

ARTICLE

An Army Marches on Its Stomach: Comparing Military Provisioning across North American Sixteenth- to Nineteenth-Century Forts

Martin H. Welker¹  and Nicole M. Mathwich²

¹Arizona State Museum and School of Anthropology, University of Arizona, Tucson, AZ, USA, and ²Department of Anthropology, San Diego State University, San Diego, CA, USA

Corresponding author: Martin H. Welker, Email: mwelker@email.arizona.edu

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Abstract

Military garrisons in North America were provisioned with a diet based primarily on domesticates. A relationship between colonial diets and nationality has been an assumed truism, encouraging the belief that colonial diets were static and predetermined by European norms and leading to devaluation of colonists' adaptability and agency. We challenge that perspective using zooarchaeological data on soldiers' diets at 49 American fortifications in North America. Statistical comparisons reveal that some sites relied heavily on provisioned livestock, while others did not. Dietary patterns were significantly impacted by accessibility, length of occupation, garrison size, and local infrastructure. This evidence suggests that reliance on wild game was an adaptive response to local environmental and cultural factors influencing the accessibility of preferred domesticates, regardless of nationality.

Resumen

Se abastecieron a las guarniciones militares ubicados en Norteamérica por medio de una dieta basada en animales domésticos. Se da por descontada la relación entre la dieta colonial y la nacionalidad, divulgando la idea de que las dietas coloniales eran fijas por normas europeas y, como resultante, redujo la habilidad y la agencia de adaptarse a los colonos. De acuerdo con los datos zooarqueológicos provienen de la dieta de los soldados esparcidos en 49 fortificaciones, nosotros los autores de este artículo cuestionamos esa perspectiva. Comparaciones estadísticas muestran que algunos sitios confían en gran medida en el ganado abastecido, mientras que otros no. Patrones alimenticios fueron impactados considerablemente por la accesibilidad, duración del asentamiento, el tamaño de la guarnición y la infraestructura local. La evidencia indica que la dependencia en caza silvestre fue una respuesta adaptativa a los factores locales, tanto medioambientales como culturales, por los cuales condicionaron la accesibilidad a los animales domésticos, independiente de la nacionalidad de los soldados.

Keywords: diet; ethnicity; military; provisioning

Palabras clave: dieta; etnicidad; militar; aprovisionamiento

Euro-American fortifications in North America have been the subject of archaeological research for decades. Many attempts have been made to distinguish occupational phases and social classes related to ethnicity, nationality, or status using zooarchaeological data from historical contexts (Cleland 1970; Greenfield 1989; Langenwalter 1980; Martin 1986; Mudar 1978; Reitz and Honerkamp 1983; Reitz and Scarry 1985). These studies have had some success, but they reveal more about the complexities of human provisioning, site location, occupants' profession, urbanization, local infrastructure, trade networks, and recovery methods (Becker 2004; Crabtree 1990; Jolley 1983; Jones and Gabe 2015; Landon 2005; Martin 1991; Reitz 1985, 1986; Reitz and Scarry 1985; Scott 1985; Welker et al. 2018). Focusing

on differences such as nationality, however, may lead scholars to overlook underlying patterns attributable to local adaptation resulting from local environmental conditions, isolation from large Euro-American settlements, and long-term multicultural interactions. Advances in the digitization and aggregation of zooarchaeological data and robust statistical programs provide opportunities to explore historical military strategy and provisioning in new ways. We use the abundant faunal data from military sites in North America to test whether dietary patterns rooted in ethnicity exist, and we explore impacts of local cultural and ecological conditions.

European settlement in the New World was a multinational endeavor bringing together individuals of many ethnic backgrounds within the settlements claimed by European nations. Euro-American military personnel and their families—whatever their background, nationality, or ethnicity—occupied lands and territories in the name of distant political powers (Johnston 2001) and depended on military or private contractors for provisions (Parker 1970). The day-to-day experiences of soldiers and their families were therefore shaped by the objectives and goals of their respective governments and the landscape around them (Forbes 1938a [1758], 1938b [1758]; Johnston 2001). French, British, and American objectives in the Americas centered primarily on controlling territory and trade in cod, furs, and other goods. Their placement of forts exemplified these goals by staking claim to land, a fact that frequently placed fortifications in urban centers supporting fishing fleets or on the inland fringes of European settlement to support trade with Native American peoples and/or enforce boundaries. In contrast, the Spanish presidio and mission system was designed to not only stake claim to territory but also facilitate the conversion of local Native American communities.

Zooarchaeological data are well suited to examine how the occupants of military (or other) sites adapted to local environments, and how widely these adaptations are shared. Archaeological studies of Euro-American military sites in North America have typically suffocated discussions of local adaptation to new environments visible through intersite comparison while emphasizing individual sites' roles within broader military strategies and political machinations (but see Becker 2004; Broughton et al. 2007; Crass and Wallsmith 1992; Parmalee 1960; Welker and Hughes 2023; Welker et al. 2018). Despite this tendency, assemblages from military sites provide a useful starting point when examining dietary patterning. Euro-Americans constructed military forts across North America during the historical period, spanning national, environmental, and social conditions. Many have been excavated, and information on nationality, status, accessibility, fort function, and history are available. Finally, the occupants of military forts largely engaged in a single profession that entailed being supplied by their respective governments following standardized, and well-documented, rationing protocols (Anderson 2007; Crowdy 2012; Elting 2009; Kennett 1967; Knox 1769; Sullivan 1997; Williamson 1795). These characteristics provide a foundation on which hypotheses regarding the composition of faunal assemblages and dietary impacts of environmental, social, and political factors can be tested using a large sample.

In this study, we employ zooarchaeological data from published and gray literature sources to seek out underlying patterns in how military fortifications supported by various national governments used wild and domesticated animals for dietary purposes, and the adaptations made by soldiers to fill shortfalls in available provisions or diversify their diets. In this study, we follow the steps of earlier scholars, including Charles Cleland (1970), who identified significantly more wild game in what he believed to be the French (1713–1760) occupation of Fort Michilimackinac than in the later British occupation (1760–1780). Cleland (1970) hypothesized that dietary differences between French and British period occupants resulted from (1) changes in the site's accessibility, (2) differences in the site's use, or (3) changes in the relationship between site occupants and local Native American populations. Cleland's (1970) results have been largely invalidated by changes in the interpretation of Fort Michilimackinac's archaeological deposits (Scott 1985); however, subsequent studies of French forts in the Great Lakes region have revealed similar patterns (Becker 2004; Martin 1986). Other work has found that variation from standard diets often reflects conditions where either supply delivery was challenging or soldiers had opportunities to shape their diets (Crass and Wallsmith 1992; Parmalee 1960; Welker and Hughes 2023; Welker et al. 2018). We expand on these initial comparisons of French and British provisioning to compare faunal datasets from 49 French, British, Spanish, and American military garrisons.

To be clear, this analysis does not seek to draw direct links between individual soldiers' nationality—or ethnicity—and their diet. Individuals can, and do, quickly change their diet based on resource availability and other variables. Rather, this analysis employs a large dataset of faunal data reflecting subsistence of individuals who share an occupation, which is grouped by the national government responsible for their provisioning. Although government representatives charged with provisioning fortifications may express elements of their own ethnic or national identity through their choice of food and its preparation, these decisions are constrained by the need to provide reliable, cost-effective foods to garrisons. The objective of this study is to examine how successful government institutions were in supplying garrisons and how fort function affected soldiers' agency over their diets. Using large, aggregated zooarchaeological datasets, this article examines the adaptations made by garrisons to diversify their diets and overcome shortfalls.

