for boneless cuts to skew the meat patterns represented by bones. In addition, food preparation and consumption practices might have been equally as important a reflection of economic status as the cuts of meat consumed; contrast a family dinner set by servants with a large boardinghouse dining room (Landon, 1987b). Yentsch's research on 18th-century meat values also shows that 19th-century conceptions of meat cut values and interpretations of "butchery waste" should not be uncritically pushed into the past. Finally, a number of analysts have emphasized that other variables might have stronger effects on assemblage patterning than economic status, including taphonomic and recovery processes (Reitz, 1987), site function (Reitz and Zierden, 1991), systemic variation in meat availability (Huelsbeck, 1991; Schmitt and Zeier, 1993), and the nature of urban market systems (Bowen, 1992). Future studies cannot assume a direct relationship between socioeconomic status and assemblage patterning, but must make a more comprehensive assessment of the potential factors affecting bone assemblages.

Other studies focus more on ethnicity than socioeconomic status, examining how ethnicity patterned faunal assemblages of Jewish households (Stewart-Abernathy and Ruff, 1989), Dutch and British settlers in New York (Greenfield, 1992), Chinese in the West (Langenwalter, 1980), and enslaved and free African-Americans in the Chesapeake (McKee, 1987; Warner, 1998). These studies have had mixed results. Not surprisingly, ethnicity seems to have the strongest effect on assemblage patterning when ethnic dietary practices are markedly different and identifiable. Unfortunately, bones give a very incomplete view of the complex system of past foodways. Animal bone assemblages often tell more about *what* was eaten than how it was prepared or served, leaving ethnic variation in food preparation and consumption difficult to discern.

Future studies of economic status and/or ethnicity should explore how food choice, preparation, consumption, and discard serve to create and define individual

and group identities. This approach goes beyond showing the patterns that exist to interpreting how the patterns reflect active behaviors aimed at maintaining or altering ethnic or economic identity, an approach exemplified in both Warner's (1998) study of African-Americans in Annapolis and Scott's (1996) study of late-18th-century households from Fort Michilimackinac. In her study, Scott compares material from essentially contemporaneous French-Canadian, British, and German-Jewish households and assesses cultural variation in food consumption. Overall, the dietary variation within the fort is not extreme, and there are broad similarities attributable to the fort's provisioning system and the resources available locally. There are, nonetheless, specific ways food functioned as an expression of identity. When the German-Jewish trader Eziekiel Solomon first arrived at Michilimackinac his choice of food was much like that of his neighbors, and he apparently ignored Jewish dietary rules and deemphasized his distinctive identity. Later, when he was more established and had become a successful trader, he altered his diet to more closely fit Jewish practice, and greatly decreased his consumption of pork, wild birds, and wild mammals. In Scott's interpretation, the emphasis is not on how availability of provisions and local resources structured food consumption, but how, within the structure of available foods, people's food consumption both reflected and created their identity.

Archaeological Interpretations

The spatial patterning of bone assemblages at sites can contribute to a variety of interpretations about site formation processes and cultural patterns of bone disposal practices. Studies of this nature often have, either implicitly or explicitly, a strong taphonomic emphasis in that they try to explain the reasons for the patterning of assemblage attributes. Taxonomic representation, skeletal part representation, bone surface modifications, and other criteria can all contribute to these interpretations. I categorize these as "archaeological" interpretations because they typically pay very close attention to details of archaeological context and assemblage formation processes. This research contributes not just to stronger analyses of bone assemblages, but also to a better understanding about overall site function and formation. Faunal evidence for site formation processes is seldom integrated into general site interpretations, an accomplishment that remains for future studies.

Price's (1985) study of intra-site distribution of faunal remains at an Ozark farmstead is an interesting and fundamentally archaeological interpretation. Her primary goal is not to reconstruct diet, but to examine how the differential distribution of faunal remains in site features reflects specific site activity areas and the butchering, cooking, consumption, and bone discard practices for specific taxa. The archaeological patterning of species and element representation in specific deposits matches historical and ethnographic accounts of the differential processing

and use of small mammals, birds, cattle, and pigs. As Price points out, faunal assemblages from individual features are not representative of overall dietary practices when animal processing and bone disposal is spatially patterned. Price's approach to the use of space and the spatial segregation of tasks might be fruitfully combined with Gibb and King's approach to studies of age and gender divisions of labor (Gibb and King, 1991) to develop additional interpretations of labor division and activity areas on farmsteads.

Reitz (1994a) has used taxonomic representation to assess whether wells were left open and served as natural traps or were filled quickly and never functioned as traps. Whyte's experimental study shows that small amphibians, turtles, and mammals are all caught in natural traps, with young animals caught more frequently than old (Whyte, 1988 summarized in Reitz, 1994a, pp. 146–147). High frequencies of these small commensal taxa in well assemblages or a concentration of bones from these taxa in lower levels could suggest the well functioned as a natural trap. Barber (1976) recognized a high proportion of commensal taxa in the Bray Plantation well, and an examination of the taxa represented in light of Reitz's criteria suggests it might have functioned as a natural trap.

