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The Economic Organization of Early Camelid Pastoralism in the Andean Highlands of Bolivia

by

José Mariano Capriles Flores

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Graduate School of Arts and Sciences
of Washington University in
partial fulfillment of the
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ABSTRACT

A fundamental goal of anthropological research is to understand the reasons for and consequences of the development of specialized agricultural systems. The domestication of South American camelids (llamas and alpacas) was associated with the development of specialized pastoralist societies that are still poorly understood. In the central altiplano of Bolivia, during the Formative Period (1800 BC − AD 400) a cultural complex known as Wankarani developed. Although Wankarani is often cited as an example of early herding society, to date, there has not been an archaeologically-oriented study, focused on understanding the characteristics of its basic economic organization. The goal of this dissertation is to improve current understanding of the nature and development of early camelid pastoralism in the Andean highlands by testing a set of hypotheses related to the economic organization of the Wankarani cultural complex and its change through time. I directed a three-year field project in Iroco (located in Oruro, Bolivia) that involved high-intensity survey of 38.35 km^2, horizontal excavations at five sites, and detailed analysis of the recovered faunal remains. Based on quantitative analyses of the collected data and ethnoarchaeologically derived expectations, I demonstrate that early camelid pastoralism was characterized by high residential and logistical mobility, low population densities, and a generalized subsistence base. In contrast to prevailing views, I show that Wankarani pastoralists complemented their reliance on camelid herds with fishing, hunting wild fauna, and cultivating chenopods and tubers. This system remained locally sustainable and largely unchanged for many centuries, but the expansion of the Tiwanaku state (AD 400−1100) produced a regional reorganization that included population aggregation, cultivation intensification, and increased caravan exchange. I conclude that camelid pastoralism developed as a long-term ecological adaptation and as an efficient economic strategy capable of managing diverse processes of environmental and socio-political change.

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For Alejandra

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

CHAPTER 1

INTRODUCTION

Understanding the causes and consequences of domestication and the development of specialized agricultural systems has been a fundamental goal of anthropological research. The changes that domesticated plants and animals brought to human societies are among the most noteworthy that humanity has ever experienced (Bellwood 2005; Childe 1952; Diamond 1997; Cowan and Watson 1992; Harris 1996; Winterhalder and Kennett 2006; Zeder et al. 2006). In several regions, the domestication of a limited set of plant and animal species was followed by the development of more intensive technologies of agricultural production (Childe 1951; deFrance 2009; Flannery 1973; Marshall and Hildebrand 2002; Sherratt 1983; Zeder 2009). For instance, the domestication of staple annual crops such as wheat, rice, and maize was followed by the development of irrigation systems that allowed more intensified production, which in turn permitted population growth and eventually triggered the emergence of complex centralized and stratified societies. Animal domestication was also followed by more intensive production strategies and extensive use of secondary products involving occupational specialization as well as complex information networks and landscape-scale management strategies (Ingold 1980; Sherratt 1983; Zeder 1991). Pastoralism, the specialized management of domesticated herding animals and their pastures, is perhaps the most significant and sustainable form of animal production subsistence system that evolved in the ancient world.

The Andes is known for the domestication of a number of species and the concomitant impacts that agriculture had on its natural and cultural landscape throughout time

(Erickson 2006; Gilmore 1950; MacNeish 1992; Moseley 2001). Because of its altitudinal and topographic variability, as well as rich cultural history, the Andes are considered a biodiversity hotspot and a center for domestication (Bellwood 2005; Zeder et al. 2006). Cultigens as varied as cotton (*Gossypium barbadense*), beans (*Phaseolus vulgaris*, *P. lunatus*), peanuts (*Arachis hypogaea*), tomatoes (*Solanum lycopersicum*), chili peppers (*Capsicum frutescens, C. baccatum*, *C. pubescens*), quinoa (*Chenopodium quinoa*), kañahua (*Chenopodium pallidicaule*), and potatoes (*Solanum tuberosum*), among others were domesticated in the region (Pearsall 2008). Intensification practices developed for each of these cultigens varied considerably from place to place beginning with incipient horticulture, to water table farming, raised fields, terracing, and even valley-scale irrigation networks (Bruno 2008; Erickson 2000, 2006). The Andes were also the center for domestication of three animal species: llamas (*Lama glama*), alpacas (*Vicugna pacos*), and guinea pigs (*Cavia porcellus*) (Stahl 2008). Since then llamas and alpacas have constituted a fundamental component of Andean culture. These herding animals not only provided meat for human consumption, but also wool for the production of textiles, dung for fuel and fertilizer in an otherwise treeless and arid environment, a means of transport for exchanging goods between different ecological zones, and an additional source of energy that allowed human colonization of high-altitude agriculturally risky environments (Aldenderfer 2008; Browman 2008; Flannery et al. 1989; Flores Ochoa 1979; Murra 1965; Orlove 1977). Camelids were also immensely important in religious ceremonies and a fundamental component of the Andean symbolic repertoire as manifested in innumerable iconographic representations, rituals involving their sacrifice, and their indispensable consumption in public feasts (Dedenbach-Salazar Sáenz 1990; López Rivas 1976; Murra 1980).

The domestication of South American camelids (llamas and alpacas) occurred between approximately 6000 and 4000 years ago transforming the use of highland landscapes (Baied and Wheeler 1993; Mengoni-Goñalons 2008; Mengoni-Goñalons and

Yacobaccio 2006; Wheeler 1995; Wing 1986). Through the development of specialized herding strategies that seem to have occurred a couple of thousand years later, humans were able to take full advantage of the highland grasslands and scrublands enhancing human adaptation and occupation of high-altitude Andean arid and semi-arid environments (Aldenderfer 2006; Kent 1982; Kuznar 1989). Equally important, the utilization of caravan networks contributed to the emergence and expansion of complex societies such as the Tiwanaku, Wari, and Inca states (Albarracin-Jordan 2007; Browman 1981; Janusek 2008; Kolata 2003; Lynch 1983; Moseley 2001; Murra 1980; Núñez and Dillehay 1995; Stanish 2003; Tripcevich 2007).

Foundational camelid zooarchaeological studies focused on the location, timing, and variation in the domestication of llamas and alpacas and provided a strong baseline for approaching the study of early pastoralist societies (Kent 1982; Miller 1979; Moore 1989; Rick 1980; Wheeler 1984, 1995; Wheeler et al. 1976; Wing 1972, 1978). These works were mostly based on evidence from the central highlands of Peru. More recent research from northern Chile and northwest Argentina has broadened our understanding of the complex processes involved in the domestication of camelids throughout the South American highlands and the related development of distinctive pastoralist strategies (Capriles 2010; Cartajena et al. 2007; Hesse 1982; Izeta 2008; Mengoni-Goñalons 2008; Mengoni-Goñalons and Yacobaccio 2006; Núñez et al. 2005; Yacobaccio 2004).

In the central altiplano of Bolivia, the Formative Period (1800 BC – AD 400) was characterized by the emergence and persistence of an archaeological cultural complex known as Wankarani (Bermann and Estévez Castillo 1995; McAndrews 2005a; Ponce Sanginés 1970). The Wankarani is among the most often cited examples of an early herding society in the Andes (Bruhns 1994; Catacora et al. 2002; Condarco et al. 2002; Giesso 2008; Janusek 2004; Michel and Lémuz 2002; Moseley 2001; Stanish 1992). It has also been speculated that Wankarani was part of the pastoralist foundation of the Tiwanaku state that developed in the Lake Titicaca basin around AD 400-1100 (Kolata 1993; Janusek 2004; Ponce Sanginés 1980). Nevertheless, to date there has not been a single subsistence-oriented study focused on understanding the structure and variability of the economic organization of the Wankarani or how it changed through time. The goal of this dissertation is to improve our current understanding of the nature and development of early camelid pastoralist communities in the Andean highlands by characterizing the ancient economic organization in the central altiplano.

This study provides quantitative and qualitative evidence for describing the characteristics of the initial stages and transformation of pastoralism in the altiplano. It builds on existing knowledge regarding subsistence systems, pastoralism, domestication of South American camelids, and emergent social complexity. It also relies extensively on ethnoarchaeological research of modern Andean herders and comparative data from other regions of the World for assessing the material culture of ancient pastoralist societies and their variability.

This dissertation is structured in ten chapters. The first and second chapters introduce the conceptual and theoretical framework regarding the archaeological study of early pastoralist societies. The third chapter discusses the research problem including the origin and organization of the Formative Period Wankarani cultural complex and its later incorporation to the Tiwanaku state. The fourth chapter describes the study area known as Iroco, which is located within the broader Andean highland altiplano of Bolivia. The fifth chapter details the materials and methods, including the explicit formulation of the research questions, hypotheses, and a research design that integrates regional survey, site excavations, and artifact and ecofact analyses, emphasizing faunal remains. The sixth chapter presents the results of the regional settlement pattern analysis, presenting the information on inter-site organization, particularly for the Archaic, Formative, and Tiwanaku periods. The seventh chapter describes the excavated sites including intra-site patterns and emphasizes the cultural contexts associated with social and economic organization. The eighth chapter, as the core of this dissertation, presents the results of the zooachaeological analysis, including a detailed quantitative taphonomic assessment of the recovered and identified faunal remains. Patterns associated with camelids, as the most frequently identified taxonomic group, are also described, but data regarding other resources such as fish, aquatic birds, and mid-sized rodents are also presented. In the ninth chapter, the hypotheses laid out in earlier chapters are assessed and a diachronic model for understanding early camelid pastoralism in the central altiplano is discussed. The tenth and last chapter includes the conclusions and recommendations of the research project. The document is complemented by a series of appendices through which the collected raw data is made available to interested researchers. This dissertation is organized as a final research monograph that is rich in empirical data but also discusses ways in which the data contribute to answering the research questions, propose new insights based on the collected information, and suggest new venues for future research.

CHAPTER 2

THE WORLD OF PASTORALISM AND ANDEAN CAMELID HERDING

The origin, spread, and evolution of pastoralist societies is a fundamental anthropological inquiry that is directly related to understanding cultural change, human-environment interactions, social complexity, and ecological adaptations (Chang and Koster 1986; Cribb 1991; Khazanov 1984; Wendrich and Barnard 2008; Zeder 2009). Reconstructing the history of pastoralism is important because the domestication of herding animals and the eventual evolution of pastoralist societies constitutes a fundamental transition in human economic and ecological history, involving a new process of interaction between humans, their domesticated herding animals, and their surrounding environments (see Browman 2008; Dyson-Hudson and Dyson-Hudson 1980; Ingold 1980; Lane 2009; Marshall 2007; Meadow 1989; Zeder 1991). The foundations for explaining the origins, nature, and variability of pastoralism across time and space is a consequence of the research collaboration between anthropologists, archaeologists, historians, ecologists, and economists. Based on current anthropological and interdisciplinary research, in this chapter I employ these literatures to build a conceptual framework for understanding pastoralism and more specifically, the evolution of camelid pastoralism in the Andean highlands.

2.1. A Conceptual Framework for Understanding Pastoralism

I define pastoralism as a general form of economic subsistence system that is fundamentally, but not exclusively, based on the management, production, and consumption of herding animals (see Barfield 1993; Chang and Koster 1986; Cribb 1991; Khazanov

1984; Dyson-Hudson and Dyson-Hudson 1980; Wendrich and Barnard 2008). In addition, pastoralism can be conceived as an environmental adaptation and risk management strategy that upholds the productivity and safety of the herding animals as equivalent to the stability and security of the human community. As a consequence pastoralism is more than an economic activity and includes other ecological, social, political, and ideological aspects (Browman 1974; Marshall 1990; Marciniak 2005). Although pastoralism is often complemented by other productive tasks such as cultivation, exchange and even hunting and gathering, pastoralist societies tend to have their primary economic activities centered on feeding and safeguarding their herds. The action of keeping and managing herds is called herding and is the fundamental role of pastoralism.

Herds or herding animals are domesticated animal species that can be kept in large groups, generally have medium to large body sizes (over 20 kg), usually have a dominance hierarchy, and are managed by their human herders to produce direct, indirect, primary, and secondary products. Domestication is defined as the process by which economically useful animals and plants are progressively incorporated into the social structure of human societies becoming objects of ownership and undergoing behavioral, morphological, ecological, and genetic changes as a consequence (see Clutton-Brock 1999; Dobney and Larson 2006; Hemmer 1990; Wheeler 1995; Zeder et al. 2006). Sheep, goats, and cattle, are good examples of domesticated herding animals, as are yaks, horses, donkeys, camels, dromedaries, llamas, and alpacas. Pastoralist societies often employ diverse types of herding animals, including various species, numbers of animals, sizes, ages, and sex. Herd size can vary from a few animals to several thousand animals. The composition of a herd in terms of species, age, and sex is often conditioned by factors such as wealth, seasonality, idiosyncratic preferences, and access to pastures, human labor, and markets.

Pastoralists or herders are defined as the owners and managers of herding animals and as such they are the direct recipients of the animal products. The most important product of herding animals is the transformation of (humanly indigestible) cellulose into energy, which can be consumed as meat protein, fat, marrow, blood, and milk or transformed into secondary products and services that include milk by-products, transportation, dung for fuel and fertilizer, and raw material from bones and horns (Chang and Koster 1986; Sherratt 1983).

The most important responsibility that herders have is to guarantee protection and adequate access to grazing land and water for their animals. Protection for animal herds is generally performed routinely through tasks such watching over the animals during the day, penning them in corrals during nights, and constantly keeping predators, pests, and rustlers out of range (Dyson-Hudson and Dyson-Hudson 1980). Access to feeding grounds is generally achieved through landscape management and cycles of mobility of varying length depending on several factors such as seasonality, climate, and local flora as well as enforcing some form of property rights to pastures (Frachetti 2009; Fratkin 1997; Khazanov 1984; Salzman 2004).

2.1.1. The Social Dimension of Pastoralism

Throughout time a large number of different pastoralist societies evolved and developed around the World (Barfield 1993; Dyson-Hudson and Dyson-Hudson 1980; Fratkin 1997; Khazanov 1984; Wendrich and Barnard 2008). These societies diverge on a number of different factors such as types of animals involved, local environment, seasonality, mobility, and sociopolitical organization, among many others. The incorporation of domesticated animals marks a distinctive transition in human-animal relations with substantial implications for social life (Marciniak 2005; Zeder 2009). Ingold (1980), suggested that it is the object of ownership that distinguishes herders from hunters (see also Browman 1981; Meadow 1989). Although feeding territories (e.g., pastures) can be comparable to hunting or foraging territories (e.g., resource patches) because in both cases, they are not individually owned, ownership of animals varies substantially. In foraging societies a hunter owns an animal only after killing it. In contrast, a herder has ownership over live animals (especially those born from her/his previous herds). Consequently, a herder can use his or her live herds and their derived products and services in reciprocity and exchange circuits as a form of economic and symbolic capital, which often constitute the basis for political power and social status (Marciniak 2005; Sahlins 1972; Stanish 1992).

Historically, pastoralist societies have been constituted of organized communities composed of individual households that base their subsistence and schedule their activities and actions according to the needs of their herding animals (Dyson-Hudson and Dyson-Hudson 1980). Pastoralist societies rely on at least a level of political organization (which is traditionally kin-based) for enforcing communal rights to feeding territories and individual (or household) property rights to animal herds and individual animals. Furthermore, aspects of pastoralist political institutions involve variously formalized regulations regarding animal tenure, heredity, and exchange. For instance, several ethnographically documented pastoralist societies have been known to be integrated into nested segments based on kinship and territorial residency (Evans-Pritchard 1940; Izko 1992; Platt 1982; Sahlins 1972). Segmentary social organization allows scalar levels of economic wealth, political aggrandizement, and social integration for managing incremental levels of social and territorial disputes. Because grazing territory is essential for the reproduction and growth of a herd, historically disputes among herders are common and violence and warfare have been associated with pastoralist societies. Generally, these disputes are more common within members of herding groups than against societies that practice other types of subsistence economy.

Because herding animals can be accumulated and constantly reproduce, they can be used as a measure of exchange but also as a saving asset, symbol of wealth, and a source for incipient capital accumulation. Ownership of herding animals can be transferred horizontally or vertically through gift giving, exchange, and inheritance but also through raiding and rustling. In this sense, pastoralism can potentially trigger (or enhance) broader processes of sociopolitical complexity, separately and independently of other agricultural societies.

Pastoralist societies have diverse types of ideological and religious practices, generally involving the ritual sacrifice and symbolic adoration of their animals. For instance, in eastern Africa, Evans-Pritchard (1940) documented numerous ceremonial traditions associated with herding including cattle songs, myths, and deities. In fact, several pastoralist groups have been described as having some form of totemic religiosity focused on the protection and multiplication of their herds, reinforcing social solidarity, and promoting political integration (see Chang and Koster 1986; Dyson-Hudson and Dyson-Hudson 1980; Hodder 2006; Khazanov 1984; Salzman 2004).

2.1.2. The Human Ecology of Pastoralism

As an ecological adaptation, pastoralism allows human groups to exploit new ecological niches and occupy previously uninhabited ecosystems (Harris 1983). Because cultivation in arid and semi-arid grassland environments is hampered among other factors by poor soils, low water availability and low and unpredictable rainfall precipitation, pastoralism is generally a more efficient subsistence strategy in these ecosystems (Cribb 1991; Kuznar 1995). In other words, pastoralism allows economic exploitation of extensive grasslands and scrublands where intensive and extensive cultivation is either not feasible or less reliable. As a consequence, pastoralism is an efficient risk management strategy because it allows people to cope with environmental variability (in fluctuating environments) by relying on mobile living animals rather than spatially bounded annual harvests (Browman 1987, 1990). The risk managing aspect of pastoralism is central to understanding the human occupation of agricultural marginal regions such as deserts and steppes (Marshall et al. 2011).

Different types of pastoralism evolved in different regions of the world but most kinds are associated with adaptations to arid and semi-arid environments (Wendrich and Barnard 2008). Although some anthropologists believe that pastoralism evolved along with agricultural villages as a consequence of sedentarization, recent archaeological research suggests emergence of pastoralist societies occurred independently and in several regions. For instance in Africa, cattle pastoralism originated considerably earlier than the domestication or introduction of domesticated crops and appears to be connected with environmental changes involving habitat patchiness and increased aridity (Marshall and Hildebrand 2002). Nevertheless, specialized pastoralism and nomadic mobile pastoralism have also been strongly connected with increased urbanized life, particularly in the Near East during the emergence of city states (Abdi 2003; Lees and Bates 1974; Zeder 1991).

Although pastoralists are often viewed as transitory occupants of a given territory, they are also actively involved in the transformation and engineering of their surrounding landscape. Like any other group of agriculturalists, pastoralists can have deep and long-term impacts on their local environment. The most obvious direct impact that herders and their herds have over the lands they occupy is the disturbance and temporary depletion of plant species (usually those that their animals graze, browse, and trample). Depending on the herding species, density and intensity, in addition to a combination of other ecological factors such as phenology, climate and soil nutrients, the spatial and temporal scale of the impact can vary substantially. Moreover, by depleting certain plant species, herding has variable impacts on different ecosystems, often determining specific vegetation succession cycles. In fact, some scholars believe that herding promoted the domestication of certain plant species such as quinoa (Kuznar 1993).

Because animals are usually kept in corrals during nights for protection (as well as tasks involved in butchering and consuming an animal), generally the largest infrastructural investments that herders make are located in their base camps. Through time the accumulation of dung in corrals and other features can potentially produce nutrient enhancement because of the soil's enrichment with phosphates, nitrates, and other nutrients (Korstanje 2005). In addition, pastoralist societies can also directly modify their landscape by investing in engineering works such as irrigation canals used to water pastures and to open broader areas for herding (e.g., Browman 2008; Lane 2006, 2009). Finally, it should be restated that pastoralist societies are dynamic and vary a great deal depending on location, environment, climate, herding animals, interaction with full-time farmers and urban centers as well as social identity and religious ideology.

2.1.3. Pastoralist Societies and Mobility

Variable levels of mobility characterize pastoralist societies because moving herds through different feeding grounds or pastures is an essential role of herders (Abdi 2003; Khazanov 1984). These movements often involve repeated residential relocation movements that can occur at different time scales from seasonal to yearly to decadal and even centennial depending on a combination of environmental and social factors (Cribb 1991). As a consequence pastoralist societies are often referred to as nomadic, but this term can be misleading (e.g., Barfield 1993). Because residential mobility is variable among different pastoralist societies, herding communities are often classified according to their degree of mobility. For instance, Khazanov (1984) classifies pastoralist societies into mobile (nomadic), seasonally mobile (transhumant or semi-nomadic), and almost sedentary (semi-sedentary or village-based). A more recent conceptualization of mobility involves assessing combinations of variable aspects in terms of moment (length of movement), motion (pattern of the movement), motivation (reason for movement), and segment (social groups involved) (Wendrich and Barnard 2008:8-9).

The extensive use of their surrounding landscapes, with herders constantly settling and occupying different places as herds change pastures, is a distinctive attribute of pastoralist societies. This continuous change produces anthropomorphized pastoralist landscapes that promote social interaction among pastoralists and between other socio-economic groups (Frachetti 2008, 2009; Wendrich and Barnard 2008). Exchange and trade is often the main mechanism by which pastoralists acquire agricultural staple goods (in addition to prestige manufactures) and there are several documented cases of long-term symbiotic relationships established between pastoralist, cultivating, and market societies (Salzman 2004). Furthermore, because of their control of mobility, a number of pastoralist societies developed specializations in middle and long-distance trade involving caravan networks with variable degrees of institutional formalization (Khazanov 1984; Medinacelli 2010).

2.1.4. The Archaeology of Pastoralist Economic Organization

The economic organization of pastoralist societies is determined by a number of factors including locally available resources, technology, organizations, and institutions (Ensminger 1992; North 1981, 1990). Organizations (such as communities, lineages, tribes, etc.), are associations of individuals structured to achieve certain goals and improve their outcomes in economic, social, and political situations and interactions (North 1981). Institutions are socially structured constraints that organizations and individuals face in order to fulfill their productive and reproductive needs and roles within society (North 1990). As a result, institutions shape human interaction and economic performance is directly tied to the institutional make-up of a given society. Institutions can be formal (such as laws and other written regulations in modern societies) or informal (such as customary rules and obligations in non-market societies). Although institutions have a degree of flexibility and can progressively change through time, they tend to be surprisingly stable, particularly in subsistence-scale societies such as pastoralists (Ensminger 1992; Frachetti 2009).

The reconstruction of ancient economic systems involves integrating archaeological evidence related to resources, technology, organizations, and institutions. On one hand, resources and technology are tangible factors that can be directly assessed by identifying and analyzing artifactual and ecofactual pattering and associations (e.g., Fritz 2005; Lyman 2005; Pearsall 2000; Reitz and Wing 2008). On the other hand, the archaeological study of organizations and institutions relies on inferences based on the configuration of these factors but also on their interpretation through analogical reasoning and construction of relational analogies often derived from actualistic or ethnoarchaeological research (Politis 2007; Wylie 1992).

Exploring the properties of the archaeological record produced as a consequence of basic daily activities such as food procurement, distribution and consumption, has produced a wealth of literature on the analysis and reconstruction of economic subsistence systems (e.g., Binford 1964; Childe 1952; Clark 1953; Cowan and Watson 1992; Lupo 2007; Parsons 1972; Sanders et al. 1979). However, these attributes also represent the consequence of other socially charged activities such as enculturation, political negotiation, identity formation, and social reproduction, which are fundamental to gaining a broader picture of social meaning in the past (Childe 1951; Hodder 2006; Meskell 2005). As a consequence, the archaeological investigation of pastoralist societies can not only inform materialist problems such as economic organization but also contribute to the discussion of broader themes related to social structure and cultural change.

2.2. Andean Pastoralism

In the Andes, two species of herding animals were domesticated, the llama (*Lama glama*) and the alpaca (*Vicugna pacos*). Camelid pastoralism was essential for the development of Andean civilization and continues to be essential for many indigenous communities (Bonavia 2008; Medinacelli 2010; Moseley 2001; Murra 1965; Wheeler 1995). Nevertheless, for a long time, Andean camelid herders were not considered "true" pastoralist societies (Browman 1974, 2008; Flores Ochoa 1968, 1979; Medinacelli 2010).

Some scholars believed that pastoralism in the Andes only began after 1532, when the Spaniards brought with them horses, sheep, goats, donkeys, and cattle. Deeply embedded Eurocentric and diffusionist ideas suggested that both domestication and pastoralism were human inventions that only occurred in the Old World (see Flores Ochoa 1979:111-119, for discussion). Even recent surveys regarding pastoralism typically exclude camelid pastoralists from their lists of legitimate pastoralist societies (e.g., Barfield 1993; Cribb 1991; Khazanov 1984; Salzman 2004). Fortunately, through anthropological research, these views have slowly begun to change and currently there is an increasing body of scientific literature specifically dedicated to different aspects of Andean camelid pastoralism (Bolton 2006; Bonavia 2008; Dedenbach-Salazar Sáenz 1990; Dransart 2002; Flores Ochoa 1977, 1979; Flores Ochoa and Kobayashi 2000; Medinacelli 2010; Murra 1965; Orlove 1977; Webster 1973; West 1981). Some of the most studied topics include domestication of Andean camelids, pre-Hispanic utilization of domesticated camelids, and the ethnographic assessment of modern pastoralist communities.

2.2.1. South American Camelids

Before characterizing Andean camelid pastoralism, it is important to describe basic aspects of the biology and ecology of South American camelids. In fact, the first systematic studies of these animals were dedicated to their evolution, physiology, and distribution (Cardozo 1954, 1975; Koford 1957). Camelids are among the few large mammal species distributed in South America and are easily recognizable by their soft wooly coats and long slender limbs and necks (Fowler 1998). Camelids have a three-chambered stomach very well adapted to feeding in arid and semi-arid grasslands with very fast and efficient cycles of rumination. They also have two toes (digits 2-3) in each feet covered by soft cutenous pads.

The family of South American camelids (Order Artiodactyla, Suborder Tylapoda, Family Camelidae, Subfamily Camelinae) is presently composed of two genera and four species: the guanaco (*Lama guanicoe* Müller 1776, wild), the llama (*Lama glama* Linnaeus 1758, domestic derivative), the vicuña (*Vicugna vicugna* Molina 1782, wild), and the alpaca (*Vicugna pacos* Linnaeus 1758, domestic derivative, formerly known as *Lama pacos*) (Bonavia 2008; Clutton-Brock 1999; Kadwell et al. 2001; Wheeler 1995). Their evolution is traced to the separation of the Suborder Tylapoda from other Artiodactyla groups during the Eocene in North America. A direct descendent from this drift was *Hemiauchenia*, which migrated to South America during the Late Pliocene (around 2 million years ago), along with other North American taxa during the Great American Biotic Interchange. *Hemiauchenia* is the ancestor of the modern South American camelids as well as the extinct *Paleolama* genus (Franklin 1982; Moore 1989). South American camelids evolved along with the emergence of the Andean mountain range, and as a consequence they were extremely well adapted to this environment when the first human groups arrived to the region during the Late Pleistocene. It is no surprise that wild camelids became an extremely important resource for human foragers since the initial colonization of the Andes (Aldenderfer 2008; Dillehay 2000).

Recent genetic research has substantially improved and clarified the understanding of the phylogenetic relationships between the four extant species of camelids (Kadwell et al. 2001; Marin et al. 2006). Genetic research has also contributed to understanding the directionality and length of camelid domestication and opened up new venues for investigating camelid management strategies through time (Wheeler et al. 2006). Currently, there are four recognized subspecies of guanacos, two subspecies of vicuñas, two breeds of llamas, and two breeds of alpacas, mainly distinguishable by distribution, body size, coat color, and fiber constitution (Table 2.1). The purported ancestor of the llama is the sierra guanaco (*Lama guanicoe cacsilensis* Lönnbeg 1913) whereas the purported ancestor of the alpaca is the northern vicuña (*Vicugna vicugna mensalis* Thomas 1917). Although all

Table 2.1. Species, subspecies and breeds of South American camelids (from Fowler 1998; Marin et al. 2006; Wheeler 1995).

Common name	**Species**	**Subspecies and breeds**
Vicuña	*Vicugna vicugna* (Molina 1782)	*V. v. vicugna* (Molina 1782) southern and south central Andes, *V. v. mensalis* (Thomas 1917) central and south central Andes
Alpaca	*Vicugna pacos* (Linnaeus 1758)	*Huancaya* (fleece at right angle to body and fibers with light crimp), *Suri* (fleece hangs in ringlets and fiber lacks crimps)
Guanaco	*Lama guanicoe* (Müller 1776)	*L. g. guanacus* (Müller 1776) southern Andes, Patagonia, and Tierrra del Fuego, *L. g. huanacus* (Molina 1782) southern Andes, *L. g. voglii* (Krumbiegel 1944) chaco lowlands, *L. g. cacsilensis* (Lönnberg 1913) central and south central Andes
Llama	*Lama glama* (Linnaeus 1758)	*Chaku* (heavy neck fiber), *ccara* (short neck fiber)

four species of camelids share the same karyotype (2n=74) and can potentially reproduce producing fertile offspring, this rarely occurs in nature (Clutton-Brock 1999).

Based on fieldwork research, Franklin (1982, 1983) established some of the critical behavioral similarities and differences between wild vicuñas and guanacos. The habitats of vicuñas are the cold, windy and snowless highlands of the central and south central Andes, between 3700 and 4900 m above the sea level, whereas guanacos have a broader distribution ranging from sea level up to 4250 m and extending from the southern cone of South America (including Tierra del Fuego and Patagonia) up to the high slopes of the central Andes. Vicuñas are grazers and obligate water drinkers whereas guanacos graze, browse, and periodically drink water. The social structure of vicuñas includes family groups (composed of one dominant male, several females and their juvenile offspring), male bachelor groups, and occasional isolated males. Guanacos in addition to family groups, also live in female groups and mixed groups of males and female bachelors. Vicuña and some guanaco family groups have year-round separated feeding (generally near permanent streams) and sleeping territories (located in higher and protected grounds), but guanacos from southern latitudes, also migrate seasonally. Because of their social composition, the sex-ratio of vicuñas favors females and that of guanacos favors males (Franklin 1983).

The aforementioned variation is also present in the domesticated species (Tomka 1992). For instance, alpacas have more specialized habitat and feeding preferences,

Table 2.2. Size ranges of South American camelids (from Fowler 1998:Table1.6).

Species	Weight (kg)	Birth weight (kg)	Height at withers (cm)	Fiber diameter (microns)
Vicuña	45-55	4-6	86-96	10-30
Alpaca	55-90	6-9	76-96	16-40
Guanaco	100-120	8-15	100-115	18-24
Llama	113-250	8-18	102-119	16-40

including a fondness for grazing on succulent forage of highland marshes. Llamas in contrast, can browse and graze in different types of environments. As a result, South American camelids are morphologically and behaviorally distinct. However, given the various similarities they share, they can be arranged in ordinal classifications that often exhibit continuous distributions. For instance, size ranges can overlap between different species, but in the continuum, vicuñas are usually the smallest and llamas and Patagonian guanacos, the largest (Table 2.2). Camelids also exhibit slight sexual dimorphism.

In recent times, vicuñas were almost hunted to extinction due to the high quality fiber they possess as an adaptation to the cold conditions of the Andean highlands. Sierra guanacos are also critically endangered because of hunting pressure and habitat loss. Presently, pastoralism of domesticated llamas and alpacas is mostly restricted to the highlands (above 3700 m above sea level) of the central and south central Andes, by Quechua and Aymara indigenous communities (Browman 1974; Orlove 1977).

2.2.2. Domestication of Andean Camelids

The first archaeologically derived models for explaining the process of camelid domestication were developed from investigations in caves and rock shelters in the puna and sierra of the Peruvian central highlands (Bonavia 1999; Kent 1987; MacNeish 1992; Moore 1989; Rick 1980; Rick and Moore 1999, 2001; Wheeler 1984, 1985, 1999; Wheeler et al. 1976; Wing 1978, 1986). At the same time, these studies also addressed the methodological problems associated with identifying correlates for domestication in the archaeological record such as the osteological differentiation of the four species of South American camelids (see Chapter 5). A generalized version of these models proposed by Jane Wheeler (1984, 1985, 1995; Wheeler et al. 1976) suggested a progressive trajectory of increased human control over camelids. Late Pleistocene generalized hunting followed increased specialized camelid hunting accompanied by a deeper knowledge of their social and territorial behavior throughout the Holocene. Preliminary management of semi-domesticated herds Wheeler (1984) argued, was succeeded by increased control over breeding and ultimately their herding under complete human care around 6000 years ago. The appearance of alpaca type incisors and increasing amounts of neo-natal deaths (presumed to be caused by infectious parasites spread due to corralling) in the faunal assemblage of the site of Telarmachay constituted further evidence for this transition (Wheeler 1984, 1985, 1995). The last phase of domestication was associated with the expansion of the distribution of domestic camelids and specialized breeding across different Andean microhabitats and cultural traditions. The Spanish conquest would have caused a rupture and erosion of this last process, in addition to the loss of previously developed breeds, and the knowledge of specialized herding (e.g., Wheeler et al. 1995). However, it is important to note that Rick and Moore (1999, 2001) have argued that sites in the Junin Puna such as Panalauca, Pikimachay and Telarmachay, were occupied by bands of specialized vicuña hunters with domesticated animals only appearing in the region at the beginning of the Formative Period (ca. 3800 BP).

Based on the integration of a large dataset of faunal identifications from archaeological sites from a greater region of the Andes, Wing (1978, 1986) proposed an independent model for camelid domestication. This scheme suggested hunting of wild camelids occurred mostly in the puna and in some highland valleys of the central Andes between 10,000 and 5500 BC, followed by intensive use and the beginnings of camelid breeding control in the puna between 5500 and 2500 BC. Subsequent camelid pastoralism was indicated by a pattern of continuous camelid use in the puna, their increased use in highland valleys, and their introduction to the coast, eastern, and northern Andes (probably due to increased exchange networks) between 2500 and 1750 BC. Continued herding intensification occurred during the remaining pre-Hispanic period including specialized improved wool-producing breeds by AD 500.

In a recent synthesis, Mengoni-Goñalons and Yacobaccio (2006) compiled and discussed abundant new evidence that suggests domestication of Andean camelids was more diverse and dynamic than previously thought. In fact, significant data produced by a number of long-term research projects carried out in southern Peru, northern Chile and northwestern Argentina, suggest multiple processes of domestication could have occurred around the same time in other regions outside the Peruvian central highlands (see also Aldenderfer 1998, 2006; Cartajena 2009; Cartajena et al. 2007; Hesse 1982; Izeta 2008; Kuznar 1989; Mengoni-Goñalons 2008; Olivera 1997; Tomka 1992; Yacobaccio 2004).

2.2.3. Archaeological Research of Camelid Utilization in the Andes

Andean camelid pastoralism is characterized by a long history that extends for over five millennia of interactions between humans and their herding animals (Bonavia 2008; Mengoni-Goñalons and Yacobaccio 2006; Moseley 2001; Olivera 1997; Stahl 2008; Wheeler 1995). Archaeological research carried out during the last thirty years has provided abundant evidence regarding the widespread importance of domesticated camelids. Archaeological research has also contributed to understanding the role of camelids in the constitution of pre-Hispanic Andean society and manifested in aspects such as their economic consumption as food, their use in rituals and sacrifices, the specialized manufacture of bone tools, wool and textiles, and their essential role (particularly llamas) in facilitating inter-regional exchange through caravanning.

Mengoni-Goñalons (2008:Table 1) classified the archaeological markers that Andean zooarchaeologists often use for determining the presence of domesticated camelids into direct, indirect, and contextual. Among the direct indicators he included tooth morphology (shape, enamel distribution, and root development), osteometry (classification into group sizes using different landmarks and quantification techniques), bone morphology (diagnostic features), osteopathology (functional modifications), and fiber characteristics (such as diameter, medullation, and cuticule color). Among the indirect archaeological indicators he included taxonomic (relative) abundance (of camelids) and (relative abundance of age categories in) mortality profiles. The contextual indicators for identifying domesticates included the presence of enclosures (such as corrals and pens), artistic representations (in rock art, figurines, and other objects), and artifacts used for handling animals such as bags or ropes used in caravanning (Mengoni-Goñalons 2008:61-62).

Analysis of faunal remains from dozens of sites across the Andes demonstrates the presence and importance of domesticated camelids in pre-Hispanic Andean society. The utilization of camelids as food increased exponentially between pre-ceramic times and the time of the Spanish conquest in AD 1532. Abundant evidence suggests that domesticated camelids were one of the most commonly consumed faunal resources from Ecuador throughout the Peruvian highlands and coast, down to the Bolivian, Chilean, and Argentinean puna and sierras (Aldenderfer 1998; Bonavia 2008; Hesse 1982; Izeta 2007; Kent 1987; Kuznar 1989; Mengoni-Goñalons 2004; Miller and Burger 1995; Moore 2011; Olivera 1997; Stahl 2008; Wake 2007; Wheeler 1995).

The use of camelids as beasts of burden in caravans and the production of wool for the manufacture of textiles is well documented archaeologically and ethnohistorically (Dransart 1991; Núñez and Dillehay 1995; Nielsen 2000; Wheeler et al. 1995). Archaeological evidence suggests that widespread camelid consumption was accompanied by processes such as the introduction of camelids into new ecosystems and the development of specialized varieties. For example, breeds of llamas and possibly alpacas were adapted to the lowland hyper-arid desert coast of the northern Peru (Kent et al. 2001; Shimada and Shimada 1985). Another example involves the development of fine fiber producing llamas such as the ones recovered from Chiribaya cemeteries in the southern coast of Peru (Wheeler et al. 1995). However, it is often assumed that llamas were domesticated mostly for providing meat and transport whereas alpacas were domesticated mostly for producing fine wool (Wheeler 1995). The archaeological documentation of extremely large llama specimens suggests that some varieties were probably bred specifically to be used for transportation purposes (Mengoni-Goñalons and Yacobaccio 2006).

Ethnohistoric evidence also provides ample evidence that llama pastoralism was one of the most important economic activities carried out in the Andes prior to the Spanish conquest (Bouysse-Cassagne 1987; Dedenbach-Salazar Sáenz 1990; Gilmore 1950; Medinacelli 2003, 2005, 2010; Murra 1965, 1975, 1980). For instance, the Inca empire, known as Tawantinsuyu, had an extremely well developed system and nomenclature associated with camelid herding. The Inca ruler himself owned large numbers of herds spread throughout the empire. Specific imperial functionaries were designated to oversee and manage his herds and monitor the size and health of all other herds within the Tawantinsuyu (Murra 1965). The number of herds was constantly documented in state records kept in *quipus*, knotted strings used as mnemonic devices. Furthermore, camelid herding was introduced into regions where either it was not practiced or the numbers of herding animals was small (Murra 1980). The Inca also tightly controlled the hunting and utilization of wild resources such as vicuñas. Camelids were used by the Inca in ritual ceremonies, divination, large redistribution feasts, clothing manufacture, exchange goods, to feed its armies, and to buffer against environmental disasters. Although herds themselves were not received as tribute, herding (the animals owned by the Inca) was a common form of labor taxation in the highland regions of the Tawantinsuyu (Murra 1975). It is difficult to say when specialized, state-controlled pastoralism began and how much the Inca innovated over preexisting herding strategies, but it seems clear that pastoralism was well structured in most regions of the Andes prior to the expansion of the Inca empire (Dransart 2002).

Textiles spun with camelid wool were considered the most valuable goods the Inca empire produced (Murra 1965, 1980). The complex manufacturing techniques employed in several of the textiles recovered archaeologically suggests a progressive evolution and diversification of textile production traditions. For instance, some of the fine polychrome textiles manufactured by the Wari and Tiwanaku states probably took months to complete and required the participation of several individuals. Some scholars have speculated that the evolution of these traditions were probably connected to the development of complex social systems that included specialized pastoralist and artisan guilds (Dransart 2002; Kolata 1993; Wheeler et al. 1995).

2.2.4. Contemporary Andean Camelid Herding

After the Spanish conquest, llamas and alpacas continued to be important in the Andean economy (Assadourian 1995; Browman 1990; Dransart 2002; Murra 1975). Llamas served as beasts of burden for transporting goods including minerals from the highland mines to the coastal ports, and herds of llamas and alpacas were utilized as the subsistence base for many Andean communities (Medinacelli 2010; Orlove 1977). With the introduction of exotic species and agricultural technological improvements, camelid pastoralism became marginalized to most inhospitable regions of the highlands (Bonavia 2008). In fact, contemporary camelid pastoralism in the Andes is mostly practiced by indigenous communities as a successful subsistence and risk management strategy that has persisted from pre-Hispanic times into modern times in the face of long-term systematic social, economic, and political marginalization (Browman 1974, 1987).

Perhaps the definitive ethnography of Andean pastoralism is the work of Jorge Flores Ochoa (1968, 1979) in the Aymara community of Paratía, located in the southeastern highlands of Peru. Because of the high elevation (roughly 4400 m above the sea level), poor soils, and cold weather, cultivation was not practiced and all of the community members relied entirely on their herds of alpacas and llamas for their subsistence. For instance, camelid meat and fat was the most important food staple, camelid dung was used for fuel and fiber was used for spinning wool and weaving textiles. Furthermore, the animals were used as beasts of burden in caravans that transported Paratía herders to lower elevations where they exchanged highland goods (such as dry meat and textiles) for plant agricultural staples (such as potatoes, quinoa, and maize). It is important to note that in contrast with other herding animals and other pastoralist traditions, Andean camelids are never milked.

The Paratía herders are paradigmatic of Andean "pure" pastoralism but, presently the variety of herding strategies in the Andes is immense (Browman 1990, 2008). In fact, Flores Ochoa (1979) explicitly decided to work in the Paratía area because it provided a case study of a community that entirely relied in their herds. Most camelid herders, however, complement their activities with some level of cultivation and seasonal migration (see Abercrombie 1998; Browman 1974, 1987, 1990, 2008; Flores Ochoa 1968, 1977, 1979; Flores Ochoa and Kobayashi 2000; Orlove 1977; Riviere 1979). The range of variability in the past is unknown. Today, moreover, the majority of Andean pastoralists include introduced exotic animal species, such as sheep, cattle, goats, and donkeys along with their herds of llamas and alpacas. In many regions presently Andean herders do not have llamas and alpacas anymore but rely entirely on exotic herds. For instance, most Aymara families living on the shores of Lake Titicaca currently own sheep, cattle, and donkeys and have completely excluded camelids from their agricultural complex. Another example involves the Uru community of Chipaya located on the northern shore of Salar de Coipasa where during the second half of the 20th century sheep and pigs were common and camelid herds were rare (Wachtel 2001).

The basic productive unit of pastoralist societies in the Andes is the household, which is typically composed of a nuclear family but may include a few additional kin relatives (Flores Ochoa 1979). Yacobaccio and Madero (2001:89) argue that a herding "family is a self-sufficient economic unit [that] can be studied as a small open system". Typical households vary in size between two and eight people. Here it is important to underscore that even though pastoralism might be less productive than farming, it can also be less labor intensive. Household families are generally articulated into broader communities, usually defined by both kinship bonds and some form of geographic and territorial delimitation (Abercrombie 1998; Harris 1987; Izko 1992; Platt 1982; Rivera Cusicanqui 1992). Both household and communal territorial boundaries are the product of historical contingencies but also productivity (i.e., available farming and grazing land) and circumscription. Population density, ecological, and geographic conditions determine the demographic and territorial size of pastoral communities (Molina Rivero 2006). Consequently, multiple communities can be commonly articulated into broader systems of political integration. Moreover, herding societies in the Andes are segmentary and can include multiple levels of political integration (Albarracin-Jordan 1996, 2003, 2007; Izko 1992; Molina Rivero 2006; Riviere 1979).

Andean herding communities share a number of similarities with contemporary herding societies around the world that occupy a marginal and vulnerable place around hegemonic political systems (Khazanov 1984; Salzman 2004). Similarly to other regions however, in the Andes, some of the factors that configure the ethnographically observed variability regarding herd composition and animal management strategies involve: diversity of microenvironments, diversity of herding animals (including native and exotic species), diversity of ethnic peoples, diversity of land-tenure, and diversity of distance to modern markets.

Generally communities located close to urban centers have a preponderance of cattle and sheep because of comparatively higher prices for their meat. For these and other reasons, camelid herders have been marginalized to the highest reaches of the puna environment, such as Paratía, where neither cultivation nor herding exotic animals is feasible. Interestingly enough, until very recently, a food taboo against the consumption of llama and alpaca meat in urban centers such as La Paz and Lima existed because of racist stereotyping that associated camelids with indigenous peoples (Sammells 1998). In recent years important steps have been made towards accepting and commercializing camelid meat, but even more importantly towards overcoming social and political decolonization (see Sivak 2008).

Although anthropological research has demonstrated the variability, antiquity, and significance of camelid pastoralism in the Andes, there are still many questions related to the cultural processes associated with the domestication of Andean camelids and the eventual configuration of specialized pastoralist societies. In other words, in spite of domestication studies that suggest a greater degree of exploitation of domesticated animals through time, few investigations have followed specific trajectories for understanding the development of specialized pastoralist societies (Mengoni-Goñalons and Yacobaccio 2006). For example, although in some regions of the Andes both cultivation and pastoralism can be simultaneously practiced, specialized pastoralist societies probably developed in several regions, particularly in high-elevation puna environments where agriculture was difficult, unreliable, and/or unfeasible. Similarly, it remains uncertain how pastoralism emerged and consolidated in many highland regions through time (Cartajena et al. 2007; Mengoni-Goñalons 2008; Yacobaccio 2004).

One place where camelid pastoralism seems to have evolved as the main source of economic subsistence is the central altiplano of Bolivia. This region is located between the Peruvian central highlands and the northern puna of Chile and Argentina and currently sustains some of the largest pastoralist communities in the Andes. Although no domestication or even Archaic Period studies have been conducted in this region, scholars have proposed that during the Formative Period (beginning roughly 3800 years ago), a pastoralist society known as Wankarani emerged and consolidated here (Bermann and Estévez Castillo 1995; McAndrews 2005a; Ponce Sanginés 1970).

CHAPTER 3

RESEARCH PROBLEM:
EARLY CAMELID PASTORALISM IN THE CENTRAL ALTIPLANO

3.1. The Central Altiplano of the South Central Andes

Stretching from Lake Titicaca to the Uyuni salt-flats, the Bolivian altiplano is currently the broadest continuous highland plain in the Andes (Figure 3.1). With an average altitude of 3750 m above the sea level, the altiplano is enclosed between two great mountain ranges. The Cordillera Real marks the eastern limit of the Andes and forms multiple valleys as it slowly merges into the Amazonian and Chaco lowlands. To the west, the Cordillera Occidental formed by igneous volcanoes, drops sharply to the desert coast of southern Peru and northern Chile. Temperature, precipitation, and elevation progressively decrease between the northern and the southern portions of the altiplano. Based on climatic and environmental variation, the altiplano can be roughly divided into three parts: 1) a northern portion, corresponding to Lake Titicaca and its tributaries, 2) a central portion located between Desaguadero River, lakes Uru-Uru and Poopó, and 3) a southern portion composed of the Coipasa and Uyuni salt flats in addition to the Lípez and Atacama deserts (Navarro and Maldonado 2002).

The shores of Lake Titicaca have the wettest and warmest climate of the altiplano as well as the best soils for cultivation. It is not surprising that this region was a major center for the development of social complexity (Janusek 2008; Kolata 2003; Stanish 2003). Following the Archaic Period and throughout the Formative Period (beginning around 1800 BC), settlements seem to dramatically increase around Lake Titicaca (Aldenderfer 1989;

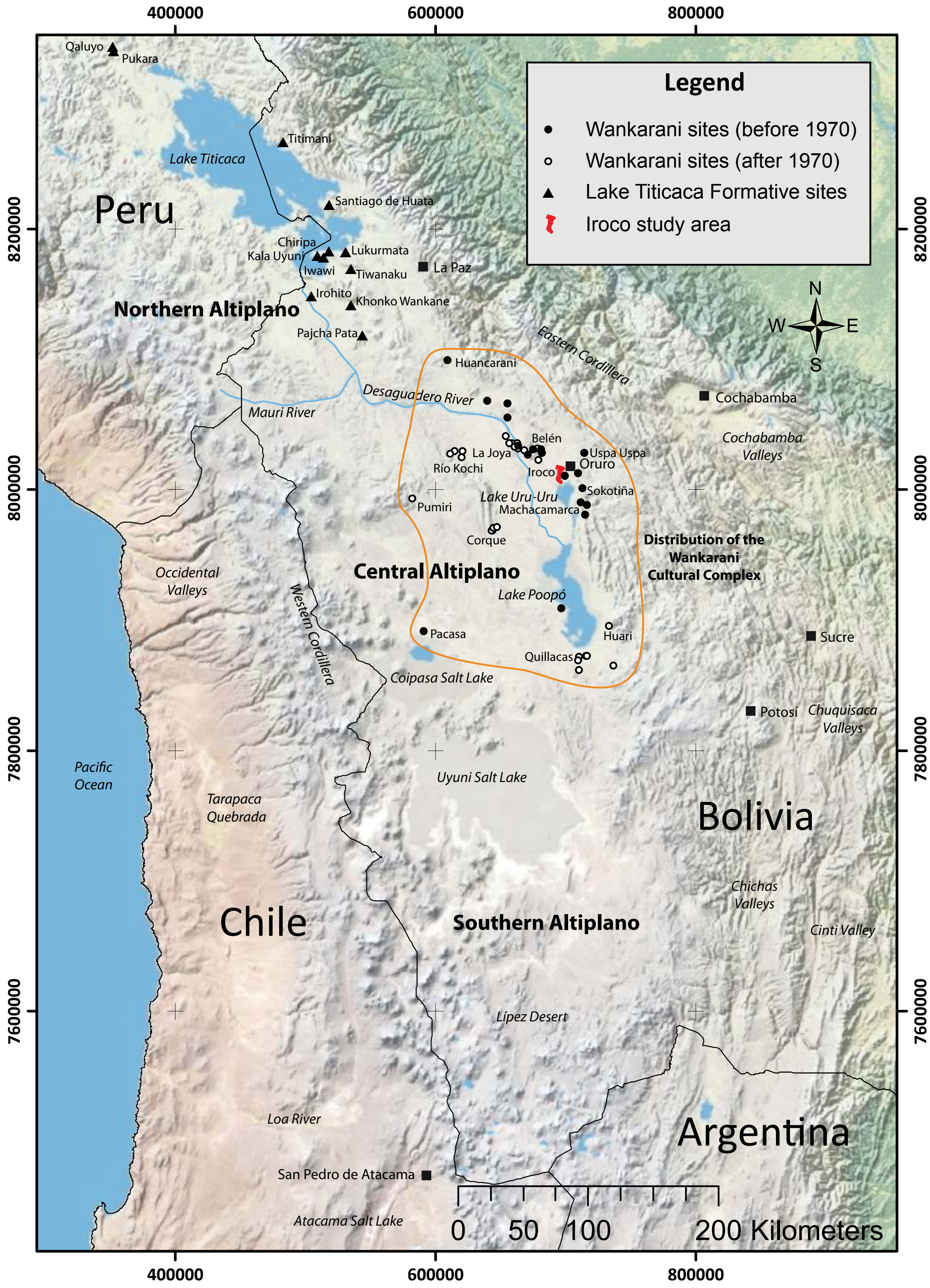


Figure 3.1. The altiplano of Bolivia including archaeological sites mentioned in the text.

Hastorf 2008). Intensive cultivation was practiced along with other subsistence activities such as camelid pastoralism, fishing, and hunting (Bruno 2009; Erickson 2006; Moore 2011). As settlements grew, spread and integrated, agriculture became the main economic activity establishing premium conditions for population aggregation, demographic growth, and increased exchange (Bandy 2001). Eventually complex sociopolitical systems such as multi-community polities evolved and competed against each other, consolidating with the emergence of the Tiwanaku state, around AD 400 (Albarracin-Jordan 2007; Bandy 2001; Hastorf et al. 2001; Janusek 2008; Kolata 2003; Stanish 2003).

In contrast to the Lake Titicaca area, the central altiplano (including the barren shores of lakes Uru-Uru and Poopó) and the southern altiplano, have comparatively poorer conditions for agricultural intensification. However, these regions (and particularly the central altiplano), have ideal conditions for camelid herding. In fact, the central altiplano currently supports some of the largest populations of llamas in the entire Andes. The historical depth and importance of camelid pastoralism in the central altiplano is manifested in its rich yet understudied archaeological record.

3.1.1. Ethnohistory and Archaeology of the Central Altiplano

At the time of the Spanish conquest, the central altiplano was occupied by a number of Aymara-speaking communities and lineages (known as *hathas* in Aymara and *ayllus* in Quechua), which were federated into larger segments or chiefdoms (Bouysse-Cassagne 1987; Del Río 2005; Molina Rivero 2006). The largest of these chiefdoms included the Carangas, Soras, Pacajes and Quillacas, and their descendants continue to inhabit the Andean highlands (Abercrombie 1998; Izko 1992; Medinacelli 2010). Ethnohistoric research suggests that during the second half of the XV century, most of the central altiplano chiefdoms were incorporated to the Inca empire through military conquest or political alliance, bringing social stability to the region (Gisbert 1994). Before then, these groups competed against each other for territory and the entire region was characterized by factionalism and endemic violence (Bouysse-Cassagne 1987).

Ethnohistoric documentation also suggests that while some of the communities of the central altiplano only practiced herding, others practiced mixed camelid pastoralism and cultivation of highland cultigens. Furthermore, several communities had colonies in coastal and inter-Andean valleys, thanks to which they were able to access other agricultural staple goods (Riviere 1979). The access to these regions was facilitated through llama caravans. In addition to the Aymara chiefdoms, ethnically distinct fishermen known as Uru occupied the shores of the Desaguadero River and lakes Uru-Uru and Poopó (Wachtel 2001). Ethnohistoric documents also suggest the cryptic occurrence in the central altiplano of vicuña and guanaco hunters known as Choquela and Larilari (Medinacelli 2010; Wachtel 2001).

The archaeological investigation of the central altiplano has been able to complement some of the interpretations suggested by ethnohistoric research in addition to extend its temporal frame. Aside from occasional stone terraces and corrals, the archaeological landscape of the region is mostly devoid of visible surface architecture. Because the conventional construction material in this region is adobe, few traces of ancient settlements are left after abandonment (see Schiffer et al. 1987). Perhaps the most conspicuous evidence of pre-Hispanic occupations are dozens of cemeteries composed of *chullpas*, which are stone and adobe burial towers (Catacora et al. 2002; Kesseli and Pärssinen 2005; Michel and Lémuz 2002; Rydén 1959; Trimborn 1967). These cemeteries were built during the Late Intermediate (AD 1100-1470) and Inca (AD 1470-1532) periods by the Aymara chiefdoms (Gisbert 1994; Pärssinen 2005).

The Aymara archaeological occupations of the central altiplano include dispersed settlement patterns with the occasional presence of *chullpas* cemeteries and hilltop fortresses commonly known as *pukaras*. These latter sites were temporarily occupied for defensive purposes during episodes of endemic warfare, particularly during the Late

Intermediate Period (see Arkush 2011). The chronology of the construction and use of *chullpas* and *pukaras* suggests the Aymara chiefdoms appeared in the central altiplano after the disintegration of the Tiwanaku state (AD 400-1100) (Albarracin-Jordan 1999, 2007; Pärssinen 2005). However, considering that the emergence and growth of Tiwanaku was mostly situated in the northern altiplano, the nature of its political impact in the central altiplano remains mostly hypothetical (see below).

The archaeological record of the central altiplano is also characterized by the presence of anthropogenic mounds littered with ceramic sherds, lithic flakes, and occasionally, stone sculptures (Figure 3.2). These sites were initially identified and investigated by Phillip Ainsworth Means (1918), Alfred Métraux and Heinz Lehmann (1937, 1953), Dick Edgar

Figure 3.2. Stone tenon heads representing camelids often found in Wankarani sites. Photograph at the Museo Antropológico Eduardo López Rivas in Oruro.

Ibarra Grasso (1957, 1965), Eduardo López Rivas (1959), Lizandro Condarco (1959), Gregorio Cordero Miranda (1965), Heinz Walter (1966, 1994), John Wasson (1967), Luis Guerra Gutiérrez (1994), and finally Carlos Ponce Sanginés (1970, 1972, 1980). By the end of the 1960s, approximately 20 of these sites were known in the central altiplano and four of them had been archaeologically excavated (Table 3.1).

Carlos Ponce Sanginés (1970) synthesized findings from these scholars and defined the archaeological culture of Wankarani, after the (type) site he excavated. Ponce Sanginés (1970) characterized the Wankarani culture by the presence of mounded settlements formed by overlapping layers of domestic occupations composed of circular houses with stone foundations and adobe walls, undecorated ceramics, and the occurrence of large (between

Table 3.1. List of mound settlements reported from the central altiplano up until 1970.

Name	Latitude	Longitude	Diameter	Type of work	References
Wankarani / Huancarani	17°12'	67°58'	73	Excavation	Ibarra Grasso 1965; Walter 1966, 1994; Wasson 1967; Ponce Sanginés 1970
Sica-Sica Km 13	17°28'	67°41'	40	Inspection	Ponce Sanginés 1970
Kella-Kellani	17°29'	67°32'		Inspection	Ponce Sanginés 1970
Kellkaña	17°35'	67°32'	200	Inspection	Ponce Sanginés 1970
La Joya	17°46'	67°31'	68	Inspection	Ponce Sanginés 1970
Kella-Kollu	17°49'	67°26'	112	Inspection	Ponce Sanginés 1970
Pukara de Belén	17°49'	67°22'	168	Collection	Condarco 1959; Ponce Sanginés 1970
Toluma	17°50'	67°18'	250	Inspection	Wasson 1967; Ponce Sanginés 1970
Uspa-Uspa	17°51'	66°59'	150	Inspection	Wasson 1967; Cordero Miranda 1968; Ponce Sanginés 1970
Sepulturas	17°58'	67°01'	150	Excavation	Wasson 1967; Ponce Sanginés 1970
Uspa-Kollu	17°59'	67°07'		Collection	Ibarra Grasso 1965; Wasson 1967; Ponce Sanginés 1970
Jikilla	18°04'	66°59'		Excavation	Wasson 1967; Ponce Sanginés 1970
Machacamarca	18°10'	67°00'		Collection	López Rivas 1959; Ibarra Grasso 1965; Wasson 1967; Ponce Sanginés 1970
Sokotiña / Sora-Sora	18°11'	66°57'	250	Excavation	Ibarra Grasso 1957, 1965; Wasson 1967; Ponce Sanginés 1970
Wilake	18°15'	66°58'	200	Inspection	Ibarra Grasso 1965:80; Ponce Sanginés 1970
Takawa	18°54'	67°08'		Inspection	Ponce Sanginés 1970
Pakasa	19°04'	68°08'		Inspection	Ponce Sanginés 1970
Belén de Janko Ake	Near	Belén	30	Collection	Means 1918; Métraux and Lehmann 1937, 1953; Condarco 1959
Pukara	Near	Oruro		Collection	Condarco 1959

50 and 100 cm) stone sculptures probably representing llama tenon heads. The latter suggested an agropastoralist subsistence economy. In agreement with previous scholars and supported by new radiocarbon dates and a tentative ceramic seriation, Ponce Sanginés (1970) established that Wankarani corresponded chronologically to the Formative Period (ca. 1500 BC - AD 400).

Ponce Sanginés (1970, 1972, 1980) further speculated that the Wankarani culture along with the Chiripa culture (distributed on the southeastern shores of Lake Titicaca), formed the societal substrate for the emergence of the Tiwanaku civilization. Moreover, because of the mounded appearance of the Wankarani culture sites, Ponce Sanginés (1980) used the analogy of Near Eastern tells for interpreting what he called the village stage of development of Andean prehistory. The former interpretation was eventually revised by later scholars who identified the origins of Tiwanaku in the socio-cultural dynamics that occurred on the shores of Lake Titicaca during the Formative Period (Albarracin-Jordan 1996, 2007; Bandy 2001; Kolata 1993; Stanish 2003). Unfortunately, the previous interpretation, involving the configuration of early sedentary villages was left unquestioned and continues to persist in readings of Andean prehistory (e.g., Bruhns 1994; Burger et al. 2000; Escalante Moscoso 1994; Giesso 2008; McAndrews 2005a).

During the last two decades, Marc Bermann from the University of Pittsburgh has directed a long-term research project focused on understanding the early residential life of Formative Period (1800 BC - AD 400) Wankarani settlements and their connection with the emergence of Tiwanaku (Bermann and Estévez Castillo 1993, 1995). His work and that of his students and collaborators has broadened our comprehension of what they refer to as the Wankarani cultural complex, providing new insights into its settlement system, site structure, chronology, and internal organization, particularly in La Joya where most of this research has been located (Aoyama 1995; Beaule 2002; Bermann and Estévez Castillo 1993, 1995; Condarco et al. 2002; Fox 2007, 2010; McAndrews 1998, 2001, 2005a, 2005b; Pérez Arias 2005; Rose 2001a, 2001b). Building on this work, I will re-examine the interpretations regarding the economic organization and materiality of the Wankarani cultural complex.

3.1.2. Wankarani and Early Village Life

Wankarani sites include stratified and well preserved residential architecture composed of foundations of circular structures associated with interior and exterior features such as hearths and storage and trash pits, which have been used to understand domestic life and social organization (Bermann and Estévez Castillo 1995; Fox 2007, 2010; Rose 2001a, 200b). For instance, Rose (2001a, 2001b) at the site of La Barca exposed the foundations of a large number of circular buildings that she classified according to size into public/ceremonial, residential, and ancillary structures. She grouped individual residential structures (which usually included an interior hearth and an outside ancillary structure) into clusters attached to larger public/ceremonial structures (Rose 2001a). Rose (2001a) suggested that this pattern represents a form of village-based society in which the adaptational unit was a form of supra-household organization such as a lineage. Bermann and Estévez Castillo (1995) have independently confirmed the domestic contents of several structures, which often include domestic refuse, hearths, and caches of agricultural lithic tools and ritual ceramic figurines.

At the regional level, Wankarani settlements have been mostly conceived as politically and economically autonomous agricultural villages. McAndrews (1998, 2005a, 2005b) based on his regional survey of 427 km^2 that included the La Joya, Río Kochi, and Belén regions, suggested population nucleated during the Formative Period in 18 villages. He further suggested that a settlement mother-daughter model could explain the distribution of Formative Period settlements, that there was an absence of settlement hierarchy, and that based on artifact distributions some form of site specialization probably existed (McAndrews 1998, 2005a).

The economic organization of the Wankarani cultural complex has only been superficially assessed. Most researchers have ascribed an “agropastoralist” social and subsistence system to the Wankarani cultural complex, suggesting camelid herding was complemented by quinoa and potato cultivation (e.g., Bermann and Estévez Castillo 1995; Catacora et al. 2002; McAndrews 2005a; Michel and Lémuz 2002; Pérez Arias 2005; Ponce Sanginés 1970). Given the extremely long time depth of Wankarani occupations and the homogeneity of their archaeological record, researchers have also assumed an agricultural component to Wankarani subsistence (Fox 2007, 2010). Evidence often cited for camelid pastoralism includes ubiquitous (although usually not quantified) presence of camelid (or more generally large mammal) bones (e.g., Bermann and Estévez Castillo 1995; Ponce Sanginés 1970). However, all published works that report some form of preliminary faunal analysis mention wild taxa such as fish, birds, rodents, and occasional deer antlers (Beaule 2002; Bermann and Estévez Castillo 1995; Fox 2007; Ponce Sanginés 1970; Rose 2001a, 2001b; Walter 1966, 1994). Interestingly enough, perhaps the strongest connection between the Wankarani and camelid pastoralism is iconography. Wankarani sites were initially discovered because they included large iconic camelid stone tenon heads that are assumed to be connected with camelid fertility rites (Guerra Gutiérrez 1994; López Rivas 1959; Means 1918; Métraux and Lehmann 1937, 1953; Ponce Sanginés 1970; Wasson 1967).

Researchers have relied on the conspicuous but largely un-quantified presence of lithic adzes, large bifaces, and hoes as indicators for quinoa and potato farming (e.g., Aoyama 1995; Bermann and Estévez Castillo 1995; McAndrews 2005a; Ponce Sanginés 1970). In addition, qualitative evidence such as the association of sites with productive soils, and the occasional presence of food processing features such as threshing bins and grinding stones, have been used to support agricultural activities in Wankarani sites (McAndrews 2005a). However, in the absence of paleoethnobotanical identification analyses, the evidence for plant cultivation is tenuous.

Given the complete absence of zooarchaeological and paleoethnobotanical studies, most of the archaeological information regarding Wankarani economic activities is not comparable with research from other regions (e.g., Moore et al. 1999, 2010). Limited analysis of faunal remains and excavation protocols not designed to recover fauna as well as taxonomic identifications that may need revision combine to impede systematic assessment of the characteristics of Wankarani's animal consumption. Preliminary evidence suggests that in addition to animal husbandry, hunting and fishing might have been important additional economic activities, but, it remains uncertain how they were integrated to other aspects of the Wankarani economic organization.

3.1.3. The Tiwanaku State and the Central Altiplano

Immediately following the lengthy Formative Period of the central altiplano, a major change occurred in the political configuration of the societies of the South Central Andes. More specifically, the emergence, consolidation, and expansion of the Tiwanaku state (centered in the southeastern shores of Lake Titicaca) brought unprecedented macro-regional political integration, economic growth to the region, and a new set of constraints and opportunities for subsistence scale societies (Albarracin-Jordan 1999, 2007; Burger et al. 2000; Janusek 2004, 2008; Kolata 1993, 2003). Understanding this process is interesting because the increased involvement of local herding societies into broader political economies probably implied changes in the regional economic organization and a new stage of camelid pastoralism. More specifically, it was probably during this time that pastoralist production began to be articulated into larger inter-regional exchange networks and macro-regional economic systems (Browman 1998; Núñez and Dillehay 1995).

The integration of the central altiplano (or Oruro as it known in this literature) to the Tiwanaku state has received little attention (but see Beaule 2002; Bermann and Estévez Castillo 1993; Browman 1997; Lecoq 1999; Michel López 2008). Ponce Sanginés (1970,

1972) initial interpretation of Wankarani was that along with the Chiripa culture, Wankarani constituted the foundations for the emergence of the Tiwanaku state (see above). Research during the last two decades on the Titicaca Basin, however, has demonstrated that Tiwanaku emerged from a mostly local tradition of development that was contemporary but largely independent of Wankarani (Albarracin-Jordan 2003; Bandy 2001; Bermann 1994; Hastorf 2008; Hastorf et al. 2001; Kolata 2003; Roddick 2009; Stanish 2003).

More recent readings of the Tiwanaku expansion on the central altiplano are varied. On one hand, given the paucity of research and significant sites with ceremonial function and elaborate monumental corporate architecture, Stanish (2003), among other scholars, sees the region as marginal and intermediate between the hinterland and the peripheral colonies located in more productive zones such as the eastern dry valleys. The most notable example is Cochabamba, where Tiwanaku-influenced settlements and cemeteries have been excavated (see Bennett 1936; Céspedes Paz 2000; Rydén 1959). From this viewpoint, the central altiplano is seen as a mostly depopulated and marginal region where pastoralists with subsistence scale economies probably persisted.

On the other hand, scholars who have worked in sites in Oruro have noted clear changes in the local economic organization associated with the expansion of the Tiwanaku state (Michel López 2008; Michel and Lémuz 2002). For instance, Bermann and Estévez Castillo's (1993) description of Jachakala, a large Tiwanaku site in the La Joya area, suggests substantial site level changes in comparison to Wankarani sites. Some of these changes include an increase in site size related to more extensive use of the occupied space by means of open areas, possible plazas, clusters of structures that could be interpreted as neighborhoods, and some form of corporate architecture represented by large circular features (see also Beaule 2002). Moreover changes in funerary practices, manufacture and distribution of ceramics, and diversification of lithic technology suggest significant differences with the previous period. The fact that high densities of black basalt lithic debitage from Querimita, a source located south of La Joya, are represented at Tiwanaku shows that at least one key resource was transported and exchanged from the central altiplano to Tiwanaku (Giesso 2003).

Browman (1997) has incorporated this information into a broader model for understanding the economic expansion of Tiwanaku. He sees sites such as Jachakala as nodes of traffic within a framework of increased caravan, economic exchange, and social interaction. Lecoq (1999) and Michel López (2008) have provided further empirical support for the presence of large node sites in the southern portion of the central altiplano. Recent excavations of settlements and burials in Cochabamba confirm the strong presence of Tiwanaku, but also suggest a local independent cultural tradition that incorporated the Tiwanaku ideology and was part of its growing exchange networks (Anderson 2009; Higueras 1996). Evidence for caravan networks has been discovered in remote regions of the southern altiplano in connection with pilgrimage and caravan roads to San Pedro de Atacama, the Río Loa region, and the Argentinean northwest (Núñez and Dillehay 1995; Stovel 2005). As a consequence, the central altiplano could have benefitted from its position as an intermediate region between the Lake Titicaca Basin, the southern altiplano, and the eastern dry valleys. In this context and as the socio-political condition of the region changed, the magnitude of production and distribution of camelids and their by-products increased.

3.2. Research Questions

Based on the previous discussion, I argue that the evidence for reconstructing the economic organization of the Formative Period Wankarani cultural complex remains largely conjectural. Consequently, my main research goal is to determine the structure and variability of early camelid pastoralism in the central altiplano and to examine its change through time. To accomplish this goal, I will address two sets of specific research questions regarding temporal, spatial, and formal aspects of economic organization that should be identifiable in patterns of archaeological data from the Formative Period Wankarani cultural complex of the central altiplano.

1. Was the Formative Period Wankarani cultural complex an example of an early pastoralist society? If so, do the distribution, layout, and faunal remains of Formative Period sites characterize the nature of the pastoralist subsistence economy? What roles did other economic activities such as fishing, hunting, and cultivation have?

2. How did early camelid pastoralism change through time? Did the political expansion of the Tiwanaku state produce significant structural changes in the economic organization of central altiplano pastoralists? Did caravan transport and exchange develop or amplify during this time?

3.3. Hypotheses

In order to systematize and integrate the main research questions of this dissertation, I propose the following set of null and alternate hypotheses.

3.3.1. Wankarani Economic Organization

H_0: Specialized Pastoralism. The economic organization of the Formative Period Wankarani cultural complex was characterized by a strong reliance on herds of domesticated camelids, their derived products and services, and possibly by exchange of staple goods.

H_a: Generalized Pastoralism. Camelid pastoralism was complemented by cultivation of domesticated plants such as quinoa and potatoes in addition to varying procurement strategies such as exchange of staple goods, hunting, and fishing.

3.3.2. Incorporation to the Tiwanaku State

H_0: Continuity. The direct incorporation of the central altiplano to the Tiwanaku state did not produce structural changes in the local economic organization.

H_a: Structural Change. Local economic organization changed substantially, involving increased social differentiation, wealth accumulation, intensified production strategies, and increased inter-regional trade.

3.4. Archaeological Expectations

In the absence of a historical written record, there are a variety of different archaeological approaches that can be used to reconstructing economic organization (Clark 1953; Cribb 1991; deFrance 2009; Reitz and Wing 2008; Parsons 1972; Zeder 1991). The archaeological study of economic organization involves using different scales of analysis that range from regional to site level but can also imply focusing on specific artifact and ecofact classes. The inferential approach that I will implement is based on analytical assessments of archaeological patterns at a regional level, settlement level, and finally focusing on faunal remains. In order to reconstruct the economy of the ancient inhabitants of the central altiplano, I will apply quantitative and qualitative analysis of ecologic, taphonomic, and behavioral aspects of the archaeological record. Interpretation of the past is inevitably built upon analogies from the present (Politis 2007) and therefore I employ relational analogies (*sensu* Wylie 2002) to construct hypotheses that can be tested through specific spatial, temporal, and behavioral patterns to strengthen my interpretations. As a consequence, this study relies to a considerable extent on new archaeological research and previous ethnoarchaeological research on present day traditional Andean herders.

3.4.1. Ethnoarchaeology of Andean Pastoralism

Recognizing the influence of geographical, ecological, and socio-cultural factors for conditioning the variability associated with herding materiality scholars have described some regularities and generalities to characterize the archaeological correlates of pastoralist economic organization (Abdi 2003; Chang and Koster 1986; Cribb 1991; Frachetti 2008; Gifford-Gonzales 2005; Houle 2010; Wendrich and Barnard 2008). In the case of Andes, indigenous descendants of the ancient pre-Hispanic societies are a great source of modern analogies regarding different attributes associated with the variability of subsistence related activities. Ethnographers and ethnoarchaeologists have previously characterized the settlement system of a number of herding communities in the Andes (Browman 1974, 1987; Caracotche 2001; Delfino 2001; Flores Ochoa 1979; Flannery et al. 1989; Haber 1997; Kuznar 1995, 2001; Nielsen 1997, 2000, 2001; Tomka 1992, 1993, 1994, 2001; Tripcevich 2008; Yacobaccio and Madero 2001). These communities however, have not persisted unchanged but have been strongly affected by economic and social marginalization. Consequently, it is important to rely on specific relational analogies and sound probabilistic approaches to support specific aspects of the reconstructed behavior.

Several archaeological studies, such as those of Lawrence Kuznar (1995, 2001) and Steve Tomka (1993, 1994), have relied on intra-settlement and inter-settlement data to describe the social and economic organization of Andean pastoralism. In terms of regional configuration, many recent and historic pastoralist landscapes consist of dispersed residential bases (occupied by single households and composed of corrals, residential, and storage buildings, see below) associated with temporary seasonal or episodic herding camps, and miscellaneous landscape features including roads, trails, and religious sites (Kuznar 1995; Nielsen 2000). Small villages and hamlets that fulfill administrative roles are also often present. These might be however, a consequence of the relatively recent integration of herding communities into broader political economies (Tomka 1994). At the settlement level, features typically present in contemporary and historic pastoralist residential bases in the Andean highlands include dormitory and storage structures, indoor and outdoor working and cooking areas (e.g., hearths), windbreaks, trash disposal middens and pits, dung piles, corrals, and animal pens (Kuznar 1995:55-56; Tomka 1994, 2001; Yacobaccio and Madero 2001). Herding camps typically include features such as small sheltered areas, corrals, caches of artifacts, and corral-like facilities (Kuznar 1995:56; Tomka 1993).

3.4.2. Reconstructing Ancient Herding

Zooarchaeological and paleoethnobotanical analyses are the primary means for reconstructing the economic behavior and the ecological context of ancient pastoral landscapes. In terms of primary research, I focus here on zooarchaeological analysis. Animal bones are abundant in most archaeological sites and incorporate substantial amounts of information. Zooarchaeology as the study of animal bones from archaeological sites, provides primary quantitative data on the properties and characteristics of the animal food remains left by ancient people (Klein and Cruz-Uribe 1984; Lyman 2005; Reitz and Wing 2008). In combination with detailed regional and site level information, zooarchaeological research can provide detailed information regarding discard, consumption, preparation, distribution, and procurement strategies based on animal remains (Reitz and Wing 2008). Faunal analysis is aided by taphonomical methods that allow us to understand what biases might have affected the composition of the animal remains as a consequence of post-depositional formation process and disturbance (Lyman 1994, 2005). Careful consideration of sampling, context, and formation processes, and quantification are central for accruing representative ideas of the material correlates of cultural behavior and these are discussed in Chapter 4 (Gifford-Gonzales 1991; Grayson 1984; Klein and Cruz-Uribe 1984; Lyman 1994; Marciniak 2005).

Zooarchaeological data can provide insights into animal management strategies practiced by ancient pastoralists by allowing analysts to: 1) estimate the degree of reliance on specific resources, 2) determine slaughtering strategies based on mortality profiles and sex ratios, and 3) reconstruct food preparation and distribution practices based on modification and fragmentation patterns (Hesse 1982; Izeta 2007; Zeder 1991). For instance, a predominance of young sub-adults could suggest a meat emphasizing strategy while a preponderance of older animals could be related to delayed harvesting for wool production and/or transport. The contrasting mortality patterns derived from pastoralism based on primary meat production versus wool production and/or transportation is a strong archaeologically visible correlate for understanding early camelid herding, especially given that Andean societies never practiced milking camelids. Species diversity and age of death can also provide information about the seasonality of the site, particularly if some migratory species and/or age classes are more common than others (Klein and Cruz-Uribe 1984). In addition, mortality profiles and analysis of paleopathologies can offer information about the overall health status of the population. High proportions of young individuals has been suggested to be a direct consequence of animal domestication because unsanitary conditions associated with corrals and continuously grazed areas often include bacterial pathogens that can cause high mortality of younger more vulnerable individuals (see Wheeler 1984, 1999). Climate stress and less frequent predation are also common factors associated with mortality of younger animals (Browman 1989; Flannery et al. 1989). In any case, increased percentages of younger individuals could potentially suggest the presence of herding as well as the occupation of sites during the wet season when most births occur. As stated above, if ancient people were pastoralists I assume that consumed and discarded remains of animal herds will dominate the assemblages recovered from excavated settlements.

3.4.3. Correlates for Reconstructing Economic Organization

This investigation follows previous research that integrates multiple scales and lines of contextual information with faunal analyses to shed light on the different components that constituted economic organization of ancient pastoralists. The first set of hypotheses is meant to verify empirically whether the Formative Period Wankarani cultural complex was in fact, an example of an early pastoralist society. The central assumption for this set of hypotheses is that the nature of an economic system is determined by the amount of energy allocated to the production, distribution, and consumption of a given resource.

A reasonable approach for assessing the economic organization and further advancing the understanding of the evolution of the Wankarani cultural complex is to compare the subsistence of Formative Period settlements with those of earlier human hunter-gatherers. Differences between these two groups are expected in all scales of analysis. Given the paucity of research regarding the Archaic Period in the central altiplano, a first step in this direction is to begin characterizing the economic organization of human groups during this time period (Aldenderfer 2009).

The initial null hypothesis follows most Andean scholars in suggesting that Wankarani was in fact a pastoralist society and consequently that it had an economic organization (as well as related ideology and rituality) centered on their herding animals. A specialized pastoralist economy would imply subsistence related activities almost exclusively centered on managing (i.e., producing and distributing) and consuming domesticated camelids. If camelid pastoralism was indeed the central economic activity for the first sedentary settlers of the central altiplano then evidence for other economic activities should be limited. Increased reliance on camelids should imply a greater dependency and consequently the establishment of a symbiotic ecological relationship between humans and their animals.

At the regional level the archaeological correlates for an economic dependence on domesticated camelids include the presence of settlements in areas associated with adequate grazing pastures where camelid herding is feasible and efficient. A spatial consistency in the location of herding sites is also expected and a high degree of residential mobility. More importantly, the settlement system should be comparable with other known pastoralist systems including a combination of regularly spaced residential bases and spread out herding camps in different seasonally available pastures (Kuznar 1990; Tomka 1994).

At the site level, the spatial layout of habitation sites should favor animal handling activities, including corrals for protecting and keeping animals, closed patio areas for slaughtering, butchering, and consuming the animals, and de facto and primary refuse associated with these activities (Kuznar 1990, 1995, 2001; Nielsen 1997, 2000, 2001; Tomka 1994, 2001). Specific stratigraphic and sedimentary structures diagnostic of dung deposition should be associated with the floors and hearths of these structures, including high frequencies of faunal spherulites, phytoliths, and phosphates (Brochier et al. 1992; Canti 1999; Coil et al. 2003; Korstanje 2005; Kuznar 1995; Shahack-Gross et al. 2003, 2004). Pastoralist sites should also contain relatively low frequencies of locally cultivated plants foods.

Economic reliance on camelid pastoralism would also be supported by evidence for a narrow diet breadth with a predominance of camelid remains in the faunal assemblages in Formative Period archaeological sites. The presence of morphologically distinct domesticated animals is also expected, and an absence of wild hunted camelids. Ubiquity of all skeletal elements of camelids as well as standardized processing and consumption patterns should also be present to support a herding emphasis. Camelid age profiles should suggest consistent and recurrent slaughtering practices. For instance, primary production or meat oriented pastoralism should leave a strong imprint in the camelid remains in the form of an under-representation of high utility elements, and an intensively fragmented bone assemblage. Camelid age profiles mostly composed of immature individuals would also be related to a primary production pastoralist strategy. Camelid mortality age profiles with high frequencies of older animals should suggest production of wool and transport animals, assuming that maintaining an animal alive as long as possible was the appropriate strategy to benefit from secondary goods and services (Sherratt 1983; Zeder 2001, 2006; Zeder and Hesse 2000). Important secondary products include wool, textiles, meat, hides, and camelid bone implements in addition to evidence of dung used for fuel.

By contrast, spatial expectations of generalized pastoralism are that sites were mainly located so as to maximize the use of all available resources and not only pastures. Wild resources could have been procured as complementary dietary resources based on their availability and return costs (Lupo 2007). Sites containing specific wild resources should be interpreted in the context of their proximity to particular resource patches. For instance, sites located close to lakes and rivers should contain greater proportions of fish and aquatic birds whereas sites located farther inland might be associated with higher proportions of wild camelids and deer. Faunal assemblages that included relatively high taxonomic diversity with high proportion of camelids but conspicuous presence of wild taxa, including wild camelids, deer, birds, fish, and other fauna, would support a generalized form of pastoralism.

Previous research also suggested a possible agropastoralist (meaning, camelid herding and quinoa cultivation) Wankarani cultural complex (Bermann and Estévez Castillo 1995; McAndrews 2005a; Ponce Sanginés 1970). Settlement patterns associated with good agricultural soils and containing abundant agricultural lithic tools might support reliance on cultivation. More importantly, high ubiquity and density of domesticated cultigens such as quinoa and tubers, should be expected in paleoethnobotanical assemblages if agriculture was a significant economic activity carried out in Wankarani settlements.

3.4.4. Correlates for Evaluating Changes in Economic Organization

The second set of hypotheses is tied to the idea that pastoralism can potentially change as a consequence of the integration of subsistence scale societies into larger political economies. In the case of the central altiplano, the expansion of the Tiwanaku state, ca. AD 400, might have disrupted a tradition of over a thousand years of institutionalized cultural and economic continuity. Consequently, changes in the economic organization will be assessed based on the results of evaluation of the first set of hypotheses. The null hypothesis predicts that the economic organization during the Tiwanaku Period would have remained more or less the same as in the previous Formative Period. Considering the temporal duration and resilience of the Wankarani cultural complex, this is not an unrealistic possibility. Evaluating the magnitude and intensity of the changes at the local level will be critical. If the influence of the Tiwanaku state was weak, partial or indirect, then no major economic changes are predicted.

The alternative hypothesis will be supported by a strong integration of the local region to the Tiwanaku state. If the growth of Tiwanaku involved different intensity of changes including direct control, population displacements, and others, then concomitant effects should be observable in the archaeological record at the regional and settlement levels (Bermann 1994, 1997). If changes in the economic organization occurred, then resource production and distribution strategies would have been impacted in a number of ways. For instance, if agriculture and increased herding intensification practices became more important, then other complementary foraging practices could have become less common. However, a more likely possibility is that pastoralism was intensified with a concomitant increase in production of herding animals and secondary products.

Exchange would have been an area of potential opportunities for herd producers as the demand for camelid based secondary products and services such as meat, wool, textiles, and transport, increased to a macro-regional scale. Economic growth would also have also fostered increased access and exchange of staples and probably a decreased reliance on wild resources. Technological improvements and increased cultivation intensification are also possible as a consequence of changing political and economic dynamics. Moreover, increased caravan exchange has been predicted as a consequence of the growth of the

Tiwanaku state. Sites involved in caravan transport should include a number of facilities associated with the manufacture and storage of secondary products as well as the by-products of making them. Settlements involved in staple exchange should include storage facilities such as bins and multiple rooms (as well as large storage vessels) for storing imported goods as well as those that will be exported (Nielsen 1997, 2000, 2001; Tripcevich 2008). The content of some of these storage rooms should include a number of clearly imported goods and staples such as maize and chili peppers.

Using herding animals as means of transport to lower altitudes will also imply a greater degree of interregional interaction probably connected with camelid specialization in caravan exchange. Exotic goods including imported ceramics, prestige trade goods (e.g., shells, beads, metals), exotic fauna and flora, and foreign lithic materials (e.g., obsidian, basalt, sodalite), are consequently expected. On the other hand, the frequencies of imported goods including food staples will allow determining the importance of staple and prestige good exchange, social hierarchy, caravan transport, and seasonal mobility.

CHAPTER 4

STUDY AREA

The study area is located within the central altiplano and the known area of distribution of the Formative Period Wankarani cultural complex. In this chapter, I will describe the environment of the central altiplano and specifically, the study area of Iroco.

4.1. Environment of the Central Altiplano

Located between 14° and 22° south latitude, 66° and 71° west longitude, and 3600 and 4200 meters above sea level, the Andean altiplano covers approximately 200,000 km^2 (Rigsby et al. 2005). This elevated plain is interspersed by rocky hills mostly covered by grasslands and shrublands (Figure 4.1) (Beck et al. 2010; Cuenca Sempertegui et al. 2005; Ibisch et al. 2004; Navarro and Maldonado 2002; Zeballos et al. 2003). The altiplano was formed by quaternary alluvial and colluvial sediments deposited within an endorheic basin formed by the division of the Andes in to the Eastern and Western cordilleras. Across the Western Cordillera is the desert coast of southern Peru and northern Chile whereas past the Eastern Cordillera are a series of inter-Andean valleys that progressively transition into the humid tropical lowlands. Biogeographically, the central altiplano is described as dry puna, in contrast to the northern altiplano also known as wet or normal puna (mostly distributed around the Lake Titicaca and expanding towards the northwest), the southern altiplano also known as salt puna (located towards the south and bordering the Atacama Desert), and the dry inter-Andean valleys (located to the east and including Cochabamba and Chuquisaca) (Ibisch et al. 2004; Navarro and Maldonado 2002; Santoro and Núñez 1987).

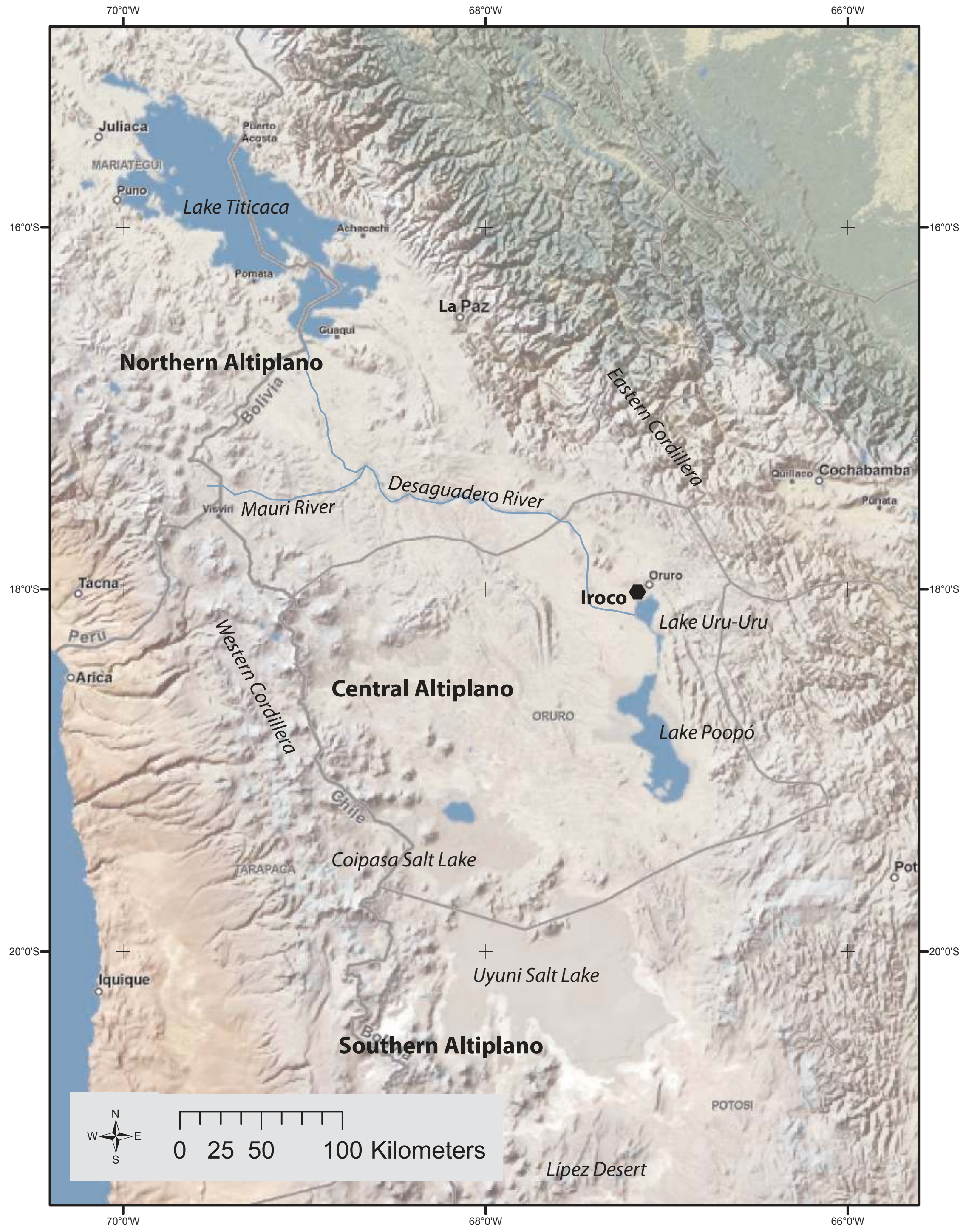


Figure 4.1. The altiplano highlands in the South Central Andes divided into north, central and southern portions and the Iroco study area.

The central altiplano (sometimes referred to as Oruro) is mostly composed of extensive grasslands interspersed by landscape features including ridges, hills, lakes, and rivers of different sizes and elevations. Two prominent lacustrine landscape features are Lake Uru-Uru and Lake Poopó. These lakes are mostly saline and due to their shallowness (average depth of 5 m) are very sensitive to climatic fluctuations. Fluvial variation is strongly connected to Lake Titicaca runoff and the Desaguadero River valley. Desaguadero runoff is also derived from additional tributaries including the Mauri River, which originates on the Western Cordillera, and can contribute more water than Lake Titicaca. In addition, these lakes collect water from multiple small permanent and seasonal streams. Precipitation increase can create seasonal to permanent lakes which not only buffer extreme temperatures but also increase the productivity of the landscape. The shores of lakes Uru-Uru and Poopó are extremely sensitive to runoff variability and have been known to fluctuate several dozen kilometers between years (Zamora et al. 2007).

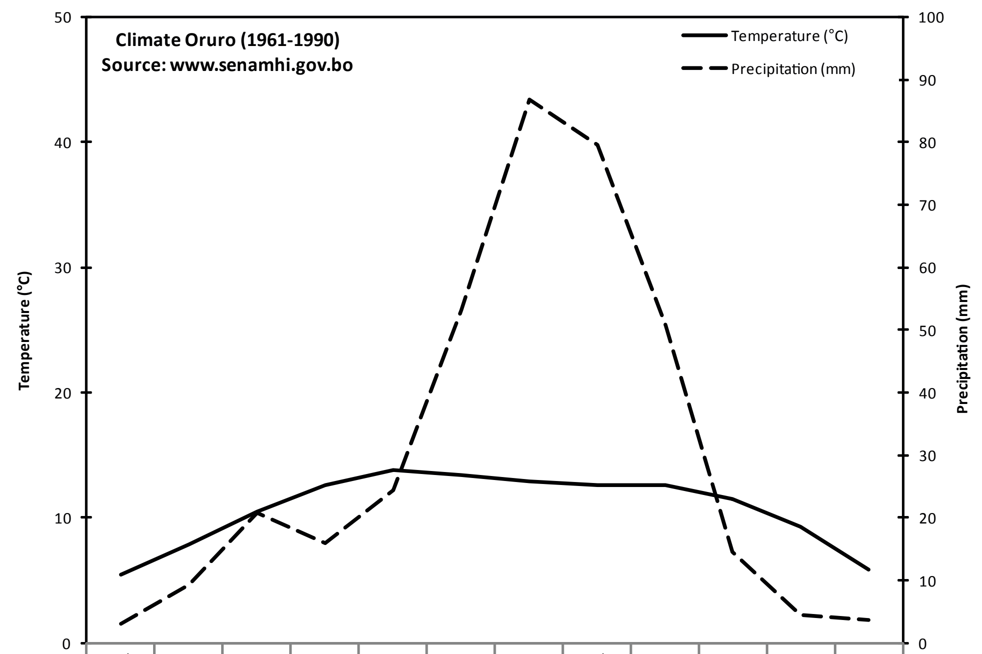
Multiple *quebradas* or temporary streams are produced by seasonal precipitation and formed in hillsides with abrupt topographical changes in an otherwise extremely flat region, provide additional water particularly during the wet season. When active, *quebradas* can transport large amounts of sediment in very little time and along with their surrounding hillsides, have the best conditions for cultivation with more colluvial soils and less wind than other locales. Other highly localized habitats include *bofedales*, which are marshes irrigated by small but perennial streams permanently covered by green vegetation. Finally, the entire altiplano is constituted by extended plains where grasses and shrubs dominate.

The climate of the central altiplano is semi-arid and markedly divided between a dry (May to October) and a wet season (November to April) (Figure 4.2). Because the altiplano is located within the tropical belt, temperature does not substantially vary between these two seasons with day-to-night differences substantially higher than seasonal variation.

The average annual precipitation recorded in the city of Oruro between 1961 and 1990 was about 367 mm and the average mean annual temperature was 10.7° C. Year-to-year rainfall can be extremely variable and precipitation predictability is only about 50%. Local water availability is connected with mountain glacial melting and fossil water percolation because springs runoff is the most important source of permanent water.

4.2. Paleoenvironment

The Late Pleistocene and Holocene paleoenvironment of the study region is mostly connected to regional and global climatic variations (Baker et al. 2001, 2005; Rigsby et al. 2005; Thompson et al. 1998). Cycles of higher humidity and temperature interchanged with cycles of dryer and cooler weather characterized most of the paleoenvironmental variation (Rigsby et al. 2003; Sylvestre et al. 1999). Throughout the Late Pleistocene, the altiplano



Month	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun
▬ Temperature (°C)	5.5	7.9	10.5	12.6	13.8	13.4	12.9	12.6	12.6	11.5	9.3	5.9
‒ ‒ Precipitation (mm)	3	9.3	20.8	15.9	24.5	53.2	86.8	79.5	50.7	14.6	4.5	3.6

Figure 4.2. Mean monthly temperature and precipitation of the city of Oruro for the period between 1961 and 1990. Source data from Servicio Nacional de Meteorología of Bolivia.

plains were periodically covered by the expansion and contraction of a series of large-scale paleo-lakes that eventually dried in successive stages (Cross et al. 2001). The last of these paleo-lake cycles are known as Lake Tauca (18,100-14,100 cal. BP) and Lake Coipasa (13,000-11,000 cal. BP) (Argollo and Mourguiart 2000; Placzek et al. 2006). Although large scale variation has stabilized since at least 4500 years ago, the fluctuation continues today enhanced by global climate change, and human landscape management (Abbott et al. 1997; Baied and Wheeler 1993).

Variation in climate during the time period of interest suggests millennial to centennial fluctuations that probably conditioned settlement location and resource availability (Craig et al. 2010; Kidder 2006). Rigsby et al. (2005; Baucom and Rigsby 2002) have produced the most important sequence of paleoenvironmental change for the central altiplano. They provide a multiproxy (paleosedimentology, diatomae, radiocarbon dates) assessment of sediment cores collected at various locations along the extent of the Desaguadero River valley. As a result Rigsby et al. (2005) produced evidence for a unique sequence of dry (riverine) and wet (lacustrine) conditions between the Late Pleistocene and historical times (see Table 6.1). Although dry conditions mostly represent episodes of riverine deposition, unconformities represented in several cores, suggest that erosion processes were also frequent throughout time in the central altiplano.

Rigsby et al. (2005:671) conclude that “during the late Quaternary the Desaguadero River valley was the site of several generations of palaeolakes and wetlands that formed during periods of increased precipitation and local runoff, augmented by increased overflow from Lake Titicaca. […] Four of these wet periods resulted in the formation of major palaeolakes in the Rio Desaguadero valley: during the last glacial maximum from before 20,000 to 16,000 cal. yr BP, during the late glacial from about 14,000 to 12,000 cal. yr BP, in the early Holocene from about 10,000 to 7900 cal. yr BP, and in the late Holocene from 4500 cal. yr BP to present. The period that appears to have been most arid was between 7900 and 4500 cal. yr BP. The Altiplano wet periods were generally synchronous with North

Atlantic cold events (respectively, the last glacial maximum, the Younger Dryas, the 8200 cal. yr BP event, and the Neoglacial) implying a relationship between past precipitation variability in tropical South America and North Atlantic sea-surface temperature."

Lake levels, aridity and water inflow to the Desaguadero River seem to be controlled by solar insolation (Baker et al. 2005; Rigsby et al. 2005). In addition, occasional El Niño Southern Oscillation (ENSO) events with their reversal, La Niña Southern Oscillation (LNSO) might have had important consequences for the climate at a decadal scale (Zamora et al. 2007). However, the intensity of the inter-tropical convergence zone is probably the most significant source of yearly precipitation variation in the alitplano because it conditions the amount of humidity that can past across the Eastern Cordillera from the Amazonian lowlands.

The seasonal, yearly and decadal fluctuations in temperature and precipitation along with their effects on lacustrine and riverine shoreline displacement, have important impacts on settlement location, herding composition, agriculture intensity, and cycles of population movement to other regions for exchanging and selling labor. Modern herders manage their landscape by distributing and allocating different resources, labor, and time as a resilient conservative risk management strategy that diversifies their potential economic losses and gains. Maximizing cultivation production can occur in times of high precipitation, but in years of drought, minimizing agricultural losses is often attempted by dispersing herds in different grazing territories.

