INTRODUCTION
Among the changes wrought by the arrival of Europeans in the Americas, the impact of introduced Eurasian livestock stands out as particularly far-reaching in space and time. The introduction of Eurasian domesticated animals was transformative for the environments, economies, sociopolitical interactions, cuisine, technology, and many other aspects of the daily life of Native Americans. And, the success or failure of domesticated livestock shaped the unfolding of the European colonial process throughout North America (Pavao-Zuckerman 2000; Pavao-Zuckerman and Reitz 2006:52). While not universally successful, Eurasian livestock in the southwestern region of North America paved the way for successful Spanish colonialism, and eventually formed the foundation of several important economic interactions in the region.

In the Southwest, Spanish colonial missions most often served as the vehicle for the introduction of livestock and for the transformation of Native American daily life. All Spanish colonial entities—secular, military, and religious—sought to
establish economies based on animal husbandry and the exploitation of domesticated animals; however, missions were particularly well suited to the ranching enterprise. Spanish policies of *reducción*, or the physical resettlement of Native American communities at missions, served both to provide a captive audience for efficient proselytizing and amassed a large labor pool in support of various mission economic enterprises, including livestock ranching. Native American labor was co-opted by missionaries into European-styled intensive agriculture and animal husbandry with the goal of establishing and maintaining self-supporting agrarian communities (Radding 1997; Sheridan 1988). Agricultural surpluses were expected to fulfill the needs of the missions and to provide material support to nascent Spanish secular and military settlements in the region. While grains, particularly wheat, were usually the most important commodities, missions also served as important sources of livestock and livestock products. This was particularly the case in the Pimería Alta (Figure 11.1), the region encompassing present-day northern Sonora (Mexico) and southern Arizona (United States), where warm and dry environments could support large herds of cattle and sheep (Pavao-Zuckerman 2000; Pavao-Zuckerman and Reitz 2006).

**MISSIONIZATION AND THE INTRODUCTION OF LIVESTOCK IN THE PIMERÍA ALTA**

Missionization of the O’odham people in the Pimería Alta began in the late seventeenth century with the travels of Father Eusebio Francisco Kino, the Italian Jesuit missionary (see Lauren E. Jelinek and Dale S. Brenneman, chapter 10 in this volume). Kino embarked on his missionization efforts among the O’odham in the 1680s; however, Spanish settlement and proselytization among the Ópatas and the “Pimas Bajas” was unfolding at the southern border of the Pimería Alta from the early seventeenth century, particularly in association with mining activities (Spicer 1962). And Spanish colonialism in the Puebloan region of the northern Southwest was long underway by the time Kino arrived in the Pimería Alta.

At the time of missionization, the O’odham were seminomadic horticulturalists. While the O’odham developed sophisticated irrigated-agricultural systems, it is estimated that 80 percent of their yearly diet was contributed by wild resources collected during seasonal movements across the landscape (Radding 1997:49–50). During the winter months, O’odham farmers moved to aggregated upland camps near permanent water sources where they hunted and gathered wild foods. Communities dispersed somewhat during the summer agricultural season, as households moved into desert lowlands to take advantage of floodwater irrigation brought on by the summer rains. O’odham children were tasked with guarding crops from animal thieves, and no doubt honed their hunting skills by picking off would-be crop-stealers for dinner (Radding 1997). “Garden
hunting” by O’odham children (or adults) was likely an important source of protein during the summer months. This practice was very common among Hohokam farmers who lived in the region until around AD 1450 (Dean 2005, 2007; Szuter 1991), and no doubt continued with the O’odham. The seasonal movements of the O’odham people were largely structured by the availability of water, a limited resource in the Sonoran Desert (Dobyns 1976:9). Winter
settlements were placed near perennial streams or springs, and summer agricultural settlements were located near arroyos that could, when flooded by rainwater, be manipulated with ditches and brush fences to irrigate agricultural fields. Seasonal mobility, and the fluctuations in community size, also served to insulate O’odham communities against hostilities by other indigenous groups.