The Challenges of Military Provisioning across a Continent

The old idiom attributed to Napoleon—"An army marches on its stomach"—was as true for North American armies as those in Europe. Soldiers throughout history have often found themselves far from the familiar, sometimes making do with local resources. Military officers and government officials understood the strategic importance of keeping soldiers fed but had to contend with unfamiliar landscapes, tenuous supply chains, and the contingencies of local politics and climate. The resulting documentary evidence reveals a multitude of strategies adopted by garrisons to mitigate the risk of food shortages. Faunal material recovered from military fortifications can provide a useful baseline to explore how these variables impacted historical diets across time and place. Eighteenth-century records indicate that French, Spanish, British, and American soldiers and officers subsisted on similar standardized daily rations based on widely available domesticated plants and animals (Anderson 2007; Crowdy 2012; Elting 2009; Kennett 1967; Knox 1769; Sullivan 1997; Williamson 1795).

In comparison to other Euro-American groups such as missionaries, traders, and settlers, soldiers' diets were expected to be regimented by the decisions of government officials (Table 1). The need to amass and deliver sufficient supplies and monitor logistical failures ensured the creation of detailed records, but it also conditioned the kinds of foods that were relied on. Cattle and pigs were reportedly the primary sources of protein, although fish were occasionally supplied to soldiers. For British soldiers, the cost of rations was subtracted from soldiers' pay (Brett-James 1994; Macdonald 2014). Officers introduced variability into their diets by selling back rations and purchasing goods for their own consumption (Macdonald 2014).

These records define soldiers' diets under optimal circumstances; however, supply delivery in North America was rarely optimal, especially during times of conflict (Bannerman 2015; Parker 1970).

Table 1. Reported Eighteenth-Century Military Rations.

| Food Item | British | French | Spanish | United States | |
|-----------------------|-----------------------------|---------------------------------|---------------------|-----------------------------------|---------------------------|
| Protein ^a | Beef | 0.45 kg (1 lb.) | 0.23 kg (0.5 lb.) | | |
| | Pork | 0.23–0.34 kg (0.5–0.75 lb.) | 0.11 kg (4 oz.) | 0.22 kg (8 oz.) | 0.34–0.45 kg (0.75–1 lb.) |
| | Fish | 0.45 kg (1 lb.) | | 0.23 kg (8 oz.) | 0.45 kg (1 lb.) |
| Bread/Flour | 0.45–0.68 kg (1–1.5 lb.) | 0.68 kg (1.5 lb.) | 0.91 kg (2 lb.) | 0.45 kg (1 lb.) | |
| Peas/Beans/Chickpeas | 0.12 L (0.25 pt.) | 0.12 L (0.25 pt.) | 0.06 kg (2 oz.) | 1.42 L (3 pts., per week) | |
| Dairy (Butter/Cheese) | 0.03 kg (1 oz.) | 0.17 kg (6 oz.) | | 0.45 L (1 pt., if available) milk | |
| Rice | 0.03 kg (1 oz.) | Amount unknown | 0.04 kg (1.5 oz.) | 0.24 L (0.5 pt.) | |
| Other | 1.42 L (3 pts.) spruce beer | 5 "livres" molasses (per month) | 0.95 L (1 qt.) wine | 0.95 L (1 qt.) spruce beer/cider | |

Sources: Adams 1978; Freney et al. 1995; Marx 1971; Morisson 1974; Phillips 1986; Sullivan 1997; Williamson 1795.

^a Typically one per meal.

Officers and contractors charged with delivering supplies collected them from farming communities in various stages of development. They faced shortages in the salt and barrels needed to preserve meat, shortages in the vehicles needed to transport supplies, and a lack of reliable roads or navigable rivers (Breitburg 1983; Wainwright 1959; Welker et al. 2018). Pack horses were adopted where road systems could not support heavy cart travel (Forbes 1938a [1758], 1938b [1758]). Live cattle were herded to fortifications for on-site butchery and salted or smoked if barrels were not available (Forbes 1938c [1758]). Some forts maintained their own fields and herds of livestock, with the Spanish presidios being the most successful (Breitburg 1983; Fradkin and Walter 2018; Parmalee 1960). Spruce beer and gardens provided fresh greens and prevented scurvy (Coe 2006; Kopperman 2007). Despite these coping strategies, many garrisons experienced shortfalls (Johnston 2001; Parker 1970), and archaeological evidence reveals evidence for malnutrition and disease (Fonzo et al. 2020; Scott et al. 2020). Soldiers living under these unreliable conditions adapted as best they could, but their choices were frequently circumscribed by supply networks and fort function.

Complications of supply delivery were compounded by variation in fort function, which ranged from supply depots and staging points for offensive and defensive actions to centers for trade, judicial, and diplomatic activities. Although soldiers depended on the supply of provisions, the functions performed by these sites exposed garrisons to different social, political, and environmental conditions, which impacted provisioning reliability. Supply depots housed stockpiles of provisions and equipment and enjoyed reliable supply lines because of their proximity to major roads or urban centers. Frontier defensive works and trade/diplomacy centers were typically located along contested borders away from established urban centers and road systems. Consequently, these sites experienced less regular access to provisions.

Failures in supply delivery to European armies operating in North America are recorded in period documents (Johnston 2001; Parker 1970). Many of those experienced by British and colonial forces during this period were a result of the British army's lack of experienced personnel. Unlike the British navy, which employed a permanent and experienced corps of personnel, the Victualling Board—which salted meat, baked biscuits, and organized supply delivery (Parker 1970)—Britain's army through this period was impermanent and relied on provisions and equipment amassed and delivered by independent contractors (Crowdy 2012; Elting 2009; Macdonald 2014; Parker 1970). Supply availability was especially unpredictable when provisions were shipped long distances from Europe or the Caribbean (Crowley 1978; Macdonald 2014; Tokar 1999). The army's reliance on contractors made supply quality and cost highly variable and delivery unreliable.

Faunal data permits a more direct method to evaluate the remains of past meals that historical records may have intentionally overlooked or not deemed worth recording. Previous analysis has revealed that site accessibility correlates strongly with the abundance of domesticates, particularly cattle and pigs, in faunal assemblages (Welker et al. 2018). Pigs thrived around urban areas and farmland but were difficult to herd and drive long distances prior to the railroad. Because of this, pigs are particularly abundant in faunal assemblages from urban contexts (Welker et al. 2018). Herd animals, including cattle and sheep in the American Southwest, were attractive in more remote locations. Brined and barreled meat was relied on at times, but spoilage, poor roads, and shortages in salt and barrels all impacted supply. This suggests that location and accessibility played a strong role in meat procurement, but more data are required to establish if these initial patterns hold true.

Euro-American Military Histories in North America

This study examines garrison accessibility as a potential influence on soldiers' diets. To better contextualize this aspect of provisioning historically, we summarize the broad contours of each colonial power's approach toward provisioning below. We define "nationality" broadly as the political regime that administered a garrison. This does not mean we dismiss the diversity and complex identities of the soldiers and their families who lived at these sites as inconsequential; however, political regimes played significant roles in defining soldiers' rations, their supply acquisition, and supply delivery, and may, therefore have a significant impact on their diet.

British, French, and American Fortifications (Largely Eastern North America)

French and British military endeavors in North America were concentrated in the eastern United States and Canada, where France's and Britain's political and economic interests resulted in repeated conflict. Britain relied primarily on "Royal American" regiments composed of colonists and understrength regiments filled with colonists rather than professional army units to defend the colonies until the French and Indian War (1754–1763; Anderson 1984, 2007). Local colonists bore a significant portion of the costs, and American colonial governments were expected to supply and pay militia when regiments were not part of armies under the command of a British officer (Knox 1769; Parker 1970). Britain also deployed regiments of professional soldiers to the Americas during the French and Indian War (Anderson 1984, 2007; Westphal 1968). Britain's need for troops in overseas theaters resulted in the formation of the British Army's first regiments recruited from Scottish clans that had supported the Jacobite uprising in 1745 (Westphal 1968). Soldiers in these regiments were recruited with the offer of land in Canada if they chose to remain in the Americas (Westphal 1968).