4.3. Iroco

The study area, locally known as Iroco, is bounded by western hills of the city of Oruro and the northern shores of Lake Uru-Uru (Figure 4.3). Iroco is located approximately at 17°57' south latitude, 67°9' west longitude, and between 3690 and 4050 meters above the sea level. The lower elevation limit corresponds to the shoreline of Karakollu River

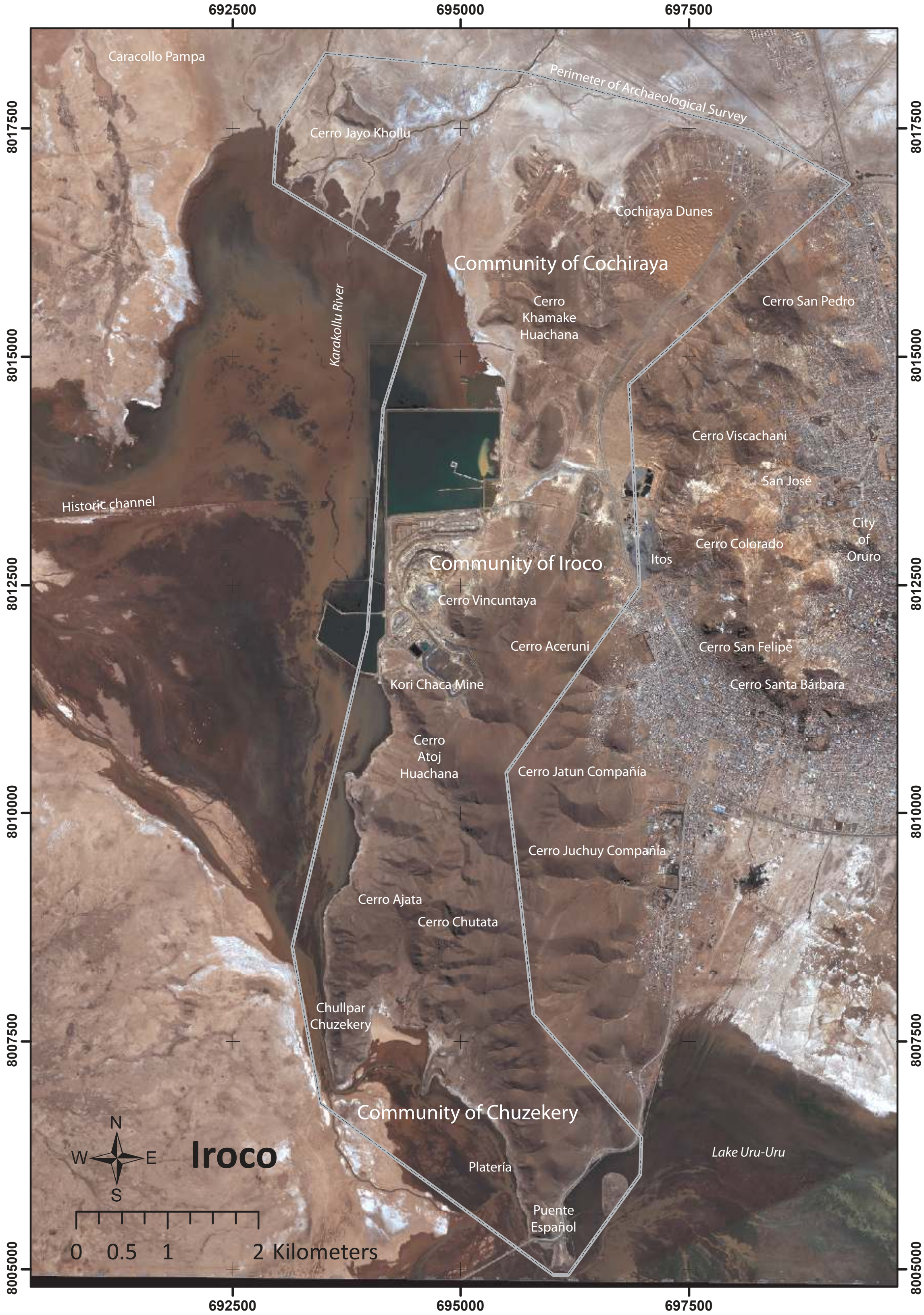


Figure 4.3. The study area including location of the communities Cochiraya, Iroco and Chuzekery, the Kori Chaca mine and the city of Oruro. Base image Google Earth.

while the upper level corresponds to the hills that flank the study area. The Iroco region is currently inhabited by ethnically Aymara and Quechua-speaking pastoralist people who still herd camelids and are organized into three territorially discrete indigenous communities: Cochiraya, Iroco, and Chuzekery.

The area surveyed during this study covers approximately 38.35 km^2, encompassing all three communities, and is located between the western hills of San Jose, San Felipe and Jatun Compañía to the shores of Karakollu River that runs from north to south and flows into the northern shores of Lake Uru-Uru in Puente Español (Figure 4.3). The hills are mostly composed of sedimentary rocky outcrops completely surrounded by Quaternary sediments. An important nonconformity divides the San Pedro larger hills of igneous dacites and evaporites dated to the Neogene from the central San Felipe and Jatun Compañía hills mostly composed of folded vertical and diagonal Silurian deposits of sandstones and latites. All of these outcrops are further covered by massive bedding of sedimentary alluvial deposits and cross-cut by several seasonal and permanent streams, such as Karakollu River.

The main waterway of the basin is the Desaguadero River that divides in two arms at Chuquiña, located in the La Joya area. One arm flows southeast to form Lake Uru-Uru and the other goes straight south to form Lake Poopó. The area between these two arms is similar to a marshy delta. In the 1970s, a portion of the Uru-Uru arm was diverted into a channel bringing water towards the east, forming a third arm and expanding the marshy Desaguadero River delta towards the north. The canal formed a straight west-to-east line and flowed into the Karakollu River very close to the community of Iroco. Periodical yearly cycles overflowed the canal making the intersection similar to a lake. On the other hand, during dry years, not enough water fills the canal, making the region a muddy marsh. In the short term, the direct impact of this canal was activating two meandering seasonal channels that eventually received most of the flow and currently resemble permanent rivers.

More recently, beginning in 2004 the Kori Chaca mine began massive construction projects that involved the virtual destruction of Cerro Vincuntaya but also inundated part of the plain around Karakollu River in the center of the study area. The most direct consequence of the construction project was the flooding of a large portion of the playa associated with the river to produce a decanting pool for the mining operations. A portion of the playa was left as a wetland lacustrine environment that serves as an aquatic bird reserve.

People from the three indigenous communities at Iroco practice llama, sheep, and cattle herding in addition to limited agriculture based on quinoa, potatoes, and more recently barley. Some families also have one or two donkeys. As additional source of income, people from these communities often migrate to urban centers for short or longer periods (Albarracin-Jordan 2005; Cuenca Sempertegui et al. 2005; Illampu 2004). The region also contains a several important known archaeological sites, including Chuzekery, a cemetery complex of *chullpa* or burial towers constructed between the Late Intermediate Period and Inca times (Garnica Bahoz 2006; Pärssinen 2005).

The study area is located within the known distribution of the Formative Period Wankarani cultural complex. Because it is part of the recognized area of distribution of Wankarani sites, I considered it likely that we would find new Wankarani sites in this area. Iroco is also adjacent to the southeast of La Joya and Belén, two of the regions that have been previously investigated by Marc Bermann and his research team (Bermann and Estévez Castillo 1993; McAndrews 1998, 2005a). By implementing a new systematic survey and excavations, my goal was to produce comparable data to previous research without replicating efforts and consequently to augment the archaeology of the altiplano.

The study area includes a permanent source of water. Water is an extremely important resource for early societies and previous research suggests the location of Wankarani sites might be closely associated with riverine environments. Iroco is permanently watered by the Karakollu River a tributary that flows into Lake Uru-Uru from its northernmost shores.

The characteristic microenvironments of the central altiplano include: lacustrine and riverine shorelines, alluvial plains, rocky hills, hillsides, *quebradas*, and *bofedales* all of which are present in the study area. By including portions of these microenvironments within the study area, I could potentially identify variability in landscape use.

The study area had been previously investigated archaeologically as part of the environmental impact assessment and mitigation salvage projects executed prior to the implementation of the Kori Chaca gold mine between 2000 and 2005 (Albarracin-Jordan 2005). This research suggested the presence of Formative Period sites. By continuing research in this region, the project benefited from initial results and increased knowledge of an area threatened by development. An additional goal of this research was to call attention to the preservation of archaeological cultural patrimony in the vicinity of the city of Oruro.

4.4. Vegetation and Microenvironments

The natural vegetation of Iroco is mostly composed of thick grasses, cushion plants, shrubs, and some annual herbs (Cuenca Sempertegui et al. 2005). The vegetation is typical of the Andean semiarid highlands (commonly known as puna), located within the ecoregion called the southern puna, one of the most arid and desert areas of Bolivia (Ibisch et al. 2004; Navarro and Maldonado 2002). The predominant vegetation in Iroco includes open tussock grasslands, shrublands or *tholares,* and *cauchiales* in salty soils (Cuenca Sempertegui et al. 2005). A vegetation survey in collaboration with Alejandra Domic was carried out in July 2009 aided by the list of plant species originally compiled for the study area by Cuenca Sempertegui et al. (2005). As a result previous identifications were reviewed and updated according to the current nomenclature, an updated list of plant species was compiled (Table 4.1), and vegetation formations for the study area were defined (Table 4.2).

The vegetation survey included linear transects complemented by direct observations in several locations of the study area. The scientific name of common species was recorded in situ and unknown plant species were photographed and collected for identification at the National Herbarium of Bolivia. Due to logistic limitations, field surveys were carried

Table 4.1. List of plant species identified at Iroco (based on Cuenca Sempertegui et al. 2005 and Alejandra Domic personal communication 2011).

Family	Scientific Name	Local Name	Economic Use	Habitat	Flowering	Cochiraya	Iroco	Chuzekery
Adiantaceae	*Cheilanthes pruinata*	Helecho torarilla	Medicinal	Between rocks, along river shores, rare			x	x
Adiantaceae	*Notholaena nivea*	Helecho blanco	Medicinal	Rocky slopes. 3000-4650			x	x
Adiantaceae	*Pellaea ternifolia*	Chucho	Toxic for herds	Rocky slopes, between rocks, rocky outcrops, and ravines			x	
Apiaceae	*Azorella compacta*	Yareta	Fuel, medicinal, dye	Rocky slopes, locally extinct	Sep-Nov			
Amaranthaceae	*Amaranthus caudatus*	Amaranto	Food	Fields in hillslopes		x		
Amaranthaceae	*Atriplex deserticola*	Liwi liwi	Fodder			x		
Amaranthaceae	*Suaeda foliosa*	K'auchi	Fodder, ornamental	Salty and sandy soils		x		x
Asteraceae	*Baccharis incarum*	Ñaka thola	Firewood, fodder, medicinal	Tholares, tholares-grasslands		x	x	x
Asteraceae	*Bidens andicola*	Muni muni	Medicinal	Grasslands and rocky slopes	Dec-May	x	x	x
Asteraceae	*Gnaphalium badium*	Pampa wira wira		Grasslands and rocky slopes	Jan-Mar			x
Asteraceae	*Gnaphalium dombeyanum*	Pampa wira wira	Medicinal	Slopes, somewhat protected from wind and humidity	Nov-Jun		x	x
Asteraceae	*Hieracium elisaeanum*	Hieracio			Jan-Mar		x	
Asteraceae	*Hymenoxys robusta*	K'ellu k'ellu	Toxic for herds	Humid, clay and salty soils		x		
Asteraceae	*Hysterionica bakeri*	Flor pluma					x	x
Asteraceae	*Mutisia friesiana*	Chinchircoma	Medicinal	Rocky slopes	Feb-Apr		x	
Asteraceae	*Parastrephia lucida*	Tolilla	Ceremonial, firewood, fodder, medicinal, dye	Tholares, slopes protected from wind and rocky outcrops	Sep-Mar	x	x	x
Asteraceae	*Schkuria pinnata*	Scoria	Medicinal			x	x	x
Asteraceae	*Senecio clivicol a*	Huaycha, Sunch'u, Waycha	Dye	Disturbed habitats, alond rivers and roads.	Sep-Dec, Apr-Jun		x	x
Asteraceae	*Sonchus oleraceus*	Leche leche	Medicinal	Fertile soil, warm and humid habitats, close to rivers	Jan-Mar			x
Asteraceae	*Stevia tarijensis*	Santa semana tikita		Slopes with low vegetation cover, rare	Jan-Apr	x	x	x
Asteraceae	*Taraxacum officinale*	Diente de león, qochi, leche leche		Moist soils and protected sites			x	x
Asteraceae	*Viguiera lanceolata*	Sank'a, sunch'u	Construction, fodder, livefences	Arid slopes		x		x
Azollaceae	*Azolla filiculoides*			Aquatic				x
Brassicaceae	*Lepidium chichicara*	Mata conejo	Toxic for herds				x	x
Brassicaceae	*Lepidium meyenii*	Maca	Food	Crop fields		x		
Bromeliaceae	*Tillandsia usneoides*	Clavel del aire	Medicinal			x	x	x
Buddlejaceae	*Buddleja* aff. *Tucumanensis*	Kiswara	Medicinal, live fences	Near crop fields and houses			x	x
Cactaceae	*Echinopsis maximiliana*	Sank'ayo, waraq'o hembra	Food, medicinal	Rocks and slopes with *Stipa ichu* , loose soil	Sep-Nov	x	x	x
Cactaceae	*Gymnocalycium marquezii*	Sank'ayo, waraq'o macho					x	
Cactaceae	*Opuntia boliviana* , Currently *Cumulopuntia boliviana*	Phusqallo waraqo	Food	Arid rocky slopes, grasslands with loose soil, shrublands	Sep-Oct	x	x	x
Cactaceae	*Opuntia soehrensii* , Currently *Tunilla soehrensii*	Airampu	Food, medicinal, dye	Rocky slopes, warm microhabitats, grasslands and shrublands	Dec	x	x	x
Cactaceae	*Trichocereus pasacana*	Pasacana	Food	Rocky slopes			x	x
Caryophyllaceae	*Cardionema ramosissimun* , Currently *Cardionema ramosissima*	Quipu dichia macho	Food, construction	Sandy soils and open flatlands	Jan-Mar		x	x
Caryophyllaceae	*Cardionema* sp.	Quipu dichia hembra					x	x
Caryophyllaceae	*Pycnophyllum macropetalum*	Chiki chiki	Firewood, dye, detergent, medicinal	Salty and sandy soils, floodplain	Nov-Jan	x	x	x
Convolvulaceae	*Dichondra repens*	Oreja de ratón	Medicinal	Tholares			x	x
Cruciferae	*Biscutella riberensis*	Anteojo de cullera			Mar-May			x
Cruciferae	*Diplotaxis virgata*	Mostaza amarilla	Medicinal		Feb-Abr			x
Cyperaceae	*Schoenoplectus californicus* var. *tatora*	Totora	Fodder, food	Aquatic			x	x
Ephedraceae	*Ephedra* cf. *rupestris*	Sanu sanu	Food, medicinal, fodder	Open and rocky slopes	Mar	x	x	x
Fabaceae	*Adesmia spinosissima*	Añahuaya	Fodder, firewood	Rocky slopes, shrublands, and grasslands	Oct-Feb	x		x
Fabaceae	*Hoffmannseggia andina*	K'onchu konchu	Fodder					x
Geraniaceae	*Erodium cicutarium*	Reloj reloj, Aguja, agujilla	Medicinal, fodder	Rich soils, protected sites and crop fields	Dec-Jun		x	x
Malvaceae	*Tarasa tenella*	Kora	Medicinal	Close to houses, corrals and near llama bosteros. Common	Sep-Nov, Feb-Abr		x	x
Oxalidaceae	*Oxalis pachyrrhiza*	Apilla apilla	Food	Rocky slopes with few vegetation	Dec-Feb		x	x
Plantaginaceae	*Plantago sericea* ssp. *sericans*	Suni Q'ayara		Rocky slopes	Mar-Apr	x	x	

Table 4.1. Continued.

Family	Scientific Name	Local Name	Economic Use	Habitat	Flowering	Cochiraya	Iroco	Chuzekery
Poaceae	*Aristida enodis*	Pasto aristida	Fodder, food	Slopes and places with loose soil, sucseptible to erosion		x	x	x
Poaceae	*Bromus catharticus*	Cebadilla	Fodder, food	Rocky slopes and disturbed flatlands with moist soils		x		x
Poaceae	*Chondrosum simplex*	Pasto bandera	Fodder	Tholares		x	x	x
Poaceae	*Dactylis glomerata*	Pasto ovillo	Fodder	Flood plain			x	
Poaceae	*Distichlis humilis*	Orko chiji	Fodder	Salty and sandy soils		x		
Poaceae	*Eragrostis curvula*	Paso lloron	Fodder	Moist soils with pasto lloron			x	x
Poaceae	*Festuca orthophylla*	Paja brava	Construction, fodder	Grasslands, dunas, salty soils, sandy and rocky slopes. Very common	Jan-Feb	x		
Poaceae	*Muhlenbergia fastigiata*	Ch'iji negro	Fodder	Open fields, moist and slightly salty soils	Feb-Mar	x		x
Poaceae	*Nassella meyeniana*	Pasto pluma	Fodder	Fallow fields	Feb-Mar	x	x	x
Poaceae	*Nassella publiflora*	Ch'iji	Fodder	Grasslands				x
Poaceae	*Stipa ichu*	Paja suave. Sikuya, sikuya wichu	Construction, fodder	Dry slopes and flat areas	Jan-Mar		x	x
Rosaceae	*Tetraglochin cristatum*	Kanlla	Firewood, medicinal	Flat areas and eroded slopes	Nov-Jan	x	x	x
Rosaceae	*Polylepis tarapacana*	Keñua	Firewood, medicinal	Rocky slopes, locally extinct	Oct-Nov			
Santalaceae	*Quinchamalium procumbens*	Qencha mali	Medicinal	Rocky slopes	Dec-Apr			x
Saxifragaceae	*Escallonia salicifolia*	Chachacoma					x	
Scrophulariaceae	*Bartsia crenata*	Quimsa q'uchu	Ritual, medicinal	Dry slopes	Jan-Apr		x	
Scrophulariaceae	*Calceolaria parvifolia*	Zapatilla, Zapatillo	Medicinal	Protected and warm slopes	Oct		x	
Solanaceae	*Cestrum auriculatum*	Hediondilla		Moutnain slopes. Rare				x
Solanaceae	*Fabiana densa* Remy	Tara tara	Firewood, medicinal, fodder	Sandy slopes and flat areas	Nov-Jan	x	x	x
Solanaceae	*Salpichroa glandulosa*	Laqoste, chirimia	Food	Rocky and humid places	Nov-Mar		x	x
Solanaceae	*Solanum nitidum*	T'usca t'usca	Medicinal	Foothills		x		
Solanaceae	*Solanum tuberosum* ssp. *andigena*	Papa qoyllu	Food	Wild potato, foothills	Nov-Mar			x

out during the dry season, which limited discovery and identification of seasonal plants, particularly those likely to flower during the rainy season. Vegetation formations were determined based on elevation, soil composition, and dominance of plant species. Five vegetation formations or microenvironments were recognized in the study area (Table 4.2, Figure 4.4).

The vegetation formations are based on variables such as topography and species representation and abundance (Beck et al. 2010; Cuenca Sempertegui et al. 2005; García and Beck 2006; Pestalozzi 1998; Zeballos et al. 2003). Because of their patchiness and intrinsic variability, these formations are not discrete and consequently they were not mapped. However, I include observations regarding their overall distribution within the study area. The actual composition and contents of the vegetation formations are related to different succession stages that are predominantly controlled by two critical factors, climate and grazing intensity. The distribution and extent of the vegetation formations vary considerably from year to year depending on climatologic factors and human controlled grazing. Given that pastoralism is the predominant landscape scale economic activity, it has

Table 4.2. Vegetation formations represented at the study area and their typical associated plant species.

Habitat	Species	Local Name	Habit
Floodplain or Cauchial	*Suaeda foliosa*	Kauchi	Rosette
	Pycnophyllum macropetalum	Chiki chiki	Cushion
	Hymenoxys robusta	K'ellu k'ellu	Herb
	Schoenoplectus californicus var. *tatora*	Totora	Reed
Grassland or Pajonal	*Festuca orthophylla*	Paja brava	Grass
	Stipa ichu	Paja suave	Grass
	Nasella meyeniana	Pasto pluma	Grass
	Eragrostis curvula	Pasto lloron	Grass
	Chondrosum simplex	Pasto bandera	Grass
	Aristida enoides	Pasto aristida	Grass
	Cardionema ramosissima	Quipu dichia macho	Herb
	Bidens andicola	Muni muni	Herb
	Tunilla soehrensii	Airampu	Cushion cactus
	Cumulopuntia boliviana	Phusqallo waraqo	Cushion cactus
	Echinopsis maximiliana	Sank'ayo, waraq'o hembra	Columnar cactus
	Tarasa tenella	K'ora	Herb
Shrubland or Tholar	*Parastrephia lucida*	Tolilla	Shrub
	Baccharis incarum	Ñaka thola	Shrub
	Taraxacum officinale	Diente de león	Herb
	Dichondra repens	Oreja de ratón	Herb
	Festuca orthopylla	Paja brava	Grass
Shrubland-Grassland Transition	*Parastrephia lucida*	Tolilla	Shrub
	Baccharis incarum	Ñaka thola	Shrub
	Festuca orthophylla	Paja brava	Grass
	Stipa ichu	Paja suave	Grass
	Tetraglochin cristatum	Kanlla	Shrub
	Fabiana densa	Tara tara	Shrub
	Adesmia spinossisima	Añahuaya	Shrub
	Aristida enoides	Pasto aristida	Grass
	Nassella meyeniana	Pasto pluma	Grass
	Echinopsis maximiliana	Sank'ayo, waraq'o hembra	Columnar cactus
	Trichocereus pasacana	Pasacana	Columnar cactus
	Plantago serciea subsp. *subsericans*	Suni Q'ayara	Herb
Native Cultigens	*Amaranthus caudatus*	Amaranto	Herb
	Chenopodium pallidicaule	Kañawa	Herb
	Chenopodium quinoa	Quinoa	Herb
	Lepidium meyenii	Maca	Herb
	Lupinus mutabilis	Tarwi	Herb
	Oxalis tuberosa	Oca	Herb
	Solanum tuberosum	Papa, Ch'uqi	Herb
Introduced Cultigens	*Allium cepa*	Cebolla, Siwilla	Herb
	Hordeum vulgare	Cebada, Siwara	Grass
	Medicago sativa	Alfalfa	Herb
	Vicia faba	Haba, Jawasa	Herb

the potential to trigger, delay or accelerate different succession stages. Climate influences the recovery rate and germination of different species. In addition, climate controls the water discharge of Karakollu River and the water level of Lake Uru-Uru that in turns influences the distribution and composition of the vegetation of the shoreline and floodplains.

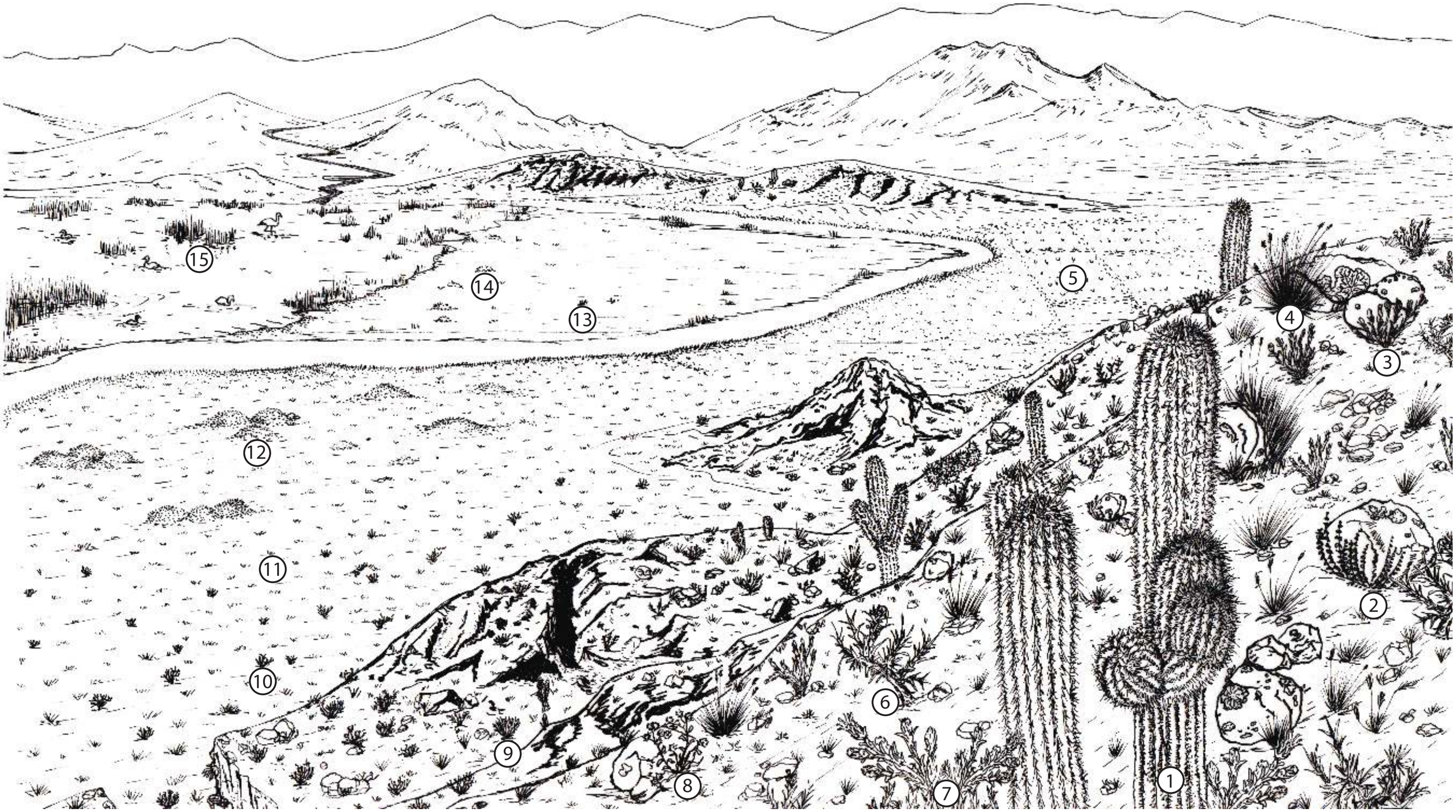


Figure 4.4. Vegetation profile of Iroco. 1) *Trichocereus pasacana*, 2) *Notholaena nivea*, 3) *Fabiana densa*, 4) *Aristida enodis*, 5) *Cultivation fields*, 6) *Tetraglochin cristatum*, 7) *Senecio clivicola*, 8) *Bartsia crenata*, 9) *Baccharis incarum*, 10) *Parastrephia lucida*, 11) *Stipa ichu*, 12) *Pycnophyllum macropetalum*, 13) *Festuca orthophylla*, 14) *Suaeda foliosa*, 15) *Schoenoplectus californicus* var. *tatora*. Drawing by Arely Palabral.

4.4.1. Floodplain or Cauchial

A large portion of Iroco has been partially inundated as part of Lake Uru-Uru's water level fluctuations, producing a barren floodplain with salty soils. Totora reeds (*Schoenoplectus californicus* var. *tatora*) and other smaller aquatic plants are often present where the Lake Uru-Uru and Karakollu River are permanent, especially in the south portion of Iroco (Figure 4.5). People traditionally harvest totora reeds as food, construction material, and occasionally fodder. Lake and river shores also constitute very productive habitats for fish, migratory birds, and aquatic plants such as reeds and algae (Rocha 2002). Changes in shoreline have an important impact in these habitats, as does human settlement and land use. For instance, fluctuation in the surface of lakes and their resources can influence migration patterns of aquatic birds, variation of biomass in lakes, and availability of specific resources. Fluctuation of the aquatic environments implied changes in settlement location as related to availability of pastures, wild resources, and water.

Figure 4.5. View of totora reeds on the shores of the Karakollu River.

Figure 4.6. View of the floodplain at Chuzekery.

The floodplain locally known as *cauchial* is one of the major vegetation formations in Iroco, particularly in the north and west portions, along the extended shores of Karakollu River and Lake Uru-Uru (Figure 4.6). Soils are sandy, salty, weathered, and poor in nutrients, which determines a low diversity of plant species. The vegetation cover has a patchy distribution dominated by *cauchi* (*Suaeda foliosa*), which constitutes one of the few species able to resist salty soils, drastic changes in temperature, especially during night frosts, and dry spells. In the *cauchial*, two other species, *Pycnophyllum macropetalum* and *Hymenoxys robusta*, are also present but they are less abundant. In Iroco, the *cauchial* is usually distributed between 3690 and 3700 m above the sea level. It is likely that halophytic species, *Sarcocornia pulvinata* and *Atriplex nitrophiloides* are also present in this unit (Garcia and Beck 2006).

Furthermore, the aridity of the area currently does not allow the development of *bofedal* habitats, possibly as a consequence of habitat degradation by overgrazing and capturing the spring waters for potable water and irrigation. In this sense the cauchial formation could be a consequence of floodplain desertification and vegetation degradation, similarly to the *colpar* vegetation in other areas of the altiplano (see Yager 2009). The absence of a typical *bofedal* implies the absence of several plant and animal species in Iroco, including the domesticated alpaca.

4.4.2. Grassland or Pajonal

Iroco is characterized by sparse vegetation cover dominated by tussock grasslands (Figure 4.7). Several plant species exhibit morphological adaptations to semiarid climate and low content of nutrient in soils. Adaptive traits include small leaves covered with a resinous cuticle in *tholas* (*Baccharis* and *Parastrephia*), presence of trichomes in fruits of *Adesmia*, and cushion habit in *Pychnophyllum*, *Cumulopuntia,* and *Tunilla*. Tussock grasses

Figure 4.7. View of grassland at Iroco.

of *Festuca orthophylla* and *Stipa ichu* dominate the grasslands or *pajonales*. Grasslands are located in hilltops, arid slopes, and extensive plains. Other small grasses are found but in less abundance including *Nasella meyeniana, Eragrostis curvula, Chondrosum simplex,* and *Aristida enoides*.

Protected by tussocks, many annuals and perennial herbs grow, such as *Cardionema ramosissima*, *Bidens andicola*, and *Aristida enoides.* In open sites, cushion-shaped cactus such as *Tunilla soehrensii*, *Cumulopuntia boliviana,* and *Echinopsis maximiliana* can be found. In places with nitrogen enriched rich soils, particularly those where camelid dung accumulates, annual herbs are present, particularly *Tarasa tenella*. There are likely several more species of smaller herbaceous plants that are predominantly seasonal and sprout during the rainy season. This microenvironment is particularly important for herds of domesticated camelids as it provides palatable and nutritious forage, especially during the wet season.

4.4.3. Shrubland or Tholar

Resinous bushes of *Parastrephia* and *Baccharis* dominate shrublands, locally known as *tholares* (Figure 4.8). They are located on foothills, hills with gentle slopes, and some plains. Distributed in gravelly, sandy, and well-drained soils, the dominant shrubs species are *Parastrephia lucida* and *Baccharis incarum* with an average height of 120 cm. The herbaceous vegetation or shrub understory includes small herbs such as *Taraxacum officinale* and *Dichondra repens* and small grasses like *Chondrosum simplex*. Intensive grazing, wood extraction and burning have seriously impacted the *tholar* in a number of areas, where grasslands of *Festuca orthopylla* have replaced them. Scattered columnar cactus *Trichocereus pasacana* is a distinctive element of rocky slopes. Llamas are well adapted for browsing on *tholar* shrubs, which they regularly do throughout the year, but particularly during the dry season.

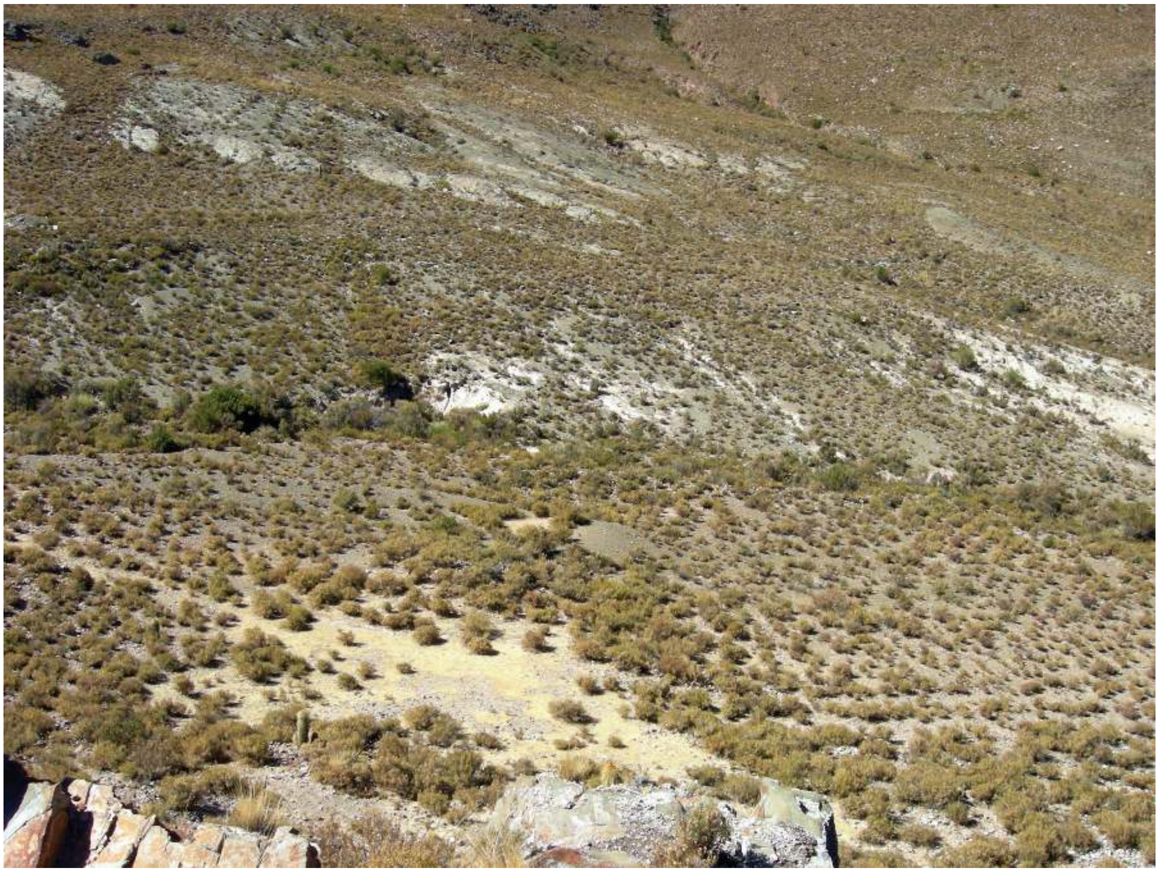


Figure 4.8. View of shrubland at Iroco.

4.4.4. Shrubland-Grassland Transition

The transition between *tholares* and grasslands is characterized by small resinous-shrubs of *Baccharis* and *Parastrephia,* locally known as *tholas* (Figure 4.9). This formation is located between 3700 and 4000 m asl in dry rocky slopes, rocky plains, and plains with salty soils. *B. incarum* and *P. lucida* are the dominant shrub species, with a mean total height of 1.2 m. *Fabiana densa, Tetraglochin cristatum,* and *Adesmia spinosissima* are shrub species that grow sparsely, between tussocks of the dominant grasses *Festuca orthophylla* and *Stipa ichu*. Under the protection of tussocks, two cactus species, *Cumulopuntia boliviana* and *Tunilla soehrensii*, grow occasionally. *Aristida enoides* and *Nassella meyeniana* are small grass species that can also be found. The columnar cacti, *Echinopsis maximiliana* and *Trichocereus pasacana*, are frequent and are usually found at

Figure 4.9. View of grassland-shrubland transition and herd of camelids at Iroco.

higher elevations. Overgrazing is producing the impoverishment of the vegetation, favoring the establishment of less palatable plants, including toxic species, such as *T. cristatum* and *Plantago sericea* subsp. *subsericans.*

4.4.5. Cultivated Fields

Traditionally, herding families at Iroco practice some form of subsistence farming (Figure 4.10). The use of modern agricultural techniques including irrigation, fertilizers, and pesticides has allowed this practice to be more resistant to environmental stress and consequently more common and less risky than it was in the past. Even so, cultivation in Iroco is only feasible in very limited locations and fields require several years of fallow. Cultivation is currently limited to a few plots mostly cared for by households that cultivate for their own consumption and to sell part of their crop in the city of Oruro.

Pre-Hispanic domesticated plants traditionally farmed in the study area include quinoa (*Chenopodium quinoa*), kañawa (*Chenopodium pallidicaule*), various varieties of potatoes (*Solanum tuberosum*), oca (*Oxalis tuberosa*), maca (*Lepidium mayenii*) and tarwi (*Lupinus mutabilis*). Potatoes are often dehydrated and transformed into *chuñu* for storage purposes. In addition, a number of exotic cultigens from the Old World have been incorporated to the farming complex and include barley (*Hordeum vulgare*), alfalfa (*Medicago sativa*), fava beans (*Vicia faba*), and onions (*Allium cepa*). Barley and alfalfa are mainly cultivated as forage for cattle, sheep, and llamas.

4.4.6. Economic Wild Plants

In addition to cultigens, the most common wild plants are also those economically important and widely used by local herders (Table 4.3). Several species are used as fodder

Figure 4.10. Cultivated fields at Cochiraya.

Table 4.3. Economic uses of some wild plants present at the study area (see Table 4.1).

Family	Species	Common name	Fodder	Medicine	Firewood	Food	Ritual
Amaranthaceae	*Suaeda foliosa*	K'auchi	x				
Apiaceae	*Azorella compacta*	Yareta		x	x		
Asteraceae	*Baccharis incarum*	Ñaka thola	x	x	x		
Asteraceae	*Bidens andicola*	Muni muni		x			
Asteraceae	*Gnaphalium bombeuanum*	Pampa wira wira		x			
Asteraceae	*Mutisia fresiana*	Chinchircoma		x			
Asteraceae	*Parastrephia lucida*	Tolilla	x	x	x		x
Asteraceae	*Schkuria pinnata*	Scoria		x			
Cactaceae	*Cumulopuntia boliviana*	Phusqallo waraqo				x	
Cactaceae	*Echinopsis maximiliana*			x		x	
Cactaceae	*Tunilla soehrensii*	Airampu		x		x	
Cyperaceae	*Schoenoplectus californicus*	Totora	x			x	
Ephedraceae	*Ephedra* cf. *rupestris*	Sanu sanu		x			
Fabaceae	*Adesmia spinossisima*	Añahuaya	x		x		
Poaceae	*Aristida enoides*	Pasto aristida	x			x	
Poaceae	*Festuca orthophylla*	Paja brava	x		x		
Poaceae	*Nassella meyeniana*		x				
Poaceae	*Stipa ichu*	Paja suave	x		x		
Rosaceae	*Polylepis tarapacana*	Keñua		x	x		
Rosaceae	*Tetraglochin christatum*	Kanlla	x	x	x		
Scrophulariaceae	*Bartsia crenata*	Quimsa q'uchu		x			x
Solanaceae	*Fabiana densa*	Tara tara	x	x	x		

for llamas, cattle, and sheep, including tussocks (*Festuca ortophylla* and *Stipa ichu*), small grasses (*Aristida enoides* and *Nassella meyeniana*), small resinous shrubs (*Adesmia spinossisima*, *Baccharis incarum*, *Fabiana densa*, *Suaeda foliosa*, and *Tretraglochin christatum*) and totora reeds (*Schoenoplectus californicus* var. *tatora*). *Suaeda foliosa* is a very important economic species in the area for fodder; it bears easily digestible leaves, soft and with a high content of proteins and nitrogen. The species constitutes an important source of fodder during dry spells and the transition between wet and dry seasons (September – November), when other plant species are scarce. Totora reeds and tussock grasses were also used in the past as construction material especially for roofing houses and making fiber ropes and crafts. Plants are also traditionally harvested as fuel. Tholas (*Baccharis incarum* and *Parastrephia lucida*) are generally the preferred species due their abundance, although other small shrubs such as *Fabiana densa* and *Tetraglochin cristatum* are also harvested as well as cushion plants such as chiki chiki (*Pycnophyllum macropetalum*). It is very likely that columnar cacti (*Trichocereus pasacana*) were used in the past as fuel and as building material.

Several of the species distributed in Iroco have medicinal properties (Cuenca Sempertegui et al. 2005). Medicinal plants include shrubs (*Fabina densa, Parastrephia lucida*, *Tretraglochin cristatum,* and *Mutisia fresiana*), herbs (*Bidens andicola, Ephedra rupestris, Gnaphalium bombeyanum,* and *Schuria pinnata*) and cacti (*Echinopsis maximiliana* and *Tunilla soehrensii*). Some plants are consumed regularly as infusions or *mate* to ameliorate fever and colds while other species are employed to treat more chronic illness such as infections, rheumatism, hepatic illnesses, and diabetes. Some species of wild flora are also used for human consumption as the case of cacti fruits (*Cumulopuntia boliviana* and *Tunilla soehrensii*) and totora sprouts and shoots. Finally, there are two species with exclusively ceremonial properties, tolilla (*Parastrephia lucida*) and quimsa q'uchu (*Bartisa crenata*), which is a rare species in the area.

The potential vegetation of the area also includes the keñua tree (*Polylepis tarapacana*) and the yareta (*Azorella compacta*) cushion plant. These two species were historically widely used as fuel and overexploitation has produced local extinctions during the last four hundred years.

4.5. Fauna

The fauna of Iroco contains several species and is typical of Andean highland ecosystems (Figure 4.11). A preliminary list includes close to 200 species of aquatic and inland birds, large and small mammals, and a few species of reptiles, amphibians, and fish (Table 4.4). The complete list includes currently extinct but potentially present taxa in addition to exotic species that have colonized the region either through human introduction or invasion during the last 400 years. Birds include at least 128 species from 37 different families. Mammals include large artiodactyls, carnivores, small and mid-sized rodents,

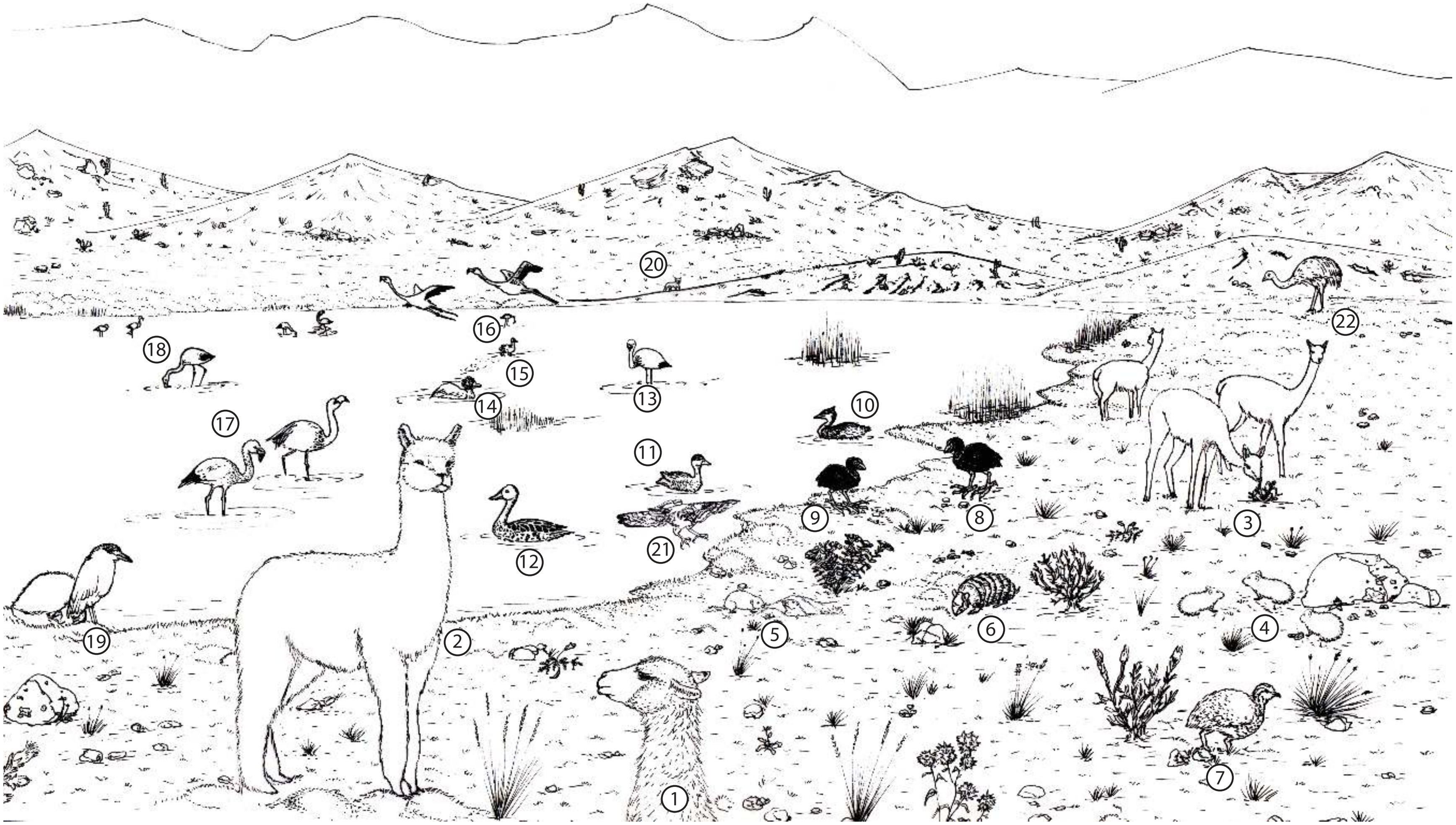


Figure 4.11. Potential representative fauna of Iroco. 1) *Lama glama*, 2) *Vicugna pacos*, 3) *Vicugna vicugna*, 4) *Cavia tschudii*, 5) *Ctenomys opimus*, 6) *Chaetophractus nationi*, 7) *Nothoprocta ornata*, 8) *Fulica gigantea*, 9) *Fulica ardesiaca*, 10) *Podiceps occipitalis*, 11) *Anas puna*, 12) *Anas cyanoptera*, 13) *Phoenicoparrus jamesi*, 14) *Anas flavirostris*, 15) *Calidris melanotos*, 16) *Recurvirostra andina*, 17) *Phoenicopterus chilensis*, 18) *Phoenicoparrus andinus*, 19) *Nycticorax nycticorax*, 20) *Lycalopex culpaeus*, 21) *Buteo polyosoma*, 22) *Rhea pennata*. Drawing by Arely Palabral.

Table 4.4. List of potential vertebrate fauna of Iroco (based on Cuenca Sempértegui et al. 2005; Flores Bedregal and Capriles Farfán 2010; Rocha 2002; Eliana Flores Bedregal personal communication 2011).

Family	Species	English Name	Spanish Name	Indigenous Name	Remarks
Didelphidae	*Thylamys pallidior*	White-bellied Fat-tailed Mouse Opossum	Marmosa coligruesa pálida	Achulla	
Dasypodidae	*Chaetophractus nationi*	Andean Hairy Armadillo	Quirquincho	Kirkinchu	
Vespertilionidae	*Histiotus laephotis*	Thomas's Big-eared Brown Bat	Murcíelago	Chiñi	
Canidae	*Canis familiaris*	Dog	Perro	Anu	Domesticated
Canidae	*Lycalopex culpaeus*	Andean Fox	Zorro	Atoj, Lari, Qamaqi, Tiwula	
Felidae	*Leopardus colocolo*	Colocolo	Colocolo	Colocolo	Extinct
Felidae	*Leopardus jacobitus*	Andean Mountain Cat	Gato Andino	Titi	Extinct
Felidae	*Leopardus pajeros*	Pampas Cat	Gato de los pajonales	Titi	Extinct
Felidae	*Puma concolor*	Cougar	Puma	Poma	Extinct
Mustelidae	*Conepatus chinga*	Skunk	Zorrillo	Anas	
Mustelidae	*Galictis cuja*	Weasel	Hurón menor	Anutaya	
Cricetidae	*Abrothrix andinus*	Andean Altiplano Mouse	Ratón de campo andino	Achaku	
Cricetidae	*Akodon albiventer*	White-bellied Grass Mouse	Ratón ventriblanco	Hucucha	
Cricetidae	*Akodon boliviensis*	Bolivian Grass Mouse	Akodont	Achaku	
Cricetidae	*Andinomys edax*	Adean Mouse	Rata andina	Achaku	
Cricetidae	*Auliscomys boliviensis*	Bolivian Big-eared Mouse	Ratón de orejas grandes boliviano	Achaku	
Cricetidae	*Auliscomys sublimis*	Andean Big-eared Mouse	Ratón de orejas grandes andino	Achaku	
Cricetidae	*Calomys lepidus*	Andean Vesper Mouse	Laucha Andina	Laucha	
Cricetidae	*Chinchillula sahamae*	Altiplano Chinchilla Mouse	Rata Chinchilla	Achallo	
Cricetidae	*Chroeomys jelskii*	Jelski's Altiplano Mouse	Colorido ratón del pajonal	Achaku	
Cricetidae	*Eligmodontia puerulus*	Andean Gerbil Mouse	Laucha	Laucha	
Cricetidae	*Phyllotis osilae*	Bunchgrass Leaf-eared Mouse	Ratón de orejas largas	Achaku	
Cricetidae	*Phyllotis xanthopygus*	Yellow-rumped Leaf-eared Mouse	Ratón de orejas largas	Achaku	
Caviidae	*Cavia porcellus*	Domesticated guinea pig	Cuy, Cobayo, Conejillo de Indias	Cuy	Domesticated
Caviidae	*Cavia tschudii*	Montane Guinea pig	Cuy silvestre	Poronccoy	
Caviidae	*Galea musteloides*	Common Yellow-toothed Cavy	Cuis moro	Cuy	
Caviidae	*Microcavia niata*	Andean Mountain Cavii	Cuy andino	Pampa huanco	
Abracomidae	*Abracoma cinerea*	Ashy Chinchilla rat	Chinchillón	Chinchillón	
Chinchillidae	*Lagidium viscacia*	Southern Viscacha	Vizcacha	Wiscacha	
Chinchillidae	*Chinchilla bravicaudata*	Chinchilla	Chinchilla	Chinchilla	Extinct
Ctenomyidae	*Ctenomys opimus*	Highland Tuco-tuco gopher	Topo, conejo	Tucu-tuco	
Octodontomidae	*Octodontomys gliroides*	Mountain Degu	Rata Cola de Pincel	Tarawank'u	
Leporidae	*Lepus europaeus*	European hare	Liebre	Wank'u	Invasive
Equidae	*Equus assinus*	Donkey	Burro	Wurru	Introduced
Camelidae	*Lama glama*	Llama	Llama	Qarwa	Domesticated
Camelidae	*Lama guanicoe* subs. *cacsilensis*	Guanaco	Guanaco	Wanaku	Extinct
Camelidae	*Vicugna vicugna* cf. *Lama vicugna*	Vicugna	Vicuña	Huari	
Camelidae	*Vicugna pacos* cf. *Lama pacos*	Alpaca	Alpaca	Paco	Domesticated
Cervidae	*Hippocamelus antisensis*	Huemul, Andean Deer	Taruca	Taruka	Extinct
Bovidae	*Bos taurus*	Cattle	Vaca, toro	Waka	Introduced
Bovidae	*Ovis aries*	Sheep	Oveja	Oweja	Introduced
Suidae	*Sus scrofa*	Pig	Cerdo	Q'uchi	Introduced

Table 4.4. Continued.

Family	Species	English Name	Spanish Name	Indigenous Name	Remarks
Rheidae	*Rhea pennata*	Lesser Rhea	Ñandú petiso	Suri	
Tinamidae	*Nothoprocta ornata*	Ornate Tinamou	Perdiz andina adornada	Pisaka	
Tinamidae	*Nothura darwinii*	Darwin's Nothura	Tinámido de darwin	K'ullu Llutja	
Anatidae	*Chloephaga melanoptera*	Andean Goose	Ganso andino	Huallata	
Anatidae	*Lophonetta specularioides*	Crested Duck	Pato de rio	Mayu Pato	
Anatidae	*Anas flavirostris*	Speckled Duck	Pato pico amarillo	Uncallo, Wislunka	
Anatidae	*Anas georgica*	Yellow-billed Pintail	Pato maicero	Pato jerga	
Anatidae	*Anas puna*	Puna Teal	Pato puneño	Pato chiro	
Anatidae	*Anas cyanoptera*	Cinnamon Teal	Pato colorado		
Anatidae	*Oxyura jamaicensis*	Ruddy Duck	Pato rojo grande	Pana	
Podicipedidae	*Rollandia rolland*	White-tufted Grebe	Zambullidor común	Sullukia, Chulpurunku	
Podicipedidae	*Rollandia microptera*	Short-winged Grebe	Zambullidor del lago titicaca	Ke-unkaya	
Podicipedidae	*Podiceps occipitalis*	Sivery Grebe	Zambullidor plateado	Chullumpi, Chulpurunku	
Phalacrocoracidae	*Phalacrocorax brasilianus*	Neotropic Cormorant	Cormorán olivo	Mijo, ljuchi pili	
Ardeidae	*Nycticorax nycticorax*	Black-crowned Night-Heron	Cuajo	Huaco, Huajohilla	
Ardeidae	*Bubulcus ibis*	Catttle Egret	Garza bueyera		
Ardeidae	*Ardea alba*	Great Egret	Garza blanca		
Ardeidae	*Egretta thula*	Snowy Egret	Garcita blanca	Chuco	
Threskiornithidae	*Plegadis ridgwayi*	Puna Ibis	Ibis puneño	Yanavico, Chiwankara	
Threskiornithidae	*Theristicus melanopis*	Black faced Ibis	Ibis andino	K'ak'enkura, Kankana	
Cathartidae	*Cathartes aura*	Turkey Vulture	Peroquí	Suwintu	
Cathartidae	*Vultur gryphus*	Andean Condor	Condor andino	Mallku, Kuntur	
Phoenicopteridae	*Phoenicopterus chilensis*	Chilean Flamingo	Flamenco chileno	Tokoko, Pariguana	
Phoenicopteridae	*Phoenicoparrus andinus*	Andean Flamingo	Flamenco andino	Jututo, Parina grande	
Phoenicopteridae	*Phoenicoparrus jamesi*	James's Flamingo	Flamenco de la laguna colorada	Chururu, Parina chica	
Accipitridae	*Circus cinereus*	Cinereus Harrier	Gavilán ceniciento	Nieblen	
Accipitridae	*Geranoaetus melanoleucus*	Black-chested Buzzard-Eagle	Aguila mora	Paca	
Accipitridae	*Parabuteo unicinctus*	Bay-winged Hawk	Gavilán mixto	Anca	
Accipitridae	*Buteo polyosoma*	Red-backed Hawk	Gavilán común	Paca, Uaman	
Accipitridae	*Buteo poecilochrous*	Puna Hawk	Gavilán de la puna	Anca	
Falconidae	*Phalcoboenus megalopterus*	Mountain Caracara	Maria	Alkamari, Kjarqa'a	
Falconidae	*Falco sparverius*	American Kestrel	Cernícalo	Q'illi-q'illi, Kili Kili	
Falconidae	*Falco femoralis*	Aplomado Falcon	Halcón plomizo	Mamani	
Falconidae	*Falco peregrinus*	Peregrine Falcon	Halcón peregrino	Waman	
Rallidae	*Gallinula chloropus*	Common Moorhen	Polla negra	Tikiwalpa	
Rallidae	*Fulica gigantea*	Giant Coot	Gallareta gigante	Ajjuya	
Rallidae	*Fulica ardesiaca*	Slate-colored Coot	Gallareta soca	Huayno, Soka	
Recurvirostridae	*Himantopus mexicanus*	Black-necked Stilt	Tero mexicano		
Recurvirostridae	*Recurvirostra andina*	Andean Avocet	Avoceta andina	Caiti	
Charadriidae	*Vanellus resplendens*	Andean Lapwing	Leque leque	Leke-leke	
Charadriidae	*Pluvialis dominica*	American Golden -Plover	Chorlo churchu		
Charadriidae	*Pluvialis squatarola*	Black-bellied Plover	Chorlo artico		
Charadriidae	*Charadrius alticola*	Puna Plover	Chorlito andino	Paltazar	
Charadriidae	*Phegornis mitchelli*	Diademed Plover	Chorlito de vincha	Pijlula	
Charadriidae	*Oreopholus ruficollis*	Tawny-throated Dotterel	Chorlo cabezón	Tiutira	

Table 4.4. Continued.

Family	Species	English Name	Spanish Name	Indigenous Name	Remarks
Scolopacidae	*Gallinago andina*	Puna Snipe	Gallinago de la puna		
Scolopacidae	*Limosa haemastica*	Hudsonian Godwit	Becasa de mar		
Scolopacidae	*Numenius phaeopus*	Whimbrel	Playero trinador		
Scolopacidae	*Bartramia longicauda*	Upland Sandpiper	Batitú		
Scolopacidae	*Tringa melanoleuca*	Greater Yellowlegs	Pitotoi grande	Tuituncalla, Chululu	
Scolopacidae	*Tringa flavipes*	Lesser Yellowlegs	Pitotoi chico		
Scolopacidae	*Calidris minutilla*	Least Sandpiper	Playerito pequeñito		
Scolopacidae	*Calidris bairdii*	Baisd's Sandpiper	Playerito de bairdi	Carachila	
Scolopacidae	*Calidris melanotos*	Pectoral Sandpiper	Playerito bandeado	Isca Tiutiuco	
Scolopacidae	*Calidris himantopus*	Stilt Sandpiper	Playerito carachila		
Scolopacidae	*Phalaropus tricolor*	Wlison's Phalaropus	Falaropo tricolor		
Thinocoridae	*Thinocorus orbignyianus*	Gray-breasted Seedsnipe	Agachona de collar	Pucu-Pucu	
Laridae	*Larus serranus*	Andean Gull	Gaviota andina	Killua, Kelluyao	
Columbidae	*Columba maculosa*	Spot-winged Pigeon	Paloma manchada	Joqori	
Columbidae	*Columba livia*	Rock Dove	Paloma casera		
Columbidae	*Zenaida auriculata*	Pared Dove	Torcaza	Urpi	
Columbidae	*Columbina picui*	Picui Ground Dove	Torcacita	Uli Uli, Ulinchu	
Columbidae	*Metropelia ceciliae*	Bare-faced Ground.Dove	Palomita moteada	Cururuta, Jurkuta	
Columbidae	*Metropelia melanoptera*	Black-Winged Gound -Dove	Paloma cordillerana	Cururuta	
Columbidae	*Metropelia aymara*	Golden-spotted Ground-Dove	Paloma ala dorada	Kullucutaya	
Psittacidae	*Psilopsiagon aymara*	Grey-hooded Parakeet	Catita aymara	Qechiche	
Psittacidae	*Psilopsiagon aurifrons*	Mountain Parakeet	Catita cordillerana	Cialla	
Tytonidae	*Tyto alba*	Barn Owl	Lechuza de campanario		
Strigidae	*Bubo virginianus*	Great Horned Owl	Búho común	Chuseca, Jucu	
Strigidae	*Athene cunicularia*	Burrowing Owl	Lechuza coneja	Pejpera	
Caprimilgidae	*Caprimulgus longirostris*	Band-winged Nightjar	Atajacaminos bigotudo	Paaspa	
Apodidae	*Aeronautes andecolus*	Andean Swift	Vencejo andino		
Trochilidae	*Colibri coruscans*	Sparkling Violet-ear	Colibrí brillante	Lulinchu	
Trochilidae	*Oreotrochilus estella*	Andean Hillstar	Picaflor puneño	Luli	
Trochilidae	*Patagona gigas*	Giant Hummingbird	Picaflor gigante	Luli Kente	
Picidae	*Colaptes rupicola*	Andean Flicker	Carpintero andino	Yaca yaca, Lakichi	
Furnaridae	*Geositta cunicularia*	Common Miner	Minero comun		
Furnaridae	*Geositta tenuirostris*	Slender-billed Miner	Minero pico fino		
Furnaridae	*Geositta punensis*	Puna Miner	Minero puneño	Tiqui tiqui, Quepi lagarto	
Furnaridae	*Geositta rufipennis*	Rufus-banded Miner	Minero cola roja		
Furnaridae	*Upucerthia jelskii*	Plain.breasted Earthcreeper	Excabadora de jelski		
Furnaridae	*Ochetorhynchus ruficaudus*	Straight-billed Earthcreeper	Excabadora pico- recto		
Furnaridae	*Cinclodes fuscus*	Bar-winged Cinclodes	Remolinera comun	Kachiranca	
Furnaridae	*Cinclodes atacamensis*	White-winged Cinclodes	Remolinera castaña		
Furnaridae	*Phleocryptes melanops*	Wren-like Rushbird	Tejedor del totoral	Pampa Jamachi	
Furnaridae	*Leptasthenura fuliginiceps*	Brown-capped Tit-Spinetail	Coludito canela		
Furnaridae	*Leptastenura aegithaloides*	Plain-mantled Tit-Spinetail	Coludito cola negra		
Furnaridae	*Schizoeaca harterti*	Black-throated harterti	Coludito barba negra		
Furnaridae	*Asthenes modesta*	Cordilleran Canastero	Canastero pálido		
Furnaridae	*Asthenes dorgignyi*	Rusty-vented Canastero	Canastero rojizo	Chijru chijru	
Furnaridae	*Phacellodomus striaticeps*	Streak-fronted Thornbird	Espinero andino	Chijru Chijru	

Table 4.4. Continued.

Family	Species	English Name	Spanish Name	Indigenous Name	Remarks
Tyrannidae	*Anairetes parulus*	Tufted Tit-Tyrant	Cachudito pico negro		
Tyrannidae	*Tachirus rubrigastra*	Many-colored Rush-Tyrant	Sietecolores de la totora		
Tyrannidae	*Lessonia oreas*	Andean Negrito	Negrito andino	Pulukipe	
Tyrannidae	*Muscisaxicola maculirostris*	Spot-billed Ground-Tyrant	Dormilona chica		
Tyrannidae	*Muscisaxicola grisea*	Taczanowski's Ground-Tyrant	Dormilona gris		
Tyrannidae	*Muscisaxicola juninensis*	Puna Ground-Tyrant	Dormilona puneña		
Tyrannidae	*Muscisaxicola cinerea*	Cinereus Ground-Tyrant	Dormilona ceniza		
Tyrannidae	*Muscisaxicola rufivertex*	Rufus-naped Ground-Tyrant	Dormilona nuca rufa		
Tyrannidae	*Muscisaxicola albilora*	White-browed Ground-Tyrant	Dormilona cejiblanca		
Tyrannidae	*Muscisaxicola capistrata*	Cinnamon-bellied Ground-Tyrant	Dormilona canela	Pampataca	
Tyrannidae	*Muscisaxicola frontalis*	Black-fronted Ground-Tyrant	Dormilona frente negra		
Tyrannidae	*Agriornis montana*	Black-billed Shrike-Tyrant	Gaucho serrano		
Tyrannidae	*Agriornis andicola*	White–tailed Shrike-Tyrant	Gaucho andino		
Hirundinidae	*Haplochelidon andecola*	Andean Swallow	Golondrina andina		
Hirundinidae	*Pygochelidon cyanoleuca*	Blue and White Swallow	Golondrina azul y blanco	Siluri	
Troglodytidae	*Troglodytes aedon*	House wren	Ratona comun		
Turdidae	*Turdus chiguanco*	Chiguanco Thrush	Chihuanco	Chiwanco	
Motacillidae	*Anthus furcatus*	Short-billed Pipit	Cachirla uña corta		
Emberizidae	*Zonotrichia capensis*	Rufus-collared Sparrow	Gorrión americano	Pichitanka, Papachiuchi	
Emberizidae	*Phrygilus atriceps*	Black-hooded Sierra-Finch	Semillero- serrano encapuchado		
Emberizidae	*Phrygilus fruticeti*	Mourning Sierra-Finch	Semillero- serrano mañanero	Chijta	
Emberizidae	*Phrygilus unicolor*	Plumbeous Sierra-Finch	Semillero- serrano plomizo		
Emberizidae	*Phrygilus erythronotus*	White-throated Sierra Finch	Semillero-serrano barbudo		
Emberizidae	*Phrygilus plebejus*	Ash-breasted Sierra Finch	Semillero- serrano plebeyo		
Emberizidae	*Phrygilus alaudinus*	Band-tailed Sierra-Finch	Semillero- serrano cantor	Chijta	
Emberizidae	*Diuca speculifera*	White-winged Diuca-Finch	Semillero ala blanca		
Emberizidae	*Sicalis lutea*	Puna Yellow-Finch	Jilguero de la puna		
Emberizidae	*Sicalis uropygialis*	Bright-rumped Yellow-Finch	Jilguero gris	Kellunchu, Chirigue	
Emberizidae	*Sicalis olivascens*	Greenish Yellow-Finch	Jilguero verdoso		
Emberizidae	*Sicalis luteola*	Grassland Yellow-Finch	Jilguero yerbero	Kellunchu	
Emberizidae	*Catamenia inornata*	Plain-colored Seedeater	Pico de oro grande		
Icteridae	*Chrysosomus thilius*	Yellow-winged Blackbird	Tordo del totoral		
Fringillidae	*Carduelis crassirostris*	Tick-billed Siskin	Chainita pico gordo	Chaioita	
Fringillidae	*Carduelis magellanica*	Hoooded Siskin	Chainita encapuchado	Jilguero	
Fringillidae	*Carduelis atrata*	Black Siskin	Chainita estrongista	Hallo-hallo	
Fringillidae	*Carduelis uropygialis*	Yellow-rumped Siskin	Chainita chileno		
Passeridae	*Passer domesticus*	House Sparrow	Gorrión europeo	Phichitanka	Invasive
Liolaemidae	*Liolaemus alticolor*	Lizard	Lagartija	Jararankhu	
Liolaemidae	*Liolaemus signifer*	Lizard	Lagartija	Jararankhu	
Colubridae	*Tachymenis peruviana*	Peruvian Slender Snake	Culebra cola corta	Katari, Amaru	
Bufonidae	*Rhinella spinulosa* cf. *Bufo spinolosus*	Warty toad	Sapo	Jamp'atu	
Ceratophryidae	*Telmatobious marmoratus*	Marbled water frog	Sapo	Jamp'atu	
Orestinae	*Orestias agassii*	Killifish	Boga	Carachi	
Trichomycteridae	*Trichomyecterus dispar*	Catfish	Pez gato	Suche	
Trichomycteridae	*Trichomyecterus rivulatus*	Catfish	Pez gato	Mauri	
Atherinopsidae	*Odontesthes bonariensis*	Silverside	Pejerey	Pejerey	Introduced

among other groups. Groups of wild vicuña (*Vicugna vicugna*) occasionally forage in the floodplain close to the northern part of the study area, but the sierra guanaco (*Lama guanicoe* subsp. *cacsilensis*) and the Andean deer or taruca (*Hippocamelus antisensis*) are locally extinct since at least the eighteenth century if not earlier. As a result of increased habitat destruction and population pressure, several other typical species of the central altiplano are currently rare or locally extinct at Oruro.

Currently the shores of the Karakollu River and Lake Uru-Uru are locations where wild fauna tends to congregate and include several species of aquatic birds including three species of flamingos (Family Phoenicopteridae) as well as several species of ducks (Family Anatidae), coots (Family Rallidae), grebes (Family Podicipedidae), herons (Family Ardeidae), gulls (Family Laridae), and others.

Fishes are limited to two species, the carachi killifish (*Orestias agassii*) and the suche and mauri catfishes (*Trichomycturus dispar* and *T. rivulatus*). Reptiles and amphibians are not common but are present and include lizards (*Liolaemus alticolor* and *L. signifer*), Peruvian slender snake (*Tachymenis peruviana*), and few species of frogs and toads (*Rhinella spinulosa* and *Telmatobious marmoratus*).

The extensive plains, mostly composed of grasslands, are not necessarily rich in animal biomass but are occupied by a number of different species, including vicuñas, tinamous (Family Tinamidae), and lesser rheas (*Pterognemia pennata*). The extensive pampas and dunes are also good habitats for Andean hairy armadillos locally known as quirquinchos (*Chaetophractus nationi*), as well as midsize rodents such as guinea pigs (*Cavia tschudii*, *Cavia aperea*, *Galea musteloides*, and *Microcavia niata*) and highland tuco-tucos gophers (*Ctenomys opimus*). The rocky hills are places inhabited by vizcachas (*Lagidium viscacia*) but are also the location where vicuñas sleep and are the natural habitat of predators such as the Andean fox (*Lycalopex culpaeus*), puma (*Puma concolor*, locally extinct), and different species of eagles and hawks (families Accipitridae and Falconidae).

Pre-Hispanic domesticated animals include llamas, alpacas, guinea pigs and dogs. Alpacas are domesticates found within the highlands but because of modern dry conditions and the absence of a *bofedal* habitat, they were not been kept by herders in Iroco in recent times. Exotic introduced domesticated animal species include cattle, sheep, donkeys, and pigs as well as Old World races of dogs.

4.5.1. Modern Camelid Pastoralism in Iroco

Today the three indigenous communities in Iroco include families that have traditionally relied on pastoralism as central or complementary economic activity (Figure 4.12). The size and composition of their herds varies with the dynamic economic activities in which the people of Iroco are involved. A survey of 46 heads of households from the three communities of Iroco conducted in 2002 determined that over two thirds of them (N=31) possessed animal herds (Illampu 2004). Only 13 of these families possessed llamas, the rest owning a variety of cattle and/or sheep herds. Alpacas were completely absent. The average llama herd was made up of 44 animals. The average composition of a llama herd included 4 males, 28 females, 2 juveniles, and 10 infants. However, it is important to note that there was a great deal of variability in the composition of herds and the high number of adult males and low number of juveniles reported is probably a consequence of how this particular question was framed in the survey, the inclusion of castrated animals, and underreporting of juveniles.

Personal observations and conversations carried out with local inhabitants between 2007 and 2009 allows some general observations regarding extensive or "traditional" herding in Iroco. Pastoralism in Iroco involves trips to pastures located in all five microenvironments defined above. Residential bases and herding camps exist in the Iroco landscape in the same way as documented for other regions. Currently herders respond to sociopolitical information regarding where other herders are and have traditionally pastured, the size of their herds, and reasonable estimations of resource availability, when they organize and plan the herding of their animals. Herding trips to pastures are undertaken on a daily basis and follow seasonal cycles of grazing with progressive moves towards available pasture land (see López García 2003). For instance, during the wet season, animas are preferentially herded in the shrublands of the nearby hills and away from the main sources of water. During the dry season herds, herding is mostly carried out in the grasslands near the shores of Lake Uru-Uru and Karakollu River.

In addition to herding several families cultivate a mixed of Andean and introduced crops (see above). After the fields have been harvested, fallow fields are generally used to pasture herds, which is a form of weeding and fertilization of the fields. Fields are also fertilized with additional dung from the animal corrals. Several herding camps are located near fields, specifically to facilitate the transportation of dung.

Although most "traditional" practices related to distributing, cooking and discarding animal products and by-products have been disrupted by acculturation and the availability of

Figure 4.12. Mixed herd of llamas and sheep herding at Chuzekery.

modern technologies, indigenous knowledge persists. For instance, an interesting practice that continues today is curing camelid meat for storage by simply adding salt and letting different packets (that often include large portions of bone) dry out in the sun. People refer to this practice as one of many ways of preparing *ch'arki*, known in Andean literature as camelid dry meat (see Browman 1989; López García 2003; Miller 1979; Stahl 1999).

Finally, traditional pastoralism in the area has changed dramatically with the Kori Chaca mining operations. Because most local people began working for the mine (mainly in the service sector) families possessing significant numbers of herding animals have substantially diminished. As might be expected, some families who continued herding substantially increased the number of herding animals that they owned. Moreover, because of environmental pressures related to water accessibility as a result of the presence of the mine, and economic pressures associated with the increased value of llama meat in the nearby city of Oruro, llamas have become more prevalent with respect to sheep and cattle. Another interesting new pattern is that as herding in Iroco diminished, herders from other communities have begun to pasture their animals in these areas. It is worth mentioning that even after a couple of years without animal herding, the local vegetation rebounds significantly, as shown by areas of the Kori Chaca mine where for security reasons, herding is not permitted.

CHAPTER 5

MATERIALS AND METHODS

In this chapter, I will describe the research design including the fieldwork and laboratory methods and techniques used to collect and analyze primary data. The research strategy was based on a detailed survey followed by excavations that involved fine recovery techniques and the detailed analysis of the recovered materials, in particular, the faunal remains.

5.1. Regional Archaeology

5.1.1. Survey Strategy

I implemented a survey with the following goals:

1. Characterizing the settlement patterns of the study area for the entire period of human occupation to provide a broad framework for understanding cultural change and continuity.
2. Locating previously unrecorded Archaic Period occupations and identifying and characterizing Formative Period settlements including both village and camp sites.
3. Collecting diagnostic lithic and ceramic materials from the identified sites and determining suitable sites for later excavation.
4. Building a relational database for the collected data and integrated to a geographic information system (GIS).

To accomplish these goals, I implemented a full-coverage survey (*sensu* Parsons et al. 2000) of a 38.35 km^2 area during the summers of 2007, 2008, and 2009 (Figure 4.3). This survey was conducted encompassing the communities of Cochiraya, Iroco, and Chuzekery. The survey boundaries were constrained by the extent of the local communities. The eastern boundary was determined by the limit of the city of Oruro, the northern limit was the extensive Caracollo plain and the western and south limits were the shores of Lake Uru-Uru. The 38.35 km^2 of continuous terrain that were surveyed also include 4.01 km^2 that were initially surveyed by Albarracin-Jordan (2005).

The Iroco landscape has optimal visibility and accessibility for carrying out an archaeological pedestrian survey. Because most of the terrain is composed of grasslands and rocky hills, vegetation cover is not a serious limiting factor for identifying sites. Accessibility is good because there are several small tracks and roads that facilitate movement in and out of the study area. In addition, the relatively proximity of the study area to the city of Oruro facilitated logistical support. The survey mostly relied on locating distributions of ceramic sherds, lithic fragments, occasional architecture, and organically rich soils to identify sites. Because of their color patterns, ceramics and lithic artifacts clearly stand out from the ground surface. Architecture in the form of stone terraces, building foundations made with aligned cobbles, and burial towers are occasionally found in the study area. Adobe, stone and sod-grass were the preferred construction materials at Iroco. Dark organically enriched soils are common in the archaeological sites of Iroco, mostly as a result of organically enriched sediments. In fact, Wankarani Formative Period mounds, made up of overlapping domestic occupations are conspicuous and noticeable landscape features (Ahlfeld 1954; McAndrews 2005b).

The survey strategy was based on the types of sites in the region and on previous research. In addition to village settlements, I wanted to identify small hunting and herding camps, and I therefore, decided to implement an intensive full-coverage survey. Consequently, survey teams included an average of four people who systematically covered the landscape following east to west orientation as well as the local topography spaced between 5 and 15 meters. Because of this type of survey intensity, sites as small as 0.10 hectares were typically identified, although it is possible that smaller settlements were missed. More care was taken when surveying the lower foothills and hillside slopes (colluvial sediments), where previous studies indicated more evidence of occupation. Correspondingly, survey intensity decreased on the floodplain where the presence of sites was very low. Handheld global positioning system (GPS) units, digital cameras, and standardized forms were used for recording and describing all the identified sites.

During the survey, archaeological sites were defined and identified by finding continuous distributions of archaeological materials, especially, fragments of pottery and lithics as well as the occasional presence of architectural features such as the remains of walls and terraces. The definition of an archaeological site employed during the survey was any discrete concentration of archaeological artifacts with a density greater than ten artifacts distributed within an area of 10 square meters and/or visible evidence of architecture such as terraces, walls, and burials.

Site location was recorded in latitude and longitude geographic coordinates as well as in Universal Transversal Mercator (UTM) projected coordinates using the WGS 1984 coordinate system with the Datum 19S. Once a site was identified, a code was assigned to it. To standardize previous research with the new survey, all sites received the prefix KCH (which stands for Kori Chaca, Aymara for golden bone). The perimeter of every site was determined in the field and recorded with the track function of a GPS. Diagnostic ceramic and lithic artifacts were identified and collected. In the case of pottery, diagnostic material included fragments of rims, bases, handles, and decorated sherds as well as body sherds of different pastes. In the case of lithics, diagnostics were considered bifacial artifacts such as projectile points, unifacial scrapers, and adzes, as well as flakes of different raw materials. In sites where the artifact densities were extremely low, all materials visible on the surface were collected. In some sites, detailed mapping and systematic surface collections were made to recover additional distributional information, particularly in Archaic, Formative, and Tiwanaku occupations.

The recording form included the following attributes: location (coordinates, elevation, community), ecology (vegetation, current land use), archaeology (chronology, function, architecture, burials, distribution of pottery and lithics), along with a detailed complementary notes about the settlement itself and the collection made. All the recovered information was inputted into a database designed in Filemaker Pro 8.5 and related to a geographic information system produced in ArcGIS 9.3.1.

5.1.2. Inter-Site Spatial Data

I built a database and a geographic information system (GIS) for the study area with fieldwork information as well as additional spatial data from multiple sources. In addition to information regarding site location and settlement perimeters collected during survey, I included additional layers of regional geo-spatial information. Some of the additional layers include satellite images (i.e., landsat, corona, google earth), topographic digital elevation models (i.e., srtm, aster), location of major geographic landmarks (i.e., rivers, lakes, roads, towns, etc.). In addition, I included in database specific data collected during fieldwork such as microhabitat distribution, as well as information such as detailed topography provided by Inti Raymi Mining Company (manager of the Kori Chaca mine) during the prior salvage fieldwork phase.

The archaeological material collected during fieldwork was analyzed in laboratories of the Carrera de Arqueología, Universidad Mayor de San Andrés in La Paz. The analysis of the diagnostic lithic and ceramic material included a suite of formal, stylistic and technological attributes with the primary objective of verifying the chronological occupation of the sites. A secondary objective of the analysis was to note the presence of imported ceramic styles and lithic raw materials. For assigning chronological phases to each settlement I used stylistic and technological attributes previously investigated in the region of study (e.g., Albarracin-Jordan 2005; Ayala Rocabado et al. 2008; Bermann and Estévez 1993, 1995; Fox 2007; McAndrews 2005a; Michel López 2008; Pärssinen 2005). The results were compared to observations made in the field to produce a final revised version of the settlement dataset. I compiled all this information in the project GIS and used it to create a series of diachronic settlement pattern maps corresponding to each of the time periods which were identified in the study area. The chronological periods used during the survey were Archaic, Formative, Tiwanaku, Carangas/Sora (or Late Intermediate Period), Inca, Colonial, Republican, and indeterminate (Table 6.1).

I used the GIS parameters of the study area to produce settlement pattern archaeological maps and spatial analysis. I produced individual maps for the settlement patterns associated with each period and made visual inspections for changes in landscape use. I also quantified variation in locations, number of occupied components, accumulated size, average size, nearest neighbor, and different types of densities. I explored some attributes to improve the characterization of the settlement system to determine the type of economic organization that produced the observed pattern. I then focused primarily on the Formative Period and secondarily on the Archaic and Tiwanaku periods, to further understand the distribution of sites and the relationship of the settlement system with the pastoralist mode of subsistence.

5.2. Site Archaeology

5.2.1. Excavation Procedures

In the summer of 2007 I undertook excavations in the study area to accomplish the following goals:

1. Documenting intra-site specific features and contexts associated with Formative Period economic activities and domestic life.

2. Recovering archaeological materials (especially faunal remains), associated with domestic features and contexts.

3. Identifying formation processes and taphonomic factors that could have influenced the location, distribution, and preservation of the archaeological materials.

4. Complementing previous excavations carried out in the region by implementing a rigorous sampling strategy of fine-recovery techniques including the systematic collection of flotation and loose soil samples.

Five archaeological sites were excavated and analyzed for this dissertation. The sites are KCH11, KCH20, KCH21 (Irucirca), KCH22 and KCH56. All of the sites have Formative Period settlement occupations. Site KCH20 has a primarily Archaic Period occupation and sites KCH11, KCH21 and KCH22, have Tiwanaku components. Sites KCH11, KCH20, KCH21, and KCH22 were initially excavated by Albarracin-Jordan (2005) as part of a salvage archaeology project. For this dissertation, I carried out additional excavations in the fall of 2007 at sites KCH11, KCH21 and KCH56, and analyzed archaeological materials recovered from all five sites.

During fieldwork, I used UTM coordinates (geographic projection WGS 1984, Datum 19S) for naming and locating the excavation units. I chose the specific location of excavations based on surface indicators, including high densities of artifacts, visible architecture, and previous excavation results. I was looking for dense archaeological accumulations associated with well preserved architecture. Excavations proceeded following the stratigraphy of the sites. Because of the depositional environment of the region, it was straightforward to differentiate upper, mostly naturally deposited windborne sediments and colluviums from archaeological occupation surfaces (often composed of compacted clays) and features (generally organically rich).

The excavation and recording procedure was based on the methods developed by Hastorf and colleagues from the Taraco Archaeological Project working on Lake Titicaca Formative Period sites (Bruno 2008; Goodman-Elgar 2008; Hastorf and Bandy 1999;

Hastorf et al. 2001; Moore et al. 2010; Roddick 2009; Whitehead 2007). In this system, the basic unit of excavation and recording is the locus (plural loci, abbreviated L.). A locus is defined as a unit of provenience that has specific tridimensional attributes. Ideally, a locus will correspond to a single depositional event within the site's stratigraphic sequence. However, multiple loci could correspond to a single depositional event and a single locus can include a mix of different depositional events, depending on how one excavates and makes decisions regarding the stratigraphy of the site during and after excavation. The system of recording includes filling in a form for each excavated locus. The form is composed of different fields for specific data that include date, provenience, sediment and soil properties, stratigraphic context, archaeological associations, volume excavated, materials recovered, and special collections. The form also includes space for drawing a plan of the locus and recording minimum and maximum depths. The locus form is complemented by digital photographs of the excavations made before and after the excavations of the locus. Profile sections were drawn before finalizing and backfilling the excavations. After the excavations, Harris matrices were compiled with the stratigraphic information as well as composite plans of inferred contemporary occupation levels.

The recovery strategy was based on two different but complementary techniques. Firstly, sediment excavated from each locus was screened using 5 mm meshes. For each locus, the total volume (measured as the number of ten liter buckets dumped into the screen including fractions) was recorded. All ceramic, lithic, and bones observed in the screens were handpicked, bagged, and tagged. The tags included site code, excavation unit, locus number, date, and the excavator initials. Some archaeological materials (such as charcoal samples for dating) were directly collected from the excavations. These materials, considered special collections, received a slash "/" number following their locus number and their point provenience (i.e., north, east, and elevation data) was mapped and recorded in the locus form.

Secondly, additional sediment samples that were collected in most formal archaeological contexts included bulk flotation and loose soil samples. Flotation samples (abbreviated hereon as flot) consisted of approximately ten liters of bulk sediment directly recovered from the excavations and deposited into large plastic bags. Loose soil samples of approximately 75 grams were collected for chemical, pollen, and phytolith analysis from most excavated loci and were also recovered directly from the excavation unit, and collected in medium sized Ziploc bags. Both flotation and bulk soil samples were considered special collections and thus, received slash numbers, and their point provenience was mapped in the locus form. Finally, micromorphological bulk samples were collected from the excavation profiles after profiles were drawn and photographed and right before backfilling.

Even though the excavation procedures used during the salvage archaeology and research-oriented projects were very similar, there are some noticeable differences. Some important similarities between both projects include the use of the locus excavation and recording systems as well as recovering archaeological materials using 5 mm mesh screens (Albarracin-Jordan 2005; Capriles 2008). Some of the most important differences that the research-oriented project included were: 1) recording the excavated volume associated with each locus, 2) utilizing fine recovery techniques such as the collection of flotation, soil, and micromorphology samples, 3) increasing detail in describing sedimentary, stratigraphic and contextual associations, and 4) documenting individual features in a geographic information system.

5.2.2. Intra-Site Spatial Data

All of the excavation locus forms including the excavations plans as well as the profile section drawings were transcribed and digitized. The excavation information was inputted into the project database and related to the survey data. In addition, Harris Matrices of the excavations were composed with the aid of excavations forms, plans, and profiles sections (see Harris 1989; Harris et al. 1992). Specific stratigraphic associations were formalized and specific archaeological contexts defined, described, and located within their stratigraphic relationships. Selected radiocarbon samples were analyzed from different stratigraphic, spatial, and contextual proveniences to verify the occupation sequence of the sites. Composite plans of more or less contemporary features were also composed.

To reconstruct cultural behavior at the excavated sites, I combined information from composite site plans, Harris matrices, quantification of feature and artifact distributions, and relational analogies. Specific intra-site spatial analysis of the collected information included:

1. Interpretation of identified formal features as probable corrals, houses, hearths, pits, burials, and others.

2. Quantification of the dimensions (i.e., surface area, perimeter, diameter, and when available volume) of identified formal features.

3. Distribution of different artifact classes as densities within sites.

4. Reconstruction of site formation processes and intra-site activity areas.

5. Tridimensional rendering of specific structures.

The produced information was further combined with artifacts and ecofact (especially faunal remains) analyses to make distributional analyses and infer different spatial and distributional patterns. I applied an integral assessment to all sites for reconstructing its spatial layout, occupation history, and formation processes by combining the data outlined above.

5.3. Archaeological Materials

The analysis of archaeological materials included archaeological artifacts and ecofacts recovered from both excavations seasons. All the recovered ceramic, lithic, and bone archaeological materials were washed, catalogued, and re-bagged (using both

Tyvek and Ziploc bags) in the field lab located in the community of Iroco. Bones were washed and dried in the shade to prevent additional weathering. All of these materials were individually catalogued using fine-point permanent markers. Flotation was carried out following standard protocols using a modified SMAP machine at the site of Tiwanaku (see Bruno 2008; Watson 1976). The recovered materials, including heavy fractions (0.5 mm) and light fractions (0.005 mm), were bagged separately for analysis. Heavy fractions were further sorted into different material classes including carbon, bone, burnt soil, ceramics, lithics, and among others. Light fractions were kept for the identification of macrobotanical remains.

I supervised all survey and excavation analysis, analysis of spatial and all faunal data. Other archaeological materials recovered from Iroco were studied as part of this project by specialists, including Patricia Alvarez Quinteros (ceramics), Sergio Calla Maldonado (lithics), BrieAnna Langlie and Maria Bruno (macrobotanical remains), Amanda Logan (phytoliths), Teresa Ortuño (pollen), and Melanie Miller (stable isotopes). Individual ceramic fragments were analyzed and recorded in forms that in addition to provenience data included technological, morphological, and stylistic attributes such as: diameter, form, firing, paste, exterior surface finish, and interior surface finish (Alvarez Quinteros 2008). Diagnostic specimens were drawn and photographed. Lithic analysis included the following attributes: individual measurements, raw material identification, reduction sequence, typology, and morphology (Calla Maldonado 2009; Capriles et al. 2011). Diagnostic specimens were also drawn and photographed. Although there is a wealth of information regarding these analyses, I will only focus on the distribution of certain attributes and their association with other cultural materials as they are directly related to the research question.

A sample of 22 light fractions recovered from the flotation samples was sorted and analyzed for identification of macrobotanical remains (i.e., wood, seeds, and parenchyma) during paleoethnobotanical analysis (Langlie 2011; Langlie and Capriles 2011). The results will provide a first assessment of the floral composition of the excavated sites. To further improve our understanding of the plant use within the site as well as test specific inferences regarding activity areas, 10 soil samples were analyzed for phytolith identification (Appendix 3). In addition, three samples of sediment were studied for pollen identification. A sample of 20 bone specimens from diverse taxa including camelids and humans were studied for carbon and nitrogen stable isotopes. In addition, I submitted a collection of 18 samples carbon and bone samples for radiocarbon dating at the University of Arizona-NSF AMS Laboratory (see Table 7.2). Data from these studies were used to assess chronology, paleoenvironment, herding intensity, cultivation, plant use, diet, and activity areas.

5.3. Faunal Remains

I performed a detailed study of the faunal remains recovered from the excavations at Iroco. Here, I will present some of aspects related to identification, recording, and recovery. I will also specify the definitions, analytical units and data analyses, used in the faunal study.

I applied a standard set of detailed zooarchaeology procedures and analyses to the faunal assemblage recovered during the excavations (Lyman 1994, 2005, 2008; Reitz and Wing 2008). Each specimen was individually identified to the most specific taxon and skeletal element possible. The portion (i.e., proximal, medial, distal), laterality, and epiphyseal fusion was recorded as well as cultural (e.g., cut, chopping and percussion marks, burning) and non-cultural modifications (e.g., weathering, carnivore damage, rodent gnawing). Quantification units included number of identified specimens (NISP), minimum number of individuals (MNI), and weight (measured in grams). Aggregation units included site component (or occupation level), depositional event, and provenience (excavation units, loci). NISP and component were the preferred units of analysis. Because several of the correlates for pastoralism are related to camelid use and consumption patterns, I especially emphasized information of variables that could be collected from the detailed study of camelid remains.

5.4.1. Camelid Intra-Specific Determination

For inter-specific comparisons, camelid specimens were identified and tallied only at the taxonomic level of family. However, I also attempted intra-specific determination of camelid remains because wild and domesticated species could be potentially present in the assemblages and understanding the extent of the variability associated with early camelid pastoralism is significant. Because camelid determinations of the four extant species based on fragmented bone specimens are difficult to assess, for intra-specific purposes, I employed different complementary analytical approaches. Specifically, I recorded incisor morphology, assessed the osteometric variation of first phalanges, and compared osteometric log size indexes.

Unfortunately, intra-specific determination of the bones from the four extant species of camelids is neither straightforward nor conclusive. In fact, because of their biological and ecological similarities, all species share a very similar morphology. In addition, some differences between specimens could be a consequence of environmental, ontogenetic, and idiosyncratic factors that could potentially hinder true distinctions between species. The fact that most specimens originated from fragmented archaeological contexts deposited thousands of years only aggravates the problem. Nevertheless, Andean zooarchaeologists have been tackling the problem of specific identification of camelid specimens for some time and currently there are a number of approaches that have proven useful depending on different cases for producing preliminary observations regarding intra-specific variability (Cartajena 2009; Grant 2010; Izeta 2009, 2010; Izeta et al. 2009; Kent 1982; Mengoni-Goñalons and Yacobaccio 2006; Mengoni-Goñalons 2008; Miller 1979; Miller and Burger 1995; Moore 1989; Wheeler 1982, 1995; Wing 1972; Vásquez Sánchez and Rosales Tham

2009). In this study, three complementary approaches were applied: 1) incisor morphology, 2) morphometric assessment of first phalanges, and 3) Meadow's log size index (Izeta et al. 2009; Meadow 1999; Wheeler 1985).

One of the most widely common approaches used to discriminate among camelids is the use of incisor morphology. Jane Wheeler (1982, 1985) described and documented differences between the incisors of vicuñas, alpacas, and llama/guanacos (Table 5.1). Unfortunately, the incisors of llamas and guanacos are indistinct and some alpaca incisor could resemble llamas, but this initial grouping is a good start. In this study, incisor morphology was recorded from individual isolated specimens as well as from specimens still inserted into mandible alveoli.

Another widely used approach is osteometry. There are several osteometric techniques that have been applied to measurements from camelid specimens and although there is a lack of consensus on which is better and what measurements should be focused on, some important steps have been advanced (for a recent review, see Izeta 2009). Most of these approaches are based on using modern reference specimens as the standard to which to compare archaeological specimens (Grant 2010; Izeta et al. 2009; Kent 1982; L'Hereux 2010; Miller 1979; Miller and Burger 1995; Moore 1989; Yacobaccio 2010). Modern camelids have a gradient size distribution beginning with vicuñas (smallest), alpacas, Sierra

Table 5.1. Morphological differences of camelid incisors (based on Wheeler 1982, 1985).

Taxa	Incisor Morphology
Vicuña	Rootless hypselodont parallel-sided permanent incisors with enamel covering the entire labial surface, and root-forming deciduous incisors with enamel covering only the upper labial surface
Alpaca	Deciduous and permanent root forming and parallel sided incisors, with enamel covering only the upper labial surface
Llama/Guanaco	Rooted deciduous and permanent spatulate incisors with an enamel covered crown

guanacos, llamas, and Patagonian guanacos (largest). Moreover, larger (guanacos and llamas) camelids differ from smaller (alpacas and vicuñas) often producing bimodal size distributions (Miller and Burger 1995; Moore 1989). Unfortunately each of these groups includes a wild and a domesticated species. Several osteometric studies have shown that although size ranges exist, overlapping occurs so no technique can fully discriminate among camelid species. However, osteometric assessments provide an idea of the variability in size distribution that might be related to animal procurement strategies. The assessment of camelid intra-specific determination at least provides a picture of morphological variation in different components through time.

The morphometric assessment of first phalanges is one of the most common approaches to intra-specific determination employed by Andean zooarchaeologists (Kent 1982; Izeta et al. 2009; Miller 1979; Miller and Burger 1995; Vásquez Sánchez and Rosales Tham 2009). The approach applied here follows the recent review by Izeta et al. (2009) with some modifications. Five measurements were collected from archaeological first phalanges using digital calipers (Figure 5.1). The measurements taken were: 1) maximum length, 2) breadth of proximal articular surface, 3) width of proximal articular surface, 4) breadth of distal articular surface, and 5) width of distal articular surface (Kent 1982:Appendix 4.1). Anterior and posterior phalanges were treated separately but undetermined specimens were also assessed. The measurements of the Iroco archaeological specimens were compared with modern camelid reference data. Kent's (1982) average measurements for vicuñas, alpacas and llamas were used as the modern reference specimens, but instead of using his data of Patagonian guanaco, a measurement of a modern sierra guanaco was used considering that it is the ancestor of the domesticated llama and its distribution included the central altiplano (Bonavia 1996) (Table 8.7). Quantitative treatments included exploratory data analysis using scatter plots and cluster analysis using unweighed pair-group average and Manhattan's similarity measure (Hammer and Harper 2006; Izeta et al. 2009).

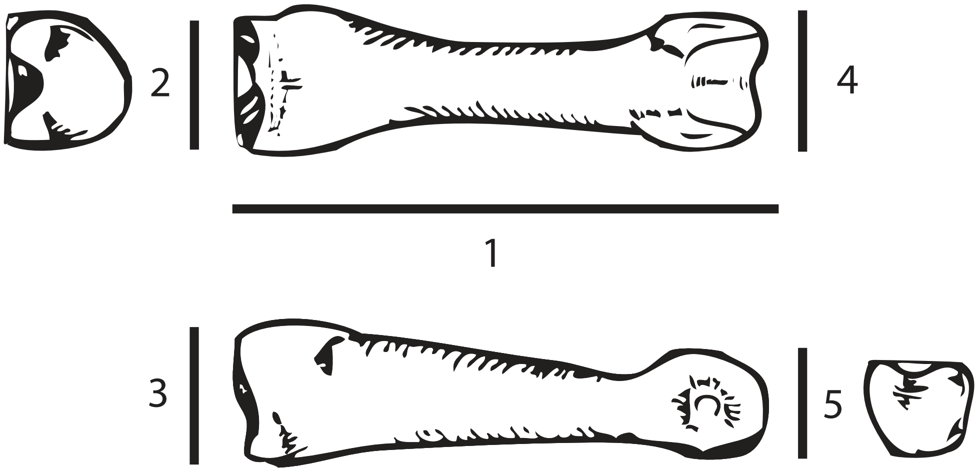


Figure 5.1. Measurements landmarks recorded from camelid first phalanges (redrawn from Kent 1982:Fig. 4.1).

Because the previous techniques relies only on one element, to further assess size variability and incorporate a greater number of elements independently of their individual sample sizes, Meadow's log size index was calculated (Linseele 2004; Meadow 1999; Russell et al. 2005). This technique standardizes and compares different measurements to a known standard. The specific assumptions, potential, limitations, and use recommendations of this technique were discussed by Meadow (1999). The standard used here is Kent's llama average for measurements that he defined (Kent 1982:Appendix 4.2).

In this study, Meadow's (1999) log size index (LSI) were multiple by -1 to place smaller individuals on the left and larger specimens to the right (a common sense approach that has been surprisingly omitted in the known references). The result is called Meadow's log size index (MLSI). The formula used in this study was:

$$MLSI = Log(x/m) * -1$$

Where "MLSI" is the Meadow's log size index, "x" is Kent's (1982:Appendix 4.2) llama average value for each specific measurement code and "m" corresponds to individual fused specimen measurements from the Iroco assemblages. The derived values were plotted into histograms, scatter plots and box-plots grouped by type of measurement and component. The formula is mathematically equivalent to the often cited standard animal differences-of-logs (SAI), but also multiplied by -1, which has the formula:

SAI = Log10(x)-Log(m)

It is worth clarifying that the MLSI results are not conclusive and only provide a measure of size dispersion. The main advantage of the MLSI (as a derive measure of the log size index) is that it allows grouping and comparing several different measurements from different elements in a single treatment. This makes full use of measurements dispersed among many body parts. Grant (2010) and Moore (1989) have both used this technique for camelids. A cursory evaluation of comparisons of the modern llama average with modern averages for Patagonia guanaco, sierra guanaco, alpaca, and vicuña suggests that some measurements are better for sorting species together than others because some differences between species can be as low as 0.01. A useful (but empirically often inaccurate) rule of thumb suggests the following variation ranges: Patagonia guanacos=+1, llamas=0, sierra guanacos=-0.05, alpacas=-0.1, and vicuñas=-0.2. Once again, values for all of the known species can overlap llama domesticates because not only are close to the family average, but also because llamas are a very morphologically plastic species and are closely located in size near the family size average. However, in the absence of better approaches and complementing other techniques for assessing intra-specific variation among camelid specimens, MLSI provides a useful approximation for assessing morphological variability.

5.4.2. Deriving Mortality Profiles

To determine the type of camelid slaughtering and herd management strategies I derived mortality patterns using data on epiphyseal fusion and mandible tooth eruption and wear (Kent 1982; Moore 1989, 2001; Wheeler 1982, 1999). The sequence of epiphyses fusion used here is largely based on Wheeler's (1999) recent revision, complemented by additional elements included in Kent's (1982:Appendix 2.5) dataset (Table 5.2). Both of these datasets provide complementary data estimation for age at death and can potentially provide information on management strategies including production emphasis, seasonality, and occupation intensity (Yacobaccio 2007; Zeder 2006). I also documented sexually dimorphic pubic symphyses attrition and male "fighting" canine teeth proportions to obtain a rough estimation of the sex-ratio of the camelid remains (Moore 1989; Wake 2007; Wheeler 1982). Several mammals, including camelids have a dimorphic pubic symphyses and their attrition follows a different sequence in males and females.

I recorded a number of different paleopathologies during the faunal analysis. Pathologies provide an idea of the sanitary and stress conditions to which animals (wild or domesticated) were exposed. Because of the specialized expertise required to correctly diagnose specific conditions and their causes, only acute and very clear cases were recorded. These should be consider examples of a probable greater repertoire of pathologies present in the Iroco assemblage. Documented instances include several of the commonly observed paleopathologies associated with camelid faunal assemblages in the Andes (Baker and Brothwell 1980; Cartajena et al. 2007; deFrance 2010; Izeta and Cortés 2006; Kent et al. 2001; Moore 2010; Park 2001; Wake 2007).

Table 5.2. Epiphyseal fusion and dental tooth eruption and wear sequence used in this study (from Kent 1982; Moore 1989; Wheeler 1982, 1999).

Stage	Age (months)	Element fusion	Mandible tooth eruption and wear
Nonates	0	Astragalus	Eruption of di1,di2,di3, dp3, dp4
Neonates	1 m	Metapodial M	Progressive eruption of m1
Juveniles	12-18 m	Scapula Glenoid	Eruption of m1, progressive wear of di1,di2,di3
	12-18 m	Humerus D	Progressive wear of dp3, dp4, and m1
	12-18 m	Radius-ulna P	Progressive eruption of m2
	12-18 m	Tibia D	Eruption of m2
Sub-adults	20-24 m	1st Phalange P	Eruption of i1,i2,i3
	24 m	Calcaneus	Shedding of dp3, strong wearing of dp4
	24 m	Humerus P	Progressive light wear of m1 and m2
Adults	33 m	Metapodial D	Progressive eruption of m3
Old adults	42 m	Radius-ulna D	Complete eruption of p3, p4, and m3
	42 m	Femur P	Wearing and loss of p3
	42 m	Femur D	Progressive light wear of p4 and m3
	42 m	Tibia P	Progressive wear of p4, m1, m2, and m3
	44 m	Radius-ulna Olecranon	Increased strong wearing of p4 and m1

5.4.3. Skeletal Element Representations

I evaluated patterns of attrition and possible sources of differential survivorship, distribution, and transport of elements using correlations of percentage of survival with ratios of volumetric density and economic utility (Izeta 2005; Lyman 1994; Stahl 1999). In this section I describe in detail the definitions and decisions involved in this particular analysis for purposes of clarification and standardization (for broader discussion on concepts, their definitions, and uses within zooarchaeology, see Lyman 1994, 2008). In this study, skeletal percentage of survivorship was measured with survivorship percentage of minimal anatomical units (MAU%). Minimal anatomical units (MAU) and minimum number of individuals (MNI) were used to estimate MAU% for each one of the eight components or assemblages. The highest MAU was designated as the MNI present at each component. MAU were calculated for each component by dividing the minimum number of elements (MNE) by the typical representation of a particular element or portion of element within a typical camelid skeleton (Benavente et al. 1993; Pacheco Torres et al. 1986) (Table 5.3). MNEs were recorded during the actual faunal analysis based on siding, size, and symmetry using the minimal aggregation unit of the locus to constrain the effects of spatial dispersion and fragmentation on the study.