Missionization and Spanish colonialism were ultimately transformative of O’odham lifeways, but this transformation was patchwork, gradual, and reciprocal. The earliest impacts of European colonialism felt in the region were no doubt biological—the introduction of zoonotic epidemic diseases and Eurasian domesticated plants and animals. While very little direct evidence exists for the impact of epidemic diseases on O’odham people prior to the arrival of missionaries and written documents, several smallpox epidemics affected the southwestern region of North America prior to the mission period, including in 1520–24, 1592–93, 1602, 1646–48, and 1662–63 (Dobyns 1983:15). Other diseases also swept through the region, including measles, influenza, bubonic plague, diphtheria, typhus, and possibly cholera (Dobyns 1983). These epidemics continued in the mission period, with records of burials in church documents often exceeding the numbers of baptisms. Although Kino established missions at existing O’odham villages, these populations quickly dwindled as a result of disease, and outlying Native American communities were often resettled at struggling missions to bolster neophyte populations. Despite these resettlement efforts, indigenous populations at missions throughout the Pimería Alta continued to see precipitous declines throughout the eighteenth century (Dobyns 1963), a testament to O’odham cultural resilience.

While diseases likely impacted O’odham ancestral communities prior to the arrival of missionaries, most Eurasian animals and crops were unknown in the region until the mission period. Indeed, the region was devoid of domesticated animals throughout the pre-Hispanic period, with the exception of domesticated dogs and, briefly, turkeys. The history of ranching in the Pimería Alta begins with the sixteenth-century Spanish entradas by Coronado and Oñate. These entradas may have accidentally introduced one or more Eurasian animals to the region, but it is unlikely that any escapees survived Native hunters or the southwestern climate for very long.

The first intentional introduction of Eurasian livestock in the Pimería Alta occurred in the 1680s with the journeys of Father Kino. Kino, however, was preceded by horses, which appear to have spread from settlements to the south or possibly from the Spanish colony in New Mexico prior to his arrival. Captain Juan Matheo Manje, who accompanied Kino, noted that horse raiding was already a problem for the Native American communities they encountered (Burrus 1971; Sheridan 1988). Horses, apparently, spread independently and in advance of the spread of European colonialism.
As he traveled throughout the region, nominally establishing missions, Kino left behind wheat, cattle, and other small livestock, presumably with some instructions on what to do with the alien creatures and crops. Winter wheat had an almost immediate impact on indigenous life in the region—it was adopted by O’odham farmers soon after its introduction by Kino. The crop yielded a harvest of grain during spring, a traditionally lean time of the year, and was therefore an attractive addition to the traditional O’odham agricultural regime (Sheridan 1988).

The fate of the Eurasian animals deposited in the upper reaches of the Pimería Alta by Kino was less rosy. It is difficult to imagine that Kino was able to provide enough instruction during his brief visits for Native peoples to take up husbandry—particularly given that animal husbandry of large hooved animals was entirely unknown in North America. In some areas, cattle and other livestock were successfully introduced (Radding 1997; Sheridan 2006), but Eurasian livestock introduced into the northern reaches of the Pimería Alta around the late seventeenth and early eighteenth centuries were probably hunted more than hounded, and disappeared soon after Kino departed (Spicer 1962:546). It was not until the establishment of permanent missions with resident priests that sustained herds of livestock were present on the landscape. Priests were resident at some missions by the second quarter of the eighteenth century, but some missions did not see a permanent presence until the late eighteenth century. Even when resident priests moved in, however, efforts to introduce livestock and co-opt Native labor for their care were not always successful. Livestock were not universally welcomed by Native people, and indigenous perceptions of livestock were often quite negative. The sharp-hooved, hungry, and thirsty animals represented a threat to both drinking water and agricultural fields and they scared off wild game. Documentary records indicate that Native peoples complained vociferously about the deleterious effects of the alien animals (Dobyns 1976; Radding 1997:171, 252, 254). The negative effects of cattle ranching were similarly felt in Alta California, where the loss of traditional hunting and gathering lands to livestock grazing forced many Native Californians onto the missions in search of food (Hackel 2005:71; Lightfoot 2005:86–87). It is not surprising, then, that attempts to expunge Europeans from the region by Native groups were often accompanied by the slaughter of livestock. During the Pima Revolt in 1751, the priest at Mission San Xavier del Bac reported that mission property including livestock was destroyed (Dobyns 1976:6, 14).

The establishment of European-style agriculture and animal husbandry was not possible without the co-option of Native lands, and Native labor. Land under the control of missions was technically the property of the affiliated Native community, an arrangement that reinforced the transitional nature of missions (Weber 2005:107). Missions were never intended to be permanent entities, but were a means to establish European-styled (but still self-sufficient) Native
American agricultural communities that were then converted from missions to secular parishes. Until that time, a portion of mission land was planted under the direction of the priest, and the remaining lands were distributed among Native households.