France relied heavily on the *Compagnies Franches de la Marine* to defend their overseas possessions. These soldiers were not part of the regular army. Except for some officers, soldiers serving in the *Compagnies Franches de la Marine* were recruited in France to prevent the civilian population of the colonies from being depleted (Crowley 1978). Like the Scottish regiments, French soldiers were encouraged to settle in the Americas following their service to increase the civilian population. Former soldiers comprised one-quarter of the immigrants to the French-Canadian territories until these transferred to British ownership in 1763 (Chartrand 1984; Crowley 1978). Although French soldiers received training and equipment to serve as a military garrison, much of their service consisted of nonmilitary activities, including construction (Crowley 1978). Because of this, soldiers with experience in the trades were in demand, and few had much military experience (Crowley 1978). Garrisons therefore reflected the distinct needs and skill sets required in historical contexts that went beyond professional soldiering.

Like other Euro-American armies, American military endeavors reflected a combination of interests. The Continental Army during the American Revolutionary War and the US military in the War of 1812 focused on securing American borders from incursion by the British from the Atlantic Coast and Canada. As American interests increasingly turned to the west, so did the role of military fortifications. Ever-changing frontier conditions inhibited the formation of a consistent federal policy on settlement and Indigenous diplomacy (Wooster 1988). Until the 1860s, federal policy favored the displacement of Native American tribes to the west of a permanent frontier demarcated by forts garrisoned by the US military; however, westward expansion of white settlers and the differing opinions of those in government prevented the formulation of a consistent US policy (Wooster 1988). Furthermore, although the fortifications that comprised the western frontier were intended to protect white settlers, they also frequently served as centers of trade, diplomacy, military actions, and resettlement programs with and against various Indigenous peoples (Wooster 1988).

Spanish Fortifications (American Southwest, Primarily)

The Spanish presidio system contrasts with British, French, and later American forts in several ways. Although British and French soldiers were sometimes recruited with the promise of lands, few fortifications were intended to become a stable, long-term communities. In contrast, Spanish presidios, even on the edges of New Spain, were intended to support permanent settlement. Presidios housed local governance and provided a base for farming, livestock, families, religious evangelism, and Indigenous diplomacy (Bense 2004; Ciolek-Torrello and Swanson 1997; Early 2004). Presidio soldiers were salaried and often married, although in Spanish Florida, many of the presidio populations consisted of criminals and conscripts (Bense 2004). Soldiers received a regulated salary, but they and their families were expected to work in the fields, and they often turned their hands to ranching (Jones 1996).

At the Presidios of Monterey and San Francisco, soldiers arrived first and accounted for a large portion of the population, and women and nonnative settlers arrived later (Conway 2003). Despite the

long presence and frequent usage of Indigenous soldiers and warriors in presidio military duties in other parts of the borderlands (Jenks 2013; Officer 1987), in San Francisco, *indios* were frequently used as day laborers to free soldiers up from their work obligations (Hull and Voss 2016). The labor of *indios* was sometimes negotiated through payment to tribal leaders and, in other cases, unpaid and conscripted, resulting from a conviction or as part of the labor obligation required from *indios* in mission communities (Hackel 2017). Labor and products from missions were interwoven pivotal pieces in broader Spanish imperialism, making many centers for long-term settlement (Mathwich and Giomi 2021). Presidios were often the only sites where a case might be investigated and tried, and presidio leaders became the main interlocutors in conflicts between missionaries, settlers, soldiers, and Indigenous communities.

Presidio locations in the northern borderlands were extremely isolated, and they were chosen using a combination of pragmatism and higher-level strategic goals, with mixed results. The colonization of California prompted the Spanish government to secure an overland route to California from the Gulf of Mexico, resulting in the relocation of multiple presidios. Establishing a presidio every 193 km (120 mi.; Officer 1987) on the northernmost reach of New Spain made these sites extremely isolated and vulnerable to raiders on horseback. The local results of this broader military strategy were mixed, with some presidios—such as Santa Cruz del Terrenate—abandoned shortly after being established. Hugo O'Connor, founder of the Tucson Presidio, was tasked with moving the Tubac Presidio northward to support the overland route to California, but he chose a location insulated by Tohono O'odham farming communities and in proximity to good fields, pasture, and water sources (McCarty 1973). The isolation of the presidios in Sonora, New Mexico, and Texas faced profound raiding threats from Apache and Comanche groups, which proved to be one of the most effective caps to the northern expansion in New Spain. Self-sufficiency, military alliances, forced labor, and reliance on mission resources were ways to mitigate the economic impacts of raiding and isolation.

Materials and Methods

Zooarchaeological data reflecting the occupation of military fortifications in North America were compiled from published and gray literature sources. To ensure data comparability, sites or contexts lacking a complete listing of identified species, or with fewer than 100 NISP (Number of Identified Specimens), were excluded except in cases where several contexts representing a continuous occupation could be aggregated. These sites were arranged into four groups: French, British/Colonial (hereafter “British”), Spanish, and United States (US). These classes identify the government institution responsible for their provisioning, although British colonial fortifications have been grouped with British regulars as one category because responsibility for provisioning these sites shifted between the colonial and British governments depending on whom was in command. No contexts of unknown affiliation were included to ensure that this comparison captured identifiable examples of French, British, Spanish, and US military diets. This dataset extends from the earliest military garrisons we could locate in the Americas to the latest assemblages we believed would not have been significantly impacted by the railroad. Typically, these sources reported data on a site level; however, contexts belonging to officers, enlisted men, and camp followers were considered separate data points in order to analyze resources by status. The dataset produced for this study spans North America and includes faunal data reflecting 49 French, British, Spanish, and US fortifications dating from 1572 to the 1860s, although some contexts may date to as late as the 1890s (Figure 1; Table 2; Supplemental Table 1).

Several distinctions in these data are worth noting. First, some early fortifications, such as the French Fort Pentagoet and the colonial Fort Christanna, were constructed by private individuals or companies. Second, some—such as the French Fortress of Louisbourg, Fort Royal, the St. Louis Bastion, and Port Royal—were centers of colonial governance in mainland Canada and the Canadian Maritimes and were in urban settings. Smaller garrisons—such as those at St. Joseph, Ouatennon, and de Chartres—were important to substantiating claims to inland North America, governing small European farming communities (Belting 2003 [1948]), serving as supply depots, and acting as fur trading posts (Keene 2002). Similar distinctions were visible in the British and colonial data with Fort Loudoun (Virginia) and the Charleston Powder Magazine defending urban centers, and