To determine whether each assemblage was mediated by attrition, correlations between MAU% and volumetric density (VD) ratio values were performed. The VDs used in this study correspond to the volumetric density adjusted for shape values published by Stahl (1999:Table 2) with some restrictions. Of the 105 scan sites and values presented by Stahl (1999:Figure 1), a smaller data set composed of 50 of those values were used in this study. The selected VD values correspond to the highest VD value available for a particular element or portion of element as presented in Table 5.3. For instance, thoracic vertebrae includes three scan sites in Stahl's (1999) publication but only the highest value of the three was selected for this study. This is consistent with the idea that the strongest portion of the bone would be the one to be preserved and identified; an argument previously suggested and evaluated by others scholars (Gifford-Gonzales 1991; Lyman 1994:270).

Lyman (1994:270) observes that “if archaeologically observed frequencies of the scan sites correlate with their structural density, then there is every reason to anticipate that the frequencies of the larger counting units of proximal and distal halves of bones will also, because the latter are (or should be) the maximum MNE of a scan site found on the proximal or distal half of a long bone. Similar arguments apply to all other skeletal parts when those parts are defined by the utility or transport indices in such a manner that they contain more than one scan site”. In most cases, a finer grained specificity could have been approached but for the sake of standardization and comparability, the dataset used seemed adequate given the composition of the Iroco faunal assemblages. However, data on the representation of the 105 scan sites published by Stahl (1999) was recorded for the entire assemblage and exploratory treatments proved that even with detailed scan sites, the overall patterns presented below persisted. This suggests the 50 selected scan sites were sufficiently robust.

To determine whether each assemblage was mediated by economic utility (EU), correlations between MAU% and economic utility values were performed (Binford 1978; Lyman 1994; Mengoni-Goñalons 2001; Stahl 1999; Tomka 1994). Specifically, the values used in this study consist of 29 values derived from the adjusted fragmentary skeletal element meat utility index produced by Tomka (1994:Table 2.12) based on ethno-archaeologically butchered llamas. Some modifications were performed to Tomka’s dataset to maximize the number of elements or portion of elements represented by EU and the studied assemblage (see also Stahl 1999) and the final values are presented in Table 5.3.

In summary, in this study 50 elements or portion of elements were used for evaluating volumetric density and 29 for evaluating economic utility. This dataset includes 28 elements or portion of elements that correspond to each other. The missing value for the volumetric

Table 5.3. Identified elements used in this study related with values of number of elements on a typically represented on a camelid skeleton (N), volumetric density (VD), and economic utility (EU).

Element	N	VD	EU	Element	N	VD	EU
Cranium Neurocranium	1			Pelvis Acetabulum	2	1.89	2017
Cranium Maxilla	2		1344	Pelvis Illium	2	3.29	
Mandible	2	7.23	950	Pelvis Ischium	2	5.04	
Hyod	2			Pelvis Pubis	2	1.83	
Atlas	1	1.94	183	Femur P	2	1.41	5908
Axis	1	1.66	549	Femur M	2	1.5	
Cervical vertebrae	5	1.33	5448	Femur D	2	1.36	3454
Sternum	1	0.83	4932	Patella	2	1.45	3454
Ribs	24	3.36	2922	Tibia P	2	1.25	2227
Scapula Acromion	2	2.22		Tibia M	2	2.09	
Scapula Blade	2	2.12		Tibia D	2	2.07	1613
Scapula Glenoid	2	1.11	2934	Astragalus	2	2.14	1613
Scapula Spine	2	1.44		Calcaneus	2	3.75	1613
Humerus P	2	0.84	2948	Lateral malleolus Fibula	2	2.84	
Humerus M	2	1.42		Cuboid T4	2	1.49	
Humerus D	2	1.39	1858	Entocuneiform T2	2	2.45	
Radius-ulna P	2	2.1	1313	Navicular T3	2	2.39	
Radius-ulna M	2	2.06		Metatarsal P	2	2.08	150
Radius-ulna D	2	1.75	1040	Metapodial M	4	2.12	
Cuneiform Radial carpal	2	1.66		Metapodial D	4	3.43	147
Lunar Intermediate carpal	2	1.86		1st phalanx	8	3.2	147
Magnum C3	2	2.59		2nd phalanx	8	2.41	147
Pisiform Accesory carpal	2	2.61		3rd phalanx	8	3.1	147
Scaphoid Ulnar carpal	2	1.98		Thoracic vertebrae	12	1.97	2897
Trapezoid C2	2	2.34		Lumbar vertebrae	7	3.02	4608
Unciform C4	2	2.68		Sacrum	1	1.71	4608
Metacarpal P	2	2.39	143	Caudal vertebrae	11		
				Total	162	50	29

density is the cranium which was not included in Stahl's (1999) study. The 22 elements or portion of elements with volumetric density values not represented by equivalent economic utility values correspond to medial portions of long-bones and individual carpal and tarsal elements. Medial long-bone parts might be potentially represented by proximal and distal ends and carpals and tarsals were mostly likely riders attached to other elements such as the distal radius-ulna, proximal metacarpal, distal tibia, astragalus, calcaneus, and proximal metatarsal. There is a negative and statistically significant correlation between VD and EU values used in this study (r_s=-0.616, P<0.001, N=28) (Figure 5.2) (Stahl 1999).

Another set of constraints placed in VD and EU comparisons include the following. Complete elements were rare but when present, they were included as part of the proximal portion of the specific element they corresponded to and counted only once. The cranium was only counted when it was represented by fragments of maxillas and neurocranium specimens were excluded because fragmentation tended to inflate their overall frequency. Scapulae and innominate were segmented into portions of elements to limit the effect of fragmentation on these specific elements and because some specimens were often too difficult to side. As in the case of long bones, some overlapping might occur with a biasing effect limiting the frequency of some portions. Hyoid bones, caudal vertebrae, and sesamoids do not have either volumetric density or economic utility associated values and were excluded from comparisons. Very few of these specimens were identified in the Iroco assemblage. Isolated teeth (incisor, canines, and molars) were not included but should be represented by mandibles and cranium maxilla elements.

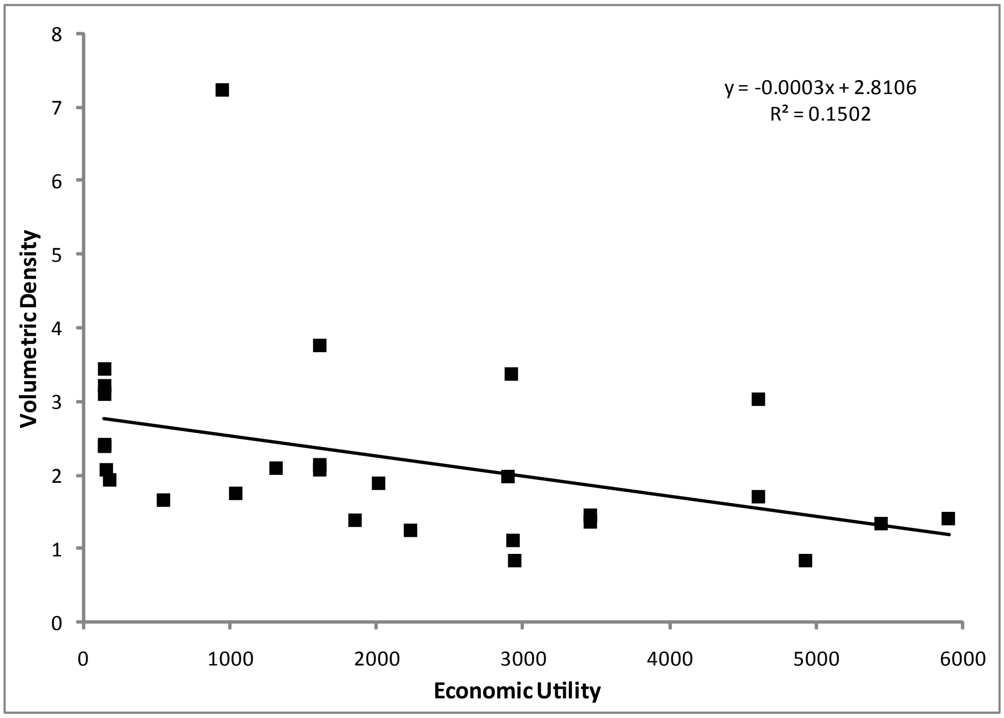


Figure 5.2. Relationship between volumetric density and economic utility for camelid skeletal elements (data from Table 5.3). Correlation is negative and significant (r_s=-0.616, *P*<0.001, N=28).

In this work, all the available VD (N=50) and EU (N=29) values were compared with MAU% (N=51) independently and not just the 28 compatible pairs in order to make individual correlations more data informed but it is expected that results would not be differ significantly. Furthermore, two data treatments were performed: a treatment including the totality of identified specimens and another one excluding elements worked into bone tools. The assemblages excluding worked bone are abbreviated %MAUw.

5.4.4. Cultural and Non-Cultural Modifications

I recorded a number of modifications observed on bone specimens and caused by a number of different behavioral and taphonomic agents. Some common modifications include bone tools (recorded as by-products of manufacture, finished products in use, and discarded used utensils), cut marks, chop marks, percussion marks (including impact scars), carnivore damage (including pitting, gnawing, incising, grooving, etc.), mechanical abrasion (often caused by trampling but also by directional transport), burning (or thermal alteration), weathering, and biological and chemical damage (such as carbonate salt precipitation on bone surfaces or color staining) (see Behrensmeyer 1978, 1991; Binford 1981; Choyke 1997; Fisher 1995; Lyman 1994; Nicholson 1998; Reitz and Wing 2008; Weissbrod et al. 2005). I should note that modifications were tallied by specimen and not by frequency within specimens. Some specimens indeed showed extreme modification (for instances, cut-marks or rodent gnawing marks) but these were counted by individual specimen. I refer to intensity as how many specimens with a given modification were observed and recorded.

5.4.5. Non-Camelid Taxa

Because of the aim of this dissertation, the faunal study emphasized the information that could be retrieved from camelids remains. However, similar variables were recorded on all studied faunal specimens. Most large mammal remains are distinguishable to genus level and care was taken to differentiate camelids from the occasional presence of taruka deer (*Hippocamelus antisensis*) or exotic animals that might have been deposited in more recent times (e.g., cattle, sheep, pigs). During identification analysis, I relied on reference specimens from the Colección Boliviana de Fauna (CBF) at the Museo Nacional de Historia Natural and the Laboratorio de Zooarqueología of the Carrera de Arqueología at Universidad Mayor de San Andrés in La Paz. I complemented identifications with reference guides and photographs of unavailable taxa.

Because of the nature of the available reference collection, I only identified bird bones and the most infrequent taxa to family level, noting size similarities and differences with regard to reference specimens. In the case of fish, I followed previous research regarding identification, and measured operculum bones to produce a size range of the identified specimens (Capriles 2006; Capriles et al. 2008). In the case of rodents, to differentiate similar species, I made additional measurements of cranium, mandible, and teeth. Occasional presence of non-funerary human remains was noted and quantified following the same standard protocol as for the rest of the faunal remains.

Considering that microfaunal remains such as fish, bird, and rodent bones tend to be underrepresented in faunal remains due to coarse grain site screening recovery, I collected and analyzed faunal remains recovered and sorted from flotation heavy fractions (Capriles et al. 2007, 2008; Moore et al. 1999, 2010). The recording procedure followed the same guidelines presented above. Data from screen and flotation recovery procedures were kept separate. A detailed dataset with all the recorded information was produced and is available in the appendixes. All the archaeological materials, including the faunal assemblages, recovered during the implementation of the research project are currently curated at the a local archaeological storage unit in the community of Iroco, which is jointly managed by Inti Raymi Mining Company, the local communities, and the Dirección General de Patrimonio Cultural of Bolivia.

CHAPTER 6

ARCHAEOLOGICAL SURVEY AND SETTLEMENT PATTERNS

6.1. Early Pastoralist Settlement Patterns at Iroco

In this chapter, I present the systematized data from the archaeological survey carried out in Iroco. Emphasis is given to information relevant for the research question. The complete raw data of the project is available in appendixes and previously presented papers and research reports (Albarracin-Jordan 2005, 2007; Alvarez Quinteros 2008; Browman et al. 2008; Calla Maldonado 2009; Capriles 2008; Capriles and Albarracin-Jordan 2011; Capriles et al. 2011; Langlie 2011; Langlie and Capriles 2011). The goal of the survey was to identify archaeological sites that could be used to characterize changing settlement patterns in the study area, especially as they relate to economic organization and pastoralism (Abdi 2003; Albarracin-Jordan 1996; Browman 1976; Cribb 1991; Hole 1968; Houle 2010; Parsons 1972; Parsons et al. 2000). Although the regional survey was primarily organized to identify pastoralist residential bases and camp sites specifically dated to the Formative Period, all abandoned archaeological occupations were documented.

To evaluate whether the settlement system of the Formative Period was characterized by dispersed villages (as suggested by previous archaeological research) or whether it was made up of a combination of residential bases and herding camps (as suggested by ethnoarchaeological research), I carried out a full-coverage regional survey over the project study area.

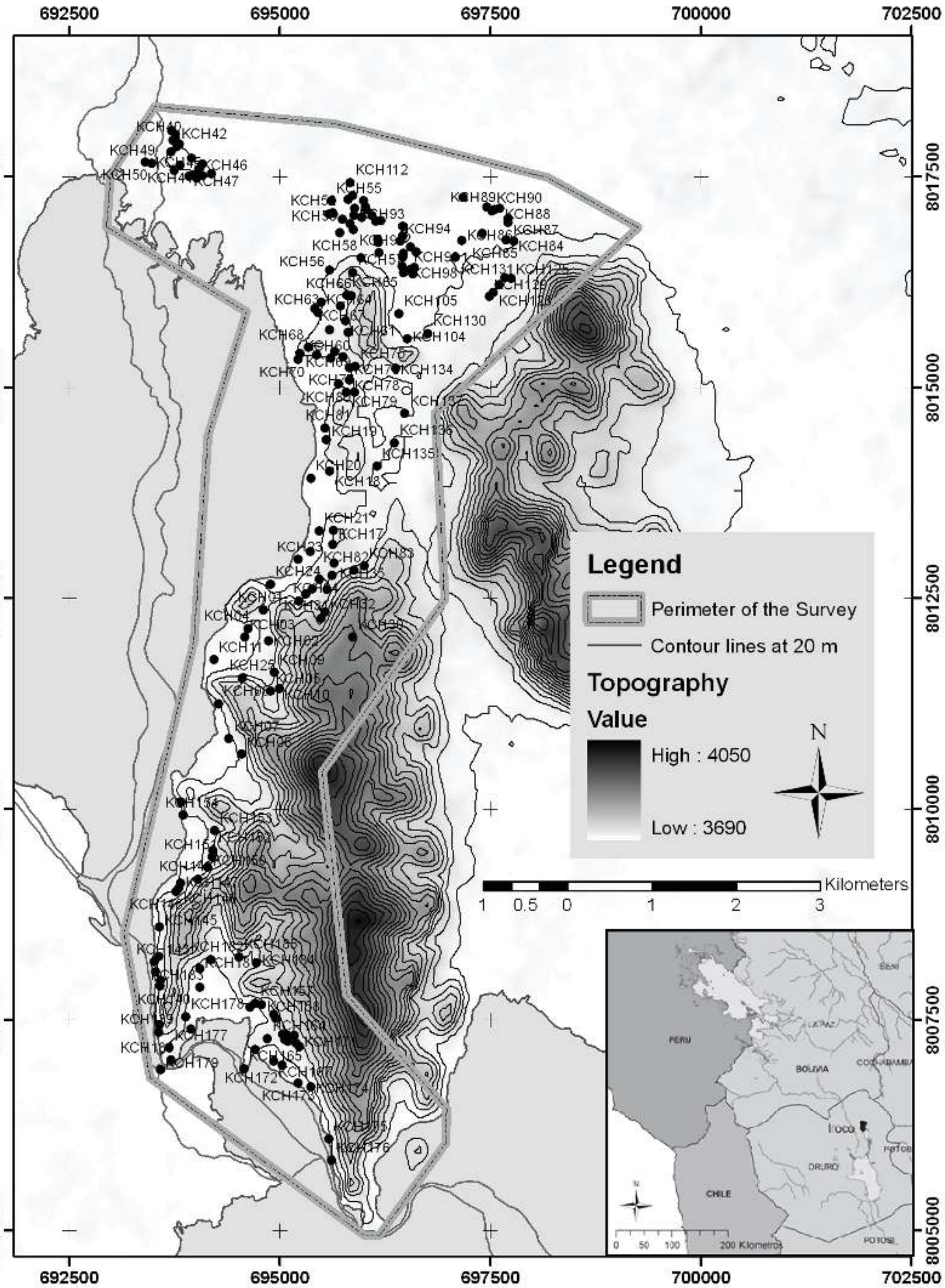


Figure 6.1. Location of all sites recorded in Iroco.

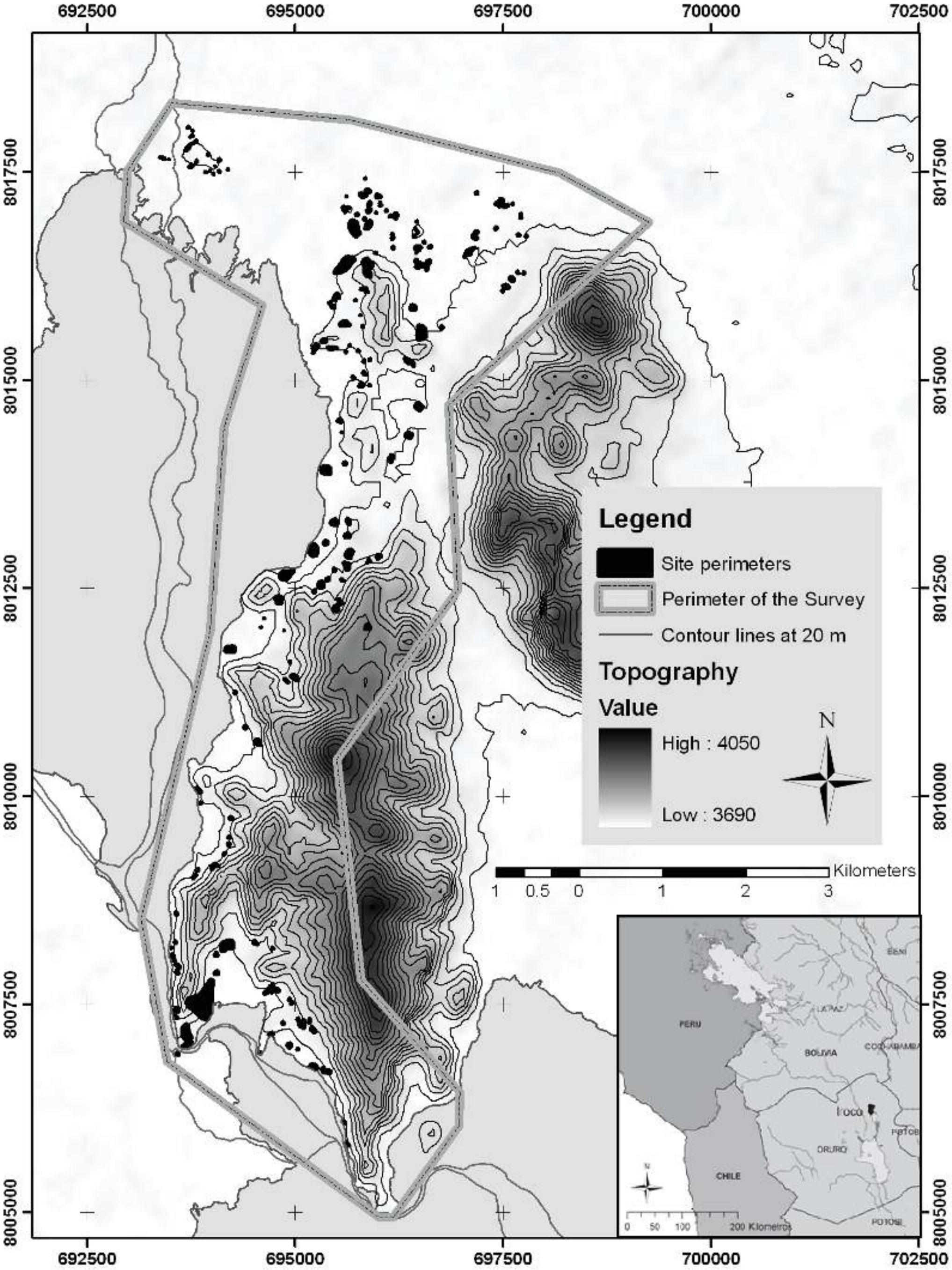


Figure 6.2. Perimeters of all components recorded in Iroco.

Within the 38.35 km^2 of terrain covered during survey, a total of 185 archaeological sites were identified, mapped, photographed, and described (Figures 6.1-6.2; Appendix 1). The average density of archaeological sites in the study area was very high (4.82 sites per km^2). Each of these sites was assigned to one or more of the following cultural components: Archaic, Formative, Tiwanaku, Carangas/Sora (or Late Intermediate Period), Inca, Colonial, Republican, and indeterminate (Table 6.1). A total of 331 components were recorded (Table 6.2). To provide a diachronic perspective (Figure 6.3), here I will focus on the settlement patterns associated with the Archaic, Formative, and Tiwanaku periods only (Figure 6.4).

Table 6.1. Comparative chronology of the study area (based on Albarracin-Jordan 2005; Ayala Rocabado 2001; Beaule 2002; Bermann and Estévez Castillo 1993, 1995; Capriles 2008; Klink and Aldenderfer 2005; Fox 2007; McAndrews 2005a; Michel López 2008; Michel and Lémuz 2002; Rigsby et al. 2005).

BP	AD/BC	South Central Andes	La Joya	Iroco	Climate	Environment
0	1950	Republican	Republican	Republican	Wet	Lacustrine
125	1825	Colonial	Colonial	Colonial	Wet	Riverine
418	1532				Wet	Lacustrine
450	1500	Late Horizon	Late Horizon	Inca	Wet	Riverine
500	1450	Late Intermediate Period	Late Intermediate Period	Sora, Carangas	Wet	Lacustrine
650	1300				Wet	Riverine
850	1100	Middle Horizon	Jachakala	Tiwanaku	Dry	Dryland
1100	850		Isahuara		Wet	Riverine
1450	500		Niñalupita		Wet	Lacustrine
2000	50	Late Formative 2	*Hiatus*	Formative	Dry	Riverine
2350	400	Late Formative 1	Late Wankarani		Wet	Lacustrine
2950	1000	Middle Formative	Middle Wankarani		Dry	Riverine
3450	1500	Early Formative	Early Wankarani		Wet	Lacustrine
3750	1800	Terminal Archaic	?	Archaic	Dry	Riverine
4500	2550	Late Archaic			Wet	Lacustrine
5800	3850	Middle Archaic			Very Dry	Dryland
7900	5950				Very Dry	Dryland
10000	8050	Early Archaic			Wet	Riverine
12000	10050				Dry	Riverine

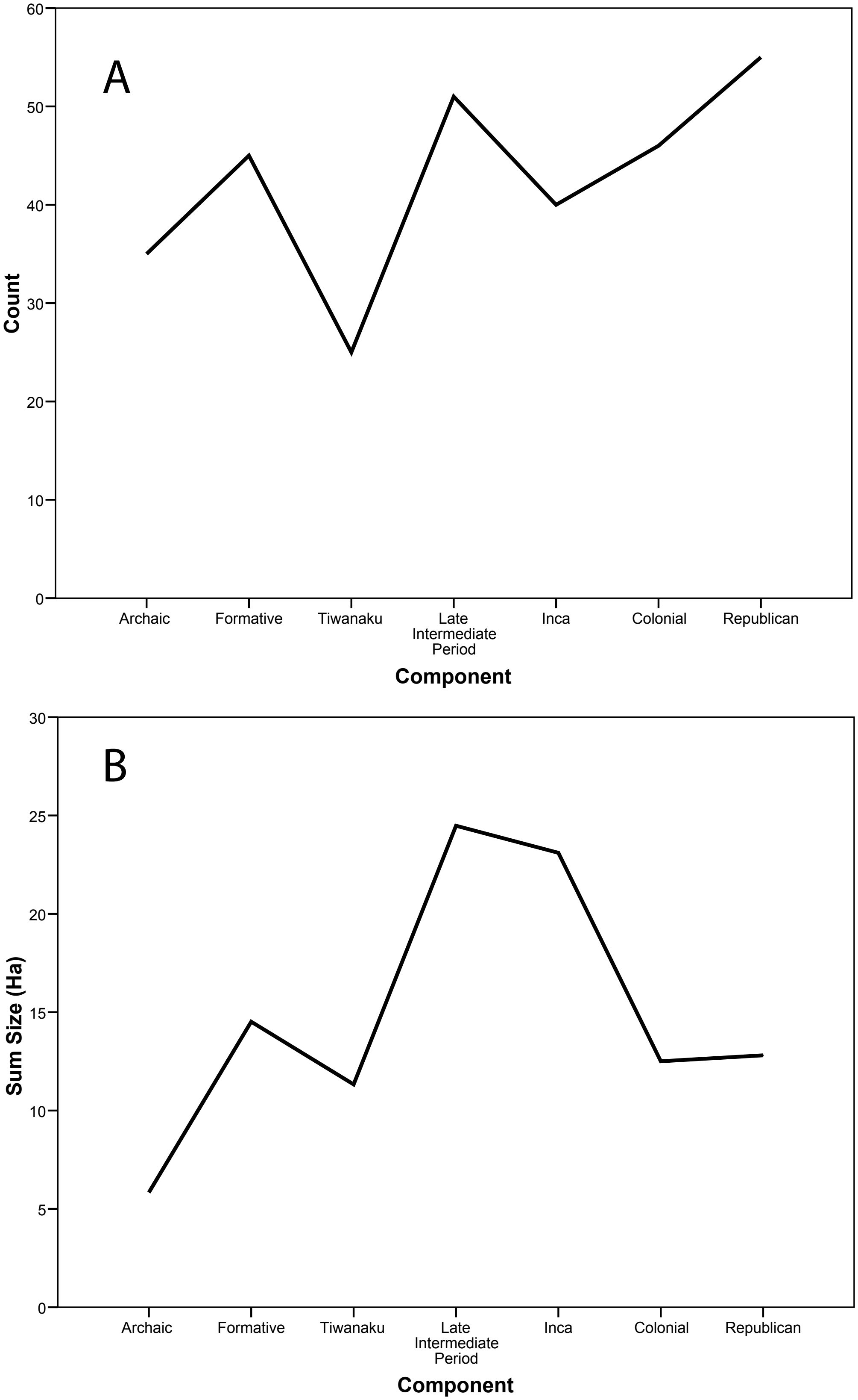


Figure 6.3. Settlement patterns change in Iroco as indicated by A) total number of sites and B) accumulated site area for all chronological components.

Table 6.2. Descriptive statistics of the settlement patterns identified at Iroco derived from the survey geographic information system.

Components	Total number of sites	Total occupied area (ha)	Avarage site size (ha)	Site density (sites/km2)	Altitude Average (m)
Archaic	35	5.83	0.17	0.91	3695
Formative	45	14.51	0.32	1.17	3700
Tiwanaku	25	11.33	0.45	0.65	3706
Soras, Carangas	51	24.48	0.48	1.33	3703
Inca	40	23.10	0.58	1.04	3702
Colonial	46	12.50	0.27	1.20	3702
Republican	55	12.81	0.23	1.43	3705
Indeterminate	34	9.21	0.27	0.89	3707
Total	**331**	**113.77**	**0.34**	**4.82**	**3702**

6.2. Archaic Period Settlement Pattern

A total of 35 sites were documented for the Archaic Period (Figure 6.5). The average density recorded for this period is 0.91 sites per km^2. Together, these settlements cover an area of 5.83 hectares, reaching an average area of 0.17 ha (SD=0.34). Only three of these sites have more than a half hectare in surface. An average nearest neighbor analysis determined that during the Archaic Period most settlements were slightly clustered between each other (Mean distance=257.63 m, SD=321 m, Expected distance=325.34 m, Nearest Neighbor Ratio=0.79, Z Score=-2.35, *P*=0.018).

The distribution of these sites is concentrated around a series of low hills, plains and dunes located near the confluence of Karakollu River in Lake Uru-Uru, in the northern sector of the survey area. The settlement pattern suggests the presence of at least three clusters of base camps surrounded by a number of stations, camps, and workshops distributed dispersedly along the plains, small hills, dunes, and the shoreline. These clusters suggest redundant use of this area during the Archaic Period, perhaps in association with improved environmental conditions and the presence of wetlands and *bofedal* patches. In addition,

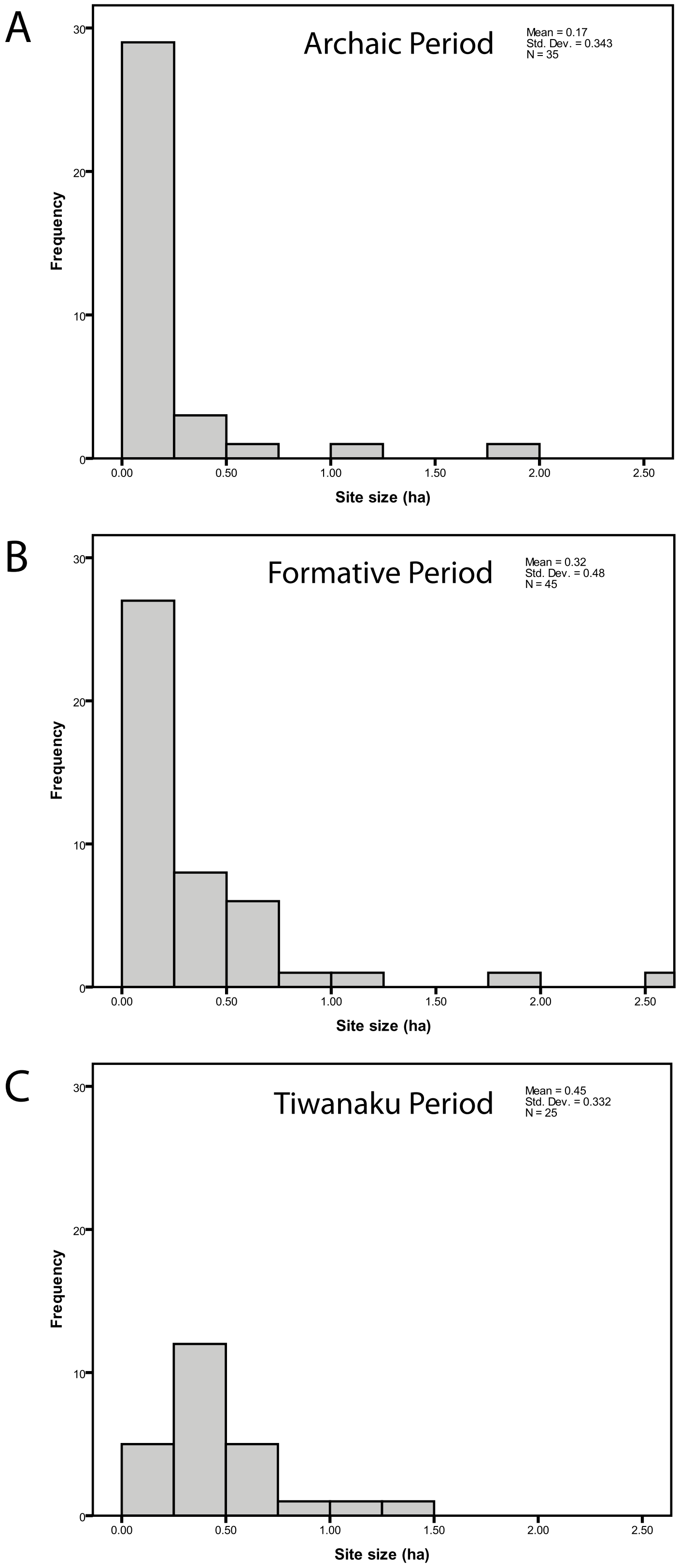


Figure 6.4. Settlement size frequencies by time period in Iroco. A) Archaic Period, B) Formative Period, C) Tiwanaku Period.

several of the camp sites located around Cerro Jayo Khollu in the northwest corner of the region, include workshops associated with chert outcrops. While chert outcrops are also occasionally found in other hillsides and ridges and might have been a factor in settlement location, lithic analysis suggests that the most commonly used raw materials were foreign black basalt and dark cherts (Capriles et al. 2011).

A synchronic interpretation of the settlement pattern suggests extensive use of aquatic environments in addition to strategic access to alluvial plains and foothills. Resources from these environments included the productive wetland and marshes but also access to other less productive habitats. Furthermore, the location of the foragers camps seem to be strategically located between the wetlands and the hills, a region intermediate between wild camelid feeding and sleeping territories (see Tomka 1992).

The great morphological variability of projectile points and other lithic tools found in these sites suggests that the occupations span much of the Holocene. In fact the typological and technological diversity of the assemblage suggests that the sites might have been occupied during all Early (10,000-8000 BP), Middle (8000-6000 BP), Late (6000-4400 BP), and Terminal Archaic (4400-3800 BP) Periods (Capriles et al. 2011; Klink and Aldenderfer 2005). Although the chronology of the Archaic Period settlement pattern at Iroco requires further refinement, given that this is the first systematic survey of the period in the central altiplano, it would be misleading to propose a finer grained chronology without absolute temporal control. The presence of Early Archaic sites has been confirmed by the dating of site KCH20 to ca. 9000 calibrated BP present making it the oldest radiocarbon-dated settlement of the region (see Chapter 7).

A phase of increased aridity during the Middle Holocene has been interpreted in paleoenvironmental reconstructions of the highland south central Andes and it is also present in the Desaguadero River sequence (Rigsby et al. 2005). Archaeologists working in northern Chile have established a period of possible "archaeological silence" during the Middle Archaic Period associated with increased aridity (Núñez et al. 2005). Given

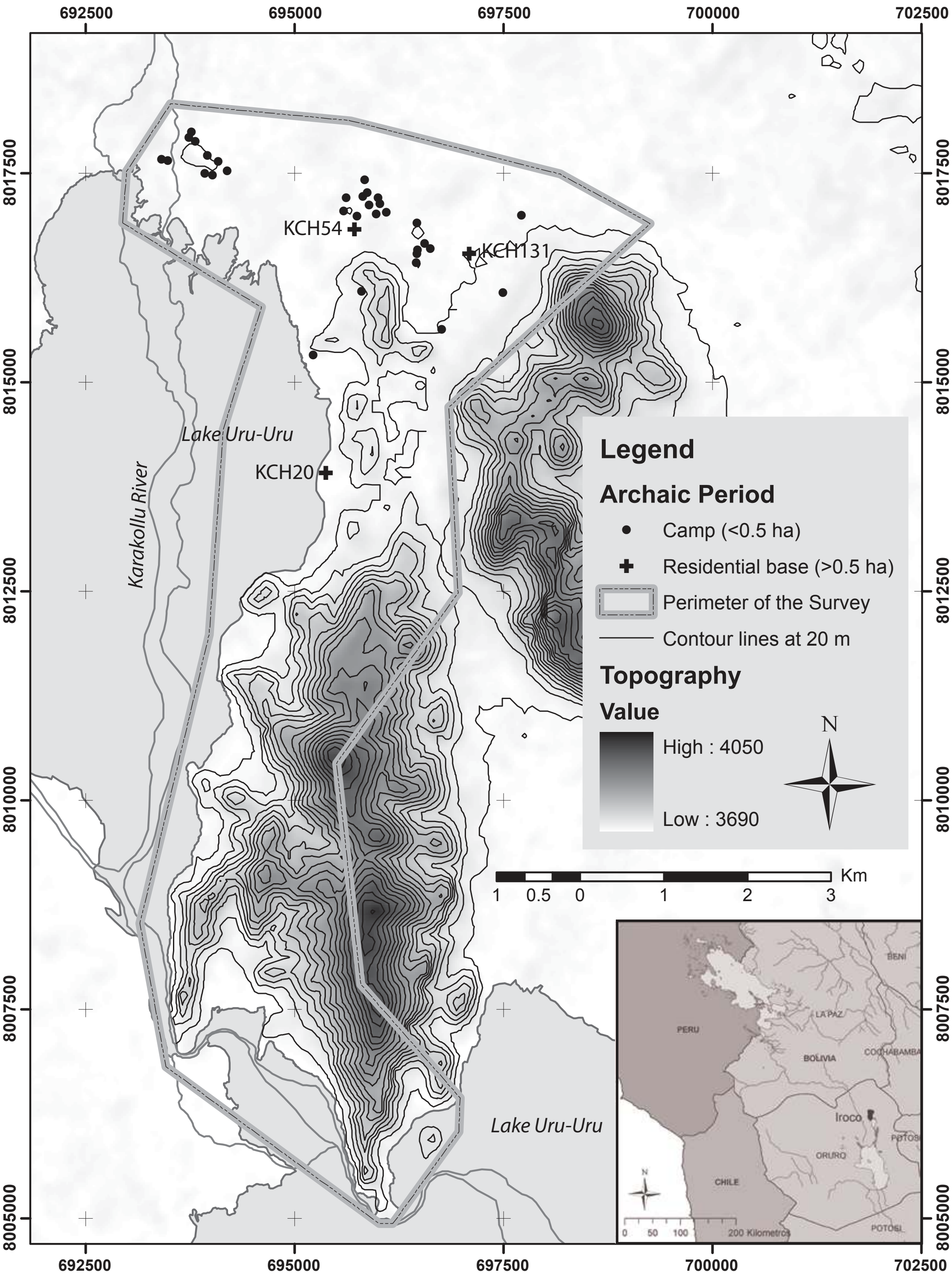


Figure 6.5. Settlement pattern of the Archaic Period.

the strong association between Archaic Period settlements and aquatic environments, it might be expected that the Iroco region was largely depopulated during this time. However, similarities that we noted in the use of lithic raw materials and a possible long-term lithic tool manufacture tradition suggest possible occupation continuity throughout this time (Capriles et al. 2011). Further research is required to better understand the Archaic Period occupation sequence at Iroco and its relationship with other subsistence process including animal domestication.

6.3. Formative Period Settlement Pattern

A total of 45 Formative Period sites were recorded (Figure 6.6). The cumulative surface area of these sites is 14.51 hectares. The average site size is 0.32 ha (SD = 0.48) and approximately ten of these sites are larger than half hectare. The density of recorded settlements amounted to 1.17 sites per km^2, slightly higher than the previous period. The nearest neighbor average distance decreased to 211.86 m (SD=212 m) producing a stronger pattern of clustering (Expected Mean Distance=507.79 m, Nearest Neighbor Ratio=0.42, Z Score=-7.48, $P<0.001$). Interestingly, only six sites include Archaic and Formative components. These sites are among the largest of the sites identified in the survey and together occupy 3.85 hectares.

The Formative Period settlements at Iroco generally consist of relatively dense surface scatters of ceramic sherds (mainly undecorated cooking pots and storage jars) and lithic tools and debitage. Distribution of lithics and their technological, functional and morphological properties suggest exploitation activities and expedient production. At least 14 different raw materials were utilized in lithic production; these included several exotic sources (e.g., black basalt, dark chert, obsidian, jasper, sodalite). Unifacial scrapers were the dominant tool type but stemmed and foliate projectile points, hoes, and knifes are also frequent (Capriles et al. 2011).

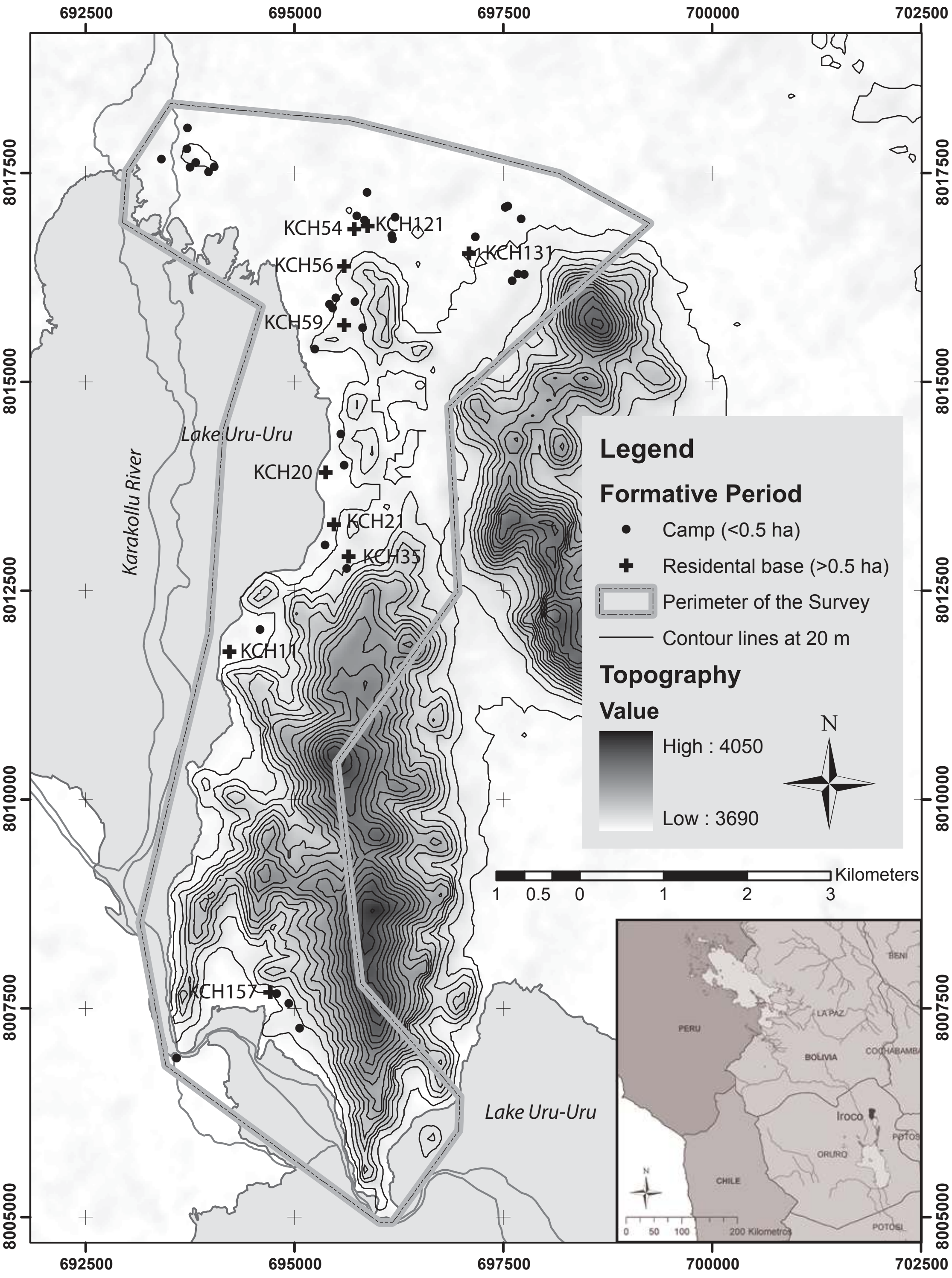


Figure 6.6. Settlement pattern of the Formative Period.

The ten sites larger than 0.5 hectares have substantial evidence of domestic occupations and were probably occupied as residential bases (Table 6.3). The rest of the sites (N=35) were mostly identified as artifacts dispersions and were probably occupied as temporary, seasonal or logistical herding camps –although some of these smaller sites clearly had significant and dense occupations (Capriles 2008). If the ten largest sites are analyzed the results of the nearest neighbor analysis suggests a pattern of dispersion (Observed Mean Distance=1016.67 m, Expected Mean Distance=592.13 m, Nearest Neighbor Ratio=1.72, Z Score=4.34, *P*<0.001). This result supports the interpretation of a settlement pattern constituted of residential bases surrounding by herding camps.

Larger settlements typically include surface architecture, including wall foundations of circular and semi-circular structures composed of large boulders, patches of burned ground, and high densities of surface artifacts. Several of the larger sites include incidental profiles produced by erosion processes that include stratified by-products of overlapping occupation levels of domestic activities in the form of sectioned middens and trash pits including protruding bones, ceramic sherds, and lithic flakes. Most large sites were probably single residential bases or aggregates of few residential bases. A notable exception is

Table 6.3. Summary of the ten largest Formative Period sites identified during the Iroco survey. The distance to the nearest neighbor is in meters and distances to nearest shore in kilometers.

Site	Northing	Easting	Elevation	Area (m2)	Area (ha)	Height	Nearest Neighbor	Distance to Karakollu River	Distance to Lake Uru-Uru	Ceramics	Lithics	Archaic Occupation
KCH56	8016384	695598	3706	25419	2.54	2.5	454.08	1.99	0.82	18	34	No
KCH54	8016823	695714	3687	17794	1.78	0.5	170.78	2.13	1.03	16	55	Yes
KCH20	8013916	695373	3690	10123	1.01	0.5	631.04	1.57	0.09	1	20	Yes
KCH11	8011764	694223	3692	8531	0.85	2.5	1833.74	0.61	0.11	15	7	No
KCH35	8012913	695652	3712	7190	0.72	1.5	419.59	1.93	0.44	52	1	No
KCH131	8016534	697089	3695	6298	0.63	0.5	1252.21	3.48	2.23	23	23	Yes
KCH59	8015673	695595	3715	6085	0.61	1.0	711.15	1.93	0.56	25	10	No
KCH121	8016862	695880	3706	5887	0.59	0.5	170.78	2.28	1.20	19	12	No
KCH21	8013293	695474	3704	5519	0.55	1.0	419.59	1.79	0.14	16	6	No
KCH157	8007690	694714	3697	5433	0.54	2.0	4103.70	0.63	0.18	15	33	No
Mean			**3700**	**9828**	**0.98**	**1.25**	**1016.67**	**1.83**	**0.68**	**20**	**20**	

KCH56, which with its 2.54 hectares size might have been an aggregated site or village. Some of the larger sites seem to have formed as a consequence of redundant occupation and reoccupation of the same location over time. The average height of the ten largest sites is 1.25 m (SD=0.82) and in this respect they strongly resemble the mound settlements typically associated with the Wankarani cultural complex elsewhere (Figure 6.7) (Bermann and Estévez Castillo 1995; Fox 2007; McAndrews 2005a; Ponce Sanginés 1970; Wasson 1967).

The distribution of settlements is more scattered than in the previous period and clusters are more separated. There is nevertheless, still a significant connection of sites to the shores of Karakollu River and Lake Uru-Uru. This distribution suggests the establishment of five to seven clusters of residential bases associated with herding camps. These clusters follow the eastern shore of Karakollu River and the western foothills of surrounding hills in locations strategic for benefitting from both aquatic and inland resources, and providing ready access to aquatic resources and pastures.

The location of Formative Period sites is also tightly constrained to the shores, plains, and foothills, with a general absence of sites in the upper hills. This might be a consequence of higher slopes and consequently, stronger erosion processes and poorer preservation. However these areas were probably occasionally used for grazing as they are today. The distribution of sites, also includes the Cochiraya dunes suggesting that this area was more humid than today. Moreover, the presence of sites within the region of modern cultivation indicates that farming might also have been an important activity. However, modern cultivation is mostly feasible because of recent technological improvements including artificial irrigation and fertilizers, so this statement requires archaeological investigation.

The absence of corporate monumental architecture or large-scale labor works, in addition to the size, distribution, and spacing of sites suggest absence of strong political integration. One must bear in mind, however, that the survey area is small compared to the size that a given polity might have encompassed and probably did not include a central

Figure 6.7. Site KCH157 viewed from the southwest with the characteristic mound configuration of Formative Period Wankarani cultural complex sites.

place. Moreover, although some Formative Period sites are located in strategic locations such as the top of hills and include features like perimeter walls and terraces (requiring greater labor investment) that might have been used for defense; these were probably constructed during later occupations and particularly during the Late Intermediate Period as suggested by the abundant ceramics of this time period at these sites. Consequently, the results of this survey do not support interpretations/hypothesis of political vertical integration of the region for the Formative Period.

The settlement system of the Formative Period marks an important contrast with the Archaic Period. Although the plains and lower slopes are still preferred areas, the gap between settlement clusters seems to increase. New areas were colonized both east towards eastern inland *quebradas* and southern foothills, possibly in association with specific resources (e.g., springs, pastures, and good agricultural soils). Although the increase in the number of sites between the Archaic and Formative periods was 10 sites, that is, an increase of 29%, the increase in occupied area was 8.68 hectares, or 149%. Many of these larger sites also include high densities of artifacts, architectural surface (foundations of semi-circular structures) and mounds. Interestingly, the only three Archaic Period sites that exceed 0.5 hectares correspond to sites that also have Formative occupations. These sites possibly consisted of base camps that constituted the material culture foundations for the growth of the settlement system during the Formative Period.

More importantly, the settlement pattern associated with the Formative Period might reflect a wider use of the available space to optimize access to grazing territories. Sites are located in relation to accessibility to key resources such as permanent sources of water and seasonally shifting resources. The connection to the lacustrine environment persists but the occupation of inland territories is evident. The spacing between sites and the distribution of ephemeral camps in between is compatible with a model of camelid pastoralism as will be discussed in Chapter 8.

6.4. Tiwanaku Period Settlement Pattern

The consolidation and expansion of the Tiwanaku state (AD 400-1100) in the Lake Titicaca basin immediately following the Formative Period produced a substantial change in the economic and political organization of the societies occupying the south central Andes (Albarracin-Jordan 2007; Janusek 2008; Stanish 2003). The consequences of this expansion are manifested in the archaeological record observed in Iroco (Figure 6.8). The settlement pattern changes include fewer sites (N=25) and smaller occupied area (11.33 ha) but more importantly changes in site location and distribution. Most of the sites in the northern sector of the survey area were abandoned and there was an increase in sites in the central sector of the survey area.

Although I observed a reduction of number of sites and area occupied, two factors suggest population might have actually increased during this time. Firstly, the Formative Period settlement pattern covers a larger time frame than the Tiwanaku Period and most probably not all the Formative Period sites were occupied contemporaneously. Secondly, ceramic densities in large settlements were considerably higher than Formative Period sites, and these included imported Tiwanaku ceramics. This pattern probably is connected to increased use of vessels in redistribution feasts, related to other socio-political processes, but also to aggregation of populations in villages. In addition, several of the large sites included protruding slab burials, large architectural features such as corrals, and in a few cases, habitation and agricultural terraces. Other changes at the site level include changes in burial patterns and possibly in domestic architecture.

The majority of the Tiwanaku Period sites are clustered in the middle of the survey area (near the modern community of Iroco). This area might have experienced greater population aggregation and it seems agricultural production and investment became increasingly important. The clustering pattern observed near the community of Iroco strongly resembles the distribution of sites near Lake Titicaca where the spacing between agricultural villages was substantially reduced compared to earlier periods (Albarracin-Jordan 1996; Bandy 2001). Furthermore all sites seem to occupy good agricultural soils connected with a permanent source of water enclosed by two hills. This setting produced a microenvironment that probably had more frost-free days than the open landscape. The cluster of sites identified in the surroundings of the community of Iroco probably functioned as an agricultural village.

In addition to the settlement cluster at the center of the survey area, the settlement system includes evenly distributed large sites. This pattern and the presence of a large site located in the northeastern portion of the survey area and another one in the southern portion suggests strategic control of the accessibility to the Iroco settlement system. Control of accessibility has been demonstrated to be a critical strategy of expanding empires (Jennings

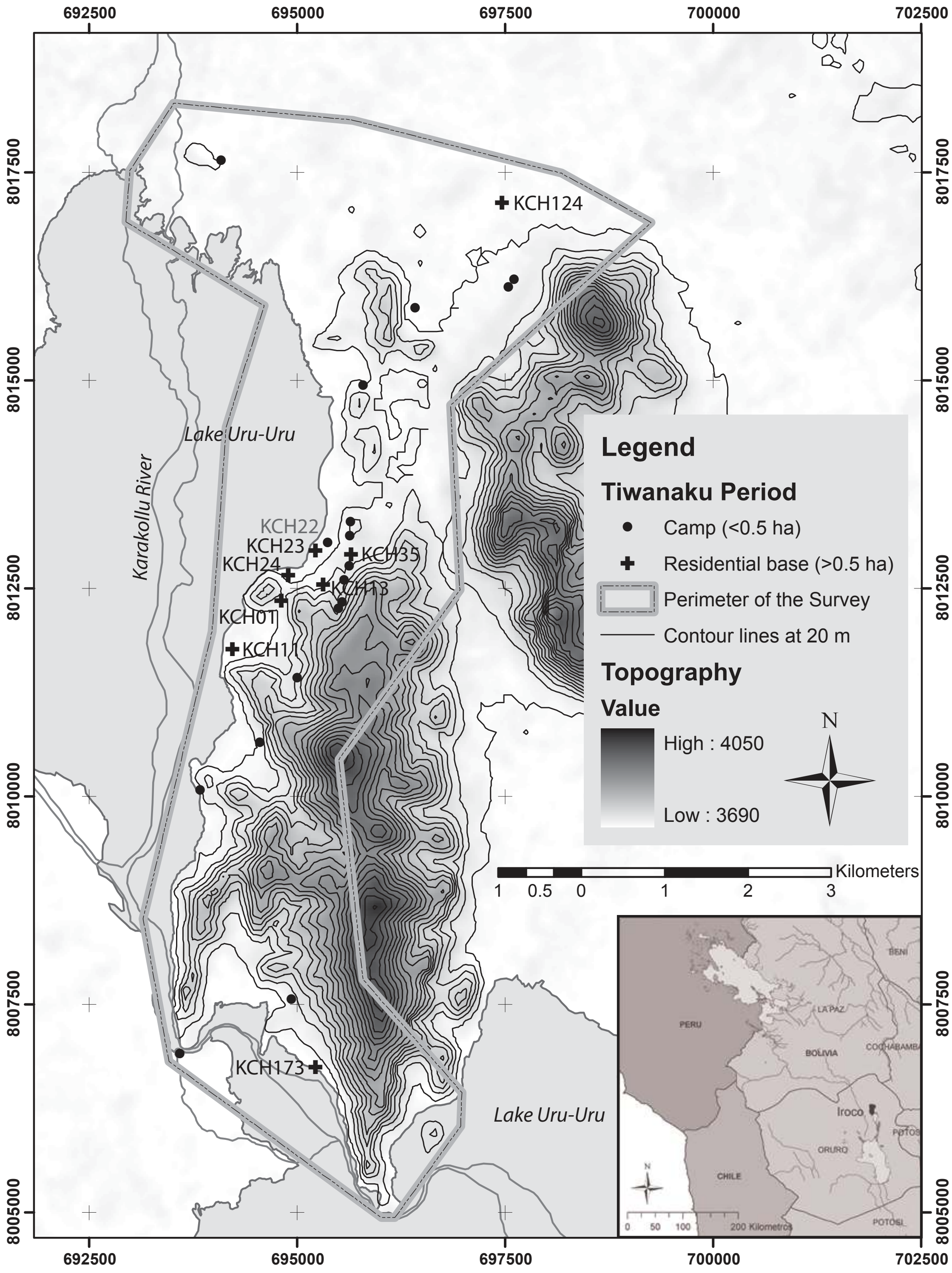


Figure 6.8. Settlement pattern of the Tiwanaku Period.

and Craig 2001). The Tiwanaku occupation of Iroco seems to involve both the promotion of elite centralization and the control of accessibility. Another possibility is however, that these sites grew as a consequence of economic growth and regional interaction, but were not directly controlled by either the Tiwanaku state or the emerging Iroco elites.

The settlement patterns that I identified suggest that camelid pastoralism continued to be a strong component of the economy. I hypothesize this could have been a response to increased requirements for caravan transport animals and secondary products for exchange such as camelid wool and textiles. The growth of caravan exchange in other regions of the central altiplano at this time is supported by increased imported goods but also by the frequent presence of large corrals in Tiwanaku settlements (see also Beaule 2002; Bermann and Estévez Castillo 1993; Michel López 2008; Michel and Lémuz 2002). The growing political control along with more efficient control institutions would have allowed increased institutionalized territorial control favoring economic expansion and possibly specialized camelid pastoralism.

In the absence of corporate religious architecture, the incorporation of Iroco into the Tiwanaku political economy probably involved religious and commercial changes that promoted aggrandizement of local elites and increased social interaction and exchange between regions. Increased reliance on agriculture, specialized pastoralism and possibly staple exchange probably involved a reduction of the use of aquatic resources. These patterns are in line with increased agricultural output, specialized pastoralism, and interregional interaction (see Albarracin-Jordan 2007; Janusek 2008; Stanish 2003).

6.5. Settlement Patterns after the Disintegration of the Tiwanaku State

Because the main goal of this dissertation is to understand early camelid pastoralism, I will only briefly discuss the nature of the settlement pattern changes after the Tiwanaku Period (but see Capriles 2008). In Iroco, the Late Intermediate Period (AD 1100-1450), following the disintegration of the Tiwanaku state, is characterized by a substantial increase in the number of sites, slight increase in average site size, and a dispersed settlement pattern. The observed settlement dispersion is most likely a result to a greater reliance on camelid pastoralism, perhaps in correlation with increased aridity and macro-regional political unrest (Arkush 2009; McAndrews 2005a; Pärssinen 2005; Stanish 2003). Some ridges and hills were also occupied for defensive purposes. Although the specific ethnic group that occupied this area is uncertain, probable candidates include factions or segments of the Carangas and Soras (Del Río 2005; Medinacelli 2010; Molina Rivero 2006; Wachtel 2001).

During the Late Intermediate Period a large set of settlements in the southern sector (i.e., Chuzekery) grew much larger than other sites. Here two large cemeteries of adobe burial towers or *chullpa* were constructed (i.e., KCH177 and KCH178, each comprising about 20 different burial towers) (Figure 6.9) (Pärssinen 2005; Trimborn 1967). Domestic occupations were also identified at the base of these cemeteries. Pärssinen (2005:157-158) sampled unburned straw from adobes of two burial towers from site KCH177 for radiocarbon dating. The two dates produced a combined calibrated result of AD 1206-1372, confirming their Late Intermediate Period age (Table 7.2). The construction of *chullpa* burial towers and the accompanying ancestor cult has been associated with increased need for institutionalized control of territory promoted by competing factions of Aymara kingdoms (Kesseli and Pärssinen 2005; Pärssinen 2005). The presence of large cemeteries in Chuzekery suggests the region incorporated significant political importance.

The Inca Period (AD 1450-1532) is represented at Iroco in the form of a dispersed settlement pattern that includes a few large sites. The Incas implemented different strategies of conquest and control depending on the region. Because Iroco was not the setting of major population aggregation or political control, the Inca presence seems to be a collateral process and part of the broader imperial control of the central altiplano. At Iroco, no regional centers were discovered but several Inca contemporary sites were reported.

Figure 6.9. Site KCH177 viewed from the east with chullpa burial towers dated to the Late Intermediate Period.

For instance, at Chuzekery several fragments of Inca ceramics suggest conspicuous consumption associated with the pre-existing *chullpa* ancestor cult. In addition, there are a few large sites with evidence of corporate architecture, but nothing comparable to what was occurring in the neighboring area of Paria, where one of the largest Inca regional centers was built (Condarco et al. 2002). Finally, during Colonial (AD 1532-1825) and Republican (1825-present) periods, the area seems to have been occupied by sparse residential sites that possibly produced agricultural goods consumed by the growing population and mining activities of Oruro. Also, during Republican times, limestone outcrops were exploited for the extraction of raw material for the production plaster, and about a dozen abandoned plaster-production ovens were identified in the Iroco landscape.

CHAPTER 7

ARCHAEOLOGICAL EXCAVATIONS AND SETTLEMENT LAYOUTS

To specify the layout and activities that took place in the herding-related settlements, I present data from eight components or occupation levels excavated at five sites (Figure 7.1). Briefly, site KCH20 is one of the largest Archaic Period settlements of the region and although it has a Formative component, only the Archaic Period occupation of the site was sampled (16.25 m^2). KCH21 is a mostly Formative Period residential base that was extensively sampled and where three occupation levels were recorded (414 m^2). KCH56 is a large Formative Period residential base from where a structure and its associated outside area were sampled (16 m^2). KCH11 is a tall mound that included Formative and Tiwanaku occupations, both of which were sampled (72 m^2). KCH22 is a smaller Formative and Tiwanaku camp site where only a Tiwanaku occupation was excavated (128 m^2). In this section, I will focus on site stratigraphy, layout, and feature distribution of these five sites.

Table 7.1. Summary of the eight chronological components analyzed in this study. Note that the Formative Period component identified at KCH22 was not excavated.

Site	Component	Chronology	Features	Excavation Units	Excavation Area (m2)	Depositional Events	Excavated Loci
KCH20	KCH20Arch	Archaic	1 possible structure	6	16.25	5	31
KCH21	KCH21FA	Formative	8 structures	16	231	65	197
KCH21	KCH21FB	Formative	3 structures, 11 burials	22	334	30	81
KCH56	KCH56FA	Formative	1 structure	1	16	21	27
KCH11	KCH11FB	Formative	3 structures	6	72	4	22
KCH21	KCH21Tiw	Tiwanaku	2 structures	27	414	4	46
KCH11	KCH11Tiw	Tiwanaku	3 burials	1	17	5	5
KCH22	KCH22Tiw	Tiwanaku	2 structures, 4 burials	3	48	5	14
Total				**82**	**1148.25**	**139**	**423**

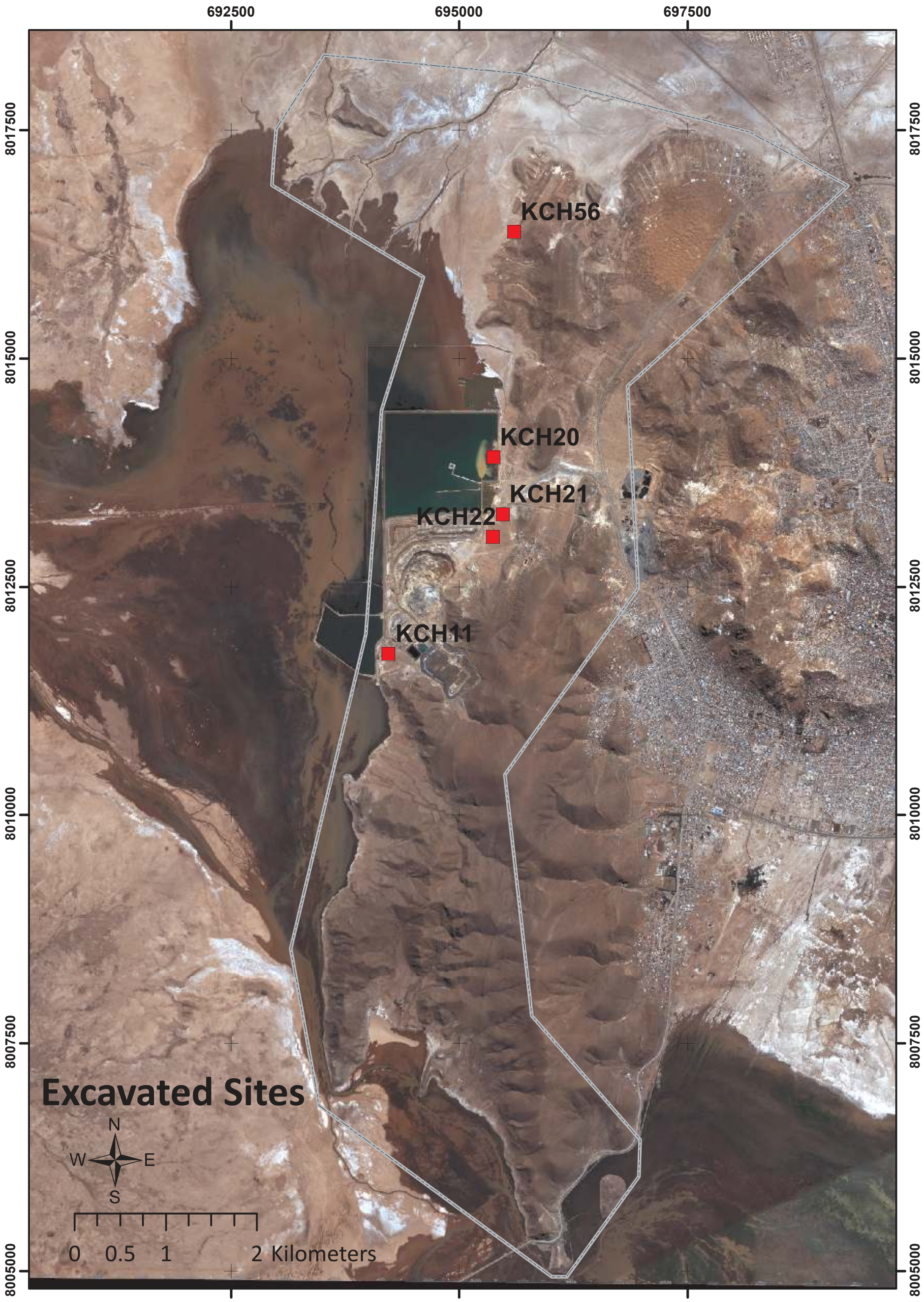


Figure 7.1. Survey area displaying sites excavated and with analyzed faunal remains.

I will spend more time describing the excavations result from KCH21 because this site was extensively sampled but I will also go over significant findings from excavations at sites KCH20, KCH56, KCH11, and KCH22 (Table 7.1; Appendix 2).

7.1. KCH20: An Archaic Period Base Camp

Site KCH20 measures about 1.01 hectares and is the second largest Archaic Period site recorded in the Iroco survey. The site consists of a dense scatter of lithic flakes and artifacts along with some Formative and Republican ceramic sherds distributed over and under a group of sand dunes (Figure 7.2). The site was studied in 2005 and since then, it has been partially destroyed by bulldozers and the intentional flooding of a portion of the alluvial plain of the Karakollu River as part of the Kori Chaca mine project (Albarracin-Jordan 2005:105-109).

Fieldwork at the site included systematic collection of the entire assemblage of lithic and ceramic artifacts distributed over a 30 meter radius. All the cultural materials from a total of 96 plots measuring 5 by 5 meters were systematically collected. As a result 4439 lithic artifacts and 688 ceramic fragments were recovered from the surface of the site (Figure 7.2). Lithic artifacts were dominated by debitage (91%) but complete and fragmented tools were also present, including several types of projectile points, unifacial scrapers, knifes, and burins. The most frequent raw material observed was black basalt (62%), followed by two types of chert (23%), and other five less frequent raw materials, including a few obsidian flakes. Distribution of lithic artifacts suggests the Archaic Period occupation predominates all around the site with the highest covariance of lithic tools and flakes in the northern and northeastern portions. Some Formative Period and a few modern ceramic sherds were found distributed in the southeast portion of the site.

In addition to the surface collections, six excavation units (including 5 square 2.25 m^2 pits and one 5 m^2 unit) were dispersedly located at the site (Figure 7.2). Interestingly,

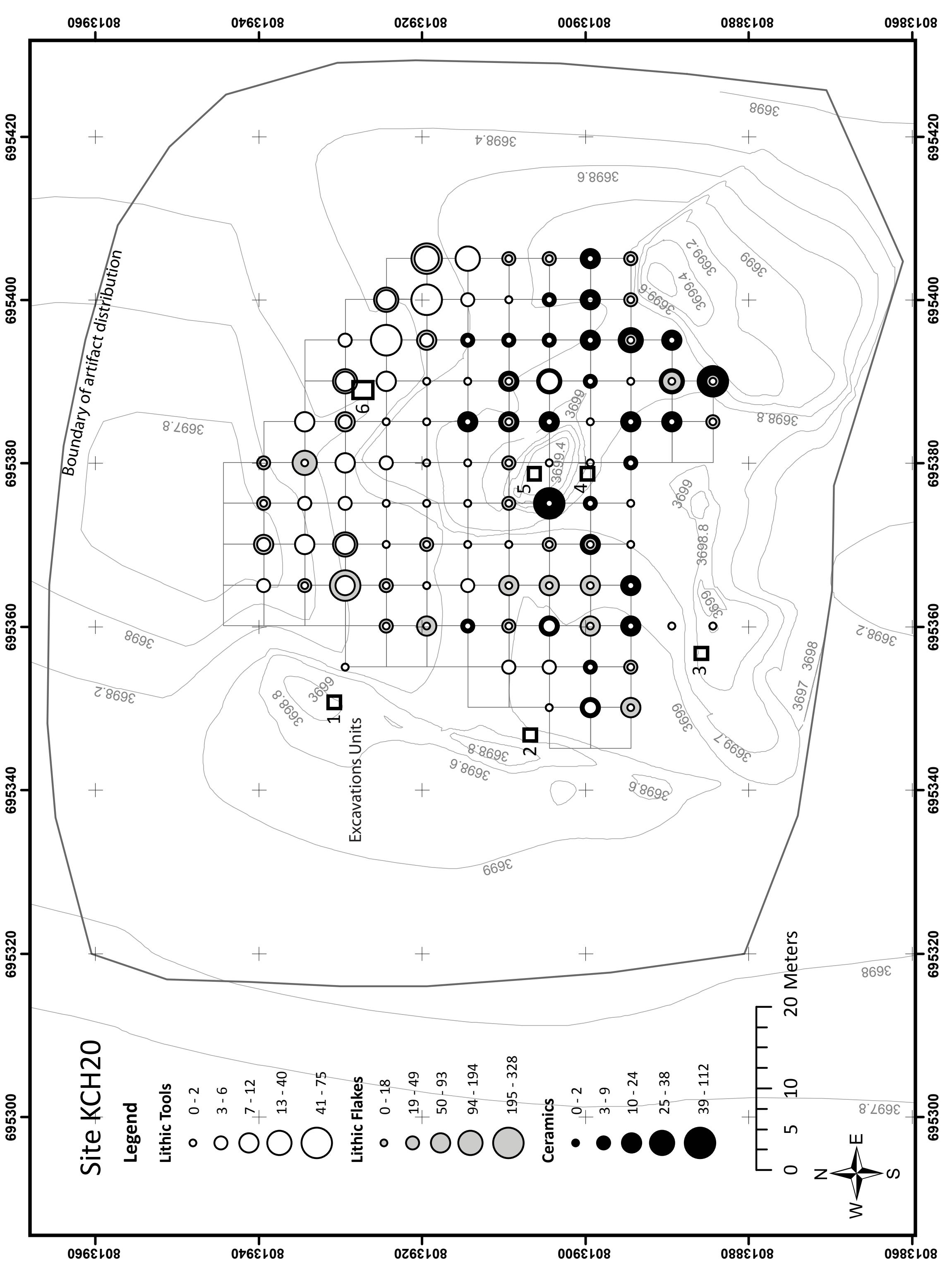


Figure 7.2. Plan of Site KCH20 showing surface collection plots and excavated units.

all of them provide complementary information for reconstructing the stratigraphy of the site. The base of the site stratigraphic depositional sequence begins with a culturally sterile downwardly graded sandy-clay bedding (about 1 m below the surface), overlaid by a thin silt-loam stratum where lithic materials and organic remains were deposited, followed by at least two sandy-loam levels (30 cm deep) on top of which a thin compact sandy-clay-loam level associated with ceramic materials was deposited. This sequence was capped by a poorly sorted layer of loose sand (about 20 cm deep) that constitutes the modern root zone. The stratigraphic sequence strongly suggests alluvial deposition characterized the initial sequence followed by strong aeolian deposition. The abandonment of the Archaic Period human occupation seems to be located between the initial alluvium and later aeolian sedimentary accumulations. In turn, this suggests that improved humid conditions characterized the depositional environment during the Archaic Period and Formative Period occupations. These were followed by drier conditions.

Unit 6 (5 m^2) was located around the highest density of lithic artifacts and included a dense feature containing several lithic and bone remains associated with the Archaic Period silt layer (Figure 7.3). Whereas lithic artifacts were found in all but one unit, only unit 6 contained lithic and faunal remains. The feature consisted of a sub-rectangular shaped probable trash pit or capped hearth that measured about 1.2 m long by 1 m wide and 15 cm deep. The feature was composed of ash, fragmented bones, lithic remains, and was surrounded by large cobbles and three stains of possible postholes, suggesting it might have been part of an intensive activity area that included food preparation and consumption, tool manufacture and maintenance, and finally refuse disposal. The lithic remains recovered from this feature include three projectile points, seven scrapers, a quartzite percussion hammer (Figure 7.3), and dozens of flakes of different raw materials (Albarracin-Jordan 2005).

Two AMS radiocarbon dates from bones recovered from the trash pit feature produced the remarkable age range of 9289-8729 calibrated years before present (Table 7.2). This

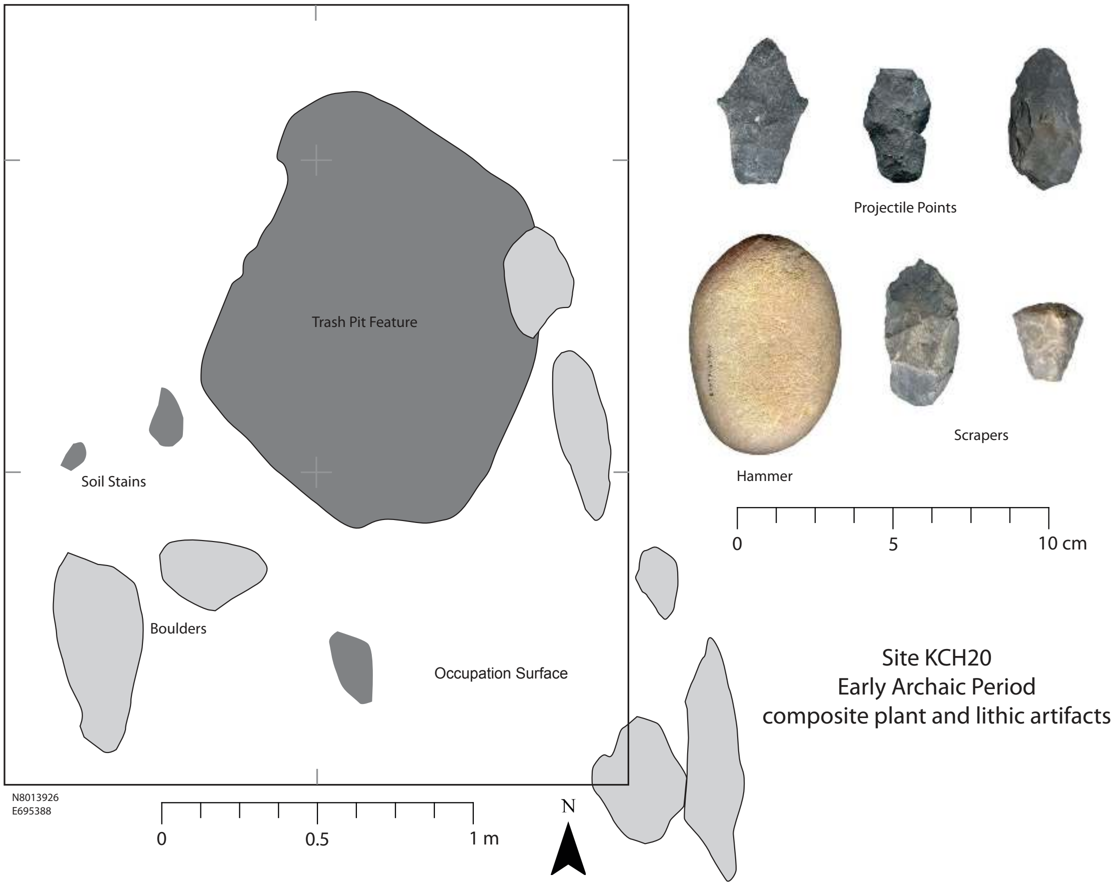


Figure 7.3. Composite plan of Unit 6 at site KCH20 and lithic artifacts recovered from the trash pit feature.

result places site KCH20 in the Early Archaic Period (10,000-8000 BP). The size and shape of the projectile points recovered from this layer (as well as others recovered from the surface systematic collections) support this proposition as two are stemmed, shouldered and have a pentagonal shape comparable to Type 1B defined by Klink and Aldenderfer (2005:31). Furthermore, the frequency and distribution of lithic artifacts strongly suggests tool manufacture and maintenance activities were carried out at the site, in addition to probable hunting and gathering exploitation tasks. Moreover, evidence of the ashy feature and faunal remains, suggest food preparation and consumption activities also occurred at the site (see Chapter 7). The fauna recovered from KCH20 serves as a good model for Archaic Period altiplano settlements and a baseline assemblage for a foraging subsistence economy in Iroco.

Table 7.2. Radiocarbon dates currently available for the Iroco study area including calibration and context information. AMS samples were analyzed at the University of Arizona-NSF AMS Laboratory and conventional samples at the University of Arizona Environmental Isotope Laboratory. Samples from KCH177 were analyzed at the Uppsala University Svedberg Laboratory and reported by Pärssinen (2005:157-158). All calibrated dates were produced using OxCal 4.1.7 (Bronk Ramsey 2009) and the SHCal04 southern hemisphere atmospheric curve (McCormac et al. 2004).

Lab Code	Method	^{14}C Years BP	δ^{13}C	Calibrated Years BP (1σ)	Calibrated Years BC/AD (1σ)	Component	Locus	Event	Material	Cultural Context
AA91568	AMS	8273 ± 82	-19.7	9289-9032	7364-7107 BC	KCH20Arch	601-1	D02	Bone collagen	Feature, *Lama guanicoe*
AA91569	AMS	8105 ± 92	-20	9088-8729	7163-6804 BC	KCH20Arch	601-2	D02	Bone collagen	Feature, *Cavia tschudii*
AA84147	AMS	2109 ± 53	-22.8	2110-1948	185-23 BC	KCH21FA	4121/1	A98	Carbon	Pit outside Structure 10
A14403	Conventional	2070 ± 70	-23	2060-1881	135 BC - AD 44	KCH21FA	1603-1	A48	Carbon	Fill above floor Structure 5
AA84148	AMS	2061 ± 53	-22.2	2037-1883	112 BC - AD 42	KCH21FA	4129/1	A84	Carbon	Pit outside Structure 9
AA84150	AMS	2059 ± 57	-22.7	2038-1880	113 BC - AD 45	KCH21FA	4130/1	A83	Carbon	Pit outside Structure 10
AA84146	AMS	2058 ± 53	-24.2	2036-1881	111 BC - AD 44	KCH21FA	4067/1	A75	Carbon	Pit in midden outside corral
AA84151	AMS	1995 ± 57	-19.7	1969-1821	44 BC - AD 104	KCH21FA	4086/1	A65	Carbon	Pit SW of the site
AA84149	AMS	1993 ± 38	-24.2	1929-1826	4 BC - AD 99	KCH21FA	4072/1	A17	Carbon	Occupation surface
A14404	Conventional	1925 ± 60	-23.5	1874-1728	AD 51-197	KCH21FA	2406-1	A58	Carbon	Hearth of Structure 8
AA91570	AMS	2185 ± 39	-25.7	2291-2010	366-85 BC	KCH21FB	4052/1	A39	Carbon	Floor of Structure 1
AA91571	AMS	2076 ± 39	-23.7	2038-1900	113 BC - AD 25	KCH21FB	4103/10	A05	Carbon	Cultural fill
AA84152	AMS	2016 ± 57	-23.2	1989-1830	64 BC - AD 95	KCH21FB	4108/1	A11	Carbon	Hearth SE of the site
AA84153	AMS	2035 ± 57	-23.7	1999-1867	74 BC - AD 58	KCH56FA	4164/7	B10	Carbon	Floor of second occupation
AA91572	AMS	2023 ± 38	-24.4	1985-1875	60 BC - AD 50	KCH56FA	4172/1	B17	Carbon	Hearth of first occupation
AA91573	AMS	2009 ± 38	-24.1	1949-1935	24 BC - AD 90	KCH11FB	4206/1	C07	Carbon	Structure floor
AA84154	AMS	1160 ± 63	-18.3	1070-934	AD 855-991	KCH11Tiw	4205-1	C02	Bone collagen	Burial 1, Human tooth
AA84155	AMS	1060 ± 62	-18.8	969-806	AD 956-1119	KCH11Tiw	4213-1	C03	Bone collagen	Burial 2, Human tooth
Ua2318	AMS	740 ± 70	N/A	716-562	AD 1206-1363	KCH177	-	-	Straw	Adobe from Chullpa 11
Ua2317	AMS	660 ± 70	N/A	650-553	AD 1275-1372	KCH177	-	-	Straw	Adobe from Chullpa 6

7.2. KCH21: A Complex Formative Period Residential Base

Site KCH21, also known as Irucirca, is a one meter tall mound that roughly covers a surface area of 0.55 hectares (Figure 7.4). The site is located in the plain between the Vincutaya hill and the Karakollu River. Before excavations, the mound was covered by medium to high densities of Formative pottery sherds and lithic artifacts, including basalt, quartzite, and slate hoes. Boulders arranged in circles, suggested the presence of circular structures and a possible corral at the top and center of the site. A large canal built in the 1960s, destroyed part of the northwestern portion of the site. KCH21 was discovered in 2002 and excavated in 2005 and again in 2007 (Albarracin-Jordan 2005:110-144; Capriles

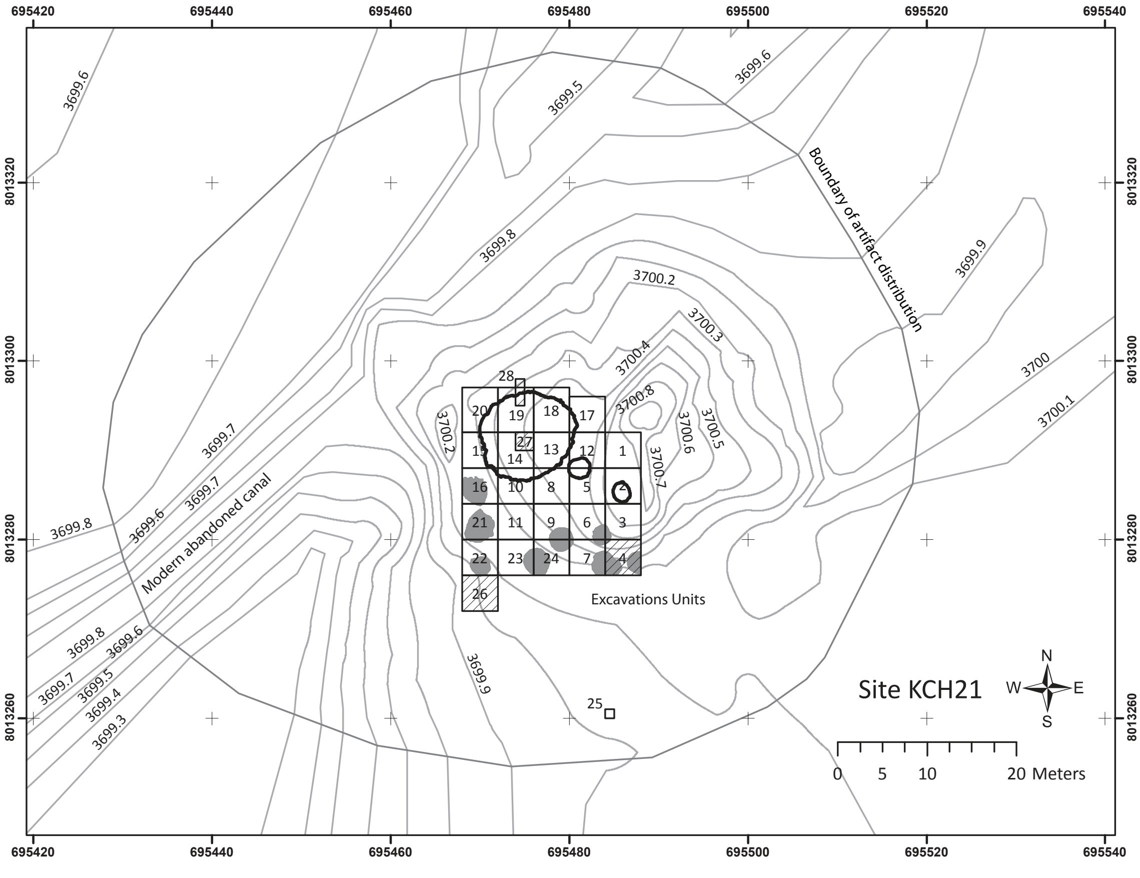


Figure 7.4. Plan of KCH21 including the 28 excavation units. Units 4, 26, 27, and 28 marked with diagonal lines were excavated in 2007.

2008:33-50). In total, 413 m^2 were exposed in a single block composed of 27 adjacent excavations units, most of which measured 4 by 4 m. An additional 1 m^2 test pit was located 11 m south of the main excavation block. Four excavations units (4, 26, 27, and 28) were excavated in 2007 employing fine-grain recovery techniques. As a result a good sample of structures, features, and cultural remains were recorded and recovered from the site.

The excavations at KCH21 emphasized horizontal exposure, so whenever well preserved features were discovered, following their clearing, excavations proceeded in adjacent units (Figure 7.5). As a result, the exposed occupation layout is a complicated aggregation of different semi-circular, slightly semi-subterranean structures, pits, walls, hearths, and patio areas, corresponding to at least three distinct (but possibly more) somewhat overlapping components or occupation levels (Figure 7.6).

Figure 7.5. Excavations at KCH21 in 2005 viewed from the south. Photograph courtesy of Juan Albarracin-Jordan.

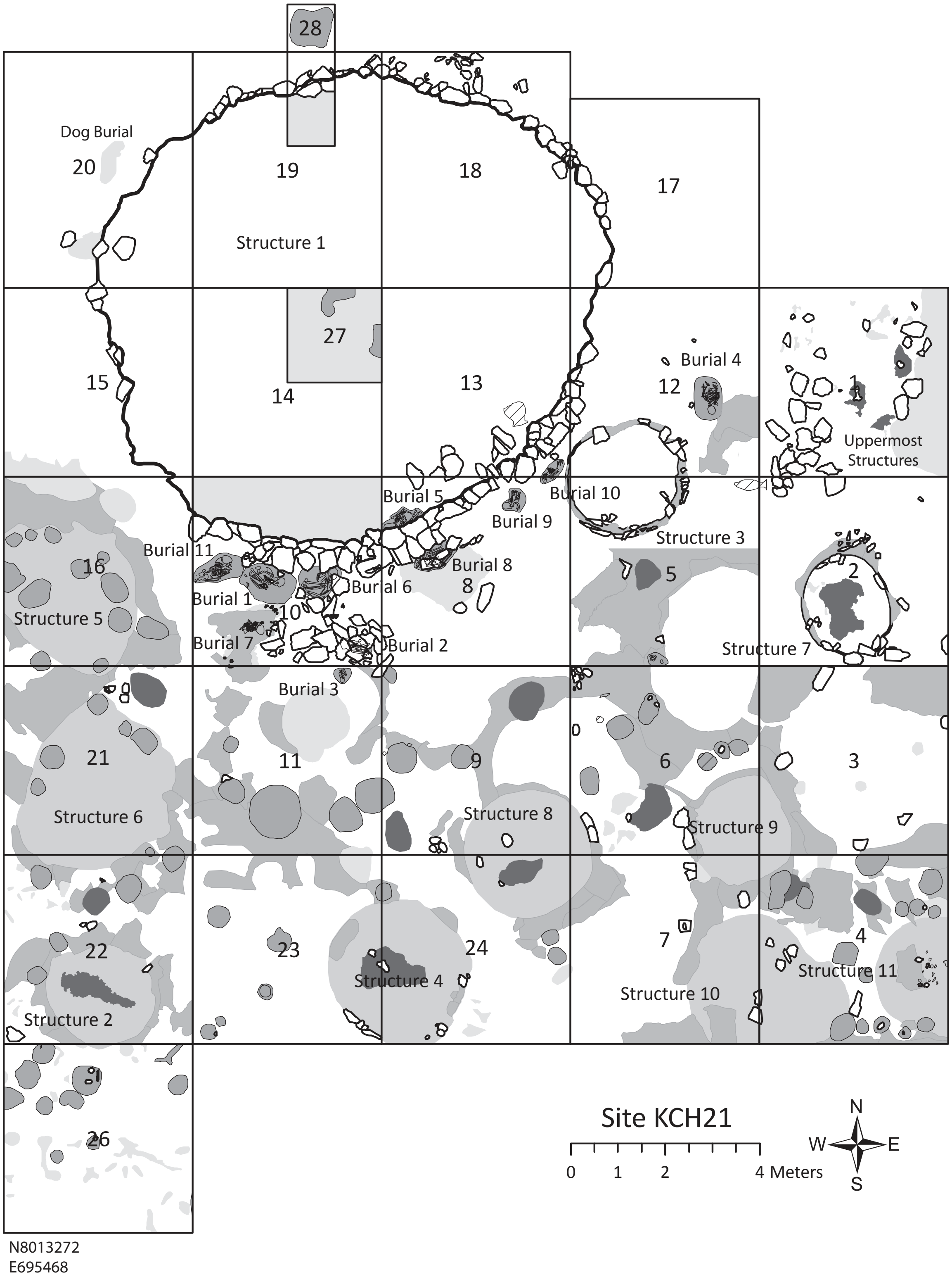


Figure 7.6. Composite plan of excavations recorded at KCH21.

Stratigraphically, the entire site overlays sandy-clay loam strata of graded bedded natural alluvium and eluviated oxidized reddish clays. The lower occupation level (KCH21FA) is mostly exposed in the south, west, and central sectors of the excavated portions of the site and is entirely deposited over the natural strata. Cultural features associated with this level include circular to semi-circular semi-subterranean structures, compacted floors and adobe walls, a number of pits with different sizes and depths, organic stains, and a midden area located in the northern part of the site. The occupation surface associated with this level is characterized by richer clay content and the inclusion of organic particles including carbon, modeled and burned clay, and archaeological artifacts. This level is capped by cultural fill composed of collapsed adobe walls and organically enriched soil. The upper level (KCH21FB), identified mostly in the northern and eastern sectors of the excavated portion of the site, includes a higher density of boulders and cobbles as well as a higher density of cultural artifacts and bone remains. Features associated with this level include two circular structures built with stone foundations, 11 human burials, and a large corral overlaid by alluvial deposition intermixed with the remains of collapsed adobe walls and cultural artifacts. A final uppermost level (KCH21Tiw) represented by two possible stone walls and an associated occupation surface was identified in the northeastern sector of the site. The entire site is capped by a sandy aeolian or windborne layer (Figure 7.7).

7.2.1. KCH21FA: Lower Level

The lower level is composed of a series of circular to sub-circular structures, built entirely of mud bricks (although occasionally including rock boulders) along with a number of additional concave features and outdoor activity areas. Although the presence and recovery of actual adobe blocks suggests these structures were built with mud bricks, because of preservation, it is not entirely clear if walls or other facilities at the site were also

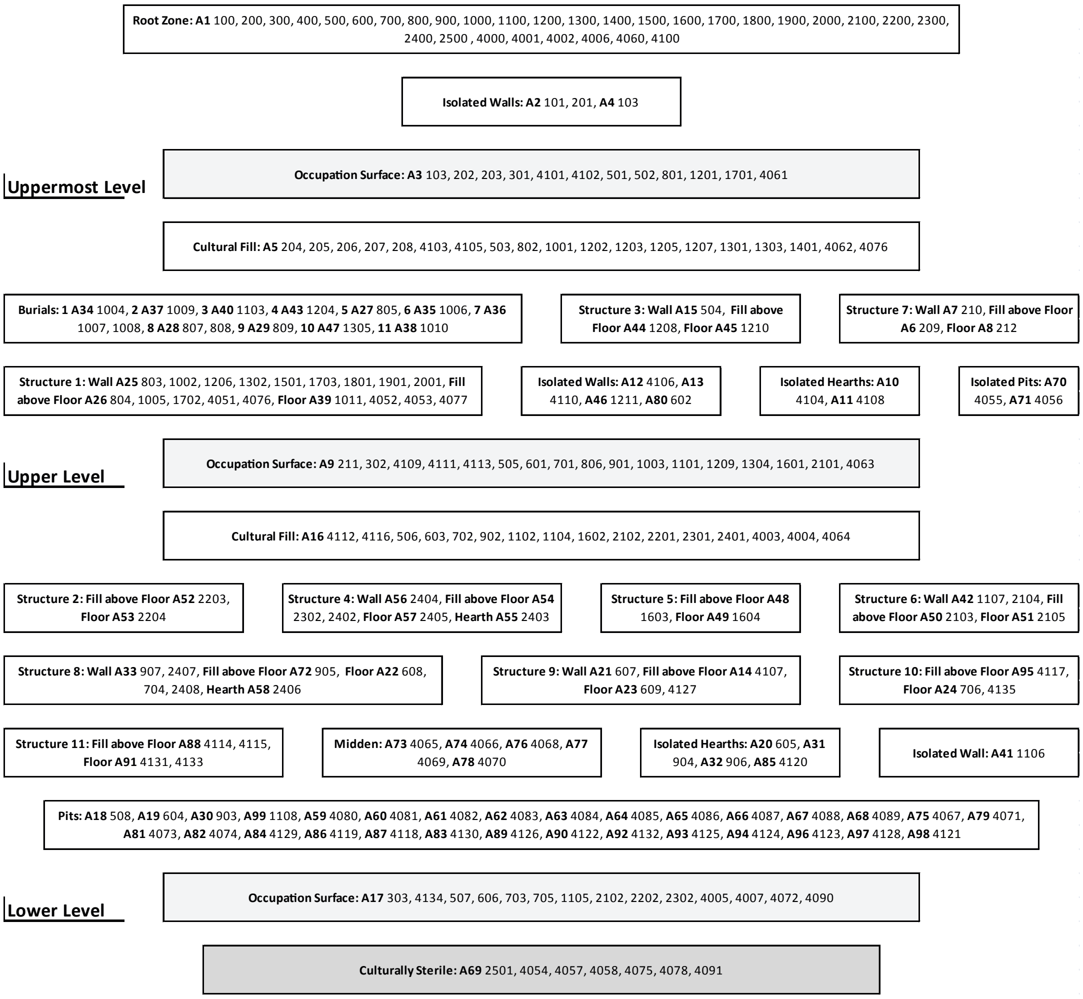


Figure 7.7. Stratigraphic depositional sequence reconstructed of site KCH21.

built with tapia and/or sod blocks. At least eight circular to semi-circular structures were identified and entirely or partially exposed during excavations (Table 7.3). These structures vary in size between 2.4 and 3.7 m in diameter and 3.7 and 8.8 m in surface area (Figure 7.8). Most of these structures were defined by the dark organically rich fill they contained. Under this fill, their floors are defined by compacted clay and are slightly concave, giving them the appearance of semi-subterranean or pit structures. Because of the rich clay content of the compacted floors, they often include dozens, if not hundreds, of empty tiny beetle burrows. Only three of the circular structures contained a central hearth but there seems to be no correlation between size and presence or absence of hearths. Interestingly

Table 7.3. Structures and associated features excavated at KCH21.

Feature	Diameter	Surface	Shape	Complete	Hearth Inside	Hearth Outside	Pits Inside	Pits Outside	Entrance	Level
Structure 1	**11**	**81.13**	**Circular**	**100%**	**No**	**No**	**2**	**0**	**E**	**Upper Level**
Structure 2	2.4	3.86	Circular	100%	Yes	No	0	12	S	Lower Level
Structure 3	**2.25**	**4.27**	**Circular**	**100%**	**No**	**No**	**0**	**0**	**E**	**Upper Level**
Structure 4	3	7.04	Circular	100%	Yes	No	0	3	S	Lower Level
Structure 5	3.6	7.18	Irregular	90%	No	Yes	10	2	SW	Lower Level
Structure 6	3.7	8.82	Irregular	100%	No	Yes	5	4	NE	Lower Level
Structure 7	**2.15**	**3.15**	**Circular**	**100%**	**Yes**	**No**	**0**	**0**	**E**	**Upper Level**
Structure 8	2.7	5.75	Circular	100%	Yes	Yes	0	4	SW	Lower Level
Structure 9	2.4	3.7	Sub-rectangular	100%	No	Yes	0	5	SW	Lower Level
Structure 10	3.4	7.1	Irregular	80%	No	No	1	1	SW	Lower Level
Structure 11	2.5	3.12	Semi-circular	50%	No	Yes	1	8	S	Lower Level

enough, the more evenly circular structures have hearths in their interior whereas the larger more amorphous semi-circular structures include pits in their interior and exterior areas. A preliminary interpretation of this pattern suggests that the circular structures included domestic occupations including sleeping, heating, and possibly cooking activities. The larger semi-circular structures might have served storage purposes.

Figure 7.8. Structure 10 and Structure 11 at KCH21, with associated features, and viewed from the south.

Most structures are surrounded by small (20-70 cm) roughly circular pits, located both inside and outside the structures. The diversity in size, shape, location, and contents of the pits, suggests multiple functions including storage, trash disposal, supporting vessels, hide-smudging, and even bioturbation. Some pits are located immediately adjacent to the walls, suggesting the walls might have been relatively thin or perhaps that some pits were excavated after the abandonment of the structure. The presence of walls and hearths in the exterior space suggests food preparation activities probably occurred outside.

Even though the distribution of the structures throughout the excavated portion of the Lower Level seems uneven, at least three groupings or clusters of two to three structures were identified (west, center and east). The intermediate spaces between these clusters contain a number of features suggesting several activities occurred in the exterior of the structures. Outside activity areas are delimited by the structures themselves as well as by collapsed adobe walls suggesting the presence of additional structures, and/or patio walls. Outside areas also include the presence of circular pits, organic stains, middens, ground stones and even hearths along with varying densities of cultural materials suggesting a busy set of activities took place in these locations. The existence of additional Lower Level structures towards the northeast of the site and beneath the Upper Level is probable, but the excavations units from the south and west (as well as solitary Unit 25) suggest the presence of additional structures towards these directions is unlikely.

7.2.2. KCH21FB: Upper Level

The overlaying Upper Level was documented in most of the excavated area of KCH21. Most importantly it included two medium sized circular structures with stone foundations associated with open spaces, a large circular structure, interpreted here as a corral, and a burial area. The two possible domestic structures were identified by the presence of boulders on their wall foundations in addition to adobes. Structure 3 (one the best preserved structures recorded during excavations) had a regular circular shape with a diameter of 2.25 m and a surface area of 4.27 m^2 (Figure 7.9). The interior of the structure contained organic soil but not a hearth. Structure 7 was considerably more disturbed. It had a slightly oval shape, a diameter of 2.15 m, and a surface area of 3.15 m^2. Although this structure was smaller, it did contain a hearth in its interior.

Evidence for outside activity areas in the Upper Level of KCH21 include plenty of dispersed artifacts such as ground stones, fragments of large storage jars, animal bones, lithic hoes, and other cultural materials in medium to high densities. Outside hearths and circular pits are also found in association with the upper occupation surface. In the southeastern portion of the site, a large rectangular lithic block was recovered. Although the block does

Figure 7.9. Structure 3 at KCH21 viewed from the east. Photograph courtesy of Juan Albarracin-Jordan.

not seem to be deposited in situ, it seems to be sculpted and slightly resembles some of the better known Wankarani lithic heads (Figure 7.10).