Native American converts provided all labor for mission lands—and mission agricultural yields were the product of Native labor. Missionaries employed several strategies to amass labor at missions in the region. Missions were usually established within O’odham communities to take advantage of the proximity to existing labor. As local populations dwindled from diseases, Spanish policies of reducción resettled more distant Native American populations at the mission. Neophyte communities were intended to be permanently settled, year-round agrarian communities, and missionaries discouraged Native people from leaving the mission for any reason. Prohibitions on seasonal movements to exploit wild resources kept labor, and souls, close by. Mission labor systems were generally structured so that all adult males worked three days on mission crops and animals, and three days on their own flocks and fields (Sheridan 1988). For their labor, Native laborers received rations from the mission’s crops and stores. Mission surplus was used as insurance against famine, as well as to support non-Indian mission personnel. Surplus was also used to generate income though trade with other colonial entities, such as presidios, mining communities, and other secular colonies (Radding 1997:67–68).

Pimería Alta missions did not exist in a vacuum. By the time Kino established his first missions in the late seventeenth century, Spanish colonial influence was already well established among the Ópata and other groups in the Pimería Baja, and several mining communities and secular ranches were operating at the southern edge of the Pimería Alta, within traveling distance of O’odham communities. Missionization unfolded almost simultaneously with secular colonization and militarization in the northern Pimería Alta. By the mid-eighteenth century, missions comprised merely one part of a complex network of colonial settlements, including privately owned ranches, mining camps, presidios, and secular communities.

All of these entities created opportunities for the sale of mission goods, including husbandry and agricultural surplus. Livestock emerged as an important link connecting the missions to a regional and emerging global economy. The ultimate success of livestock in the region is due in great part to the co-option of O’odham labor and to a climate that is amenable to Eurasian livestock; however, the growth of ranching also occurred in response to the development of other colonial industries.

The growth of herds also had unintended consequences, including the creation of “24-hour, one-stop shops” for Native groups who adopted raiding as a strategy for economic survival during the colonial period. Large, permanent
communities with growing herds of livestock were attractive targets for raiding. Mission livestock supported not only the colonial regime, but provided a handy and predictable resource for many raiding parties.

By the late eighteenth century, livestock was the foundation of three key economic processes in the region: ranching, rendering, and raiding. Livestock ranching became a primary economic strategy for the self-sufficiency of Spanish colonial missions, and in support of future colonialism. Rendering of mission livestock created animal products for a regional market in support of other colonial enterprises, including mining. And mission herds were a primary target of raiding that supported an entirely separate, illicit, regional economy. In concert with documentary evidence, zooarchaeological data from two Pimería Alta missions—San Agustín de Tucson (Pavao-Zuckerman 2010, 2011b; Pavao-Zuckerman and LaMotta 2007; Thiel and Mabry 2006) and Nuestra Señora del Pilar y Santiago de Cocóspera (Kessell 1970; Martínez 2005; Pavao-Zuckerman 2008, 2011b)—can illuminate the role of introduced Eurasian livestock and O’odham labor in these three primary economic interactions: ranching, rendering, and raiding.

**PIMERÍA ALTA ZOOARCHAEOLOGY**

Excavations at Mission San Agustín de Tucson were carried out by Desert Archaeology, Inc. as part of the City of Tucson’s downtown revitalization project (Thiel and Mabry 2006). These excavations yielded a large assemblage of zooarchaeological remains from seven features dating to between 1795 and 1820 (Cameron et al. 2006; Pavao-Zuckerman and LaMotta 2007). Father Kino established the San Agustín Mission in the 1690s within an existing community of O’odham farmers living along the Santa Cruz River in what is now downtown Tucson, Arizona (Dobyns 1976:4). For much of the eighteenth century, San Agustín was a visita, serviced by the priest at the nearby head mission (cabecera) of San Xavier del Bac. San Agustín became a full-fledged mission with its own resident priest only after the expulsion of the Jesuits (and the arrival of the Franciscans) in 1767. It was only after the arrival of Franciscan missionaries that livestock herds took off—under the intermittent Jesuit presence, herds were slow to grow. The arrival of the Spanish garrison to Tucson in 1776, less than a decade after the arrival of the Franciscans, introduced a new market for livestock. Mission herds were large enough at that time to furnish the newly established presidio with livestock (see J. Homer Thiel, chapter 12 in this volume). By the turn of the nineteenth century, documentary records indicate that livestock herds were thriving (Dobyns 1976).