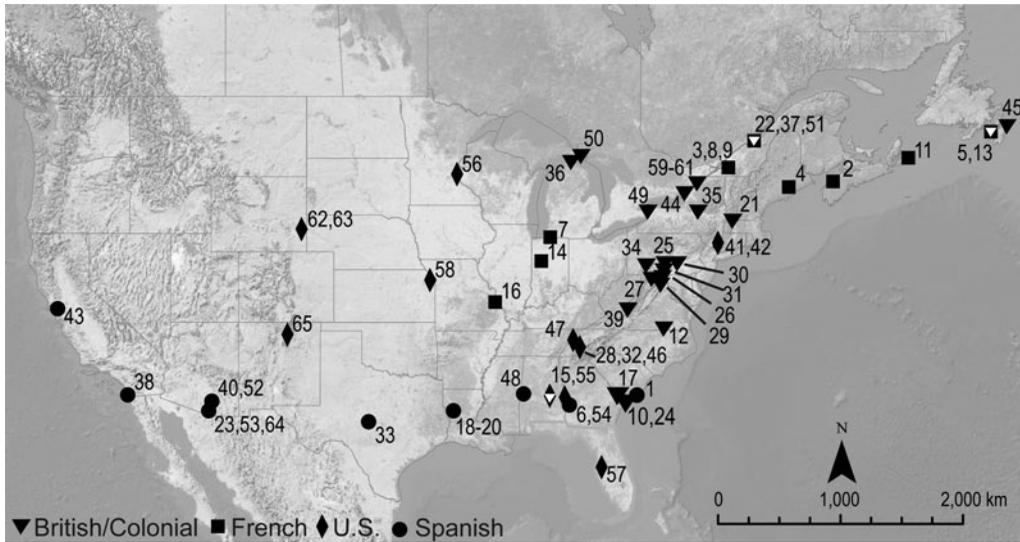


Figure 1. Sites used in this study by nationality. Numbering follows the order of sites provided in Supplemental Table 1.

smaller fortifications such as Fort Loudoun (Tennessee) and Fort Shirley (Pennsylvania) acting as frontier posts and trading centers. Because France lost much of its North American territory at the end of the French and Indian War, the French sample effectively ends at 1763. Because of challenges in determining when the British or colonial government was responsible for provisioning early fortifications from colonial contexts, these were considered part of the British dataset (some statistical tests were run with these considered separately to demonstrate that they do not unreasonably influence comparisons).

The US sample begins with Fort Montgomery, constructed at the start of the American Revolutionary War in 1776 to guard access to the Hudson River in southeastern New York and destroyed by the British in 1777 (Fisher 2004). Fort Sullivan was built on the coast of Maine in 1809 to defend against British invasion from Canada during the war of 1812 (Depaoli 1986). The remaining fortifications in the US sample served primarily as trade forts or were involved in the many conflicts between the United States and Indigenous peoples or Mexico as the United States expanded westward toward the Pacific. Provisioning of these sites followed British and British-colonial traditions, but it may have benefited from increasing development, the propagation of livestock and farms, and, in some cases, the railroad.

The Spanish sample is primarily composed of presidios from the northernmost edge of New Spain: Alta California, Pimería Alta, and Texas. Nuevo Mexico was excluded because of the lack of published, available datasets. Most of the sites used here date to the eighteenth century, and they are contemporaneous with British, French, and US sites in our dataset. Spanish presidios, including those used in this analysis, were intended to support territorial claims and missionary activity, and to house local

Table 2. Averages for Faunal Assemblages from Military Forts by Nationality.

| | Occupation | NISP | %Dom. ^a | %Wild | %Ration | %Furs | Ungulate Index | Chicken Index | Birds | Fish |
|--------------------------|------------|-------|--------------------|-------|---------|-------|----------------|---------------|-------|------|
| British/British Colonial | 1712–1853 | 3,114 | 68 | 32 | 57 | 8 | 90 | 35 | 12 | 11 |
| French | 1613–1763 | 5,199 | 34 | 66 | 36 | 22 | 66 | 17 | 21 | 21 |
| Spanish/Mexican | 1572–1850 | 4,131 | 50 | 50 | 31 | 10 | 58 | 65 | 16 | 10 |
| United States | 1792–1890 | 4,800 | 73 | 27 | 57 | 4 | 91 | 76 | 13 | 10 |

^a %Domesticates.

government administrations (Kessell 1976); however, they were also intended to be largely permanent centers of governance. Because of this, efforts were made to ensure that Spanish presidios were largely self-sufficient through a combination of open-range ranching and presidio gardening (Kessell 1976), often at a scale not seen in fortifications built by other Euro-American militaries. Some variation in this sample may be introduced because Spanish presidios in Texas, New Mexico, and Arizona likely experienced heightened levels of raiding, which may have further isolated them relative to presidios in California.

Data aggregation, especially using legacy zooarchaeological data produced by different researchers over decades with high variability in taxonomic categories, reporting methods, and diverse methodological practices, presents a known and thorny challenge (Atici et al. 2013; Cooper and Green 2016). To address these challenges, we relied on species-level identifications for the creation of standardized indices. Intersite comparisons were conducted using %NISP (percent of Number of Identified Specimens) to measure the dietary significance of species. NISP-based calculations include only material identified to species, or in some cases, family or other taxon (e.g., artiodactyla). ANOVA analyses based on %NISP were performed in R and test for dietary patterning by nationality (French, British, US), accessibility as described in documentary sources—(1) Urban: in cities; (2) Accessible: located in proximity to known roadways or navigable rivers by which provisions could be delivered as described in documentary sources; (3) Isolated: far from population centers and/or without easy access to roads or waterways (see Welker et al. 2018)—and collection methodology to assess whether screening (screened, unscreened, unknown) impacted our findings. Much of the information used to assess accessibility was available in the sources we drew upon for zooarchaeological data, or sources referenced therein. We also investigate the presence of fur-bearing species, defined as those which could conceivably have been eaten but whose pelts bore high commercial value (i.e., beaver, lynx, and otter). Additional tests were based on an “ungulate index” calculated as:

$$\text{Ungulate Index} = \frac{\sum \text{NISP}_{\text{domestic ungulate}}}{\sum \text{NISP}_{\text{domestic+wild ungulates}}}$$

A similar index was calculated for chickens as:

$$\text{Chicken Index} = \frac{\sum \text{NISP}_{\text{chicken}}}{\sum \text{NISP}_{\text{chicken+all birds}}}$$

Spearman’s Rho correlation tests were used to assess the strength of correlations between occupation length, garrison size, and other variables. Finally, we evaluated whether differences existed between enlisted soldiers’ and officers’ diets using a Kruskal-Wallis test to account for the small size of this dataset.

Previous studies of Euro-American diet have employed cookbooks and other sources to identify differences in historical diets and define which species were or were not consumed by individuals of a particular ethnicity (Deagan 1973; Pavao-Zuckerman and Loren 2012; Smith-Lintner 2007). The large quantity of sites and diversity of researchers’ reporting standards meant that this more detailed, butchery-focused approach could not be attempted, although we did exclude commensal species and those generally not used as subsistence resources (mice, voles, cats, dogs, etc.) to focus on the broader patterns in resource use.

Results

ANOVA Analysis of Taxa by Nationality and Accessibility

ANOVA comparison of dietary patterns present within these datasets reveals that statistically significant differences in the contribution of domesticates do exist between sites when grouped by nationality ($F=5.101$; $df=3, 61$; $p=0.003$). When comparing nationalities individually, only comparisons between British and French ($p=0.003$), British and Spanish ($p=0.005$), and French and US ($p=0.013$) samples reach significance. This may seem to validate assertions that national cultural traditions do produce distinct dietary patterns. However, the pattern does not hold when examining the

contribution of specific domesticates. No statistical difference in the contribution of cattle to the diet ($F = 1.547$; $df = 3, 61$; $p = 0.211$), and statistically significant differences in the contribution of pigs ($F = 8.279$, $df = 3, 61$; $p < 0.000$) are driven by the near absence of pigs in Spanish presidio assemblages (Supplemental Table 1). Important sources of wild game including fish ($F = 1.48$; $df = 3, 61$; $p = 0.229$) and birds ($F = 0.976$; $df = 3, 61$; $p = 0.41$) do not correlate strongly with nationality. These findings suggest that more nuance is needed to understand the significance of taxa at forts.