A large circular structure measuring about 11 by 10 meters and occupying a surface area of about 81 m^2 was identified in association with the structures of the Upper Level (Figure 7.11). The structure has circular shape but it is clearly elongated on its sides. The walls of this structure are partially delimited by single to double rows of large calcareous boulders. At least seven of these boulders include holes as if they were meant to support poles. Consequently, it is possible that the walls were made of a combination of rocks and wooden fences. The holes might have also been used to support the gate or entrance of the structure which, given a gap in the presence of boulders, seems to have been located towards the east.

Figure 7.10. Possible camelid lithic head at KCH21 viewed from the west.

During excavations, the exterior walls of the structure were exposed but its floor was not completely uncovered. Specific excavation units (10, 27, and 28) were used to sample the interior of the structure. The excavation showed that the floor of Structure 1 was mostly clean of artifacts and that it was composed of a dark, compact, and organically enriched matrix. The sediment underneath the floor was sandy and completely devoid of any cultural material and the finding of two shallow pits suggests they were probably produced by burrowing rodents. Phytolith, pollen and macrobotanical analyses of sediments recovered from this unit included very low densities of organic materials but also suggested slight differences between the sediments that composed the floor of the structure and its underlying and overlying strata. Based on this information as well as ethnographic information, the most likely interpretation of this feature is a corral for penning camelids.

Figure 7.11. Structure 1 at KCH21 viewed from the north. Photograph courtesy of Juan Albarracin-Jordan.

A funerary area composed of 11 different burials (several of which included more than one individual) was identified south and southeast of the large circular structure (Figure 7.12). Most burials were directly deposited in holes and placed in fetal position, but some were surrounded by cobbles or attached to boulders. Some of these boulders were part of the structure wall. Although most of the burials did not contain mortuary offerings, some included multiple individuals and at least in three cases, the body was accompanied by lithic hoes or other sharp volcanic stones, carefully placed at the base of their crania. Almost every individual, including children, had frontal-occipital elongated cranial deformations (Table 7.4; Albarracin-Jordan 2005; Villamor 2005). Several of the burials seem to cluster around the southern portion of the corral but it is uncertain if all of them correspond to the

Figure 7.12. Burial 6 at KCH21 viewed from the west. Photograph courtesy of Juan Albarracin-Jordan.

upper level. Additionally, human bones were sparsely found throughout most of the site as evidenced during the faunal analysis.

A unique characteristic of the upper level is the use of calcareous amorphous rocks composed of fossilized corals as construction material. These rocks are common in the nearby hills and were heavily exploited in the recent past for making plaster. More importantly, their transport to the site suggests increased labor investment in construction, perhaps implying reduced mobility. Another interesting characteristic of the Upper Level is

Table 7.4. Human burial data from excavations carried out in Iroco. Data from Albarracin-Jordan (2005), Villamor (2005), and personal observations.

Site	Locus	Burial	Individual	Age	Specific Age	Sex	Cranial Deformation	Observations
KCH21	1004	1	1	Infant	1-2 years			
KCH21	1004	1	2	Adult	30-35 years	Female	Yes	Epicondylitis of humerus and ulna enlargement, loss of teeth, lithic hoe and rock behind head
KCH21	1009	2	3	Juvenile	15-20 years	Male	Yes	Rock behind head
KCH21	1102	3	4	Infant	1-1.5 years	Female	Yes	Associated with some adult bones
KCH21	1102	3	5	Infant	0.5-1 years	Indet	Yes	Associated with some adult bones
KCH21	1204	4	6	Infant	7-9 years	Female		Supernumerary cranial bones
KCH21	805	5	7	Adult	30-36 years	Female	Yes	Supernumerary cranial bones
KCH21	1006	6	8	Adult	20-26 years	Male		Healthy
KCH21	1006	6	9	Infant	1.5-2.5 years	Male		Below Individual 8
KCH21	1006	6	10	Infant	0.5-1.3 years		Yes	
KCH21	1007	7	11	Infant	4.5-5.5 years			Rock on body
KCH21	808	8	12	Adult	35-38 years	Male	Yes	Supernumerary cranial bones, erosive lession in maxilla, also lession in temporal, height 1.75 m
KCH21	808	8	13	Infant	3.5-4.5 years	Male	Yes	
KCH21	808	8	14	Infant	2.5-3.5 years		Yes	
KCH21	808	8	15	Infant	0.5-1 years		Yes	
KCH21	808	8	16	Infant	0.5 years		Yes	
KCH21	808	8	21	Unborn	0			
KCH21	808	9	17	Infant	1.5-2.5 years		Yes	
KCH21	1305	10	18	Infant	1-2 years	Male		Secondary burial
KCH21	1305	10	19	Unborn	0			
KCH21	1010	11	20	Adult	30-45 years	Male	No	Supranumerary cranial bones, well developed epindondyle in humerus, complete except atlas
KCH21	2302	NN	21	Adult			Yes	Cranium only, secondary deposition
KCH11	4205	1	22	Adult	30-45 years	Male	Yes	Slab stone burial, complete
KCH11	4213	2	23	Adult	30-45 years	Male	Yes	Slab stone burial, complete
KCH11	4203	3	24	Juvenile	15-20 years			Lower limbs, partially excavated
KCH22	203	1	25	Adult				Cranium only
KCH22	303	2	26	Adult	18-25 years	Male		Cranium and some postcranials
KCH22	306	3	27	Juvenile	15-20 years		Yes	Frontal only

the absence of pits. The only two pits recorded in association with this level were the two shallow possible burrowing pits excavated beneath the floor of Structure 1. Although the sandier matrix associated with this occupation level might have contributed to differential preservation, contextual evidence supports different activities and perhaps intensity of occupation changed between the two occupation levels. Interestingly enough and in contrast with the previous phase, the three structures associated with the Upper Level at KCH21 had their entrances facing east.

7.2.3. KCH21Tiw: Uppermost Level

The final occupation level recorded at KCH21 includes two linear north-to-south collapsed walls of rock boulders located at the northeastern sector of the site, an associated occupation surface, and a dog burial in the northwest of the site. The rocks for the walls seem to have been reutilized from dismantling the walls of Structure 1 (Figure 7.12). Although the chronology of this level is uncertain, it is also not clear how the site was used during this time. It is possible that this level is associated with a small Tiwanaku occupation not identified during the surface survey. This is suggested by the occasional presence of diagnostic Tiwanaku sherds in the soil matrix associated with this level. The sporadic presence of ceramics from later periods suggests that following the abandonment of the uppermost level, the entire site might have continued to be used as a herding camp, but since there is no evidence for substantial features or architecture, these occupations were probably temporary and of short duration. It is possible that excavations towards the northeast and the top of the mound might reveal additional structural features associated with these later occupation episodes.

KCH21 is interpreted as a herding residential base with at least three (and perhaps more) different occupation levels. The overlap between these levels is neither complete nor entirely vertical, an attribute shared with typical Formative Period Wankarani settlements documented in La Joya (Fox 2007; Rose 2001a). The southern portion of the site includes lower level structures and features almost entirely underneath the sandy stratum and largely devoid of upper level occupations. The northern (and higher) sector of the site however, is mostly occupied by upper level structures overlying the lower level as well as a probable third occupation level. The easterly units include occupations of the Lower and Upper levels. Additionally, the construction of the large corral seems to have cut and destroyed some lower level activity areas including a midden, as evidenced by one of the excavations profiles.

A suite of 11 radiocarbon dates bracket the most significant occupation of KCH21 between 185 BC and AD 104 (Table 7.2; Figure 7.13). Interestingly, some of the radiocarbon dates are inconsistent with the general stratigraphic interpretation of the site and hint that

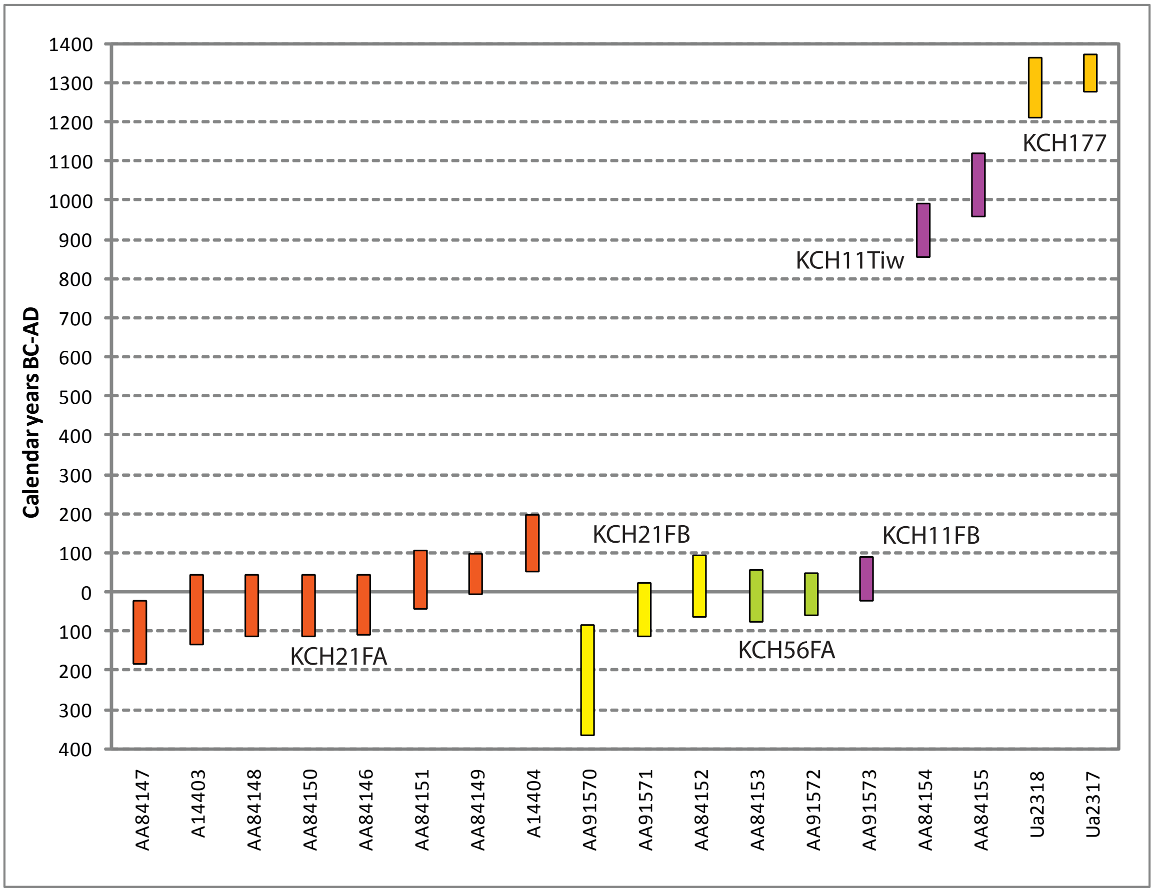


Figure 7.13. Calibrated radiocarbon dates ranges for the Iroco study area (see Table 7.2 for context information). Note that samples from KCH20Arch are not displayed.

the lower and upper occupations are closely related in time. For instance, some of the samples collected from upper level contexts are contemporary with or earlier than the lower occupation levels and vice-versa. The case of the floor of Structure 1 is particularly intriguing because it has the oldest date of the site. The fact that no significant features (not to mention structures) were constructed over the lower occupation level further supports this alternative. However, it is also possible that taphonomic factors and particularly bioturbation could have contributed to these results. For instance, more recent samples could have been moved upward, particularly if substantial remodeling was involved during the intensive construction events associated with the upper occupation level. In line with this interpretation, ethnoarchaeological information suggests that residential remodeling is not uncommon as the (head of) households occupying residential bases grow old (Delfino 2001).

In any case, the radiocarbon dates suggest that the chronological span between the two initial occupation phases of the site was brief. Considering that the entire occupation of the site did not extend over a long period of time, the frequent remodeling of the site suggests dynamic cycles of occupation and abandonment possibly related to seasonal, yearly or even inter-generational residential mobility patterns, typical of herding societies. Finally, the faunal remains assemblages recovered from all components excavated at KCH21 include substantial sample sizes and a unique outlook into the Formative Period economy of the central altiplano.

7.3. KCH56: A Residential Structure within a Formative Period Settlement

Measuring about 2.54 hectares and elevated 1.5 meters above the ground, KCH56 is the largest Formative Period settlement recorded during survey (Figure 7.14). The site is situated in the northwestern side of a hill and it has been slowly eroding by a combination of slope and seasonal precipitation. The surface of the site is covered by medium to high densities of ceramic and lithic artifacts. Several incidental profiles show a variety of occupations as well as different artifacts including a number of lithic tools (including several hoes) manufactured from different raw materials, high densities of faunal remains, and many ceramic fragments. The foundations of several circular structures of varying size are evident in several locations. The site also includes an enormous crater (25 meters in diameter) caused by a military explosion exercise, performed sometime in the 1980s.

In 2007, a square excavation unit covering 16 m^2 was placed on top of one the circular structures visible on the surface to sample both interior and exterior areas (Capriles 2008:28-33). A total of 27 loci were recorded. As a result several features associated with a sequence (that did not reach culturally sterile strata) comprising at least three different

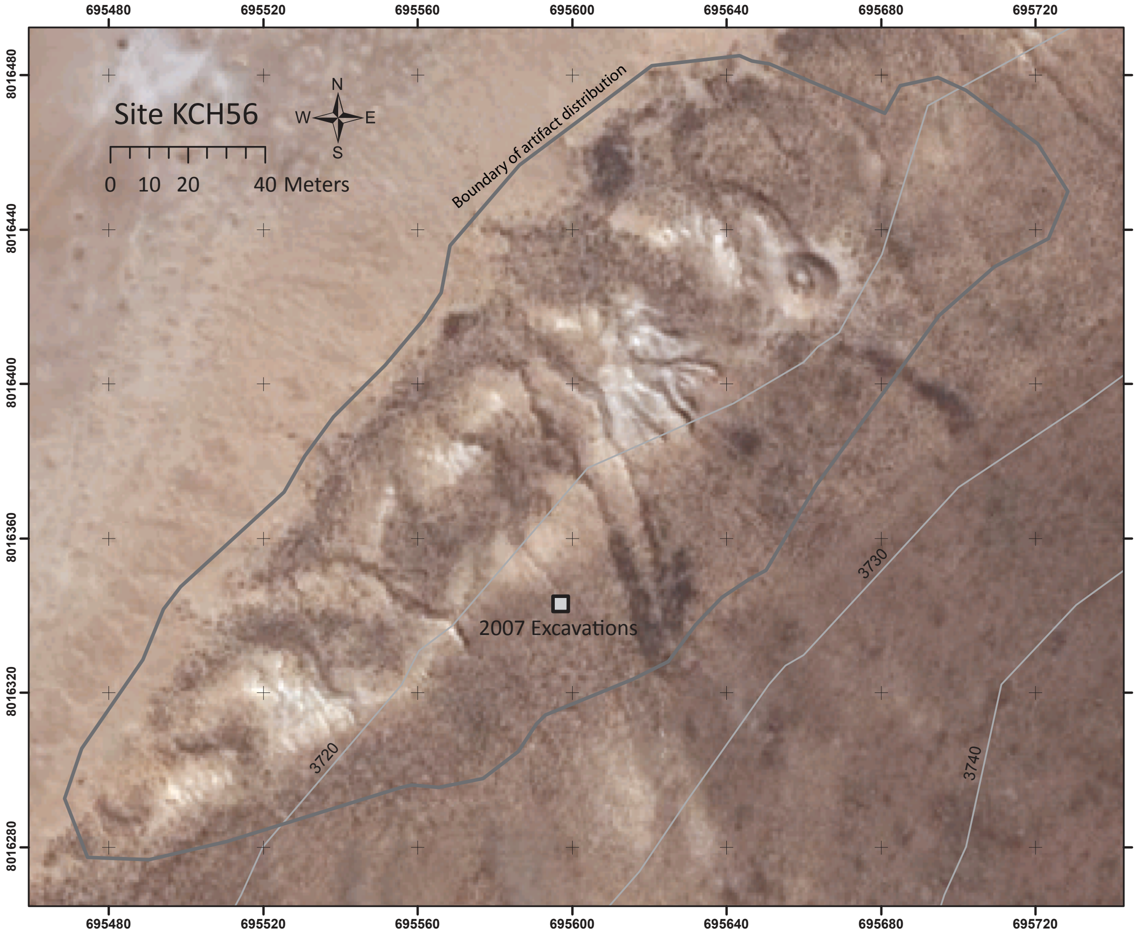


Figure 7.14. Map of site KCH56. Base image Google Earth.

occupation levels, was documented (Figure 7.15). The soil texture of most strata varied between silty-loam and sandy-loam and was associated with recent natural depositions.

The deepest deposits predate the construction of the circular structure. The only contexts excavated of this occupation –including a hearth and a linear rock alignment– were under the floor of the initial level of occupation of the circular structure. The next level is composed of a degraded clay floor surrounded by the walls of the circular structure, and is interpreted here as the first house level. In association with the inside floor there were two ash pits and a densely filled trash pit mostly composed of fragmented camelid bones (Figure 7.16). The foundations of the structure consist of a row of large stone boulders, about 50 cm in diameter placed with their heaviest portions on the base and surrounded by compacted adobe. Apparently these blocks were inserted into the ground. The first floor of the structure roughly corresponds to the same level as the boulders. Unfortunately only the northeast and east portions of the wall were well preserved.

The second house level is separated from the first by a heterogeneous fill deposition, including burned clay, possibly associated with the maintenance of the walls of the structure but most probably produced by alluvial deposition. The floor is composed of compacted clay and includes a hearth in its center along with at least one pit. This level has a moderate

Figure 7.15. Excavations of the first occupation level at KCH56 viewed from the south.

density of cultural materials. The entrance of the structure has been identified towards the west and is associated with two outside circular pits as well as an open activity area. A slight change in texture and color of the sediment and the degree of compaction of sediment that otherwise is very sandy, suggest this area extends towards the west of the excavation. To the south and southeast of the unit, the sediment is very sandy and has a lower density of

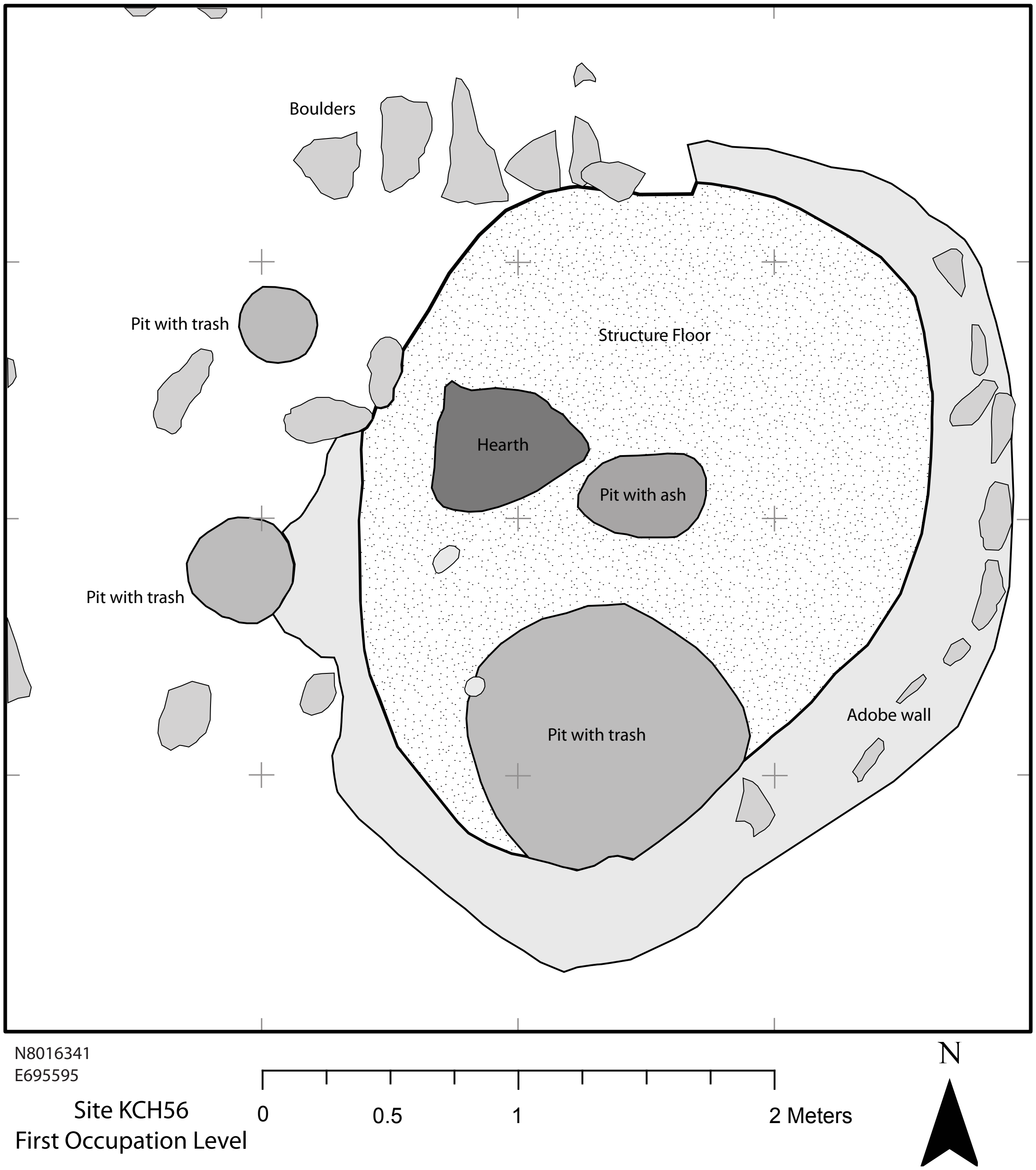


Figure 7.16. Composite plan of the first occupation level recorded at KCH56.

cultural material that remains of the area outside the structure. Several large blocks were found in this area, including an east to west alignment of boulders towards the northwest of the structure. In addition, about 1.8 meters west outside of the northwest corner of the unit, a second circular structure composed of boulders delimiting its perimeter, was identified on the surface.

After the domestic structure was abandoned, it is uncertain to what extent the site continued to be occupied. In addition to a very sandy post-occupational fill, the excavation area was evenly covered by a very dense but thin layer of cultural materials, particularly lithics. This layer is a combination of materials that were re-deposited from the top of the site by wind erosion that slowly removed the smaller particles leaving the largest, which together form a crust. This type of palimpsest is common in open dry sites. Because this crusty layer covers the entire excavation area, it suggests the previously described occupational sequence was not greatly affected by recent large-scale disturbance processes.

Although the excavation area at KCH56 did not include evidence of having been plowed over its surface (a fact confirmed by local inhabitants) approximately 15 meters to the north, a small plot was being plowed and planted during the course of our excavations. The detailed microstratigraphic series of depositional events documented at KCH56 is similar to multilayered Formative Period Wankarani sites documented elsewhere (e.g., Bermann and Estévez Castillo 1995; Condarco et al. 2003). Finally, the excavations at KCH56 produced a large collection of well preserved faunal remains along with numerous fragments of ceramics and lithic fragments.

Two AMS radiocarbon dates consistently place the occupation of KCH56 between the years 74 BC and AD 95, suggesting it was roughly contemporary with the Formative occupations at KCH21 and KCH11 (Figure 7.13). The structure and features associated with KCH56 provide a good source for comparing the contexts excavated in other Formative Period domestic sites. The laminated nature of the deposition inside of the structure corresponds to what Marc Bermann and his students have identified in several

La Joya settlements including San Andrés, Chuquiña, and Pusno (Bermann and Estévez Castillo 1995; Fox 2007). Moreover, because the evidence for hearths was identified, it is probable that cooking activities occurred within the structure. Finally, the layout and size of the structure as well as the materials associated with different features and including a good sample of faunal remains provide insights into the domestic activities that took place in this structure.

7.4. KCH11: A Formative and Tiwanaku Pastoralist Settlement

Located over an alluvial plain and away from the hillsides, KCH11 is a 2.5 meters tall mound with a surface area of about 0.85 hectares (Figure 7.17). The site was excavated

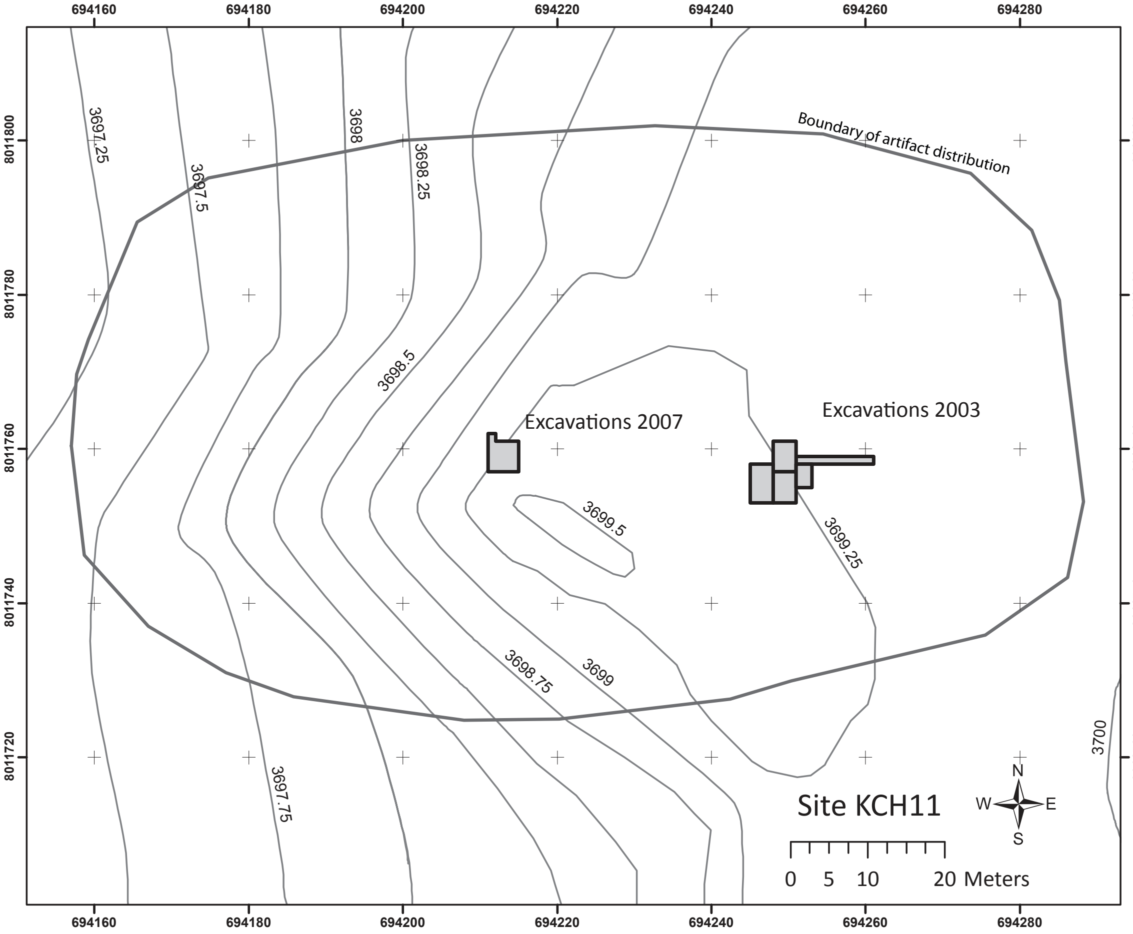


Figure 7.17. Plan of site KCH11 including archaeological excavations.

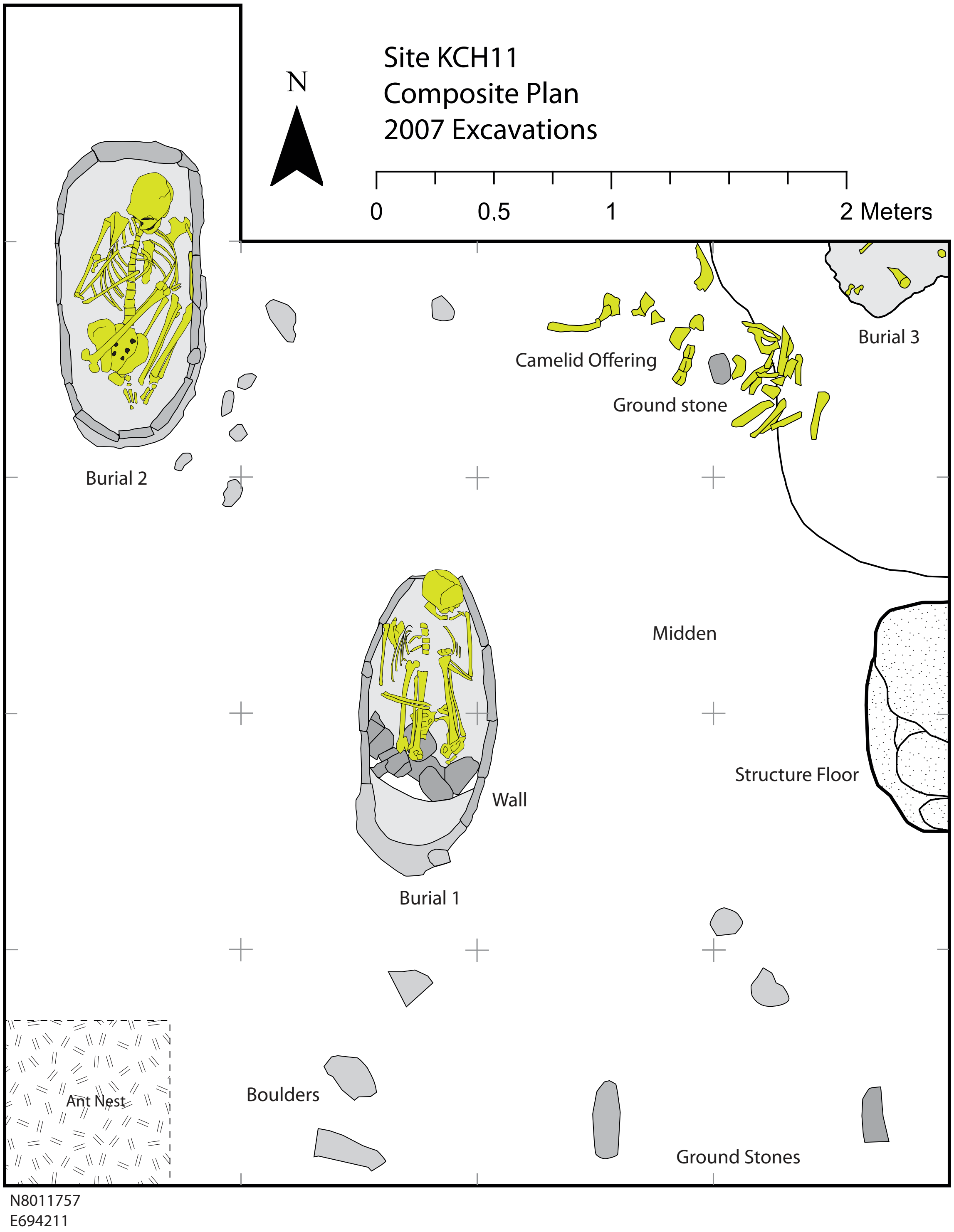


Figure 7.18. Composite plan of the 2007 excavations recorded at KCH11.

in 2003 and 2007 in different sectors. During the 2003 test excavations, an area of 49 m^2 in the eastern portion of the site was exposed, revealing at least two very disturbed semi-circular domestic structures and a possible outside surface area (Albarracin-Jordan 2005:87-92). In 2007, an area of 17 m^2 was excavated in the center of the mound (Capriles 2008:23-27). Excavations did not reach culturally sterile deposits but included a Formative Period occupation surface including a possible structure as well as two Tiwanaku slab-stone tombs (Figure 7.18).

The stratigraphic sequence of the 2007 excavations begins with a dense and highly organic silty midden that covered much of the unit, except for the NE sector. This midden included high densities of faunal remains, ceramics, and lithic fragments, including large ground stones. Although the excavations did not reach culturally sterile soil, beneath Burial 1 (see below), and about a meter below the surface, a nicely preserve straight wall was identified. The wall was composed of medium-sized cobbles, partially worked stones, and some reused ground stones, but because of the small portion that was exposed, it is difficult to determine its specific function. Overlying the midden in the eastern side of the unit, a

Figure 7.19. Photograph of possible camelid offering identified at KCH11.

disturbed clay surface of a possible semi-circular structure was identified. Surrounding this structure were abundant faunal remains including a possible ritual deposition. A sandy cultural fill covered the structure.

The identified slab-stone burials were constructed cutting the sandy sediment and the midden but might have been associated with a possible offering of well-preserved disarticulated and fragmented large camelid bones that were deposited as a result of a discrete food consumption event (Figure 7.19). The burials were oriented north to south. The bodies were placed on formal slab-stone tombs without any burial goods (except for two turquoise beads and perhaps some meat fragments as suggested by the presence of semi-complete fragments of camelid bones contained in the fill covering the bodies) (Figure 7.20). Each burial contained a single adult male individual with cranial deformation,

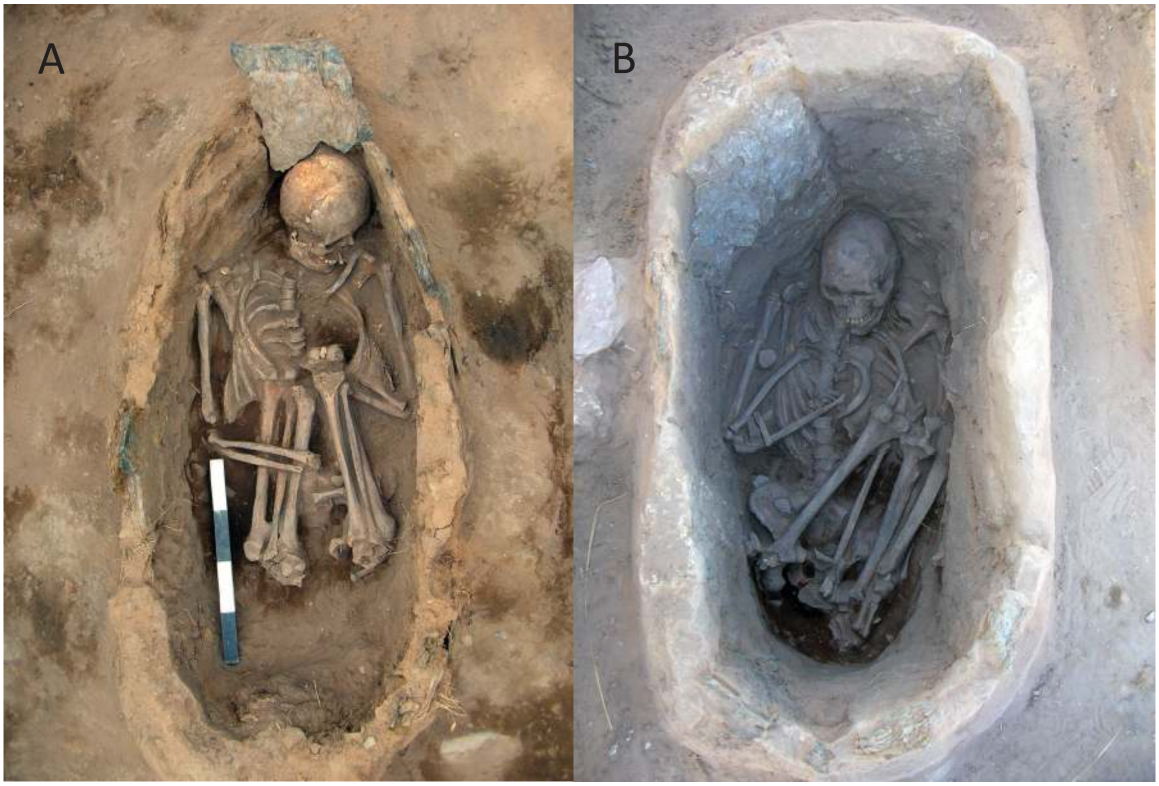


Figure 7.20. Slab stone tombs excavated at KCH11 viewed from the south including A) Burial 1 and B) Burial 2.

placed on its back, and in flexed position. In addition, a third burial was identified in the northeastern corner of the excavation, consisting of a juvenile individual directly buried in a hole without slab stones.

AMS radiocarbon dating of a sample from the semi-circular structure feature provided the calibrated date of 24 BC – AD 94, making it contemporary with the Formative Period occupations at KCH21 and KCH56. Additional AMS radiocarbon dates from the individuals excavated from Burial 1 and Burial 2 directly date them to the Tiwanaku period, between AD 855 and 1119 (Table 7.2, Figure 7.13). Analyzed faunal remains correspond only to the 2007 excavations carried out at the center of the site but include Formative and Tiwanaku components.

7.5. KCH22: A Tiwanaku Period Settlement

Site KCH22 is a relatively small Formative and Tiwanaku period camp site covering about 0.27 hectares. The site is located on the alluvial plain southeast of KCH21 and is composed of four small sandy dunes eroded by recent agricultural activity. The sandy soil includes low vegetation cover and good visibility of archaeological materials. Pottery sherds and stone artifacts are scattered on the surface in low densities. Scattered rocks, several aligned, probably formed part of structure walls. In 2005 archaeological excavations were conducted in the central part of the site and over one of the mounds (Albarracin-Jordan 2005:145-152). Although the upper layer was removed from eight contiguous units of 4 by 4 m, only three of these proceeded into undisturbed archaeological contexts.

None of the excavation units included Formative Period contexts. However, at least four period burials and other associated features were documented. Based on the associated ceramics, the excavated occupation area was dated to the Tiwanaku Period (Albarracin-Jordan 2007:167-168). One of the buried individuals was secondarily placed outside a large cist tomb enclosed by calcareous rocks, perhaps as a result of a looting event. Considering

Figure 7.21. Large empty cist excavated at KCH22 and dated to the Tiwanaku Period. Photograph courtesy of Juan Albarracin-Jordan.

the large cist was mostly empty another possible interpretation of this feature is that it was a large storage bin (Figure 7.22). In addition, possible domestic structures were also partially exposed. Seven loci corresponding only to Tiwanaku levels contained faunal remains that were analyzed in this study and verify overall low densities of food remains associated with this sector of the site.

7.6. Paleoethnobotanical Analysis and Plant Utilization at Iroco

This dissertation is mostly focused on faunal remains (see Chapter 7). However, plants also comprised an essential component of the landscape and economic subsistence of the Iroco local inhabitants. Consequently, a collection of flotation light fractions and soil sediment samples were studied for identification of macro and micro paleoethnobotanical remains (see Chapter 5). Microbotanical remains from loose soil samples were studied by Amanda Logan (University of Michigan) in order to analyze phytoliths and by Teresa Ortuño (Universidad Mayor de San Andrés) in order to identify pollen samples. Macrobotanical remains from flotation light fractions were studied by BrieAnna Langlie and Maria Bruno (Washington University in St. Louis) in order to identify carbonized seeds and other plant tissues. These results complement the regional plants survey conducted in situ in collaboration with Alejandra Domic (Saint Louis University) regarding the modern vegetation of Iroco (see Chapter 4). The following summary is based on the results provided by my specialist colleagues.

7.6.1. Microbotanical Remains

The phytolith and pollen data provide insights into the ancient landscape of Iroco. Not surprisingly all the identified phytoliths correspond to different taxa of grasses (Family Poaceae) (Table 7.5; Appendix 3). Almost two thousand specimens were identified and classified into at least 35 different types of phytoliths from five different morphological categories. All the generally and specifically identified plant taxa from the phytolith analysis are grasses of different subfamilies, tribes and genera of the Poaceae family. Two of the identified grass genera, *Festuca* and *Stipa*, were also recorded in the plant survey. Interestingly enough, the presence of one specific type of phytolith might suggest the possible presence of maize (*Zea mays*) at the site but given that these were identified in culturally sterile fills and that other more diagnostic maize phytoliths were not found, it is possible that they actually correspond to other species of naturally available grasses (see also Logan 2006 for a similar results in the Taraco Peninsula). However it is also possible that taphonomic factors such as biological activity (e.g., organic decay and invertebrate ingestion) could be biasing the results.

Table 7.5. Results of the phytolith identification analysis carried out by Amanda L. Logan (see Appendix 3).

							Cat. 1 Simple			Cat. 2 Conical													Cat. 3 Rondel														Cat. 5 Lobed				Cat. 7 Other	
Code	Component	Locus	Event	Context	No. Rows Scanned	Extract weight	Panicoid	Festucoid	Chloridoid	2A	2Ab: *Elymus* sp.	2B	2Ba	2C	2Ca: *Piptochaetium* sp.	2Cb	2Cc	2D	2E	2Ea	2Ec: *Aciachne* sp.	2F	3A	3Aa	3Ab	3Ac	3Ad	3Af	3Ag: *Festuca* sp.	3Ah	3Aj: *Stipa* sp.	3Al	3Ba	3Bc	3Bd: *Elymus* sp.	3Bf: cf. *Zea mays*	5A	5C	5D	5E: *Cortaderia* sp.	7C: *Trisetum* sp.	Total Count
ALL 1	KCH21FB	4052/2	A39	Structure 1 floor center	4	0.230	16	122	4	10	3			4	1	1	2	1	5		2	2		3	1					2				12	1	8	1	1				202
ALL 2	KCH21FB	4053/3	A39	Structure 1 floor center	8.5	0.246	18	120	3	12		2		1	1			1	4		4	1	2	3				3	2	2			2	12	1	4	2					200
ALL 3	KCH21FA	4054/3	A69	Culturally sterile	3.5	0.218	8	135	17	6	3		1						3		1	1		3					5	5		1		7		3						199
ALL 4	KCH21FA	4058/3	A69	Culturally sterile	3.5	0.145	12	105	15	38				5	1			4		2	1	1		1						9		1		5								200
ALL 5	KCH21FA	4068/3	A76	Midden outside St. 1	5	0.188	25	119	17	15	1			3			1	1					4						1	6	1	4	1						2			201
ALL 6	KCH21FA	4069/3	A77	Midden outside St. 1	1.5	0.180	25	117	24	8		1	2	2				1	1		1			4						2	1	2		2		3						196
ALL 7	KCH21FA	4070/3	A78	Midden outside St. 1	1.5	0.267	24	125	23	6				1	2		2		2				2	3		1			2	3	1			3				1		1		202
ALL 8	KCH21FB	4077/3	A39	Structure 1 floor north	1	0.280	26	108	28	10		1		2					2							1				8		3		2		1			4		1	197
ALL 9	KCH21FA	4129/2	A84	Semicircular pit	1.75	0.241	31	121	7	15	1				1		1		2			2					1			6		1		9					1			199
ALL 10	KCH21FA	4131/2	A91	Structure 11 floor	1.5	0.198	23	124	15	12	2			2					1					1				2	1	7	1			1		2			1			195
				Total	**31.75**	**2.193**	**208**	**1196**	**153**	**132**	**10**	**4**	**3**	**20**	**6**	**1**	**6**	**8**	**20**	**2**	**9**	**7**	**8**	**18**	**1**	**2**	**1**	**5**	**11**	**50**	**4**	**12**	**3**	**53**	**2**	**21**	**3**	**2**	**8**	**1**	**1**	**1991**

Table 7.6. Results of pollen grain identification analysis carried out by Teresa Ortuño.

Component	Locus	Event	Context	No. Rows Scanned	Asteraceae	Gentianaceae	Juncaceae	Malvaceae	Poaceae	Solanaceae	Brassicaceae	Chenopodiaceae cf. *Chenopodium*	Cactaceae	Fabaceae	Total Count
KCH21FB	4052/5	A39	Structure 1 floor center	4	7				5	9		4	1	1	27
KCH21FB	4056/4	A71	Pit under St. 1 floor	5	11	2	1	2		8	3	11			38
KCH21FA	4058/3	A69	Culturally sterile	4	1				2			1			4
			Total	**13**	**19**	**2**	**1**	**2**	**7**	**17**	**3**	**16**	**1**	**1**	**69**

Identification of pollen provides additional taxa, including several Asteraceae, Solanaceae, Malvaceae herbs and aquatic plants (Table 7.6). Significantly chenopod (*Chenopodium* sp.) pollen grains were also identified. The plant taxa represented in the pollen assemblage indicate a mostly semi-arid environment associated with a lacustrine shore typical of the central altiplano. The density of these remains is not particularly high, possibly in correspondence with the surrounding vegetation but also in relation to the depositional sedimentary environment. Compared with other regions, the few identified pollen grains suggest the environment was particularly dry (see Baied and Wheeler 1993).

Regarding specific features, an expectation based on ethnoarchaeological research in the Andes and in Africa was that a greater proportion of phytoliths and other microbotanical remains could be identified in samples from Structure 1 at KCH21, if in fact, it was the floor of a corral (see Coil et al. 2003; Korstanje 2005; Shahack-Gross et al. 2003, 2004, 2008). Unfortunately, the microbotanical remains were inconclusive for determining whether the floor of this structure was particularly dense in organic matter as compared with other cultural and natural depositions. This is probably confounded by the fact that hearths and trash pits may also include large amounts of dung burned as fuel. Furthermore, taphonomic processes including invertebrate soil digestion (by agents such as beetle larvae) could have contributed to the degradation of phytoliths and other materials. However, comparisons with off-site samples would have reduced dependence on taxonomic identity and density differences might produce clearer results.

7.2.2. Macrobotanical Remains

The macrobotanical plant assemblage consisted of carbonized wood, parenchyma, and seeds (Table 7.7) (Langlie 2011; Langlie and Capriles 2011). These remains were burned prior to final deposition and probably originated from burning fuel for fire (as plant matter or camelid dung) and the additional incorporation of food, weeds, and other vegetable materials into hearths, trash pits, and other archaeological features. The plant materials are similar to those recovered from archaeological sites elsewhere on the Andean puna and including the well studied Lake Titicaca Basin (Browman 1986; Bruno 2006, 2008; Bruno and Whitehead 2003; Whitehead 2007; Wright et al. 2003).

Among the most abundantly identified botanical remains are hundreds of small chenopod seeds (Family Amaranthaceae, Subfamily Chenopodioideae). A cursory revision of the Iroco chenopod seeds suggests that at least three distinct varieties are present including kañiwa (*Chenopodium pallidicaule*), quinoa (*Chenopodium quinoa*), and quinoa negra (*Chenopodium quinoa* var. *melanospermum*). It is possible that other species and varieties are also present and considering that over three quarters of these seeds were smaller than 1 mm, a good portion of the assemblage is probably composed of wild-growing weeds, but also that some probable domestic chenopods are present. However, specific measurements especially of the testa thickness are required for accurately determining the domesticated status of these seeds (Bruno 2006, 2008; Bruno and Whitehead 2003; Langlie et al. 2011).

Several wild plants including herbs and grasses from the Families Amaranthaceae, Cactaceae, Cyperaceae, Fabaceae, Malvaceae, and Poaceae are also commonly represented by seeds in the Iroco assemblage. These seeds (along with several of the chenopods) were probably incorporated to the assemblage as undigested seeds inside camelid dung that

Table 7.7. Summary results of the macrobotanical identification analysis carried out by BrieAnna S. Langlie.

Component	Locus	Event	Context	Flot No.	Volume	>0.5mm weight	>1mm weight	>2mm weight	Total weight	Cactaceae >2mm	Cactaceae >1mm	Cactaceae >0.5mm	Chenopodium >1mm	Chenopodium >0.5mm	Cyperaceae >1mm	Cyperaceae >0.5mm	Fabaceae >1mm	Fabaceae >0.5mm	Lepidium >0.5mm	Malvaceae >1mm	Malvaceae >0.5mm	Plantago >0.5mm	Poaceae >1mm	Poaceae >0.5mm	Ruppia >1mm	Unknown seeds 10 types	Total Seeds	Wood >2mm	Parenchyma >2mm	Dung >2mm	Fungus >2mm	Fungus >1mm	Fungus >0.5mm
KCH21FB	4052/1	A39	Floor Structure 1 center	1024	10.5	3.92	0.77	0.14	7.03																			2					
KCH21FB	4053/1	A39	Floor Structure 1 center	1001	11	1.3	0.66	0.45	8.54					1										1			2		1				
KCH21FA	4054/1	A69	Culturally Sterile	1077	9	1.14	0.28	3.5	3.5												2						2	4					
KCH21FA	4058/1	A69	Culturally Sterile	1050	10	0.33	0.18	0.27	1.1																								
KCH21FA	4067/1	A75	Pit with "X" shape	1002	9.5	22.93	11.25	4.82	49.45	2			13	196		70	3				109			55		4	452	133	182	13	19	47	
KCH21FA	4080/1	A59	Pit, circular, u-shaped w/fish bones	1033	9.5	3.83	2.11	1.51	8.95				2	6		20	4				11			2		1	46	67	40			2	
KCH21FA	4086/1	A65	Pit, circular, u-shaped	1086	8	4.43	1.26	0.46	7.37		2	26	2	82	1	35	3	10			33	17		6		39	256	33	17	2		2	
KCH21FA	4118/3	A87	Pit	1091	10	11.22	5.11	3.23	23.3	12			21		8					3			8		2		54	107	81		1	12	
KCH21FA	4120/1	A85	Hearth, elipitical, v-shaped, isolated	1055	9.5	14	4.73	3.85	24.58	4			13	41	6	89	5	2	1	1	48		1	23		7	241	119	178		2	2	
KCH21FA	4121/1	A98	Pit, circular, trash	1006	10	12.63	5.51	3.61	42.17	7			9		1		4			1			2			17	41	113	57	1	6		
KCH21FA	4123/1	A96	Pit, circular, u-shaped, possibly storage	1000	3	1.7	0.57	0.3	4.64					5		21					3			1			30	13	7			2	1
KCH21FA	4124/4	A94	Pit, circular, v-shaped, possibly storage	1080	8	9.04	4.1	2.11	16.9	4			11		7								5		5		32	67	48		3	14	
KCH21FA	4129/1	A84	Pit, semi-circular, u-shaped	1013	9	4.99	2.2	1.34	17.11	14	25	43	5	382		52	23	10	3	2	576	1		176		191	1503	56	20	7		4	
KCH21FA	4131/1	A91	Floor Structure 11	1075	10	5.48	3.13	25.54	35.6	4			32		41		21			9			5		4	5	121	92	106	7	2	7	
KCH56FA	4158/1	B05	Pit, trash	1060	7	4.14	1.2	1.26	29.53	1			2			3				1	1					2	10	23	1				
KCH56FA	4159/1	B06	Pit, trash	1027	7	7.81	2.5	1.29	16.38							2		2			4				1		9	13				1	
KCH56FA	4162/1	B08	Hearth inside structure	1028	10	7.1	3.71	4.07	30.76		1			7		5		1			6		1	1			22	82	9				
KCH56FA	4163/4	B09	Pit, trash with ash and bones	1059	10	6.57	2.7	7.86	27.99				1														1	30	11				
KCH56FA	4172/1	B17	Hearth inside structure	1036	9.5	9.86	3.34	1.88	23.96	2			12	5		11					2			2			34		22		1	7	
KCH11Tiw	4202/1	C05	Camelid offering in burial	1011	10	10.78	3.52	2.77	78.05	2			1	6		5		1			8						23	48	17				3
KCH11FB	4206/1	C07	Structure floor	1083	10	6.62	2.4	4.42	23.49				1	3		13		1			1						19	33	1				
KCH11FB	4207/1	C08	Midden	1015	10	17.19	4.73	2.45	59.42	1			1	2	1	24					4			3			36	105	13		1	7	4
			Total	22	201	167.01	65.96	77.13	539.82	53	28	69	126	736	65	350	63	27	4	17	808	18	22	270	12	266	2934	1140	811	30	35	107	8
			Mean	1	9.1	7.59	3.00	3.51	24.54	2.4	1.3	3.1	5.7	33.5	3.0	15.9	2.9	1.2	0.2	0.8	36.7	0.8	1.0	12.3	0.5	12.1	133.4	51.8	36.9	1.4	1.6	4.9	0.4

was later burned. These and other identified plant taxa suggest that camelid herds were grazing in diverse types of territories including lake shores, grasslands, shurblands, and possibly highland wetlands (*bofedales*). In addition, several carbonized fragments of dung were directly identified in the macrobotanical remains. Nevertheless, several fragments of wood and twigs suggest that dung was not the only fuel, but that firewood was also used. Considering the local environment the wood possibly could be identifiable as thola (*Baccharis incarum* or *Parastrephia lucida*).

Tuber parenchyma tissue was relatively common and could be potentially identified as potato (*Solanum tuberosum*) but other tuber species are also possible including oca (*Oxalis tuberosa*), ulluku (*Ullucus tuberosus*) and isañu (*Tropaeolum tuberosum*). An interesting macrobotanical finding is the discovery of numerous and ubiquitous carbonized (N=150), yet to be identified fungus specimens, some of which were attached to parenchyma tuber fragments (Langlie 2011; Langlie and Capriles 2011). Potential interpretations for the presence of this fungus include agricultural pests on potatoes or other tubers, tubers rotting during storage, and even curing potatoes through dehydration. Furthermore, it suggests the risk of cultivation in this region was higher than expected considering that cultivation was not only affected by climatic variation but probably also affected by significant pathogens. Broader implications of the paleoethnobotanical analysis and its relationship to the problem of reconstructing early pastoralist economic organization will be discussed in Chapter 9.

CHAPTER 8

ZOOARCHAEOLOGICAL ANALYSIS

In this chapter, I describe the results of the zooarchaeological analysis. The goal of this analysis is to provide a detailed assessment of the taphonomy and economic utilization of ancient animal resources in Iroco. The archaeofaunal assemblages of each component are characterized and compared in terms of inter-taxonomic composition, intra-taxonomic skeletal representation, and cultural and non-cultural modifications.

8.1. Quantitative Properties

8.1.1. Assemblage Composition

As Schiffer (1987) observes, archaeological sites do not have homogenous structure and material culture distributions, but are the consequence of aggregate human behavior manifested in material movable (artifacts and ecofacts) and permanent features (architectural structures) that have been directly and indirectly affected by a number of cultural and non-cultural depositional and post-depositional transformations or formation processes. It is well known that faunal remains are affected by a range of taphonomic processes that together contribute to produce the identified faunal assemblages (Lyman 1994, 2008; Reitz and Wing 2008; Stahl 1996). It is also well known that the recovery methods utilized during excavations also determine the characteristics and composition of the archaeofaunal assemblages and their derived information. These factors must be taken into account during analysis and interpretation. In Iroco, there is an observable progressive change in the type of behavioral repertoire, construction technology, spatial organization, and length of occupation associated with each site and occupation phase.

8.1.2. Sampling Strategy

The faunal assemblages studied from Iroco are representative of archaeological sites, depositional events, and cultural contexts encountered during excavations of archaeological sites in the study area. These assemblages are comparable because during excavations a careful evaluated sampling strategy was applied. I focused particularly on the identification, horizontal exposure, and detailed documentation of significant cultural features. Not all sites, however, shared the same spatial configuration, type of architectural preservation, or received the same amount of sampling intensity. During the 2007 excavations sampling was intensified compared to the earlier work and I collected flotation samples and recorded more detailed data. As a consequence of all of these factors, sample sizes, exposed areas, and types of depositional events sampled vary considerably among site components. Nevertheless, during the analysis phase all available faunal specimens were carefully studied using a single standardized procedure (see Chapter 5).

As a result of the inherent complexity associated with quantification of diverse data from multiple proveniences, specific choices regarding aggregation and quantification units are required to group and present zooarchaeological results. During analysis, each faunal specimen was correlated to different sampling (i.e., sites, area, excavation units, loci), contextual (i.e., components, depositional events), and recovery (i.e., screen, flotation) categories. Although some of these aggregation units are useful for keeping contextual and provenience information, others are better for representing culturally meaningful patterns. Considering this, throughout this section I explicitly mention aggregation units and recovery procedures employed. The minimal contextual aggregation unit is the locus as defined in the Methods chapter. Increasingly general units of aggregation include the excavation unit, depositional event, type of cultural context, chronological component, and site. In addition, all specimens are classified by their recovery procedure (i.e., screen or flotation). Identification was performed at the specimen (or individual fragment of bone) level. In this chapter the preferred quantification unit is the number of identified specimens (NISP), but weight and other derived measures are occasionally used for specific purposes.

8.1.3. Sample Size

The archaeofaunal assemblage from Iroco comprises a grand total of 43,240 specimens, weighing 49,602.35 grams, and belonging to eight components from five different sites (Table 8.1). For the purpose of intertaxonomic comparisons, I made two primary distinctions. Initially, the assemblage was classified into the eight components or occupation phases that are represented within the five excavated sites. The characteristics

Table 8.1. Sample composition and total results of the Iroco faunal assemblage.

Component	Recovery Procedure	Exc. units	Dep. events	Loci	Area (m2)	Taxa	NISP	Weight
KCH20Arch	Screen	1	2	2	5	7	446	1082.63
KCH21FA	Flot	4	33	38	39	8	19395	206.29
	Screen	12	32	50	179	18	2739	12921.32
KCH21FB	Flot	3	8	11	23	11	5129	74.79
	Screen	14	12	36	207	19	7495	15216.98
KCH56FA	Flot	1	18	21	16	7	1408	487.64
	Screen	1	16	22	16	10	1523	7789.76
KCH11FB	Flot	1	4	4	17	6	764	48.32
	Screen	1	3	5	17	10	828	3509.2
KCH21Tiw	Flot	2	1	2	19	6	1178	22.95
	Screen	22	2	29	349	12	1019	5972.84
KCH11Tiw	Flot	1	3	5	17	9	987	46.28
	Screen	1	5	5	17	4	197	1646
KCH22Tiw	Screen	3	5	7	48	3	132	577.35
	Total Flot	6	67	81	72	14	28861	886.27
	Total Screen	33	77	156	499	23	14379	48716.08
	Grand Total	33	99	186	499	27	43240	49602.35

of these components were described in the Chapter 7 and have temporal and contextual validity. Secondly, I organized the assemblage according to recovery procedure.

Faunal assemblages analyzed in this study are heterogeneous, but given similarities in recovery and analysis they are comparable with each other. Table 8.1 relates the general contextual information of the excavated components with the results of the faunal analysis. Figure 8.1 represents the absolute frequencies of number of identified faunal specimens and their weight from each component by recovery procedure. Flotation samples tend to substantially increase the frequency of NISP but does not substantially affect the overall weight. More importantly, the Formative Period components KCH21FA and KCH21FB include the greatest frequencies both in flotation and screen samples, suggesting robust samples are available for making inferences about this time period.

8.1.4. Recovery Procedure

During excavations two recovery procedures were employed, namely screen (5 mm) and flotation (0.5 mm) (see Chapter 5). Identification of specimens recovered from

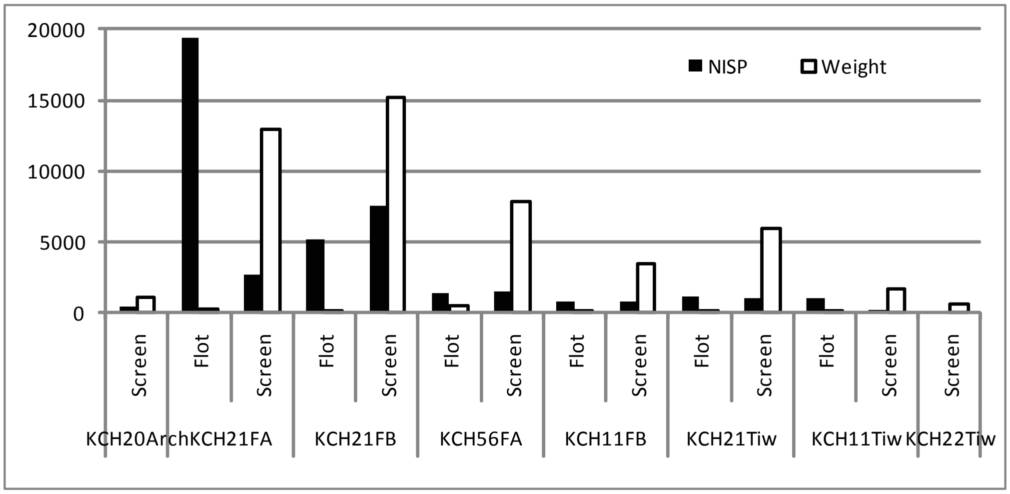


Figure 8.1. Faunal samples sizes: NISP and weight by site and recovery procedure.

these fractions produced different results in terms of taxonomic richness and abundance. Sample size (measured as NISP) seems to condition several of the actual observed patterns, as the relationship between NISP and taxa shows. Surprisingly when samples sorted by component and recovery procedure, there was no significant relationships between NISP and taxa (r=0.23, *P*=0.42, N=14). This result is mostly driven by the composition of flotation samples that are very heterogeneous (r=0.22, *P*=0.67, N=6). The incongruity observed between number of identified specimens and identified taxa might be a consequence of a number of factors not limited to sampling intensity, differential deposition, sample size, and taphonomic processes, several of which I will address in subsequent sections.

Screen and flotation (abbreviated flot) fractions contained different information in terms of identified taxa (Table 8.2). Some taxa represented in screen fractions were not represented in flotation fractions and vice-versa. For instance, of 27 identified taxa in the Iroco assemblages, 23 were identified in screen fractions, and only 14 in flotation samples. Of these, 13 taxa were exclusively identified in screen fractions and four exclusively in flotation samples. Two opposing factors are partially responsible for producing the difference between screen and flotation taxa composition. Flotation samples are made up of small specimens and sampling intensity increased the likelihood of recovering identifiable elements of small taxa (and small elements of large taxa). But because flotation samples were only collected from the contexts excavated in 2007, the results are compounded by incomplete contextual sampling.

Collecting flotation samples increased the overall sampling intensity during excavations. Even though less area and sediment (by volume) was sampled through flotation samples, these samples contained more smaller and potentially identifiable specimens. However, not all excavated contexts were sampled by means of flotation. Flotation samples were only collected from six out of 33 excavated units and from six out of eight components. In the case of site KCH21, although several identified depositional contexts were sampled, their distribution (such as in occupation surfaces and cultural fills) was spatially constrained to the four excavation units excavated in 2007. This also means that although the spatial distribution of flotation samples was not comprehensive, most depositional events were still sampled.

The frequency or abundance of the represented taxa in each fraction is patterned. In general, screen fractions tend to have higher richness and abundance of identified taxa than most flotation samples, yet their overall arrangement varies substantially. The relationship between these two variables is controlled not only by sample size but also by context and recovery procedure. On one hand, flotation samples tend to have more specimens by number of taxa. This is a consequence of the great abundance of fish remains from flotation samples. On the other hand, screen samples have a steep relationship between NISP and number of taxa, probably in connection with the low diversity of large animals potentially identifiable in screen fractions.

The actual cultural context sampled can also affect the results. For instance, some features that included large frequencies of fish (of both *Orestias* and *Trichomycterus* genera), reptiles, and amphibians, tend to be systematically underestimated and negatively biased in screen samples. However, it is worth noting that fish completely dominate the flotation assemblages and their frequencies are so great that even though the total weight of accumulated flotation specimens corresponds to about 1% of the screen fraction, by NISP, flotation specimens correspond to roughly two thirds of the assemblage. With over ten thousand identified specimens, fish remains clearly influence the count in flotation samples and are probably systematically underrepresented in screen fractions. However, to argue that fish dominated the flotation samples is not to say that fish were absent from screen fractions. For instance, at KCH21FB, fish were the most common taxonomic group by NISP in screen samples. However, the overall abundance (and ubiquity) of fish might be seriously underestimated in screen samples. Interestingly enough, this does seem to be the case for other groups of small animals, which are unpredictably infrequent in flotation samples, including birds (with the notable exception of bird egg-shells and the

Table 8.2. Representation of taxonomic groups in NISP by component and recovery procedure.

Taxa	Common Name	KCH20Arch	KCH21FA		KCH21FB		KCH56FA		KCH11FB		KCH21Tiw		KCH11Tiw		KCH22Tiw	Total	Total	Grand
		Screen	Flot	Screen	Flot	Screen	Flot	Screen	Flot	Screen	Flot	Screen	Flot	Screen	Screen	Flot	Screen	Total
Mammalia																		
Camelidae	Camelids	106	25	1055	8	1537	90	669	6	311	2	525	6	69	51	137	4323	4460
Cervidae	Deer	6		13		15						15					49	49
Canidae	Dogs and foxes	1		1		2						83					87	87
Caviinae	Guinea pigs	88		21		12				6		11	1			1	138	139
Ctenomyidae	Tuco-tuco gophers		1	14	1	47		8		1		2	2	7		4	79	83
Sigmodontinae	New World mice		3	4	4	3	5	2			2		12	41		26	50	76
Artiodactyla	Large-size mammals	187	546	839	411	1106	1009	805	218	402	94	322	230	41	75	2508	3777	6285
Hystricognathi	Medium-size rodents		22	14	25	14	37	6	13	10	4	1	7	10		108	55	163
Aves																		
Anatidae	Ducks	10		61		42				3	1	6	1		1	2	123	125
Ardeidae	Herons			2		9				2		1					14	14
Charadriidae	Plovers			1		3											4	4
Columbidae	Doves						3									3		3
Laridae	Gulls			2	1	1		1	1							2	4	6
Passeriformes	Passerines				1											1		1
Phoenicopteridae	Flamingos			3		58				3		2					66	66
Podicipedidae	Grebes					3				1							4	4
Rallidae	Coots	12	4	65	1	51		2	1	10	3	12			1	9	153	162
Recurvirostridae	Avocets	2															2	2
Rheidae	Rheas			2		37		1		10		2					52	52
Strigidae	Owls			1													1	1
Threskiornithidae	Ibis					1											1	1
Tinamidae	Tinamous					1						3					4	4
Indeterminate		22	134	116	16	130	16	11	33	57	29	18	11	9	4	239	367	606
Egg-shells			787	4	99	35	17	2	93		12		49			1057	41	1098
Reptilia																		
Lacertilia	Lizards		2		2		2						2			8		8
Tachymenis	Slender snakes				1				1							2		2
Amphibian																		
Anura	Frogs and toads		3		9		14	1	1				8	8		35	9	44
Osteichtyes																		
Orestias	Killifishes - bones		6213	194	1916	1897	46	4	183		424	4	314			9096	2099	11195
Orestias (Scales)	Killifishes - scales		8402	115	1785	2084	32		92		332		170			10813	2199	13012
Trichomycterus	Catfishes		48	4	28	48	3	1		3	4		24			107	56	163
Indeterminate			2828	168	661	288	13		65		228		83			3878	456	4334
Microfauna																		
Indeterminate	Small vertebrates	12	377	36	160	47	121	8	57	9	43	12	67	12		825	136	961
Mollusca																		
Bivalvia	Scallops and mussels			2													2	2
Gastropoda	Snails			2		24		2									28	28
Total NISP		446	19395	2739	5129	7495	1408	1523	764	828	1178	1019	987	197	132	28861	14379	43240

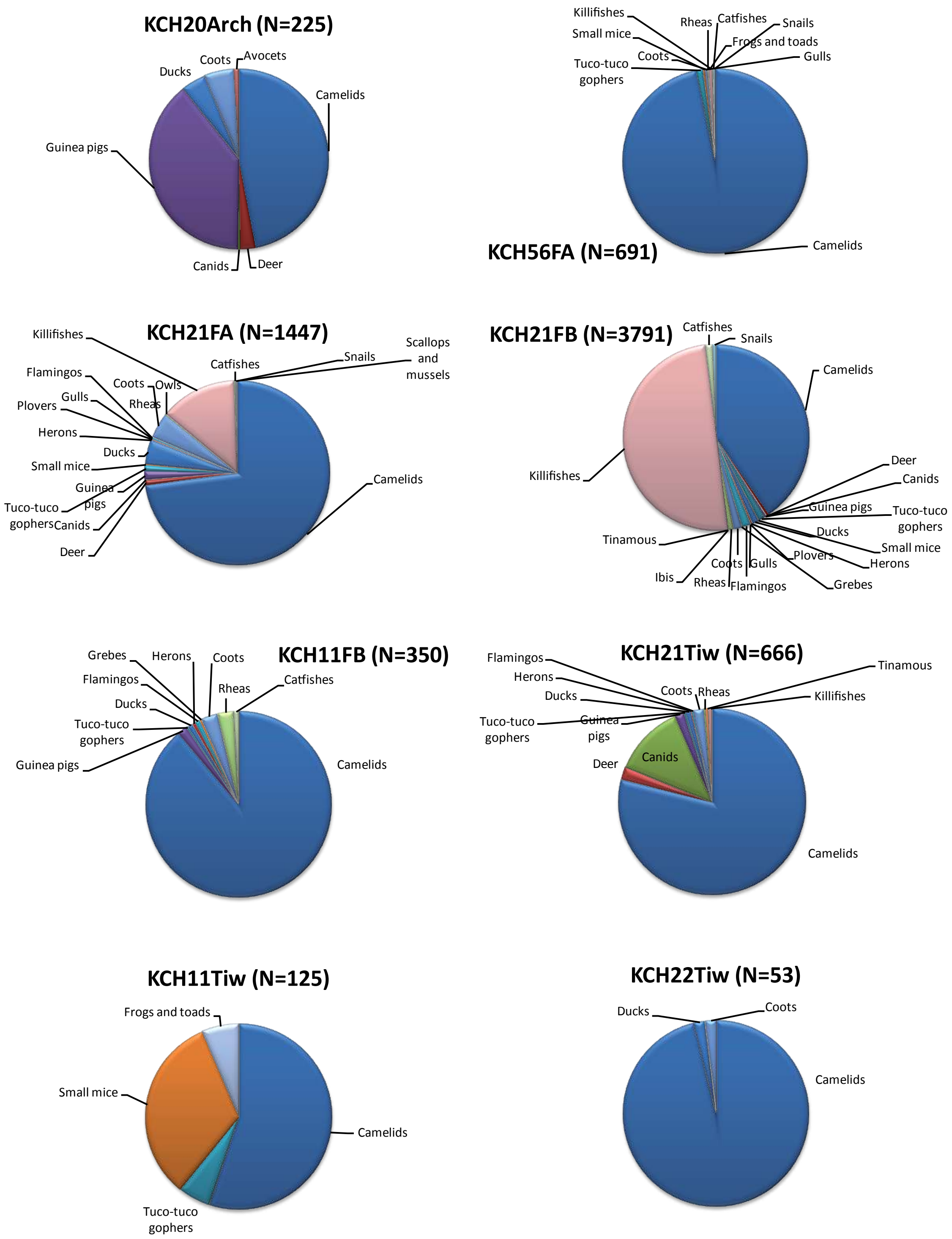


Figure 8.2. Pie-charts showing NISP relative frequencies of identified taxa by component from the Iroco faunal assembalges.

sole identification of doves and passerines in the flotation samples) and mid-size rodents. The low frequency of birds and rodents in flotation samples suggests their frequency is controlled by depositional contexts and taphonomy in addition to recovery procedure. The specific role of these factors in producing the recovered assemblage will be assessed when discussing the relative economic importance of individual taxa.

8.2. Inter-Taxonomic Representation

8.2.1. Arrangement

I will describe inter-taxonomic representation from screen fractions because this sample accounts for over 98% of the assemblage by weight and, excluding fish, over 95%

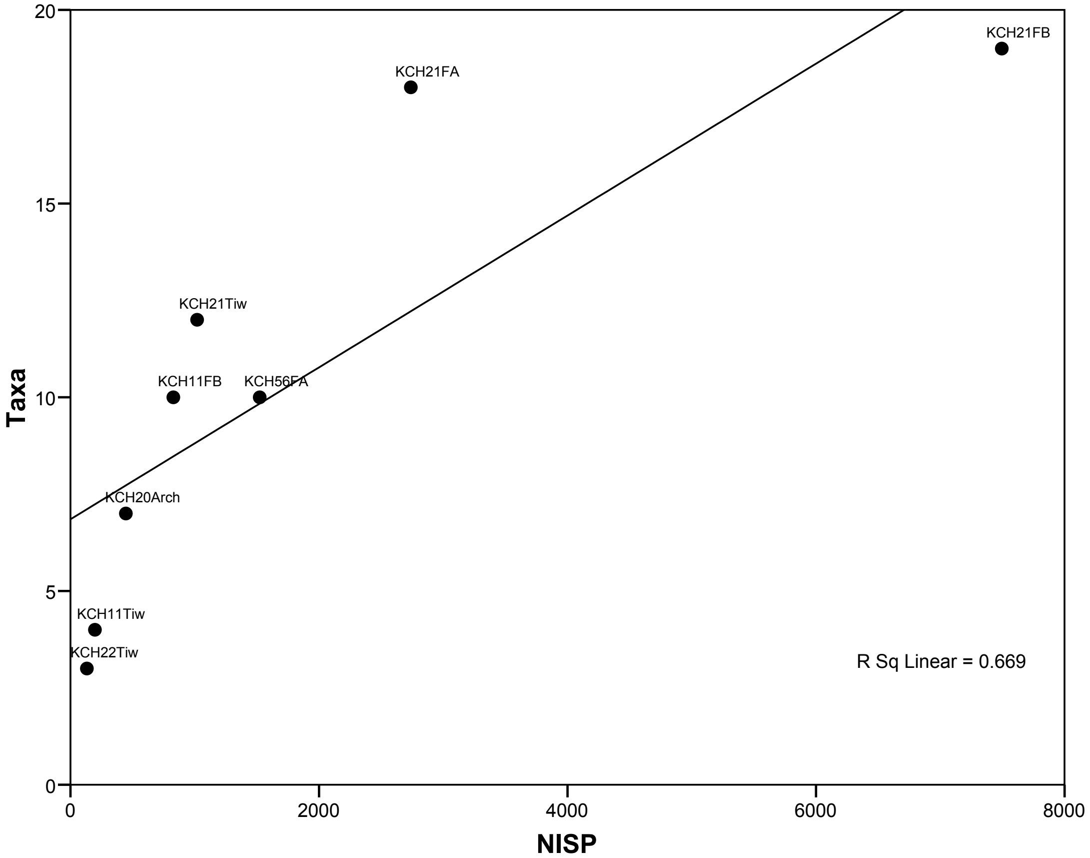


Figure 8.3. Relationship between NISP and taxa for screen fractions.

Table 8.3. Representation of non-overlapping taxonomic groups in NISP by component from screened fractions.

Common Name	KCH20Arch	KCH21FA	KCH21FB	KCH56FA	KCH11FB	KCH21Tiw	KCH11Tiw	KCH22Tiw	Total	Rank-Order	Ubiquity by Event
Camelids	106	1055	1537	669	311	525	69	51	4323	1	0.96
Deer	6	13	15			15			49	12	0.23
Canids	1	1	2			83			87	6	0.15
Guinea pigs	88	21	12		6	11			138	4	0.29
Tuco-tuco gophers		14	47	8	1	2	7		79	7	0.23
Small mice		4	3	2			41		50	11	0.10
Ducks	10	61	42		3	6		1	123	5	0.38
Herons		2	9		2	1			14	14	0.18
Plovers		1	3						4	16	0.03
Gulls		2	1	1					4	17	0.02
Flamingos		3	58		3	2			66	8	0.15
Grebes			3		1				4	18	0.05
Coots	12	65	51	2	10	12		1	153	3	0.40
Avocets	2								2	20	0.06
Rheas		2	37	1	10	2			52	10	0.19
Owls		1							1	22	0.004
Ibis			1						1	23	0.01
Tinamous			1			3			4	19	0.07
Frogs and toads				1			8		9	15	0.03
Killifishes - bones		194	1897	4		4			2099	2	0.26
Catfishes		4	48	1	3				56	9	0.11
Scallops and mussels		2							2	21	0.01
Snails		2	24	2					28	13	0.04
Total	225	1447	3791	691	350	666	125	53	7348	23	0.17

of the NISP counts. Table 8.3 represents the taxonomic representation by NISP of the non-overlapping taxa from screen fractions of the eight cultural components studied in Iroco. Of the 27 non-overlapping taxa identified in the total assemblage, 23 were identified in the screen fractions (Figure 8.2). Figure 8.3 shows a strong positive linear relation between number of identified taxa and NISP for the screen fractions of the eight faunal assemblages studied from Iroco (r=0.818, *P*=0.013, N=8). This pattern is probably an effect of sample size and is often encountered in zooarchaeological studies (Grayson 1984; Lyman 2008; Marshall and Pilgram 1993). Although the sum of NISP could be related to the amount of excavated area and sediment, regressions show that this is not the case. Generally speaking, the actual number of identified specimens (i.e., sample size), independently of their provenience or the size of their provenience units, is the most significant factor that influences taxonomic representation (Table 8.4). Of course, behavioral and taphonomic factors such as differential discard and fragmentation determine sample size. Consequently, contexts in which a greater number of specimens is expected, such as trash pits and middens, also have a higher probability of including a greater number of identified taxa. This is a pattern that makes sense quantitatively and fits archaeologically with the results of Iroco.

Site KCH21 has the largest excavated area, analyzed number of loci, depositional events, and therefore, the largest faunal sample (over 85% by NISP and 69% by weight of the whole collection) (Figure 8.1). Site KCH21 also includes three different chronological

Table 8.4. Correlation among sample size variables. Significant correlations are flagged.

Linear Regression Models	**R**	***P***
NISP = -1744.34 + 341.37 (Taxa)	0.61	0.01*
Events = 8.23 + 0.01 (Area)	-0.14	0.7
NISP = 917.36 + 8.4 (Area)	0.05	0.28
Taxa = 7.36 + 0.029 (Area)	0.28	0.1
NISP = 890.97 + 94.17 (Events)	0.017	0.33
Taxa = 6.93 + 0.36 (Events)	0.29	0.09
Log Taxa = -1.04 + 0.47 (Log NISP)	0.9	0.00015*
Log(Events) = 1.02 + 0.207 (Log Area)	-0.054	0.45
Log NISP = 5.02 + 0.46 (Log Area)	0.15	0.18
Log Taxa = 1.29 + 0.23 (Log Area)	0.16	0.17
Log NISP = 5.46 + 0.71 (Log Events)	0.18	0.16

components or occupation phases. Because KCH21 has the largest sample size, cultural contexts, and faunal richness, more detailed inferences can be made from this than other sites. The assemblages from the other sites provide additional insights into the temporal and spatial variability associated with faunal utilization in the study area and are used for diachronic and synchronic comparisons.

Lyman (2008) has demonstrated that independently of the effort placed in zooarchaeological identification, NISP provides better ordinal type results than most other measures of taxonomic abundance. Table 8.3 presents a summary of the specimens identified from screen fractions showing the rank-abundance of the 23 taxa identified in screen fractions. The most common faunal resources can be grouped into specific categories of animal resources with specific habitat preferences and associated with specific procurement strategies. Consumption and discard behavior also affects these groupings. In approximate order of importance these categories are: camelids, fishes, aquatic birds, mid-sized rodents, dogs, and others (including terrestrial birds, deer, mice, etc.). Given that these categories comprise fundamentally different faunal resources associated with markedly different habitat preferences (ecological distribution), differential patterns of procurement, consumption, and discard can be expected for each of them. Consequently, I will analyze their zooarchaeological properties separately and then discuss the implications of these results. However, before venturing into inter-component comparisons, I will discuss the intra-taxonomical properties of the utilized resources.

8.2.2. Diversity

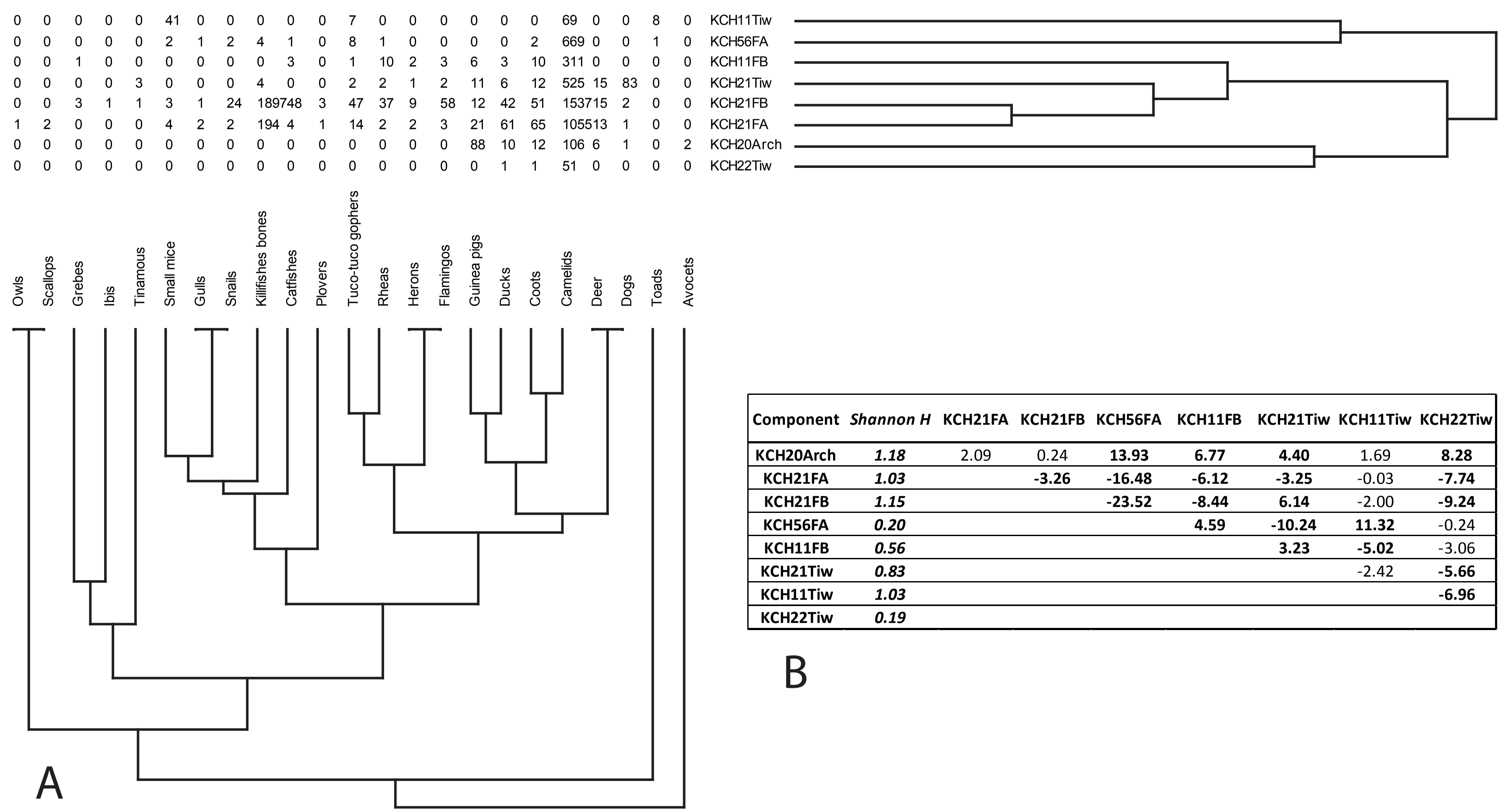
Diversity indexes were calculated to estimate taxonomic heterogeneity and evenness using the taxonomic representation data quantified in number of identified specimens (Lyman 2008; Reitz and Wing 2008). I identified considerable taxonomic diversity in the faunal remains from the eight components or occupation levels as well as in the aggregated total (Table 8.5). These results suggest a trend of reduction in diversity through time. The most taxonomically rich components are KCH21FA and KCH21FB. However, bearing in mind that these components have the greatest associated sample size, this result might very well be a consequence of sample size (see above). KCH20Arch has the highest evenness observed between assemblages. In contrast, KCH56FA has the highest dominance and lowest evenness. The components associated with Tiwanaku have mixed results because on one hand, few identified taxa suggest camelids predominated in these assemblages, but their small associated sample sizes weaken this conclusion. It is worth noting that some indexes are more sensitive to sample size than others.

Comparing diversities also suggests that taxonomic heterogeneity persists among components but the relative importance of taxa represented tends to change. A cluster analysis (Figure 8.4A) performed using taxonomic representation suggests that contextual and spatial variability is important as well as chronological change in understanding taxonomic representation. Furthermore, t-test comparisons of Shanon's H index among different components produced more significant differences than similarities suggesting the Iroco faunal assemblages is quite heterogeneous (Figure 8.4B).

Rank-abundance between components allows us to observe the specific location of these differences (Table 8.3). Although camelids dominate most assemblages, the rank of other taxonomic groups varies in different components. For example, the increase in canids, flamingos and rheas, is balanced by an equivalent decline in coots, ducks, and catfishes. However, tuco-tuco gophers, deer and other underrepresented taxonomic groups tend to

Table 8.5. Diversity indexes calculated for each component based on NISP from screens.

Variable	KCH20Arch	KCH21FA	KCH21FB	KCH56FA	KCH11FB	KCH21Tiw	KCH11Tiw	KCH22Tiw	Total
NISP	225	1447	3791	691	350	666	125	53	7348
Taxa S	7	18	19	10	10	12	4	3	23
Dominance D	0.38	0.55	0.42	0.94	0.79	0.64	0.42	0.93	0.43
Shannon H	1.18	1.03	1.15	0.20	0.56	0.83	1.03	0.19	1.24
Evenness e^H/S	0.46	0.16	0.17	0.12	0.18	0.19	0.70	0.40	0.15
Equitability J	0.61	0.36	0.39	0.09	0.24	0.33	0.74	0.17	0.40



	Owls	Scallops	Grebes	Ibis	Tinamous	Small mice	Gulls	Snails	Killifishes bones	Catfishes	Plovers	Tuco-tuco gophers	Rheas	Herons	Flamingos	Guinea pigs	Ducks	Coots	Camelids	Deer	Dogs	Toads	Avocets
KCH11Tiw	0	0	0	0	0	41	0	0	0	0	0	7	0	0	0	0	0	0	69	0	0	8	0
KCH56FA	0	0	0	0	0	2	1	2	4	1	0	8	1	0	0	0	0	2	669	0	0	1	0
KCH11FB	0	0	1	0	0	0	0	0	0	3	0	1	10	2	3	6	3	10	311	0	0	0	0
KCH21Tiw	0	0	0	0	3	0	0	0	4	0	0	2	2	1	2	11	6	12	525	15	83	0	0
KCH21FB	0	0	3	1	1	3	1	24	1897	48	3	47	37	9	58	12	42	51	1537	15	2	0	0
KCH21FA	1	2	0	0	0	4	2	2	194	4	1	14	2	2	3	21	61	65	1055	13	1	0	0
KCH20Arch	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	88	10	12	106	6	1	0	2
KCH22Tiw	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	51	0	0	0	0

Component	***Shannon H***	**KCH21FA**	**KCH21FB**	**KCH56FA**	**KCH11FB**	**KCH21Tiw**	**KCH11Tiw**	**KCH22Tiw**
KCH20Arch	***1.18***	2.09	0.24	**13.93**	**6.77**	**4.40**	1.69	**8.28**
KCH21FA	***1.03***		**-3.26**	**-16.48**	**-6.12**	**-3.25**	-0.03	**-7.74**
KCH21FB	***1.15***			**-23.52**	**-8.44**	**6.14**	-2.00	**-9.24**
KCH56FA	***0.20***				**4.59**	**-10.24**	**11.32**	-0.24
KCH11FB	***0.56***					**3.23**	**-5.02**	-3.06
KCH21Tiw	***0.83***						-2.42	**-5.66**
KCH11Tiw	***1.03***							**-6.96**
KCH22Tiw	***0.19***							

B

Figure 8.4. Diversity comparisons among the components recovered from Iroco. A. Cluster analysis showing the relationship between taxonomic representation and component produced using the two-way unweighed distance method and Jaccard's measure. B. Correlation matrix showing Shannon's H diversity index for each component and t-scores for individual comparisons among all components (significant differences are flagged in bold).

maintain relatively stable positions. Perhaps the most dramatic change from component KCH21FB to component KCH21Tiw is the sudden increase in canids. However, this is really a consequence of the presence of a relatively complete individual deposited in the uppermost occupation level at KCH21Tiw (see below).

The change in use of resources in Iroco is demonstrated by a number of interesting patterns. Given the heterogeneity of the assemblages studied, the diversity suggests significant differences are common among assemblages. Furthermore, the results indicate a general trend towards increased dominance of camelids. This occurs within a framework of surprising evenness. Andean faunal assemblages are often assumed to be dominated by camelids, but a wide variety of taxa are present in many of the Iroco samples.

8.3. Camelids

8.3.1. Abundance

Camelids were the single most important faunal resource consumed in Iroco. Rank-ordering of the identified taxa places camelids at the very top of the identified taxa in all but one component. Relative proportions of camelid specimens suggest they varied between 41% and 97% of the identified taxa, with an average of 59% (Table 8.6). Moreover,

Table 8.6. Camelid frequencies in screen samples.

Component	NISP	%	Weight	%	MNE	MNI	NISP/MNI	MNE/NISP	Weight/NISP	Weight/MNE	Weight/MNI
KCH20Arch	106	47.1	819.05	95.1	82	4	26.50	0.77	7.73	9.99	204.76
KCH21FA	1055	72.9	10754.81	96.4	835	25	42.20	0.79	10.19	12.88	430.19
KCH21FB	1537	40.5	12387.48	97.5	1208	41	37.49	0.79	8.06	10.25	302.13
KCH56FA	669	96.8	6935.5	99.8	494	14	47.79	0.74	10.37	14.04	495.39
KCH11FB	311	88.9	2726.1	99.5	217	4	77.75	0.70	8.77	12.56	681.53
KCH21Tiw	525	78.8	4854.62	93.8	431	12	43.75	0.82	9.25	11.26	404.55
KCH11Tiw	69	55.2	1522.7	99.6	62	4	17.25	0.90	22.07	24.56	380.68
KCH22Tiw	51	96.2	439.93	99.5	42	2	25.50	0.82	8.63	10.47	219.97
Total	4323	58.8	40440.19	97.3	3371	106	40.78	0.78	9.35	12.00	381.51

using weight instead of NISP, camelids overwhelmingly dominate the assemblages with percentages between 95% and 99.5%. Together these results suggest camelids were not only the most consumed resources, but they were also the largest readily consumed faunal resource. Camelid NISP and weight are strongly positively and significantly correlated (r=0.984, $P<0.001$, N=8), and so are NISP with MNI (r=0.985, $P<0.001$, N=8) and weight with MNI (r=0.957, $P<0.001$, N=8). This is probably a consequence of their shared interdependence (Figure 8.5) (Lyman 2008).

The Upper Level of KCH21 (KCH21FB) is the only component in which camelids were ranked second (Table 8.3). Here, killifishes were more abundant when counted by NISP (or MNI) but as might be expected insignificant when weight was used for estimating taxonomic representation (where camelids dominated with 97.5%). Interestingly enough, the Archaic Period site KCH20 (KCH20Arch), had the second lowest relative frequency of camelids by NISP and weight. Comparatively, here guinea pigs were the second most frequent taxa. In contrast, the component where camelids more strongly dominated the assemblage was the Formative site KCH56 (KCH56FA) where they made up 96.8% of the assemblage. The Formative Period and Tiwanaku Period components had varying frequencies of camelids and confirm the general trend of increased camelid consumption and dietary specialization through time.

Comparisons between different quantification units suggest fragmentation was consistently similar among most components. Camelid elements weighed an average of 9.4 grams suggesting fragmentation was considerable, and probably mainly produced during food preparation. A scatter plot of the relationship between NISP and weight shows that camelid specimens of the Tiwanaku component of KCH11Tiw had the largest average weight by specimen and consequently the best preservation (Figure 8.5). This is probably a consequence of the camelid offering found in this component that included several well preserved semi-complete elements. In contrast, the Archaic Period site of KCH20 had the greatest fragmentation and lowest average weight per specimen. The lower and upper levels

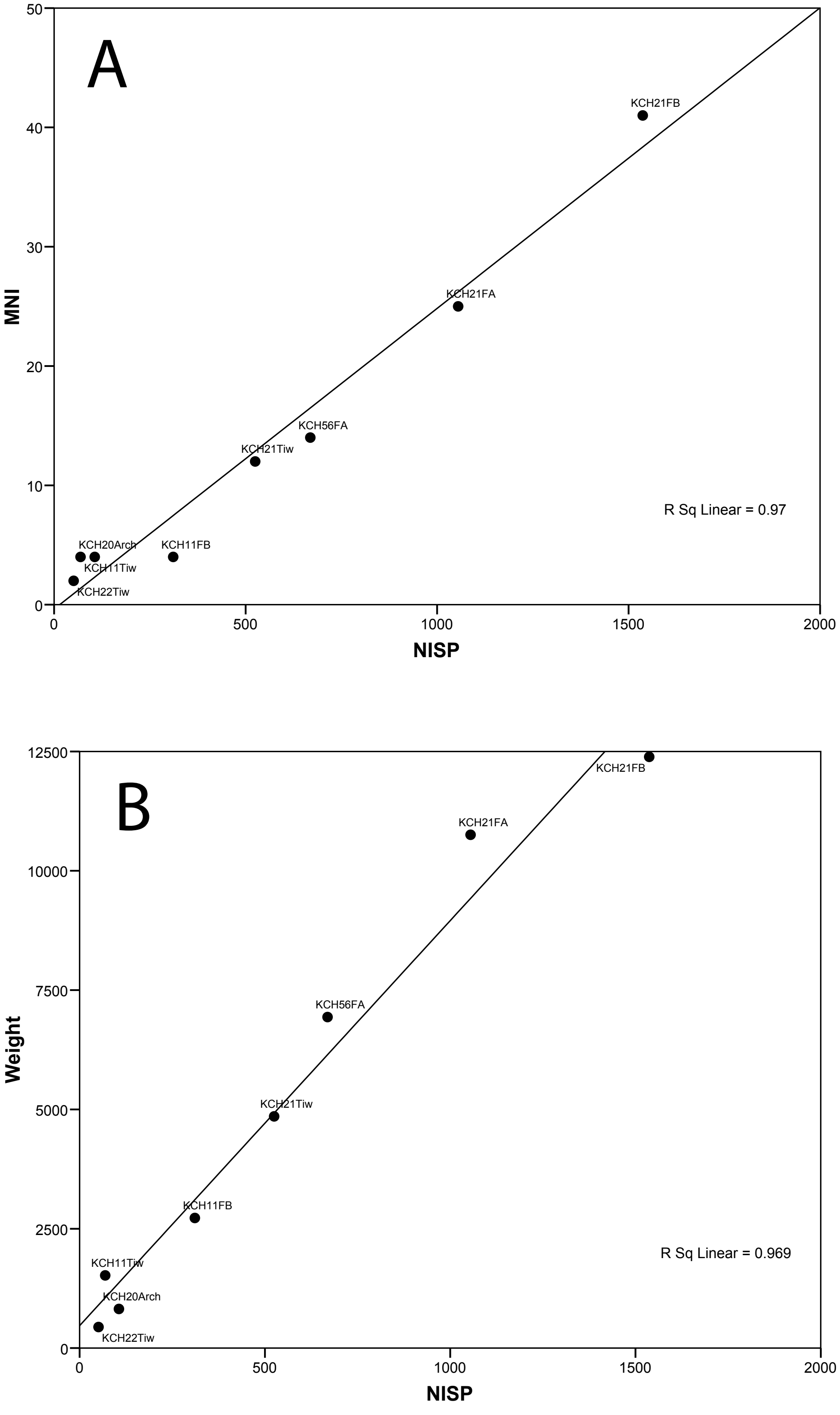


Figure 8.5. Relationship between camelid NISP and A) MNI and B) weight for screen fractions.

of KCH21 had the greatest number of identified specimens but were on opposite sides of the trend line, suggesting, probable better preservation of the Lower Level (KCH21FA).

Strong contextual evidence confirms camelids were the most frequent faunal taxa identified in all assemblages. Camelids were the most ubiquitous resource, present in 96% of all excavated depositional events (Table 8.3). The data presented above does not include several thousand additional fragments identified as large mammals during the faunal analysis (and mostly identified as fragment of long-bone shafts) that were likely derived from camelid elements. These are important results directly relevant to the research question. In fact, it was expected that camelids would be the most important faunal resource consumed in the Iroco settlements. In the following sections, primary data associated with camelid specimens will be used to obtain information on consumption patterns and herd management strategies.

8.3.2. Camelid Intra-Specific Determination

8.3.2.1. Incisor Morphology

To assess camelid inter-specific determination, incisor morphology (Wheeler 1982, 1995) was recorded from individual isolated incisor specimens as well as from incisors still placed within mandibular alveoli. As a result 35 different independent instances (when several incisors were identified from a single mandible they were counted as one) were recorded from all components, 27 of which were identified as llama/guanaco and eight as vicuña (Table 8.7). No alpaca type incisors were identified in the assemblage.

At KCH21, from a total of 11 incisors articulated to mandible fragments and 15 isolated incisors recovered individually from different contexts, 23 corresponded to the guanaco/llama pattern and three to the vicuña pattern. More specifically, the KCH21FA included seven (three complete and four fragmented) incisors of the llama/guanaco type

Table 8.7. Frequencies of isolated incisors and incisors inserted into mandible specimens from Iroco and description of incisor morphology.

Components	Isolated Incisors		Incisors in Mandibles		Total	
	Vicuña	Llama/guanaco	Vicuña	Llama/guanaco	Vicuña	Llama/guanaco
KCH20Arch						
KCH21FA		7	1	3	1	10
KCH21FB	1	5		7	1	12
KCH56FA	2		3		5	
KCH11FB		1		2		3
KCH21Tiw	1	1			1	1
KCH11Tiw		1				1
KCH22Tiw						
Total	4	15	4	12	8	27

and four mandibles specimens included incisors three of which were identified as llama/guanaco type and one as vicuña type. KCH21FB included six isolated incisors (four complete and two fragmented) five out of which were identified as llama/guanaco and one as vicuña. Seven different mandibles specimens included llama/guanaco incisors from this same level. The assemblage of KCH21Tiw included two isolated complete incisors, one llama/guanaco type and the other vicuña type but no instances in mandibles.

KCH56FA contained two isolated complete incisors identified as vicuña. One of these specimens might be an alpaca incisor, the only one in the assemblage. Vicuña type incisors were also identified in three different mandibles. The assemblage of KCH11FB included one complete isolated and two mandibular fragments with llama/guanaco incisors. KCH11Tiw comprised only a fragmented specimen of a llama/guanaco incisor. No incisors specimens were identified at KCH20Arch or at KCH22Tiw.

8.3.2.2. Morphometric Assessment of First Phalanges

The Iroco collection included only five anterior and six posterior complete and fully fused first phalanges, which were measured and compared (Table 8.8). Cluster analysis

Table 8.8. Measurements of first phalanges used for the osteometric assessement.