Excavations at Mission Nuestra Señora del Pilar y Santiago de Cocóspera were carried by the Instituto Nacional de Antropología e Historia (Sonora, Mexico) (Martínez 2005). Like San Agustín, Cocóspera was established by Kino among a
group of O’odham rancheria settlements. It was initially established as a visita in the 1690s and was serviced by the clergy at a nearby head mission. Below, I use the general term “mission” to refer to both San Agustín and Cocóspera, although they are more accurately described as visitas, for at least most of their history. Livestock were more successful at Cocóspera than at San Agustín, and herds grew faster—at the turn of the eighteenth century, the neophytes at Cocóspera maintained around 500 head of cattle (Pickens 1993:43). Unfortunately, as a result of this success, the mission was frequently a target of livestock raiding.

In the zooarchaeological analyses below, three quantitative indices common to zooarchaeological analyses are employed. The first, NISP, or the number of identified specimens, is a count of the number of bone fragments, exclusive of mending pieces. This index is highly influenced by fragmentation, which is especially problematic for large-bodied taxa, whose skeletons tend to break into more fragments. In highly fragmented assemblages, larger-bodied taxa may appear more common in the archaeological assemblage than they were in the “death assemblage.” The second, MNI, or the minimum number of individuals, is in part used to overcome some of the biases inherent in NISP. This method estimates the minimum number of individual animals that must have contributed a zooarchaeological assemblage, and is based on paired elements, portions, and age, when possible. The measure tends to inflate the importance of rarer and smaller-bodied taxa, particularly in smaller assemblages. Like NISP, MNI is also affected by fragmentation. A high rate of fragmentation tends to lower estimates of MNI. Third, biomass, which is based on bone weight, can be used in concert with NISP and MNI to overcome some of the problems encountered with fragmentation rates. Biomass is an estimate of the meat that may have been contributed by a given taxa. It is based on established ratios of bone-to-meat weights derived from modern experimental studies on animal carcasses (Reitz et al. 1987). While all of these indices are problematic when used on their own, together they provide a more complete and accurate depiction of animal use in the past.

RANCHING

Although Kino’s initial attempts at introducing livestock met with mixed success, documentary records indicate that by 1701 the five missions established by Kino collectively held approximately 4,200 head of cattle (Jordan 1993:142). As Kino’s brief visits were replaced by permanent missionaries, livestock continued to gain a foothold in the region, despite continued conflicts between Native farmers and the introduced animals. During the 1751 Pima Revolt, and the many smaller uprisings that preceded it, livestock were slaughtered alongside priests and in the company of the destruction of Catholic ritual objects, no doubt because the animals were viewed as symbols of Spanish oppression (Perez 2003).
Despite, or perhaps because of, this resistance, the growth of herds was patchy: at some missions herds grew quickly; at others, herds remained small until the late eighteenth century. This growth contrasts somewhat with that of ranching in Alta California. Missionization in the latter region was later, beginning in 1769, but introduced Eurasian livestock (and plants) exploded on the landscape (Hackel 2005:68–70; Lightfoot 2005). California missions maintained ranchos in the hinterlands, where cattle, horses, sheep, goats, and pigs were raised (Lightfoot 2005:57). Although the growth of herds was uneven across the Pimería Alta, mission inventories indicate that livestock holdings increased markedly at most missions throughout the eighteenth century (Table 11.1). Mission herds consisted predominantly of cattle (Bos taurus) and sheep (Ovis aries); many missions also maintained much smaller herds of goats (Capra hircus) (Dobyns 1976; Kessell 1970; McCarty 1976). Documentary records suggest that the ratio of cattle to sheep declined through the eighteenth century. In 1737, cattle outnumbered sheep 3 to 2 at Missions Guevavi and Bac, while in the 1760s, the animals occurred in roughly equal numbers at Guevavi, and sheep outnumbered cattle at the Bac Mission (Kessell 1970:197, 199, 200–201, 204).

Zooarchaeological evidence from Mission San Agustín and Mission Cocóspera confirms that ranching was a predominant economic activity at both missions, with primary reliance on cattle (Figures 11.2 and 11.3) (Pavao-Zuckerman 2010, 2011a, 2011b; Pavao-Zuckerman and LaMotta 2007).