Welker and colleagues (2018) found that reliance on domesticates correlates strongly with site accessibility as assessed through documentary sources. Following Welker and colleagues (2018) sites were grouped into three classes (isolated, accessible, and urban). Although initial ANOVA analysis reveals no statistically significant patterning ($F = 0.831$; $df = 2, 62$; $p = 0.44$), Spanish fortifications frequently have more domestic livestock, whereas British and French sites in Atlantic urban fishing centers have significantly less domesticated livestock than expected based on Welker and colleagues' (2018) analysis. Spanish investment in self-sufficiency (Kessell 1976) likely explains their unusual signature, whereas on the coast, soldiers were fed offcuts from the cod fishery at the Fortress of Louisbourg (Welker and Hughes 2023), suggesting that low contribution of domesticates at urban centers on the Atlantic Coast reflects commercial fishing.

When Spanish presidios and urban sites with commercial fisheries are removed, Welker and colleagues' (2018) pattern of statistically significant variability in the contribution of domestic livestock becomes apparent in this dataset ($F = 3.468$; $df = 2, 62$; $p = 0.041$), with the comparison between urban and isolated sites driving this pattern ($p = 0.031$). High variability in accessible sites renders them not statistically different from either urban or isolated sites (Supplemental Table 2). Isolated sites also have statistically higher contributions of fur-bearing species and wild ungulates than either accessible (fur: $p < 0.001$; ungulates: $p < 0.000$) or urban (fur: $p = 0.001$; ungulates: $p < 0.000$) sites. These findings support the conclusion that wild game was an important food source for soldiers at isolated sites regardless of nationality.

ANOVA performed on the proportion of assemblages consisting of species listed in standard military provisions for soldiers (Anderson 1984; Crowley 2012; Elting 2009; Kennett 1967; Knox 1769; Sullivan 1997; Williamson 1795) reveals that the statistical differences between the British and Spanish ($p = 0.017$) reflects the high contribution of ovicaprids to Spanish diets (Figure 2). No statistically significant differences were identified in the contribution of fur-bearing species to French or British assemblages ($p = 0.112$); furthermore, isolated British and French sites in the Ohio River Valley have comparable levels of fur-bearing species. The four sites with the highest proportions of fur-bearing animals were the British Fort St. Joseph (Ontario), the Spanish Fort Tombecbe (Alabama), the British colonial Fort Shirley (Pennsylvania), and the French Fort Ouiatenon (Indiana), all of which were classified as isolated. These results substantiate the conclusion that location and accessibility had significant impacts on provisioning.

Ungulate Taxa

Welker and colleagues (2018) identified not only differences in the contribution of wild game but also the relative significance of cattle and pigs to soldiers' diets at urban, accessible, and isolated sites. Accessibility was not found to correlate strongly with reliance on cattle or pigs in the larger dataset. Differences in provisioning strategies were most apparent in the ratios of wild and domestic ungulates (Table 2). When using the ungulate index (NISP of domestic ungulates divided by all ungulates in the assemblage), ANOVA reveals statistically significant differences based on accessibility ($F = 15.79$; $df = 2, 62$; $p < 0.000$) and nationality ($F = 6.773$; $df = 3, 61$; $p = 0.001$). When one considers accessibility, inaccessible sites are significantly different from both urban ($p < 0.000$) and accessible ($p < 0.000$) sites. Considering nationality, the Spanish are again significantly different from the British ($p = 0.002$) and the US military ($p = 0.006$). No other pairings reached significance. Wild ungulates composed, on average, 27%–65% of all ungulates found at the sites. Ungulates provided hides, fats, bone for tools, and meat for consumption. Urban fortifications and Spanish presidios in the American Southwest, however, stand out as extremes because domestic livestock comprise over 90% of identified

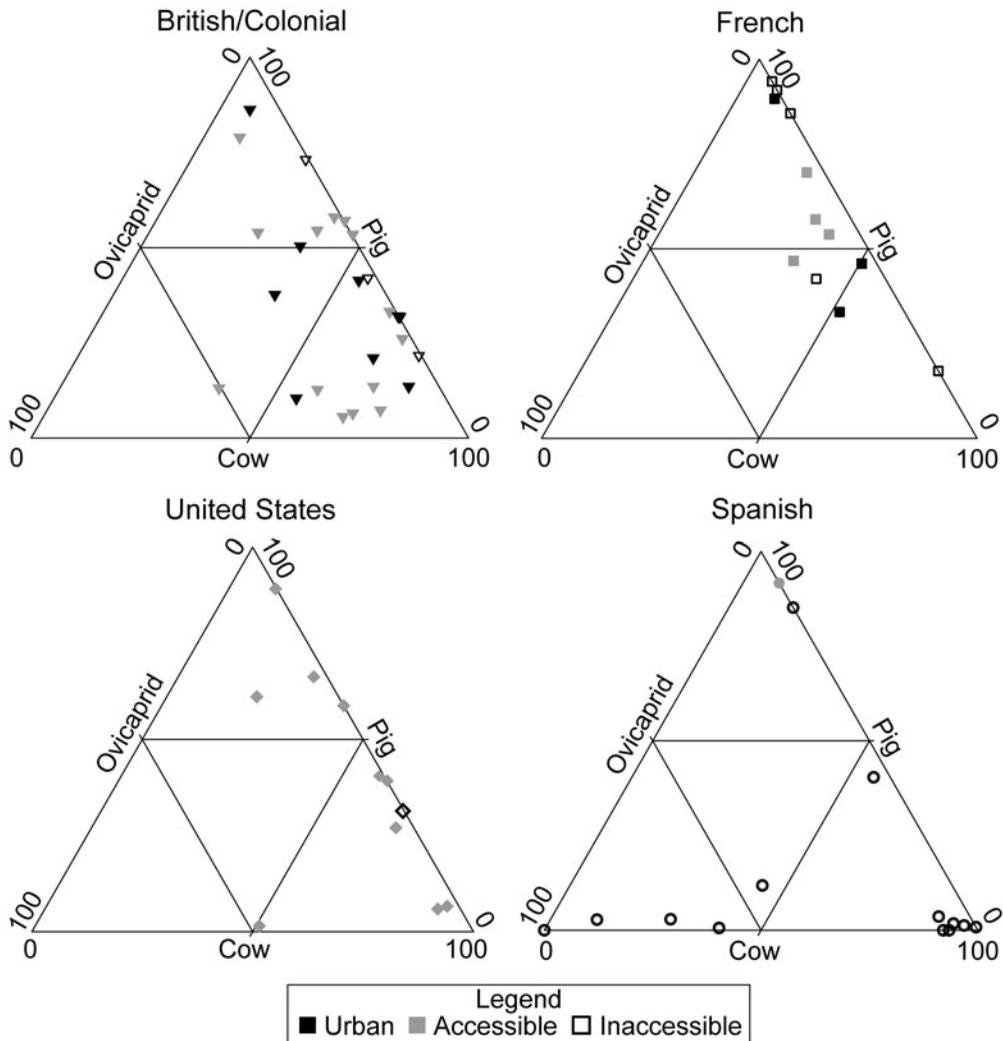


Figure 2. The contribution of domesticates to soldiers' rations.

ungulate specimens. Presidio locations were isolated, and their similarity to urban centers supports Spanish success in overcoming provisioning challenges experienced by other militaries.