Component	Element	1	2	3	4	5	Reference / Locus
Vicuña (mean)	1st phalanx anterior	61.33	15.53	15.09	13.56	12.96	Kent 1982:Appendix 4.2
Alpaca (mean)	1st phalanx anterior	60.5	17.6	16.37	14.98	14.34	Kent 1982:Appendix 4.2
Guanaco (mean)	1st phalanx anterior	71.32	19.65	18.37	17.58	16.29	Izeta et al. 2009:Table 1
Llama (mean)	1st phalanx anterior	71.89	22.16	19.98	18.62	17.36	Kent 1982:Appendix 4.2
Vicuña (mean)	1st phalanx posterior	57.13	15.3	14.37	13.8	12.77	Kent 1982:Appendix 4.2
Alpaca (mean)	1st phalanx posterior	54.49	19.6	15.22	14.2	13.22	Kent 1982:Appendix 4.2
Guanaco (mean)	1st phalanx posterior	61.93	18.67	16.59	15.51	13.38	Izeta et al. 2009:Table 2
Llama (mean)	1st phalanx posterior	62.87	20.33	17.39	16.79	15.42	Kent 1982:Appendix 4.2
KCH11FB	1st phalanx anterior	65.62	22.34	19.57	18.59	15.21	4201
KCH11FB	1st phalanx anterior	55.39	16.92	16.16	14.93	12.81	4207
KCH21FB	1st phalanx anterior	73.13	20.39	19.18	16.18	14.34	209
KCH56FA	1st phalanx anterior	59.0	16.74	15.91	14.43	13.17	4160
KCH11FB	1st phalanx posterior	69.42	20.45	18.82	16.7	15.15	4201
KCH11FB	1st phalanx posterior	69.32	19.39	16.62	17.2	14.81	4207
KCH21Tiw	1st phalanx posterior	66.34	20.3	19.62	18.02	16.12	4006
KCH22Tiw	1st phalanx posterior	61.98	17.12	16.43	14.73	12.81	304
KCH22Tiw	1st phalanx posterior	69.37	19.28	19.41	15.94	15.11	304
KCH56FA	1st phalanx posterior	68.41	20.36	18.02	17.61	16.26	4153
KCH21FA	1st phalanx anterior	51.96	16.56	15.22	13.61	12.79	706
KCH21FB	1st phalanx anterior		18.65	17.34			209
KCH11FB	1st phalanx		20.51	15.3			4207
KCH20Arch	1st phalanx		21.78	20.99			601
KCH20Arch	1st phalanx		21.18	18.6			601
KCH20Arch	1st phalanx		22.48	20.03			601
KCH20Arch	1st phalanx		22.05	20.74			601
KCH20Arch	1st phalanx		21.65	20.28			601
KCH20Arch	1st phalanx		21.38	19.2			601
KCH21FA	1st phalanx		20.08	17.47			4127
KCH21FB	1st phalanx		22.83	21.11			209
KCH21FB	1st phalanx		16.79	15.48			4105
KCH21Tiw	1st phalanx		19.98	17.57			800
KCH21Tiw	1st phalanx		25.79	23.24			1300
KCH21Tiw	1st phalanx		22.06	18.67			1800
KCH22Tiw	1st phalanx		16.19	15.14			304
KCH56FA	1st phalanx		20.2	19.15			4156
KCH56FA	1st phalanx		19.89	17.56			4170
KCH22Tiw	1st phalanx		18.03	15.28			304

suggests that two specimens of anterior first phalanges from the Upper Level of KCH21 group well with the average llama specimen (Figure 8.6). A specimen from KCH56 groups well with the alpaca average and one specimen from the Lower Level of KCH21 and another from the Formative Level of KCH11 are intermediate between alpacas and vicuñas.

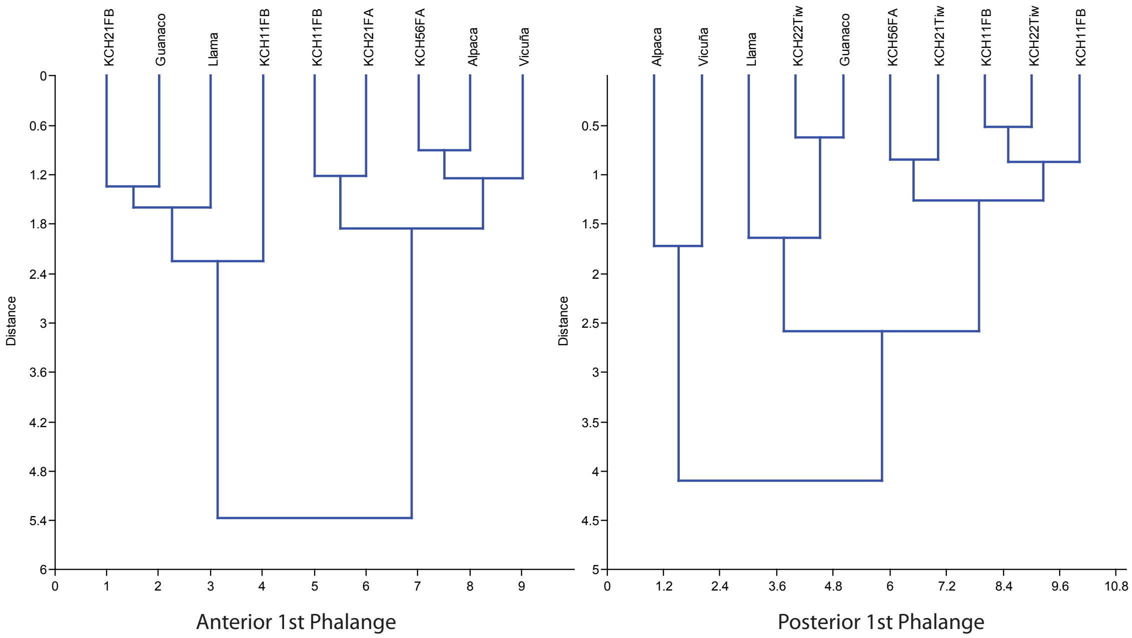


Figure 8.6. Cluster analysis comparing Iroco anterior and posterior first phalanges with modern reference specimens.

All six posterior first phalanges group with the large camelids and one is particularly close to the modern sierra guanaco.

An exploratory treatment was applied to 17 additional fused first phalanges for which their anterior or posterior position within the animal was unknown. As a result, thirteen specimens grouped with the large camelid group and just four with the small camelid group (Figure 8.7). The large specimens included all six KCH20 Archaic Period specimens that interestingly enough, mostly grouped with llamas. Other large specimens included one specimen from the Lower Level, one of the Upper Level and three of the Uppermost Level of KCH21 (including a particularly large one), and two specimens from KCH56. The specimens that grouped with the smaller camelids included one from KCH21FB one from KCH11FB, and two specimens from KCH22Tiw.

A broader direct grouping of all the first phalanges suggests larger specimens predominate over smaller forms by 21 to 7 (Table 8.9). In other words, although about three quarters of the animals represented correspond to large camelids, smaller individuals

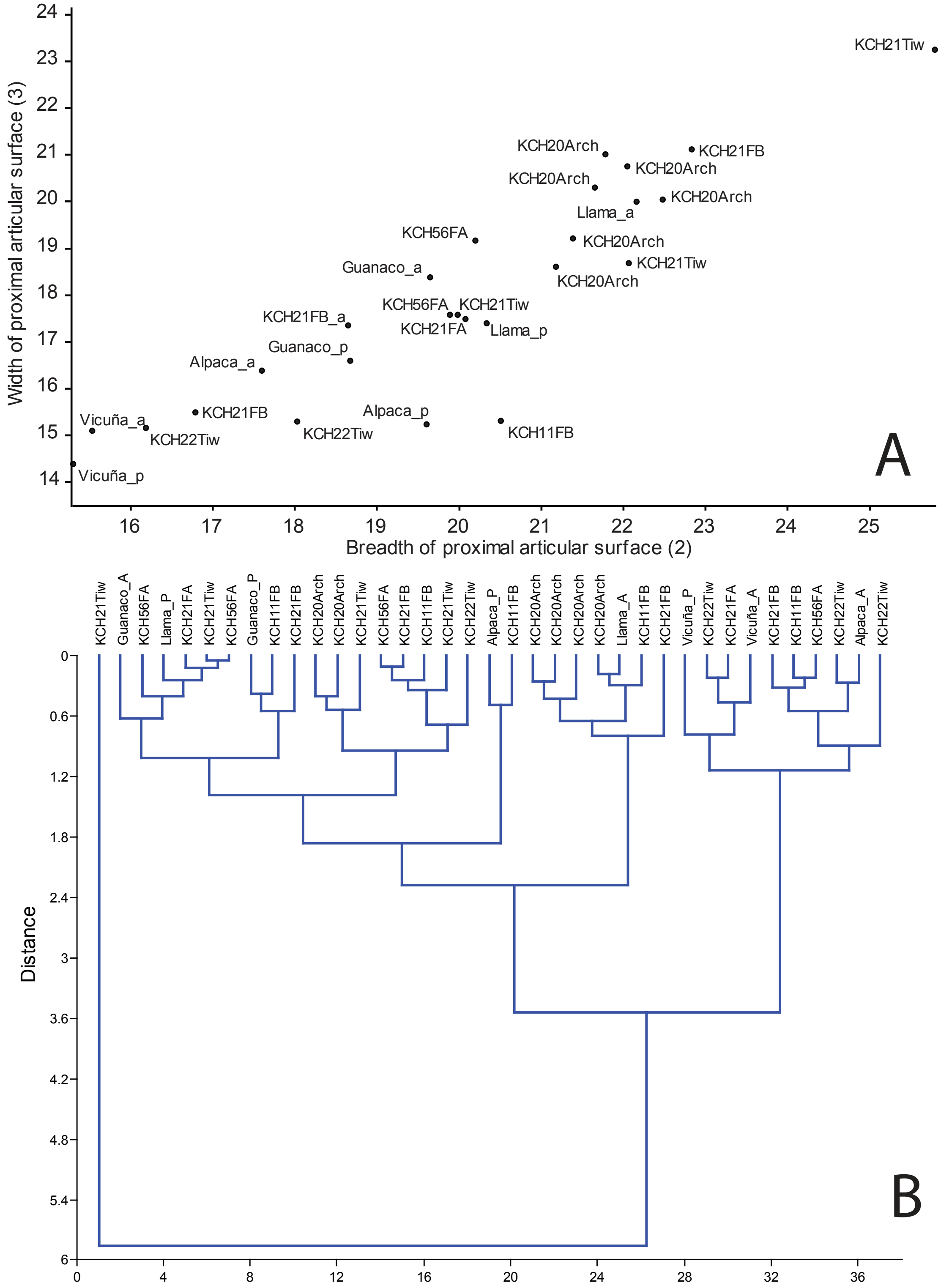


Figure 8.7. Scatter-plot (A) and cluster analysis (B) of fused first phalanges using the breadth of the proximal articular surface (2) and the width of proximal articular surface (3).

Table 8.9. Results of the osteometric assessment based on first phalanges.

Components	Anterior and Posterior					Undetermined					Total		
	Vicuña	Alpaca	Guanaco	Llama	Unknown	Vicuña	Alpaca	Guanaco	Llama	Unknown	Small	Large	Total
KCH20Arch									4	2		6	6
KCH21FA					1				1		1	1	2
KCH21FB			1			1			1		1	2	3
KCH56FA		1			1				1	1	1	3	4
KCH11FB				1	3		1				2	3	5
KCH21Tiw					1				1	2		4	4
KCH11Tiw													
KCH22Tiw			1		1	1	1				2	2	4
Total		1	2	1	7	2	2		8	5	7	21	28

were ubiquitous. The quantitative assessment suggests that even though there is substantial diversity, most specimens tend to cluster with the largest group of camelids. However, smaller camelids definitely constitute an important part of the camelid variability from the Iroco assemblages and were present in most sites. Moreover, in all datasets, the majority of the measured specimens tend to group with the llama size average. Taken together, osteometric data tends to support the hypothesis that llamas were the most commonly represented camelid species in Iroco. This pattern seems to hold for both Formative and Tiwanaku components. Nevertheless, it is important to caution that because of the small sample size (in comparison with the large collection of identified specimens) other analysis employing better represented elements should be implemented to verify this pattern.

8.3.2.3. Meadow's Log Size Index

During analysis, several hundred measurements were collected from different landmarks in various elements. The result of applying the Meadow's log size index (MLSI) produced a distribution of sizes that shows the Iroco assemblages contained significant morphometric variation (Figure 8.8A). In total, I recorded 354 individual measurements on 26 different measurement landmarks. The range of variation is between -0.25 and 0.45. Interestingly some measurements showed different ranges of variation than others (Figure 8.8B), something that might be related to age, preservation, or sample size. This is something

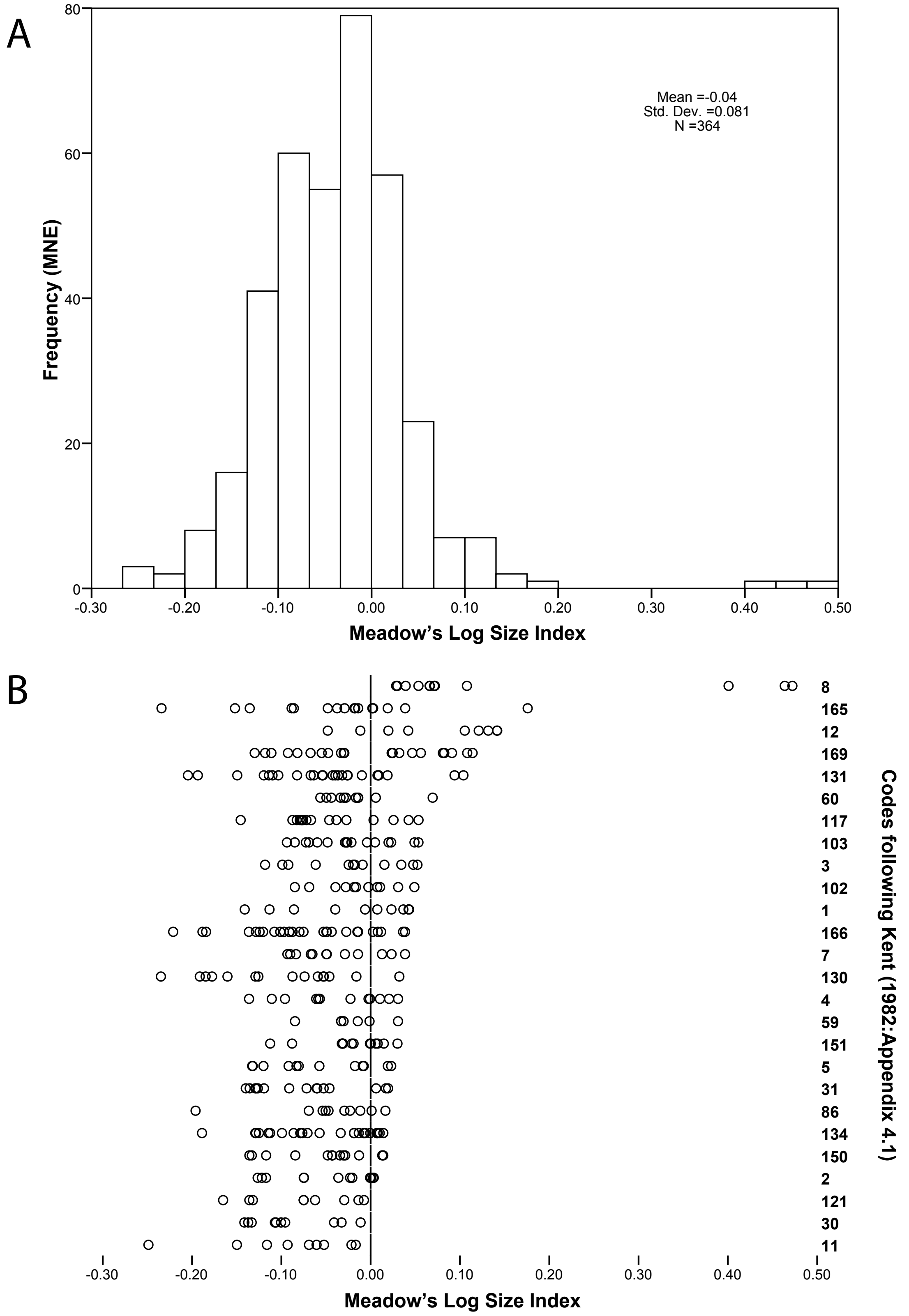


Figure 8.8. Composite frequency histogram of the results of the modified log size index from the Iroco faunal assemblage. A) Histogram, and B) Scatter-plot.

that should be explored in the future with larger sample sizes. The observed variation is also considerably broader than published differences for other taxa (e.g., Linseele 2004; Russell et al. 2005). The MLSI of all measurements produced a normal distribution with a mean of -0.038 that suggests most specimens were only a little smaller in size than modern average llamas. Nevertheless, there were several specimens substantially larger and smaller than this average suggesting that multiple species were likely present in the assemblages.

A brief overview of the distribution by component suggests the specimens of KCH20Arch were larger than modern llamas, a result consistent with the first phalange results (Figure 8.9). Of the four specimens, three were larger and one smaller than a modern llama, suggesting the possibility that these animals were large guanacos or herded llamas. Most probably guanacos in the region during this time period were larger (and more varied) than modern critically endangered Sierra guanacos.

Formative Period specimens show a wide range of distribution but the bulk of specimens near the total average, showing a size reduction in comparison to the previous period. The lowest observed mean corresponds to KCH56FA, a site which included vicuña-type incisors and mixed animal sizes (see above). The evidence suggests animals of different sizes were present including vicuña size animals, but also alpaca and llama size individuals. The specimens of the lower and upper levels of KCH21 nicely group around the slightly smaller than llama mean with specimens substantially larger and smaller than this group. In contrast, the Formative level of KCH11 includes a collection of specimens that were substantially larger than the average and might represent caravanning animals. The great variability associated with the Formative Period components suggests herding of llamas complemented by hunting of guanacos and vicuñas. Specimens from the Tiwanaku levels at KCH21, KCH11 and KCH22, fit well within the llama size group (and are slightly smaller with almost no outliers) suggesting animals from this time period were probably domesticates.

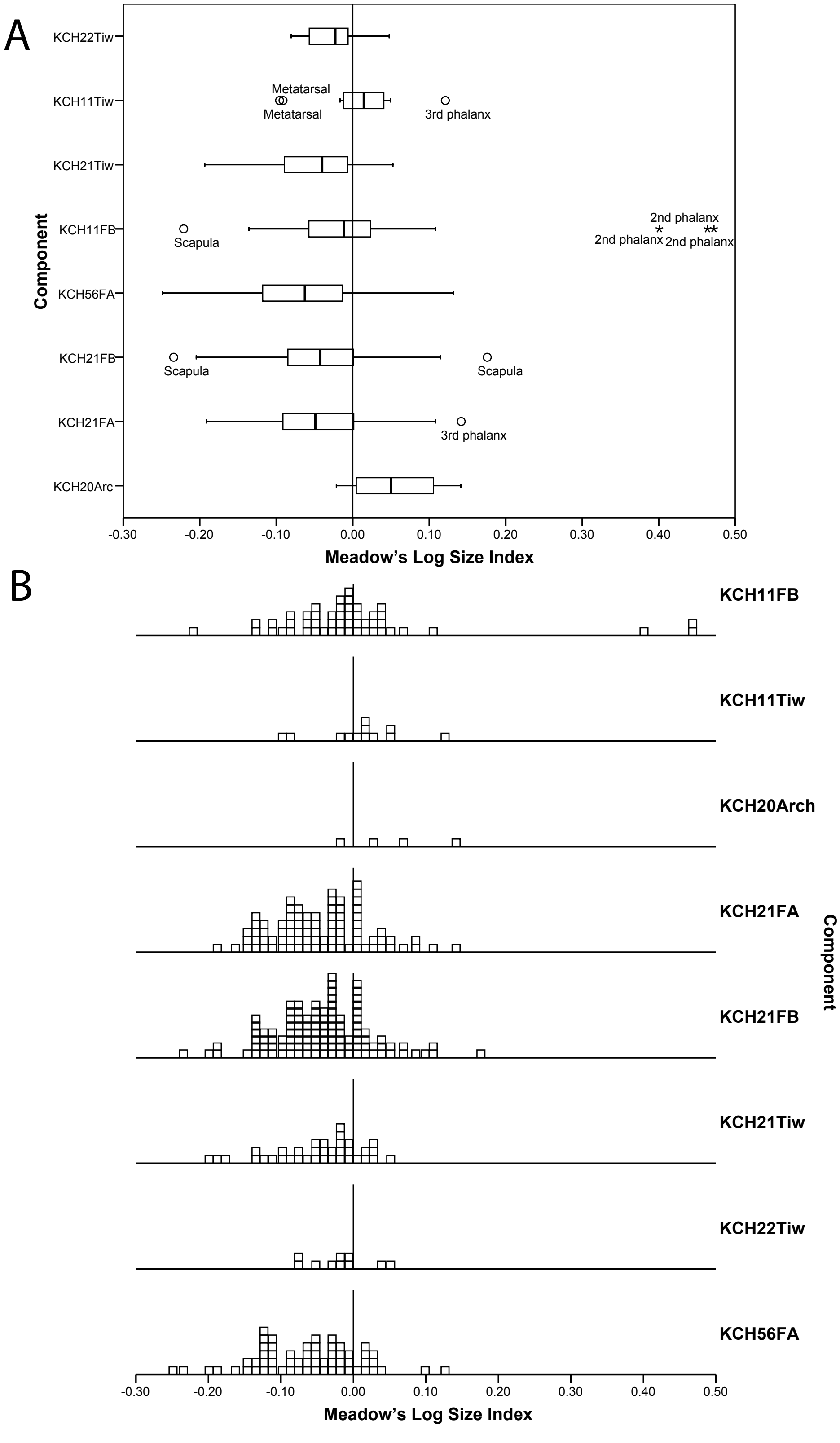


Figure 8.9. Meadow's log size index organized by component. A) Box-plots, and B) Histogram.

8.3.3. Mortality Profiles

8.3.3.1. Epiphyseal Fusion

Mortality profiles for each component were calculated using independent sequences of epiphyses fusion and tooth eruption and wear. Initially, the well known sequence of epiphyseal fusion of camelids derived from modern reference specimens was used to produce frequencies of epiphyseal fused specimens (Kent 1982; Wheeler 1999). As a result age or mortality profiles composed of percentages of fused epiphyses were derived for each component and combined profiles were constructed for each chronological period (Table 8.10, Figure 8.10).

The first mortality profile described is for the Archaic Period site KCH20. Contextual evidence suggests this assemblage was probably produced in a very short time so I interpret it here as a single event. This profile is unique among the recorded assemblages because it is mostly composed of adult individuals. Young individuals are absent. Although the sample size for this component is small, the observed pattern is surprisingly consistent. It could be interpreted as a consequence of two things. Firstly, the assemblage might represent only a few animals that were killed, consumed, and discarded *in situ*. The fact that these animals were adults but younger than 44 months, might support the hunting interpretation. Assuming these animals were hunted and that they were representative of the locally available resources, then the age profile could suggest the foraging event occurred during the dry season when young animals are rare, and wetlands such as the Karakollu River were mostly visited by groups of adults (Moore 1989). Given the small sample size this is only a tentative interpretation.

Secondly, if the KCH20Arch sample derives from herd management and is a cumulative representation of several consumption episodes, it could suggest late sacrifice

Table 8.10. Frequencies of epiphyseal fusion data from the Iroco faunal assemblages. Elements highlighted in gray were excluded for deriving figures 8.10A and B. Percentage of fused specimens for each age stage is represented as %Fus.

		KCH20Arch				KCH21FA				KCH21FB				KCH56FA				KCH11FB			
Months	Element	Fused	Not Fused	Total	%Fus	Fused	Not Fused	Total	%Fus	Fused	Not Fused	Total	%Fus	Fused	Not Fused	Total	%Fus	Fused	Not Fused	Total	%Fus
0	Astragalus	1	0	1	100	4	0	4	100	13	0	13	100	2	0	2	100	2	0	2	100
1	Metapodial M	1	0	1	100	39	0	39	100	49	0	49	100	20	0	20	100	7	0	7	100
12	Scapula Glenoid	2	0	2	100	46	4	50	92	29	2	31	93.5	2	2	4	50	2	1	3	66.7
12	Humerus D	1	0	1	100	11	0	11	100	13	6	19	68.4	3	1	4	75	4	2	6	66.7
12	Radius-ulna P	2	0	2	100	12	4	16	75	17	12	29	58.6	7	2	9	77.8	2	2	4	50
12	Tibia D	0	0	0	0	4	5	9	44.4	12	7	19	63.2	1	2	3	33.3	1	1	2	50
20	1st Phalanx	8	1	9	88.9	4	9	13	30.8	5	9	14	35.7	4	10	14	28.6	6	4	10	60
24	Calcaneus	1	0	1	100	4	4	8	50	4	8	12	33.3	1	5	6	16.7	0	0	0	0
24	Humerus P	0	0	0	0	1	3	4	25	8	4	12	66.7	5	4	9	55.6	0	1	1	0
33	Metapodial D	6	0	6	100	10	21	31	32.3	20	51	71	28.2	8	21	29	27.6	1	4	5	20
42	Radius-ulna D	0	1	1	0	2	3	5	40	2	5	7	28.6	3	12	15	20	0	0	0	0
42	Femur P	0	0	0	0	3	7	10	30	8	3	11	72.7	3	6	9	33.3	1	1	2	50
42	Femur D	0	0	0	0	5	3	8	62.5	5	7	12	41.7	6	3	9	66.7	1	1	2	50
42	Tibia P	0	0	0	0	4	7	11	36.4	4	8	12	33.3	6	12	18	33.3	1	2	3	33.3
44	R-U Olecranon	0	2	2	0	9	10	19	47.4	8	30	38	21.1	3	8	11	27.3	1	4	5	20
	Total	22	4	26	84.6	158	80	238	66.4	197	152	349	56.4	74	88	162	45.7	29	23	52	55.8

		KCH21Tiw				KCH11Tiw				KCH22Tiw				All Formative				All Tiwanaku			
Months	Element	Fused	Not Fused	Total	%Fus	Fused	Not Fused	Total	%Fus	Fused	Not Fused	Total	%Fus	Fused	Not Fused	Total	%Fus	Fused	Not Fused	Total	%Fus
0	Astragalus	4	0	4	100	1	0	1	100	1	0	1	100	21	0	21	100	6	0	6	100
1	Metapodial M	19	0	19	100	2	0	2	100	1	0	1	100	115	0	115	100	22	0	22	100
12	Scapula Glenoid	15	1	16	93.8	1	1	2	50	0	0	0	0	79	9	88	89.8	16	2	18	88.9
12	Humerus D	5	4	9	55.6	2	0	2	100	1	0	1	100	31	9	40	77.5	8	4	12	66.7
12	Radius-ulna P	6	3	9	66.7	1	0	1	100	1	0	1	100	38	20	58	65.5	8	3	11	72.7
12	Tibia D	3	2	5	60	1	1	2	50	1	0	1	100	18	15	33	54.5	5	3	8	62.5
20	1st Phalanx	4	3	7	57.1	0	1	1	0	5	2	7	71.4	19	32	51	37.3	9	6	15	60.0
24	Calcaneus	2	1	3	66.7	2	0	2	100	0	1	1	0	9	17	26	34.6	4	2	6	66.7
24	Humerus P	1	0	1	100	0	0	0	0	0	0	0	0	14	12	26	53.8	1	0	1	100.0
33	Metapodial D	5	11	16	31.3	1	0	1	100	1	2	3	33.3	39	97	136	28.7	7	13	20	35.0
42	Radius-ulna D	1	2	3	33.3	1	2	3	33.3	0	1	1	0	7	20	27	25.9	2	5	7	28.6
42	Femur P	0	7	7	0	1	0	1	100	0	0	0	0	15	17	32	46.9	1	7	8	12.5
42	Femur D	1	3	4	25	1	2	3	33.3	0	0	0	0	17	14	31	54.8	2	5	7	28.6
42	Tibia P	2	4	6	33.3	1	0	1	100	0	0	0	0	15	29	44	34.1	3	4	7	42.9
44	R-U Olecranon	0	9	9	0	1	0	1	100	0	2	2	0	21	52	73	28.8	1	11	12	8.3
	Total	68	50	118	57.6	16	7	23	69.6	11	8	19	57.9	458	343	801	57.2	95	65	160	59.4

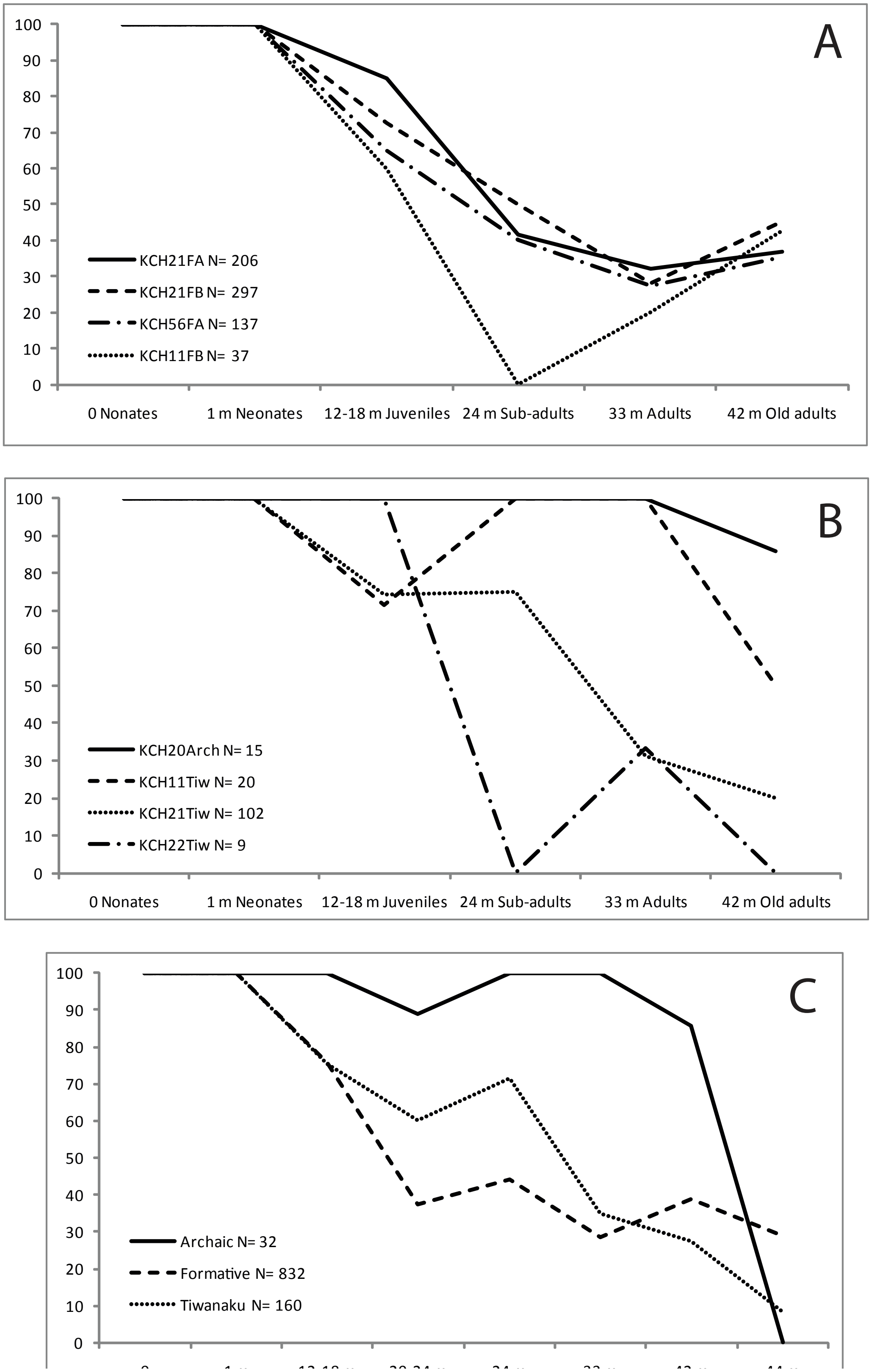


Figure 8.10. Mortality profiles derived from percentage of fused epiphyses by each age class. A) Formative components, B) Archaic and Tiwanaku components, and C) Aggregated chronological comparison.

of selected individuals. Although traditional herding for wool and transport tend to delay animal slaughtering, it has been hypothesized that initial stages of domestication emphasized meat consumption. These findings are inconsistent with theories and empirical data regarding animal domestication that predict a larger fraction of younger individuals in Archaic Period assemblages (Moore 1989; Wheeler 1995, 1999). The possibility that delays in return were involved in the initial process of camelid domestication has not been previously discussed, but it has been documented in animal management of Old World herds of cattle, sheep, and goats (Marshall and Hildebrand 2002; Zeder 2006). Nevertheless, the assemblage from KCH20 dates to Early Archaic Period and consequently in the very initial stages of camelid management and domestication.

The largest samples for assessing Formative Period mortality profiles are from KCH21FA and KCH21FB. Abundant contextual information suggests the faunal assemblages were accumulated through different episodes (albeit possibly from the same season). The Lower and Upper levels have very similar and consistent age profiles that can be interpreted as a consequence of well structured herding management practices that comprised three stages.

The first stage included young juveniles that probably died of natural causes during their first year. Although most animals survived the initial month of birth, 15% were dead by the end of the first year. The second stage is more dramatic and included sacrificing older sub-adult animals. About 60% of the animals were the dead by the end of the second year. In this stage, most animals were slaughtered as they were reaching physical and reproductive maturity. As herds reach maturity their growth curve stabilizes and it makes economic sense to sacrifice them if maximization for meat production is the management goal. As animals reach reproductive maturity sacrificing males is also necessary to keep the herd under control as males tend to fight with each other. Having more reproductive females in a herd also enlarges its growth potential (Flannery et al. 1989; Moore 1989). Sacrificing sub-adult males is a strategy commonly practiced by pastoralists around the world. A slow attritional trend is observed for the third and last stage of the mortality sequence. Animals that survived the second stage were kept around for a long time as reproductive individuals and also because of the additional products such as wool, dung, and transportation they provided.

Although some variations are observed between the Lower and Upper levels at KCH21, the slaughtering pattern is strongly consistent between these two components. KCH21FA includes more marked mortality stages and suggests adult individuals were kept alive even after 45 months. In contrast, KCH21FB is composed of a slightly greater percentage of younger individuals and a steady attrition of older animals throughout the end of the sequence. If the pattern is interpreted as reflecting some type of seasonality, then it suggests either the site was occupied during the dry season or permanently through a herding managing system, like the three-stage mortality pattern previously described. If the mortality patterns are interpreted as herds, then they suggest they were composed of healthy neonates, some juveniles, few sub-adults, several adults, and few older adults. Adults herds probably consisted of numerous reproductive females and a few males.

The mortality pattern recorded at KCH56FA is consistent with the one observed at the Formative Period levels of KCH21. Animals include a large representation of sub-adult individuals but also the presence of some adults (but not older adults) and the absence of nonates and neonates. The mortality profile is consistent with selective slaughtering of sub-adults. Here there is a linear continuous drop from neonates to sub-adults. Juvenile individuals at KCH56FA suggest a progressive attritional mortality during the first two years with about 70% of the individuals sacrificed before reaching maturity. Moreover, frequencies of older individuals suggest the individuals that survived into adulthood tended to live longer. If this assemblage is interpreted as a single herd, it was composed of several younger individuals including younger adults. If these animals were hunted, then the mortality patterns suggest the site was occupied during the wet season or on an annual basis.

The pattern observed at the Formative level of KCH11 is consistent overall with the Formative pattern observed at KCH21 but includes a steeper attrition pattern for sub-adults by the end of the first year. Adult individuals are present but comprise a smaller fraction of the assemblage and were comparatively less well represented than those at KCH21 and KCH56. Unfortunately, small samples sizes associated with KCH11Tiw and KCH22Tiw produced somewhat inconsistent results and only allow for general interpretations. Inconsistency in this case is expressed as age profiles that do not show progressively decreasing percentages of unfused elements. Although these types of specific patterns could be theoretically present in a site, for instance, as a consequence of specific distribution and discard practices, here the three "inconsistent" sequences also have the smallest sample sizes. As a result it is likely that they provide insufficient data for an accurate reconstruction of slaughtering strategies.

The Tiwanaku level at KCH21 had a good sample size for interpreting management practices. This assemblage included about 25% of juveniles but in contrast with Formative Period assemblages, these individuals not only survived the first year, but also past the second and into the third. After this stage, there is an abrupt drop and consequently considerably fewer adults are represented in the mortality profile. This sequence suggests that a larger fraction of the herd was kept after the end of the second year and into the third but then they were quickly sacrificed. If deaths were contemporaneous and this pattern represented a herd, it probably included some neonates, some juveniles, several sub-adults, several young adults, and very few older adults. This sequence supports the possibility that meat production increased in importance, but also that wool and transport were emphasized. It also suggests that management practices such as male castration might have been incorporated into the pastoralist economy.

If all eight assemblages are sorted into the three temporal periods then the different management strategies are strongly contrasting (Figure 8.10C). The Archaic Period assemblage indicates an absence of young and subadult individuals with a preponderance of adults. This probably derives from dry-season hunting. The Formative Period shows a herding pattern that included the natural death of some individuals during the first year, increased harvesting of sub-adults right before their second year, and a progressive culling of older individuals as they were no longer useful for reproductive purposes or wool or transport. The pattern observed for the Tiwanaku period includes a delayed harvest of sub-adults.

8.3.3.2. Mandible Tooth Eruption and Wear

In addition to epiphyseal fusion, I used dental eruption and wear from mandibles specimens as an independent line of evidence for reconstructing mortality profiles and assessing herd composition and slaughtering patterns (Table 8.9) (Moore 1989; Wheeler 1982). The results slightly vary with the patterns derived from epiphyseal fusion, probably as a consequence of differential preservation and fragmentation, but also because of the way each sequence is derived (Table 8.11, Figure 8.11). The sequence derived from dental eruption and wear is based on mandible specimens and consequently each tallied specimen is equivalent to a complete individual. The same is not true for epiphyseal specimens which includes different specimens and averages-out the overall mortality profile. In addition, even though the dental eruption and wear sequence is well understood, fragmented specimens only provide partial information. For instance, some individuals were identified as sub-adults because they were aged using incisors and some neonatal specimens were identified based on the presence of extremely fragmented and small mandible specimens. Similarly, the specimens for which ageing was not possible vary between juvenile and older adults. In addition, isolated fragments of teeth were present in most loci. Moreover, although both sequences have somewhat different temporal resolutions (the dental eruption and wear sequence provides more sensitive results than epiphyses fusion) an effort was made to produce a single temporal scheme. I made this decision because it made the sequences somewhat more comparable, and because it allowed time-averaging. There are advantages and limitations of both approaches, but both provide complementary information, and that is precisely why they were both used in this study.

The results of the dental eruption and wear sequence are presented in Table 8.11. Approximately 43 mandible elements from a total of 92 were preserved well enough to estimate their age of death. Aged specimens are correlated to sample size for each studied component. The Archaic site KCH20 did not include mandible specimens but the presence of a P3 in place a maxilla alveolus suggests the presence of an individual that was at least three years old. KCH21FA included specimens from all age categories, including neonates but is dominated by sub-adults followed by younger individuals. KCH21FB included the best representation of mandibles of the entire collection and it was composed of specimens from all ages with a preponderance of sub-adults followed by neonates and older adults. The assemblage from KCH56FA included sub-adult specimens and old adults. The Formative component of KCH11 only included sub-adults and adults. Aggregating all Formative Period components produces a mortality profile that includes a preponderance of sub-adults followed by older adults and younger individuals (Figure 8.11C). The Tiwanaku components of KCH21, KCH11 and KCH22 included small sample sizes, but when aggregated showed a representation of all age classes with a clear predominance of adults and especially older adults (Figure 8.11B).

Table 8.11. Frequencies of mandible dental tooth eruption and wear data from the Iroco faunal assemblages. Component cumulative relative frequency is represented as Fc(Xr).

Age	KCH21FA		KCH21FB		KCH56FA		KCH11FB		KCH21Tiw		KCH11Tiw		KCH22Tiw		Formative		Tiwanaku		Total	
Category	**N**	**Fc(Xr)**	**N**	**Fc(Xr)**	**N**	**Fc(Xr)**	**N**	**Fc(Xr)**	**N**	**Fc(Xr)**	**N**	**Fc(Xr)**	**N**	**Fc(Xr)**	**N**	**Fc(Xr)**	**N**	**Fc(Xr)**	**N**	**Fc(Xr)**
Nonate	0	100	0	100	0	100	0	100	0	100	0	100	0	100	0	100	0	100	0	100
Neonate	2	77.8	3	78.6	0	100	0	100	0	100	0	100	1	50	5	85.3	1	88.9	6	86.0
Juvenile	2	55.6	2	64.3	0	100	1	66.7	1	80	0	100	0	50	5	70.6	1	77.8	6	72.1
Sub-adult	3	22.2	5	28.6	3	62.5	2	0	1	60	0	100	0	50	13	32.4	1	66.7	14	39.5
Adult	1	11.1	1	21.4	1	50	0	0	1	40	1	50	0	50	3	23.5	2	44.4	5	27.9
Old adult	1	0	3	0	4	0	0	0	2	0	1	0	1	0	8	0	4	0	12	0
Subtotal	9	50	14	46.7	8	42.1	3	50	5	33.3	2	100.0	2	100	34	46.6	9	47.4	43	46.7
No-data	9	50	16	53.3	11	57.9	3	50	10	66.7	0	0.0	0	0	39	53.4	10	52.6	49	53.3
Total	**18**	**100**	**30**	**100**	**19**	**100**	**6**	**100**	**15**	**100**	**2**	**100**	**2**	**100**	**73**	**100**	**19**	**100**	**92**	**100**

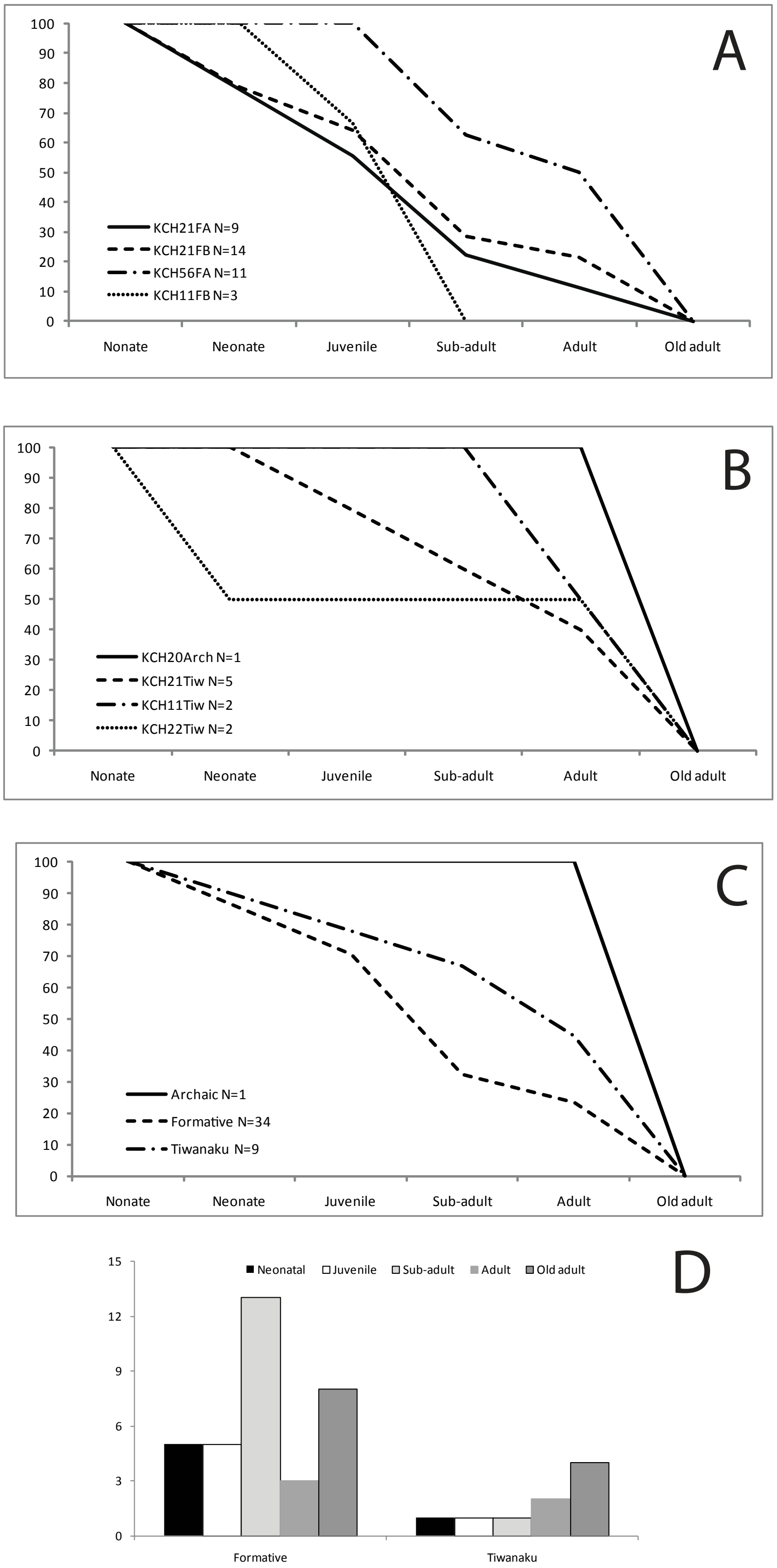


Figure 8.11. Mortality profiles derived from mandible tooth eruption and wear. A) Formative components, B) Archaic and Tiwanaku components, and C) Aggregated chronological comparison, and D) Aggregated absolute frequencies.

Finally, as a general observation, the documented tooth eruption and wear sequences are consistent with the results derived from epiphyseal fusion but differ in some respects, including the clear evidence of neonates. It is possible that neonates were not recorded in the epiphyseal fusion sequence because of differential attrition of the bones used for determining neonates, and their inclusion through the dental sequence is an improvement to the available dataset. In addition, it is worth mentioning that tooth use-wear of some specimens suggests they were considerably older than epiphyseal sequence could suggest. In fact, about seven specimens were 6 years or older and there were a couple of specimens aged between 11 and 13 years, clearly at the very end of the life span of a managed herd.

8.3.3.3. Sex-Ratio

To obtain a rough estimation of the sex-ratio of the camelid remains, sexually dimorphic pubic symphyses attrition and male "fighting" canine teeth proportions were documented (Moore 1989; Wake 2007; Wheeler 1982). Although a large number of fragmented innominate specimens were identified in the Iroco assemblages, pubic symphyses were extremely rare, possibly as a consequence of taphonomic factors, including butchering practices, consumption patterns, and differential preservation (see Miller 1979:59-61).

Only nine pubic symphyses were available for study. All of these specimens were females and (with one exception) originated from Formative Period components (Table 8.12). Most of these specimens also correspond to sub-adult and adult individuals suggesting the presence of some reproductive animals. For instance, a pubis specimen from KCH21FB belonged to a 24-45 months old female, and another specimen from KCH21Tiw suggests the presence of an individual at least 16 months old.

I recorded camelid canine teeth which were inserted into mandibles and cranial maxillae and as isolated teeth. Wheeler (1982) suggests deciduous canines are present in all animals but that erupted specimens are present in 5% of the males and that permanent

Table 8.12. Sex data from pelvis wear and canine presence.

Components	Pelvis		Isolated Canines		Canines Mandibles		Canines Maxillae		Total	
	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
KCH20Arch										
KCH21FA		2			1	3	4	2	5	7
KCH21FB		4				7	1	2	1	13
KCH56FA		1	2		2	1	1	13	5	15
KCH11FB			2			1	2	1	4	2
KCH21Tiw		1				1		1		3
KCH11Tiw						1				1
KCH22Tiw		1								1
Total		9	4		3	14	8	19	15	42

canines erupt between two and half years and three years and a half. Male "fighting" canines are characteristically larger, and therefore, more likely to preserve better and be recovered more frequently than female canines (see also Wake 2007). Although some specimens identified as female might correspond to undeveloped male juvenile individuals, canine development provides a unique line of evidence for assessing sex ratio that is otherwise not available.

Comparisons of size and proportion suggest a preponderance of female individuals (Table 8.12). Specifically, KCH21FA included four well-preserved mandible specimens including at least three females and one male. In addition, independent data from cranium maxillas suggests that four males and two females were present. No isolated canine teeth were identified in this component. From KCH21FB seven female specimens were identified in mandible specimens with no instances of male mandibles. Male canines from maxillae on the other hand, suggest at least two females and one male specimen were present in this assemblage. At KCH21Tiw, canine eruption data suggest at least one female mandible and one female maxilla of different ages were present.

The KCH56FA assemblage had the largest proportion of well preserved skull specimens. Here, two isolated canines were identified as belonging to the possible same male maxillae. Two mandible specimens were identified as male and one as a female. Furthermore, cranial maxillae specimens suggest the presence of at least thirteen females and one male were also present in this assemblage. Some of these specimens might belong to juvenile individuals, but in most cases canines were very underdeveloped. One complete pelvis specimen was identified as female.

The Formative Level of KCH11 included two complete specimens of male canines, one female mandible, and two male and one female maxilla specimens. The Tiwanaku Level of KCH11 included only a specimen of a female mandible. At KCH22 the Tiwanaku assemblage only included the previously referred worn pubic symphysis of a female camelid but no canines. The assemblage from KCH20Arch did not include any specimens useful for sex identification.

In total a male/female ratio of 0.36 was observed, representing a clear preponderance of female individuals. This trend seems to be present in most components with two notable exceptions. KCH21FA includes an even distribution of females and males and KCH11FB is composed of a greater presence of male individuals. However, given the number of identified specimens, the overall trend of female preponderance seems to be robust. Furthermore, mandible specimens including information on both incisor morphology (see above) and sex included eight female llama/guanacos (mainly from KCH21), one female vicuña, and two male vicuña (from KCH56). These results are significant; implying a typical pattern of herding (with more females than males) for the llamas case, and possible hunting of male groups in the case of vicuñas.

8.3.4. Paleopathology

A number of paleopathologies were recorded during the faunal analysis. Because of the specialized expertise required to correctly diagnose specific conditions and their causes, only acute and very clear cases were recorded. These should be considered examples of a probable greater repertoire of pathologies present in the Iroco assemblages.

Ten different types of paleopathologies were recorded during the analysis (Tables 8.13-8.14). Three of these consist of different degrees of exostosis, a condition that generates augmented bone growth, particularly in articular surfaces (Cartajena et al. 2007; deFrance 2010). Fourteen cases of mild and medium exostoses were recorded in different elements including cervical vertebrae, humeri, metapodials, radii-ulnae, innominate, scapulae, and a seasamoid. Excessive and disorganized bone growth may be produced as a consequence of continuous stress or pressure and were probably caused by a combination of occupational stress and aging. Cases of severe exostoses were recorded in two first phalanges, two cervical vertebrae, and a proximal metacarpal. In all instances the result was ossification extending beyond the bone to the point of causing substantial deformation. For instance, both first phalanges were deformed towards their medial side. Izeta and Córtes (2006) have recently reported extreme cases of this condition on two second phalanges suggesting it could be a consequence of possible osteoarthritis related to the use of the animals for pack transport in caravan trips.

Eburnation, identified as rapid remodeling of peripheral bone and observed as a characteristic shine polish produced as a consequence of excessive joint friction, was another common pathology. Represented elements included astragali, cervical vertebrae,

Table 8.13. Summary of paleopathology frequencies in the Iroco faunal assemblages.

Pathology	KCH21FA	KCH21FB	KCH56FA	KCH11FB	KCH21Tiw	KCH11Tiw	Total
Camelidae	**8**	**17**	**18**	**3**	**3**	**3**	**52**
Eburnation	4	3	4	1	2		14
Exostosis	3	2	1			1	7
Healed lesion		3	2				5
Mild exostosis	1	1	4	1			7
Osteomyelitis		1	1				2
Osteophytoses		2	1				3
Periostitis		3				1	4
Polydactylia		1	1				2
Porosity		1	1			1	3
Severe exostosis			3	1	1		5
Large mammal		**1**			**1**		**2**
Periostitis					1		1
Porosity		1					1
Canidae					**1**		**1**
Healed lesion					1		1
Total	**8**	**18**	**18**	**3**	**5**	**3**	**55**

Table 8.14. Frequency of element and paleopathologies associated with the Iroco faunal assemblages.

Element	Pathology	KCH21FA	KCH21FB	KCH56FA	KCH11FB	KCH21Tiw	KCH11Tiw	Total
Camelidae		**8**	**17**	**18**	**3**	**3**	**3**	**52**
Mandible	Osteomyelitis		1	1				2
Atlas	Osteophytoses		1					1
Cervical vertebrae	Eburnation			1				1
Cervical vertebrae	Exostosis		1					1
Cervical vertebrae	Mild exostosis			1				1
Cervical vertebrae	Severe exostosis			2				2
Ribs	Eburnation	1						1
Ribs	Healed lesion		2	1				3
Scapula Glenoid	Eburnation	1						1
Scapula Glenoid	Exostosis	1						1
Scapula Spine	Periostitis		1					1
Humerus P	Porosity			1				1
Humerus M	Periostitis		2				1	3
Humerus D	Eburnation		1					1
Humerus D	Exostosis	1						1
Humerus D	Mild exostosis				1			1
Radius-ulna P	Eburnation	1		1				2
Radius-ulna P	Healed lesion		1					1
Radius-ulna P	Mild exostosis	1	1					2
Radius-ulna D	Eburnation		1					1
Radius-ulna D	Mild exostosis			2				2
Lunar Intermediate carpal	Eburnation					1		1
Pisiform Accesory carpal	Eburnation					1		1
Unciform C4	Eburnation				1			1
Metacarpal P	Polydactylia			1				1
Metacarpal P	Severe exostosis			1				1
Pelvis Illium	Exostosis		1					1
Femur M	Healed lesion			1				1
Femur D	Porosity						1	1
Tibia P	Eburnation			2				2
Astragalus	Eburnation	1						1
Metatarsal P	Exostosis			1				1
Metatarsal P	Porosity		1					1
Metapodial D	Exostosis						1	1
Metapodial D	Mild exostosis			1				1
Metapodial D	Polydactylia		1					1
1st phalanx	Severe exostosis				1	1		2
Sesamoid	Exostosis	1						1
Thoracic vertebrae	Osteophytoses		1	1				2
Lumbar vertebrae	Eburnation		1					1
Large mammal			**1**			**1**		**2**
Long-bone	Periostitis					1		1
Long-bone	Porosity		1					1
Canidae						**1**		**1**
Ribs	Healed lesion					1		1
Total		**8**	**18**	**18**	**3**	**5**	**3**	**55**

humeri, lumbar vertebrae, radii-ulnae, and carpals. This type of pathology occurs through progressive wearing of the cartilage between joints and can be related to occupational stress as well as aging. A related condition is the presence of osteophytes or osteophytoses, usually produced by severe hernias developed on articular ends of joints, for example, in vertebral bodies (i.e., spinal disc herniation). Three clear cases of osteophytoses were recorded, one in an atlas and two in thoracic vertebrae. Porosity, as reduced bone mineral density causing incomplete (and porous) structural bone remodeling, was identified in humerus, femur, and metatarsal specimens. Injuries are represented by healed fractures and fissures present in specimens of femur, radius-ulna, and three ribs. Healed injuries might have been caused by blows or occupational stress, perhaps connected with animal handling and transportation. Eburnation, osteophytoses, and porosity are conditions mostly associated with aging (particularly in the case of vertebrae) but can also be caused by malnutrition, occupational stress, and specific injuries.

Periostitis, noted as the ossification of tissue surrounding longitudinal sections of bone, was identified in three humeri specimens as well as in metacarpal and scapula specimens. Inflammation of the periosteum (the membrane that surrounds bone) resulting in ossification is usually caused by bacterial infection in an open wound but could also be the result of a transmitted infectious disease. A particular severe case of eburnation that developed into a severe case of exostosis was identified in a medial humerus that was part of the camelid offering recorded at KCH11Tiw (Figure 8.12A). Surprisingly, the animal bearing this condition survived for some time as evidenced by the impressive amount of bone remodeling observed in this specimen. Moreover, the absence of a clear lesion suggests the inflammation was caused by a transmitted pathogen or an infection that spread from a different part of the animal. Similarly, two cases of mandibles with osteomyelitis were identified and were probably caused by a contagious infectious disease. Pastoralists today often report animals with several of these types of pathogenic infections (Fowler 1998).

The last form of pathology noted is a congenial type known as polydactylia, or presence of multiple digits. Specifically, two metapodial specimens were observed to have four distal ends (as opposed to the normal two) (Figure 8.12B). One specimen belonged to KCH56 and the other to KCH21FB. Inbreeding caused by endogamous domesticated herds seems to be a likely explanation for this condition (Kent et al. 2001). Interestingly enough, modern vicuña specimens have been known to suffer from this condition, probably a consequence of the hunting pressure that reduced their population to near extinction in

Figure 8.12. Paleopathologies observed in the Iroco faunal assemblages. A) Periositis and severe exostosis on medial humerus recovered from L. 4202, KCH11Tiw, B) Distally unfused metacarpal with polydactylia recovered from L. 4161/7, KCH56FA, compare with C) Normal distally unfused metacarpal from L. 4167, KCH56FA.

1970s, and caused gene bottlenecking manifested in these types of phenotypic expressions (Wheeler 1995).

In addition to the aforementioned pathologies, calculi were observed within molars of some older mandible and maxilla specimens. Moreover, two cases of pathologies were observed in large mammal long-bones and include porosity and periositis. Finally, a canid rib specimen had evidence of a healed fissure.

Diachronically, Formative Period levels have the highest frequencies of pathology occurrences and particularly KCH56FA and KCH21FB. No specimens with paleopathologies were recorded at KCH20Arch or KCH22Tiw. This result seems independent of sample size and possibly connected with the presence of older individuals. This in turn, is possibly connected with specific herd management strategies. Eburnation and exostosis are the most common forms of pathology, but in most components there is no particular pathology that dominates the assemblage but a diversity of them.

In general, paleopathologies were not uncommon and when present usually indicated infections, congenital deformations or more often, degenerative diseases. Considering that domestication has a strong impact on congenital, occupational stress, and infectious diseases, the frequencies and diversity of paleopathologies can be connected to animal herding. Most of the degenerative conditions such as osteophytoses and eburnation are represented in vertebral discs of cervical, thoracic, and lumbar vertebrae but are also surprisingly common in limb bones. Exostosis and ossification of tendons is common in camelids and is usually associated with age but can be connected with occupational stress. Several scholars (e.g., deFrance 2010; Izeta and Cortés 2006) have linked joint and vertebral lesions to animal transport, and this might be the case of some of the pathologies observed in the Iroco assemblages. All of these are consistent with managed herds and breeding of animals. More importantly, the fact that animals survived after significant forms of physical stress, injuries, and pathogens suggests human care.

8.3.5. Skeletal Element Representations

8.3.5.1. Structural Density and Economic Utility

A very important result of the faunal analysis was the reconstruction of differential skeletal element representations. In this section, these patterns are assessed with the goal of understanding specific economic and taphonomic patterns. Initially, reconstructed patterns of skeletal element representations were compared to volumetric density and economic utility datasets, but no correlations were found in all except one component (Table 8.15).

Table 8.15. Results of Spearman's Rank Correlation Coefficient (r_s) for the comparisons made between percentage of survivorship with volumetric density and economic utility. The first treatment includes all elements and the second excludes elements modified into bone tools.

A. Including all specimens			**VD**			**EU**	
Component	**MNI**	**Rs**	***P***	**N**	**Rs**	***P***	**N**
VD vs FUI		**-0.616**	**<0.001**	28			
KCH20Arch	4	-0.051	0.786	31	-0.064	0.807	17
KCH21FA	25	-0.048	0.744	49	0.087	0.658	28
KCH21FB	41	-0.042	0.778	48	0.021	0.916	28
KCH56FA	14	-0.013	0.932	47	-0.035	0.858	29
KCH11FB	4	0.086	0.596	40	-0.288	0.172	24
KCH21Tiw	12	0.05	0.739	47	-0.215	0.281	27
KCH11Tiw	2	-0.027	0.891	28	0.054	0.816	21
KCH22Tiw	2	-0.099	0.669	21	**-0.692**	**0.004**	15
Total	99	-0.038	0.795	50	0.037	0.847	29

B. Excluding worked bones			**VD**			**EU**	
Component	**MNI**	**Rs**	***P***	**N**	**Rs**	***P***	**N**
MNI all vs. excluding worked		**0.979**	**<0.001**	9			
KCH20Arch	3	-0.061	0.748	30	-0.083	0.759	16
KCH21FA	11	-0.061	0.679	49	0.137	0.487	28
KCH21FB	19	-0.002	0.992	48	0.031	0.876	28
KCH56FA	14	-0.046	0.76	46	0.016	0.937	28
KCH11FB	4	0.21	0.199	39	-0.288	0.172	24
KCH21Tiw	9	0.113	0.45	47	-0.234	0.241	27
KCH11Tiw	2	-0.071	0.723	27	0.067	0.78	20
KCH22Tiw	2	0.009	0.969	21	**-0.692**	**0.004**	15
Total	49	0.003	0.985	50	-0.022	0.909	29

These results were consistent using both the entire collection of faunal elements or when worked elements were excluded (Table 8.16). Excluding worked bone from these comparisons was attempted because it can eliminate the bias produced by intentional accumulation of bone for utilitarian purposes. Lyman (1994) and other scholars have argued that bone manufacture can potentially exclude some bones from representation because modifications progressively distort the bone until it is no longer identifiable. Although this is true for some manufactured bones (see below), it does not appear to be the case for the large amounts of identified scapulae. In the Iroco assemblages, bone tools inflated the count of specific modified elements, suggesting bone tool manufacture was an accumulation biasing process. Nevertheless, both tool manufacture and differential skeletal element representation were not influenced by differential preservation or economic utility. Furthermore, although the minimum number of individuals varied substantially between the datasets including and excluding worked bones, MNIs were significantly positively correlated (r_s=0.979, *P*<0.001, N=9).

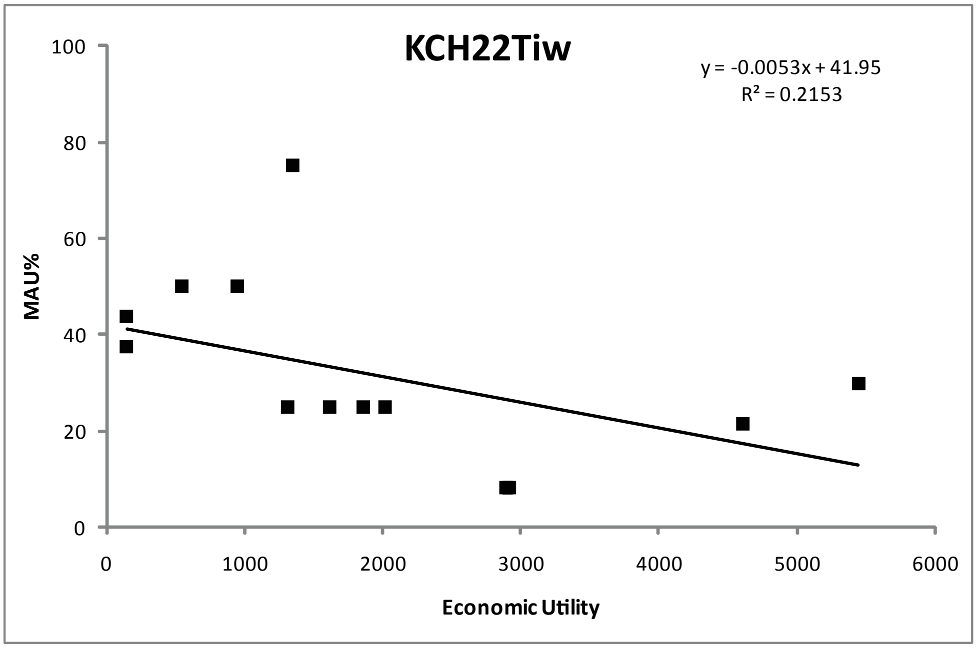


Figure 8.13. Relationship between camelid element percentage of survivorship (%MAU) and economic utility including worked for component KCH22Tiw. Correlation is negative and significant (r_s=-0.692, *P*=0.004, N=15).

The Tiwanaku component of KCH22 showed no correlation between the percentage of survivorship and volumetric density, but showed a negative and significant correlation between percentage of survivorship and food utility (r_s=-0.692, *P*=0.004, N=15) (Figure 8.13). This particular pattern is generally called reverse (bulk) strategy and is often associated with specific context and taphonomic processes, such as butchery areas (Binford 1978). This suggests differential transport of high utility elements out of the site and in the Andes, could indicate differential transport caused by dry meat production (or *ch'arki*) and exchange (see Browman 1989; Miller 1979; Miller and Burger 1995; Stahl 1999).

Differential attrition caused by structural density destruction and differential transport seems to be ruled out for the rest of the assemblages. Figures 8.14 to 8.17 were composed by grouping all components to show the strength of the patterns. However, the possibility that ontogenetic factors influenced the results is not entirely eliminated. For instance, Izeta (2005) and Gutierrez et al. (2010) have demonstrated that structural density values of individual bone elements change with age. As a result the specific values and rank order of volumetric density for different elements and portion of elements will vary during the span of life of an animal and structural density might negatively affected bones of immature individuals. However, volumetric density (as well as economic utility) values for most immature elements are currently unavailable so determining the effect of age in biasing assemblages remains problematic. In any case, the lack of correlation between element survivorship and both volumetric density and economic utility suggests the assemblages of Iroco were produced and discarded locally as a consequence of site level taphonomic processes and particularly human behavior.

8.3.5.2. Element Representation

The overall conclusion of the above analyses is that although structural density and economic utility (with the noted exception) do not seem to be biasing camelid skeletal

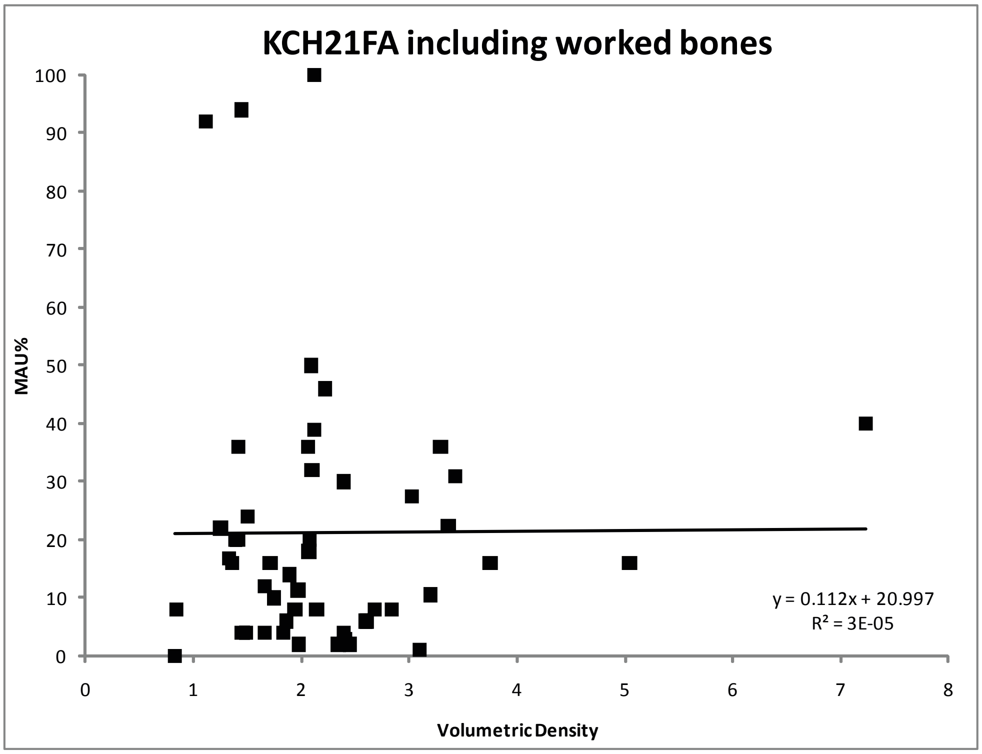


Figure 8.14. Relationship between %MAU and volumetric density for the camelid remains of KCH21FA, including worked bone.

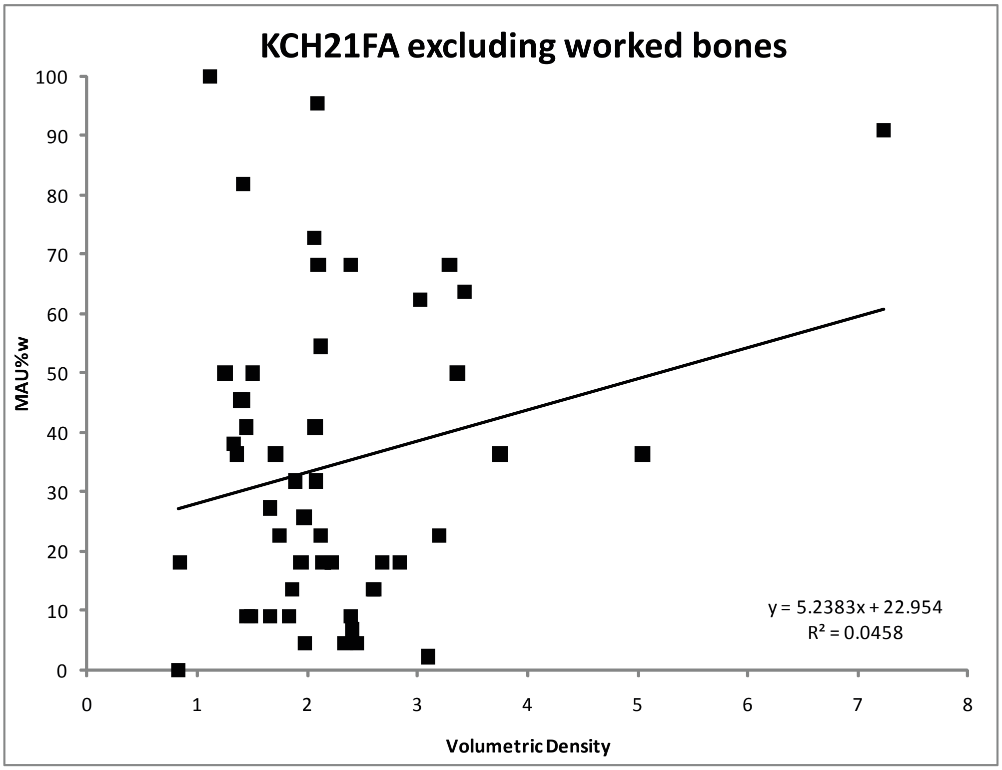


Figure 8.15. Relationship between %MAUw and volumetric density for the camelid remains of KCH21FA, including worked bone.

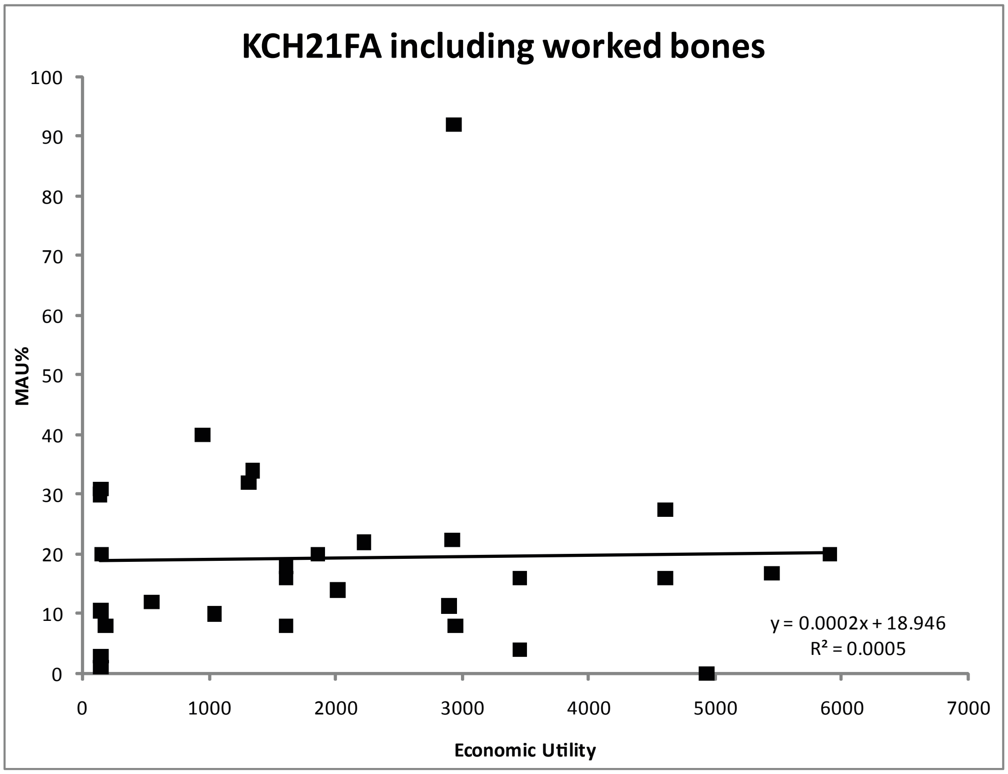


Figure 8.16. Relationship between %MAU and economic utility for the camelid remains of KCH21FA from Iroco, excluding worked bone.

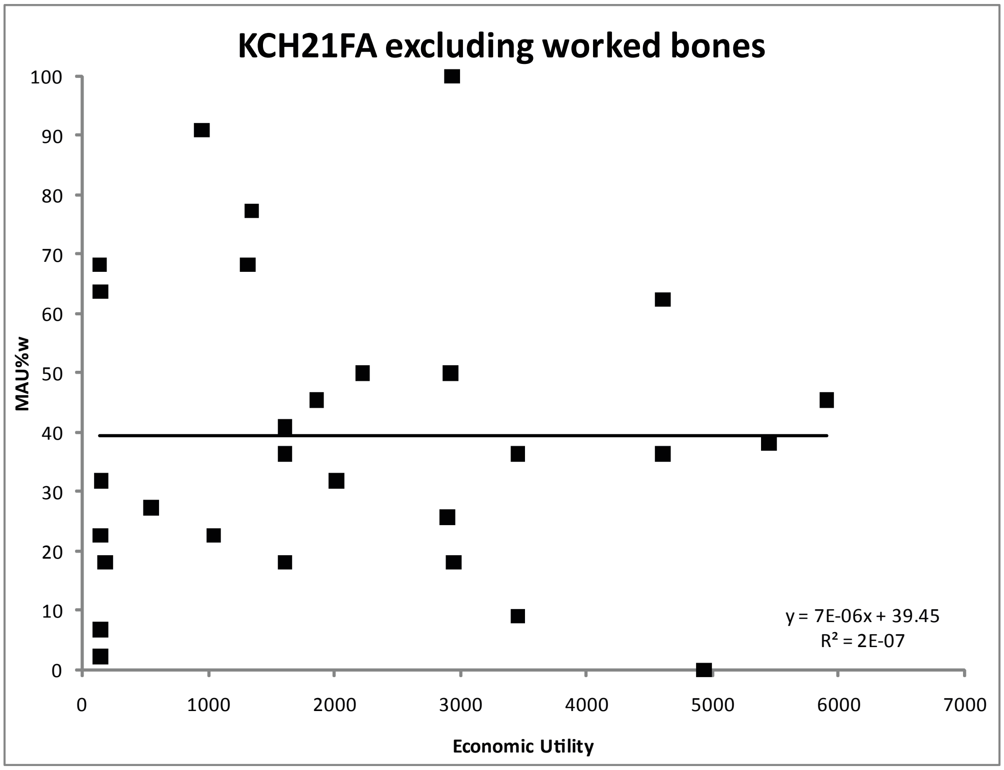


Figure 8.17. Relationship between %MAUw and economic utility for the camelid remains of KCH21FA, excluding worked bone.

element preservation, differential survivorship of bones is present in the Iroco assemblages. Differential element survivorship can be a consequence of specific interactions between human induced and natural taphonomic processes and in this section some of those processes will be explored. Considering the overwhelming contextual (archaeological) and stratigraphic evidence that demonstrates the faunal assemblages were produced and deposited by humans, then most taphonomic processes were caused, mediated or triggered by some form of human behavior prior, during, and after final discard. Relevant human behavior include food preparation and consumption (including specific slaughtering, butchering, differential transport, cooking, preserving, and eating activities), and by-product purposeful modification (such as bone tool production, maintenance, and use) all of which, mediate final discard. Discard practices can also mediate factors such as location, degree of burning, accumulation intensity, surface exposition, trampling, and post-burial disturbance, constraining or enhancing specific natural taphonomic processes such as mechanical abrasion, weathering, biological activity, and others.

Although there is variation among assemblages, particularly regarding the element presence or absence (Figures 8.18-8.25 and Table 8.16 for primary data), the most frequently represented skeletal elements are scapulae, ribs, mandibles, and crania fragments. These elements have an 80% or higher percentage of survivorship (Table 8.16). However, the frequency of these elements is compounded by the fact that scapulae were divided into portions and neurocranium specimens were excluded from the analysis suggesting that the actual representation of these elements might even be higher.

The undisputed ubiquity and conspicuousness of these elements in most assemblages suggests some other factor might be driving their frequency. That these bones are fairly easy to identify is not an explanation, because given the preservation of the assemblage this was true of most faunal elements. The fact that MNEs were calculated by locus could have slightly enhanced the presence of some of these elements in combination with others but this factor would have produced a similar bias in other elements. These elements

Table 8.16. Frequencies and percentages of survivorship of camelid skeletal remains for all components including all identified specimens.

	KCH21FA									KCH21FB								
Element	NISP	R	L	MNE	MAU	MAU%	Worked	MAUw	MAU%w	NISP	R	L	MNE	MAU	MAU%	Worked	MAUw	MAU%w
Cranium Maxilla	28	6	9	17	8.5	34		8.5	77.27	33	8	10	18	9	21.95		9	47.37
Mandible	27	8	12	20	10	40		10	90.91	45	11	19	30	15	36.59		15	78.95
Atlas	2			2	2	8		2	18.18	5			3	3	7.32		3	15.79
Axis	4			3	3	12		3	27.27	10			8	8	19.51		8	42.11
Cervical vertebrae	28			21	4.2	16.8		4.2	38.18	63			50	10	24.39		10	52.63
Ribs	160	68	66	134	5.58	22.33	2	5.5	50	339	122	98	222	9.25	22.56		9.25	48.68
Sternum																		
Scapula Glenoid	78	23	23	46	23	92	24	11	100	40	10	18	29	14.5	35.37	21	4	21.05
Scapula Acromion	35	12	11	23	11.5	46	19	2	18.18	31	8	17	26	13	31.71	17	4.5	23.68
Scapula Spine	58	15	14	47	23.5	94	38	4.5	40.91	96	34	29	81	40.5	98.78	60	10.5	55.26
Scapula Blade	59	7	9	50	25	100	45	2.5	22.73	91	11	13	68	34	82.93	47	10.5	55.26
Humerus P	7	2	2	4	2	8		2	18.18	12	7	4	12	6	14.63		6	31.58
Humerus M	18	6	4	18	9	36		9	81.82	18	5	6	17	8.5	20.73		8.5	44.74
Humerus D	10	6	4	10	5	20		5	45.45	20	7	12	19	9.5	23.17		9.5	50.00
Radius-ulna P	16	6	10	16	8	32	1	7.5	68.18	39	17	12	29	14.5	35.37		14.5	76.32
Radius-ulna M	21			18	9	36	2	8	72.73	46	7	2	39	19.5	47.56	2	18.5	97.37
Radius-ulna D	5	4	1	5	2.5	10		2.5	22.73	10	4	3	7	3.5	8.54		3.5	18.42
Metacarpal P	15	11	4	15	7.5	30		7.5	68.18	19	10	5	15	7.5	18.29	3	6	31.58
Cuneiform Radial carpal	2	1	1	2	1	4		1	9.09	4	1	3	4	2	4.88		2	10.53
Lunar Intermediate carpal	3		3	3	1.5	6		1.5	13.64	3	2	1	3	1.5	3.66		1.5	7.89
Pisiform Accesory carpal	3	2	1	3	1.5	6		1.5	13.64	3	1	2	3	1.5	3.66		1.5	7.89
Scaphoid Ulnar carpal	1		1	1	0.5	2		0.5	4.55	6	4	1	6	3	7.32		3	15.79
Trapezoid C2	1	1		1	0.5	2		0.5	4.55									
Unciform C4	4	3	1	4	2	8		2	18.18	8	3	5	8	4	9.76		4	21.05
Pelvis Acetabulum	8	5	2	7	3.5	14		3.5	31.82	5	2	3	5	2.5	6.10		2.5	13.16
Pelvis Illium	18	11	7	18	9	36	3	7.5	68.18	37	14	19	33	16.5	40.24	3	15	78.95
Pelvis Ischium	9	3	5	8	4	16		4	36.36	11	6	5	11	5.5	13.41		5.5	28.95
Pelvis Pubis	2		2	2	1	4		1	9.09	4	3	1	4	2	4.88		2	10.53
Femur P	13	4	6	10	5	20		5	45.45	13	5	6	11	5.5	13.41		5.5	28.95
Femur M	12	1	1	12	6	24	1	5.5	50	15	3	7	14	7	17.07		7	36.84
Femur D	8	6	2	8	4	16		4	36.36	13	6	6	12	6	14.63		6	31.58
Patella	2	1	1	2	1	4		1	9.09	3	2	1	3	1.5	3.66		1.5	7.89
Tibia P	12	6	4	11	5.5	22		5.5	50	14	5	8	12	6	14.63		6	31.58
Tibia M	25	6	5	25	12.5	50	4	10.5	95.45	22	3	3	20	10	24.39		10	52.63
Tibia D	9	4	3	9	4.5	18		4.5	40.91	20	10	8	19	9.5	23.17	1	9	47.37
Metatarsal P	11	3	7	10	5	20	3	3.5	31.82	13	8	5	13	6.5	15.85	1	6	31.58
Astragalus	4	1	3	4	2	8		2	18.18	14	6	7	13	6.5	15.85		6.5	34.21
Calcaneus	8	5	3	8	4	16		4	36.36	13	5	7	12	6	14.63		6	31.58
Cuboid T4	2	1	1	2	1	4		1	9.09	4	2	2	4	2	4.88		2	10.53
Entocuneiform T2	1		1	1	0.5	2		0.5	4.55	2	2		2	1	2.44		1	5.26
Lateral malleolus Fibula	4	1	3	4	2	8		2	18.18	3	1	2	3	1.5	3.66		1.5	7.89
Magnum C3	3	3		3	1.5	6		1.5	13.64	4	1	3	4	2	4.88		2	10.53
Navicular T3	2	1	1	2	1	4		1	9.09	3	2	1	3	1.5	3.66		1.5	7.89
Thoracic vertebrae	51			34	2.83	11.33		2.83	25.76	37			36	3	7.32		3	15.79
Lumbar vertebrae	78			48	6.86	27.43		6.86	62.34	66			59	8.43	20.56		8.43	44.36
Sacrum	10			4	4	16		4	36.36	2			2	2	4.88		2	10.53
Metapodial M	45			39	9.75	39	15	6	54.55	60			49	12.25	29.88	7	10.5	55.26
Metapodial D	34			31	7.75	31	3	7	63.64	79			71	17.75	43.29	4	16.75	88.16
1st phalanx	23	12	9	21	2.625	10.5	1	2.5	22.73	22	11	8	20	2.5	6.10		2.5	13.16
2nd phalanx	7	2	4	6	0.75	3		0.75	6.82	9	6	3	9	1.13	2.74		1.13	5.92
3rd phalanx	2	1	1	2	0.25	1		0.25	2.27	2	1	1	2	0.25	0.61		0.25	1.32
Cranium Neurocranium	57			35						78			38					
Incisor	7	3	4	7						6	3	3	6					
Canine																		
Mollar	23			17						25			24					
Hyoid										4			4					
Caudal vertebrae	3			3						1			1					

Table 8.16. Continued.

	KCH56FA									KCH11FB								
Element	**NISP**	**R**	**L**	**MNE**	**MAU**	**MAU%**	**Worked**	**MAUw**	**MAU%w**	**NISP**	**R**	**L**	**MNE**	**MAU**	**MAU%**	**Worked**	**MAUw**	**MAU%w**
Cranium Maxilla	42	14	13	27	13.5	96.43		13.5	96.43	7	3	3	6	3	75		3	75
Mandible	24	9	10	19	9.5	67.86		9.5	67.86	8	6	1	7	3.5	87.5		3.5	87.5
Atlas	2			2	2	14.29		2	14.29	2			2	2	50		2	50
Axis	3			3	3	21.43		3	21.43	2			2	2	50		2	50
Cervical vertebrae	54			25	5	35.71		5	35.71	18			13	2.6	65		2.6	65
Ribs	175	73	57	130	5.42	38.69		5.42	38.69	53	23	17	40	1.67	41.67		1.67	41.67
Sternum	1			1	1	7.14		1	7.14									
Scapula Glenoid	1	1		1	0.5	3.57	1			2		2	2	1	25	1	0.5	12.5
Scapula Acromion										2	1	1	2	1	25	2	0	0
Scapula Spine	6	4	1	6	3	21.43	3	1.5	10.71	8	4	2	8	4	100	7	0.5	12.5
Scapula Blade	4	1	3	4	2	14.29	3	0.5	3.57	3		1	3	1.5	37.5	1	1	25
Humerus P	9	3	6	9	4.5	32.14		4.5	32.14	2	1		1	0.5	12.5		0.5	12.5
Humerus M	6	2		6	3	21.43		3	21.43	5			5	2.5	62.5		2.5	62.5
Humerus D	4	2	2	4	2	14.29		2	14.29	6	2	4	6	3	75		3	75
Radius-ulna P	9	7	2	9	4.5	32.14		4.5	32.14	4	1	3	4	2	50	1	1.5	37.5
Radius-ulna M	13	2		11	5.5	39.29	1	5	35.71	5		1	4	2	50		2	50
Radius-ulna D	17	4	11	15	7.5	53.57		7.5	53.57									
Metacarpal P	8	5	3	8	4	28.57		4	28.57	3	2	1	3	1.5	37.5		1.5	37.5
Cuneiform Radial carpal	2	1	1	2	1	7.14		1	7.14	1	1		1	0.5	12.5		0.5	12.5
Lunar Intermediate carpal	1		1	1	0.5	3.57		0.5	3.57	3	3		3	1.5	37.5		1.5	37.5
Pisiform Accesory carpal	1	1		1	0.5	3.57		0.5	3.57									
Scaphoid Ulnar carpal																		
Trapezoid C2	1		1	1	0.5	3.57		0.5	3.57									
Unciform C4	2	2		2	1	7.14		1	7.14	3	1	2	3	1.5	37.5		1.5	37.5
Pelvis Acetabulum	9	6	3	9	4.5	32.14		4.5	32.14	2		2	2	1	25		1	25
Pelvis Illium	9	5	4	9	4.5	32.14		4.5	32.14	4	1	2	3	1.5	37.5		1.5	37.5
Pelvis Ischium	7	2	4	6	3	21.43		3	21.43	2	1	1	2	1	25		1	25
Pelvis Pubis																		
Femur P	10	4	5	9	4.5	32.14		4.5	32.14	2	1	1	2	1	25		1	25
Femur M	6	1	2	6	3	21.43	1	2.5	17.86	1		1	1	0.5	12.5		0.5	12.5
Femur D	10	6	3	9	4.5	32.14		4.5	32.14	2		2	2	1	25		1	25
Patella	2		1	2	1	7.14		1	7.14									
Tibia P	23	10	10	20	10	71.43		10	71.43	3	2	1	3	1.5	37.5		1.5	37.5
Tibia M	7		1	7	3.5	25.00	1	3	21.43	5			5	2.5	62.5		2.5	62.5
Tibia D	3	1	1	3	1.5	10.71		1.5	10.71	2	1	1	2	1	25		1	25
Metatarsal P	5	2	3	5	2.5	17.86		2.5	17.86	3	2	1	3	1.5	37.5		1.5	37.5
Astragalus	2	1	1	2	1	7.14		1	7.14	2	1	1	2	1	25		1	25
Calcaneus	6	2	4	6	3	21.43		3	21.43									
Cuboid T4	3	2	1	3	1.5	10.71		1.5	10.71	2		1	1	0.5	12.5		0.5	12.5
Entocuneiform T2	1	1		1	0.5	3.57		0.5	3.57									
Lateral malleolus Fibula	1		1	1	0.5	3.57		0.5	3.57	1	1		1	0.5	12.5		0.5	12.5
Magnum C3	4	2	2	4	2	14.29		2	14.29	2	1	1	2	1	25		1	25
Navicular T3	3	1	2	3	1.5	10.71		1.5	10.71	2	1	1	2	1	25		1	25
Thoracic vertebrae	16			15	1.25	8.93		1.25	8.93	10			8	0.67	16.67		0.67	16.67
Lumbar vertebrae	32			24	3.43	24.49		3.43	24.49	23			14	2	50		2	50
Sacrum	1			1	1	7.14		1	7.14	1			1	1	25		1	25
Metapodial M	25			20	5	35.71	1	4.75	33.93	13			7	1.75	43.75		1.75	43.75
Metapodial D	30			29	7.25	51.79		7.25	51.79	5			5	1.25	31.25		1.25	31.25
1st phalanx	22	12	10	22	2.75	19.64		2.75	19.64	13	7	6	13	1.63	40.63		1.63	40.63
2nd phalanx	9	6	3	9	1.125	8.04		1.125	8.04	10	7	3	10	1.25	31.25		1.25	31.25
3rd phalanx	5	3	2	5	0.625	4.46		0.625	4.46									
Cranium Neurocranium	76			20						29			5					
Incisor	2	1	1	2						1	1		1					
Canine	2	1	1	2						2	2		2					
Mollar	39			21						37			8					
Hyoid	2			2						1			1					
Caudal vertebrae	1			1														

Table 8.16. Continued.

	KCH20Arch									KCH21Tiw								
Element	**NISP**	**R**	**L**	**MNE**	**MAU**	**MAU%**	**Worked**	**MAUw**	**MAU%w**	**NISP**	**R**	**L**	**MNE**	**MAU**	**MAU%**	**Worked**	**MAUw**	**MAU%w**
Cranium Maxilla	1	1		1	0.5	12.5		0.5	16.67	4	2	1	4	2	16.67		2	22.22
Mandible										23	9	8	17	8.5	70.83		8.5	94.44
Atlas										3			3	3	25		3	33.33
Axis										4			3	3	25		3	33.33
Cervical vertebrae	4			3	0.6	15		0.6	20	22			20	4	33.33		4	44.44
Ribs	8	4	4	8	0.33	8.33		0.33	11.11	100	34	41	76	3.17	26.39		3.17	35.19
Sternum										2			2	2	16.67		2	22.22
Scapula Glenoid	1	1		1	0.5	12.5	1			24	9	5	15	7.5	62.5	9	3	33.33
Scapula Acromion	2	1	1	1	0.5	12.5		0.5	16.67	7	5	2	7	3.5	29.17	4	1.5	16.67
Scapula Spine	7	2	5	7	3.5	87.5	2	2.5	83.33	14	3	4	10	5	41.67	7	1.5	16.67
Scapula Blade										34	3	6	24	12	100	14	5	55.56
Humerus P										1		1	1	0.5	4.17		0.5	5.56
Humerus M	2	1		2	1	25		1	33.33	11	4	1	10	5	41.67		5	55.56
Humerus D	1		1	1	0.5	12.5		0.5	16.67	10	4	5	9	4.5	37.5		4.5	50
Radius-ulna P	2	1	1	2	1	25		1	33.33	9	6	3	9	4.5	37.5		4.5	50
Radius-ulna M	4			1	0.5	12.5		0.5	16.67	15	3	1	12	6	50	1	5.5	61.11
Radius-ulna D	2			1	0.5	12.5		0.5	16.67	3		3	3	1.5	12.5		1.5	16.67
Metacarpal P	1		1	1	0.5	12.5		0.5	16.67	9	5	3	8	4	33.33		4	44.44
Cuneiform Radial carpal	1	1		1	0.5	12.5		0.5	16.67	1		1	1	0.5	4.17		0.5	5.56
Lunar Intermediate carpal										1		1	1	0.5	4.17		0.5	5.56
Pisiform Accesory carpal	2	1	1	2	1	25		1	33.33	1		1	1	0.5	4.17		0.5	5.56
Scaphoid Ulnar carpal	1	1		1	0.5	12.5		0.5	16.67	1		1	1	0.5	4.17		0.5	5.56
Trapezoid C2	1	1		1	0.5	12.5		0.5	16.67	1	1		1	0.5	4.17		0.5	5.56
Unciform C4	2	1	1	2	1	25		1	33.33	4	1	3	4	2	16.67		2	22.22
Pelvis Acetabulum										11	4	3	8	4	33.33		4	44.44
Pelvis Illium										11	4	7	11	5.5	45.83		5.5	61.11
Pelvis Ischium										8	4	4	8	4	33.33		4	44.44
Pelvis Pubis										4	2	1	3	1.5	12.5		1.5	16.67
Femur P										7	4	3	7	3.5	29.17		3.5	38.89
Femur M	11	2	1	3	1.5	37.5	1	1	33.33	5	2	2	5	2.5	20.83		2.5	27.78
Femur D										5	3	1	4	2	16.67		2	22.22
Patella	1		1	1	0.5	12.5		0.5	16.67	1	1		1	0.5	4.17		0.5	5.56
Tibia P										6	4	2	6	3	25		3	33.33
Tibia M	4			2	1	25		1	33.33	14	1	2	11	5.5	45.83	1	5	55.56
Tibia D										5	1	1	5	2.5	20.83		2.5	27.78
Metatarsal P										7		7	7	3.5	29.17	1	3	33.33
Astragalus	1		1	1	0.5	12.5		0.5	16.67	4	3	1	4	2	16.67		2	22.22
Calcaneus	1	1		1	0.5	12.5		0.5	16.67	3		3	3	1.5	12.5		1.5	16.67
Cuboid T4	1		1	1	0.5	12.5		0.5	16.67	3	2	1	3	1.5	12.5		1.5	16.67
Entocuneiform T2	1	1		1	0.5	12.5		0.5	16.67	2		2	2	1	8.33		1	11.11
Lateral malleolus Fibula																		
Magnum C3	1	1		1	0.5	12.5		0.5	16.67	1	1		1	0.5	4.17		0.5	5.56
Navicular T3	1		1	1	0.5	12.5		0.5	16.67	4	3	1	4	2	16.67		2	22.22
Thoracic vertebrae	3			3	0.25	6.25		0.25	8.33	7			6	0.5	4.17		0.5	5.56
Lumbar vertebrae	7			4	0.57	14.29		0.57	19.05	26			19	2.71	22.62		2.71	30.16
Sacrum										1			1	1	8.33		1	11.11
Metapodial M										25			19	4.75	39.58	1	4.5	50
Metapodial D	10	4	4	6	1.5	37.5		1.5	50	16			16	4	33.33		4	44.44
1st phalanx	13	6	6	12	1.5	37.5		1.5	50	11	7	4	11	1.38	11.46		1.38	15.28
2nd phalanx	4	4		4	0.5	12.5		0.5	16.67									
3rd phalanx	1	1		1	0.13	3.13		0.13	4.17									
Cranium Neurocranium										30			20					
Incisor										2	1	1	2					
Canine																		
Mollar	2			2						4			4					
Hyoid																		
Caudal vertebrae																		

Table 8.16. Continued.

	KCH11Tiw									KCH22Tiw								
Element	**NISP**	**R**	**L**	**MNE**	**MAU**	**MAU%**	**Worked**	**MAUw**	**MAU%w**	**NISP**	**R**	**L**	**MNE**	**MAU**	**MAU%**	**Worked**	**MAUw**	**MAU%w**
Cranium Maxilla	2	2		2	1	50		1	50	7	1	2	3	1.5	75		1.5	75
Mandible	2	1	1	2	1	50		1	50	2	2		2	1	50		1	50
Atlas																		
Axis										1			1	1	50		1	50
Cervical vertebrae	3			2	0.4	20		0.4	20	3			3	0.6	30		0.6	30
Ribs	13	4	6	10	0.42	20.83		0.42	20.83	6	1	3	4	0.17	8.33		0.17	8.33
Sternum																		
Scapula Glenoid	1		1	1	0.5	25	1											
Scapula Acromion																		
Scapula Spine										4			2	1	50	1	0.5	25
Scapula Blade	4	1	1	2	1	50	1	0.5	25	2			1	0.5	25		0.5	25
Humerus P																		
Humerus M	1	1		1	0.5	25		0.5	25									
Humerus D	2	2		2	1	50		1	50	1		1	1	0.5	25		0.5	25
Radius-ulna P	1	1		1	0.5	25		0.5	25	1		1	1	0.5	25		0.5	25
Radius-ulna M	1			1	0.5	25		0.5	25	1			1	0.5	25		0.5	25
Radius-ulna D	3	1	2	3	1.5	75		1.5	75									
Metacarpal P	1		1	1	0.5	25		0.5	25									
Cuneiform Radial carpal																		
Lunar Intermediate carpal	1	1		1	0.5	25		0.5	25									
Pisiform Accesory carpal																		
Scaphoid Ulnar carpal																		
Trapezoid C2																		
Unciform C4																		
Pelvis Acetabulum										1		1	1	0.5	25		0.5	25
Pelvis Illium																		
Pelvis Ischium	4	2	2	4	2	100		2	100									
Pelvis Pubis										1		1	1	0.5	25		0.5	25
Femur P	1	1		1	0.5	25		0.5	25									
Femur M	3	2	1	3	1.5	75		1.5	75	1			1	0.5	25		0.5	25
Femur D	3	2	1	3	1.5	75		1.5	75									
Patella	1		1	1	0.5	25		0.5	25									
Tibia P	1		1	1	0.5	25		0.5	25									
Tibia M	1	1		1	0.5	25		0.5	25									
Tibia D	2		2	2	1	50		1	50	1			1	0.5	25		0.5	25
Metatarsal P	2	1	1	2	1	50		1	50									
Astragalus										1	1		1	0.5	25		0.5	25
Calcaneus	2		2	2	1	50		1	50	1	1		1	0.5	25		0.5	25
Cuboid T4																		
Entocuneiform T2																		
Lateral malleolus Fibula										1	1		1	0.5	25		0.5	25
Magnum C3																		
Navicular T3																		
Thoracic vertebrae	1			1	0.08	4.17		0.08	4.17	2			2	0.17	8.33		0.17	8.33
Lumbar vertebrae	4			4	0.57	28.57		0.57	28.57	3			3	0.43	21.43		0.43	21.43
Sacrum																		
Metapodial M	2			2	0.5	25		0.5	25	1			1	0.25	12.5		0.25	12.5
Metapodial D	1			1	0.25	12.5		0.25	12.5	3			3	0.75	37.5		0.75	37.5
1st phalanx	1	1		1	0.13	6.25		0.13	6.25	7	4	3	7	0.88	43.75		0.88	43.75
2nd phalanx																		
3rd phalanx	1		1	1	0.13	6.25		0.125	6.25									
Cranium Neurocranium										4			3					
Incisor										1	1		1					
Canine																		
Mollar										4			3					
Hyoid																		
Caudal vertebrae										1			1					

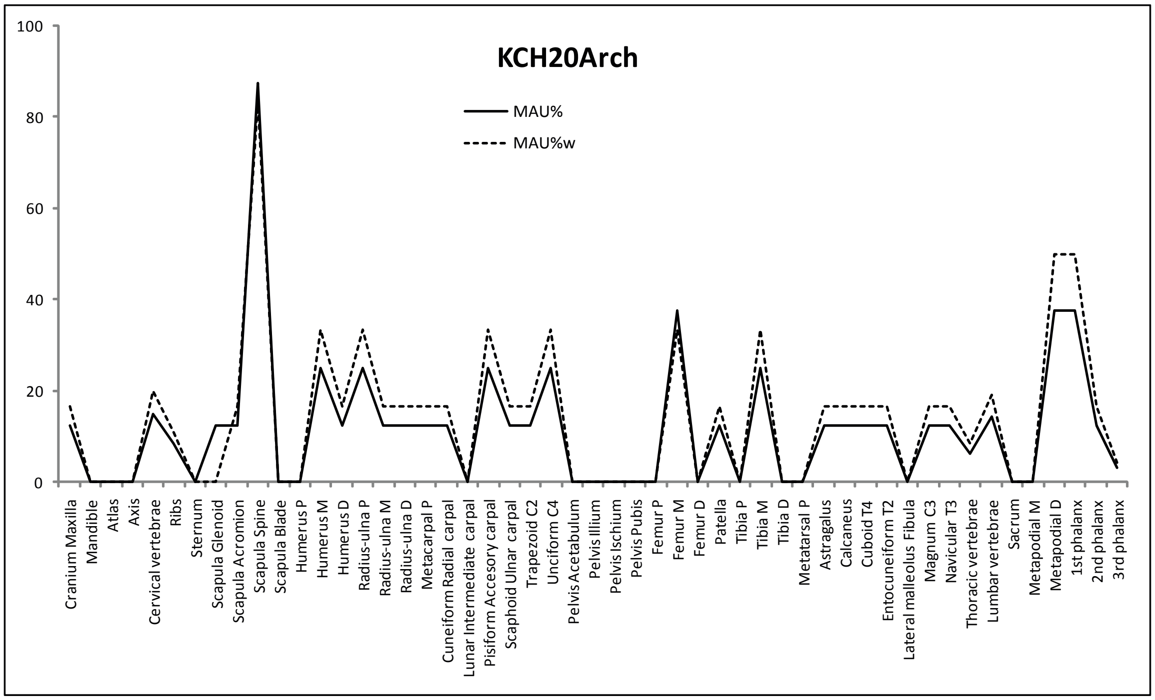


Figure 8.18. Skeletal representation of camelid elements from KCH20Arch.