At Mission San Agustín, the NISP and biomass of cattle remains far exceed all other taxa combined, and exceed those values for caprines (sheep and goats) by 3 to 1. At Mission Cocóspera, cattle dominate both by measures of NISP and biomass, although equal minimum numbers of caprine and cattle individuals are estimated. It should be noted that while sheep and goat skeletons are notoriously difficult to distinguish, the documentary record suggests that sheep were more numerous than goats, and the latter were not always present in mission flocks. In 1737, herds at Missions Guevavi and Bac each boasted approximately 150 sheep and 50 goats. By 1761, goats were absent from both missions (Kessell 1970:197, 200–201). And, while very few caprine specimens in the zooarchaeological assemblages are identifiable to species, most identifiable caprines are attributed to sheep. Given these observations, it is safe to assume that a majority of the remains identified only as inclusive in the subfamily Caprinae are, in fact, sheep.

While the data do suggest that the mission ranching strategies were focused primarily on cattle, there are several reasons why the data likely overemphasize the role of cattle relative to sheep. The large discrepancy between cattle and caprine in terms of biomass is largely attributable to the greater body size (and, therefore, bone weight) of cattle versus caprines. In addition, because cattle
bones are larger than caprine remains, the former tend to break into more fragments, resulting in an inflated NISP.

Finally, sheep were raised for wool, meaning that many animals lived well into adulthood. Cattle, on the other hand, were exploited primarily for butchery products such as meat, hide, and tallow (Pavao-Zuckerman 2011b). The discrepancy between herd sizes as reported in written documents and the proportions of these animals in the zooarchaeological assemblages likely reflects a reduced life expectancy for cattle—cattle were killed younger, and in greater numbers, resulting in a much larger archaeological population than actually lived on the landscape at any given time.

Mission ranching strategies may have served to complement the ranching strategies of other nearby colonial enterprises, including presidios. Research by Dan Broockmann (2007) on zooarchaeological remains from the Tucson Presidio, located across the river from Mission San Agustín, suggests that caprines, including sheep, were more common at the presidio than at the mission. And, an 1819 census of the missions at Bac and Tucson indicates that cattle outnumbered sheep and goats by 9 to 1 (Dobyns 1976:51), while at the Tucson Presidio, the proportion of sheep to cattle was roughly equal, with cattle contributing only a slight majority (McCarty 1976:90). At the Tubac Presidio, located about forty-five miles to the south, sheep outnumbered cattle 5 to 1 on the 1804 inventory (McCarty 1976:85), indicating an even stronger emphasis on shepherding at the presidio. Tubac was located just three miles from the closest mission, at

<table>
<thead>
<tr>
<th>Mission/ presidio, year</th>
<th>Cattle (%)</th>
<th>Sheep</th>
<th>Total</th>
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</thead>
<tbody>
<tr>
<td>Mission Guevavi</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1737</td>
<td>248</td>
<td>150</td>
<td>398</td>
</tr>
<tr>
<td>1761</td>
<td>890</td>
<td>723</td>
<td>1,613</td>
</tr>
<tr>
<td>Mission Bac</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1737</td>
<td>240</td>
<td>150</td>
<td>390</td>
</tr>
<tr>
<td>1765</td>
<td>487</td>
<td>536</td>
<td>1,023</td>
</tr>
<tr>
<td>Missions Bac and Tucson</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1819</td>
<td>5,700</td>
<td>700</td>
<td>6,400</td>
</tr>
<tr>
<td>Tucson Presidio</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1804</td>
<td>3,500</td>
<td>2,600</td>
<td>6,100</td>
</tr>
<tr>
<td>Tubac Presidio</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1804</td>
<td>1,000</td>
<td>5,000</td>
<td>6,000</td>
</tr>
</tbody>
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Source: from Dobyns (1976), Kessell (1970), and McCarty (1976).
Tumacácori. Given close proximity and interaction, it is possible that presidios and missions opted for complementary specialization of husbandry strategies in terms of the proportion of cattle versus sheep.

Documentary evidence suggests that cattle herds were not closely managed—the animals were probably primarily free-ranged and perhaps semiferal (Dobyns 1976; Jordan 1993; Radding 1997). A 1761 inventory at Mission Guevavi, located about sixty miles south of Mission San Agustín reported that over 800 head of...
cattle were “on the range,” while less than 60 were housed in branding pens (Kessell 1970:200).

Age at death data within the zooarchaeological assemblages suggest that a typically “optimized” husbandry strategy was practiced at both missions. Zooarchaeological evidence indicates that a majority of cattle were slaughtered when they were between the ages of two and four (Pavao-Zuckerman 2010; Pavao-Zuckerman and LaMotta 2007). At this age, cattle reach adult size, and additional inputs into the animal do not result in additional consumable meat or animal byproducts (Dahl and Hjort 1976). A few animals at both missions, however, were allowed to reach an older age—these were perhaps animals used for traction (such as oxen), breeding, or dairying. While evidence for age at death in the caprine assemblages is scarce, it is telling that only a single caprine specimen in either assemblage was juvenile at the time of death. These animals were likely kept longer for their wool.