Occupation Length, Garrison Size, and Status

Spearman's Rho tests were applied to evaluate correlations between occupation length, garrison size, and dietary patterning. Occupation length and size are indicative of the level of political and resource investment in the location and they steered garrison strategies toward more local provisioning. Large forts may have invested in building the structures necessary for rearing and processing animals on-site. No statistically significant correlations were found with the variables except the contribution of furs (*Spearman's Rho* = 0.912, $p < 0.000$) and the ungulate index (*Spearman's Rho* = -0.817, $p = 0.002$). Excluding the Spanish fortifications, the proportion of domesticates (*Spearman's Rho* = -0.302, $p = 0.033$) and ration species (*Spearman's Rho* = -0.299, $p = 0.034$) correlated significantly with occupation length.

Garrison size correlated significantly with the contribution of domesticates (*Spearman's Rho* = 0.304, $p = 0.05$; Figure 3), ration species (*Spearman's Rho* = 0.312, $p = 0.044$), and the ungulate index (*Spearman's Rho* = 0.504, $p = 0.001$). These positive correlations suggest that the relative permanence of the garrison contributed to its meat procurement strategy but that it was not one among many

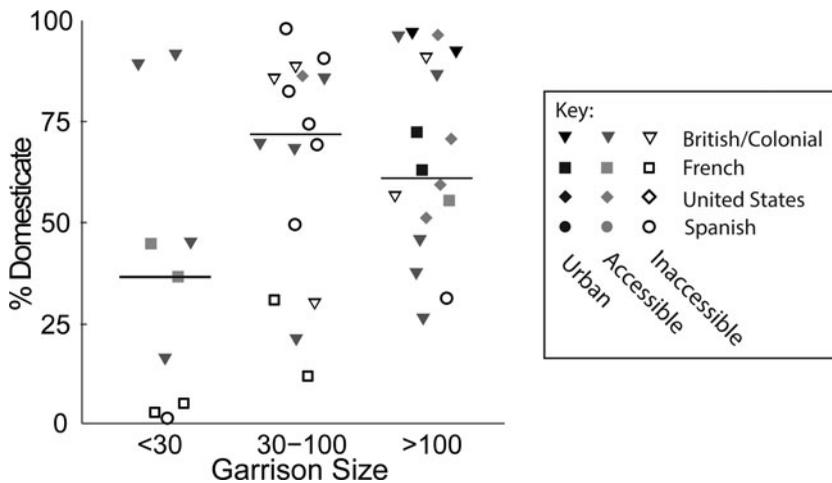


Figure 3. The relationship between garrison size and the contribution of domestic livestock to faunal assemblages.

considerations in provisioning strategies. Notably, fur-bearing species correlated negatively with garrison size (*Spearman's Rho* = -0.429 , $p = 0.005$). Without the Spanish, these correlations are stronger (Supplemental Table 2).

Because of small sample sizes, a Kruskal-Wallis test was used to assess whether dietary differences existed between contexts associated with officers and enlisted men at these sites. None of the variables examined in this study approached statistical significance (Supplemental Table 2). This shows that officers and enlisted men's diets revealed no statistically significant correlations on any of the variables tested. An additional test on species diversity reveals that officers did not experience significantly greater species diversity in their diets ($X^2 = 0.012$, $p = 0.914$).

Screening and Assemblage Size

ANOVA analysis was used to assess whether or not screening unduly impacted these results by organizing data into "screened," "unscreened," and "unknown" categories. ANOVA analysis revealed no statistically significant patterns between assemblages that had been screened and those that had not (Supplemental Table 2). Because soldiers' diets were based primarily on relatively large animals, including cattle and pigs, this result is not unexpected. Despite this, a Spearman's Rho test did reveal significant positive correlations between assemblage size and species diversity (*Spearman's Rho* = 0.349 , $p = 0.022$), which is not unexpected (see Supplemental Figure 1).

Discussion

Numerous attempts have been made to characterize ethnic dietary signatures using archaeofaunal remains (Greenfield 1989; Hardy 2011; Mudar 1978). Human diet is impacted by many factors that are often difficult to account for (Crabtree 1990; Jolley 1983). Because of this, assumptions regarding a direct link between ethnicity and diet are problematic, and large datasets are necessary for any meaningful study (Honerkamp 1980; Miller 1988). Professional militaries supported large numbers of soldiers over extended periods of time and established standardized rations based on predictable domesticates for those soldiers. These rations enable us to formulate expectations about what soldiers' diets should look like and to examine soldiers' diets cross-culturally. Our analysis reveals several important points. First, soldiers, regardless of nationality, relied on domestic livestock when possible (Figures 2 and 3). Second, factors such as fort accessibility, local social and environmental conditions, and fort function all impacted the diet of soldiers in garrisons in predictable ways. Obvious examples include lower-than-expected contributions of domesticates at urban sites with commercial fishing fleets and reduced reliance on domesticates at isolated fortifications. These findings echo initial observations at Fort Michilimackinac (Cleland 1970).

Self-Sufficiency and the Spanish Presidios

Spanish strategy concentrated on defending territory and converting the local Native American populace (Bense 2004; Ciolek-Torrello and Swanson 1997; Early 2004). Spanish presidios in semiarid regions are a notable exception to the norm in this dataset. Like other isolated sites, presidios were built to support Spanish claims over territory, support missionary activity, and house local government administrations (Kessell 1976). Despite this, Spanish efforts in the American Southwest and Pacific coast did not entail the large-scale settlement of Spanish colonists or trade. Spanish presidios in these regions were often incredibly isolated. They functioned as military posts, centers of secular governance, and communities of soldiers' families. Colonial populations grew slowly and varied from 69,500 in New Mexico to 1,300 in the Arizona Territory as late as 1850 (Haverluk 1997). Self-sufficiency became the *de facto* strategy at inland presidios where Spanish food husbandry blended with established Indigenous traditions (Kessell 1976), and herds of domestic livestock were ranched for presidio provisions (Broockmann 2008; Mathwich et al. 2019).

Although imported goods and funding for soldiers' salaries were expected on an annual basis, the inland presidios were often left to the vagaries of the rare mule train from city centers to the south. At San Saba in Texas, the constant threat of raiding made resupply unreliable, limited gardening to areas within the presidio walls, and led to malnutrition. Faunal remains from San Saba indicate that about 18% of meat was supplied by wild animals (Fradkin and Walter 2018). Wild animals contributed even less to diets in the Pimería Alta, located in the Sonoran Desert. Despite the diversity of location and climate, these sites served a similar purpose: empowering Spanish claims to a territory, providing protection and secular legal structures, and deterring Indigenous raiders and uprisings among colonized Indigenous peoples.

Spanish efforts to achieve self-sufficiency are visible in the high proportion of domesticated cattle and ovicaprids in archaeofaunal assemblages when compared to similarly isolated sites (Figure 4). A Spearman's Rho comparison by nationality reveals that only Spanish presidios achieved an increased reliance on domestic livestock that correlates positively with site occupation length (Figure 5). The semiarid grassland environment where many presidios were located was likely a key feature in Spanish success because it supported herds of semiferal cattle and sheep, which were allowed to range freely (Mathwich 2022). Open-range ranching minimized necessary labor investment by the Spanish while producing a reasonably reliable source of meat for garrisons. The correlation between the length of site occupations and increases in the contribution of domestic livestock identified at Spanish presidios, coupled with the declining species diversity (Figure 5; Supplemental Figure 1), indicates that the Spanish were often successful in this endeavor.