Reitz looks for these characteristics in a series of well assemblages from the Southeast. Most of the wells do not appear to have functioned as natural traps, and were probably intentionally filled over a short period of time. This research area could be easily expanded to broaden the range of conclusions about feature filling. For example, assessment of the degree of carnivore gnawing and bone weathering could help determine whether the quick filling episode was mostly secondary refuse deposition, such as dumping kitchen trash straight into the feature, or tertiary deposition, such as dumping yard sweepings or other yard trash into the well. In the first instance, fewer bones will have dog chew marks or weathering damage than in the second case. Answers to these types of questions make a general contribution to interpretations of artifacts from feature fills.

I examined taxonomic representation, skeletal part representation, butchery marks frequencies, bone burning, and weathering in a bone assemblage from Fort Christanna (Landon, 1992). The specimens were highly fragmented, extensively modified, and difficult to identify, rendering dietary interpretations difficult. Nonetheless, the assemblage provided much information about site formation processes. Two root cellars held concentrations of burned bone, a result of tertiary deposition of fireplace trash. The third bone concentration was a surface midden adjacent to the fort's palisade wall. This contained a small number of burned bones and some differentially weathered bones that suggested stability during slow burial. These characteristics helped define an area that functioned as a surface dump for food refuse, perhaps a butchering or processing area as well. Though we cannot be confident about drawing extensive dietary conclusions from the assemblage, we can use the bone characteristics to gain insight into the use of space and refuse disposal practices at the fort. This approach potentially increases the analytical value of highly fragmented and modified bone assemblages.

BEYOND SUBSISTENCE: FUTURE DIRECTIONS IN HISTORICAL ZOOARCHAEOLOGY

Virtually all of the topics covered to this point could benefit from additional work, and few of the future directions it is possible to envision represent a total departure from past interpretive emphases. It is important to avoid the tendency towards "intellectual deforestation" that results from dismissing all past work in favor of the theory or approach of the moment. It is preferable instead to emphasize the cumulative nature of archaeological research, and the ways future research questions build on and relate to past studies. In this sense, assessing our current state of knowledge is a necessary precursor to suggesting future methodological, interpretive, or theoretical directions. One of the strengths of historical archaeology is its pluralistic view of the past, and there are numerous different insights future animal bones studies can potentially contribute.

In his 1983 review of historical zooarchaeology, Jolley stresses the potential of comparative analyses to document and interpret intra- and inter-site variability in assemblages and its relation to settlement type, socioeconomic status, temporal variation, and spatial variation (1983, p. 75). Many such studies have appeared in the intervening years, showing the strength of multi-assemblage comparative analysis. The full value of this type of work is far from realized. Perhaps the most direct ways future studies build on previous work is through reanalyzing past collections with new questions and methods. Walsh *et al.*'s (1997) study, "Provisioning Early American Towns," an NEH funded project that brought together zooarchaeological data from some 50 excavated sites, is perhaps the preeminent example. Historical archaeology is further along in the Chesapeake than in most other regions, but continued excavation of sites will hopefully allow a similarly detailed corpus of data to be gathered for other regions, creating the opportunity for similarly complex multi-site analyses.

Several more recent overview articles stress the need for "integration" as a key for future development (Crabtree, 1990; Gumerman, 1997; O'Conner, 1996). In its simplest form, the idea is to treat bones as another form of archaeological data and make certain that it is fully incorporated into archaeological interpretations. Crabtree suggests the future for zooarchaeology in the study of complex societies lies in integrative and interpretive studies drawing on archaeological data, historical information, pictorial representations, and computer simulations (1990, pp. 188–190). Similarly, Gumerman suggests researchers studying complex societies use "contextual associations, language, iconography, ethnography, and ethnohistory to provide details concerning the symbolic nature of food" (1997, p. 112). Reitz *et al.* (1996) in their book, *Case Studies in Environmental Archaeology*, provide a good model for integrating diverse sources of environmental data. Integration of diverse material has always been a core issue for historical archaeology. Nonetheless, successful interweaving of archaeological, historical,

anthropological, environmental, and other strands of data remains a key challenge for future development. The value of working this direction lies in the potential synergy.

One research area that could be much better developed is the connection of zooarchaeological data to cooking and other aspects of food preparation and consumption. Improvements in our ability to recognize specific cooking practices from bone assemblages would provide new ways to link bones with pots and people. Drawing together anthropological approaches to the meaning of foods with historical and archaeological data about cooking, serving, and eating would help us develop more holistic explanations of the symbolic and cultural dimensions of foodways. Detailed foodways studies also have much to gain from a more explicit consideration gender roles and the gender division of household labor, topics often overlooked in zooarchaeological studies (Gifford-Gonzales, 1993). Yentsch's (1994) study of the Calvert household is an example of how this approach could be framed for historic sites.