Documentary evidence suggests that cattle slaughter was a seasonal activity that took place in October or November when cooler temperatures meant that meat could be preserved by drying before spoiling (Pfefferkorn [1795] 1949:99). The Jesuit priest Ignaz Pfefferkorn recorded that meat from the fall slaughter was dried and served as a staple protein, often rehydrated in soups (Pfefferkorn [1795] 1949:100). Fresh meat was probably only seasonally available at the missions. In 1758, the priest (with limited medical training) at nearby San Ignacio recorded the death of a neophyte who died, he concluded, of an intestinal blockage from overindulgence of fresh beef during the fall slaughter (Stiger 1758). For the sin of gluttony, she was denied the sacraments of death.

**Rendering**

Although mission herds were clearly an important source of meat (in dried form) that fed the neophyte community throughout the year, zooarchaeological and documentary evidence also suggest that mission herds were managed for the extraction of nonmeat products, such as hide and tallow, as was common in Alta California (Dallas 1955; Gust 1982; Hackel 2005; Lightfoot 2005; Pavao-Zuckerman 2011b).

Zooarchaeological assemblages from both Mission San Agustín and Mission Cocóspera are highly fragmented (Pavao-Zuckerman 2011b). Roughly 90 percent of medium and large mammal specimens from both missions were broken into fragments of less than four centimeters—a degree of fracturing that is not typical when carcasses are butchered solely for meat. And, it appears that much of this breakage at both missions occurred perimortem—in other words, when the bones were still fresh (Pavao-Zuckerman 2011b).

This pattern of bone breakage is consistent with other zooarchaeological assemblages believed to have been rendered for tallow or bone grease (Binford
While this pattern is cross-cultural (Binford 1978; Logan 1998; Manne and Bicho 2009; Mateos 2005; Munro and Bar-Oz 2005; Peale 1871; Reitz 1986; Yellen 1977; Zierhut 1967), the written record provides a local description of tallow rendering in the Pimería Alta during the mid-eighteenth century:

Now the animal is skinned, the fat and tallow removed . . . Fat is melted and preserved in bladders, the largest intestines of cattle, or in earthen pots. . . . Those who slaughter several cattle at one time throw all the bones and marrow into a kettle full of water, cook them, and skim off the fat floating on top . . . Tallow is either kneaded together after all fibres have been separated from it by much pounding, or it is melted. In this condition it is kept until candles are made or soap is boiled. (Pfefferkorn [1795] 1949)

As has been the practice in human societies for millennia (Burnham 1978), the bones from the butchered carcass are placed in boiling water and the fat (tallow) is skimmed off the top. However, Pferfferkorn’s ([1795] 1949) description of tallow rendering omits the critical step of bone fracturing, a stage in tallow rendering that is abundantly visible in the archaeological record at both of the Pimería Alta mission sites discussed here.

Historically, tallow was used in the manufacture of food-grade greases, soaps, candles, and industrial lubricants (Burnham 1978; West 1949). While these materials were important for household and mission use, candles and industrial lubricants were particularly important to the mining industries in the southern reaches of the Pimería Alta. Tallow candles were the only source of illumination available to the mines, and tallow was the only widely available industrial grease (Bloom 1935; Sheridan 1988; West 1949:64–65). In the mid-eighteenth century, tallow was in such high demand that rendered grease from cattle carcasses was worth more than the living animal, and the price of tallow was highest near the mines (Pfefferkorn [1795] 1949:198–200). Documentary evidence from colonial-period New Mexico indicates that Spanish laws regulating intercolony trade were relaxed to permit the free flow of tallow candles to the region’s mines (Trigg 2005; West 1949). Cattle hide was also in high demand by the mines, as it was used to make bags for hauling mineral ore. Unfortunately, any skinning marks are obscured by the high degree of fragmentation (Pavao-Zuckerman 2011b).