English and French Fortifications

England and France concentrated much of their efforts on controlling the coveted cod and fur trades in the northeastern United States and Canada (Anderson 2007) and establishing settlers in the New World (Chartrand 1984; Crowley 1978). Fortification placement was inevitably impacted by these objectives. Consequently, some forts were constructed near farming or fishing communities, which made provisioning relatively easy, whereas others were in remote, forested locations where furs remained accessible and domestic livestock were hard to come by. Fortifications placed in urban centers with fishing fleets—including the British Fort Royal and Signal Hill in Newfoundland, the British/Colonial Charleston Powder Magazine, and the French Fortress of Louisbourg—relied heavily on fish. The Fortress of Louisbourg, an urban center and capital of the French colony Île Royale, suffered repeated provisioning shortages (Johnston 2001), reflected in human skeletal remains from the site (Fonzo et al. 2020; Scott et al. 2020). The administration at Louisbourg sought to overcome these shortages by reserving the offcuts of cod caught by the fishing fleet for soldiers (Dunton and Johnston 1986; Johnston 2011) and through trade for supplies (Welker and Quintana Morales 2022). Reliance on locally abundant cod resulted in a predictable decrease in the significance of domesticates to military diets. This pattern also characterizes the coastal Spanish Presidio of San Francisco, which relied more heavily on wild game and fish than other presidios (Supplemental Table 1). Consequently,

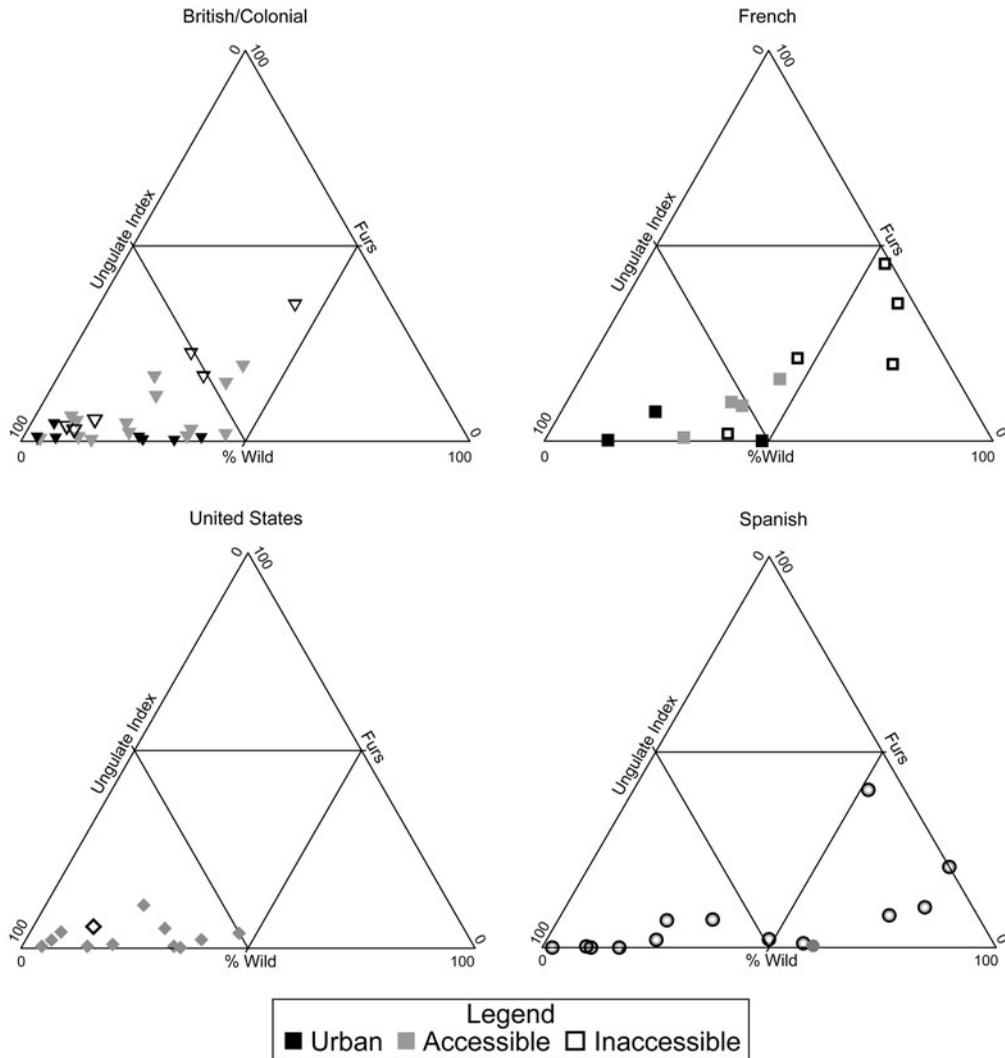


Figure 4. The contribution of wild game, fur-bearing species, and domestic ungulates to military diets.

although urbanization may have improved provisioning reliability, it did not guarantee reliance on domesticates.

Elevated quantities of fur-bearing animals have been promoted as a signature dietary pattern for French occupations of Michilimackinac and other sites (Becker 2004; Cleland 1970; Martin 1986; Scott 1985). However, archaeofaunal assemblages from the St. Louis Bastion in Quebec and Port Royal in Nova Scotia (Balkwill and Cumbaa 1987; Henderson 1992) are dominated by domestic livestock, whereas those at the Fortress of Louisbourg in Cape Breton and Fort Royal in Newfoundland (Grange 1971; Welker and Hughes 2023) include heavy contributions of fish. Consumption of wild game is, therefore, situational rather than being a reliable dietary pattern associated with French identity. Statistical comparison performed earlier on inland French, British/Colonial, and US fortifications substantiates this finding and reveals that site isolation correlates strongly with the higher significance of wild game. This echoes Martin's (1986) finding that French and British dietary patterns at Fort Ouiatenon remained similar—though reliance on wild game, especially white-tailed deer, increased during the British occupation. Reliance on wild game at Fort Ouiatenon during the British occupation may reflect both reluctance to keep the post open and the discontinuation of gift-giving cattle to the local Native groups (Martin 1986).