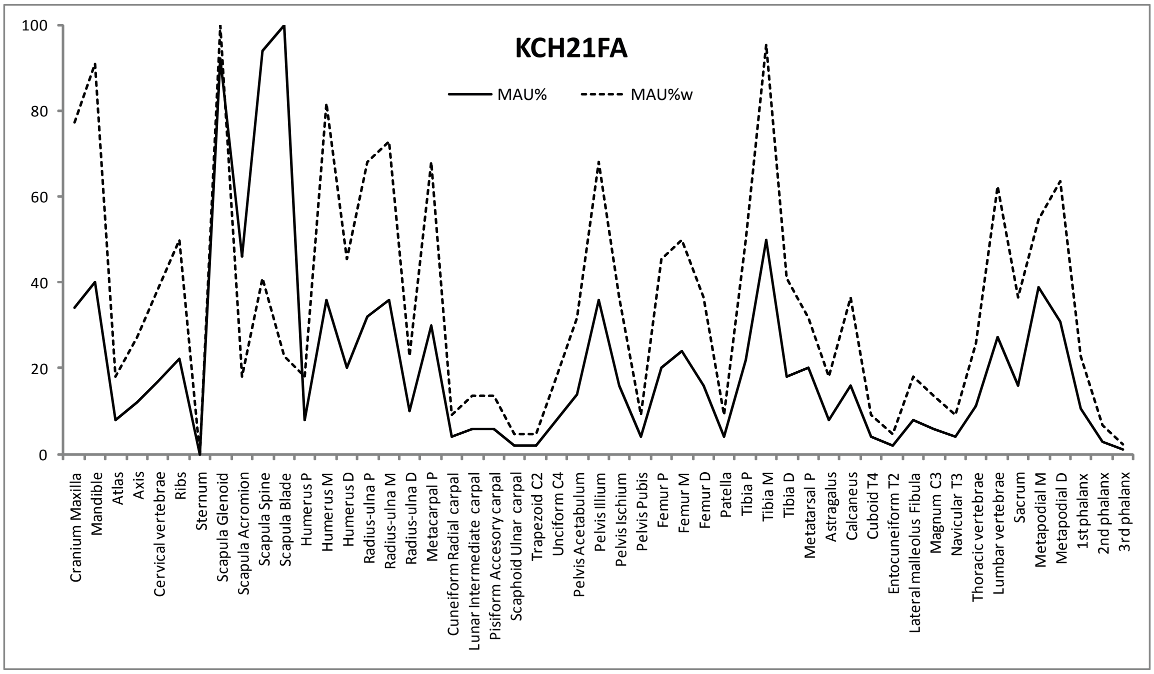


Figure 8.19. Skeletal representation of camelid elements from KCH21FA.

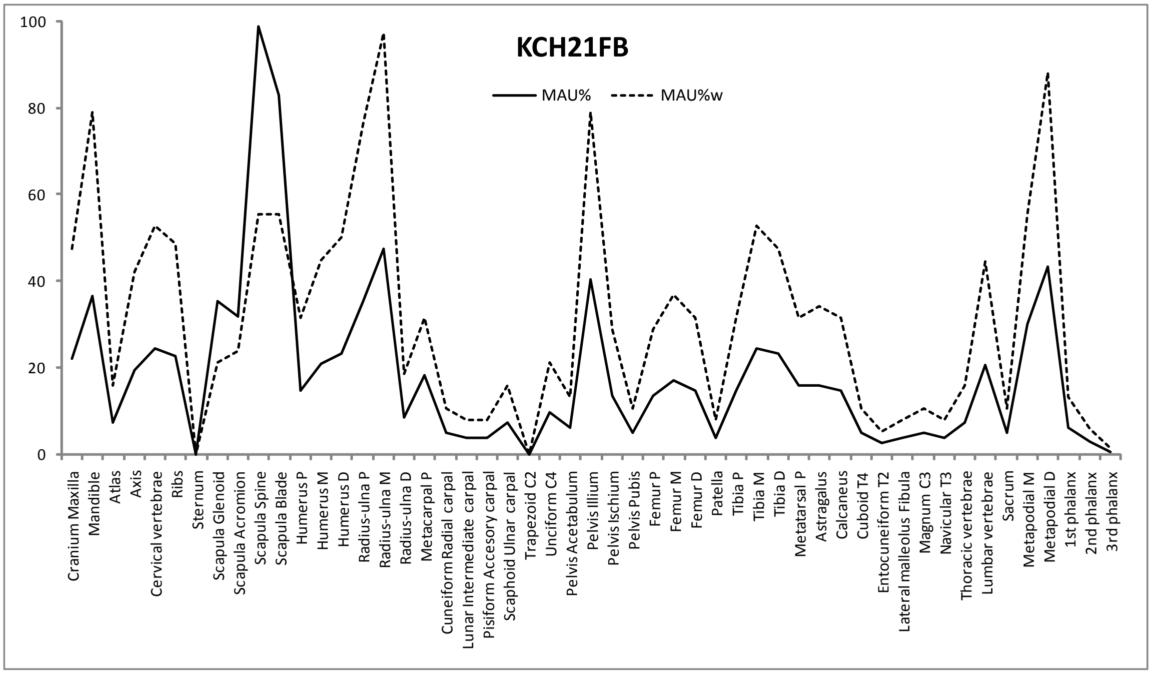


Figure 8.20. Skeletal representation of camelid elements from KCH21FB.

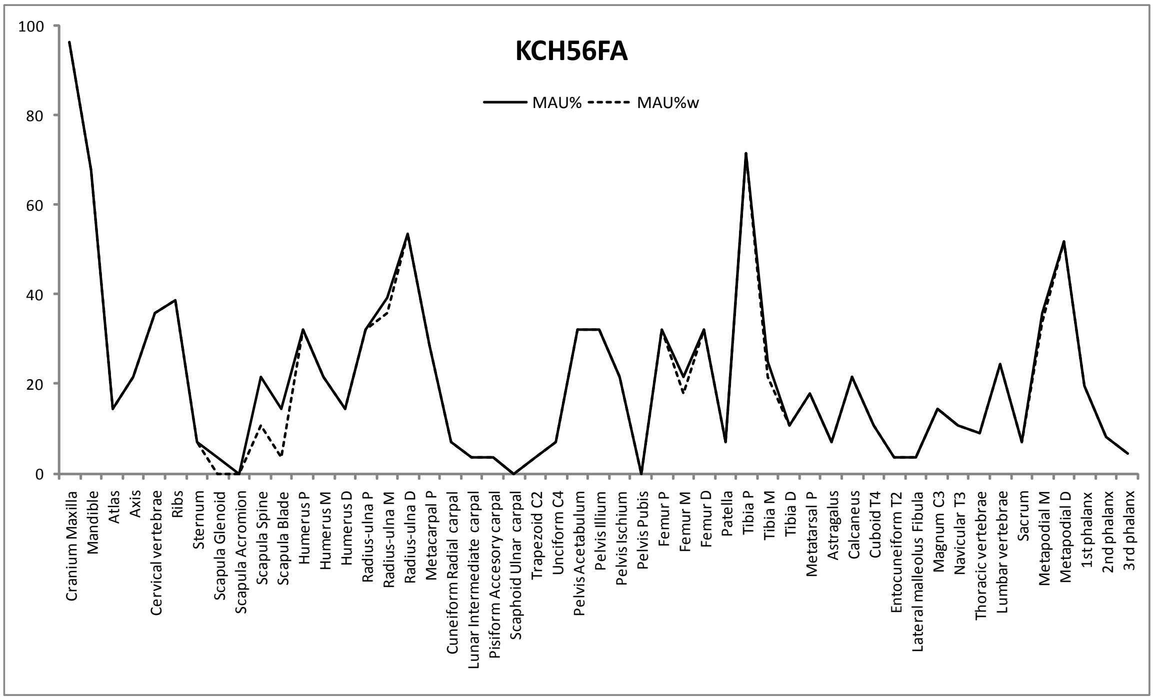


Figure 8.21. Skeletal representation of camelid elements from KCH56FA.

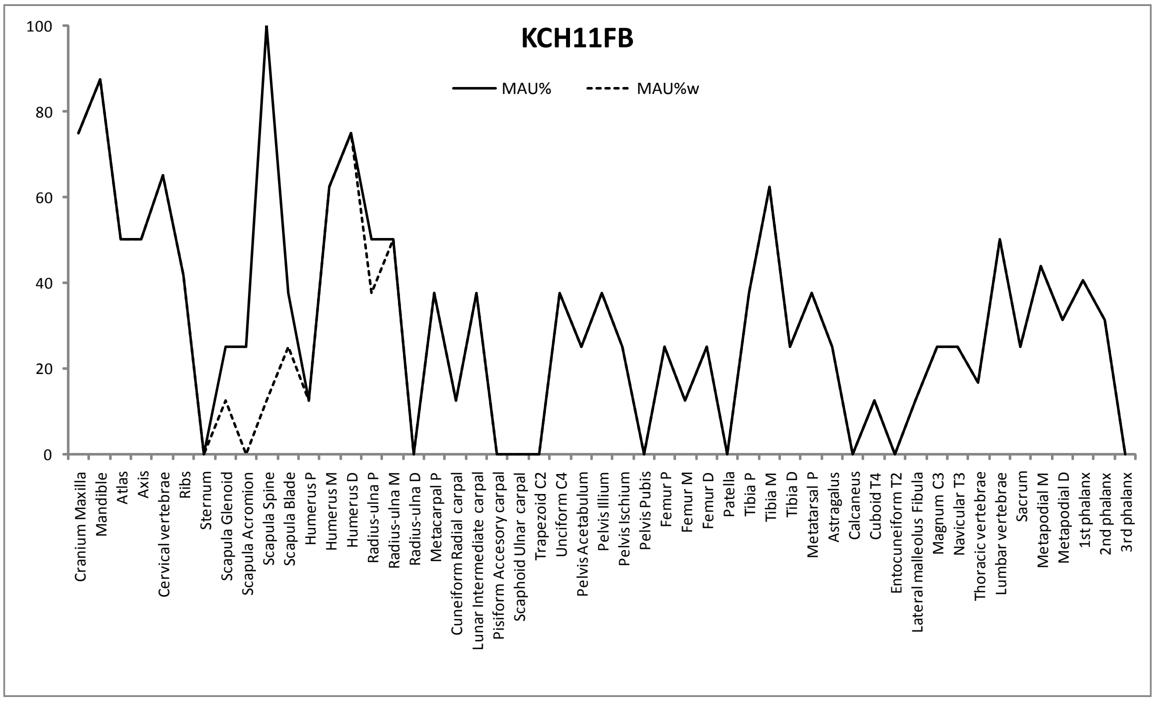


Figure 8.22. Skeletal representation of camelid elements from KCH11FB.

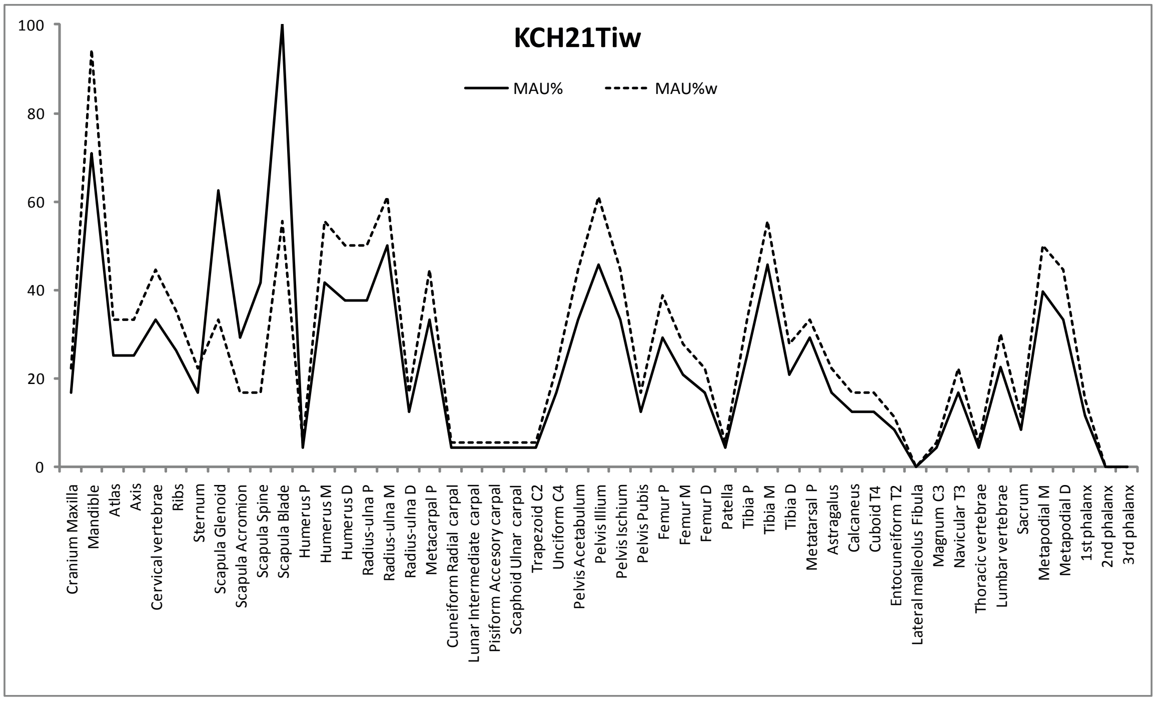


Figure 8.23. Skeletal representation of camelid elements from KCH21Tiw.

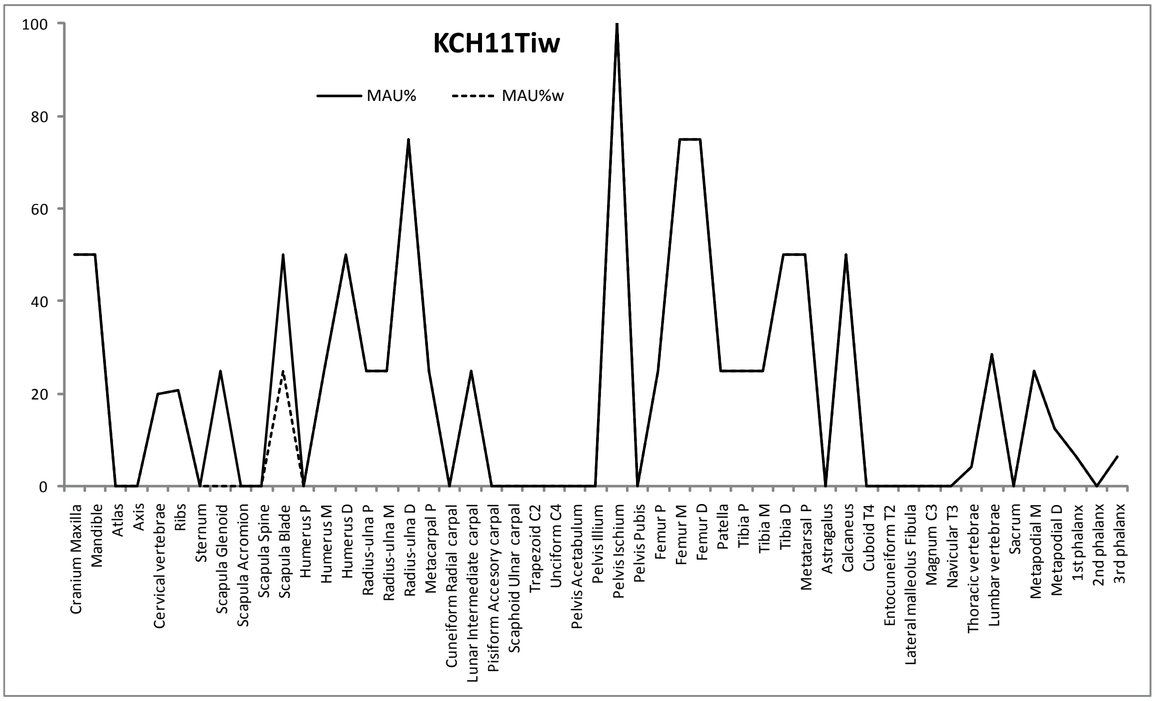


Figure 8.24. Skeletal representation of camelid elements from KCH11Tiw.

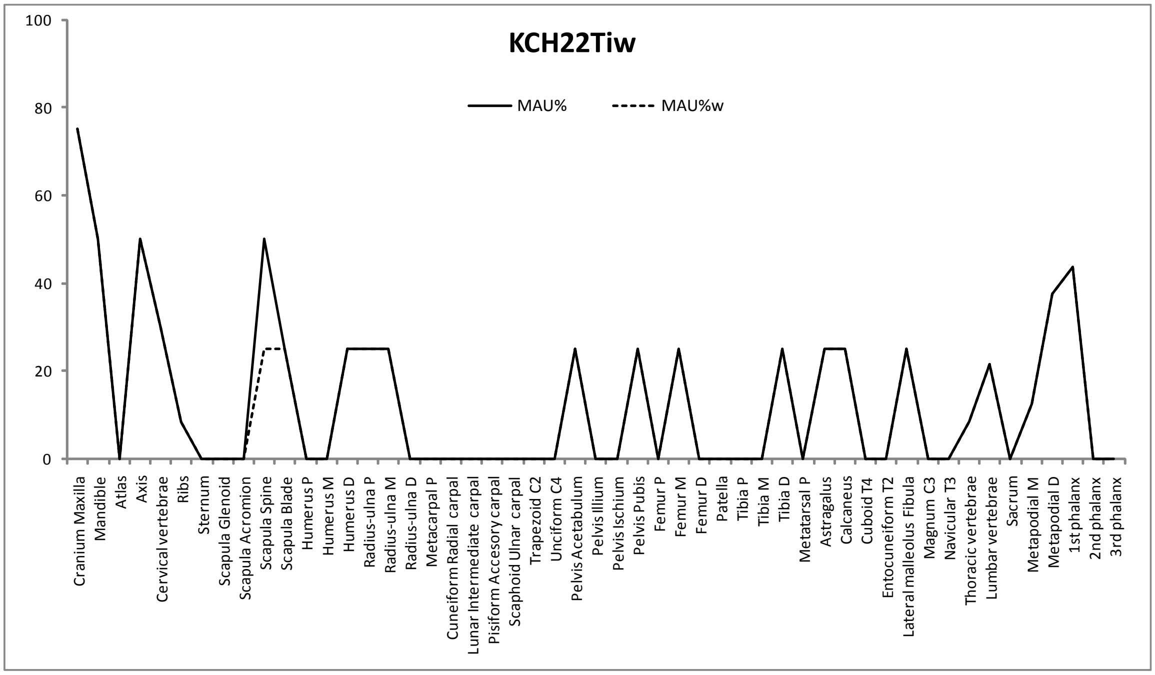


Figure 8.25. Skeletal representation of camelid elements from KCH22Tiw.

are also heavily fragmented and although it is possible that their high representation is a consequence of differential fragmentation, their presence suggests a pattern might be revealed by their deposition.

All in all for the case of scapulae, the factor that seems to bias their high frequency is bone tool manufacture and use (see below). Interestingly enough, if worked bones are excluded from the assemblage, the evenness of the assemblage increases substantially. This is particularly true for the Formative Period assemblages, which are characterized by a great frequency of worked scapulae bones. For crania specimens and ribs, possible accumulating factors included aggregation and fragmentation.

If bone tools are excluded from the skeletal representation profiles, the predominance of scapulae reduces and the assemblages have more even distributions. Along with skulls and ribs, other bones that are well represented include long limb bones and vertebrae. Only ten elements have a frequency of less than 10% and only two have a frequency of 80% or more. This supports the idea that slaughtering, butchering, consuming, and discarding animals were practices mostly carried out in situ. The particular case of the Formative Period levels at KCH21 where adequate sample sizes are available seem to support this possibility.

Regarding other elements, most are represented in the assemblages, although their exact frequencies and proportions vary. Sample size is probably one of the most significant controlling factors for skeletal composition along with food preparation and discard. For instance, about 20 (out of 51) elements or portion of elements have a percentage of survivorship of 20% or less. On the other hand, well represented elements hint that differential accumulation of specific skeletal elements could be biasing their representation.

Long bones were relatively evenly distributed. Medial and proximal radius-ulna, medial and proximal tibia, and medial and distal humerus were better represented than the distal tibia, and the medial, proximal, and distal femur. Distal radius-ulna and proximal humerus were the least common limb long bones. Distal and medial metapodials were also common but proximal metacarpals were considerably more frequent than proximal metacarpals. Medial portions of long bones were considerably more common in the assemblages (also taking into account the great number of unidentified specimens of large mammal long-bones) than proximal ends (however, recall epiphyseal preservation suggested by the number of well preserved specimens for measurement and age determination). This pattern suggests fragmentation and probably pre-discard fragmentation is a strong characteristic of the assemblages.

Vertebrae are common in most assemblages, but cervical vertebrae (including the axis) in addition to lumbar vertebrae and the atlas were more common than thoracic vertebrae and the sacrum which were surprisingly underrepresented. It is possible that differential preparation and consumption of these elements contributed to these differences. Some of the least common bones include tarsals and carpals (although the calcaneus and astragalus were not unusual), possibly partially affected by recovery and identification caused by fragmentation. Distal limbs represented by phalanges are unevenly distributed with more first phalanges identified than second and third phalanges. In addition, caudal vertebrae were extremely uncommon, possibly as a consequence of recovery bias and fragmentation, but also because they might have been left as riders with the skin of the animals during initial butchery (along with distal phalanges) (Miller 1979:48).

Specific butchery and cooking practices seem to have significantly affected the assemblages. For instance, one of the least frequent elements in the assemblage is the sternum. Only three sterna elements were recorded in the assemblage; one in KCH21FA and the other two at KCH21Tiw. The fact that so few elements of the sternum were present might be attributed to intensive consumption in addition to differential preservation. Miller's (1979:44) ethnoarchaeological observations suggest the sternum is removed from the rest of the skeleton with the first package during animal butchery. The sternum is butchered along with its accompanying muscle in a single anatomical package (brisket). Cooking and consumption of this high utility food package would have destroyed much of the sterna and its accompanying rib-cage cartilage. Although these observations could be idiosyncratic to the highlands of southern Peru of the 1970s, a comparable pattern seems to be represented in Iroco. The sternum is indeed a very fragile element and susceptible to destruction due to trampling and mechanical erosion and together these factors or a combination of them could have contributed to the observed extremely low numbers of identified sterna fragments.

Similar interpretations can be made regarding several other elements. The fact that the Iroco assemblage is quite fragmented is unavoidable. Most of the observed fragmentation seems to have occurred during the settlements occupation with additional fragmentation produced during eating and discarding the specimens. These processes enhanced the destruction of immature individuals because their bones are more fragile. As a consequence, I believe that fragmentation was mostly caused by butchering, food preparation, and consumption during the sites occupation as opposed to post-depositional destruction. In the next section, some commonly observed human and non-human produced modifications on the bones are described.

8.3.6. Modification

In addition to the information provided by the skeletal representation, a number of modifications were observed and recorded on individual specimens. It should be noted that modifications presented in this section were tallied by specimen and not by frequency within individual specimens. A summary of some of the recorded modifications on camelid skeletal specimens by component is presented in Table 8.17 and by element frequency on the complete assemblage in Table 8.18.

Table 8.17. Camelid modified bones represented in the Iroco assemblage organized by component.

Component	Worked tools	Cut marks	Chop marks	Percussion marks	Carnivore damage	Rodent gnawing	Mechanical abrasion
KCH20Arch	4	3	5	20	1		11
KCH21FA	161	103	53	81	21	11	124
KCH21FB	166	116	133	130	61	28	118
KCH56FA	11	50	30	26	16	60	39
KCH11FB	12	19	15	6	1	7	22
KCH21Tiw	38	47	40	72	12	17	45
KCH11Tiw	2	6	6	2	1	4	5
KCH22Tiw	1	1			3		6
Total	**395**	**345**	**282**	**337**	**116**	**127**	**370**

8.3.6.1. Bone Tools

As suggested by the previous section, bone tools were of common occurrence in the Iroco faunal assemblages (see frequencies by elements in Table 8.18). Here, only a brief description of bone tools is presented but given their large frequency, they represented an important component of the artifact tool-kit utilized at Iroco. Moreover, bone tool manufacture, utilization, maintenance, and discard seem to be significant activities that probably contributed to the distribution patterns associated with faunal remains. In other words, tool production and use was a central activity and not a collateral consequence of having bones readily available, and bone-tools utilization contributed to the depositional and distributional patterns associated with camelid bone remains.

Bone tools were classified into manufacture by-products and finished tools. Most of the finished tools had been discarded with clear evidence of wearing, accidental, and intentional breaks. By-products of manufacture were conspicuous. In Table 8.19, identified camelid bone tools are presented in addition to bone tools derived from large mammal long bones. Given that camelids were the most common large mammal available in Iroco and

Table 8.18. Recorded modifications on camelid specimens grouped by skeletal elements.

Element	Worked tools	Cut marks	Chop marks	Percussion marks	Carnivore damage	Rodent gnawing	Mechanical abrasion
Cranium Maxilla			1	1			6
Mandible		17	4	1	4	3	6
Atlas		2					1
Axis		1	3				1
Cervical vertebrae		7	14	1	2	1	
Ribs	2	77	35	5	7	65	38
Sternum							
Scapula Glenoid	58	14	37	29	1	2	44
Scapula Acromion	42	16	5	1	2	1	17
Scapula Spine	118	35	25	16		5	50
Scapula Blade	111	31	13	4		2	39
Humerus P		1	4	6	6		1
Humerus M		5	3	15		1	5
Humerus D		9	14	11	5	2	3
Radius-ulna P	2	9	11	13	2	2	5
Radius-ulna M	6	10	2	18	1	2	11
Radius-ulna D		1	3	5		2	1
Metacarpal P	3	4	3	19	1	6	3
Cuneiform Radial carpal		5	1				1
Lunar Intermediate carpal			2				
Pisiform Accesory carpal		1	1				
Scaphoid Ulnar carpal			2		1	1	1
Trapezoid C2							
Unciform C4				1			
Pelvis Acetabulum		3	2		1	2	1
Pelvis Illium	6	5	5	5	4		9
Pelvis Ischium		5	4	1		1	3
Pelvis Pubis			1				1
Femur P		4	5	5			3
Femur M	3	3		20	1		3
Femur D		6	7	5	4	1	4
Patella					1	1	
Tibia P		2	2	9	2	2	5
Tibia M	6	11	1	12	4	2	10
Tibia D	1	1	4	13	2		1
Metatarsal P	5	3	5	13	2	3	1
Astragalus		4	8	1	5	1	2
Calcaneus			3	5			2
Cuboid T4		6	4		1	1	1
Entocuneiform T2							
Lateral malleolus Fibula							2
Magnum C3							
Navicular T3			1			1	
Thoracic vertebrae		3	13	2	4	1	4
Lumbar vertebrae		12	15	2	1	3	3
Sacrum			1				
Metapodial M	24	10	1	19	4	6	7
Metapodial D	7	10	9	26	11	4	13
1st phalanx	1	3	4	43	8	2	5
2nd phalanx			3	7	3		1
3rd phalanx				3			2
Cranium Neurocranium		3	1		26		26
Incisor							1
Mollar							24
Hyoid		4				1	
Sesamoid							3
Total	**395**	**345**	**282**	**337**	**116**	**127**	**370**

the degree of transformation observed in the bones as a consequence of tool manufacture, it is fair to assume that most of the tools derived from large mammal long bones were manufactured on camelids elements. Moreover, the observed tools are similar to the types recorded from identified camelid elements.

The most common tool type was scrapers and the most common by-products were unfinished scrapers and waste from manufacturing scrapers. Scapula was the preferred bone element used for manufacturing scrapers. In fact, 54% of all the identified scapula bones were modified in one way or another (329 out of 614 by NISP). A number of varieties of scapula scrapers were identified (Figure 8.26). These varied function and amount of ware. The first variety was also the most elaborate and consisted of half a scapula with the glenoid and spine transformed into a handle and the blade into a notched use blade. The blade included retouched denticulations. A second variant did not included notches but just a smooth sinuous edge. A third type included scrapers that did not include handles and were often used expediently. Most of these tools were used for scraping, polishing, sawing, scooping, and other similar functions.

At Iroco, and particularly at KCH21, most scapulae were modified into scrapers and there is good evidence of the entire sequence of production, from initial manufacture all the way up to finished, discarded, and even curated (i.e., recycled) products. Scapula scrapers were probably manufactured through the following sequence. Once disarticulated and defleshed, the bones were chopped into two halves (some partially burned specimens suggests heat treatment for strengthening the bone might have been involved) and polished. Each half was transformed into a different but symmetrical tool. The acromion and tuberosities were chopped off, and the glenoid expediently polished to serve as a handle. The spine was stripped up to the blade and the transversal interior side of the blade was modified into a use-wear edge, probably to serve scraping or polishing functions and producing multiple striae and polished surfaces in the process. Some fragments of the broken blade seemed to have been used to manufacture other implements such as plaque or button ornaments. Several varieties of scraper edges were produced including notched, sinuous, irregular and linear.

By products of these processes are abundant and include cut out acromion projections, spines, tuberosities, and blade fragments, scraper blanks, and others. Some of the sinuous and notched scrapers were extremely worn out suggesting intensive and continuous use. Constant utilization of the tools seems to have produced increasingly reduced edges and consequently, tools were used until the edge was almost completely worn-out or after structural damage causing breakage. If the structural break occurred before the edge was

Table 8.19. Typology of bone tools identified from camelid elements and large mammals specimens organized by component.

Tool type	KCH20Arch	KCH21FA	KCH21FB	KCH56FA	KCH11FB	KCH21Tiw	KCH11Tiw	KCH22Tiw	Total
Camelidae	**4**	**161**	**166**	**11**	**12**	**38**	**2**	**1**	**395**
Awl	1	10	7						18
Awl, fine point		3	3	1					7
Awl, round point		5	6	3					14
Awl, triangular point	1	6	3	1	1				12
By-product, awl		9	3						12
By-product, bead		4	2						6
By-product, scraper	2	69	76	5	9	25		1	187
Needle		2	2			1			5
Net-gauge		2	3						5
Ornament, button		2	1			1			4
Retouching tool		7	1			1			9
Scraper		23	28	1	1	2	2		57
Scraper, sinuous		10	23		1	4			38
Scraper, notched		7	8			2			17
Tube		2				2			4
Large mammal	**1**	**28**	**28**		**2**	**8**	**1**		**68**
Awl	1	5	2		1	2			11
Awl, fine point		5	2			1			8
Awl, round point		3	6			3			12
Awl, triangular point		3	6			1			10
By-product, awl		3	3		1				7
Needle		6	6			1	1		14
Net-gauge		1	1						2
Retouching tool		2	2						4
Total	**5**	**189**	**194**	**11**	**14**	**46**	**3**	**1**	**463**

Figure 8.26. Camelid scapula modified bone tools. A) L. 4115/12, B) L. 4102/5, C) L. 4202, D) L. 4120, E) L. 4105/5, F) L. 4105/7, G) L. 4201, H) L. 4105/9, I) L. 4115/3, J) L. 4201, K) L. 4131/7.

heavily worn, some tools were kept as handle-less scrapers. Moreover, if the structural strength of the tool remained after the edge was worn-out some tools were transformed into awls. This suggests that although raw material was readily available, it was probably more economic to keep a tool working than to manufacture a new one. More importantly, it hints that after initial manufacture transformation, the specimen was no longer a bone, but a cultural artifact, a tool.

Similar scraping tools have been found and described from different regions of the world and are often associated with scraping fat from hides during tanning processes (Julien and Lavallée 1995). Scraping camelid hides seems to be the likeliest use for the scapula scrapers. Nevertheless, Moore (2006) has suggested that these tools as well as the mandible scrapers could have been used as knifes to cut totora reeds or to polish vegetable foods and fibers (see also Browman 2011). Interestingly enough, unlike the Lake Titicaca region, camelid mandibles at Iroco were not transformed into bone tools.

Awls were the second most common bone tool type (Figure 8.27). There were different types of awls, varying in manufacturing formality, size, sharpness, and use-wear. Three general types were identified, awls with fine points, awls with round or butted points, and awls with triangular and flutted points. The last type roughly corresponds with the *wichuña* type known ethnographically and archaeologically as textile weaving implement (Kehoe 1990; Moore 1999). Most awls were manufactured on metapodials but also from upper limb bones such as the radius-ulna, femur, and tibia. Some specimens made on scapula blades were also observed (see below). These bones were probably selected because of their straight sides, compact cortical structure, and strong density. Several of the identified awls were worn out and seem to be manufacture expediently with very little modification. Pointy tips were produced but the rest of the bones were left unmodified. This further supports local manufacture enhanced by readable availability of raw materials. Awls were probably used for a number of purposes including perforation, weaving, manufacturing ropes, spinning, and others.

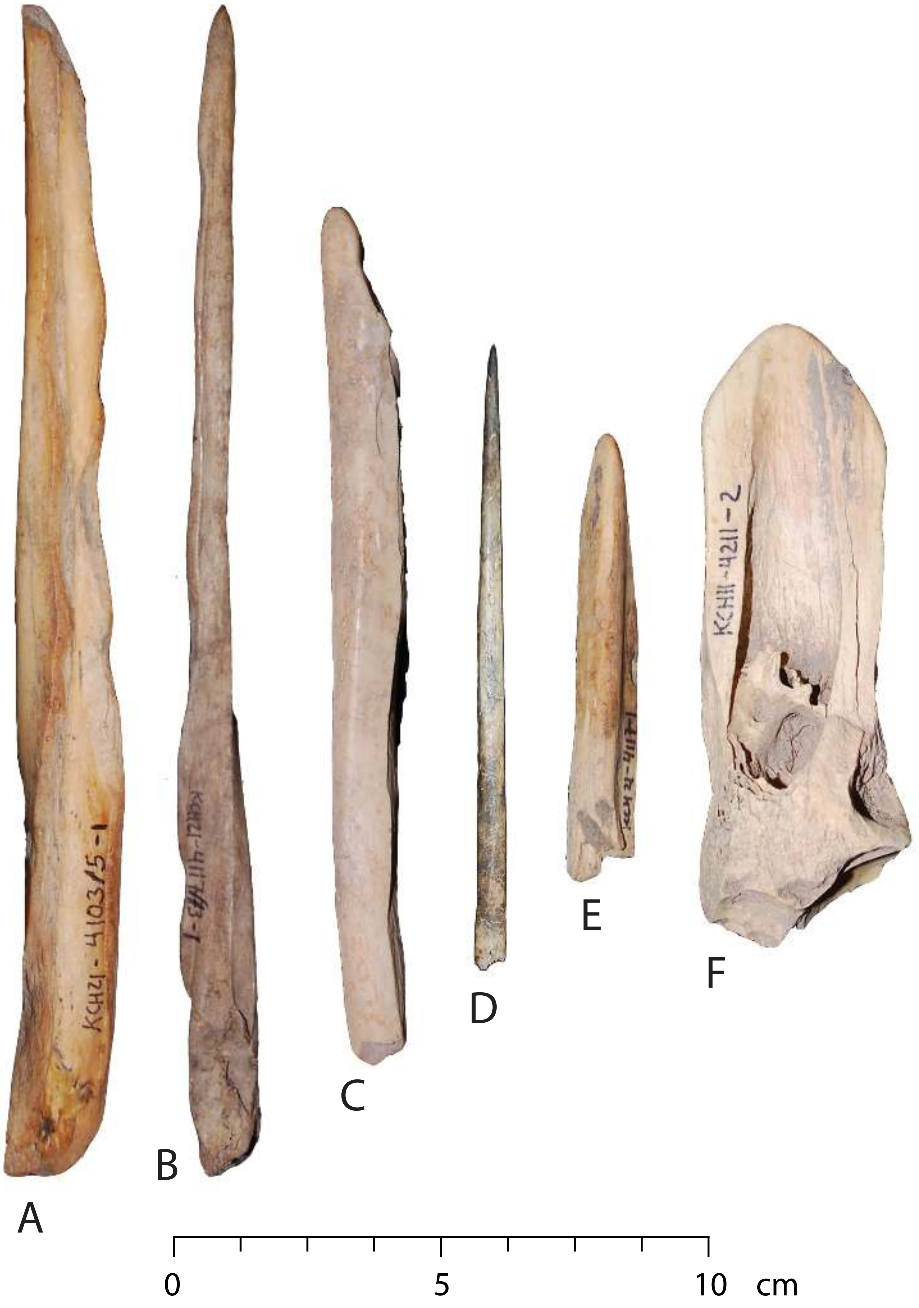


Figure 8.27. Camelid modified bone tools. A) awl expediently manufactured L. 4103/5, B) awl with fine point L. 4117/13, C) awl with fine point L. 4156, D), needle L. 4105/12, E) awl with round point L. 4117, F) awl with triangular point L. 4211.

A related and common tool types were needles. Needles and fragments of needles, defined as extremely-well polished compact bones with one or two extremely fine points were anther common tool type. These tools are similar to awls but smaller, strongly polished, included one or two very pointy tips, and were probably used in specific functions such as stitching or netting. Because needles required so much work, in most cases, these were unidentifiable to bone element but were probably manufactured on compact long bone diaphyses.

Another commonly represented tool type was retouching tools. Preferentially manufactured on hard and compact sections of long bones (and particularly deer antler, see below), retouching tools were characterized by a stronger cylindrical tip, the presence of flaking scars on their sides, and strong use-wear. The assumed use for these tools is lithic tool manufacture and maintenance.

Net-gauges were another type of bone tool present in the faunal assemblages. These finely cut and polished rectangular pieces of flat bones were probably used in the manufacture nets for fishing and are common in sites in the shores of Lake Titicaca (Moore 1999, 2011). Bones specifically transformed into tubes were also identified. The function of these tools is uncertain but might be related to inhaling (e.g., specific substances such as powdered psychotropic plants) or blowing (e.g., air into musical instruments).

Ornamental tools were also present in the assemblage and include round circular beads and flat buttons or plaques. Although beads were not particularly common, different sizes and forms were identified. Local bead manufacture is also evident in some by-products like grooved first phalange diaphyses. Buttons were manufactured on flat bones and often included holes. These bones are similar to slate lithic ornaments frequently found in the Formative Period sites of the study area. Some bead and button ornaments were also manufactured in bird, mollusks, and other animal bones (see below).

Bone tools were particularly well represented in the Iroco assemblages. Diachronically, most of the tool production and use is associated with the Formative Period. The Archaic

Period and the Tiwanaku levels have substantially less evidence for tool manufacture. An exception in the Tiwanaku level at KCH21 which suggests this site continued to be a pastoralist site throughout this period. Moreover, the Formative Period components of KCH11 and KCH56 do not have substantial amounts of bone tools. This could be related to the sampled contexts or some form of specialization associated with KCH21. This evidence also suggests that specialized tool manufacture might have occurred at the site level. In fact, most bone tools are associated with the Formative Period levels of KCH21. Assuming KCH21 was a pastoralist site, processing hides and textile manufacture were probably common practices that could have been performed at the household level for local use and consumption as well as occasional exchange at a regional scale.

8.3.6.2. Cut Marks

Cut marks were identified in 345 camelid bone specimens (Table 8.17). Most of the cut marks observed were identified in scapulae (N=98) (particularly in the glenoid and blade portions) but considering most of these were identified in bone tools, they were probably produced during their manufacture or use (Table 8.18). The second element with most cut marks were ribs (N=77). These were probably produced during skinning and during food processing. Long bone elements with the largest frequencies of cut marks include the medial and proximal radius-ulna, distal and medial metapodials, distal humerus, medial tibia, distal femur, innominate, lumbar vertebrae, and others.

A general expectation about cut marks is that their presence in epiphyseal ends might be related to disarticulation while their presence in medial diaphyses might be associated with skinning or defleshing. The abundance of cut marks in the Iroco assemblages seems to support either possibility, yet the ratio of medial to distal and proximal ends for the upper limb bones is 0.88. This result suggests a slight preponderance of proximal and distal portions (although more of these ends were also recorded). In any case, few cut marks were actually observed on proximal ends (Table 8.18). Moreover, the presence of cut marks in carpal and tarsal bones suggests that disarticulation definitely occurred and the presence of multiple medial ribs with cut marks suggests skinning was also a conspicuous processing practice. This evidence seems to suggest both disarticulation and skinning activities were routinely performed at Iroco. Cut marks were probably produced by formal and expedient lithic end-scrapers found throughout the site.

Cut-marks in mandibles were probably produced during skinning and defleshing. These were inconsistently distributed in different parts of the element. Miller (1979) suggests that cut marks produced during the actual slaughtering of an animal can occur in the atlas and the cranial occipital condyles, particularly when the ventral throat slit and the dorsal stab methods are employed, but not in the *ch'illa* (which involves an incision to the right of the sternum through which the aorta is pulled from the heart), and apparently was the most common pre-Hispanic slaughtering practice. The presence of only two cut marks on the atlas and three on cranium specimens, supports the *ch'illa* might have been the preferred slaughtering practice. Interestingly enough, four of the seven hyoid bones identified in the assemblage had cut-marks. These cut-marks might have been produced during the actual slaughtering of the animal if the two initially described methods were performed (although Miller does not mention the hyoid in his slaughtering descriptions). However, it is also possible that cut marks in the hyoid could be produced during the skinning of the animal or during processing because it is attached to the tongue, a particularly nutritious meat portion (Olivera 2001).

8.3.6.3.Chop Marks

Chopping marks were of common occurrence in the Iroco faunal assemblages (Table 8.17). Chop marks were more commonly observed on vertebrae than in long bones and they were also the most common modification observed in vertebrae. Deep cuts as a variant of chop marks (in the form of a clean blow) was particularly common in ribs, but was also occasionally observed in long bones (particularly in the humerus) as well as in vertebrae. Specifically, chopping was recorded in specimens that had flat edges caused by single or multiple clean and discrete blows (Fisher 1995; Lyman 1994; Reitz and Wing 2008). Most of the time the blow would have divided the specimen in two or more parts but in several cases, the chop was incomplete leaving a characteristic wide incision on the bone. These incisions are substantially broader and deeper than cut marks and are consequently counted with the more common fragmented specimens by clean blows. Miller (1979) in describing modern Andean slaughtered practices observes that it is through a series of penetrating blows that most elements are butchered for cooking and food processing.

8.3.6.4. Percussion Marks

Percussion marks are also very common in the Iroco assemblages (Table 8.18). The majority of the recorded percussion impact scars were present on limb long bones such as the humerus, femur and metapodials. In addition, many unidentified long bones have evidence of percussion marks. Percussion marks were most likely produced by direct blows with lithic hammers. Fractures caused by percussions included several different varieties, including helicoidal, spiral, transversal, longitudinal, serrated, irregular, and others. Most of the percussion marks were indiscriminate and probably produced in the final stages of butchering and particularly food processing and consumption with the goal of maximizing the extraction of nutrients from the bones (i.e., marrow) and their attached soft tissue. Percussion marks are evenly distributed among most elements and seem to be independent of other modifications (such as bone tools).

8.3.6.5. Carnivore Damage

Dogs and possibly other carnivores were present in the Iroco sites (see below). Carnivore damage was recorded in a number of camelid bone specimens that include a large range of the bone elements (Table 7.18). Crania were the most commonly bone elements in which carnivore damage was observed. Several neurocranium fragments had the characteristic "skull disc" form described as a consequence of dog ravaging (Binford 1981:62; Fisher 1995). Carnivore damage was also noted in long bones from several components evidenced as tooth ravaging marks as well as characteristic perforations. In addition, several metapodial specimens had evidence of limited gnawing, pitting, and grooving caused by carnivores. The fact that carnivore damage marks were identified in carpal and tarsal bones could explain the reduced presence of these bones on the assemblage.

Carnivore damage was not limited to camelid specimens as suggested by a femur fragment of a tuco-tuco gopher that included a perforation. Dogs today play an important role in the daily lives of Andean herders. Early Spanish chroniclers mentioned the specific use of dogs for hunting, company, and in rituals often associated with death, but not as part of the Andean pastoralist complex. On the other hand, even though dogs are often mentioned as part the first domesticates that migrated with the earliest Americans, they are often ignored or excluded from zooarchaeological descriptions (Mendoza España 2004). This study suggests dogs were an important component of Andean pastoralism.

8.3.6.6. Rodent Gnawing

Rodent gnawing was also evidenced in the Iroco assemblages (Table 7.17). The bone most commonly observed with rodent teeth gnawing marks were ribs. In addition, scapulae being among the among the most common represented bone elements, was also characterized by a great frequency and diversity of cultural and non-cultural modifications, including gnawing marks. Rodent gnaw marks were for the most part, absent in long bones, but when present, they are usually found in the compact medial portions suggesting rodents were using these bones to sharpen their teeth in addition to extract nutrients such as calcium and protein. Rodent remains are common in most assemblages but the most frequent gnawers were probably the tuco-tuco gophers (most probably the highland tuco-tuco, *Ctenomys opimus*) that not only burrow but are also have known to gnaw on bones and disturb archaeological contexts (Moore et al. 2010).

8.3.6.7. Mechanical Abrasion

Another variable recorded in the camelid bones of the Iroco assemblages was mechanical abrasion (Table 8.18). Abrasion was identified by a characteristic non-intentional and unpatterned polish on different parts of various specimens. Mechanical abrasion and fragmentation can be caused by trampling, compression, soil compaction, soil disturbance, alluvial deposition, fluvial erosion, and other processes. Refitted specimens with different polished surfaces suggested differential processes occurred after initial fragmentation.

Interestingly enough, discarded scapula bone tools often had the clearest evidence of mechanical abrasion, possibly as a direct consequence of their increased presence within sites, and perhaps in correspondence with in situ discard and delayed curation (see Tomka 1993). Mechanical abrasion was explicitly identified during excavations in the upper strata of KCH56, KCH20Arch and less evidently at KCH21Tiw and was mostly caused by various cultural and natural pre and post-depositoinal processes.

8.3.6.8. Burning

Faunal specimens were also assessed for type of burning (Table 8.20). As a result, complete profiles of thermal alteration over bones were constructed (Figure 8.28). In

Table 8.20. Frequencies of burned or thermally altered camelid specimens by component.

Burning	KCH20Arch	KCH21FA	KCH21FB	KCH56FA	KCH11FB	KCH21Tiw	KCH11Tiw	KCH22Tiw	Total
None	82	913	1286	692	268	419	66	50	3776
Partially burned	24	99	184	34	20	86	1	0	448
Burned	0	58	68	29	17	16	8	1	197
Calcined	0	10	7	4	12	6	0	0	39
Grand Total	**106**	**1080**	**1545**	**759**	**317**	**527**	**75**	**51**	**4460**

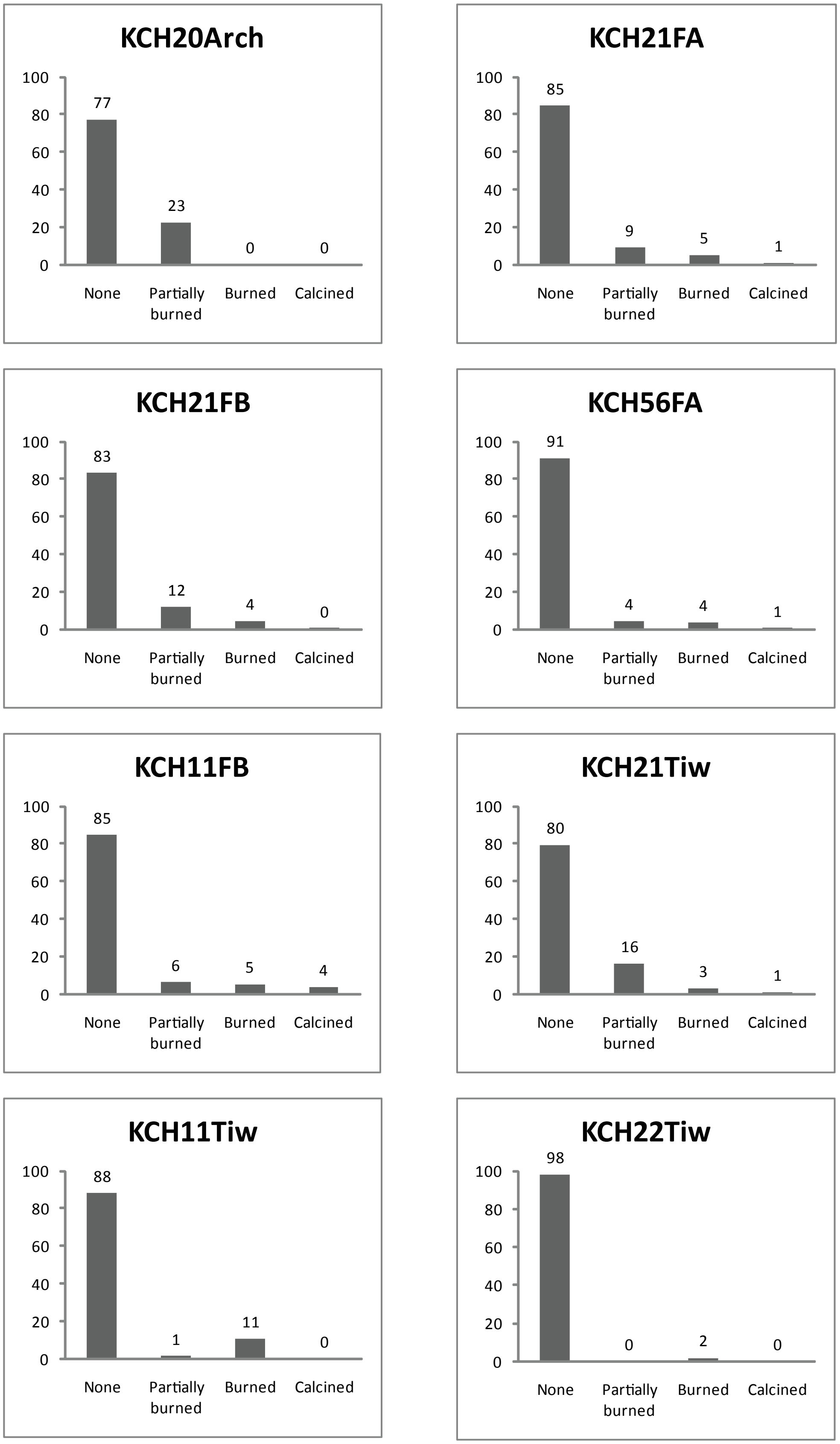
general, these profiles show that most of the bones from the Iroco faunal assemblages were not exposed to firing. An interesting exception is present by the Archaic Period component of KCH20 that has several partially burned specimens. In line with an interpretation of this context as derived from hunting and in the absence of cooking ceramic vessels, some of these bones might have been grilled. Grilling is also a possibility for interpreting some of the identified partially burned specimens in other components. The few observed burned specimens were probably exposed to thermal shock when deposited near firing features such as hearths. Furthermore, the extremely uncommon presence of calcined bones suggests that high temperature fires were rare in the excavated sites. In addition, the fact that few hearths were built right on top of deposits implies the amount of separation between layers by wind-blown soil would work against the creation of calcined bone. These results support the interpretation that most food was processed through cooking in pots as stews.

8.3.6.9. Weathering

Specimens were observed to record weathering using Behrensmeyer's (1978, 1991) well-known six stage sequence (0-5). Most identified camelid specimens fell in categories

Table 8.21. Frequencies of weathering stages on camelid specimens by component.

Weathering Stage	KCH20Arch	KCH21FA	KCH21FB	KCH56FA	KCH11FB	KCH21Tiw	KCH11Tiw	KCH22Tiw	Total
0	9	612	727	525	167	240	31	46	2357
1	46	295	575	175	105	197	20	2	1415
2	50	116	172	41	42	63	11	2	497
3	1	57	67	18	3	23	11	1	181
4	0	0	4	0	0	4	2	0	10
Total	**106**	**1080**	**1545**	**759**	**317**	**527**	**75**	**51**	**4460**



KCH20Arch

KCH21FA

KCH21FB

KCH56FA

KCH11FB

KCH21Tiw

KCH11Tiw

KCH22Tiw

Figure 8.28. Relative frequency of burning on camelid specimens by component.

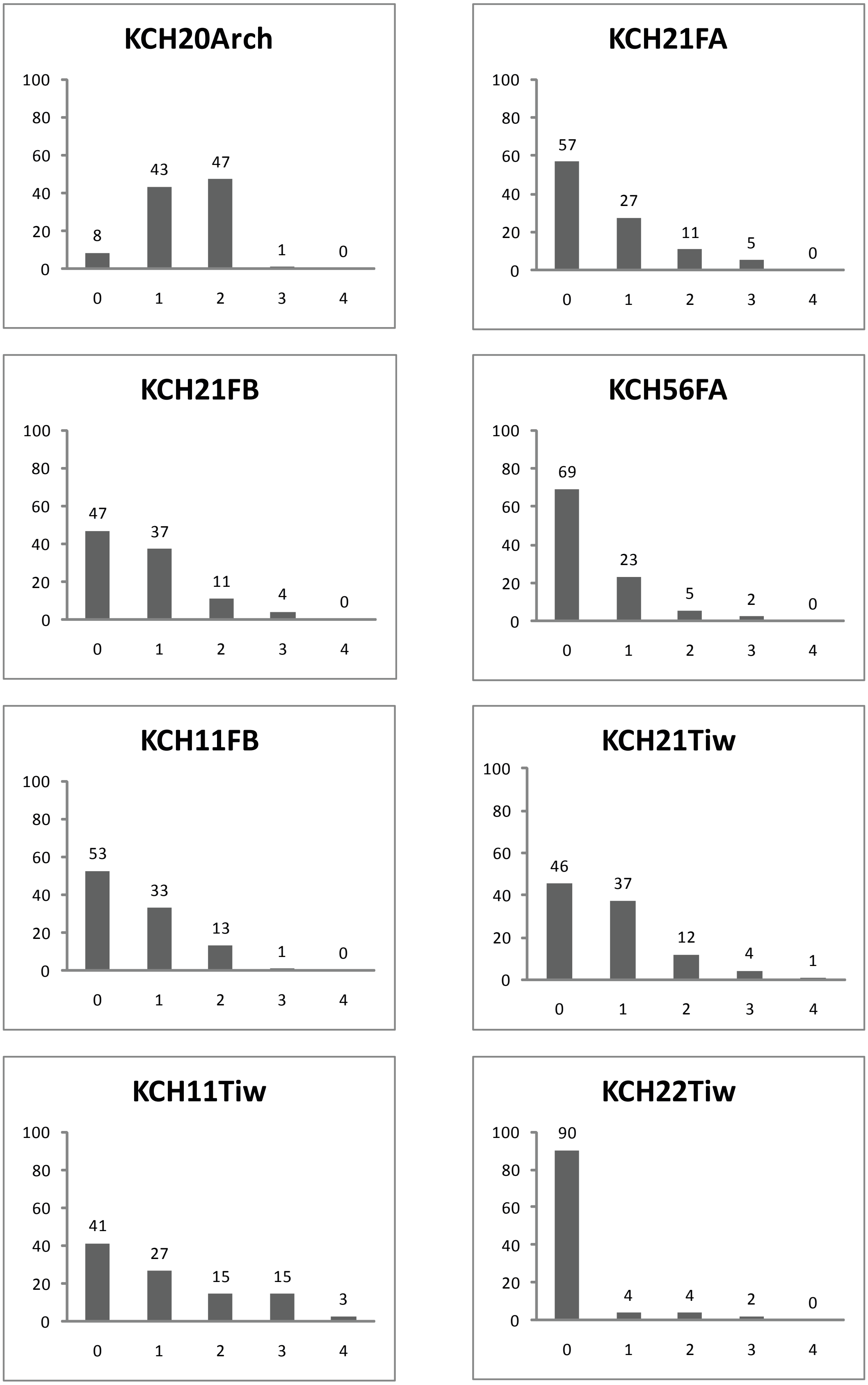


Figure 8.29. Relative frequency of weathering on camelid specimens by component.

0 and 1 suggesting the majority of specimens were quickly deposited before experiencing substantial weathering (Table 8.21, Figure 8.29). Extremely weathered specimens were rare and often associated with specific cultural contexts, including fills and occupation surfaces that could have permitted greater environmental exposure. Specimens in stage 5 are often so fragmented that become unidentifiable and consequently it is not surprising that this stage was not observed in the Iroco assemblage at all. Furthermore, the recorded weathering stages confirm the observations made by several Andean ethnoarchaeologists that bones left in open areas and not quickly deposited in discard contexts such as trash pits are often infrequent in pastoralist sites because they are quickly weathered (see Horn 1984; Kuznar 1995). Considering the high solar radiation of the Andean highlands, it is common to observed extremely weathered bone specimens on the ground of modern pastoralist residential sites. However, bones rapidly buried after discard, generally preserve well.

Once again, KCH20Arch is an exception to the general trend observed in other components. Here, the high frequency of weathered specimens might be related to diagenesis processes associated with the antiquity of the site and the depositional environment. It also suggests that part of this assemblage was partially exposed before final burial. The results are comparable to the pattern observed for the burned bones. Camelid bones in this case can be used as a proxy for the burning and weathering of artifacts and ecofacts within the Iroco excavated contexts.

8.3.6.10. Chemical and Biological Processes

A few chemical processes were documented in the bone specimens of the Iroco faunal assembalges. For instance occasional presence of carbonate incrustations in camelid bones was observed at KCH20Arch, KCH21FA, KCH21FB, and KCH11FB. Carbonates are more frequent in fish bones and other microfauna (see below). An effect of salt carbonate incrustations was an increase in well preserved articulated fish remains, but also the addition of some extra grams in their weight values. Magnesium purple stains on bones were uncommon but were noted in some contexts, particularly in KCH11FB. Some bones also included evidence of red or ochre staining. For instance, a coot ulna bone from KCH21FB had red ochre stains opening up the possibility that feathered wings were used for ritual and performance purposes.

Biological activity is observed at Iroco in the form of corrosion produced by root etching, but also in strong preservation of bones with greasy-like texture probably produced by re-crystallization and collagen cross-fiber interlocking (Nicholson 1998). Some camelid bones had a particularly greasy texture and aspect (either extremely white or orange) and were mostly identified from fills at KCH21FA and KCH21FB. Examples of corroded bones specimens were rare. For instance, only one possibly digested fragment of rib was identified at KCH11FB and one fragment of a long bone from KCH20Arch. Root etching was identified in several specimens and cases with particularly heavy root etching were identified at KCH56FA and KCH21FA. Beetle nests were common throughout the site, but apparently did not adversely affect bone remains at all. These and other biological agents benefitted from phosphates and other nutrient enrichment produced by human activities, including camelid herding.

Some elements were found to be articulated in situ, but this was not particularly common. A number of contexts also included excessively fragmented splinters of bone. Very few features included specifically deposited packages or semi-complete portions of camelid remains. For instance, some camelid articulated elements were identified near the burial area south of structure 1 at KCH21FB. Other features with animal remains include a pit with the complete skeleton of a dog at KCH21Tiw and the camelid offering in the northeast portion of KCH11Tiw. The low frequency of tarsals can also be related to the few proximal metatarsals found in the assemblage because these elements are often articulated and kept attached to each other as raiders during the dismemberment of the lower limbs (Miller 1979). This could suggest differential transport of these elements. The reduced frequency of phalanges and particularly third phalanges might be associated with a similar differential process associated with lower limbs.

8.4. Other Faunal Resources

8.4.1. Deer

Deer were not common at Iroco. Identified deer specimens included some postcranial fragments as well as antlers (Table 8.22). Deer specimens were identified only in two sites, KCH20 and KCH21. The specimens from KCH20Arch were particularly fragmented, possibly as a consequence of local consumption. KCH21FA include several well preserved cranial specimens and KCH21FB and KCH21Tiw included several postcranial specimens. The probable species identified is the taruca or north Andean deer (*Hippocamelus antisensis*). Currently this species is locally extinct in Iroco and is extremely rare in most of the altiplano where it is restricted to the uninhabited slopes of the highest mountains.

Table 8.22. Deer specimens and their modifications identified at Iroco organized by component.

Element	KCH20Arch	KCH21FA	KCH21FB	KCH21Tiw	Total	Worked	Cut marks	Chop marks	Percussion marks	Mechanical abrasion
Antler	6	5	2		**13**	6	3	1	1	2
Cranium		4			**4**					
Cervical vertebrae		1			**1**		1			
Ribs				3	**3**					
Scapula Blade				2	**2**	1	1			1
Scapula Glenoid				7	**7**		1	1		
Humerus M			9	1	**10**					1
Radius-ulna M		1	2	1	**4**				2	1
Femur M			1		**1**				1	
Tibia M		1		1	**2**					
Tibia D		1			**1**				1	
Metapodial M			1		**1**					
Total	**6**	**13**	**15**	**15**	**49**	**7**	**6**	**2**	**5**	**5**

Taruca are solitary animals, which makes hunting more difficult, but small family groups and bachelor groups are occasionally observed.

All the deer specimens were recovered from screen fractions. The fact that one of the scapula deer bones was worked suggests that there was no specific taxonominic discrimination for producing bones tools (Table 8.22). One cranial specimen had evidence of growing antler and consequently was an adult male. Only one specimen was burned, a medial metapodial. The majority of deer specimens did not show evidence of weathering but the preservation of antler was not ideal. For instance, two of the identified antlers

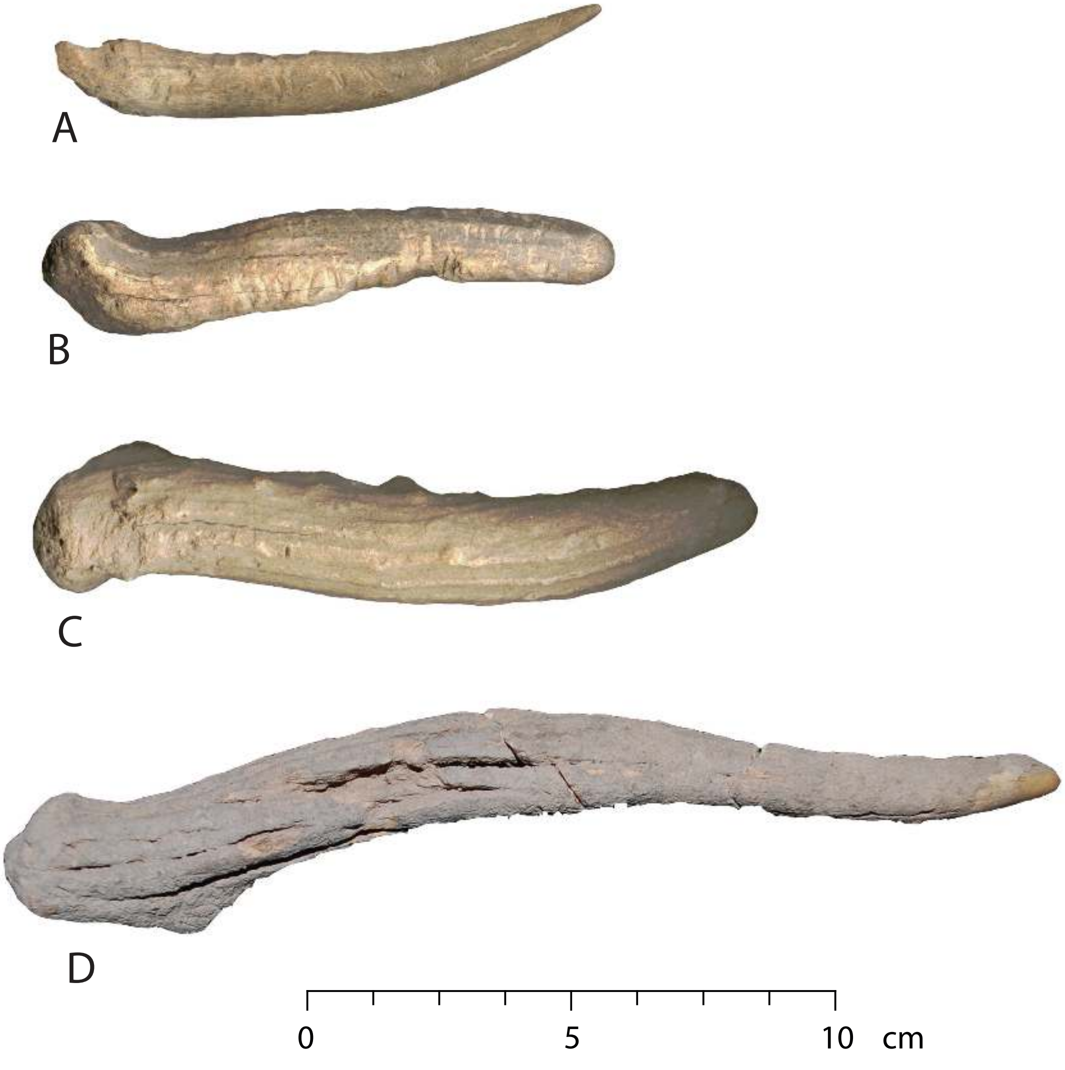


Figure 8.30. Antler specimens from KCH21FA. A) L. 606, B) L. 603, C) L. 606, D) L. 4080/4. The first three specimens have clear evidence of use as pressure flaking tools.

were broken into six and four fragments, respectively. Carbonate incrustations, mechanical abrasion, and weathering affected the structure of some antler specimens.

A number of identified deer specimens showed evidence of tool use including most antlers (Table 8.22). Although most antlers were worked, several were weathered and fragmented affecting the specimen frequency. Figure 8.30 shows how some of the antler specimens recovered from Iroco were used as percussion tools, most probably as soft hammers and pressure flaking retouching tools. Notice the flake scars that these specimens bear as well as their polished tips. Given the degree of modification, it is unclear whether these antler specimens were collected shed or if they originated from hunted individuals. Most antler tools were identified from KCH21FA.

The small frequency of deer specimens and their skeletal representation suggests their procurement was rare, and probably a consequence of opportunistic hunting during herding trips. Antlers were probably a high valued good as a tool for flint-knapping and particularly maintaining lithic tools. The large non-worked complete deer antler included in Figure 8.30D was found in the bottom of a possible storage pit at KCH21FA, where it was probably stored as a cache for later use. Lithic hoes are also found in caches in Iroco and other Formative period sites (e.g., Bermann and Estévez Castillo 1995).

8.4.2. Canids

Canids and particularly dogs were definitely present at the site and were probably kept as company animals. A dog burial was identified in a midden area at the northwest of the excavations at KCH21Tiw within an intentionally excavated burial feature outside the northwest boundary of Structure 1 (Figure 8.31). The individual in question had a sub-pubic angle of 30° (cumulative 120°), a shallow sagital crest on the cranium, strongly developed mandibular fossa, complete set of permanent teeth, lightly developed occipital condyles, and restricted and prominent mandible angular apophysis. Together these

Table 8.23. Skeletal representation of canid remains by component.

Element	KCH20Arch	KCH21FA	KCH21FB	KCH21Tiw	Total
Cranium				2	2
Mandible				2	2
Atlas				1	1
Axis				1	1
Cervical vertebrae				5	5
Thoracic vertebrae				7	7
Lumbar vertebrae				11	11
Sacrum				2	2
Ribs				15	15
Scapula				2	2
Humerus				2	2
Radius				2	2
Ulna				2	2
Carpal				1	1
Intermediate radial				1	1
Metacarpal				4	4
Metatarsal			1	8	9
Pelvis	1			2	3
Femur			1		1
Astragalus				2	2
Calcaneus		1		1	2
Phalanx				5	5
Indeterminate				5	5
Total	**1**	**1**	**2**	**83**	**87**

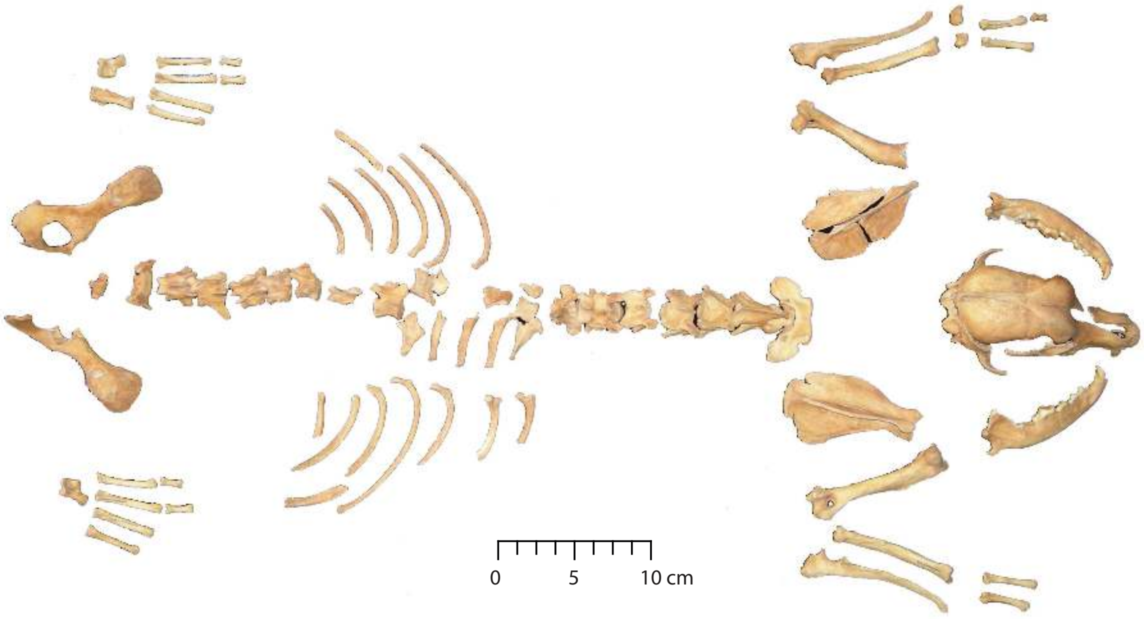


Figure 8.31. Reconstructed dog skeleton recovered from L. 2000, KCH21Tiw.

attributes suggest the individual in question was a female adult medium-sized dog. The dog included a healed rib fracture (Table 8.13). This particular burial might have been deposited after the Tiwanaku occupation of KCH21, but calls attention to the importance of these animals for the local inhabitants through time. Considering that ethnographically dogs are often sacrificed in a number of ceremonies practiced by Andean people (Mendoza España 2004), another possibility for the presence of this burial is a ritual sacrifice.

Additional specimens of canids were found in other excavated components (Table 8.23). For instance, isolated canid bones were identified in the two other KCH21 components as well as in KCH20Arch. Several of the aspects regarding dogs have been presented in the section on carnivore damage on camelid bones (see above). All dog specimens were recovered from screen fractions. The low frequency and ubiquity of these carnivores do not allow conclusions regarding their consumption as food. Nevertheless, the specimens do confirm canids were present in Iroco and speculations about their role in camelid herding are suggested (Mendoza España 2004). The role of carnivores as taphonomic agents is suggested by occasional contextual features such as burrowing pits that are frequent at site KCH21 and it would not be surprising if some of these features were produced by dogs (see Jeske and Kuznar 2001). Furthermore, the taphonomic signature of carnivores in general and dogs in particular, is strongly suspected by the frequency of perforation, gnawing, and other carnivore damage found in several camelid specimens as well as in other taxa.

8.4.3. Rodents

Rodents were another group with significant presence in Iroco. Rodents include undetermined midsized rodents (composed of specimens taxonomically classified to the Order Rodentia, Suborder Hystricomorpha, Infraorder Histricognathi), guinea pigs (Family Caviidae, Subfamily Caviinae, probable species *Cavia tschudii*, *Cavia aperea*, and *Galea musteloides*, see below), tuco-tuco gophers (Family Ctenomyidae, probable species

Table 8.24. Frequencies of rodents identified at Iroco by component and recovery procedure.

Taxa	Recovery	KCH20Arch	KCH21FA	KCH21FB	KCH56FA	KCH11FB	KCH21Tiw	KCH11Tiw	Total
Guinea pigs	Flot							1	1
(*Cavia tschudii*)	Screen	88	21	12		6	11		138
Tuco-tuco gophers	Flot		1	1				2	4
(*Ctenomys opimus*)	Screen		14	47	8	1	2	7	79
Midsized rodents	Flot		22	25	37	13	4	7	108
(Histricognathi)	Screen		14	14	6	10	1	10	55
Small rodents	Flot		3	4	5		2	12	26
(Sigmodontinae)	Screen		4	3	2			41	50
Subtotal	Flot		26	30	42	13	6	22	139
	Screen	88	53	76	16	17	14	58	322
Total		**88**	**79**	**106**	**58**	**30**	**20**	**80**	**461**

Ctenomys opimus), and small mice (Suborder Myomorpha, Superfamily Muroidea, Family Cricetidae, Subfamily Sigmodontinae).

There are a number of questions related to the presence of rodents in Iroco because most specimens were identified and unidentified midsized individuals. In fact, most of the rodents can be classified as guinea pigs or tuco-tuco gophers. The first question to address is whether these rodents were consumed by humans at the sites or were deposited as a consequence of bioturbation. Although rodent remains were not particularly abundant, they were ubiquitous in all components with the exception of KCH22Tiw (Table 8.24). In terms of recovery, the pattern of rodent arrangement is very similar to the one identified for birds where most specific determinations were produced from relatively large and well preserved specimens recovered from screens whereas smaller often unidentifiable bones were recovered from flotation samples. This is a consequence of context, sampling, preservation, and the fact that the majority of the recovered rodents were midsized. Well preserved skull specimens (either crania or mandibles) were particularly critical for making consistent identifications beyond the Order level. Flotation fractions on the other hand, included only generally identifiable postcranial bones. An exception is KCH11Tiw where more small rodents were identified from screen than from flotation fractions (see below).

The site where the presence of guinea pigs was most significant is KCH20Arch. Here guinea pigs constitute the second most frequent taxa and their abundance, composition, and physical properties suggests human consumption. For instance, several intentionally fragmented specimens with percussion marks were recorded (Table 8.25). A perforation mark that might have been produced by humans was also noted. Furthermore, several of these remains were partially burned, suggesting that along with the camelid remains, they were probably grilled (Table 8.26). Similar evidence for consumption of guinea pigs was less frequent at other components, but definitely present at KCH21FA. Consequently, a decreasing trend through time in the economic importance of guinea pigs is noted, with few specimens found at Tiwanaku components.

Given the available morphological and osteometric information, it is difficult to determine whether these specimens were domesticated or caught (hunted or snared) in the wild. Measurements of archaeological specimens overlap with the lower range of modern domesticated guinea pigs (*Cavia porcellus*), but also with the larger range of the wild species currently present in the study area including *Cavia aperea*, *Cavia tschudii*, and even *Galea musteloides* (but not with *Microcavia niata*, which is a smaller and morphologically distinct wild highland guinea pig). Based on cranial morphology, including the absence of yellow incisors suggests *Galea musteloides* was not among the consumed animals. Given that the modern distribution of *Cavia aperea* does not include the highlands, this species is also discarded. Consequently, the most likely species present in the Iroco assemblages is *Cavia tschudii*. Given the strong similarity between the specimens from the Early Archaic Period site of KCH20 and those from the later occupied site KCH21, I consider that domesticated guinea pigs were probably not present in the studied assemblages. However, for the case of specimens from KCH21, size is inconclusive for a clear intra-specific distinction. A more detailed study of morphological attributes and measurements is required for determining the presence of domesticated guinea pigs based on fragmented archaeological specimens.

The decrease in representation of guinea pigs contrasts with the slight increase in the presence of tuco-tuco gophers (preliminarily identified as the highland tuco-tuco *Ctenomys opimus*). Unfortunately, the evidence for human consumption is less strong for this group.

Table 8.25. Frequencies of identified rodent elements including recorded modifications.

Element	Guinea pigs	Percussion marks	Carnivore damage	Mechanical abrasion	Tuco-tuco gophers	Carnivore damage	Mechanical abrasion	Midsized rodents	Mechanical abrasion	Small rodents	Total
Cranium	60			2	17	1	1	22		19	118
Mandible	28				29			4		16	77
Incisor	10				4			14	2	1	29
Mollar	7				10			7	1		24
Vertebrae								25		6	31
Ribs								11		5	16
Scapula	5							4			9
Humerus	6	3			4			13		8	31
Radius-ulna	3	3		1				9		1	13
Pelvis	5				10			12		3	30
Femur	8	4	1		8	1		7		9	32
Sacrum								1			1
Tibia-fibula	6	4		2	1			7		3	17
Calcaneus	1							2		1	4
Metapodial								2			2
Digit								6			6
Long-bone								17		4	21
Total	**139**	**14**	**1**	**5**	**83**	**2**	**1**	**163**	**3**	**76**	**461**

Table 8.26. Frequencies of burned rodent specimens by component.

Taxa / Burning	KCH20Arch	KCH21FA	KCH21FB	KCH56FA	KCH11FB	KCH21Tiw	KCH11Tiw	Total
Guinea pigs								
None	60	20	12		6	8	1	107
Partially burned	28	1				3		32
Tuco-tuco gophers								
None		14	41	8	1	1	9	74
Partially burned			7			1		8
Burned		1						1
Midsized rodents								
None		29	32	39	19	5	16	140
Partially burned			2		2		1	5
Burned		3	4	4	2			13
Calcined		4	1					5
Small rodents								
None		7	5	6			53	71
Partially burned			1			2		3
Burned			1	1				2
Total	**88**	**79**	**106**	**58**	**30**	**20**	**80**	**461**

Tuco-tuco specimens include evidence of thermal alteration and few modifications such as carnivore damage and mechanical abrasion (Tables 8.25-8.26). Tuco-tuco gophers are particularly common at KCH21FB where they were probably consumed in connection with commensalism. Another possibility that requires further exploration is that these animals colonized the site during transitional abandonments episodes, either between occupations or during seasonal migrations. The best evidence for human consumption of gophers is their ubiquity, fragmentation, and burning or thermal alteration (all present at KCH21FB). Together the evidence for tuco-tuco gopher human consumption is inconclusive. Unfortunately, these animals are also characteristically fosorial and they could have been attracted to the sites because of the enriched soils. Evidence against their presence being solely related to bioturbation is that no complete individuals were identified. Evidence in favor includes the quantity of rodent gnawing observed on camelid remains (see above).

The small mice identified at Iroco most likely correspond to the Subfamily Sigmodontinae of New World rats and mice and might include species of the genera: *Abrothrix*, *Akodon*, *Neotomys*, *Phyllotis*, and *Punomys*, among others. Unfortunately no complete skulls were recovered, so further identification is presently unfeasible. The relatively numerous specimens of small rodents identified at KCH11Tiw is a result of partial skeletons of small mice identified within the fill of slab stone burials 1 and 2. Most likely these specimens were not consumed by humans but were accumulated as a result of commensalism and post-depositional bioturbation. This is also corroborated by the fact that not a single modification mark was identified in small rodents and that only a few specimens had evidence of thermal alteration.

Guinea pigs, tuco-tuco gophers, and mice were accumulated at Iroco by a combination of human consumption and natural bioturbation. In fact, given their relatively large size, tuco-tuco gophers –and wild guinea pigs– are traditionally hunted by Aymara and Uru peoples who snare them during the dry season as part of scheduled specialized hunting trips (Molina Rivero 2006). On the other hand, the large frequency of pits identified at

KCH21 might not only have attracted these animals (as potential sources of nutrients both as trash or storage pits) but some of them might have been produced by tuco-tuco gophers themselves. In this respect, the presence of most small rodent remains suggest they were mostly present at the sites as a consequence of bioturbation. This suggests that commensalism occurred and that it is possible that human consumption of commensals occurred. Furthermore, evidence for human consumption of tuco-tuco gophers as well as increased frequencies of these animals has been reported by Moore and her colleagues (1999) from sites in the Taraco Peninsula.

Although evidence for consumption of guinea pigs is good, particularly for KCH20Arch and KCH21FA, the presence of tuco-tuco gophers seems to be a consequence of both human consumption and post-depositional bioturbation. The abundant gnawing marks on ribs and other camelid bones were probably produced by tuco-tuco gophers. In fact, some tuco-tuco gopher remains include evidence of human use, particularly at KCH21FB. Nevertheless, if tamed or domesticated guinea pigs were kept at the site, they could have also been a source for potential bone gnawing. Nevertheless, plenty of evidence from percussion marks, burning, and other modifications suggests tuco-tucos were in fact consumed at the site. Finally, commensal or not, the presence of small mice is another potential source of post-depositional disturbance. Weathering was also uncommon in rodent remains.

Rodent species from the following genera were not identified in the Iroco faunal assemblages: *Abrocoma*, *Chinchilla*, *Lagidium*, *Lagostomus*, *Microcavia*, and *Octodontomys*, all of which have overlapping distribution ranges and several of which have been identified in Andean archaeological sites (Hesse 1984; Labarca 2005). Furthermore, no specimens were identified corresponding to the Andean hairy armadillo (*Chaetophractus nationi*), also known as *quirquincho*, even though this is a typical, but unfortunately, increasingly uncommon species in the region today.

8.4.4. Birds

8.4.4.1. Recovery

Birds were a faunal resource commonly found at the Iroco sites. Birds were the third most abundant faunal resource consumed and discarded at the investigated sites (Table 8.27). The relative frequency of bird remains among different components varied between 1 and 10% in screen fractions and between 2 and 17% in flotation samples. The diversity of birds is surprisingly large and is comprised by at least 14 different families of aquatic and terrestrial species (Table 8.27). Nine of these taxa include typically aquatic birds and five terrestrial. Although no intra-specific determination was attempted, during the faunal analysis, different sizes and morphological attributes suggest that some families included several species. More specifically, ducks and coots were represented by at least three different species each.

Recovery bias also affected the representation of bird remains but given the taxonomic and size diversity, the direction of the bias was varied (see also Moore 2011). For instance, although more bird specimens were recovered from flotation fractions, only five taxa were identified in these samples, three of which were also represented in screen fractions. The two additional taxa recovered only from flotation samples include small birds, specifically, doves and passerines. Most of the bird specimens identified from flotation samples consisted of unidentifiable fragments of bones and egg-shells. Given the spatial and contextual provenience of these samples it seems likely that flotation samples indeed contain more bird specimens but specimen size and completeness (a function of differential taphonomy) is a better factor for predicting taxonomic representation. The majority of the bird bones recovered from screen fractions were identifiable and only the largest (>5 mm) specimens from the flotation samples were identifiable. In summary, whereas more specimens were

Table 8.27. Taxonomic representation of birds identified from the Iroco assemblages by component and recovery procedure.

Taxa	Comon Name	Habitat	KCH20Arch	KCH21FA		KCH21FB		KCH56FA		KCH11FB		KCH21Tiw		KCH11Tiw		KCH22Tiw	Total		Total
			Screen	Flot	Screen	Flot	Screen	Flot	Screen	Flot	Screen	Flot	Screen	Flot	Screen	Screen	Flot	Screen	
Anatidae	Ducks	Aquatic	10		61		42				3	1	6	1		1	2	123	125
Ardeidae	Herons	Aquatic			2		9				2		1				0	14	14
Charadriidae	Plovers	Aquatic			1		3										0	4	4
Columbidae	Doves	Terrestrial						3									3	0	3
Laridae	Gulls	Aquatic			2	1	1		1	1							2	4	6
Passeriformes	Passerines	Terrestrial				1											1	0	1
Phoenicopteridae	Flamingos	Aquatic			3		58				3		2				0	66	66
Podicipedidae	Grebes	Aquatic					3				1						0	4	4
Rallidae	Coots	Aquatic	12	4	65	1	51		2	1	10	3	12			1	9	153	162
Recurvirostridae	Avocets	Aquatic	2														0	2	2
Rheidae	Rheas	Terrestrial			2		37		1		10		2				0	52	52
Strigidae	Owls	Terrestrial			1												0	1	1
Threskiornithidae	Ibis	Aquatic					1										0	1	1
Tinamidae	Tinamous	Terrestrial					1						3				0	4	4
Indeterminate			22	134	116	16	130	16	11	33	57	29	18	11	9	4	239	367	606
Egg-shell				787	4	99	35	17	2	93		12		49			1057	41	1098
Total			46	925	257	118	371	36	17	128	86	45	44	61	9	6	1313	836	2149
Weight			27.04	13.49	159.71	3.04	239.41	0.76	4.8	3.18	41.6	4.11	35.76	1.45	4.8	4.15	26.03	517.27	543.3

recovered using flotation fractions, screen fractions were good enough for determining taxonomic representation of medium and large sized birds and incomplete representation of small birds and small elements of medium and large birds. This suggests that accurate identification of bird bones is more related to preservation and taphonomy than to recovery bias.

8.4.4.2. Richness and Abundance

Bird remains are common at KCH21FA, KCH21FB, KCH20Arch and KCH11FB, and surprisingly uncommon at KCH56FA, KCH11Tiw and KCH22Tiw. Taxa commonly present in sites with few bird specimens include water fowl, namely ducks and coots in addition to egg shells. Most of the identified birds by taxa and abundance correspond to aquatic habitats, particularly coots, ducks, flamingos and herons (Table 8.27).

Coots (Family Rallidae) are the most common bird taxa present in the Iroco faunal assemblages. Currently there are several species of coots distributed in Iroco, including the plumbeous rail (*Pardirallus sanguinolentus*), common moorhen (*Gallinula chloropus*), giant coot (*Fulica gigantea*), horned coot (*Fulica cornuta*), and slate colored coot (*Fulica ardesiaca*) (see Table 4.4) (Flores Bedregal and Capriles Farfán 2010). These birds flock, are easy to spot, abundant, and include plenty of meat. Their preferred habitats include totora reeds and marshes near the lake shore. It has been documented ethnographically that coots are occasionally hunted as food and their eggs collected during fishing trips by Uru fishermen (Portugal Loayza 2002). Coots were ubiquitous in most components and were particularly well represented in screen fractions from KCH21FA and KCH21FB.

Ducks (Family Anatidae) were also well represented in the Iroco assemblages. Ducks are presently abundant in the study area and include several common species such as the Andean goose (*Chloephaga melanoptera*), crested duck (*Lophonetta specularioides*), speckled teal (*Anas flavirostris*), yellowed-billed pintail (*Anas georgica*), white-cheeked pintail (*Anas bahamensis*), and puna teal (*Anas puna*). Ducks often share the same habitat and social behavior as coots. Some ducks are migratory and usually occupy the region during the wet season. Collecting coot and duck eggs is a well documented practice that often is performed at the beginning of the wet season from muddy islands and totora reed fields (Rocha Olivo 2002).

Flamingos (Family Phoenicopteridae) are the third most common group of birds represented in Iroco. There are currently three species of flamingos in the Andes, namely the Chilean flamingo (*Phoenicopterus chilensis*), Andean flamingo (*Phoenicoparrus andinus*), and James's Flamingo (*Phoenicoparrus jamesi*). These three species are migratory and are often found in Lake Uru-Uru during the dry season (Caziani et al. 2007). Flamingos prefer open calm waters and flock in large groups. Flamingos have been traditionally hunted using specialized net traps by Uru groups (Wachtel 2001). They are mainly hunted for their feathers that are used in traditional dances as well as their fat, which is supposed to be medicinal (Rocha Olivo 2002).

Rheas (Family Rheidae) were the most common terrestrial bird found in Iroco. The probable identified species is the lesser rhea (*Rhea pennata*), also known as Darwin's rhea and locally as suri. Lesser rheas are flightless and are the largest terrestrial bird in the Andes. Rheas have been traditionally hunted for their feathers, which are incorporated in traditional festivity head-dresses. Given the size of these animals (up to 1 m tall and 25 kg in weight), in the past they could have provided plenty of edible meat. In fact, in the Patagonia they were traditionally hunted for this purpose as they are effectively a very good source of animal protein (Cruz and Elkin 2003).

Herons (Family Ardeidae) were the fifth represented group and although there are several species present in Lake Uru-Uru, some species are migratory and mainly present during the wet season. Herons are usually solitary individuals with large body sizes and are generally not traditionally hunted.

The following ten taxa were identified by six specimens or less and represented aquatic plovers, gulls, grebes, avocets, and ibis and the terrestrial tinamous, doves, owls, and passerines. Some of these birds are traditionally hunted and could be important sources of meat, such as grebes, tinamous, and doves. Hunting or snaring tinamous (in addition to collecting their eggs) is a well documented traditional supplementary economic practice. Most of these taxa were identified at site KCH21. As an added note, site KCH20Arch included (in addition to ducks and coots) the only two specimens of avocets. These two specimens correspond to two left proximal humeri that could be further identified as *Recurvirostra andina* also known as the Andean avocet. One specimen was broken with a spiral fracture and the other was partially burned suggesting human consumption.

8.4.4.3. Element Representation

Table 8.28 shows a profile of skeletal representation associated with each bird taxonomic group in addition to some observed modifications. This table includes data combining all components and is mostly useful as a preliminary assessment of how specific identifiable individual elements were modified. Interestingly, no single element was particularly diagnostic for identifying most taxa and specimen preservation was the most important aspect for allowing determination. Sterna (usually represented by their proximal ends) were very common suggesting that meat was probably a factor in the differential accumulation of bird bones. Limb bones were common and unlike assemblages where bird wings were used for ceremonial purposes, they have a relatively even distribution with a preponderance of humerus and tibiotarsus elements, both of which are particularly dense. Coracoid, tarsometatarsus, ulna, and femur were also very diagnostic elements and were well represented in the assemblages. Some flamingo ulnae were well preserved in spite of their fragility, perhaps because they were still attached to feathers and were not consumed as food, but kept as part of specific manufactured crafts.

Table 8.28. Skeletal representation of bird elements by taxonomic family and modifications observed on bird specimens.

Element	**Anatidae**	**Ardeidae**	**Charadriidae**	**Columbidae**	**Laridae**	**Passeriformes**	**Phoenicopteridae**	**Podicipedidae**	**Rallidae**	**Recurvirostridae**	**Rheidae**	**Strigidae**	**Threskiornithidae**	**Tinamidae**	**Indeterminate**	**Total**	**Medular bone**	**Worked**	**Cut marks**	**Chop marks**	**Percussion marks**	**Carnivore damage**	**Rodent gnawing**	**Mechanical abrasion**
Skull	3						1		6						15	**25**								1
Vertebrae									1						1	**2**								
Sternum	25		1	3			6	1	28		7				68	**139**								1
Ribs									2		1				5	**8**		1						
Clavicle furculum							2		1		1				5	**9**		1	1					
Scapula							2									**2**								
Coracoid	18	6					3	1	19			1	1		8	**57**					4			1
Humerus	10	2					11	1	8	2	3			3	31	**71**	4	1	1	1	19	1		1
Radius	5								2						12	**19**					1			
Ulna	6	3			3		4	1	6		1				26	**50**			1		4	1		2
Carpometacarpus	4						1		5						7	**17**			1		1			
2nd digit, phalanx 1															4	**4**								
2nd digit, phalanx 2															6	**6**								
Pelvis	8		1				10		3						14	**36**					1			
Femur	2						2		10					1	7	**22**	2	1	1		6	1		1
Tibiotarsus	22	1	2			1	4		42		7				42	**121**		1	4		26	6	1	5
Tarsometatarsus	11	2			3		2		24		7				7	**56**		1	3		10	1		2
Digit															23	**23**						1		
Long-bone	11						15		5		25				227	**283**	5	9	1	5	3			5
Indeterminate							3								98	**101**								1
Egg-shell																**1098**								
Total	**125**	**14**	**4**	**3**	**6**	**1**	**66**	**4**	**162**	**2**	**52**	**1**	**1**	**4**	**606**	**2149**	**11**	**15**	**13**	**6**	**75**	**11**	**1**	**20**

8.4.4.4. Modifications

In addition to meat, feathers, and eggs, another interesting use that birds provided was raw materials for the manufacture of specialized bone tools. Bird bone tools were preferentially manufactured on long bones of medium and large sized birds such as flamingos, coots, and rheas (Table 8.29). Finished and unfinished worked beads made with bird long bones were identified in Iroco. Another identified bone tool includes and particularly fine awls made of coot long bones.

Some cut and several percussion marks were identified in long bones and were probably produced during food processing. Most bird long bones were fragmented, possibly as a consequence of human cooking and eating. Carnivore damage is present in some

Table 8.29. Frequencies of worked bird bones by component.

Taxa / Tool	KCH21FA	KCH21FB	KCH11FB	KCH21Tiw	Total
Phoenicopteridae					
By-product, bead				1	1
Rallidae					
By-product, bead		1			1
Ornament, bead		1			1
Rheidae					
Awl		1			1
Awl, fine point		1			1
By-product, bead	1				1
Indeterminate					
By-product, awl	1				1
By-product, bead	4	1		1	6
Ornament, bead		1	1		2
Total	**6**	**6**	**1**	**2**	**15**

bones and might be a consequence of human and dog action during food consumption and discard. Very few specimens had any evidence of weathering and it was probably not a strong factor in the differential identification of bird remains. The frequencies of thermally altered bird bones are not particularly large and support that most cooking was performed through boiling (Table 8.30, Figure 8.32).

Given the abundance and diversity of birds it can be suggested that their procurement was an important activity for the Iroco inhabitants. The practice of procuring birds was more common during the Archaic and Formative periods by inhabitants settled near the shoreline. It seems plausible that procuring birds and bird eggs were complementary subsistence activities that were carried out somewhat regularly. Perhaps the most important nutrients that bird provided was fat. Most altiplano aquatic birds have strong concentrations of fat to cope with the high elevation and arid cool climate. Some birds like flamingos can be probably thought of as highly predictable seasonal resources. Their hunting could have been scheduled particularly at the beginning of the dry season when they are abundant and other resources are scarce. Their exploitation was also probably motivated to procure feathers for special purposes.

Table 8.30. Frequencies of burned or thermally altered bird specimens by component.

Burning	KCH20Arch	KCH21FA	KCH21FB	KCH11FB	KCH56FA	KCH21Tiw	KCH11Tiw	KCH22Tiw	Total
None	40	963	454	185	46	75	58	6	1827
Partially burned	5	133	20	18	3	7	8		194
Burned		66	12	8	4	3	4		97
Calcined	1	20	3	3		4			31
Total	**46**	**1182**	**489**	**214**	**53**	**89**	**70**	**6**	**2149**

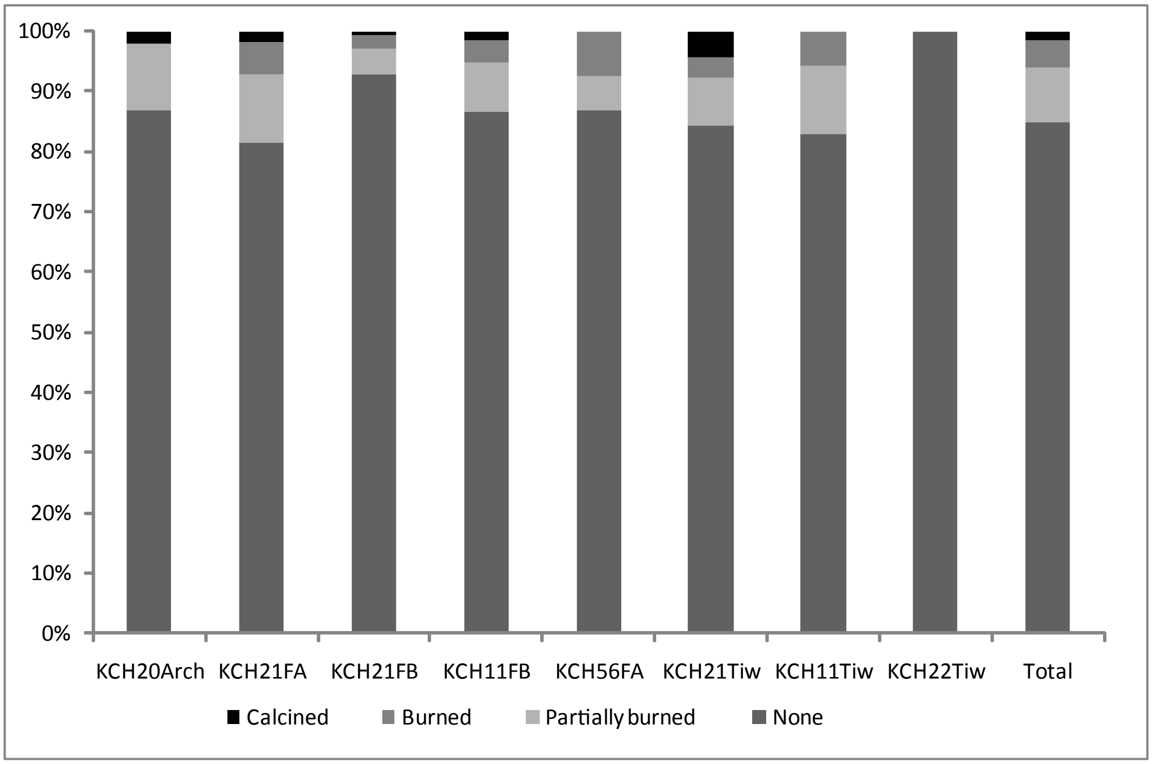


Figure 8.32. Relative frequency of burning on bird specimens by component.

8.4.4.5. *Egg-shells*

Egg-shells are the byproducts of the initial developmental stage of a bird and consequently are included in the bird remains count, but not as a separate taxonomic class (Table 8.27). Most egg-shells were recovered from flotation samples and were very fragmented. A few cultural contexts included particularly large quantities of egg-shells. For instance, at KCH21, the stratified midden excavated at the north of the site as well as the pits associated with southeast and southwest units were particularly dense in egg-shells. Cursory observations during the faunal analysis permitted to distinguish several types of bird egg-shells based on texture, color, thickness, and other attributes that might be related to different species, but in the absence of adequate reference collections, their specific identification is still pending. Bird egg-shells were abundant at KCH21FA, common at KCH21FB and KCH11FB, but infrequent at KCH56FA and KCH21Tiw. Egg-shells were often partially burned, suggesting that thermal alteration was in part related to their discard and preservation.

8.4.5. Reptiles and Amphibians

Reptiles and amphibians were uncommon but present at Iroco (Table 8.31). Currently lizards (e.g., Class Reptilia, Family Liolaemidae, Genus *Liolaemus* spp.) are common around the plains and hills of Iroco (Cuenca Sempertegui et al. 2005). Snakes are less common but occasionally present, particularly the Peruvian slender snake (Family Colubridae, Species *Tachymenis peruviana*). Aymara and Uru people occasionally use both lizards and snakes for medicinal purposes, but otherwise do not consume them.

Amphibians are rare in Iroco and the incidence of particularly large toads in the assemblage suggests the possible occurrence of extinct species. It is possible that frogs entered the archaeological contexts as part of fossorial behavior motivated by thermoregulation (as most of these animals burrow during nights to keep warm) and consequently, suggests bioturbation processes related to increased humidity. Moreover, their current rareness could be a consequence of a combination of environmental and anthropogenic causes.

Table 8.31. Skeletal representation of reptiles and amphibians by component.