The importance of animal products in the Pimería Alta economy is not unique. In Alta California, mission ranchos served as vast factories on the hoof for the production of hide and tallow. So much tallow and hide was rendered from Alta California herds that the meat from the slaughtered carcasses was often just left to rot (Dallas 1955:25–26). Tallow and hides from California were shipped to Mexico City where they were redistributed for various uses, including for mining. In Alta California, hide processing is archaeologically visible in
the presence of tanning vats, as well as hide scrapers (beamers) made from segments of cattle ribs (Deetz 1978). No such architectural or artifactual evidence from the Pimería Alta is known to support the hypothesis that tallow and hide were important trade commodities in this region. It is possible that the scale of hide processing was much greater in Alta California than in the Pimería Alta; however, archaeological investigations in the Pimería Alta have focused primarily on central mission compounds, rather than the surrounding landscapes, where evidence for rendering and hide processing are most likely to be found. In the Pimería Alta, missions and mines were located in close proximity, a unique situation in North America (West 1993:60). Mining communities were largely dependent upon local production of foodstuffs and materials, particularly hide and tallow, resulting in a strong economic link between mines and livestock ranching. Pimería Alta missions, with established herds and a captive labor force, were particularly well positioned to take advantage of this market. Many of the economic strategies employed by missions were no doubt influenced by their economic relationship with the mines, and missions ramped up production of agricultural surplus and livestock products to meet mining demands.

RAIDING

The introduction of livestock provided additional sources of food and raw materials that supported a well-developed “official” regional economy, but the herds also quickly became targets of Apache raiding, leaving the O’odham people, missionized or not, vulnerable. It is argued that livestock raiding was “the most significant economic catalyst for cultural interaction in the post-contact Southwest” (Record 2008:74). The “unofficial” raiding economy in many ways dwarfed the impact of sanctioned economic interactions in the region. Raiding, and the threat of raiding, was truly transformative of Native American and Spanish colonial life. Indeed, Apache raiding may have more significantly altered the daily life of the O’odham people than Spanish colonialism itself (Record 2008:84).

Apache raiding, generally in response to food shortages (Basso 1971:16), began in earnest in the mid-1600s, and spread with Spanish colonialism and Eurasian livestock. By the mid-eighteenth century, Apache raiding intensified to the point that the region was in chaos (Record 2008:79), and it continued throughout the latter half of the eighteenth century (Jordan 1993:143). Intense raiding lead to the abandonment of many cattle ranches, and livestock herds shrunk considerably in the wake of raids. The expulsion of the Jesuits in 1767 furthered this decline, and it was not until the 1790s that herds regained their numbers.

Although more study is needed, documentary evidence suggests that missions modified their ranching strategies in response to intensified raiding, particularly by shifting the species composition of mission herds. While sheep and cattle were usually introduced in roughly equal numbers, the proportion of sheep in
the Pimería Alta generally declined (Jordan 1993). By the 1760s, sheep were rare in many parts of Sonora, both because shepherding is labor intensive compared to cattle ranching, and because the fluffy animals are more easily caught in the thorny Sonoran Desert scrub (Jordan 1993:142). In New Mexico, however, sheep were often preferred by secular colonists because the animals were more difficult for raiding groups to run off than cattle (Merrill 1994:137; Weber 1992:310). Wool was no doubt an important resource for local consumption in the Pimería Alta, but a wool-based textile industry never developed to the extent that it did in the Puebloan region—Sonoran herds were small, and wool textile production occurred primarily for household consumption, not for export (Pfefferkorn [1795] 1949: 102–3).

While sheep may have declined in some parts of Sonora, inventories of livestock holdings at various missions in the Pimería Alta (see Table 11.1) suggest that the proportion of sheep actually increased from the 1730s to the 1760s, just as raiding intensified (Dobyns 1976; Kessell 1970; McCarty 1976). The presence of thriving cattle herds at Mission Cocóspera made the community the target of raiding by hostile Native American groups, and the mission was attacked repeatedly throughout its occupation (Martínez 2005). Interestingly, sheep were more common at Mission Cocóspera than at Mission San Agustín. This may have been an adaptive response to managing risk during a volatile period in the mission’s history.

In contrast, the cattle-dominant zooarchaeological assemblage from Mission San Agustín dates to the turn of the nineteenth century, during a hiatus in intensive raiding activity (Record 2008:81). Data from an 1819 inventory of livestock in the combined herds at Mission San Agustín and the nearby Mission San Xavier del Bac indicate that cattle outnumbered sheep by 9 to 1. During peaceful times, it may have been possible for missions to intensify cattle ranching and reduce investment in the more labor-intensive husbandry of sheep.