There are several research areas where historical zooarchaeologists could potentially make methodological contributions, including improvements in tooth wear aging, cementum increment analysis, quantification, and butchery analysis. While new or improved methods of analysis have their own merit, they are most important when they help stimulate new interpretive directions. For example, Reitz and Ruff (1994), and Cossette and Horard-Herbin (2003) have both published analyses of cattle bone measurements, documenting cattle size and looking at variation both through time and across sites. Cattle size and morphology varies greatly across their samples, raising important interpretive questions about the original source stock brought to the colonies, the response of domestic animals to New world environments, animal husbandry practices, and the development of regional breeds.

There are a variety of other new scientific or analytical methods, including identification of DNA and other ancient biomolecules and stable isotope analysis, that could potentially be applied to historic zooarchaeological assemblages, opening new questions for study (Landon, in press) To choose one area of scientific zooarchaeological research, there have been important advances in the use of fine scale growth structures to determine the ages of animals at death and to reconstruct aspects of their life history (Klevezal, 1996). Stable isotope data from teeth is increasingly augmenting this line of research, providing information about the season of birth of animals (Balasse *et al*., 2003) and even weaning practices for domestic cattle (Balasse and Tresset, 2002). These types of specific data about animals' life histories could potentially provide detailed and significant new insights into aspects of past animal husbandry regimes.

Future studies that move past just dietary reconstruction to broader environmental archaeology questions will increase the field's contributions to our understanding of the environmental consequences of past human action (Redman,

1999). It is possible to take a "historical ecological" (after Crumley, 1993) approach that focuses on the diachronic interrelationships among the environment, technological systems, and social systems, embedded in a model of culture that includes active individuals in groups with potentially conflicting interests. The historic period is one of rapid environmental change, much of it human induced, yet historical archaeologists have paid little attention to this topic. We should engage this significant modern issue both through our research and through public education efforts that highlight our disciplinary insight into the role of humans in past ecosystems and environmental change (Marquardt, 1994).

There are many issues warranting this approach. The temporal period covered by historical archaeology saw significant environmental change with lasting consequences for the present. European exploration and colonization spread plants, animals, and diseases around the planet on a massive scale (Crosby, 1986), with differential consequences for specific populations. The budding urban areas that were colonial outposts changed the environment, and set a foundation for future settlement and growth patterns. Expansion into interior areas, such as the American West, brought conflict with indigenous peoples and the institution of new subsistence, economic, and resource-use patterns. With the onset of industrialization the pace and scale of resource exploitation increased, human-land interactions were altered in significant ways, and we were set on the path towards our current environmental predicament.

Some of these topics are, in fact, approachable through historical zooarchaeology. Studies of the past distribution of animals and their culturally induced changes through time can provide insight into the human role in environmental change and its consequences, in turn, for people. For example, Armitage (1993) has studied the successive waves of invading rats in the New World, outlining their spread and some of their economic effects. At the level of the individual site, rat bones, rat-gnawed bones, and rat-gnawed macrobotanical remains from the Lowell boardinghouses contributed to reconstructing the conditions in the boardinghouse backlots, and interpreting urban health and sanitation (Mrozowski *et al*., 1989). Specific economic and subsistence systems also had environmental implications. Hales and Reitz (1992) examine changes in age and growth rates of Atlantic croaker based on otoliths recovered from pre- and post-contact sites in the Florida. Dramatic changes took place after Spanish settlement, possibly as a result of increased fishing pressure. Rojo (1986, 1987) has generated equations to estimate the size and weight of live cod from bone measurements. This could easily be applied to historical assemblages, where cod remains are often common, to examine fish size and look for the long-term effects of intensive fishing on cod populations. Similarly, Hamilton (1993, reprinted in Orser, 1996) takes a broad view of the environmental implications of the fur trade, and examines the consequences of changes in food availability for the fur trade social system. Studies that examine the spread and consequences of domestic or introduced animals (e.g. Clason and Clutton-Brock, 1982; Tchernov and Horwitz, 1990), reconstruct

local environments, assess effects of new subsistence practices on the environment, or address other historical ecological questions will make important new contributions to our understanding of the past.

These interpretations will be most meaningful if framed in a historical context that fully encompasses the complexity and plurality of the past. As we study past social variation, we must go beyond simply documenting patterning to interpretations of the roles and functions of foods in cultural systems that served to create and define social boundaries. As we study the emergence of capitalist market systems (Little, 1994), we can elucidate the process of commoditization, the move of production outside the home, and the diverse ways individuals and households interacted with changing market systems. Studies of animal bone assemblages have added much to our comprehension of the past; future researchers must now try to build on this framework to realize the full potential of historical zooarchaeology.

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