Taxa Element	KCH21FA Flot	KCH21FB Flot	KCH56FA Flot	 Screen	KCH11FB Flot	KCH11Tiw Flot	 Screen	Flot	Screen	Total
Reptilia	**2**	**3**	**2**		**1**	**2**		**10**		**10**
Lacertilia	2	2	2			2		8		8
Dentary	2	1	2			1		6		6
Maxilla						1		1		1
Pelvis		1						1		1
Tachymenis		1			1			2		2
Dentary		1			1			2		2
Amphibian	**3**	**9**	**14**	**1**	**1**	**8**	**8**	**35**	**9**	**44**
Anura	3	9	14	1	1	8	8	35	9	44
Cranium							4		4	4
Vomer							1		1	1
Scapula		4						4		4
Humerus		1	6	1			2	7	3	10
Pelvis		2	7		1	5		15		15
Femur							1		1	1
Long-bone	1	2				3		6		6
Indeterminate	2		1					3		3
Total	**5**	**12**	**16**	**1**	**2**	**10**	**8**	**45**	**9**	**54**

8.4.6. Fish

8.4.6.1. Recovery

Following camelids, fish were the second most frequent animal resource identified in the Iroco faunal assemblages. Because recovery procedures tend to bias the frequency of fishes more than any other taxonomic group (see above), their specific abundance is estimated only from contexts where flotation samples were collected. For instance, all fish remains from KCH11Tiw were recovered from flotation samples and the amount of fish remains recovered from the screen fractions of KCH56FA, KCH11FB, and KCH21Tiw was extremely low (Table 8.32). In fact, a lack of correlation was determined between screen and flotation samples despite the appearance of a trend line in Figure 8.33 (r=0.139, *P*=0.792, N=6). Screen samples show a complete underrepresentation of fish remains. More than any other factor, this is a consequence of recovery bias.

Table 8.32. Frequencies of NISP and weight of fish remains identified from the Iroco assemblages by flotation and screen fractions.

Component	**Flot**				**Screen**			
	NISP	**Weight**	**%NISP**	**%Weight**	**NISP**	**Weight**	**%NISP**	**%Weight**
KCH21FA	17491	94.73	90.2	45.92	481	13.68	17.6	0.11
KCH21FB	4390	30.21	85.6	40.39	4317	27.71	57.6	0.18
KCH56FA	94	0.74	6.7	0.15	5	0.4	0.3	0.01
KCH11FB	340	2.15	44.5	4.45	3	0.3	0.4	0.01
KCH21Tiw	988	7.16	83.9	31.20	4	0.3	0.4	0.01
KCH11Tiw	591	3.74	59.9	8.08	0	0	0.0	0.00
Total	23894	138.73	82.8	15.65	4810	42.39	33.5	0.09

8.4.6.2. Abundance

Fish remains were conspicuous in flotation samples but their abundance varied among different components and cultural contexts. For instance, fish remains dominated the assemblages from all components of site KCH21 with proportions above 80% of the entire faunal assemblage, if quantification relies on NISP (Table 8.32). A slight decreasing trend through time is observed. These results suggest that fish consumption was present in the region of study at least during the Formative and Tiwanaku periods and possibly some form of fish procuring specialization associated with site KCH21. In strong contrast, KCH56FA had less than 7% of fish remains. This could suggest that sites located further away from the lacustrine environments (such as KCH56) seem to include substantially lower frequencies of fish remains. The spatial pattern is stronger than the chronological trend that shows that during the Tiwanaku Period fish continued to be important both at KCH21 and at KCH11.

Interestingly enough, if weight is used as the measure of taxonomic representation, fish comprise between 0.02% and 46%, considerably less than using NISP. A strong, positive and significant relationship was identified between NISP and weight (r=0.992, $P<0.001$, N=12) (Figure 8.34). This result did not change when only flotation samples were

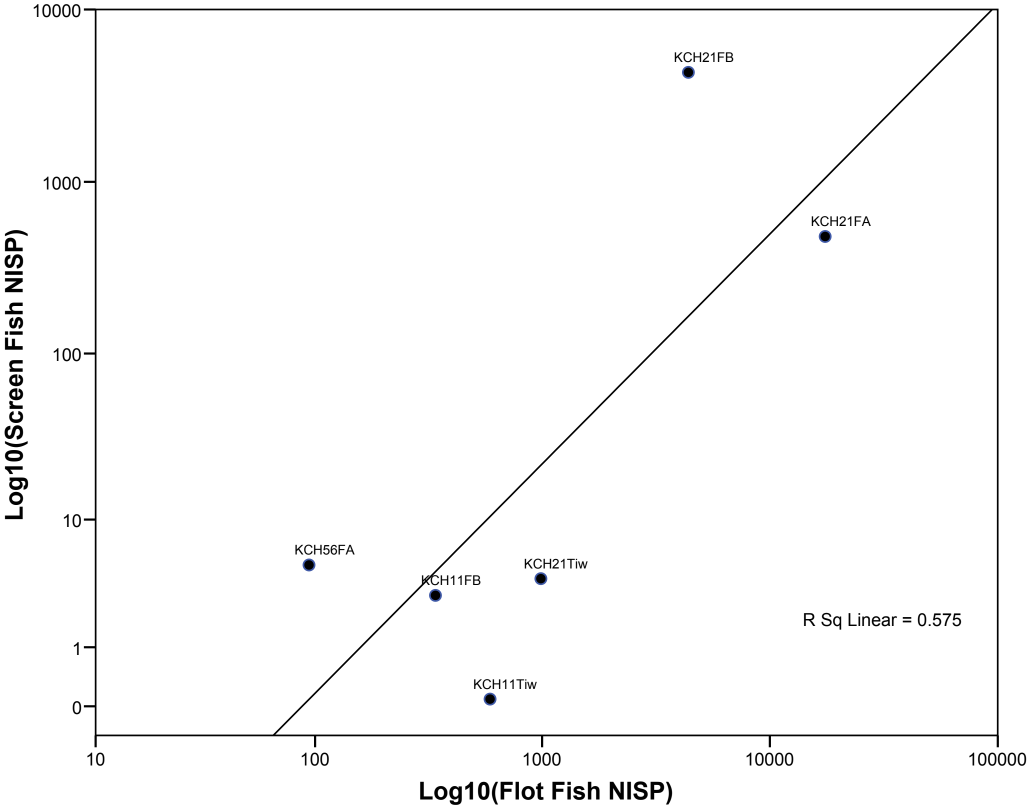


Figure 8.33. Relationship between fish NISP from screen and flotation fractions.

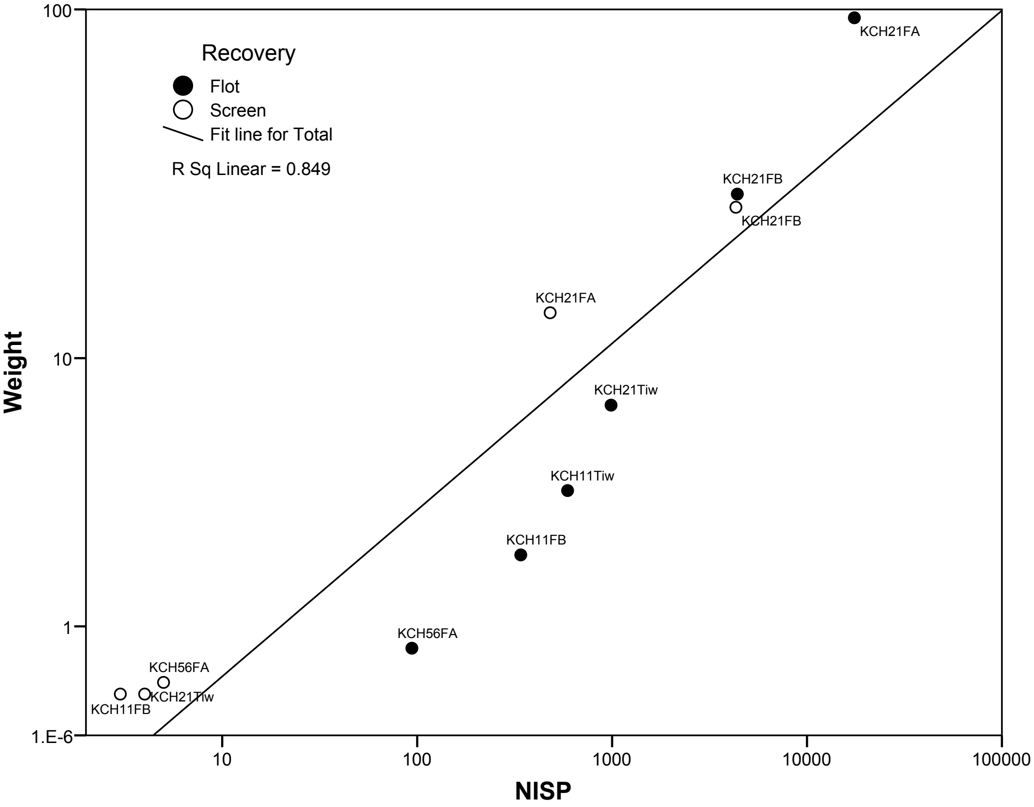


Figure 8.34. Relationship between fish weight and NISP from screen and flot fractions.

used but on the contrary, made the correlation stronger (r=0.998, $P<0.001$, N=6). This type of relationship has been previously recognized in Formative Period samples from Lake Titicaca (Capriles 2006).

Of all components, KCH21FA has the highest frequency of fish remains with close to 17,500 identified specimens. The rest of the components followed far behind, and KCH56FA only had 94 identified fish specimens. The considerable variability in the quantity of fish remains is probably a consequence of differential fish procurement and consumption at the sites although taphonomic aspects should also be considered (see below). As argued above, the fact that no fish remains were identified at KCH20Arch or at KCH22Tiw is heavily conditioned by recovery bias, but it might also be related to depositional factors. Taking into account that faunal assemblages from these two components did not involve the implementation of fine recovery techniques, the absence of fish remains might be related to recovery bias.

8.4.6.3. Assemblage Composition

A great effort was placed into identifying the specific taxa and elements represented in the fish faunal specimens from the Iroco assemblages. As a result most fish remains were readily classified to the genus level as confirmed by the identification of the two native genera currently present in Lake Uru-Uru, *Orestias* (or killifishes, Order Ciprinodontiformes, Family Ciprinodontidae) and *Trichomycterus* (or catfishes, Order Siluriformes, Family Trichomycteridae). Identified specimens were further classified to element (Table 8.33).

On average, over 83% of the fish remains were able to be identified to taxonomic and element level. *Orestias* were more frequent than *Trichomycterus* in the archaeological samples by a ratio of over 100 to 1 using NISP, and 10 to 1 using MNI, although this varies substantially from component to component. This suggests *Orestias* were the preferred catch, but might also be a reflection of the living ecosystem. Currently, only one species of killifishes and one species of catfishes are present in Lake Uru-Uru, namely, *O. agassii* and *T. rivulatus*. Killifishes are more abundant in open waters and totora reed beds whereas catfishes are benthic feeders and are common in meandering rivers. Because of their different habitat preferences, these two genera are often captured by different fishing techniques. Killifishes are usually caught using dragging nets and gill-nets whereas catfish are sometimes caught in nets but can also be caught with spears. Fishing was a traditional seasonal activity for Uru fishermen and during Horn's (1984) ethnoarchaeological study of the Uru-Muratos, it was regulated to be carried out during the winter or dry season.

8.4.6.4. Skeletal Representation

A general classification of fish elements suggests that *Orestias* scales were the most frequent element followed by *Orestias* postcranial bones (ribs, vertebrae, rays, and urostyle), *Orestias* cranial bones, and *Trichomycterus* bones (Figure 8.35). However, note that *Trichomycterus* do not have scales (because as members of the catfish Order they only have skin covering their bodies) and although they are generally larger than *Orestias*, they have less identifiable cranial and postcranial bones (Capriles 2006). Furthermore, although it appears that *Trichomycterus* were relatively more frequent at KCH56FA and KCH11Tiw, probably as a consequence of sample size adversely affecting their proportions at KCH21.

The variations in the frequencies of different parts of the *Orestias* skeleton might be a consequence of differential deposition, preservation, and/or identification. Cranial elements are expected to be more sensitive to mechanical erosion and post-burial disturbance than some robust postcranial specimens or scales. Surprisingly, *Orestias* cranial bones have a consistent presence of 10% in all assemblages. Fluctuation in the percentage of scales seems to be related to the identification of postcranial elements and thus, taphonomy.

To further assess taphonomy of fish remains, I calculated MAU and MAU% (see Chapter 5) for *Orestias* elements identified at KCH21FA and KCH21FB –the assemblages

Table 8.33. Taxonomic determination and skeletal element representation of fish remains from the Iroco assemblages.

Taxa/Element	Flot						Total	Screen					Total	Total
	KCH21FA	KCH21FB	KCH56FA	KCH11FB	KCH21Tiw	KCH11Tiw	Flot	KCH21FA	KCH21FB	KCH56FA	KCH11FB	KCH21Tiw	Screen	
***Orestias* Bones**	**6213**	**1916**	**46**	**183**	**424**	**314**	**9096**	**194**	**1897**	**4**		**4**	**2099**	**11195**
Premaxilla	12	1				1	14	1	7				8	22
Maxilla	40	15			1	2	58		16				16	74
Dentary	44	17				2	63	1	9				10	73
Articular	25	2					27	1	10				11	38
Quadrate	40	15		2	2	1	60		21				21	81
Ceratohyal	3				1		4							4
Hyomandibular	144	42	1	5	7	4	203	2	20				22	225
Pharyngeal inferior	95	17		1	6		119	1	42				43	162
Pharyngeal superior	34	9			4		47		21				21	68
Cleithrum	217	118	2	2	22	20	381	15	71	2		1	89	470
Operculum	307	99	3	15	18	22	464	58	118	2			178	642
Interoperculum	87	33		1	4	4	129	2	17				19	148
Preoperculum	70	20			4	3	97	7	13				20	117
Suboperculum	58	14		2	2	2	78	7	24			2	33	111
Frontal	127	36	2	3	8		176	3	34				37	213
Basioccipital	45	15	2	1			63	1	9				10	73
Parasphenoid	35	9			1	1	46		11				11	57
Urostyle	41	12		1	1		55							55
Ribs	2075	579	24	70	145	126	3019	86	631			1	718	3737
Vertebrae	2539	848	12	73	188	124	3784	5	607				612	4396
Rays	175	15		7	10	2	209	4	216				220	429
***Orestias* Scales**	**8402**	**1785**	**32**	**92**	**332**	**170**	**10813**	**115**	**2084**				**2199**	**13012**
>10mm Plain		5					5							5
>10mm Rough	6	1					7							7
>5mm Plain	1806	621		13	43	87	2570	85	177				262	2832
>5mm Rough	84	9	1	2	20	1	117	1	23				24	141
<5mm Plain	6442	1135	31	77	259	81	8025	29	1884				1913	9938
<5mm Rough	64	14			10	1	89							89
Trichomycterus	**48**	**28**	**3**		**4**	**24**	**107**	**4**	**48**	**1**	**3**		**56**	**163**
Basioccipital					1		1	3	4				7	8
Dentary	1						1							1
Frontal		1					1							1
Interoperculum	13	12			1	12	38		11	1			12	50
Maxilla	1						1		2		2		4	5
Operculum	11	5			1		17		19				19	36
Parasphenoid									1				1	1
Quadrate	1						1							1
Ribs	1		1				2							2
Urostyle		1					1	1	11				12	13
Vertebrae	19	8	2		1	12	42				1		1	43
Vomer	1	1					2							2
Indeterminate	**2828**	**661**	**13**	**65**	**228**	**83**	**3878**	**168**	**288**				**456**	**4334**
Total	**17491**	**4390**	**94**	**340**	**988**	**591**	**23894**	**481**	**4317**	**5**	**3**	**4**	**4810**	**28704**
***Orestias* MNI**	154	59	2	8	11	11	191	29	59	1	0	1	89	321
***Trichomycterus* MNI**	7	6	1	9	1	6	19	3	10	1	1	0	10	25

with highest frequencies of fish remains (Table 8.34). The result suggests that bones of the gill arch and ribs were the most frequently identified elements (Figure 8.36). Gill bones, including operculum, cleithrum, interoperculum, and others were the most frequently identified. Ribs, vertebrae, and other bones including hyomandibular, basioccipital, and pharyngeal superior, are fairly well represented. In contrast small bones such as fin rays and elements of the oral cavity are quite under-represented. A similar pattern is suggested by the *Trichomycterus* remains for which the operculum, interoperculum, and vertebrae are the most frequently represented elements.

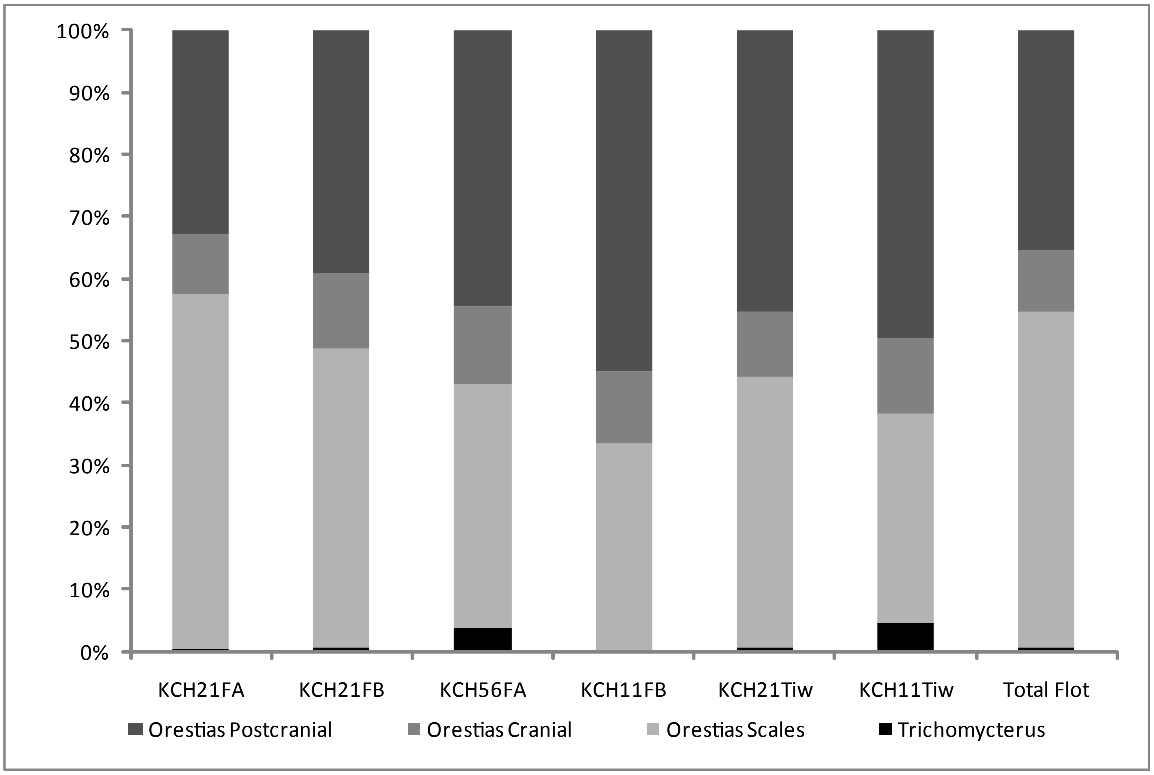


Figure 8.35. Representation of identified fish general portions by component.

Generally, these fishes are small (see below) and are often prepared and consumed whole, so we do not expect a strong bias towards economic utility, but volumetric density might be a factor that could bias the distribution of certain elements (Butler and Chatters 1994). The elements that constitute the gill arch include the largest and easily identifiable elements from an *Orestias* skeleton but not necessarily the densest or economically valuable. Even though more than double MNIs (154 vs. 59) were identified at KCH21FA, the standardized profiles of skeletal representation were strikingly similar suggesting these assemblages were similarly affected by taphonomic, recovery, and/or identification factors.

8.4.6.5. Burning and Other Modifications

As an additional assessment of taphonomic factors as well as to suggest some form of food preparation and disposal behavior, thermal alteration or burning was documented.

Table 8.34. Skeletal representation and percentage of survivorship of fish remains from

		KCH21FA			KCH21FB		
Element	***Orestias***	**NISP**	**MAU**	**MAU%**	**NISP**	**MAU**	**MAU%**
Premaxilla	2	12	6	3.9	1	0.5	0.8
Maxilla	2	40	20	13.0	15	7.5	12.7
Dentary	2	44	22	14.3	17	8.5	14.4
Articular	2	25	12.5	8.1	2	1	1.7
Quadrate	2	40	20	13.0	15	7.5	12.7
Ceratohyal	2	3	1.5	1.0	0	0	0.0
Hyomandibular	2	144	72	46.8	42	21	35.6
Cleithrum	2	217	108.5	70.5	118	59	100.0
Operculum	2	307	153.5	99.7	99	49.5	83.9
Interoperculum	2	87	43.5	28.2	33	16.5	28.0
Preoperculum	2	70	35	22.7	20	10	16.9
Suboperculum	2	58	29	18.8	14	7	11.9
Pharyngeal inferior	2	95	47.5	30.8	17	8.5	14.4
Pharyngeal superior	2	34	17	11.0	9	4.5	7.6
Frontal	2	127	63.5	41.2	36	18	30.5
Basioccipital	1	45	45	29.2	15	15	25.4
Parasphenoid	1	35	35	22.7	9	9	15.3
Urostyle	1	41	41	26.6	12	12	20.3
Ribs	26	2075	79.8	51.8	579	22.3	37.7
Vertebrae	30	2539	84.6	55.0	848	28.3	47.9
Rays	50	175	3.5	2.3	15	0.3	0.5
Total	**139**	**6213**	**MNI = 154**		**1916**	**MNI = 59**	

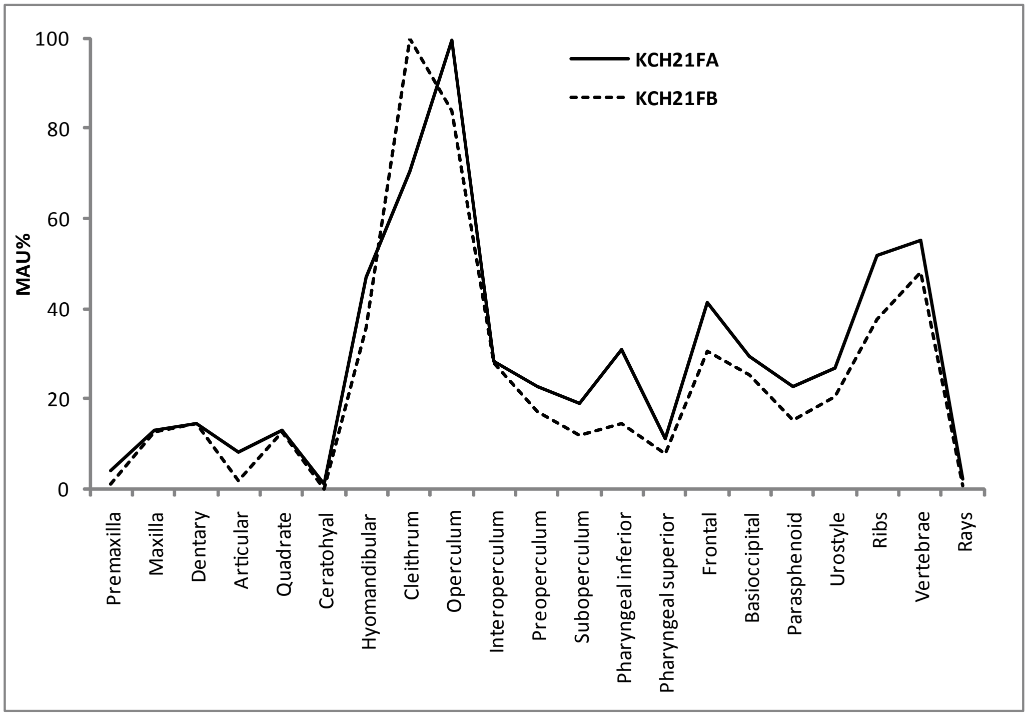


Figure 8.36. Skeletal element representation and percentage of survivorship of fish specimens recovered from flotation fractions of KCH21FA and KCH21FB (see Table 8.34).

Table 8.35. Frequencies of burned or thermally altered fish specimens by component.

Burning	KCH21FA	KCH21FB	KCH56FA	KCH11FB	KCH21Tiw	KCH11Tiw	Total
None	13027	3509	84	268	893	346	18127
Partially burned	2514	443	1	56	42	150	3206
Burned	1643	423	5	15	51	94	2231
Calcined	307	15	4	1	2	1	330
Total	**17491**	**4390**	**94**	**340**	**988**	**591**	**23894**

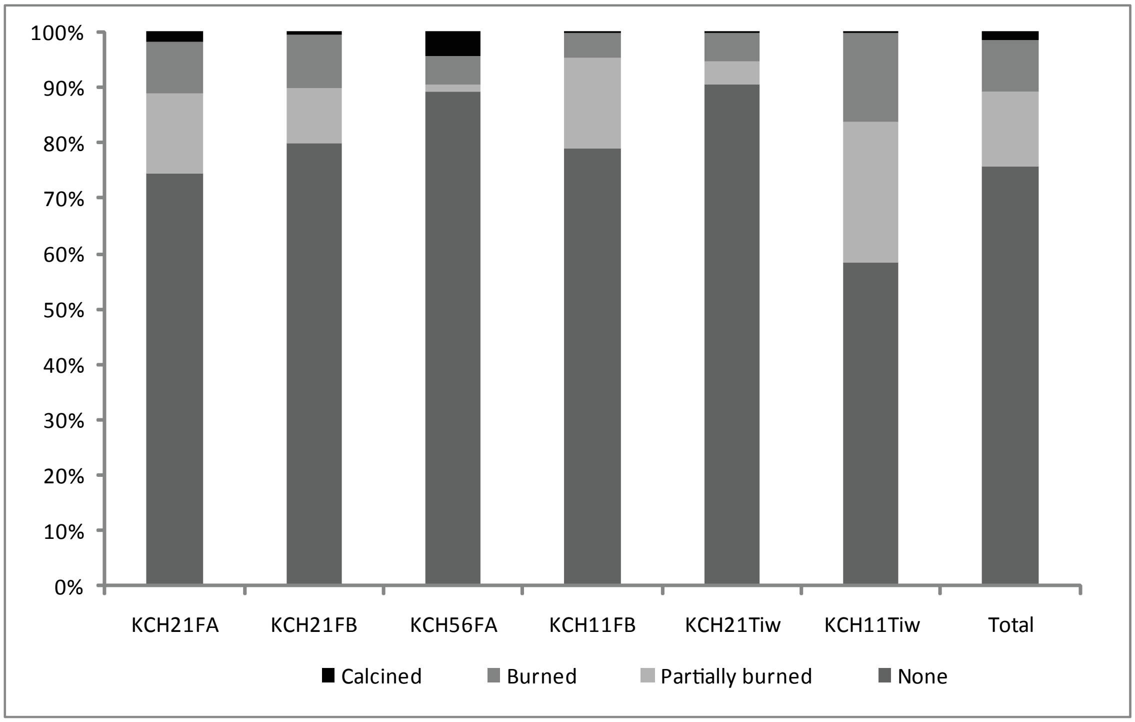


Figure 8.37. Relative frequency of burning on fish specimens by component.

Burning was recorded using a similar classification scheme as the one presented for camelid remains (see above). The result suggests that on average 76% of the specimens were not burned, close to 14% were partially burned, 9% were burned, and 1% were calcined (Table 8.35, Figure 8.37). These results are fairly consistent among components, but particularly high incidences of burned remains were identified at KCH11FB and KCH11Tiw. Given the widespread presence of burned fish remains, burning could have been a consequence of food processing and unintentional exposure to fire from hearths as well as from burning trash. The specially low frequency of calcined specimens further suggests that sources of high temperatures were not particularly common at the sites. It is also worth noting that fish bones requires higher temperatures than mammal bones to become calcined (see Moore et al. 2010).

Ethnographically, fishes are commonly cooked in pots and boiled in stews. Cooking fish in pots facilitates dissolving tissues and maximizes the extraction of fat and other nutrients. Given that occasional bent scales are present at the Iroco assemblages, this seems plausible. Another traditional way of cooking fish is in hearth ovens or *watias*. Cooking fishes this way can leave some form of charring, particularly in the scales and some portions of the cranial skeleton. Fishes can also be cooked deep-fried and grilled, but these are more common recent cooking practices, made possible thanks to the increased availability of cooking vegetable oil.

Few fish specimens had evidence of intentional modification such as cut marks or gnawing but excessive fragmentation was present in some contexts. Cuts, percussion, and other types of marks are difficult to record from tiny fragments and were extremely infrequent. Some scales had evidence of been boiled (as folded and bent upside down)

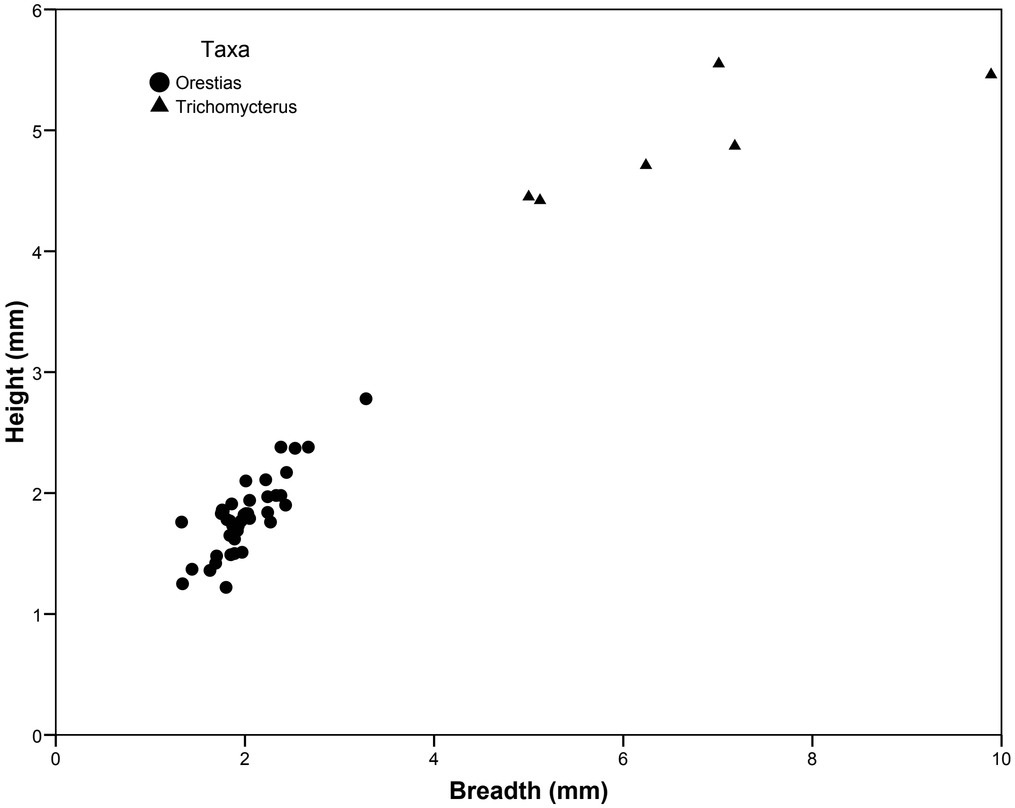


Figure 8.38. Measurements of bassioccipital condyle breadth and height for *Orestias* and *Trichomycterus* well preserved specimens.

and this can also be a consequence of quick dehydration after consumption. Several fish specimens had evidence of carbonate incrustations suggesting soil chemistry at the site affects preservation in some cases. Specific contexts included particularly high densities of fish remains, including the midden in the northern part of the KCH21 excavations as well as specific pits associated with the outside of Structure 11.

8.4.6.6. Osteometry

To further identify more specific represented fish species, measurements were taken from well preserved operculum and basioccipital bones. The basioccipital data shows the great deal of difference between *Orestias* and *Trichomycterus* specimens (Figure 8.38).

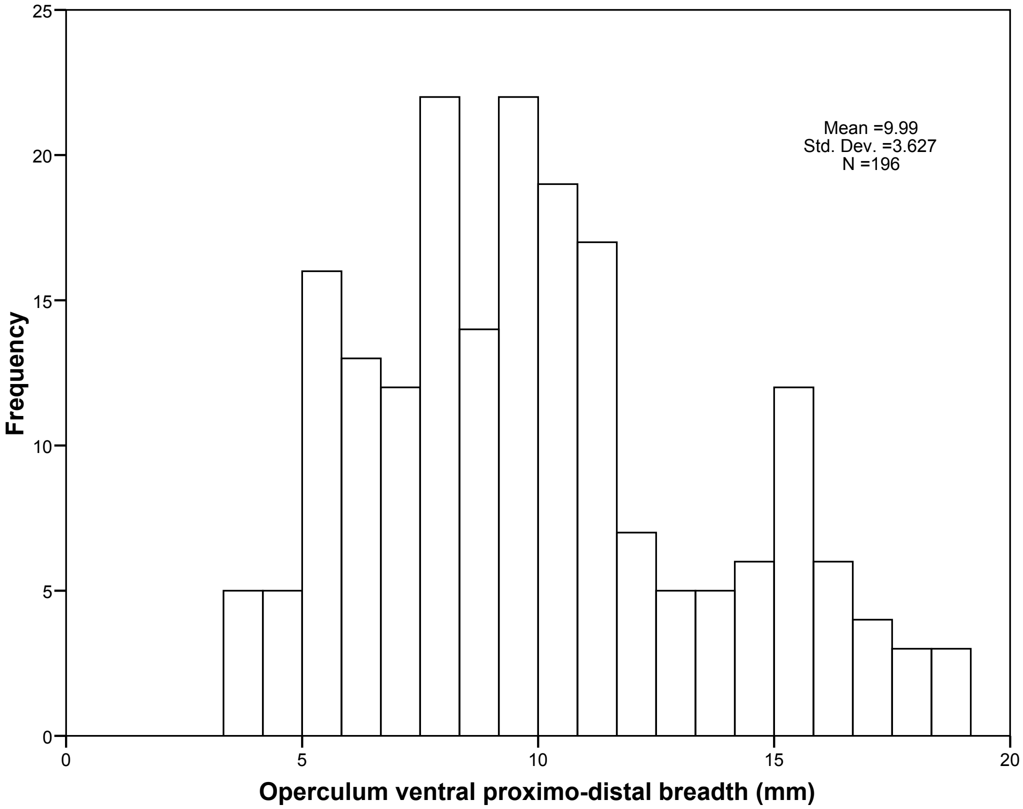


Figure 8.39. Frequency graph of measurements of Orestias operculum from all Iroco components.

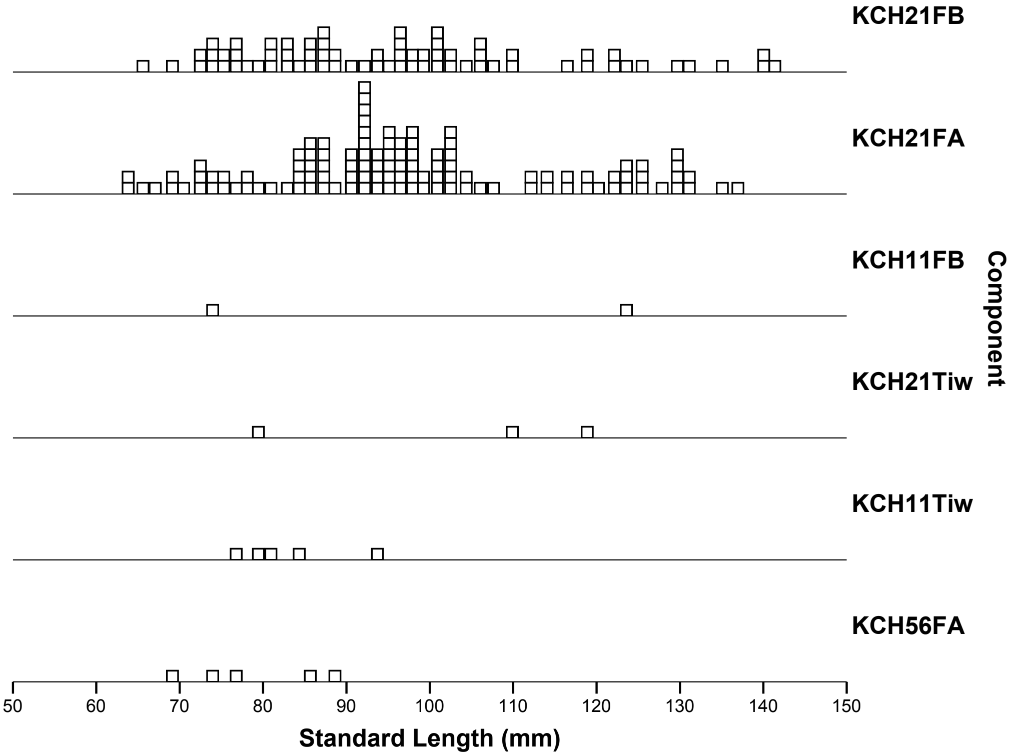


Figure 8.40. Derived standard lengths based on operculum measurements by component (see text).

It further suggests some of the represented catfishes were particularly large. A great deal of variability was associated with *Orestias* operculum bones. The range varied of the operculum greatest height was 3.45 to 19 mm with a mean of 9.99 mm (Figure 8.39). Smaller fish were probably consumed complete. The frequency diagram also suggests that two and perhaps more size classes were present.

Applying a linear regression based on modern reference specimens (Capriles 2003) to the operculum measurements, produced a range of live specimens between 63.72 and 141.34 mm (Figure 8.40). The observed range suggests that multiple age classes were present and that individuals substantially larger than the largest modern specimens were fished at Iroco. In fact the range is broader than the known modern range for *Orestias agassii*, currently the only species present in the combined basins of the Desaguadero River, Lake Uru-Uru, and Lake Poopó (Parenti 1984; Rocha Olivo 2002). This further suggests the likely possibility that extinct species were present at Lake Uru-Uru. Few specimens were enough preserved to be measured from Tiwanaku contexts, but the measured ones were associated with the smaller range of sizes. Most of the variability including the largest specimens are associated with KCH21FA and KCH21FB. Comparatively, the range is not as broad and does include specimens as large as the ones identified in archaeological sites from the Taraco Peninsula (Capriles 2003, 2006; Capriles et al. 2008).

The presence of *O. luteus* is suggested by the presence of rough scales (see Table 8.33) which are characteristic of this species and others that are part of the monophyletic *Orestias luteus* group (e.g., *Orestias albus*) (see Parenti 1984). Furthermore, *Orestias* scales were classified into three size classes. Scales larger than 5 mm are infrequent in most modern fishes and are usually present in the head of the largest fishes so the presence of scales larger than 10 mm is significant. Scales larger than 10 mm were only recorded from the two Formative components at KCH21. Most of these scales were of the rough type, suggesting particularly large individuals associated with the *O. luteus* group. This is the first study to document the presence of *Orestias luteus* and related species outside of Lake Titicaca and its immediate vicinity, suggesting: 1) *Orestias luteus* was distributed in Lake Uru-Uru, and 2) *Orestias luteus* (and possibly fish other taxa) became extinct sometime in the recent past, probably as a consequence of anthropogenic processes.

There are several implications of these results. Firstly, fish were probably first exploited during the Formative as no fish remains were recovered from KCH20 or any other known Archaic Period site from the south central Andes. For instance, Herhahn (2007) discusses a similar case in Lake Titicaca where fish remains are rare in Terminal Archaic and Early Formative contexts (see also Craig 2005; Stanish et al. 2002). Secondly, the local environment was probably richer than today and included several additional fish species. Taxonomic and biogeographic studies and long-term research has confirmed the presence of only two species in Lake Uru-Uru and Lake Poopó (Parenti 1984; Rocha

Olivo 2002; Sarmiento and Barrera 2003). Zooarchaeological data from Iroco however, suggests that additional species were present in the past and suggest the extinction of one and possibly more species in the Lake Uru-Uru occurred during the last two millennia. The possible connection between this extinction and anthropogenic impacts, not limited to fishing exploitation, is a question that prompts for further research (see Capriles et al. 2008).

8.4.7. Mollusks

Three types of mollusks were identified in Iroco (see above, Tables 8.2-8.3). The first type includes two specimens of bivalve (Class Bivalvia) shells originated on the Pacific Coast, and that were identified at KCH21FA. One specimen consisted of a semi-complete slightly polished shell of a probable scallop (Family Pectinidae) that might have been used as a spatula (Figure 8.41A, Locus 2402). The other specimen was a shell piece with

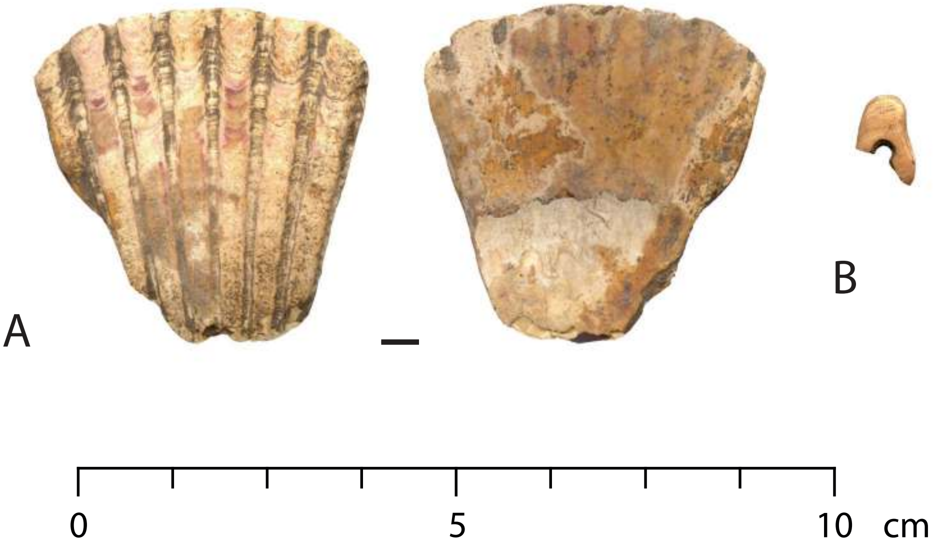


Figure 8.41. Bivalves from KCH21FA. A) scallop spatula from L. 2402, B) mussel pendant from L. 2406.

evidence of substantial modification of a saltwater mussel (Family Mytilidae) and was probably a bead ornament (Figure 8.41B, Locus 2406). Both pieces were found in similar cultural contexts and close proximity; the complete shell was discovered in the hearth of Structure 4 and the ornament from the mixed fill and hearth of Structure 8.

The specific bivalve specimens identified at Iroco were probably imported from sites in the Pacific Ocean coast of northern Chile. These items signal inter-regional exchange, but given their infrequency it does not allow to speculate on the nature of the broader exchange networks. Although these shells are rare in archaeological sites, they are occasionally present. For instance, Michel López (2008:Fig. 6.1) recovered a *Spondylus* shells from the Formative mound site of Casca Kollu near Pampa Aullagas in the southern shore of Lake Poopó. The bivalve specimens from Iroco did not come from the coast of Ecuador but were probably transported from the coast of modern northern Chile. Shells in the Andes have strong ritual connection with water and are often included in fertility ceremonies.

The second type of mollusks identified at Iroco includes medium sized (<5 cm long) gastropods recovered from screen fractions. Two shell specimens were identified from KCH21FA, 24 from KCH21FB, and two from KCH56FA. About 13 of the specimens recovered from KCH21FB actually fit together and probably represent post-depositional fragmentation of a gastropod shell ornament that included at least one cut mark. Gastropods are common at the study area and suggest a relatively humid aquatic environment. The archaeological specimens are probably land snails of the Family Orthalicidae.

The third type of mollusk identified at Iroco includes dozens of small and diverse gastropod shells recovered from flotation samples. These shells are smaller than 5 mm and are part of the local Quaternary lacustrine sedimentary environment of the altiplano (Rigsby et al. 2005). Because of their natural origin, these mollusks were not included in the faunal dataset. Nevertheless, these specimens were present in most flotation samples and have an important role to play in the interpretation of the stratigraphic, geomorphological, and paleoecological context of Iroco.

CHAPTER 9

DISCUSSION: UNDERSTANDING EARLY ANDEAN CAMELID PASTORALISM

The Iroco research project produced a wealth of data regarding Archaic, Formative, and Tiwanaku period settlement patterns, site configuration, and faunal remains. I will now discuss some of the implications of the archaeological data for reconstructing early camelid pastoralist economic organization and its change through time in the central altiplano. I will compare the reconstructed patterns with known aspects of the archaeology of the south central Andes, and due to the nature of the collected data, I will mostly focus on the Formative Period. I will also address the broader issue of the economic organization of early camelid pastoralism by evaluating the research hypotheses.

9.1. The Archaic Period Foraging System

An important result provided by this investigation is the first settlement pattern for the Archaic Period (10,000-3800 BP) of the central altiplano. These data provide a baseline for understanding ecological and economic variability associated with the human occupations predating the Formative Period in the central altiplano. The large number of open-air sites identified for this period (N=35) is unprecedented for the central altiplano and is a probable consequence of the location, regional taphonomy, and survey strategy.

Settlement density and composition is consistent with patterns identified by Aldenderfer and his students in some of the tributaries of Lake Titicaca such as the Ilave, Huenque, and Huancané-Putina rivers (Aldenderfer 2002, 2009; Cipolla 2005;

Craig 2005; Craig et al. 2010; Klink 2005). Spatial and zooarchaeological data support assertions that aquatic and inland resources were important for the earliest inhabitants of the central altiplano, who lived as hunter-gatherers. The distribution and composition of sites, in addition to the variability of the lithic materials they contain, suggests concentrated territorial use of areas adjacent to the shores of the Karakollu River and Lake Uru-Uru (Capriles et al. 2011). Documented settlements mostly consisted of logistical camps and lithic workshops that preserved high densities of lithic remains.

The aggregation, density, and multiple redundant re-occupations of similar locations through time, could have produced the patchy but dense distribution of Archaic Period sites documented in Iroco. This is strikingly similar to the character of other Preceramic sites in the altiplano and could be attributed to frequent logistical mobility and seasonal residential mobility (see Aldenderfer 2002; Habu and Fitzhugh 2002). Similarities in site composition and lithic technologies to other regions suggest that Iroco represents a previously identified but not well-understood pattern of highland Archaic Period occupations. For instance, the famous site of Viscachani, located near the Wankarani (i.e., Huancarani) type site, has received considerable attention for its density of lithic artifacts and possible great antiquity (Ibarra Grasso 1965; Lizarraga-Mehringer 2004; Patterson and Heizer 1965). Although the preceramic occupation at Viscachani is dense and large (approximately 10 hectares), it is mostly made up of surface deposits and has not produced substantial stratigraphic deposition (Ibarra Graso 1965; Lizarraga-Mehringer 2004). Researchers have speculated however, that the lithic technology identified in Viscachani was used over a substantial amount of time (Ibarra-Grasso 1965). Given the evidence from Iroco, it is possible to suggest that localities such as Viscachani were preferred locations for foraging wild resources and over time produced the observed dense palimpsest accumulations.

The extended time associated with the Archaic Period included phases during which the altiplano experienced fluctuating climatic conditions that could have incentivized or inhibited human occupation. The paleoclimatic sequence produced by Rigsby and colleagues (2005) suggests that the arid conditions between 7900 and 4500 BP could have limited the permanent presence of human populations (see Craig et al. 2010; Núñez et al. 2005; Placzek et al. 2006; Rigsby et al. 2003; Yacobaccio and Morales 2005). Consequently, the main Archaic Period occupations might correspond to periods before or after this arid phase. Interestingly enough, the only radiocarbon dated Archaic Period site in Iroco, KCH20, corresponds to the phase before the increased climatic aridity.

9.1.1. Foraging Subsistence in the Central Altiplano

Site KCH20, dated to 9289-8729 calibrated years BP, is one of the earliest sites recorded in the central altiplano. Data from this site provides a snapshot in time of the subsistence associated with the Early Archaic Period inhabitants. The site probably represents a base camp employed by highland hunters before any form of incipient pastoralism developed in the region (see Aldenderfer 2006, 2008, 2009; Mengoni-Goñalons 2008; Mengoni-Goñalons and Yacobaccio 2006; Wheeler 1984, 1995). The stratigraphy of KCH20 confirms the presence of an extremely arid event that followed the abandonment of the Early Archaic Period human occupation. This is characterized by a fining downward bedding stratigraphic sequence capped by a thick aeolian deposit. More importantly, the subsistence data from KCH20 provides a baseline for what a foraging group of this period in the central altiplano was consuming and discarding.

The faunal assemblage recovered from Unit 6 at KCH20 included approximately 225 identifiable bone specimens out of a total of 446 and were dominated by camelids, but also included wild guinea pigs and aquatic birds. Taxonomic richness (comprised by seven taxa), abundance and cultural modifications as well as the contextual association of dozens of lithic implements to the faunal remains, provide information on hunting and food consumption strategies. Considering the discrete stratigraphic deposition and composition of the faunal remains, it is likely that KCH20 was occupied seasonally. All the camelid bones identified at the site (MNI=4) were from young adults (about three and half years old). These animals were the size of modern Sierra guanacos (currently extinct in the central altiplano), the ancestor of the domesticated llama. Guanacos occasionally migrate from wetland areas during the dry season to higher pastures during the wet season. Therefore, this assemblage might correspond to a hunting episode that occurred in the vicinity of the site during the dry season, when guanacos would have been grazing near the shoreline of Lake Uru-Uru, and where KCH20 is located.

In addition to adult camelids, which could have been hunted near their grazing grounds, remains of abundant aquatic resources including ducks, coots and avocets, suggest a generalized procurement strategy oriented to maximizing the utilization of the wetland habitat. Furthermore, the remains of dozens of wild guinea pig bones with clear evidence of human consumption –such as burning, helicoidal fractures, and percussion impact marks– imply reliance on a broad range of resources. Taken as a whole faunal data support a model of a broad spectrum diet (see Lupo 2007). Given the density of Archaic Period sites and considering the impetus for risk management as a result of the unpredictability of the altiplano environmental conditions, this is certainly possible. However, an alternative hypothesis that requires further evaluation is that guinea pigs and perhaps some aquatic birds might have been collected by children who might have snared and collected these animals as complementary diet resources and, more importantly, as part of their cognitive skill development (e.g., Bird and Bliege Bird 2000). In this case the group as a whole might have specialized in the procurement of other specific resources, such as the wild guanaco.

Although only one of six excavation units included faunal remains, the frequency, preservation, and arrangement of these remains is important because it constitutes one of the earliest securely dated faunal assemblages from an Early Archaic Period open air site in the South Central Andes. The only comparable collections are either from the Peruvian central Andes (e.g., Moore 1989, 1998; Rick and Moore 1999, 2001; Wheeler 1984, 1995; Wing 1986) or from a few sites in the southern Peru such as Asana (Aldenderfer 1998). Early

Archaic Period sites with analyzed faunal remains from northern Chile include Hakenasa, Tulan 68 and Tambillo 1 (Cartajena et al. 2007; Moreno et al. 2009; Núñez et al. 2005; Santoro and Núñez 1987) and Pinstocayok 1 and Inca Cueva from northwest Argentina (Elkin and Rosenfeld 2001; Olivera 1997). Most of these sites suggest a progressive increase in the consumption of wild camelids through time in comparison to other wild fauna such as deer and rodents (Mengoni-Goñalons 2008). In their later occupation phases, several of these sites also show an increase in activities associated with animal handling such as mortality profiles showing increased presence of younger individuals and changes in size (Mengoni-Goñalons and Yacobaccio 2006; Yacobaccio 2004). Faunal data from KCH20 is consistent with an Early Archaic Period hunting base camp that predates later processes of camelid taming.

9.1.2. Transitioning into the Formative Period

Ponce Sanginés (1970) and later Bermann and Estévez Castillo (1995) argued that the Wankarani cultural complex was composed of villages identifiable in the archaeological record as large mounds. They suggested these began to spread throughout the central altiplano at the beginning of the Formative Period, an idea later supported by McAndrews (1998, 2005a), using regional survey data from La Joya in Oruro. However, because neither McAndrews (2005a) nor his predecessors identified any Archaic Period sites, the connection between the Archaic Period and later Formative Period sites until now, remained unclear. Although Fox (2007:72) did report the existence of a possible pre-Formative layer in his excavations at Chuquiña, the absence of systematic research regarding the Archaic Period of the central altiplano has been a major problem. Through a combination of survey, excavation, dating, and analysis the systematic research at Iroco is beginning to contribute to clarifying this issue as well as to respond Aldenderfer's (2009:81) fundamental question of "Where is the Bolivian Archaic?"

In the central altiplano, the transition to the Formative Period occurred about a millennium after the climatic amelioration that occurred around 4500 BP. As a result, this period probably reflected improved environmental conditions. Continuous use of lithic raw materials such as black basalt and dark chert as well as similar forms of projectiles points and other lithic tools suggest that the Late Archaic and Terminal Archaic Periods transitioned directly to the Formative Period with some level of cultural continuity (Capriles et al. 2011). Although no Early Formative Period occupations were dated or sampled during this study, the analysis of lithic remains and the settlement patterns suggests that population replacement is unlikely.

9.2. The Formative Period Pastoralist System

9.2.1. Inter-Site Settlement Patterns and Pastoralism

If we are to understand the Formative Period Wankarani cultural complex as a pastoralist society, the primary inter-site spatial expectation is that its settlement pattern should resemble a modern pastoralist settlement system. Ethnographically and ethnoarchaeologically documented modern pastoralist settlement systems in the Andes and elsewhere in the world are characterized by residential bases located near high-quality grazing areas and complemented by a complex set of temporal and seasonally occupied herding camps (e.g., Cribb 1991; Flores Ochoa 1979; Kuznar 1990, 1995; Tomka 1994, 2001). In contrast to this expectation, Formative Period Wankarani cultural complex sites have been previously described as stratigraphically complex mounds and interpreted as permanently occupied agricultural villages (Bermann and Estévez Castillo 1995; Fox 2007, 2010; McAndrews 1998, 2001, 2005a; Ponce Sanginés 1970; Rose 2001a, 2001b). In the following section I compare the results of the Iroco survey with that of the La Joya, Río Kochi and Belén survey carried out by Timothy McAndrews, which is currently the only other available regional survey carried out in central altiplano (McAndrews 1998, 2001, 2005a, 2005b). Based on the results of research in Iroco, I then explain why the Wankarani settlement pattern is better characterized as a pastoralist settlement system than one composed of agricultural villages.

The perimeter of the survey carried out by McAndrews (1998, 2005a) covers an area of 427 km^2 in which 18 Formative Period sites were identified, implying a density of 0.04 sites per square kilometer (Figure 9.1). The average size of these sites is 1.12 hectares (SD=0.53), with a height of 2.72 meters (SD=1.9), and an average distance to the nearest neighbor of 3.5 km (SD=1.4).

The Formative Period settlement pattern at Iroco includes 45 settlements –over double the number of sites in a tenth of the survey area– with a density of 1.17 sites per square kilometer, average site size of 0.32 hectares (SD=0.48), and a distance to the nearest neighbor of only 0.21 km (SD=0.21). Moreover, the size and distribution of sites demonstrates the presence of large residential sites as well as smaller camps.

If the smallest sites recorded in Iroco (<0.5 ha) are excluded in the comparison, several differences between the two datasets persist, but some similarities are noted (Table 9.1). A set of t-tests indicates significant differences in elevation, distance to river, and distance to nearest neighbor, but not in settlement area (Table 9.2). The elevation and distance to the nearest river varies considerably among sites recorded at the two areas but this is probably a consequence of local differences related to the much larger area sampled by McAndrews (1998, 2005a). The distribution and spacing between sites is substantially greater in La Joya than in Iroco. Unlike the dispersion observed within the Iroco settlement pattern (see Chapter 6), the Formative sites in La Joya –independently of the actual distance between them– show an evenly spread distribution (Observed Mean Distance=3518.37 m, Expected Mean Distance=4092.2 m, Nearest Neighbor Ratio=0.85, Z Score=-1.13, *P*=0.255). Moreover, although several sites in Iroco have the shape of mounds, the sites in La Joya are on average a meter and a half taller than sites in Iroco.

Table 9.1. Formative Period settlements reported from the surveys at Iroco and La Joya. Data from La Joya as reported by McAndrews (1998, 2005b) except for nearest neighbor distance which was calculated using ArcGIS 9.3.1.

Survey	Site	Northing	Easting	Elevation	Area (m2)	Area (ha)	Height (m)	Distance to River (km)	Nearest Neighbor (m)
Iroco	KCH56	8016384	695598	3706	25419	2.54	2.5	1.99	454.08
Iroco	KCH54	8016823	695714	3687	17794	1.78	0.5	2.13	170.78
Iroco	KCH20	8013916	695373	3690	10123	1.01	0.5	1.57	631.04
Iroco	KCH11	8011764	694223	3692	8531	0.85	2.5	0.61	1833.74
Iroco	KCH35	8012913	695652	3712	7190	0.72	1.5	1.93	419.59
Iroco	KCH131	8016534	697089	3695	6298	0.63	0.5	3.48	1252.21
Iroco	KCH59	8015673	695595	3715	6085	0.61	1	1.93	711.15
Iroco	KCH121	8016862	695880	3706	5887	0.59	0.5	2.28	170.78
Iroco	KCH21	8013293	695474	3704	5519	0.55	1	1.79	419.59
Iroco	KCH157	8007690	694714	3697	5433	0.54	2	0.63	4103.70
La Joya	LJ-B	8031830	663941	3710	16000	1.6	5	1.6	1691.67
La Joya	LJ-C	8033484	663586	3725	2500	0.25	3	0.6	1691.67
La Joya	LJ-D	8035675	663140	3710	7129	0.71	3	0.6	2235.93
La Joya	LJ-G	8035435	658945	3720	7918	0.79	2.5	2.5	2010.44
La Joya	LJ-H	8035534	656937	3730	8033	0.80	3	4.6	2010.44
La Joya	LJ-I	8040773	654137	3720	5837	0.58	2	5	5940.30
La Joya	LJ-36	8033031	661135	3740	7426	0.74	3	2.2	2492.51
La Joya	RK-1	8029776	614651	3860	14300	1.43	0	0.7	3963.79
La Joya	RK-17	8029504	621381	3760	8899	0.89	2.5	0.9	5030.34
La Joya	RK-19	8024609	620222	3785	11616	1.16	0	4.1	5030.34
La Joya	RK-26	8027514	611396	3920	21430	2.14	0	0.4	3963.79
La Joya	B-1	8030384	668502	3740	19371	1.94	5	1.5	4700.08
La Joya	B-2	8030700	675100	3740	17671	1.77	5.5	8.4	3465.25
La Joya	B-3	8031634	678437	3740	12306	1.23	3	11.8	2753.28
La Joya	B-4	8028099	682020	3755	7409	0.74	0	16	3127.93
La Joya	B-5	8022997	679326	3720	5134	0.51	2.5	10	5769.58
La Joya	B-6	8026584	671268	3740	13191	1.32	6	2.4	4700.08
La Joya	B-7	8031100	681138	3760	14606	1.46	3	14.4	2753.28
Iroco	**N=10**	**Mean**		**3700**	**9828**	**0.98**	**1.25**	**1.83**	**1016.67**
La Joya	**N=18**	**Mean**		**3754**	**11154**	**1.12**	**2.72**	**4.87**	**3518.37**

Table 9.2. Results of comparing the settlement patterns data of La Joya and Iroco using Student's T-Test with significant differences flagged.

Variable	Iroco N=10	La Joya N=18	t	*P*
Elevation (m)	3700.4	3754.17	**-4.11**	**<0.001**
Area (ha)	0.98	1.11	-0.54	0.59
Height (m)	1.25	2.72	**-2.87**	**<0.01**
Distance to River (km)	1.83	4.87	**-2.5**	**<0.05**
Distance to Nearest Neighbor (m)	1016.67	3518.37	**-4.96**	**<0.001**

The most significant similarity between the two areas is the size of the sites themselves. However, this equivalence disappears if all the smaller sites (<0.5 ha) recorded in the Iroco survey are included in the comparison. Given the available information, it seems that methodological differences between the studies accentuated the observed variation. Notable differences between the two studies include the absence of sites smaller than 0.5 hectares in La Joya and the closely spaced distribution of sites in Iroco. I attribute these differences to differential survey intensity, mostly consisting of closer spacing between surveyors and detailed mapping of artifact distributions during survey, providing an increasingly detailed settlement dataset for the Iroco study area. The survey intensity employed in Iroco permitted the identification of both large residential sites and smaller camps. In addition, observations from the Iroco survey suggest that some of the large residential sites were not particularly tall mounds and that some of the camps included especially dense material accumulations. Furthermore, these results imply that several Formative Period sites in La Joya, Río Kochi, and Belén might have been missed during survey.

McAndrews (2001) hypothesized that Wankarani "villages" fissioned before reaching the carrying capacity of their individual catchment areas and that consequently settlement densities were related to social stress as opposed to ecological productivity. The catchment areas estimated by McAndrews were, however, derived from archaeological agricultural settlement systems from the Mantaro valley in Peru and the Mexico central valley (i.e., Hastorf 1993; Sanders et al. 1979), and not on more appropriate ecological requirements of altiplano herding communities.

Furthermore, Fox (2007, 2010) has explicitly tested McAndrews's (2001) hypothesis in La Joya and did not find evidence to suggest that the hypothesized mother (and larger) village of Chuquiña was older than the hypothesized daughter (and smaller) village of Pusno. He explained this discrepancy and the fact that the Wankarani villages do not seem to grow through time by proposing a peer-community system in which pastoralism constrained population growth. Fox (2010) suggested that increased reliance on pastoralism

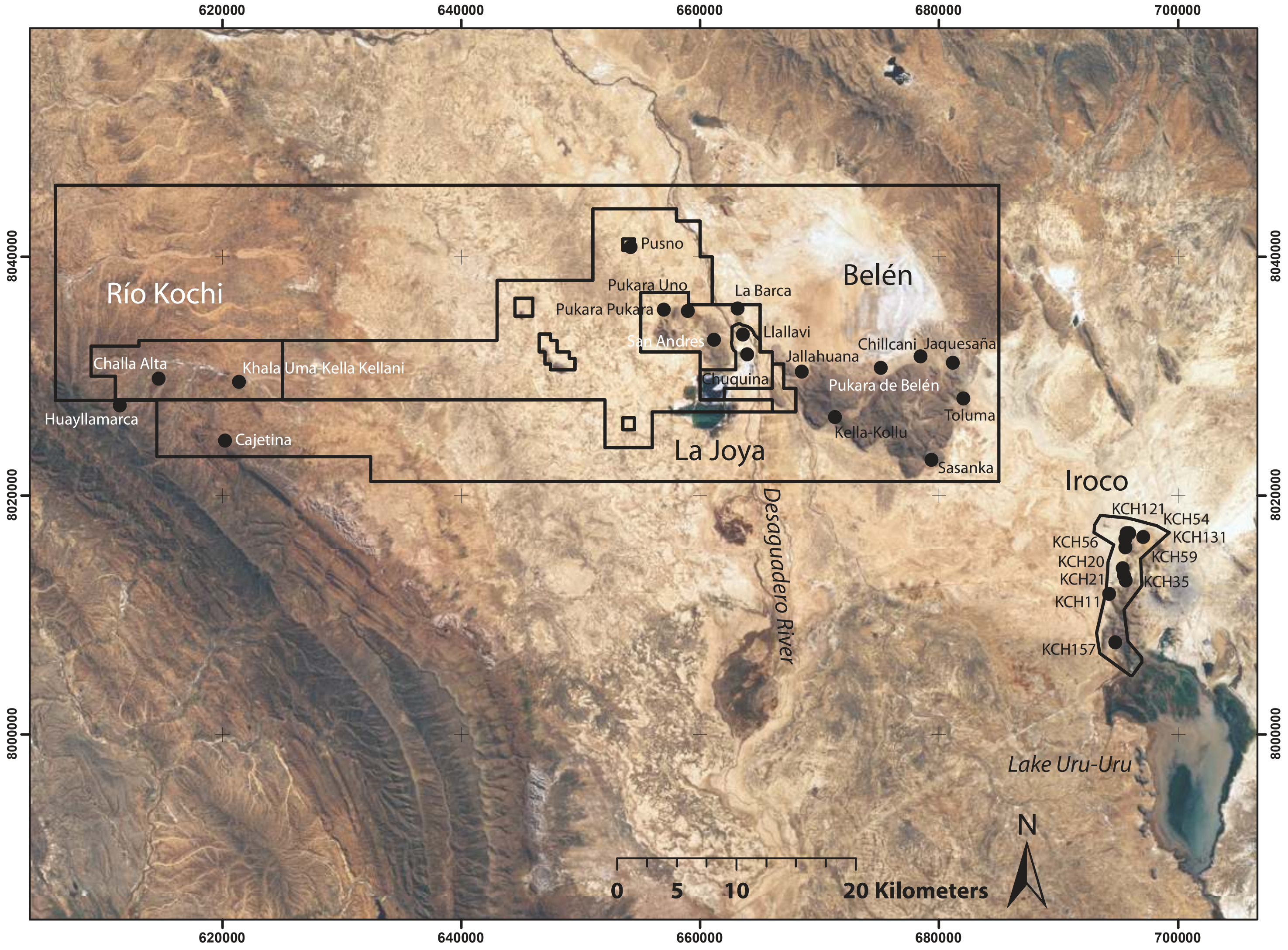


Figure 9.1. McAndrews (1998, 2005a, 2005b) Río Kochi, La Joya, and Belén survey areas including all Formative Period settlements. Iroco area and all large Formative Period settlements.

would have implied greater mobility (or what he calls transhumance) and larger catchment areas would have been required for herds. Greater mobility he argues, would have also inhibited aspects associated with village life, such as reduced birth spacing and increased demands for agricultural labor (Fox 2010:203). Although these propositions are plausible and testable, they rely on the settlement pattern identified by McAndrews (1998, 2005a), which the Iroco results suggest is an artifact of survey intensity.

The Iroco survey provides some interesting insights into the Wankarani cultural complex settlement system. Based on the Iroco data it is unlikely that the Wankarani cultural complex settlement system corresponded to a dispersed village system. The settlement pattern from this region suggests that the settlement patterns of the central altiplano during the Formative Period were characterized by the presence of dispersed residential bases attached to temporarily and seasonally occupied herding camps. Most of the previously identified Wankarani "villages", I argue, were in fact residential bases, which due to their specific location tended to be reoccupied more frequently than other sites (see Bernbeck 2008). Permanently occupied villages were probably few, if not completely absent in the Wankarani settlement system. That the majority of sites were smaller than two hectares further supports the inference that villages were uncommon. Furthermore, ethnoarchaeological research suggests recent pastoralist residential bases tend to vary in location through time, and although occupation redundancy throughout time is extremely common, new residential bases and camps are constantly established (Delfino 2001; Tomka 1994, 2001). Archaeologically, the Iroco data suggest that some of the factors that could have favored occupation redundancy included access to good pastures, benefiting from existing infrastructure, and herd territoriality (see Tomka 1992). The repetition of this process for several generations would have resulted in formation of deep, stratified, and relatively dispersed mounds, along with remains of residential and logistical camps scattered throughout the landscape.

Although the Wankarani settlement pattern was previously characterized as stable and conservative, in the light of these new theoretical and methodological perspectives it seems likely to have been more dynamic. Previous understanding of the Wankarani settlement system has been strongly biased in favor of large sites and against smaller residential bases and herding camps as well as ceremonial and raw material extraction settlements (see Kuznar 1995; Nilsen 2000; Tripcevich 2007). Moreover, these biases were produced by an absence of knowledge regarding herding settlement patterns, which is tied to theoretical paradigms that privileged outside readings of Andean prehistory over a better understanding of present indigenous Andean communities. The failure to identify herding sites (in addition to preexisting Archaic Period settlements) has had the unfortunate consequence of masking the variability associated with the evolution of pastoralist landscapes in the central altiplano. It also highlights the need for more research including full-coverage intensive surveys and as well as horizontal excavations and dating of the identified sites.

9.2.2. Intra-Site Settlement Configuration and Economic Organization

The intra-site settlement data from the Iroco area is unique. Opening large horizontal areas, particularly at KCH21, allowed us to expose well preserved architecture and to document contextual associations for reconstructing the spatial configuration of Formative Period residential bases. Modern pastoralist residential bases are characterized by the presence of diverse structures and features related to domestic, storage, and animal penning activities (e.g., Delfino 2001; Kuznar 1990, 1995; Nielsen 2000; Tomka 1994, 2001; Yacobaccio and Madero 2001). The layouts of the excavated sites in Iroco preserved groups of constructed features that were the locus of analogous activities. Based on ethnoarchaeological expectations of structure size and function, the identified features can be classified into three broad categories: corrals, domestic structures, and miscellaneous features (cf. Rose 2001a).

9.2.2.1. Corrals

In the Andes, modern pastoralist residential bases often include corrals attached to sleeping and domestic structures (Kuznar 1995; Tomka 2001). Although corrals vary in size, shape, and construction materials, circular corrals made with a combination of boulders and wooden poles are extremely common in the altiplano landscape. During the excavations at KCH21 the remains of at least one architectural feature, Structure 1, were identified as comprising the attributes of a modern herding corral. Structure 1 measures about 11 meters in diameter and covers about 81 m^2. The structure is delimited by large boulders of calcite, several of which had circular perforations that might have served for attaching poles. We assume that organic materials were used to raise the walls. The interior fill of the structure is mostly clean of artifacts, but a few bones, ceramics, and lithics were recovered from its interior. The floor of the structure was only exposed in three sectors but appears to have been kept clean. The floor is composed of organically compacted silty clay that could have been produced by the degradation of camelid dung. Phytoliths were abundant in samples from this context. Macrobotanical remains were rare but given the absence of open fires within this structure, this was not unexpected.

Structures of similar size, construction material and layout have been identified in Formative Period sites in the neighboring La Joya area. Rose (2001a, 2001b) exposed at least three of these structures in her excavations at La Barca, and Fox (2007) documented a few partial circular walls of structures larger than 5 meters in diameter in his deep excavation trenches at Pusno and Chuquiña. In addition, Beaule (2002) documented the foundations of several large circular structures in her site plan of the Tiwanaku Period site of Jachakala.

Rose (2001a:97-99) compared the three large features she found in La Barca with Kuznar's (1990) ethnoarchaeological data, but rejected the possibility that these were corrals. According to Rose (2001a:98), the La Barca features were too small (less than 68 m^2), did not include distinctive floors of compacted clay of blocky structure, were relatively clean of faunal remains, and were sometimes associated with human burials. The area outside these structures included dense middens that contained high densities of artifacts such as ceramic tubes and figurines, which led Rose (2001a) to believe that the structures were used for ritual purposes.

Nevertheless, the hypothesis that such structures were corrals, based on relational analogies from ethnoarchaeological studies of contemporary Andean pastoralist habitation sites, can be tested with archaeological data from Iroco. The size, shape, and construction materials fit with modern examples of corrals. The use of large boulders as foundations and even the attachment of poles to enlarge the structure are common throughout the Andes. The clean interior is also common because having artifacts around could harm herding animals, especially juveniles. Furthermore, these structures were probably kept clean by recurrent collection of dung for fuel and fertilizer. The fact that the structure floors of the corrals at KCH21 and La Barca were not composed of hard compact clay with blocky structure (as suggested by Kuznar 1990, 1995) is a consequence of site formation processes characteristic of the study area including the combined action of biological activity, precipitation, and weathering. The presence of high phytolith density supports the ethnoarchaeologically based hypothesis that the circular feature at KCH21 was a corral. It seems apparent that the large enclosures present in altiplano Formative Period settlements including KCH21 and La Barca were corrals (Kuznar 1990, 1995; Nielsen 2000, 2001; Tomka 1994, 2001).

All of this is not to say that ceremonial activities did not take place in corrals, in fact ethnohistoric and ethnographic information suggests they are primary loci for ritual activities (Bonavia 2008; Browman 1974; Flannery et al. 1989; Flores-Ochoa 1979; Kuznar 1995; Medinacelli 2003; Nielsen 2000; Tomka 1994). For instance, corrals and patios are the places where llamas and alpacas are decorated with ear tassels and often sacrificed. Corrals are also the locations where animals are grouped before any ceremony (Tripcevich

2008). The specific ceremonial meaning of corrals is important in Andean culture. Two words in Aymara describe corral, *uyu* and *cachi* (Medinacelli 2003:22). The word *cachi* also associates the meaning of corral with enclosure and cemetery. Although I am not aware of any modern ethnographic case study in which humans were buried in/or around corrals, interestingly enough, this relationship was documented both at KCH21 and La Barca (Albarracin-Jordan 2005; Rose 2001a).

However, the central role of corrals is fundamentally economic. Corrals are used for protecting herding animals from predators during nights and as bases for sleeping. Camelids are territorial and having specific sleeping grounds is one of their behavioral traits (see Franklin 1983; Tomka 1992). In addition, corrals are used as locations for accumulating dung (used both for fuel and fertilizer). Medinacelli (2003:21), based on ethnohistoric information, also points out that corrals were used for grouping and separating herds. Animals were often classified into groups according to sex, age, color, and fiber quality. Sorting animals by these or any other visible trait is one of the most common forms of artificial selection. Corrals are also used for curing and separating sick animals (Medinacelli 2003). At a landscape level, corrals are often used as territorial markers for separating herds and even communities. Corrals in this sense are a fundamental instrument in the process of herding animal management, and their presence in Formative Period sites provides strong support for economic reliance on camelid pastoralism.

9.2.2.2. Domestic Structures

Ten structures documented at KCH21 in addition to one at KCH56 and one at KCH11, provide evidence of residential domestic functions such as sleeping, food preparation, artifact maintenance, and storage. The structures identified as domestic in Iroco are similar to those reported in other Formative Period Wankarani cultural complex sites and interpreted by their respective excavators as domestic (e.g., Bermann and Estévez

Castillo 1995; Condarco et al. 2002; Fox 2007; Rose 2001a, 2001b; Ponce Sanginés 1970; Walter 1966, 1994; Wasson 1967). The remains of these buildings also share attributes such as size, shape, and construction materials with the traditional and ethnographically documented Uru-Chipaya and Aymara houses of the central altiplano (Albarracin-Jordan 2005; Gisbert 1988; Métraux 1935; Wachtel 2001; Zerda Ghetti 1993).

The archaeological structures are circular to semi-circular and vary between 2.4 and 5 meters in diameter. Most structures included prepared floor surfaces of compacted clay. There is significant variability associated with these structures. For instance, only four circular structures at KCH21 and one at KCH56 had evidence of hearths in their interior. The walls of the foundations also varied from pure adobes and adobes with stones to others made entirely with stones. The Upper Level at KCH21 (KCH21FB) included two well preserved structures with stone foundations that suggest considerable labor investment. The aspect (i.e., orientation of the entrance) of these structures varied substantially too, but, all the structures associated with the Upper Level (including the probable corral) were oriented towards the east.

At KCH21 there seems to be an association between shape, contents, and function. For instance, the structures associated with hearths from the Lower Level (KCH21FB), had more circular shapes than those that did not. Furthermore, the structures that did not have hearths, had on average more pit features, and comparatively more irregular base plans. A possible interpretation for this pattern is that circular structures with hearths were used as typical domestic residences whereas the other structures were reserved mostly for storage.

Another interesting attribute shared by several of the domestic structures is that they often show evidence of reoccupation and have thin stratigraphy on top of floors. For instance, at least four different occupation and reoccupation phases were identified at KCH56. At KCH21FA, most structures have a thick and often laminated fill on top of the structure floors. These could be a consequence of post-abandonment dumping of successive layers of trash. They could also be related to reoccupation events (see Schiffer et al. 1987).

Although people seem to have reoccupied the same building over and over again in a number of cases, evidence from KCH21 suggests that multiple structures were abandoned and constructed on a regular basis. In summary, evidence from KCH21, KCH56, and KCH11 suggests that domestic structures were occupied for domestic purposes. These structures probably articulated broader residential space. The presence of multiple structures with multiple purposes is also apparent. In this sense, the Formative Period settlements were not occupied by various individual households, but possibly by single families that used several structures for different purposes. Moreover, the construction, abandonment, and reconstruction dynamics associated with these structures suggests short term cycles of temporal (and probably seasonal) residential mobility.

9.2.2.3. Miscellaneous Features

Storage structures, artifact caches, and disposal pits and middens, have all been reported and described in pastoralist ethnoarchaeological studies. Trash heaps that eventually build up into middens and trash pits of different sizes and shapes are common features not exclusively found in modern herding residential bases (Schiffer 1987). For instance, agricultural villages include disposal features, and intensity of occupation often determines their size and contents (Goodman-Elgar 2008). Modern examples of storage structures in herding settlements are characterized by a great deal of variability and include buildings that can be as large as residential structures (Kuznar 1995; Nielsen 2000; Tomka 1994). Moreover, ethnoarchaeological data suggest that abandoned residential structures are often reutilized for storage purposes.

In addition to residential structures, the Iroco sites included a number of other features including interior and exterior pits, hearths, walls, and open patio areas. The pits were probably produced by a number of agents and processes as they show a great deal of variability in sizes, shapes, and contents (see Chapter 7). However, the most important processes related to pit production were probably storage and trash disposal. Pits used for storage include caches of tools including large ceramic storage jars with round bases, lithic hoes, ground stones, and even bone tools (see also Bermann and Estévez Castillo 1995:395). As part of the settlement use and in connection with abandonment processes, several of these pits were transformed into disposal features. Several pits were also probably explicitly made for trash deposition. Some of these features include high densities of plant macrobotanical remains, high densities of camelid bones, and/or thousands of fish bones and scales.

Interestingly enough, in contrast with other Formative Period settlements, large storage features were uncommon in Iroco. However, some of the domestic structures documented at KCH21 that lacked hearths but included multiple pit features could potentially be interpreted as storage facilities (see above). The complex layout of KCH21 also included other features such as isolated walls, often attached to other structures. These walls could have served as divisions within the settlement, connecting structures, and forming small patios or open air rooms used in specific activities. Walls connecting structures have been documented in Uru-Chipaya settlements and are used to prevent animals from disturbing open air activities such as weaving (Albarracin-Jordan 2005; Métraux 1935; Wachtel 2001).

9.2.2.4. Configuration of Residential Bases

Comparing settlement layouts from Iroco with those from other Formative Period sites and testing hypotheses based on relational analogies from ethnoachaeological studies contextualizes the results of the investigation and the domestic economy of the ancient inhabitants of the central altiplano. The complex stratigraphy and layout of Formative Period Wankarani settlements has been previously acknowledged, but few investigators have connected overlapping occupation layers with variation in occupation intensity. Data of this type provides insights into intermittent developmental cycles of residential utilization.

Instead, there has been a tendency to interpret sites as stratified single occupations. At KCH21 three main occupation phases were documented stratigraphically, but considering their complex layout and subtle stratigraphic variations, it is entirely possible that the site was occupied intermittently and that the excavated layout reflects multiple phases of occupation and reoccupation. Radiocarbon dating, stratigraphy, and faunal analysis further suggest that seasonal mobility could have contributed to the observed patterns.

The stratigraphy and feature layout documented at KCH11 and KCH56 also suggest complex sequences of occupations and reoccupations. The interior floor of the structure documented at KCH56 is characterized by several layers of deposition and there are several pits and hearths that indicate the structure was constantly remodeled. It is likely that the complexity of Formative Period residential bases such as KCH21 as well as other Formative Period sites were the consequence of several overlapping residential bases with different developmental trajectories. The presence of a large circular corral structure as part of the settlement is also typical of herding residential bases (Kuznar 1995; Tomka 2001).

Although several of the previously studied Wankarani sites have been radiocarbon dated between 1300 and 400 BC (Fox 2010; Ponce Sanginés 1970), the sites studied at Iroco are somewhat later, dating to the Late Formative Period, roughly between 200 BC and AD 200. This could potentially limit generalizations about Wankarani social organization. However, the fact that the site layouts and contents of the Iroco settlements are similar to older Formative Period sites verifies the long-term trajectory of stability that is a landmark of the Wankarani cultural complex (Fox 2010). Furthermore, a cursory review of the archaeological research carried out in other Wankarani sites suggests discrepancies between excavated and dated levels with a bias in favor of dating lower strata.

In summary, excavations at Iroco documented site layouts that resemble typical pastoralist residential bases (Figure 9.2). Inter-site variability in settlement patterns consisted of residential bases complemented by temporarily occupied camps and excavations from residential bases included extremely good preservation of intra-site functional diversity

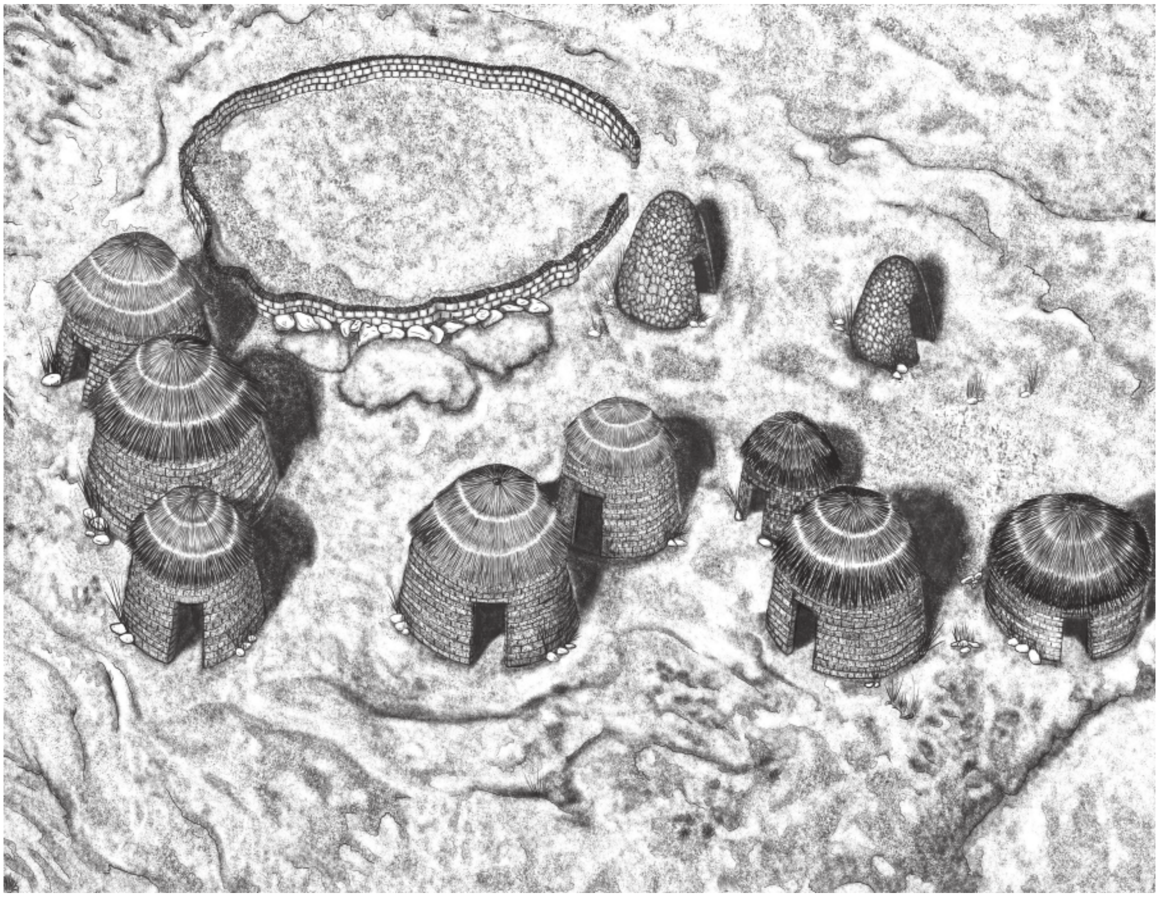


Figure 9.2. Artistic reconstruction of site KCH21. Drawing by Alexandra Ramírez.

manifested in domestic contexts as well as animal handling and storage activities. The layouts of residential bases included round structures typical of Formative Period settlements in the central altiplano. Furthermore, cyclical reoccupation of residential bases (including the domestic structures they contain) suggests recurrent abandonment and high residential mobility possibly connected to pastoralist seasonal mobility. Finally, the presence of domestic structures, animal handling facilities, storage features, and plenty of activity and discard behavior suggest Formative Period Wankarani cultural complex settlements were structured analogously to ethnoarchaeologically documented pastoralist residential bases.

9.2.3. Fauna

The domestic occupations excavated at Iroco, and particularly those excavated at KCH21 are unique and constitute some of the best documented Formative Period contexts from the south central Andes. In these sites, not only was the architecture well preserved but so were artifacts and ecofacts including faunal and plant remains. Limited faunal analysis has been reported from Wankarani cultural complex sites including those of San Andrés, La Barca, Chuquiña, and Pusno, in addition to the Tiwanaku Period settlement of Jachakala (Beaule 2002; Bermann and Estévez Castillo 1995; Fox 2007; Rose 2001a). However, because of the way the data were recovered, analyzed and reported, this information can only be used nominally. Interestingly enough, large mammals (i.e., camelids) were ubiquitous in these sites, but so were birds, fish, and other wild taxa. A significant result of this dissertation is the detailed analysis of over 40,000 faunal specimens. As a result, the Iroco faunal assemblages make up the largest collection of faunal remains ever analyzed from the central altiplano and constitute empirical baseline evidence for assessing the economic organization of early societies occupying this region. These results also support the hypothesis that the central altiplano Formative Period Wankarani cultural complex relied on domesticated camelids and a range of wild resources.

9.2.3.1. Camelid Herding

The detailed faunal analysis carried out at the Iroco sites produced a robust dataset for assessing the subsistence of the early inhabitants of the central altiplano. Camelids were the most important faunal resource consumed in Formative Period sites. Camelid remains are ubiquitous, constitute between 40 and 96 percent of the faunal remains, and are characterized by multiple signatures of human management, consumption and discard.

The implications of the intra-specific determination of camelid remains are significant because the majority of the camelid remains were identified as domesticated animals and particularly, llamas. Although incisor specimens of the llama/guanaco type cannot be sorted into domesticated and wild specimens and osteometric distinction is not completely conclusive, llama size individuals predominate in the Iroco faunal assemblages. In fact, the variability within the larger size of individuals could be interpreted as either a consequence of the presence of both domesticated llamas and wild guanacos or as a result of population heterogeneity within domesticated forms. Alpacas are for the most part, absent in the studied faunal assemblages. The absence of alpacas is likely because the ecology of the area does not allow the development of green pastures such as soft *bofedal* vegetation, which are the favored habitat of alpacas (see also Yager 2009). However, wild camelids including vicuña were definitely present, which suggests that hunting was also a component of the economic subsistence.

Diachronically, osteometry seems to suggest llama-size animals were already present during the Early Archaic. Given the age of these specimens, it is certain these animals were wild hunted guanacos and not incipiently herded llamas, suggesting Archaic Period groups relied on specialized camelid hunting for their subsistence. The absence of smaller vicuña-sized individuals is probably a consequence of the small sample size associated with this assemblage, but it could also be tied to a behavioral preference or specialization for hunting larger guanaco-sized animals as well as differences in large mammal resource availability and habitat distribution prior to camelid domestication.

The Formative Period preserves the largest sample of specimens and therefore, the general observations made about intra-specific variability are mostly applicable to this period. Larger forms of camelids were predominant, most probably representing llamas but smaller animals, predominantly represented by vicuñas, were also present. Meadow's Log Size Index suggests these larger forms were very close to the modern llama average, yet slightly smaller. These data suggest llama herding was consolidated as the main subsistence activity, but also that hunting wild resources continued. Moreover, it is possible that during the late part of the Formative Period, people experimented and developed breeds for meat, wool, transport, and others uses. Even though occasional hunting of guanaco and vicuña persisted, the data suggest these practices probably became opportunistic and complementary to an increasingly specialized pastoralist mode of life.

During Tiwanaku times in Iroco, the trend outlined above seems to continue. In all three assemblages that correspond to this time period, no small-sized camelids were represented by first phalanges and only one vicuña incisor was identified. MLSI suggests size variability decreased because the range of specimens is considerably smaller and the mean is grouped around the llama average. Although the largest first phalange is associated with KCH21Tiw (and probably belonged to a caravan animal), there is slight trend of reduction in the size of camelids. By Tiwanaku times, specialization of herding llamas was consolidated in Iroco and was probably integrated into the larger political economy of the south central Andes.

To summarize, intra-specific determination suggests that most of the specimens represented in the assemblage correspond to llamas, vicuñas were ubiquitous, and wild guanaco were occasionally present. Data on slaughtering patterns, cultural modifications, and activities enhance these findings, by providing information on how animals were consumed, used and managed at Iroco. An assessment of resource use and discard also contributes to interpretations suggested by incisor morphology and osteometry.

Based on epiphyseal fusion, the Formative Period shows a three-stage mortality pattern. The first stage includes the consumption of immature animals younger than one year, which probably died of natural causes. The second stage is characterized by slaughtering of sub-adult individuals right before their second year just as they were reaching their physical and reproductive maturity. The final stage is characterized by a progressive sacrifice of older individuals as they were no longer useful for reproductive purposes, wool and/or transport.

The pattern observed for the Tiwanaku period includes a delayed harvest of sub-adults. The survival of a larger fraction of sub-adults after the first 24 months and increased abundance of adult individuals contrasts with the previous period. I interpret this pattern to indicate more intensive pastoralist management strategies. The survivorship of a greater proportion of adult individuals was probably motivated by delayed use of these animals for wool production and transportation. Moreover, this management system would have been enhanced by either larger individual herds and/or castration of males. Castration of males was likely related to caravanning and possibly increased exchange of meat production. Meat production also suggests use of camelid breeds that could gain greater size and weight, even if it implied keeping them alive for additional time.

The documented tooth eruption and wear sequences are consistent with the results derived from epiphyseal fusion but differ in some respects, including the evidence of neonates. It is possible that neonates were not recorded in the epiphyses fusion sequences because of differential attrition of the bones used for determining neonates, and their inclusion through the dental sequence is an improvement to the available dataset. In addition, it is worth mentioning that tooth use-wear of some specimens suggests they were considerably older than epiphyseal sequence could suggest. In fact, about seven specimens were six years or older and there were a few specimens aged between 11 and 13 years, clearly at the very end of the life span of a managed herd. In the wild, most camelids do not survive beyond ten years (Koford 1957:165-166).

Moreover, sex ratio data suggest females predominated in the assemblages. Analysis of skeletal element representations and cultural modifications showed consistent patterns of camelid consumption and discard including a greater frequency of discarded limb bones and vertebrae. The production or herding management strategy established during the Formative Period seems remarkably consistent in all four analyzed components. This suggests stable patterns of camelid consumption related to a long-term pastoralist herding tradition.

Numerous paleopathologies suggest that animals were handled by people and although several pathologies were probably the consequence of rough human treatment, the fact that several animals survived and healed painful injuries also speaks of human care. The evidence of some activity-related stress pathologies in vertebrae and joints hints at the use of animals in transportation. The evidence of congenital conditions such as polydactylia was probably caused by inbreeding, and perhaps related to artificial selection. However, most of the pathologies seem to be related to infections probably caused by unsanitary aggregation in corrals and degenerative lesions related to aging.

In summary, during the Formative Period, the herding management strategy in Iroco involved slaughtering and consuming animals in all stages of their development. Epiphyses fusion and tooth eruption and wear data produced consistent mortality profiles. Although neonatal individuals were uncommon, about half of the herd died between the first and second year of age, and right before reaching physical and reproductive maturity. The surviving animals tended to stay alive for a longer period of time. In fact, some individuals older than ten years were recorded. Preliminary sex-ratio data suggest approximately three quarters of the surviving animals were females, a pattern consistent with modern herding, in which herds are dominated by adult reproductive females. This also suggests that meat production was essential, but also that other important factors were significant such as the reproduction the herds and keeping animals around for anticipating environmental risk and benefiting from secondary products and services (i.e., wool, dung, and transportation).

9.2.3.2. Food Processing and Cooking

Comparisons of skeletal element survivorship with bone structural density and economic utility indexes suggest that the pattern of fragmentation and bone attrition observed in the camelid specimens identified from the Iroco archaeofaunal collections was primarily produced by human action. The overrepresentation of some elements such as crania and the relationship between different quantification units (i.e., NISP, MNI, weight) demonstrate high levels of fragmentation. Frequency and fragmentation of faunal remains suggests abundance and high consumption intensity of camelids.

The absence of correlations between bone volumetric density and element percentage of survivorship as well as between economic utility and element survivorship is a strong pattern present in all the Formative Period assemblages. This is probably connected to the fact that most of the elements associated with a camelid skeleton were present at the site. This pattern suggests that animals were slaughtered, butchered, prepared (as food and/or as secondary products), and discarded at the sites. However, not all the elements were equally present and factors such as food preparation, manufacturing and differential discard behavior probably contributed to the observed patterns.

Although no relationship was found between percentage of skeletal element survivorship and economic utility, it is possible that the observed patterns are associated with utilization of within-bone nutrients such as fat and marrow, instead of meat. Unfortunately, marrow and fat are more difficult to estimate using fragmented faunal assemblages. In addition, there is a great deal of variability associated with the distribution of nutrients among animals of different ages, weights, and other idiosyncratic factors (see Mengoni-Goñalons 2001; Olivera 2001; Olivera and Nasti 2001).

Low mechanical abrasion and the fact that the camelid assemblages were not significantly weathered suggests rapid bone deposition or that settlements were intensively occupied. Camelid bone specimens preserved more evidence of human damage (combination of cut marks, chop marks, and percussion marks) than carnivore damage and rodent gnawing. Rodent damage was mostly frequent on ribs and most carnivore damage was present on neurocrania. The low levels of weathering and modifications suggests that most camelid remains were not severely affected by natural taphonomic factors, but were mostly caused by dismemberment for food preparation and consumption.

Several scholars have noted that Andean daily cooking (as opposed to occasional and scheduled feasting) is heavily focused on stews and soups, which maximize the extraction of nutrients and particularly lipids (Olivera 2001; Olivera and Nasti 2001). Given the technical challenges of cooking at high-elevation and the fact that camelid meat is characteristically lean, fragmenting bones and cooking them in stews is one of the most economically efficient means of extracting protein, fat, marrow, and other nutrients from animal tissue (Miller 1979; Moore et al. 2010). Preparing food this way requires fragmenting the bones into small pieces as observed in modern Andean herding households. For instance, Miller (1979) noted that before cooking long bones were chopped using a combination of longitudinal and transversal blows into minimally four or more portions (humerus 5, radius-ulna 4, femur 6, and tibia 5). The same was true for the cranium (five portions), mandible (between four and five portions), scapula (five portions), innominate (six portions) and vertebrae (between two and three portions). The Iroco assemblages are similarly highly fragmented.

The fragmentation of camelid bone recovered at Iroco, frequency of chop marks, deep cut marks, and percussion marks, and the overall low frequency of partially burned and burned camelid specimens suggest that boiling was the preferred means of cooking (Moore et al. 2010). An abundance of storage jars and cooking ollas has been reported from ceramic analysis of Formative Period Wankarani cultural complex sites (Ayala Rocabado and Uribe Rodríguez 2003; Ayala Rocabado et al. 2008). Likewise, several large jars and ollas were identified in the ceramic analysis of the Iroco collections (Alvarez Quinteros 2008) and in addition to their use for storing water and other goods, these containers were probably used for cooking camelid stews.

9.2.3.3. Secondary Products and Services

Camelids in Iroco were used for more than just food. Herders probably utilized by-products such as wool, hides, tendons, bones for raw materials, and dung for fuel and fertilizer, as well as used their animals for transportation. The preparation of skin hides, wool spinning and textile weaving, are practices in which modern Andean herders are deeply engaged (Browman 1974; Flores-Ochoa 1979; Kehoe 1990; Murra 1965; Orlove 1977). Bone tool manufacture, use and discard, were activities that left an important material record in the studied sites, and modifications observed in the bones are consistent with complementary pastoralist activities (e.g., hide processing and textile manufacturing). In fact, evidence for the preparation of skins includes cut and striation marks that were common and widely distributed among most elements. A consistent underrepresentation of phalanges, and particularly third phalanges, suggests that they might have been left attached to skins as riders.

More importantly, the widespread distribution of bone tools is consistent with localized manufacture of camelid secondary products (Choyke 1997; Moore 1999, 2011). Some camelid bones were used as a source for producing ornamental beads and pendants but more commonly to make textiles, maintain tools, and process hides. However, most of the Iroco bone tools can be classified as utilitarian and related to specific functions such as puncturing, sawing, scraping, weaving, and multitasking. Typical bone tools include different types of awls, scrapers, needles for making nets or other fine textiles, and retouching tools for lithic pressure flaking (Moore 1999, 2006). Bone tools used to manufacture textiles include awls and needles of different shapes and sizes. Finely polished awls with triangular points made on camelid metapodials recorded at Iroco are remarkably similar to *wichuñas*, which are tools often used by modern Andean herders to manufacture textiles (Browman 2011; Moore 1999). Ceramic spindle-whorl discs used for spinning wool were also documented at Iroco (Albarracin-Jordan 2005; Alvarez Quinteros 2008).

The most common camelid bone tools were scrapers made of scapulae. At KCH21 the preponderance of camelid scapulae is clearly related to the manufacture of different types of scrapers and awls. Remains of by-products of production, complete tools, and discarded and broken worn tools are all present. The presence of multiple use-stages from manufacturing to discard, also suggests *in situ* manufacturing. Experimental reconstruction of scrapers similar to the Iroco ones from Telarmachay, suggests they were probably used for removing fat from the skins in the process of tanning hides (Julien and Lavallée 1995). However, Moore (2006) and Browman (2011) have also suggested these tools could be used for cutting the stems and sprouts of totora reeds.

As argued above camelids in Iroco were also important for dung for fuel and possibly for fertilizer. These results are supported by the paleoethnobotanical data recovered at the site. Dung was particularly important in this environment because other sources of fuel are scarce. Given the low productivity of soils, fertilizers were probably also essential for reducing the risk associated with cultivation and perhaps for improving their productivity.

Another service provided by camelids at Iroco was transportation. Llamas were possibly employed in caravans to other regions for exchange of staple and prestige goods. During the Formative Period, black basalt and other lithic materials were transported to the sites from other regions of the altiplano. The presence of two shells (one scallop and one mussel) from the Pacific coast suggest people participated of some form of long-distance exchange networks. However, evidence of significant transportation of meat and other staple goods such as salt or minerals for exchange from Iroco is currently weak. For instance, lowland cultigens such as maize or chili peppers, seem absent from the Iroco sites. Only during the Tiwanaku Period there is some evidence for the differential transport of camelid high utility elements as suggested by the negative correlation of economic utility and element survivorship documented at KCH22. In addition, the predominance of older llamas in the Tiwanaku Period faunal assemblages also supports the hypothesis that some animals were kept alive longer for transportation purposes.

9.2.3.4. Wild Fauna

Zooarchaeological evidence conclusively demonstrates that communities in Iroco did not exclusively rely on domesticated camelids. In fact, the richness and abundance of other faunal taxa support the contention that Formative Period people relied heavily on wild resources procured from different habitats. Hunting and fishing played an important economic and dietary role, complementary to herding activities. Some resources were probably exploited on a planned and scheduled basis. For instance, fish and possibly aquatic birds were so abundant that their procurement was probably the consequence of planned efforts. These included setting up nets, hunting, and fishing expeditions. Other resources such as deer, rheas and tinamous were probably procured through opportunistic hunting.

Fish were the second most common faunal resource identified at the Iroco sites and were intensively exploited. The high frequency of fish remains could be explained in part, by the large number of bones and scales that these animals have in comparison with other vertebrate groups (Reitz and Wing 2008). Nevertheless, it is important to note that the frequency of fish and other microfauna recovered would have been higher if finer recovery procedures were more intensively applied (Capriles et al. 2007, 2008).