**Conclusions**

Throughout North America, European colonialism was predicated on the successful introduction of Eurasian livestock that had the potential to transform the daily life, economies, and environments of Native peoples. This was particularly the case at Spanish missions, where clergy were responsible for establishing and maintaining self-supporting agrarian communities by co-opting Native American labor into European-styled intensive agriculture and animal husbandry. Native laborers were also expected to produce a surplus that could fulfill the needs of the missions, and provide material support to nascent Spanish secular and military settlements. Pimería Alta missions were particularly well suited to the ranching enterprise; they were located in an environment that was amenable to livestock ranching, among Native communities who ultimately provided the labor.
for ranching and in proximity to other colonial entities with demands for both domesticated animals and livestock products. In concert with documentary evidence, zooarchaeological data from Mission San Agustín de Tucson and Mission Nuestra Señora del Pilar y Santiago de Cocóspera indicate that introduced Eurasian livestock, particularly cattle, served as the foundation for several central regional economic interactions, including ranching, rendering, and raiding.

Mission ranching activities were supported on the backs of Native laborers. The co-option of Native labor by missions had profound effects on the daily life of the O’odham at missions. Policies of permanent residency, reducción, and the three-day labor (plus one day of worship) requirement conflicted with traditional practices of seasonal mobility to exploit wild resources. The introduction of domesticated livestock, the labor demands of ranching, and restrictions on traditional hunting practices no doubt all came with implications not just for workloads, but the division of labor within O’odham communities.

Wild game was not entirely abandoned, however, as wild species are found in both zooarchaeological assemblages. Many of these species may have been caught in agricultural fields, perhaps by young hunters sent into the fields to protect crops from hungry pests. However, some game animals, such as deer, were no doubt captured some distance from the missions. In writing, priests disapproved of hunting trips that took neophytes away from the missions (and therefore away from their influence) (Dobyns 1976:24), but wild game remains were found within the mission compounds at both sites, suggesting that priests derived some benefits from these activities, including access to fresh meat and a wider variety of foods than was otherwise available. Mission priests in Alta California were equally disapproving of traditional hunting pursuits by Native converts, but were also equally happy to partake of the fruits of neophyte fishing expeditions, particularly on Fridays (Lightfoot 2005:98). Ironically, the involvement of O’odham people in livestock ranching may have decreased their access to fresh meat, except through what was captured through “garden hunting.” Cattle were primarily free-ranged, and rounded up by Native laborers usually only once or twice a year, particularly in the fall, for slaughter. This may have been the only time that fresh beef was available, as most was dried for later consumption. O’odham children, who protected crops from animal pests, may have contributed more fresh meat to the diet than the vast mission herds.

Native labor also supported not just production of meat protein for local consumption, but also the rendering of tallow for candles and industrial lubricants that fed the demands of nearby mining enterprises. The impact of this additional labor demand on O’odham daily life and division of labor is not fully understood, but it was no doubt substantial. Paradoxically, while missions and mining enterprises were often in competition for Native labor and colonial resources, the mining communities in the southern Pimería Alta were dependent upon the
local production of foodstuffs as well as raw materials, including hide and tallow. Mines were an important source of wealth for the Spanish Crown, so much so that normal restrictions on intercolony trade were lifted so that missions could fulfill the material needs of the mines (West 1949). However, this aspect of the relationship between missions and mines in the region is illuminated only by the zooarchaeological record (Pavao-Zuckerman 2011b), as written documents are relatively silent on the role of animal products in intracolony trade (West 1949). As a result of this relationship, the co-option of Native labor at missions ultimately supported a regional economic system that enriched the colonial regime.

Thriving herds made missions the target of livestock raiding by hostile groups, and the zooarchaeological and written records give some insight into how missions may have managed herds in response to the stresses of livestock raiding. Ranching strategies were always diversified, but the documentary record suggests that under normal conditions, cattle were the preferred ranch animal in the Pimería Alta, as they were less labor intensive and easier to manage in the Sonoran thorn scrub. During times of intensified raiding, however, it appears that sheep, which were more resistant to raiding, and easier to corral, took on greater importance.

Zooarchaeological and documentary evidence demonstrate that introduced Eurasian livestock not only transformed Native environments and daily life, but served as the catalyst for social and economic interactions in the Pimería Alta. Eurasian livestock and Native labor connected missions to a broader regional and global economy, both sanctioned and illicit, and ultimately supported the Spanish colonial endeavor. Far from isolated frontier outposts, missions were surprisingly interconnected to regional and global colonial enterprises, and responded dynamically to economic opportunity, and economic stresses.

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