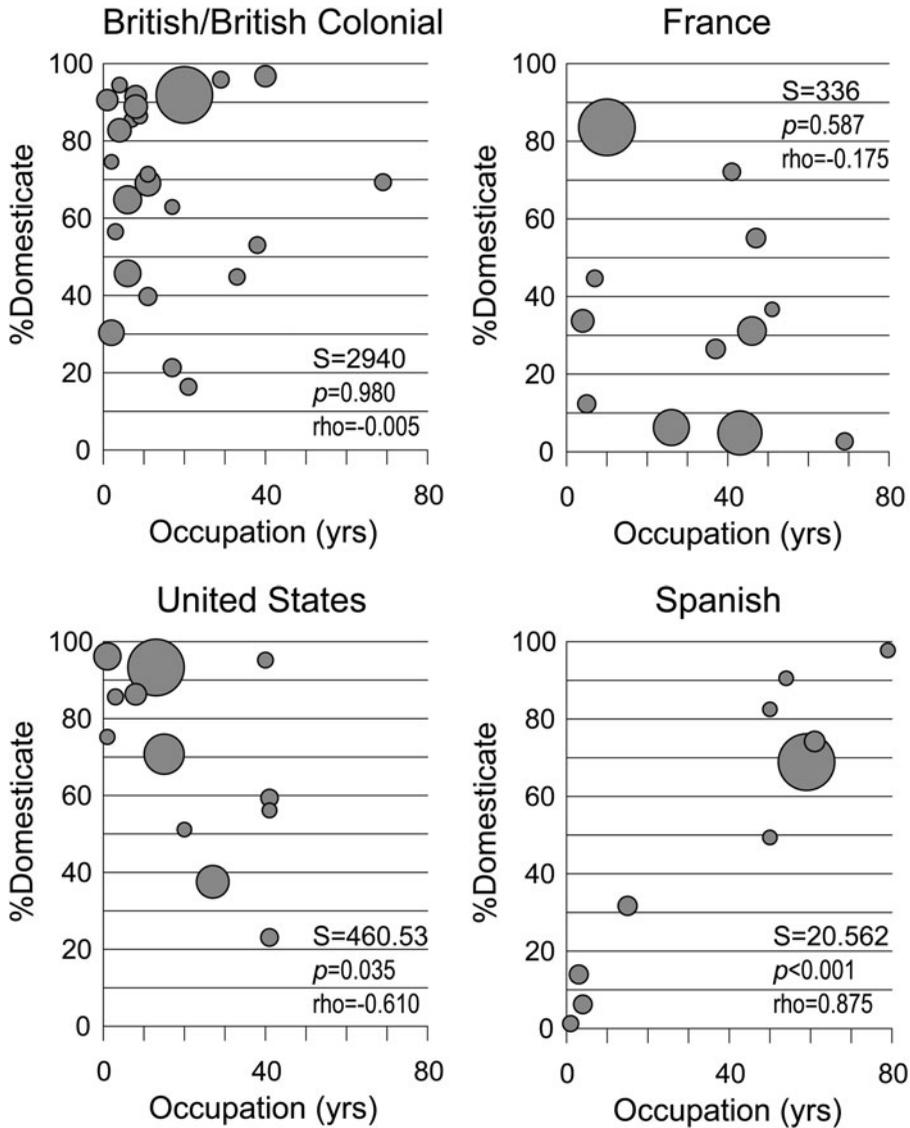


Figure 5. The relationship between occupation length and reliance on domesticates by nationality (bubble size reflects total NISP).

It is imperative to consider the procurement strategies used when provisioning fortifications, which likely drove situational adaptation to local shortfalls. Welker and colleagues' (2018) analysis of British provisioning during the French and Indian War revealed that urban and accessible sites relied on different combinations of cattle and pigs. Statistical analysis of this larger dataset did not. We contend that this may reflect changes in the sourcing and transport of livestock through time and space. During the French and Indian War, poor road systems and limited sources of livestock encouraged the British military to herd live cattle out to sites. Potential challenges in herding pigs over long distances may explain their reduced abundance outside of urban centers. In addition, villages and herds were likely smaller and less capable of producing surplus animals for soldiers to consume without compromising herd viability (see Welker et al. 2022). Because Spanish herds were managed locally, transport costs were not significant factors in provisioning garrisons. Open-range ranching was less practical in the forested conditions of the eastern United States and Canada where some garrisons attempted to establish and maintain herds (Breitburg 1983; Mather

2020), but these attempts were generally less successful, and many relied instead on freshly slaughtered animals or meat preserved through brining or smoking (Breitburg 1983; Forbes 1938c [1758]; Parmalee 1960).

The relative risk of provisioning failure faced by garrisons is difficult to assess for several reasons. Later, larger, or more strongly garrisoned sites may have benefited from greater access to farms, better roads, and more efficient—or persistent—suppliers. However, length of occupation for non-Spanish forts correlates negatively with the significance of domesticates to assemblages (Figure 5). This may reflect periodic provisioning shortfalls experienced by many fortifications. Clear examples include sites such as Fort Loudoun (Tennessee), which was initially well provisioned, but supply lines could not be sustained, and the fort was ultimately abandoned (Breitburg 1983). Further complications could have been introduced by the changing significance and function of some forts over time. In contrast to occupation length, garrison size correlates strongly with the significance of domesticates, ration species, fur-bearing species, and ungulates. This may reflect accessibility. Frontier garrisons were often small, isolated, and impermanent. The lack of strong correlation between site occupation length and the number of species identified in frontier assemblages ($S = 28,194$, $p = 0.096$, *Spearman's Rho* = 0.217) may provide some support for this idea.

Social Status and Rank

Social rank may also impact dietary patterns. Officers at the Spanish Presidio Los Adaes (Pavao-Zuckerman and Loren 2012) and the US Fort Laramie (Wolff 2016) had greater access to hunting and wild game than lower-ranked soldiers. Interestingly, our study identified no statistically significant differences between officers and soldiers. The small number of sites with known status differentiation likely impacts the reliability of this comparison. The fact that officers may simply have enjoyed higher-quality cuts of the same meats (Eichelberger 2019) may complicate this further.

Conclusions

This large dataset was made possible by an intensive focus on Euro-American sites, which has been critiqued by scholars of postcolonialism and settler-colonialism approaches (Nelson 2020; Panich 2020; Rifkin 2017; Schneider 2015). Military sites garner a great deal of interest among Euro-American descendants, and uncritical approaches toward this period have traditionally supported views that enable settler-colonialist narratives of erasure and replacement of Indigenous peoples in the Americas. This cross-cultural comparison acknowledges the bias that made this dataset possible but employs a methodological approach to examine and reframe these data and identify patterning in dietary adaptation. Using historical sources, we formulate predictions about what soldiers should be expected to eat. By then exploring deviations from these expectations, we further our understanding of adaption in these conditions.

This study explored the consistency of soldiers' diets at North American historic fortifications by grouping garrisons by the nation in charge of their provisioning. Identifying and characterizing human dietary patterns and response to social and environmental factors is challenging. Links between ethnicity and environmental and social conditions in human diet have been widely studied, but these studies often rely on small sample sizes, or they suffer from methodological challenges. Historic military provisioning practices are a useful experiment because a large sample is available and rationing protocols are documented. We use these strengths to formalize and test expectations regarding the impacts of nationality, accessibility, garrison size, fort function, and local social and environmental conditions on soldiers' diets at garrisons. Some French faunal assemblages do contain statistically more wild game than British and American assemblages, whereas Spanish assemblages contain more domesticates. This may seem to support the idea that nationality is significant, but subsequent comparisons reveal accessibility, garrison size and length of occupation, and local infrastructure have significant impacts on the abundance of domesticated and wild species. These findings indicate that local environmental, social, and political factors had an impact on soldiers' diets.

Cattle and pigs were the primary meats consumed by soldiers in Euro-American armies. Domestic livestock occur in relatively large herds in predictable locations—factors that made them more appealing and reliable than wild game, whose abundance and location is unpredictable. However, provisioning systems were fallible and impacted by many environmental and social factors, resulting in variability in soldiers' day-to-day diets (McBride 2013). These shortfalls were varied, and they stemmed from the local economic systems and the availability of herds, acquisition and transport of animals, environmental conditions, conflicts, and even status. Notably, soldiers in Euro-American armies in North America, regardless of nationality, often responded in predictable ways. Urban fortifications with fishing fleets consumed locally available fish. Inaccessible, smaller, forts relied more heavily on wild game than urban sites with large garrisons. Investment in local infrastructure and self-sufficiency produces improvements in provisioning reliability.

Although focused on soldiers, these findings are significant because they provide a baseline and framework from which to explore other examples of human provisioning. Despite the challenges faced in compiling substantial multisite datasets (Jones and Gabe 2015), intersite comparisons hold great promise for addressing key questions about the human past, including many relating to human diet and environmental interaction (Kintigh et al. 2014). It is regrettable that standardized reporting procedures (Driver et al. 2011), widely accessible datasets, and data repositories remain undeveloped within archaeology. It is our hope that this analysis encourages further examination of human diet and provides a dataset from which further studies may develop. This analysis did not consider biome, latitude, biodiversity, average temperature, or precipitation, which may play important roles in determining which species were available to garrisons. These behavioral and ecological factors require further investigation and likely play an important role in the abundance of some taxa than social and economic variables.

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Competing Interests. The authors declare none.

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Supplemental Table 1. Zooarchaeological data used in this analysis.

Supplemental Table 2. Statistical results for analyses.

Supplemental Figure 1. The comparison between occupation length and species diversity (bubble size reflects NISP).

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