The detailed study of the flotation samples collected from some depositional contexts and in which, fish remains are abundant, provides substantive data regarding the use and deposition of these remains. The presence of varying species of different sizes shows that fishing was probably an activity that was scheduled and carried out in a consistent and recurrent manner. Killifishes (*Orestias agassii*) and mauris (*Trichomycterus rivulatus*) are relatively small fish (6 to 15 cm standard length) and have been historically fished by Uru groups in lakes Uru-Uru and Poopó (Horn 1984). Both of these species were identified in the Iroco assemblage. Killifishes were significantly more abundant than other taxa, which implies the use of nets. Moreover, I identified taxa known today only to Lake Titicaca, such as members of the *Orestias luteus* group at Iroco (cf. Parenti 1984). This suggests a broader ancient distribution of these species than known today and probably a greater biomass in lakes and rivers than presently documented (see Zamora et al. 2007). Bone tools specifically manufactured for fishing were found at site KCH21, including needles, awls, and net gauges.

The high frequency of fish and aquatic bird remains suggests that for people living in Iroco during the Formative Period, fishing and hunting were complementary subsistence activities. In this sense, the location of KCH21 and KCH11 near the shores of Karakollu River and Lake Uru-Uru was probably a conscious decision to guarantee reliable access to grazing, fishing, hunting, and gathering territories. People hunted aquatic birds in the lake, particularly coots, ducks and flamingos, and collected eggs from nests among the totora reeds. Some of the abundant scapula tools identified at the site might have been used for cutting the stems and sprouts of the totora reeds, which were not only consumed by humans and camelids but also used as material for construction and crafts manufacture.

Midsized rodents, specifically wild guinea pigs and tuco-tuco gophers, were also abundant in the faunal assemblages of sites KCH21 and KCH56. Both of these rodents are common in the altiplano and are often found near houses in small towns and also in isolated dwellings of rural areas (Anderson 1997). The presence of some burrowing pits and several camelid bones with gnawing marks implies presence of bioturbation by rodents at KCH21. However, considering that some modifications were observed in specimens from KCH21FA, it is likely that rodent remains were also procured for human consumption. In fact, Molina Rivero (2006) documented that during the dry season, modern Aymara herders in Oruro used to organized trips for hunting wild medium-sized rodents.

9.2.4. Formative Period Pastoralism in the South Central Andes

In addition to some of the commonalities with other Wankarani cultural complex sites, the layouts and faunal assemblages analyzed in Iroco share some attributes with other settlements studied in the south central Andes. For instance, Chullpa Playa is a Late Formative Period site excavated in Potosí that shares the architectural layout documented at Iroco (Lecoq 2001). Similarly, the extremely well preserved villages of Guatacondo, Ramaditas, Tulan 54, and Tulor located in the Tarapacá and Atacama deserts of northern Chile have similar architectural configuration to the one described at site KCH21 (Ayala Rocabado 2001; Ayala Rocabado et al. 2008; Graffam and Martindale 1995; Graffam et al. 1996; Núñez 2005; Núñez et al. 2006; Stovel 2005). All of these sites include circular structures with adobe and/or cobble walls and foundations, in addition to the occasional presence of larger enclosures. Furthermore, zooarchaeological evidence suggests that camelid pastoralism and hunting wild camelids and rodents were important in the northern Chilean puna during the Formative Period (Cartajena et al. 2007; Dransart 1991; Hesse 1982, 1984; Labarca 2005). Although these similarities were initially interpreted as a consequence of cultural interaction, given the limited evidence of actual exchange between these regions, the most likely explanation is analogous economic organization (Ayala Rocabado 2001; Ayala Rocabado et al. 2008; Núñez 2005; Núñez and Dillehay 1995).

The eastern inter-Andean lowland valleys of Cochabamba constitute another region of potential interaction with the central altiplano. Based on the presence of stratified mounds, lithic effigies, and undecorated ceramics, Ponce Sanginés (1972) and other scholars have labeled some Formative Period settlements from this region as Wankarani. Nevertheless, research carried out in the Cochabamba valleys during the last twenty years has demonstrated that in spite of limited social interaction and occasional exchange with the altiplano, the settlements of the Cochabamba area correspond to a different yet equally lengthy cultural tradition (Gabelmann 2001, 2008; Gabelmann et al. 2009; Higueras 1996; Pereira et al. 2001).

Some Late Formative Period sites in Cochabamba such as Pirque Alto contain abundant camelid bones, which given that this region is inadequate for breeding camelids as documented ethnohistorically and ethnographically, were probably procured through some form of interaction and exchange with highland groups (Capriles et al. 2010). However, the sites from Iroco included very little evidence of contact with lowland groups, including an apparent absence of faunal remains of lowland taxa. Furthermore, there is no evidence that high utility camelid meat packages left Iroco as part of exchange goods. The low frequencies of some skeletal elements, including phalanges, however, suggests that some meat, skins, and possibly wool and textiles might have left the site as exchange goods.

Chronologically, the Iroco Formative Period components are also contemporary with the Late Formative Period I or Kalasasaya Phase of the southeastern Lake Titicaca Basin including specific occupation phases at Chiripa, Iwawi, Kala Uyuni, Kumikipa, Sonaji, and Tiwanaku (Bruno 2008; Capriles 2003; Hastorf 2008; Hastorf et al. 2001; Moore 2011; Moore et al. 1999; Park 2001; Roddick 2009; Webster 2003; Webster and Janusek 2003). Another settlement that is beginning to produce significant comparative data is Khonkho Wankane, but currently most of this material is under analysis (Berryman 2010; Gladwell 2007; Janusek 2008). Archaeological evidence suggests that social interactions between the Formative Period traditions of the northern and central altiplano were extremely limited. Although this is a theme that requires further research, previous work suggests that the inter-regional exchange between these regions was limited, people of the southeastern shore of Lake Titicaca Basin relied more on cultivation than people from the central altiplano, and that the diversity of faunal resources including camelid pastoralism was also important in the northern altiplano throughout the Formative Period (see Bandy 2001; Browman 1998). An specific good that seems to have been exchanged from the central to the northern altiplano is black basalt for manufacturing hoes and other lithic tools (see Bandy 2004; Giesso 2003).

The faunal remains from sites in the Taraco Peninsula of the southern shore of Lake Titicaca have been studied in detail by Moore (1999, 2006, 2011) and much like the Iroco assemblages, contain a great diversity of taxa including camelids of a wide range of sizes, dense concentration of fishes, rodents of different sizes and species, a large diversity of birds, and other miscellaneous taxa. The large samples studied from these sites coupled with fine recovery protocols have allowed a very detailed understanding of the faunal patterns consumed in the Taraco Peninsula (Browman 2011; Capriles 2006; Capriles et al. 2007, 2008; Kent 1982; Kent et al. 1999; Miller et al. 2010; Moore 1999, 2006, 2011; Moore et al. 1999, 2010). The camelid remains from the Taraco Peninsula show a number of differences from those of Iroco including the likely presence of alpacas, the manufacture of different types of tools and a wide diversity of processing strategies (Moore 2006, 2011). The fishes from Lake Titicaca sites are more abundant, have broader size ranges, and are associated with a complex bone tool kit associated with the manufacture of nets (Capriles 2006; Capriles et al. 2007, 2008; Moore 1999, 2011).

The significance that the use of wild resources in Formative Period economies of the central altiplano is an important finding of this study. Still, the patterns in Iroco need to be verified in other settlements from the central altiplano. The analysis of faunal remains recovered during the excavation of other sites like KCH56 and KCH11 indicate some variability in the reliance on wild resources. Some settlements (or at least some sectors within sites) included extremely low frequencies of wildlife and therefore a greater degree of dependency or specialization in camelid pastoralism. On the other hand, the subsistence emphasis of the economy might hint that the use of wild resources and a broad diet breadth was a consequence of economic subsistence stress possibly related to unpredictable environmental fluctuations.

In summary, the results presented here allow for the first time to reconstruct the subsistence patterns of herding settlements from the central altiplano. The faunal assemblages from the Iroco sites provide a preliminary view of animal consumption patterns during the Formative Period Wankarani cultural complex. The economic subsistence system seems to have been self-sufficient and diversified, but primarily locally or highland based. As initially expected, camelids were extremely important for the economic subsistence of the inhabitants of the region and as such constituted the foundation for a new type of ecological adaptation to the environmental conditions of the central altiplano. Nevertheless, the abundance of other taxonomic groups suggests multiple procurement activities and management of wildlife resources. In this sense, although there is strong evidence that pastoralism was fundamental, the zooarchaeological data suggests considerable economic complexity.

9.2.5. Implications of the Paleoethnobotanical Data

The results of the palethnobotanical analyses reveal some aspects of the way that people used plants in Iroco and complement the data provided by the faunal analysis. The analyzed samples verify that herding was a significant economic practice in the region. Evidence of dung used as fuel is supported by macrobotanical remains. Most of the identified plants represent the diet of the camelids herded at Iroco. Not surprisingly, phytolith remains suggest a predominance of grasses. Moreover, macrobotanical remains suggest Malvaceae and Amaranthaceae seeds were the most common taxa. These two taxa are common in disturbed habitats such as the ones camelids would produce after grazing patches of grasslands, shrublands or *bofedales* (Beck et al. 2010; García and Beck 2006; Kuznar 1993; Pestalozzi 1998; Yager 2009; Zeballos et al. 2003).

The plant assemblage includes a fair amount of aquatic plants including seeds of the Cyperaceae and Potamogetonacae families. The most significant plant of the Cyperaceae family is totora (*Schoenoplectus californicus* var. *tatora*). The presence of these and other seeds of aquatic plants could suggest the collection of totora reeds for economic uses such as matting and net manufactures. For instance, totora reed boats were commonly built for fishing by indigenous communities in the shores of Lake Titicaca, Desaguadero River, and Lake Poopó at least since late pre-Hispanic times (Horn 1984; Molina Rivero 2006; Orlove 2002; Portugal Loayza 2002).

The presence of aquatic plant seeds might also suggest that camelids consumed totora. Orlove (2002) has documented how modern Aymara people in the Lake Titicaca area often supply their cattle herds with freshly harvested totora reeds (see also Arguedas 1919). Browman (1986) identified fragments of burned camelid dung containing fish scales in samples from Chiripa (Taraco Peninsula). These were probably consumed while eating totora or other aquatic plants. Furthermore, it is important to note that llamas and alpacas occasionally graze on aquatic vegetation without being fed it as fodder. This occurs particularly during the end of the dry season when grassland vegetation is exhausted.

Although there is tentative evidence of maize from the phytolith analysis, no maize specimens were identified from the flotation light fractions. This result suggests that staple exchange with regions with different climates and plant species was not in place by the Late Formative Period in the central altiplano (cf. Hastorf et al. 2006). Given the wide use that traditional people of Iroco have for the diverse available wild plants for medicinal and other economic purposes (Cuenca Sempertegui et al. 2005), it is also possible that most of the identified plants had a variety of economic uses. However, their inclusion at the site was most likely, the result of burning camelid dung. In summary, richness, abundance, and distribution of plant remains suggest a wide use of floral resources in Iroco.

The plant assemblages also suggest that domestic chenopods and tubers were probably cultivated at Iroco. The finding of dozens of complete and fragmented lithic hoes also supports this possibility (Calla Maldonado 2009; Capriles et al. 2011). However, further analysis of plant remains is required to better understand the ancient use of plants in the central altiplano as well as to make adequate comparisons between this region and the Lake Titicaca basin during the Formative Period (e.g., Bruno 2008; Whitehead 2007; Wright et al. 2003). For the moment, paleoethnobotanical data seem to support that camelid pastoralism was complemented by use of domesticated and wild plant resources.

9.2.6. Formative Period Generalized Camelid Pastoralism

The first hypothesis of this dissertation stated that specialized camelid pastoralism was the main economic subsistence pursuit of the Formative Period Wankarani cultural complex. The survey, excavations, and faunal analyses demonstrate the importance of camelid pastoralism for the economy of the studied Formative Period settlements. However, the evidence for the consumption of fish, aquatic birds, and rodents was abundant and conspicuous. Furthermore, paleoethnobotanical data suggest that cultivation of chenopods and tubers was also practiced. Consequently, the null hypothesis is not supported.

The data fit better with the alternative hypothesis, that the Formative Period Wankarani cultural complex relied on a form of generalized pastoralism that involved plant cultivation and procurement of diverse set of wild fauna resources. Paleoethnobotanical data (in addition to abundant lithic hoes) suggest that some chenopods and tubers were cultivated locally. Sampling differences aside, plant remains also show interesting similarities with other studied agricultural settlements including those from the Taraco Peninsula and Tiwanaku, where plant cultivation had a central economic role throughout the Formative Period (Bruno 2008; Whitehead 2007; Wright et al. 2003). However, given the differences in number and diversity of excavated contexts, it is possible that many of the identified plant remains from Iroco derived from burning dung as fuel and that relatively few taxa represented food remains. Moreover the presence of a probable pathogenic fungus on tuber fragments could also be suggesting that cultivation was sufficiently practiced as to be susceptible to progressive attacks by specialized pests (Langlie 2011). The existence of a fungus on tuber fragments further suggests that cultivation was a risky task and that in addition to climatic fluctuation other factors also made economic diversification advantageous.

The distribution of sites during the Formative Period in Iroco fits the ethnoarchaeologically derived model of residential bases complemented by herding, and/or logistical camps for procuring wild resources. The association of Formative Period settlements with the shores of Lake Uru-Uru and Karakollu River correlates well with the conspicuous presence of aquatic resources in these sites. The abundance and ubiquity of fish remains further suggests these resources were probably procured on a habitual and scheduled basis. From a subsistence perspective, fish were a significant source of food for people in Iroco and access to this resource probably influenced factors such as settlement location and seasonal mobility.

The richness and abundance of bird remains suggests aquatic birds were probably also procured regularly. Hunting coots, ducks, and other aquatic birds in addition to collecting their eggs could have been carried out during fishing trips or even during trips for collecting totora reeds. Based on bird behavior and ecology, it is possible that occasionally specialized hunting trips were organized to procure large aquatic birds during specific times of the year and in certain environments. For instance, flamingoes are particularly common in open waters during the dry season when they migrate in large numbers from their nesting grounds in the high-elevation lakes of the southern altiplano (Caziani et al. 2007). Coots and ducks are common in marshy and reedy environments during most of the year (Flores Bedregal and Capriles Farfán 2010).

Rodents were probably attracted to the organic remains discarded by humans. It is probable that some of these animals occupied the sites during or after people abandoned them, particularly if the settlements were inhabited seasonally. Nevertheless, abundant evidence suggests that rodents were also occasionally consumed. Other wild resources including deer and terrestrial birds such as rheas and tinamous were probably procured opportunistically during herding trips.

The abundance of camelid remains in addition to a great diversity of wild fauna from different highland habitats suggests that fishing, hunting, trapping, and gathering wild resources were also fundamental components of the economic organization during the Formative Period. The absence of exotic species from the eastern lowlands suggests the people of Iroco were not actively engaged in inter-regional staple good exchange. This is also confirmed by the absence of maize and other exotic plants in the paleoethnobotanical assemblages. Exchange was limited to specific lithic raw materials in addition to ritual goods such as the Pacific Ocean bivalves found in the Lower Level of KCH21. In synthesis, although camelid pastoralism was probably the main economic endeavor, people also relied on a number of additional procurement activities during the Formative Period in Iroco. The reason for the exploitation of additional resources could be attributed to economic opportunism given the abundance of patchy localized resources but more likely to economic diversification as a risk management strategy.

9.3. The Tiwanaku State and the Central Altiplano

The expansion of the Tiwanaku state incorporated the central altiplano into a political economy process that involved significant changes at the local level. The emergence and consolidation of the Tiwanaku state was a complex process that lasted about seven hundred years and consequently it involved a dynamic history. Indirect incorporation of diverse kings of regions through economic alliances with emerging elites seems a likely initial process. However, the presence and character of these “elites” is still absent in the archaeological record of the central altiplano.

Settlement patterns suggest that the politically decentralized pastoralist system persisted even throughout this period of vertical integration. The absence of large scale corporate ritual architecture is probably a reflection of this process. Formalization of ceremonial practices including redistribution feasts and new forms of ancestor veneration were probably used as an immediate ideological connection with pre-existing religious practices redefined into an increasingly complex system of institutionalized ritual. For instance, burial patterns changed from direct pits to the use of elaborate cists as documented in KCH11. Settlements like Jachakala in La Joya or the cluster of Tiwanaku sites around the modern community of Iroco include high densities of imported decorated ceramics. As increased agricultural production was incentivized, settlements grew in size and complexity and participation in middle and long-distance trade was fostered.

Tiwanaku integrated the subsistence system of Iroco into a larger political economy and incorporated it into a broader economic network. As an intermediate region between Tiwanaku and Cochabamba, communities in the central altiplano could have benefited from increased traffic and regional interaction (Albarracin-Jordan 2007; Browman 1997; Hastorf et al. 2006). Considering that several Tiwanaku ceramic vessels present in Iroco sites might have been imported, it is possible that some Oruro sites became hubs for exchanging goods (Bermann and Estévez Castillo 1993). I hypothesize that locations such as the cluster of sites near the modern community of Iroco might have worked as middle points for llama caravans moving to and from Tiwanaku and other consumptions nodes such as Cochabamba or San Pedro de Atacama. Some of the larger sites might have served as gathering places for fairs, where exchanging prestige goods, consumption rituals (possibly involving maize chicha from Cochabamba) and incipient political integration occurred. Resources such as camelid meat, salt, black basalt, copper, maize, chili peppers, psychotropic plants, and other goods might have been readily exchanged and consumed, but this is not entirely evident at Iroco. Changes in other material aspects are also observed during this period including new burial patterns and possibly a higher consumption of prestige goods (see Albarracin-Jordan 2007; Browman 1981; Giesso 2003; Núñez and Dillehay 1995).

The emergence of specialized pastoralism geared towards providing growing markets with animal products (i.e, meat, hides, wool, and textiles) and using domesticated animals for facilitating the circulation of goods, through caravanning is nevertheless a plausible hypothesis. During this process pastoralism is likely to have been consolidated as an aggrandizing economic strategy. It could have been readily incorporated into a larger economic sphere and institutional constraints. Camelid herders were set to fully take advantage of these opportunities while relying on the autonomy associated with mobility. Evidence for meat transportation in Iroco is weak but suggested by the negative correlation between camelid element percentage of survivorship and economic utility, independent of volumetric density, at KCH22. This pattern suggests that higher economic cuts were leaving the settlements but it is uncertain where to and to whom. Possible answers include inter-regional exchange, emerging elites, tribute or multiple combinations.

Interestingly enough, although the subsistence reliance on wild resources, including fish and aquatic fauna diminished, they were still present and probably contributed a significant portion of the diet of the herders during the Tiwanaku Period. Agriculture probably became more prevalent as suggested by the location of sites near good soils and permanent springs. The economic reliance on camelids became more important than ever at this time, as caravanning and secondary products became the economically important for exchange and facilitating social interaction. By Tiwanaku times, specialized llama herding was probably consolidated in Iroco, as the region was integrated into the larger political economy of the south central Andes. Iroco probably had an economic opportunity for caravan exchange and for the production of wool, manufacture of crafts, and intermediation in long-distance inter-regional exchange, but more research regarding the Tiwanaku Period in the region is necessary to verify this hypothesis.

9.3.1. Wankarani, Tiwanaku, and the Changing Political Economy

Previous researchers have suggested that although some Tiwanaku sites are present in the central altiplano, political integration took the form of strategic alliances that promoted the aggrandizement of locally emerging elites (Catacora et al. 2002; Michel López 2008; Michel and Lémuz 2002). Given the little that is known about the Tiwanaku Period in the central altiplano, it has been difficult however, to estimate the impact of the state expansion at the local level (Beaule 2002; Bermann and Estévez Castillo 1993). I hypothesized at the outset that Wankarani economic organization was not significantly altered with the incorporation of the region into the Tiwanaku political economy. Settlement patterns, site layouts, and artifact analysis from Iroco suggest that although the impact of the state was not dramatic, there were noticeable differences between the Formative and Tiwanaku periods. For example, faunal data indicates that despite the fact that several of the resources consumed in earlier time periods continued to be utilized, there was a subtle increase in the relative abundance of domesticated camelids during Tiwanaku.

Some of the characteristics of the Tiwanaku presence in Iroco signal new political and economic conditions. Although there is no evidence for the establishment of a large Tiwanaku regional center, there was a shift from a dispersed settlement system to a concentration of sites or village aggregation near the center of the study area. This settlement pattern may be related to intensification of cultivation. This pattern also suggests increased population growth and probable increases in flow of goods. For instance, settlements located at the north and south ends of the major cluster of sites suggest a form of indirect regional control (see Jennings and Craig 2001).

Taken together the data suggest that indeed the Iroco economic organization adjusted to the changing political and economic panorama of the south central Andes. During this period the relationship between the Lake Titicaca Basin and the Cochabamba valleys became increasingly important and involved strategic exchange of staple and prestige goods such as maize, vessels, sodalite, coca, and others (Anderson 2009; Capriles et al. 2010; Hastorf et al. 2006; Higueras 1996; Janusek 2008; Kolata 1993, 2003). There are several indications that the pastoralist societies settled in Iroco could have taken advantage of increasing inter-regional exchange and interaction. A decrease in use of wild resources suggests camelid pastoralism might have become the prevalent economic resource. The predominance of older animals supports the use of camelids for transportation and wool production. Absence of high utility packets from site KCH22 suggests that independently of bone volumetric density, some high yield cuts were been transported out of the site. Additionally, in the absence of paleoethnobotanical evidence, a few exotic goods found at the Iroco sites include some Tiwanaku style ceramics and exotic lithic raw material such as black basalt, obsidian, and sodalite (Albarracin-Jordan 2005, 2007; Alvarez Quinteros 2008; Calla Maldonado 2009). Nevertheless, the persistence of fish and aquatic birds implies that (at least opportunistic) procurement of wild resources continued to be important. Continuous presence of bone tools suggests hide, wool and textile production continued to be important tasks at the residential base level.

In summary, the changes that occurred during the Tiwanaku Period in Iroco were varied. There is evidence for increased control of the flow of goods, residential aggregation, agricultural intensification, ceramic vessels importation, and differential transportation of camelid meat. At the same there is absence of direct regional control, substantial staple good exchange, and major decrease of wild resource utilization. As a consequence, although the economic organization in Iroco seems to have changed structurally with the emergence and growth of the Tiwanaku state, these changes can be interpreted as local adjustments and responses to the changing political and economic conditions of the south central Andes as opposed to dispositions imposed by the expanding state.

CHAPTER 10

CONCLUSIONS

> "*As all the kids of his parish, Evo became a rural worker the day he started to walk. When he was five years old, he already had the status of a llama herder. Some could see there a biblical allegory or those who give courses on leadership, the germ of a leader. Evo got accustomed to giving his animals orders, to huddle and to obey him. (…) In Isallavi, the Morales family lived in a mud and thatch house. It was actually a room of three meters by four that served as bedroom, kitchen, and dining room. Next to it they had their corral. Not only to poverty and lack of materials was the floor of dirt. Aymara communities prefer contact with the earth, Pachamama, and avoid mediation, such as cement and even furniture. At dawn Dionisio made his offering to the Pachamama, María made libations with alcohol and coca leaves to have a good day*." (Sivak 2008:55-56, my translation).

In this dissertation, I have tried to implement a research design that used complementary data from survey, excavations, and detailed analysis of faunal remains. Reconstructing the economic organization of early camelid pastoralism in the central altiplano of Bolivia was the central concern of this investigation. Furthermore, I have relied on previous archaeological and ethnoarchaeological research to arrive at a holistic understanding of the Formative Period Wankarani cultural complex. In this chapter, I discuss key theoretical and methodological insights resulting from this research.

10.1. Methodological Insights

In this dissertation I have presented and systematized data collected from the region of Iroco. At the regional level, the high-intensity archaeological full-coverage survey was carried out over a typical area for the Formative Period Wankarani cultural complex including microenvironments characteristic of the central altiplano such as grasslands, flood-plains, foothills, and hill slopes. The presence, abundance, and diversity of sites dated to this period confirms the adequacy of working in this region. In fact, the study area is contiguous to the La Joya, Río Kochi and Belén regions, where most research regarding Wankarani had been previously carried out (Bermann and Estévez Castillo 1995; Condarco 1959; Fox 2007; McAndrews 2005a; Métraux and Lehmann 1937; Rose 2001a). In contrast with these regions, Iroco is not adjacent to the Desaguadero River, a connection often mentioned as a feature of the Wankarani cultural complex. However, because Iroco borders the Karakollu River and Lake Uru-Uru, shoreline sites probably had access to riverine and lacustrine resources similar to those provided by the Desaguadero River. Iroco also does not include a *bofedal* habitat. This is important because these vegetation formations are often the preferred habitats of camelids, particularly alpacas. However, *bofedales* are also absent in La Joya, Río Kochi, and Belén, and consequently, Iroco is not substantially different from those regions. Economic organization in all these regions would have been constrained by the same ecological factors. Iroco in this sense, is a typical herding habitat as evidenced by the fact that extensive camelid herding is still practiced by some families of the local communities. Finally, in addition to previous research, settlement patterns corresponding to the Archaic Period were described for the first time.

At the site level, abundant data on settlement context and layout was collected. Site KCH20 constitutes one of the few Archaic Period excavated sites in south central Andes. The site is significant because it is dated to the Early Archaic Period (10,000-8000 BP) and it includes a singular faunal assemblage that currently serves as the only known window into the foraging pattern prior the Formative Period. Given more time it would have been useful to have sampled other Archaic Period sites, particularly Late Archaic and Terminal Archaic Period sites, which given comparisons of projectile points, are present in Iroco (e.g., Aldenderfer 2009; Capriles et al. 2011; Klink and Aldenderfer 2005).

The Iroco Formative Period is represented by four components or occupation levels from three different sites. The layout of all of these components included well preserved domestic occupations. Domestic occupations typically included circular structures of different sizes and varied construction materials in addition to pits, hearths, and burials that are very similar to previously excavated Formative Period Wankarani cultural complex sites such as Chuquiña (Fox 2007, 2010), Huancarani (Ponce Sanginés 1970; Walter 1966, 1994), La Barca (Pérez Arias 2005; Rose 2001a, 2001b), Pusno (Fox 2007, 2010), San Andrés (Bermann and Estévez Castillo 1995), and Uspa-Uspa (Condarco et al. 2002; Wasson 1967). As some of these sites are earlier than settlements documented at Iroco, similarities in structure, composition and contents, confirm that the Wankarani cultural complex was characterized by a long-term tradition of cultural continuity.

There are however, some specific factors that impede an uncritical generalization of the data from Iroco to the entire extent of the Wankarani tradition. Pastoralism is a subsistence strategy that can dynamically change through time because selection of domesticated animals is a long-term process and because herders are constantly making risk management decisions in response to changing environmental and social circumstances. Nevertheless, the patterns observed and documented in this study can be interpreted as a result of the variability associated with the Formative Period Wankarani cultural complex economic organization. Investigation of additional occupations dated to earlier phases of the Formative Period in Iroco and of later phases in other regions, should verify how well the patterns and trends identified in this dissertation hold.

Regarding the Tiwanaku Period, some aspects of the data require further refinement. For instance, all of the analyzed components were associated with less architectural and cultural features than those documented for the Formative Period. Most of the assemblages do not correspond to the main Tiwanaku settlements documented in Iroco but to specific Tiwanaku occupations in mostly Formative Period settlements. Finally, most of the faunal assemblages are comparatively smaller than the Formative Period assemblages. In fact, some of the faunal assemblages were clearly associated with specific ritual or non-domestic activities. For instance, a portion of the assemblage from KCH11Tiw was associated with a consumption episode associated with a burial area. Nevertheless, these components constitute the only detailed collection of studied faunal remains from Tiwanaku settlements in the central altiplano. Consequently, they provide a baseline for understanding some of the changes produced with the incorporation of the central altiplano into a state-level political economy sphere. It would be important to follow-up questions regarding the possible specialization of camelid use as related to agricultural intensification and llama caravanning. For instance, the Tiwanaku components include mortality profiles with a substantial presence of older animals and the presence of several pathologies indicate increased occupational stress. Further research from larger settlements including sampling of domestic features should help to corroborate some of the patterns outlined here for the Tiwanaku Period.

Excavations emphasized exposing horizontal layout configurations providing solid contextual information. The archaeological settlements that I studied in Iroco did not seem to represent early villages, but accumulations of residential bases with various developmental cycles and phases of occupation, abandonment, and reoccupation. Actualistic research on modern Andean herding systems was crucial in interpreting and making sense of these patterns. In addition, a wealth of information was collected through analyzing carefully recovered faunal remains as well as other artifacts (e.g., ceramics, lithics) and ecofacts (e.g., phytoliths, pollen, macrobotanical remains) through a combination of recovery techniques. Although part of this information is available in the field reports and appendixes of this dissertation, unfortunately, not all of the data can make it into a single document. I hope in future papers to explore some of the details and nuances of this research and explore further possibilities of research in Iroco.

Zooarchaeologically oriented research has proven to be a useful approach for studying ancient economies and societies, anthropogenic induced long-term biodiversity change, and human-animal symbiotic relationships throughout time (Lyman 2006; Hayashida 2005). In this dissertation I have relied on detailed analysis of quantitative and qualitative taxonomic identification, taphonomic, and behavioral information from faunal remains. From a zooarchaeological point of view, pastoralism does not represent initial stages of animal domestication, but can be characterized as a consolidating phase in the continuing process of animal selection and domestication (Harris 1996; Zeder 2006). By explicitly testing the hypothesis that the Wankarani cultural complex was an example of early pastoralist society, this project contributed abundant empirical data for evaluating the degree to which people of the Formative Period in the central altiplano relied on domesticated camelids and specific information on the characteristics and variability of other faunal resources use. I hope that the information produced here will help to provide a better understanding of the historical trajectory of camelid pastoralism, which has long been one of the most important ways of life for indigenous communities of the Andes.

One interesting result of this dissertation is that even with the aid of morphometric techniques, differentiating sierra guanacos and modern llamas is difficult (Grant 2010; Izeta et al. 2009; Yacobaccio 2010). The osteometric analyses of suggest that wild guanaco specimens from the Early Archaic Period site KCH20 were comparable in size to modern llamas. These results imply that osteometry alone is insufficient to discriminate wild from domesticated camelid species, and suggests more emphasis should be placed on associated mortality profiles, identification of occupational pathologies, and cultural context. These data further suggest that the differences between modern domesticates and wild ancestors are less pronounced in the central altiplano than in other regions. This might be a consequence of a direct relationship between modern domesticates and ancient wild guanacos in this region. Furthermore, given the morphological similarities between wild and domesticated camelids, the specialization in the utilization of camelids, and the long-term human utilization of this landscape, the central altiplano is a potential candidate for an independent center for the domestication of llamas.

Furthermore, partially confirmed by this study is the assertion that trajectories of camelid pastoralism continued even with the incorporation of the study area into the broader political economy of the expanding Tiwanaku state. In this sense, although the patterns of the studied Formative Period components are relevant as a snapshot of Wankarani during its latest phase, they allow a better understanding of the incorporation of the region to the Tiwanaku political economy. Future research should explore how some of these patterns changed and perhaps reverted, with the disintegration of the state, during the Late Intermediate Period (AD 1100-1450).

The central altiplano was part of a broad set of early food production and manipulation centers across the Andean highlands. Preliminary data analysis suggest that in addition to possible animal domestication, an agricultural component also developed in Iroco and by extension, the central altiplano. The Formative Period settlement system probably included some sites that focused on cultivation and although more could be said with respect to plant cultivation, additional paleoethnobotanical analyses are required. Furthermore, I have to make clear that this dissertation did not aim to undermine the role of agriculture during the Formative Period in the central altiplano, but to emphasize the importance of camelid pastoralism and the utilization of animal resources.

A methodological limitation of this work has been the limited use of the spatial information related to the recovered artifacts and ecofacts including the identified fauna. As a consequence, there is great potential to further explore the spatial distribution of faunal remains in sites like KCH21 that have excellent preservation and good contextual associations. Future analysis should include specific comparisons between individual contexts in terms of different taphonomic and behavioral variables.

10.2. Theoretical Insights

The results of the archaeological survey and analysis of settlement patterns from Iroco have a number of implications for understanding the environmental context and social organization of early camelid pastoralism in the south central Andes. The results also question a number of previous theoretical assumptions regarding the Archaic and Formative periods of the central altiplano. For instance, paleoenvironmental studies from neighboring regions suggested that climatic fluctuations could have placed constraints and stress on human populations during the Archaic Period (Núñez et al. 1997; Yacobaccio et al. 2008). In fact, some evidence from Chile points to a possible depopulation of the puna during the Middle Holocene (Grosjean et al. 1997; Santoro and Núñez 1987). As an example, Puripica is a valley in the Atacama desert that included fresh running water during this period allowing population persistence whereas most other previously occupied areas were abandoned (Núñez et al. 2005). Similarly, data from the Salar de Coipasa suggest that human occupation might have persisted in the central altiplano where somewhat different environmental conditions developed (Placzek et al. 2006:527). Furthermore, Craig et al. (2010) have recently suggested that throughout the Holocene there was a tendency of population increase in some parts of the northern altiplano. Along these lines, the Iroco data suggest that population intensity during the Archaic Period in the central altiplano was probably correlated to climatic fluctuations and resource availability. Given the stability of aquatic and terrestrial resources, human population could have continually persisted throughout the Holocene. As a result, as more sites are excavated, I expect an increase in the discovery of Early, Middle, and Late Archaic Period occupations.

The Bolivian highlands and the central altiplano in particular are located between the Peruvian central Andes and the puna of northern Chile and Argentina. Because major research has been conducted in these regions, but not in the central altiplano, the broader regional picture has been incomplete. The Wankarani region, as it has been traditionally called, has been used as a model for camelid pastoralism. However, very little was known about the Archaic Period and its transition into the Formative Period Wankarani cultural complex. Several questions are still unanswered regarding the human occupation of this region including broader processes of camelid domestication, resource utilization, emergence of political complexity, and increased social interaction throughout time.

Taking into account that theoretical frameworks define our interpretations of the past, knowledge of early pastoralist societies in the Andes could be enhanced by a further understanding of traditional Andean herding systems. The seminal work of ethnographers, ethnohistorians, and ecologists constitutes a strong baseline with which to approach this topic (see Abercrombie 1998; Medinacelli 2010; Molina Rivero 2006; Murra 1975, 1980; Wachtel 2001). A recursive relationship between models based on this information and archaeological data is indispensable for building empirically based reconstructions of the past (see Aldenderfer 2001; Browman 2008; Wylie 2002). The implementation of actualistic research on present-day traditional Andean herding communities has been a fundamental step for advancing the archaeological research on prehistoric pastoralism in the Andes (e.g., Kuznar 1990, 1995; Nielsen 2000, 2001; Tomka 1994, 2001; Tripcevich 2008; Yacobaccio 2007). These works have begun to build important middle-range research to bridge our understanding of the present with the configuration of the remains from the past and to serve as sources of archaeological hypotheses and the construction of empirically testable models. The research presented in this dissertation has made extensive use of the lessons learned from actualistic research for assessing an ancient society that has been somewhat uncritically assumed to be pastoralist.

By refocusing the interpretation of Wankarani based on construction of relational analogies and testing models of the spatial organization and economic subsistence derived from modern pastoralist communities, I provide new insights into this ancient society. I argue that past pastoralists of the central alitplano utilized their landscape extensively and the by-products of their presence are materialized not as large mounds composed of collapsed villages of fully sedentary agriculturalists, but in cyclically occupied and abandoned residential bases, multiple scattered temporary camps, intermittently revisited seasonal pastures, and redundantly trampled pathways. The archaeological evidence of the Formative Period shows engaged pastoralists actively utilizing their landscape and transforming it according to different economic, social, and environmental constraints.

Considering the results of the survey carried out in Iroco, I think that the currently accepted interpretation of the Formative Period Wankarani cultural complex as a settlement system made up of permanent villages spread out in the landscape is artificial (Bermann and Estévez Castillo 1993; Fox 2010; McAndrews 2005a; Ponce Sanginés 1970). In fact, I think that the current state of our interpretation regarding Formative Period settlement patterns in the altiplano is ontologically biased by a failure to utilize adequate relational analogies and appropriate archaeological correlates for understanding herding landscapes and their evolution through time (Yacobaccio 2007). Specifically, researchers working with Wankarani sites have created a meta-narrative of the past that involves an agricultural emphasis and privileges patterns associated with agricultural communities, including sedentarization, farming, and population aggregation. Given the data presented in this dissertation and a reassessment of the evidence from previously investigated sites in the central altiplano, a pastoralist-oriented interpretation might provide to be more useful.

In a provocative synthesis, Aldenderfer (2001:19) identified four major areas for research regarding the origin and evolution of Andean pastoralism: “the domestication process, the transformation of the initial contexts of domestication into an Andean version of a ‘secondary products’ revolution, modes of pastoral production and their interrelationship with other Andean production systems, and finally social transformations of pastoral societies, including the origins of social inequalities, the role of conflict, and the process of wealth accumulation.” In this dissertation, I have touched on some of these processes, but mainly focused on the evolution of pastoralism as ecological adaptation that was characterized by its articulation with other economic strategies. Further research is required to build stronger frameworks for integrating the dispersed data regarding early herding in the Andes. As I have discussed in reviewing the results and implications of the collected data, however, there is plenty of evidence that suggests camelid pastoralism in the Andes did not evolve as a specialized economic pursuit but was accompanied by a strong reliance on other forms of resource exploitation including cultivation, fishing, and hunting.

Early camelid pastoralism in the Andes as a system of social organization and an institutional framework evolved independently but analogous to other nomadic pastoralist traditions around the world. The apparent absence of social differentiation is manifested in a narrow range of residential base dimensions, domestic structures that are more or less the same size, and an absence of differential treatment of the dead. Early camelid pastoralism was probably based on households, archaeologically manifested as residential bases composed of groups of circular structures, and integrated with their kin into larger lineage-based organizations.

Given lack of evidence for elite stratification, leadership and political aggrandizement was probably discouraged. There is also no evidence for vertical political integration. Although it is true that the sample size still is very small, the lack of complex corporate architecture suggests that a strong religious theocracy was not developed in this region. These results are also supported by previous regarding Wankarani social organization (e.g., Bermann and Estévez Castillo 1995; Fox 2007; McAndrews 2005a).

Stone camelid effigies are present in several Formative settlements but only few, like Belén, Uspa-Uspa and Machacamarca have a substantial number of these (López Rivas 1959; McAndrews 2005a; Métraux and Lehmann 1937). These effigies have been use to suggest the presence of an animism religious system focused on fertility rites and to strengthen the interpretation of Wankarani as a pastoralist society (Guerra Gutiérrez 1994; López Rivas 1976; Métraux and Lehmann 1953). Although I have argued that villages were virtually absent in the settlement patterns of the central altiplano, sites like Belén (a five meter tall mound containing several llama stone tenon heads) have special attributes that could suggest some form of pastoralist coalescence. I hypothesize these and other similar sites served as aggregation loci during specific times of the year, when in a ceremonially charged environment, exchange of goods and information promoted social cohesion and a sense of shared identity.

The archaeology of camelid pastoralism has been often approached from a perspective of political economy (e.g., Graffam 1992; Stanish 1992, 2003), but I think that before overarching arguments regarding ultimate political motives can be made, further baseline empirical research should be presented. This study has attempted to understand early camelid pastoralism as an ancient economic organization and ecological adaptation that left an important material record. Through detailed analysis and large sample sizes, I documented previously unidentified taphonomic and behavioral patterns. Moreover, these patterns were interpreted in a context of hypothesis testing for reconstructing the bases of Formative Period economic organization. Similarly, recent zooarchaeological approaches to ancient economies have been characterized by increasingly detailed levels of analysis, synthesis, and incorporating substantive information from different sites producing very specific models related to broader frameworks of cultural change (Borrero 2008; Crabtree 1993; deFrance 2009; Frachetti and Benecke 2009; Marciniak 2005; Olsen 2006; Zeder 2009).

Pastoralism is often viewed as an ecological adaptation to semi-arid conditions with research focused on material configuration and the reconstruction of economic behavior. Although economic and ecological aspects are essential for understanding the decisions that determined the location of settlements, so are politically and socially institutionalized constraints (Cribb 1991; Frachetti 2009). The spatial configuration of changing settlement patterns intersects these aspects in the context of an emerging complex socio-economic system. The consequences of these processes are central to understanding the variability associated with pastoralism because they can trigger specific development trajectories, condition wealth accumulation opportunities, and tolerate varying levels of sociopolitical integration.

10.3. Early Camelid Pastoralism in the Central Altiplano

I have explored the topic of early camelid pastoralism based on very specific data from Iroco, a small yet intensively studied area of the central altiplano. Together spatial, contextual, artifactual, and ecofactual data support the great importance that camelid pastoralism had during the Formative Period in Iroco. Survey data have been used to explore changing settlement patterns before, during, and after the incorporation of domesticated camelids into the economy of the local inhabitants. Excavations of five sites have permitted a glimpse into the materiality of settlement layout and configuration during these periods. Furthermore, these excavations allowed the recovery of abundant faunal remains that were studied in detail to determine the role of different faunal resources (including camelid domesticates) in the diets of the local inhabitants. Complementary studies of other artifacts and ecofacts has provided a broader outlook into the material culture of the earliest herders of the altiplano.

An important question that this research prompts regarding the economic organization of the Formative Period Wankarani cultural complex is related to the documented broad economic diversification. Given the discrete size and composition of the Formative Period settlements, including probably no more than a few households, it seems that most people were involved in a broad range of economic exploitation tasks. Specialization in any of these tasks consequently seems unlikely. For the moment, it can be speculated that Formative Period Wankarani cultural complex involved multi-tasking and a broad diet breadth as a risk management strategy. Paleoenvironmental data suggest that there were significant environmental fluctuations during the Late Formative Period including a significant decrease of Lake Titicaca's surface (Abbott et al. 1997; Baker et al. 2001, 2005). Although the impact of climate change during this period was less pronounced in the central altiplano (Placzek et al. 2006; Rigsby et al. 2005), these factors could have contributed to making the region increasingly climatically unpredictable, encouraging implementation of risk management strategies.

I hypothesize that camelid herding was the main economic activity at Iroco during the Formative Period, but that a wide range of other resources were also procured and consumed. Complementary livelihood strategies dynamically balanced camelid pastoralism with seasonal and opportunistic harvesting of wildlife available in different patches and highly localized ecosystems as well as cultivation of chenopods and tubers. Grazing, fishing and hunting (waterfowl, rodents, vicuña, deer and other wildlife) are activities that require different types of scheduling, abilities, tools, and ecosystems, many of them relatively accessible from Iroco. The broad spectrum of resources used could be interpreted as part of a complex system of risk management that articulated camelid pastoralism with an efficient integrated use of diverse and scattered wildlife resources and cultivated and wild plants.

The data suggest that the economic diversity of pastoralism at Formative Period sites was substantially higher than expected. Considering the temporal depth of sites associated with the Formative Period of the central altiplano, economic diversification articulated with a pastoral economy would have been an effective risk management strategy. Still, the variety and abundance of wild animal resources at Iroco also indicates the importance of economic diversification as a strategy of ecological adaptation. Given various similarities both in subsistence patterns and spatial organization (e.g., distribution and location of settlements, construction technology, etc.), it is likely that several of the adaptive responses employed by Aymara and Uru-Chipaya groups during the ethnohistoric and ethnographic past (Horn 1984; Molina Rivero 2006; Wachtel 2001) were initially applied by herders during the Formative Period. These patterns have a common source, determined by environmental factors and social environment that favored the selection of similar responses.

Finally, although this dissertation confirms that the people of the Formative Period Wankarani cultural complex were pastoralists, it also proposes an increasingly sophisticated understanding of this mode of subsistence. The people of the Wankarani cultural complex relied predominantly on camelid pastoralism, but also on resources derived from fishing, hunting, and cultivation. In fact, the Wankarani cultural complex economy significantly relied on wild resources. Camelids alone seem to have been insufficient to sustain the local populations and consequently the diet breadth of these herders was broader than assumed. Scheduled fishing and hunting trips were probably more frequent than encounter-based opportunistic foraging. The settlement system of the Wankarani was increasingly more complex than previously assumed. Detailed survey documented dozens of herding camps attached to discrete residential bases and suggested that village life was probably not the rule, but rather the exception during the Formative Period in the central altiplano. Yet, it was the incorporation of herding populations into the Tiwanaku political economy sphere –more than political incorporation into an expanding empire– that probably incentivized the development of specialized pastoralism with increased llama caravan inter-regional exchange.

10.4. Epilogue: Pastoralism in the Central Altiplano Today, 2011

Pastoralism in the Andean highlands persists today. Thousands of Aymara, Quechua, Uru, and mestizo families rely on their herds of llamas and alpacas and have willingly adopted sheep, cattle, pigs, and donkeys, as a significant component of their economic subsistence (López García 2003). Several of these families also practice extensive agriculture of traditional crops (such as quinoa and potatoes), but have also adopted new cultigens and have benefited from industrial innovations such as fertilizers, pesticides, tractors, and artificial irrigation. Some Uru families even continue fishing and occasionally hunting coots, ducks, and flamingos (Molina Rivero 2006; Rocha Olivo 2002; Wachtel 2001). Although it is true that most if not all of these people are articulated into larger market economies and have been strongly affected by acculturation, marginalization and globalization, they have also managed to preserve some essential components of their identity and ethos (Abercrombie 1998; Medinacelli 2010). Even though indigenous identity has been fluctuating as new economic opportunities materialize with migration and professionalization, a connection with their herds and landscape persists. People still celebrate festivities by sharing and eating camelid-based meals and if available, they sacrifice llamas before beginning any significant stage of their life. Even houses at the outskirts of modern cities resemble residential bases more than typical peri-urban homes.

Despite the fact that urban indigenous populations have substantially increased, redefining their identities and creating new material ties, rural lives persists in the Andean highlands. Pastoralists still continue to take care of their herds and they still struggle to overcome environmental and social risks. Although a plethora of development projects aimed at supporting the local economies have been implemented, their results have been mixed, some more successful than others (Bolton 2006). For instance, llama and alpaca herders have benefited from a greater openness to eating llama meat by urban peoples as well as by increasing markets for wool and textiles (Sammels 1998). A great success story has been the preservation of the vicuña, which in the 1970s was nearing extinction, but is now managed and sheared by Andean herders employing pre-Hispanic techniques (Rocha Olivo 2002). Pastoralists continue to be extremely mobile people and although caravans of llamas have been replaced by trucks and buses, goods from the highlands (such as meat and salt) continue to travel to the lowlands and vice versa (such as maize and chili-peppers). People also travel to towns and cities to sell goods and their labor, returning during moments of increased labor necessity, local festivities or even when urban conditions become unbearable. Moreover, the caravan ethos has also metamorphosed in the middlemen and some families who control a fair portion of the transport and commerce businesses. They are particularly concerned with the importation of goods from Chile; this includes manufactured commodities from overseas. For instance, some families that buy and sell electronics manage large sums of money, yet continue to live on residential bases and herd their animals on a daily basis.

But with new opportunities also come new problems. Global warming, for instance has produced major melting of the Andean mountain glaciers and water supplies have started to become a major issue as permanent streams and springs begin to dry up. Precipitation has also become increasingly unpredictable and increasingly harsh. The number of days with hail and snow (possibly due to deforestation in Amazonia), has been reportedly increasing bringing along massive herd mortalities. Being a pastoralist has never been easy; as we have seen, in its beginnings herders relied on wild resources to complement their economy while today they rely on commerce and selling their labor. Nevertheless, pastoralism continues to be an essential component of their culture and economy and it seems it will continue to be so in the future.

In a recent publication, Gonzáles-Ruibal, Hernando, and Politis (2011) explore how the Awá indigenous people from the Brazilian Amazon persist in the manufacture and use of bows and arrows, in spite of the availability of more efficient hunting and subsistence technologies. These authors argue that by making, maintaining, and using bows and arrows, the Awá men reproduce their sense of being and identity. This process, defined as ontology of the self, is an epistemological entanglement between place, materiality, practice, identity, and ethos. After all, being an Awá is being a bow and arrow hunter. In the same way, the identity of many altiplano Aymara and Quechua indigenous herders is still strongly connected to pastoralist activities such as herding, maintaining corrals, spinning wool, weaving textiles, and ritualized acts of remembering, through which they invigorate their identity and their connection to their landscape and their deep past. Embedded in this process emerged the leadership of Evo Morales Ayma, who born as an Andean herder from the central altiplano, in 2002 and nearly 500 years after the Spanish conquest of the Andes, became Bolivia’s first indigenous president.

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APPENDIX 1. SETTLEMENTS RECORDED DURING SURVEY

Site	East	North	Elevation	Perimeter	Area (m2)	Area (ha)	Archaic	Formative	Tiwanaku	LIP	Inca	Colonial	Republican	Indet	Lithics	Ceramics
KCH01	694807	8012354	3717	315.11	6964	0.696	0	0	1	1	0	0	0	0	10	13
KCH02	694871	8011990	3704	27.79	60	0.006	0	0	0	0	0	0	0	1	0	5
KCH03	694591	8012029	3693	36.57	100	0.010	0	1	0	0	0	0	0	1	8	11
KCH04	694630	8012135	3695	41.52	132	0.013	0	0	0	0	0	0	0	1	1	16
KCH05	694894	8011390	3724	158.97	1461	0.146	0	0	0	1	0	0	0	0	8	6
KCH06	694550	8010647	3700	247.47	4018	0.402	0	0	1	1	0	1	1	0	6	22
KCH07	694401	8010828	3698	112.68	988	0.099	0	0	0	0	0	1	1	0	0	18
KCH08	694280	8011244	3697	92.00	652	0.065	0	0	0	0	0	0	1	0	0	0
KCH09	694940	8011612	3717	62.54	288	0.029	0	0	0	0	0	0	1	1	3	16
KCH10	694998	8011426	3727	267.70	4432	0.443	0	0	1	0	1	1	1	1	6	17
KCH11	694223	8011764	3692	350.31	8531	0.853	0	1	1	1	0	0	1	0	7	15
KCH12	695231	8012460	3700	94.71	692	0.069	0	0	0	1	0	0	0	1	6	32
KCH13	695315	8012540	3704	277.98	5778	0.578	0	0	1	0	1	0	0	1	12	21
KCH14	695390	8012605	3703	135.48	1414	0.141	0	0	0	0	0	0	1	1	1	15
KCH15	695476	8012721	3711	104.40	783	0.078	0	0	0	0	0	0	1	0	0	0
KCH16	695630	8013130	3711	207.81	3133	0.313	0	0	1	1	0	0	0	1	6	19
KCH17	695640	8013300	3703	198.79	2442	0.244	0	0	1	1	0	1	1	0	1	18
KCH18	695599	8013996	3701	117.88	1063	0.106	0	1	0	0	0	0	0	0	0	9
KCH19	695560	8014370	3701	42.37	136	0.014	0	1	0	0	0	0	0	0	1	13
KCH20	695373	8013916	3690	377.23	10123	1.012	1	1	0	0	0	0	0	0	20	1
KCH21	695474	8013293	3704	266.96	5519	0.552	0	1	0	0	0	0	0	0	6	16
KCH22	695369	8013044	3695	185.11	2663	0.266	0	1	1	0	0	1	1	0	4	13
KCH23	695221	8012952	3703	406.15	12287	1.229	0	0	1	0	0	0	0	1	1	22
KCH24	694890	8012660	3694	472.30	13926	1.393	0	0	1	1	1	0	0	0	0	16
KCH25	694562	8011546	3708	8.78	5	0.001	0	0	0	0	0	0	0	1	0	0
KCH26	694194	8017527	3695	56.76	244	0.024	1	0	0	0	0	0	0	0	16	0
KCH27	694089	8017508	3693	76.49	433	0.043	0	0	0	0	0	0	0	1	1	0
KCH28	694038	8017572	3691	32.46	70	0.007	0	1	0	0	0	0	0	0	4	10
KCH29	694089	8017640	3690	109.37	766	0.077	1	0	1	0	0	0	0	0	42	3
KCH30	695873	8012032	3864	232.79	3723	0.372	0	0	0	0	0	0	1	1	2	3
KCH31	695495	8012256	3750	243.01	3902	0.390	0	0	1	0	0	0	0	0	0	5
KCH32	695540	8012333	3747	226.19	2516	0.252	0	0	1	0	1	0	0	0	9	12
KCH33	695568	8012594	3722	116.53	761	0.076	0	0	1	0	0	0	0	1	2	3
KCH34	695623	8012767	3719	306.15	4761	0.476	0	1	1	1	0	1	0	0	6	26
KCH35	695652	8012913	3712	325.52	7190	0.719	0	1	1	0	0	1	1	0	1	52
KCH36	693956	8017707	3685	76.23	411	0.041	1	0	0	0	0	0	0	0	15	0
KCH37	693814	8017874	3684	58.67	233	0.023	1	0	0	0	0	0	0	0	26	0
KCH38	693769	8017994	3693	44.88	139	0.014	1	0	0	0	0	0	0	0	28	0
KCH39	693717	8018034	3699	81.40	418	0.042	0	1	0	0	1	0	0	0	26	4
KCH40	693766	8017934	3688	67.91	341	0.034	0	0	0	0	1	0	0	0	1	4
KCH41	693739	8017921	3691	32.37	77	0.008	1	0	0	0	0	0	0	0	14	0
KCH42	693781	8017850	3687	55.38	226	0.023	0	0	0	1	0	0	0	0	1	2
KCH43	693714	8017789	3700	231.67	2609	0.261	0	1	0	0	0	1	0	0	62	30
KCH44	693818	8017625	3707	88.59	406	0.041	0	1	0	0	0	0	0	0	1	18
KCH45	693975	8017511	3696	51.79	189	0.019	0	1	0	0	1	0	0	0	9	7
KCH46	694021	8017476	3695	45.95	158	0.016	1	0	0	0	0	0	0	0	12	0
KCH47	693923	8017495	3696	52.43	208	0.021	1	0	0	0	0	1	0	0	9	1
KCH48	693749	8017565	3697	136.88	1306	0.131	0	1	0	0	1	0	0	0	19	21
KCH49	693484	8017650	3695	34.96	85	0.009	1	0	0	0	0	0	0	0	9	0
KCH50	693412	8017664	3693	169.65	1039	0.104	1	1	0	0	0	0	0	0	38	7
KCH51	695588	8017049	3694	179.58	1162	0.116	1	0	0	0	0	0	0	0	30	0
KCH52	695632	8017061	3695	105.27	603	0.060	0	0	0	1	1	0	1	0	2	15
KCH53	695745	8016987	3693	100.06	762	0.076	1	1	0	0	1	0	0	0	41	3
KCH54	695714	8016823	3687	536.77	17794	1.779	1	1	0	0	1	0	0	1	55	16
KCH55	695619	8017204	3697	46.27	162	0.016	1	0	0	0	0	0	0	0	55	0
KCH56	695598	8016384	3706	719.01	25419	2.542	0	1	0	1	1	0	0	0	34	18
KCH57	695871	8016354	3734	595.27	18442	1.844	0	0	0	1	0	1	0	0	5	9
KCH58	695971	8016527	3699	82.15	476	0.048	0	0	0	0	0	1	0	0	6	2
KCH59	695595	8015673	3715	315.25	6085	0.609	0	1	0	1	0	0	0	0	10	25
KCH60	695814	8015642	3712	78.89	449	0.045	0	1	0	0	0	0	1	0	0	16
KCH61	695785	8015779	3710	36.56	103	0.010	0	0	0	1	1	0	1	0	1	18
KCH62	695725	8015958	3702	63.96	306	0.031	0	1	0	0	0	1	0	1	5	11
KCH63	695459	8015882	3696	136.28	1397	0.140	0	1	0	0	1	1	0	0	0	10
KCH64	695498	8016000	3695	265.71	4197	0.420	0	1	0	0	0	0	0	0	12	7
KCH65	695804	8016090	3712	94.48	686	0.069	1	0	0	0	0	0	0	0	13	0
KCH66	695854	8016076	3715	169.58	1626	0.163	0	0	0	0	0	0	1	1	0	14
KCH67	695420	8015923	3692	91.23	558	0.056	0	1	0	0	0	0	0	0	49	9
KCH68	695347	8015468	3720	181.94	2451	0.245	0	0	0	0	0	0	1	1	2	17
KCH69	695248	8015396	3711	230.37	3617	0.362	0	1	0	0	0	0	0	0	5	6

Site	East	North	Elevation	Perimeter	Area (m2)	Area (ha)	Archaic	Formative	Tiwanaku	LIP	Inca	Colonial	Republican	Indet	Lithics	Ceramics
KCH70	695220	8015328	3697	64.27	298	0.030	1	0	0	0	0	0	0	0	48	0
KCH71	695445	8015381	3707	279.46	2955	0.295	0	0	0	0	0	0	1	0	0	1
KCH72	695611	8015339	3691	66.26	334	0.033	0	0	0	0	0	0	1	0	4	12
KCH73	695658	8015416	3699	57.36	251	0.025	0	0	0	0	1	0	0	0	4	5
KCH74	695759	8015353	3701	95.00	627	0.063	0	0	0	0	0	1	0	0	4	5
KCH75	695898	8015245	3707	74.44	405	0.040	0	0	0	0	0	0	1	0	0	2
KCH76	695830	8015225	3697	88.34	585	0.059	0	0	0	0	1	0	1	0	3	10
KCH77	695896	8014935	3697	65.31	314	0.031	0	0	0	1	0	0	1	1	5	8
KCH78	695832	8015081	3694	141.44	1173	0.117	0	0	0	1	0	0	1	0	2	4
KCH79	695796	8014935	3698	185.56	2554	0.255	0	0	1	0	1	0	0	0	6	12
KCH80	695700	8015032	3694	95.83	624	0.062	0	0	0	0	0	0	1	0	0	7
KCH81	695540	8014510	3695	166.25	2019	0.202	0	0	0	0	0	1	0	0	5	7
KCH82	695887	8012826	3712	130.82	1086	0.109	0	0	0	0	0	1	0	0	0	1
KCH83	696006	8012879	3712	185.16	2591	0.259	0	0	0	0	0	0	1	0	0	0
KCH84	697779	8016726	3701	86.60	573	0.057	0	0	0	0	1	0	0	1	7	23
KCH85	697690	8016739	3699	94.79	589	0.059	0	0	0	0	0	1	0	1	4	29
KCH86	697714	8016950	3701	71.23	361	0.036	0	1	0	0	0	0	0	0	11	7
KCH87	697716	8016993	3699	59.86	251	0.025	1	0	0	0	0	0	0	0	13	1
KCH88	697616	8017113	3694	58.61	260	0.026	0	0	0	1	0	0	0	1	4	5
KCH89	697555	8017098	3698	80.62	489	0.049	0	1	0	0	0	0	0	0	14	6
KCH90	697520	8017086	3699	116.43	1008	0.101	0	1	0	0	0	0	0	0	6	19
KCH91	696622	8016598	3694	108.78	879	0.088	1	0	0	0	0	0	0	0	7	0
KCH92	696553	8016657	3698	74.69	405	0.041	1	0	0	1	0	0	0	0	21	3
KCH93	696463	8016902	3697	63.75	305	0.030	1	0	0	0	0	0	0	0	2	0
KCH94	696436	8016726	3696	103.06	804	0.080	0	0	0	1	0	0	0	0	6	2
KCH95	696474	8016585	3697	241.19	3159	0.316	1	0	0	0	0	0	0	0	33	0
KCH96	696466	8016790	3700	147.15	698	0.070	0	0	0	0	1	0	0	0	0	20
KCH97	696461	8016534	3700	64.35	285	0.029	1	0	0	0	0	0	1	0	4	3
KCH98	696518	8016379	3698	161.87	1720	0.172	0	0	0	1	0	0	1	0	0	5
KCH99	696539	8016387	3697	27.33	56	0.006	0	0	0	0	0	0	1	0	0	6
KCH100	696472	8016355	3698	140.91	1038	0.104	0	0	0	0	0	1	1	0	0	10
KCH101	696457	8016427	3699	125.44	955	0.095	1	0	0	0	0	0	0	1	5	3
KCH102	696601	8016412	3695	179.12	2296	0.230	0	0	0	1	0	0	0	0	4	5
KCH103	696588	8016338	3695	127.94	843	0.084	0	0	0	1	0	1	0	0	0	9
KCH104	696519	8015568	3698	501.47	16543	1.654	0	0	0	0	0	1	1	0	0	10
KCH105	696419	8015868	3690	233.15	4158	0.416	0	0	1	1	0	0	0	0	0	13
KCH106	696208	8016973	3693	192.25	2413	0.241	0	1	0	1	0	0	0	1	9	9
KCH107	696145	8016965	3696	81.79	510	0.051	0	0	0	0	0	0	0	1	2	8
KCH108	696098	8017034	3696	73.37	384	0.038	1	0	0	0	0	0	0	0	6	0
KCH109	696030	8017101	3697	78.44	426	0.043	0	0	0	1	0	0	0	0	3	14
KCH110	696021	8017131	3698	52.12	186	0.019	1	0	0	0	0	1	0	0	6	2
KCH111	695999	8017205	3699	182.59	1845	0.185	1	0	0	0	0	0	0	0	18	0
KCH112	695841	8017421	3695	44.22	148	0.015	1	0	0	0	0	0	0	0	15	0
KCH113	695872	8017267	3694	186.01	2527	0.253	1	1	0	0	0	0	0	0	32	10
KCH114	695813	8017220	3691	224.27	2848	0.285	1	0	0	0	0	0	0	0	9	0
KCH115	695893	8017115	3692	155.27	1624	0.162	1	0	0	0	0	0	0	1	19	2
KCH116	695888	8017033	3694	174.98	1760	0.176	0	0	0	0	1	1	0	0	3	10
KCH117	696172	8016710	3696	114.76	897	0.090	0	1	0	1	0	0	0	0	5	7
KCH118	696169	8016750	3697	60.87	237	0.024	0	1	0	0	0	0	0	1	9	3
KCH119	695975	8017007	3699	53.93	201	0.020	1	0	0	0	0	0	0	0	11	0
KCH120	695836	8016936	3700	95.69	682	0.068	0	1	0	1	0	0	0	0	5	11
KCH121	695880	8016862	3706	312.18	5887	0.589	0	1	0	1	0	0	0	0	12	19
KCH122	696180	8016590	3698	90.17	594	0.059	0	0	0	1	1	0	0	0	1	5
KCH123	697182	8017246	3693	101.34	751	0.075	0	0	0	1	0	0	0	1	7	5
KCH124	697466	8017131	3697	329.21	6184	0.618	0	0	1	0	0	0	0	0	9	10
KCH125	697750	8016286	3709	77.06	297	0.030	0	1	0	0	0	0	0	0	3	7
KCH126	697674	8016294	3705	95.28	532	0.053	0	1	0	0	0	0	0	0	2	8
KCH127	697605	8016213	3700	192.24	2579	0.258	0	1	1	1	0	0	0	0	5	12
KCH128	697539	8016121	3703	211.47	2890	0.289	0	0	1	0	0	0	0	0	7	4
KCH129	697492	8016072	3701	91.46	535	0.053	1	0	0	0	0	0	0	0	5	1
KCH130	696765	8015632	3696	126.21	1162	0.116	1	0	0	1	0	1	0	0	9	12
KCH131	697089	8016534	3695	424.22	6298	0.630	1	1	0	0	0	0	0	0	23	23
KCH132	697166	8016736	3692	313.72	4501	0.450	0	1	0	0	0	0	0	1	8	11
KCH133	697412	8016821	3700	105.73	727	0.073	0	0	0	0	0	0	1	0	1	12
KCH134	696379	8015217	3707	349.46	5189	0.519	0	0	0	0	0	0	1	0	1	16
KCH135	696157	8014058	3701	228.21	2962	0.296	0	0	0	0	1	0	0	0	3	12
KCH136	696367	8014337	3699	270.52	4717	0.472	0	0	0	0	0	0	1	1	0	1
KCH137	696488	8014682	3697	300.10	6485	0.649	0	0	0	0	1	0	0	0	1	10
KCH138	693579	8007435	3687	198.36	2907	0.291	0	0	0	1	0	1	0	0	2	19
KCH139	693571	8007348	3684	99.56	683	0.068	0	0	0	1	0	1	0	0	0	13

Site	East	North	Elevation	Perimeter	Area (m2)	Area (ha)	Archaic	Formative	Tiwanaku	LIP	Inca	Colonial	Republican	Indet	Lithics	Ceramics
KCH140	693584	8007892	3699	144.72	1266	0.127	0	0	0	0	1	1	0	0	0	29
KCH141	693589	8007965	3700	185.85	1700	0.170	0	0	0	0	0	1	0	0	0	29
KCH142	693530	8008065	3689	220.74	2235	0.224	0	0	0	0	1	1	0	0	1	13
KCH143	693516	8008182	3690	61.98	238	0.024	0	0	0	0	0	1	0	0	0	4
KCH144	693565	8008247	3691	84.87	526	0.053	0	0	0	0	0	1	0	0	0	11
KCH145	693572	8008594	3698	112.55	840	0.084	0	0	0	0	0	1	0	0	2	14
KCH146	693804	8009057	3696	84.71	465	0.047	0	0	0	0	1	0	1	1	0	12
KCH147	693827	8009113	3698	112.22	808	0.081	0	0	0	1	1	0	1	0	4	13
KCH148	693774	8009019	3698	69.63	308	0.031	0	0	0	1	0	0	1	0	1	14
KCH149	694031	8009161	3705	271.07	3377	0.338	0	0	0	0	1	1	0	0	0	20
KCH150	694151	8009307	3706	102.23	691	0.069	0	0	0	0	1	1	0	0	0	28
KCH151	694204	8009424	3710	107.55	878	0.088	0	0	0	1	1	0	1	0	1	20
KCH152	694209	8009506	3717	95.19	614	0.061	0	0	0	1	0	1	0	0	0	12
KCH153	694231	8009739	3708	124.38	1107	0.111	0	0	0	0	0	0	1	0	0	4
KCH154	693860	8009919	3692	96.15	649	0.065	0	0	0	1	1	0	0	0	1	7
KCH155	693836	8010071	3696	222.95	3322	0.332	0	0	1	0	0	0	1	0	1	7
KCH156	694647	8007640	3692	133.78	1145	0.114	0	0	0	0	0	0	1	0	0	5
KCH157	694714	8007690	3697	290.87	5433	0.543	0	1	0	0	1	1	0	0	33	15
KCH158	694790	8007672	3699	146.56	1089	0.109	0	1	0	1	1	1	0	0	7	5
KCH159	694958	8007516	3713	103.02	665	0.067	0	0	0	1	0	0	1	0	0	6
KCH160	694935	8007558	3714	96.96	636	0.064	0	1	1	1	0	1	0	0	3	16
KCH161	695101	8007306	3711	97.97	680	0.068	0	0	0	0	0	0	1	0	0	12
KCH162	695058	8007265	3707	147.65	1409	0.141	0	1	0	1	0	0	1	0	0	14
KCH163	695036	8007322	3711	102.15	625	0.063	0	0	0	0	0	0	1	0	0	1
KCH164	694858	8007274	3708	108.07	836	0.084	0	0	0	1	0	0	0	0	7	7
KCH165	694581	8006915	3690	105.54	810	0.081	0	0	0	0	0	0	1	0	1	12
KCH166	694715	8007143	3703	155.98	1598	0.160	0	0	0	0	0	0	1	1	0	5
KCH167	694931	8007005	3693	194.77	2630	0.263	0	0	0	0	0	0	1	0	1	2
KCH168	695102	8007237	3705	154.72	1404	0.140	0	0	0	0	0	1	1	0	0	13
KCH169	695174	8007306	3721	108.22	518	0.052	0	0	0	1	1	1	0	0	2	24
KCH170	695196	8007218	3718	125.58	718	0.072	0	0	0	1	0	1	0	0	1	13
KCH171	695236	8007176	3720	119.57	947	0.095	0	0	0	0	0	1	0	1	2	8
KCH172	695034	8006961	3692	71.04	346	0.035	0	0	0	0	0	1	0	0	0	12
KCH173	695225	8006746	3691	297.86	5748	0.575	0	0	1	0	0	0	0	0	15	13
KCH174	695370	8006699	3692	311.85	4761	0.476	0	0	0	1	0	0	1	0	0	9
KCH175	695590	8006079	3688	128.55	1184	0.118	0	0	0	0	0	0	1	0	0	3
KCH176	695620	8005830	3689	140.07	1144	0.114	0	0	0	0	0	0	1	0	1	0
KCH177	693691	8007162	3701	504.34	15242	1.524	0	0	0	1	1	1	0	0	6	93
KCH178	693891	8007531	3708	1324.99	87232	8.723	0	0	0	1	1	0	0	0	14	53
KCH178	693951	8007383	3700	181.23	1755	0.175	0	0	0	0	0	0	1	0	0	0
KCH179	693589	8006909	3687	128.76	1150	0.115	0	1	1	0	1	1	0	0	0	40
KCH180	693712	8007019	3702	325.08	4992	0.499	0	0	0	0	0	1	0	0	1	13
KCH181	694052	8008102	3699	156.28	1645	0.164	0	0	0	0	0	0	1	0	7	9
KCH182	694182	8008211	3702	499.07	16216	1.622	0	0	0	0	1	0	1	1	0	21
KCH183	694056	8007878	3694	169.01	1903	0.190	0	0	0	0	0	0	1	0	1	2
KCH184	694730	8008171	3719	104.11	642	0.064	0	0	0	1	1	0	0	0	3	13
KCH185	694521	8008241	3707	176.39	1673	0.167	0	0	0	0	1	1	0	0	0	11

APPENDIX 2. EXCAVATED LOCI AND PROVENIENCE INFORMATION

Site	Component	Locus	Unit	Event	Cultural Context	Area	Vol	Excavation Date
KCH20	KCH20Arch	600	600	D01	Occupation surface	5		08/03/2005
KCH20	KCH20Arch	601	600	D02	Pit filled with ash and trash	5		08/03/2005
KCH20	KCH20Arch	602	600	D03	Culturally sterile fill	5		08/03/2005
KCH21	KCH21Tiw	100	1	A01	Root zone	16		05/12/2005
KCH21	KCH21Tiw	101	1	A02	Isolated rock wall W	16		05/12/2005
KCH21	KCH21Tiw	102	1	A03	Occupation surface	16		05/12/2005
KCH21	KCH21Tiw	103	1	A04	Isolated wall of rocks E	16		05/12/2005
KCH21	KCH21Tiw	200	2	A01	Root zone	16		05/12/2005
KCH21	KCH21Tiw	201	2	A02	Isolated rock wall NW	16		05/15/2005
KCH21	KCH21Tiw	202	2	A03	Occupation surface with storage jar	16		05/14/2005
KCH21	KCH21Tiw	203	2	A03	Occupation surface N	16		05/15/2005
KCH21	KCH21FB	204	2	A05	Cultural fill	16		05/18/2005
KCH21	KCH21FB	205	2	A05	Cultural fill	16		06/15/2005
KCH21	KCH21FB	206	2	A05	Cultural fill	16		06/15/2005
KCH21	KCH21FB	207	2	A05	Cultural fill with ground stone	16		06/17/2005
KCH21	KCH21FB	208	2	A05	Cultural fill	16		06/17/2005
KCH21	KCH21FB	209	2	A06	Fill above floor Structure 7	16		06/17/2005
KCH21	KCH21FB	210	2	A07	Wall Structure 7	16		06/19/2005
KCH21	KCH21FB	211	2	A09	Occupation surface	16		06/19/2005
KCH21	KCH21FB	212	2	A08	Floor Structure 7	16		06/19/2005
KCH21	KCH21Tiw	300	3	A01	Root zone	16		05/12/2005
KCH21	KCH21Tiw	301	3	A03	Occupation surface	16		05/15/2005
KCH21	KCH21FB	302	3	A09	Occupation surface	16		05/29/2005
KCH21	KCH21FA	303	3	A17	Occupation surface	16		05/30/2005
KCH21	KCH21Tiw	400	4	A01	Root zone	16		05/12/2005
KCH21	KCH21Tiw	500	5	A01	Root zone	16		05/13/2005
KCH21	KCH21Tiw	501	5	A03	Occupation surface	16		05/15/2005
KCH21	KCH21Tiw	502	5	A03	Occupation surface with storage jar	16		05/17/2005
KCH21	KCH21FB	503	5	A05	Cultural fill	16		05/15/2005
KCH21	KCH21FB	504	5	A15	Wall Structure 3 S	16		06/12/2005
KCH21	KCH21FB	505	5	A09	Occupation surface	16		06/12/2005
KCH21	KCH21FA	506	5	A16	Cultural fill, dense like midden	16		06/12/2005
KCH21	KCH21FA	507	5	A17	Occupation surface	16		06/20/2005
KCH21	KCH21FA	508	5	A18	Pit for storage hoes	16		06/24/2005
KCH21	KCH21Tiw	600	6	A01	Root zone	16		05/15/2005
KCH21	KCH21FB	601	6	A09	Occupation surface	16		05/16/2005
KCH21	KCH21FB	602	6	A80	Isolated rock wall NW	16		05/16/2005
KCH21	KCH21FA	603	6	A16	Cultural fill	16		05/28/2005
KCH21	KCH21FA	604	6	A19	Pit for storage jar	16		05/29/2005
KCH21	KCH21FA	605	6	A20	Isolated hearth	16		05/29/2005
KCH21	KCH21FA	606	6	A17	Occupation surface	16		05/29/2005
KCH21	KCH21FA	607	6	A21	Wall Structure 9 NW	16		05/29/2005
KCH21	KCH21FA	608	6	A22	Floor Structure 8 NE	16		05/29/2005
KCH21	KCH21FA	609	6	A23	Floor Structure 9 NW	16		06/02/2005
KCH21	KCH21Tiw	700	7	A01	Root zone	16		05/15/2005
KCH21	KCH21FB	701	7	A09	Occupation surface	16		05/15/2005
KCH21	KCH21FA	702	7	A16	Cultural fill	16		06/18/2005
KCH21	KCH21FA	703	7	A17	Occupation surface	16		06/20/2005
KCH21	KCH21FA	704	7	A22	Floor Structure 8 NW	16		06/20/2005
KCH21	KCH21FA	705	7	A17	Occupation surface with ground stone	16		06/20/2005
KCH21	KCH21FA	706	7	A24	Floor Structure 10 W	16		06/20/2005
KCH21	KCH21Tiw	800	8	A01	Root zone	16		05/15/2005
KCH21	KCH21Tiw	801	8	A03	Occupation surface	16		05/16/2005
KCH21	KCH21FB	802	8	A05	Cultural fill	16		05/17/2005
KCH21	KCH21FB	803	8	A25	Wall Structure 1 SE	16		05/19/2005
KCH21	KCH21FB	804	8	A26	Fill above floor Structure 1 SE with camelid bones	16		05/19/2005
KCH21	KCH21FB	805	8	A27	Burial 5	16		05/23/2005
KCH21	KCH21FB	806	8	A09	Occupation Surface	16		05/23/2005
KCH21	KCH21FB	807	8	A28	Burial 8 with stones	16		05/23/2005
KCH21	KCH21FB	808	8	A28	Burial 8	16		05/23/2005
KCH21	KCH21FB	809	8	A29	Burial 9	16		05/23/2005
KCH21	KCH21Tiw	900	9	A01	Root zone	16		05/16/2005
KCH21	KCH21FB	901	9	A09	Occupation surface	16		05/17/2005
KCH21	KCH21FA	902	9	A16	Cultural fill	16		05/26/2005
KCH21	KCH21FA	903	9	A30	Pit with camelid bones, offering Burial 3	16		05/26/2005
KCH21	KCH21FA	904	9	A31	Isolated hearth	16		05/28/2005
KCH21	KCH21FA	905	9	A72	Fill above floor Structure 8 N	16		06/10/2005
KCH21	KCH21FA	906	9	A32	Isolated hearth	16		06/21/2005
KCH21	KCH21FA	907	9	A33	Wall Structure 8 N	16		05/28/2005
KCH21	KCH21Tiw	1000	10	A01	Root zone	16		05/17/2005
KCH21	KCH21FB	1001	10	A05	Cultural fill	16		05/15/2005
KCH21	KCH21FB	1002	10	A25	Wall Structure 1 S	16		05/15/2005

Site	Component	Locus	Unit	Event	Cultural Context	Area	Vol	Excavation Date
KCH21	KCH21FB	1003	10	A09	Occupation surface	16		05/15/2005
KCH21	KCH21FB	1004	10	A34	Burial 1	16		05/18/2005
KCH21	KCH21FB	1005	10	A26	Fill above floor Structure 1 S with camelid bones	16		05/20/2005
KCH21	KCH21FB	1006	10	A35	Burial 6	16		05/24/2005
KCH21	KCH21FB	1007	10	A36	Burial 7	16		05/26/2005
KCH21	KCH21FB	1008	10	A36	Burial 7 base	16		05/27/2005
KCH21	KCH21FB	1009	10	A37	Burial 2	16		06/13/2005
KCH21	KCH21FB	1010	10	A38	Burial 11	16		06/16/2005
KCH21	KCH21FB	1011	10	A39	Floor Structure 1 S	16		06/16/2005
KCH21	KCH21Tiw	1100	11	A01	Root zone	16		05/17/2005
KCH21	KCH21FB	1101	11	A09	Occupation surface	16		05/17/2005
KCH21	KCH21FA	1102	11	A16	Cultural fill	16		05/20/2005
KCH21	KCH21FB	1103	11	A40	Burial 3	16		05/21/2005
KCH21	KCH21FA	1104	11	A16	Cultural fill	16		05/24/2005
KCH21	KCH21FA	1105	11	A17	Occupation surface	16		05/24/2005
KCH21	KCH21FA	1106	11	A41	Adobe wall fall N	16		05/22/2005
KCH21	KCH21FA	1107	11	A42	Wall Structure 6 E	16		05/25/2005
KCH21	KCH21FA	1108	11	A99	Pit S	16		05/25/2005
KCH21	KCH21Tiw	1200	12	A01	Root zone	16		05/18/2005
KCH21	KCH21Tiw	1201	12	A03	Occupation surface	16		05/20/2005
KCH21	KCH21FB	1202	12	A05	Cultural fill	16		05/20/2005
KCH21	KCH21FB	1203	12	A05	Cultural fill	16		05/21/2005
KCH21	KCH21FB	1204	12	A43	Burial 4	16		05/22/2005
KCH21	KCH21FB	1205	12	A05	Cultural fill	16		06/12/2005
KCH21	KCH21FB	1206	12	A25	Wall Structure 1 E	16		06/12/2005
KCH21	KCH21FB	1207	12	A05	Cultural fill	16		06/12/2005
KCH21	KCH21FB	1208	12	A44	Fill above floor Structure 3 N	16		06/13/2005
KCH21	KCH21FB	1209	12	A09	Occupation surface	16		06/14/2005
KCH21	KCH21FB	1210	12	A45	Floor Structure 3 N	16		06/14/2005
KCH21	KCH21FB	1211	12	A46	Isolated adobe wall fall E	16		06/14/2005
KCH21	KCH21Tiw	1300	13	A01	Root zone	16		05/19/2005
KCH21	KCH21FB	1301	13	A05	Cultural fill	16		05/20/2005
KCH21	KCH21FB	1302	13	A25	Wall Structure 1 SE	16		05/20/2005
KCH21	KCH21FB	1303	13	A05	Cultural fill with storage jar	16		05/20/2005
KCH21	KCH21FB	1304	13	A09	Occupation surface with camelid bones	16		05/21/2005
KCH21	KCH21FB	1305	13	A47	Burial 10	16		05/21/2005
KCH21	KCH21Tiw	1400	14	A01	Root zone	16		05/19/2005
KCH21	KCH21FB	1401	14	A05	Cultural fill with cobbles	16		05/19/2005
KCH21	KCH21Tiw	1500	15	A01	Root zone	16		05/21/2005
KCH21	KCH21FB	1501	15	A25	Wall Structure 1 W	16		05/21/2005
KCH21	KCH21Tiw	1600	16	A01	Root zone	16		05/22/2005
KCH21	KCH21FB	1601	16	A09	Occupation surface	16		06/15/2005
KCH21	KCH21FA	1602	16	A16	Cultural fill	16		06/18/2005
KCH21	KCH21FA	1603	16	A48	Fill above floor Structure 5	16		06/18/2005
KCH21	KCH21FA	1604	16	A49	Floor Structure 5	16		06/20/2005
KCH21	KCH21Tiw	1700	17	A01	Root zone	16		05/25/2005
KCH21	KCH21Tiw	1701	17	A03	Occupation surface	16		05/25/2005
KCH21	KCH21FB	1702	17	A26	Fill above floor Structure 1 NE	16		05/27/2005
KCH21	KCH21FB	1703	17	A25	Wall Structure 1 NE	16		05/27/2005
KCH21	KCH21Tiw	1800	18	A01	Root zone	20		05/25/2005
KCH21	KCH21FB	1801	18	A25	Wall Structure 1 NE	20		05/26/2005
KCH21	KCH21Tiw	1900	19	A01	Root zone	20		05/23/2005
KCH21	KCH21FB	1901	19	A25	Wall Structure 1 N	20		05/26/2005
KCH21	KCH21Tiw	2000	20	A01	Root zone	20		05/23/2005
KCH21	KCH21FB	2001	20	A25	Wall Structure 1 NW	20		05/25/2005
KCH21	KCH21Tiw	2100	21	A01	Root zone	16		05/29/2005
KCH21	KCH21FB	2101	21	A09	Occupation surface	16		06/03/2005
KCH21	KCH21FA	2102	21	A16	Cultural fill	16		06/03/2005
KCH21	KCH21FA	2103	21	A50	Fill above floor Structure 6	16		06/11/2005
KCH21	KCH21FA	2104	21	A42	Wall Structure 6	16		06/11/2005
KCH21	KCH21FA	2105	21	A51	Floor Structure 6	16		06/11/2005
KCH21	KCH21Tiw	2200	22	A01	Root zone	16		05/29/2005
KCH21	KCH21FA	2201	22	A16	Cultural fill	16		06/03/2005
KCH21	KCH21FA	2202	22	A17	Occupation surface	16		06/11/2005
KCH21	KCH21FA	2203	22	A52	Fill above floor Structure 2	16		06/20/2005
KCH21	KCH21FA	2204	22	A53	Floor Structure 2 including hearth	16		06/20/2005
KCH21	KCH21Tiw	2300	23	A01	Root zone	16		05/29/2005
KCH21	KCH21FA	2301	23	A16	Cultural fill	16		06/03/2005
KCH21	KCH21FA	2302	23	A17	Occupation surface with human cranium	16		06/13/2005
KCH21	KCH21FA	2303	23	A54	Fill above floor Structure 4 W	16		06/17/2005
KCH21	KCH21Tiw	2400	24	A01	Root zone	16		05/29/2005
KCH21	KCH21FA	2401	24	A16	Cultural fill	16		06/03/2005

Site	Component	Locus	Unit	Event	Cultural Context	Area	Vol	Excavation Date
KCH21	KCH21FA	2402	24	A54	Fill above floor Structure 4 E including hearth	16		06/15/2005
KCH21	KCH21FA	2403	24	A55	Hearth and midden Structure 4	16		06/17/2005
KCH21	KCH21FA	2404	24	A56	Wall Structure 4	16		06/17/2005
KCH21	KCH21FA	2405	24	A57	Floor Structure 4	16		06/17/2005
KCH21	KCH21FA	2406	24	A58	Hearth Structure 8	16		06/17/2005
KCH21	KCH21FA	2407	24	A33	Wall Structure 8 S	16		06/17/2005
KCH21	KCH21FA	2408	24	A22	Floor Structure 8 S	16		06/22/2005
KCH21	KCH21Tiw	2500	25	A01	Root zone	16		06/22/2005
KCH21	KCH21FA	2501	25	A69	Sterile	16		06/22/2005
KCH21	KCH21Tiw	4000	26	A01	Root zone	16	2100	09/11/2007
KCH21	KCH21Tiw	4001	26	A01	Root zone	16	425	09/11/2007
KCH21	KCH21Tiw	4002	26	A01	Root zone	16	160	09/12/2007
KCH21	KCH21FA	4003	26	A16	Cultural fill	16	610	09/12/2007
KCH21	KCH21FA	4004	26	A16	Cultural fill	16	1200	09/12/2007
KCH21	KCH21FA	4005	26	A17	Occupation surface	16	410	09/12/2007
KCH21	KCH21Tiw	4006	26	A01	Root zone	16	548	09/13/2007
KCH21	KCH21FA	4007	26	A17	Occupation surface	16	1945	09/14/2007
KCH21	KCH21FB	4050	27	A05	Cultural fill	4	1135	09/14/2007
KCH21	KCH21FB	4051	27	A26	Fill above floor Structure 1 center	4	146	09/14/2007
KCH21	KCH21FB	4052	27	A39	Floor Structure 1 center	4	84	09/14/2007
KCH21	KCH21FB	4053	27	A39	Floor Structure 1 center	4	170	09/15/2007
KCH21	KCH21FA	4054	27	A69	Sterile	4	28	09/15/2007
KCH21	KCH21FB	4055	27	A70	Pit burrow	4	4	09/15/2007
KCH21	KCH21FB	4056	27	A71	Pit burrow	4	2	09/15/2007
KCH21	KCH21FA	4057	27	A69	Sterile	4	96	09/17/2007
KCH21	KCH21FA	4058	27	A69	Sterile	4	403	09/17/2007
KCH21	KCH21Tiw	4060	28	A01	Root zone	3	440	09/18/2007
KCH21	KCH21Tiw	4061	28	A03	Occupation surface	3	46	09/18/2007
KCH21	KCH21FB	4062	28	A05	Cultural fill	3	30	09/18/2007
KCH21	KCH21FB	4063	28	A09	Occupation surface dense like midden	3	35	09/18/2007
KCH21	KCH21FA	4064	28	A16	Cultural fill	3	116	09/18/2007
KCH21	KCH21FA	4065	28	A73	Midden	3	115	09/18/2007
KCH21	KCH21FA	4066	28	A74	Midden with clay	3	45	09/19/2007
KCH21	KCH21FA	4067	28	A75	Pit burrow	3	5	09/19/2007
KCH21	KCH21FA	4068	28	A76	Midden	3	140	09/19/2007
KCH21	KCH21FA	4069	28	A77	Midden	3	92	09/19/2007
KCH21	KCH21FA	4070	28	A78	Midden	3	177	09/20/2007
KCH21	KCH21FA	4071	28	A79	Pit trash	3	54	09/20/2007
KCH21	KCH21FA	4072	28	A17	Occupation surface	3	70	09/20/2007
KCH21	KCH21FA	4073	28	A81	Pit trash fish bones	3	3	09/20/2007
KCH21	KCH21FA	4074	28	A82	Pit burrow	3	0	09/20/2007
KCH21	KCH21FA	4075	28	A69	Sterile	3	63	09/20/2007
KCH21	KCH21FB	4076	28	A26	Fill above floor Structure 1 N	3	202	09/21/2007
KCH21	KCH21FB	4077	28	A39	Floor Structure 1 N	3	20	09/21/2007
KCH21	KCH21FA	4078	28	A69	Sterile	3	53	09/21/2007
KCH21	KCH21FA	4080	26	A59	Pit storage	3	0	09/21/2007
KCH21	KCH21FA	4081	26	A60	Pit trash	3	0	09/21/2007
KCH21	KCH21FA	4082	26	A61	Pit storage deep	3	0	09/21/2007
KCH21	KCH21FA	4083	26	A62	Pit superficial burrow	3	0	09/21/2007
KCH21	KCH21FA	4084	26	A63	Pit trash	3	0	09/21/2007
KCH21	KCH21FA	4085	26	A64	Pit for storage ground stone and hoes	3	27	09/21/2007
KCH21	KCH21FA	4086	26	A65	Pit for storage	3	0	09/21/2007
KCH21	KCH21FA	4087	26	A66	Pit trash	3	0	09/21/2007
KCH21	KCH21FA	4088	26	A67	Pit trash	3	2	09/21/2007
KCH21	KCH21FA	4089	26	A68	Pit superficial burrow	3	2	09/21/2007
KCH21	KCH21FA	4090	26	A17	Occupation surface	3	100	09/21/2007
KCH21	KCH21FA	4091	26	A69	Sterile	3	370	09/24/2007
KCH21	KCH21Tiw	4100	4	A01	Root zone	16	1091	09/17/2007
KCH21	KCH21Tiw	4101	4	A03	Occupation surface	16	1090	09/18/2007
KCH21	KCH21Tiw	4102	4	A03	Occupation surface	16	100	09/19/2007
KCH21	KCH21FB	4103	4	A05	Cultural fill	16	430	09/19/2007
KCH21	KCH21FB	4104	4	A10	Isolated hearth NW	16	30	09/19/2007
KCH21	KCH21FB	4105	4	A05	Cultural fill	16	2230	09/20/2007
KCH21	KCH21FB	4106	4	A12	Isolated adobe wall fall N	16	608	09/26/2007
KCH21	KCH21FA	4107	4	A14	Fill above floor Structure 9 SE	16	0	09/26/2007
KCH21	KCH21FB	4108	4	A11	Isolated hearth E	16	370	09/26/2007
KCH21	KCH21FB	4109	4	A09	Occupation surface	16	0	09/22/2007
KCH21	KCH21FB	4110	4	A13	Isolated adobe wall fall S	16	60	09/22/2007
KCH21	KCH21FB	4111	4	A09	Occupation surface	16	0	09/26/2007
KCH21	KCH21FA	4112	4	A16	Cultural fill	16	900	09/26/2007
KCH21	KCH21FB	4113	4	A09	Occupation surface	16	0	09/26/2007
KCH21	KCH21FA	4114	4	A88	Fill above floor Structure 11	16	0	09/26/2007

Site	Component	Locus	Unit	Event	Cultural Context	Area	Vol	Excavation Date
KCH21	KCH21FA	4115	4	A88	Fill above floor Structure 11	16	178	09/27/2007
KCH21	KCH21FA	4116	4	A16	Cultural fill	16	100	09/27/2007
KCH21	KCH21FA	4117	4	A95	Fill above floor Structure 10	16	610	09/27/2007
KCH21	KCH21FA	4118	4	A87	Pit trash ash	16	15	09/27/2007
KCH21	KCH21FA	4119	4	A86	Pit trash	16	25	09/27/2007
KCH21	KCH21FA	4120	4	A85	Isolated hearth	16	60	09/27/2007
KCH21	KCH21FA	4121	4	A98	Pit trash	16	54	09/27/2007
KCH21	KCH21FA	4122	4	A90	Pit for storage jar	16	60	09/27/2007
KCH21	KCH21FA	4123	4	A96	Pit storage	16	4	09/28/2007
KCH21	KCH21FA	4124	4	A94	Pit storage	16	5	09/27/2007
KCH21	KCH21FA	4125	4	A93	Pit storage	16	22	09/27/2007
KCH21	KCH21FA	4126	4	A89	Pit storage three together	16	25	09/27/2007
KCH21	KCH21FA	4127	4	A23	Floor Structure 9 SE	16	125	09/28/2007
KCH21	KCH21FA	4128	4	A97	Pit storage	16	12	09/29/2007
KCH21	KCH21FA	4129	4	A84	Pit trash	16	64	10/01/2007
KCH21	KCH21FA	4130	4	A83	Pit storage Structure 10	16	31	10/01/2007
KCH21	KCH21FA	4131	4	A91	Floor Structure 11	16	415	10/02/2007
KCH21	KCH21FA	4132	4	A92	Pit for storage jar	16	5	10/02/2007
KCH21	KCH21FA	4133	4	A91	Floor Structure 11	16	0	10/02/2007
KCH21	KCH21FA	4134	4	A17	Occupation surface	16	0	10/02/2007
KCH21	KCH21FA	4135	4	A24	Floor Structure 10 E	16	0	10/02/2007
KCH56	KCH56FA	4150	50	B01	Root zone	16	370	09/25/2007
KCH56	KCH56FA	4151	50	B02	Cultural fill, sandy	16	215	09/25/2007
KCH56	KCH56FA	4152	50	B01	Fill with high density of artifacts, part of root zone	16	390	09/26/2007
KCH56	KCH56FA	4153	50	B02	Cultural fill, sandy	16	710	09/26/2007
KCH56	KCH56FA	4154	50	B03	Cultural fill	16	473	09/27/2007
KCH56	KCH56FA	4155	50	B04	Fill above occupation surface SW	16	230	09/27/2007
KCH56	KCH56FA	4156	50	B04	Fill above occupation surface NW	16	334	09/27/2007
KCH56	KCH56FA	4157	50	B04	Fill above occupation surface SE	16	120	09/27/2007
KCH56	KCH56FA	4158	50	B05	Pit, trash, outside	16	0	09/27/2007
KCH56	KCH56FA	4159	50	B06	Pit, trash, outside	16	0	09/27/2007
KCH56	KCH56FA	4160	50	B07	Cultural fill over floor	16	92	09/28/2007
KCH56	KCH56FA	4161	50	B07	Cultural fill over floor	16	144	09/28/2007
KCH56	KCH56FA	4162	50	B08	Hearth	16	10	09/28/2007
KCH56	KCH56FA	4163	50	B09	Pit, trash interior, camelid bones	16	0	09/28/2007
KCH56	KCH56FA	4164	50	B10	Floor, 2nd floor	16	203	09/28/2007
KCH56	KCH56FA	4165	50	B11	Pit, trash interior, camelid bones	16	13	09/28/2007
KCH56	KCH56FA	4166	50	B12	Hearth	16	0	09/29/2007
KCH56	KCH56FA	4167	50	B13	Pit, ash	16	0	09/29/2007
KCH56	KCH56FA	4168	50	B14	Cultural fill above floor	16	95	09/29/2007
KCH56	KCH56FA	4169	50	B15	Occupation surface	16	125	09/29/2007
KCH56	KCH56FA	4170	50	B16	Floor, 1st house	16	284	10/04/2007
KCH56	KCH56FA	4171	50	B16	Floor, 1st house	16	110	10/04/2007
KCH56	KCH56FA	4172	50	B17	Hearth	16	24	10/04/2007
KCH56	KCH56FA	4173	50	B18	Pit, trash interior, camelid bones	16	14	10/04/2007
KCH56	KCH56FA	4174	50	B19	Cultural fill, sandy	16	240	10/04/2007
KCH56	KCH56FA	4175	50	B20	Floor, pre-house	16	57	10/10/2007
KCH56	KCH56FA	4176	50	B21	Pit, trash, interior	16	10	10/10/2007
KCH11	KCH11Tiw	4200	60	C01	Root zone	17	736	10/07/2007
KCH11	KCH11FB	4201	60	C06	Cultural fill	17	1640	10/05/2007
KCH11	KCH11Tiw	4202	60	C05	Feature with possible camelid offering	17	0	10/05/2007
KCH11	KCH11Tiw	4203	60	C04	Burial 3	17	0	10/05/2007
KCH11	KCH11Tiw	4204	60	C02	Burial 1	17	11	10/05/2007
KCH11	KCH11Tiw	4205	60	C02	Burial 1	17	126	10/09/2007
KCH11	KCH11FB	4206	60	C07	Structure floor	17	0	10/06/2007
KCH11	KCH11FB	4207	60	C08	Midden	17	828	10/06/2007
KCH11	KCH11Tiw	4208	60	C01	Root zone	17	40	10/08/2007
KCH11	KCH11FB	4209	60	C06	Cultural fill	17	76	10/08/2007
KCH11	KCH11FB	4210	60	C06	Cultural fill	17	54	10/08/2007
KCH11	KCH11FB	4211	60	C06	Cultural fill	17	100	10/08/2007
KCH11	KCH11Tiw	4212	60	C03	Burial 2	17	150	10/09/2007
KCH11	KCH11Tiw	4213	60	C03	Burial 2	17	30	10/10/2007
KCH11	KCH11FB	4214	60	C09	Wall	17	30	10/10/2007
KCH22	KCH22Tiw	100	1	E01	Root zone	16		30/06/2005
KCH22	KCH22Tiw	200	2	E01	Root zone	16		30/06/2005
KCH22	KCH22Tiw	204	2	E02	Empty cist	16		03/07/2005
KCH22	KCH22Tiw	300	3	E01	Root zone	16		01/07/2005
KCH22	KCH22Tiw	301	3	E03	Occupation surface	16		01/07/2005
KCH22	KCH22Tiw	302	3	E04	Floor of structure	16		01/07/2005
KCH22	KCH22Tiw	304	3	E05	Cultural fill	16		03/07/2005

APPENDIX 3.

PHYTOLITHS FROM SOIL SAMPLES AT IROCO, BOLIVIA

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Introduction and Background

Ten soil samples were examined from archaeological contexts excavated from the Iroco region of Bolivia in order to document plant diversity across the site, with a specific focus on defining corral deposits. The highland Andes has seen little phytolith work until recently (Chávez and Thompson 2006; Logan 2006; Perry et al. 2006), and these attempts have for the most part focused on the spread of maize throughout the region in the Formative period. Elsewhere in the world, several authors have focused on tracing domestic activity areas, including those associated with pastoralism, using approaches that combine several specialized techniques (soil chemistry, micromorphology, isotopes, and phytolith analysis) (e.g. Shahack-Gross et al. 2003). In this study, I attempt to distinguish between different activity areas at Irucirca using phytolith analysis, with a special focus on corrals.

Methodology

Soil samples were processed using chemical extraction techniques specifically designed for dual extraction of silica and calcium oxalate and carbonate crystals in the Andes (Logan 2006; Pearsall 2000). Five grams of soil were processed, and a standard volumetric measure of extract approximating 0.001g was mounted and scanned. Slides were scanned until a count of 200 grass short cells were reached, following standard protocol (Pearsall 2000).

Several other authors have attempted to identify pastoral sites using phytolith analysis. An ethnoarchaeological study of Masaai corrals suggested that the gross density of grass phytoliths (millions of phytoliths per gram soil) were exponentially greater in corral vs. non-corral deposits. Density of phytoliths was determined by processing a standard weight of soil, mounting a standard amount of extract, and conducting standard counts of phytoliths in eight locations per slide. Quantification of phytoliths is notoriously difficult; Shahack-Gross et al. (2003) estimated the error range of their study at 29%. Much of this error (up to 20%) resides in weighing the extract. Since so little is mounted, most scales are not very accurate and fluctuate wildly. This is indeed the case with our scale, so I mounted a standard volumetric mount. In this study, density of grasses will be approximated by the number of rows necessary to reach a standard count of grass phytoliths (200 count) as well as the weight of phytolith extract for each standard 5 gram soil sample.

Shahack-Gross et al. (2003) noted that phytolith morphologies were not helpful for distinguishing between corral and non-corral deposits; however they lacked a regionally specific phytolith typology, and were also focusing on different animals (sheep/goat and cattle). Further, Duncan (2003) has suggested that for lower elevations in the Andes, corrals may be distinguished archaeologically by high percentages of Festucoid grasses, which are preferred by camelids. In higher elevation regions such as Iroco, festucoid grasses dominate the natural flora, so in order for phytolith morphologies to be used, a more specific regional level typology must be used. Fortunately, Logan (2006) examined and characterized phytolith production in all Andean grasses found above 3000 masl, and was able to isolate several morphotypes that can identify specific grass genera in addition to traditional grass subfamily identification (Twiss et al. 1969). It is important to remember that while this aid in the visibility of some genera, such as *Stipa* and *Festuca*, it means that it biases the visibility of others that do not produce unique forms. In this study, a standard 200 count of phytolith morphotypes defined in Logan's (2006) typology will be used to record grasses in each sample.

Other important plants that can be identified in the Andes using phytoliths including sedges (Cyperaceae), maize (*Zea mays*; Poaceae), squashes (Cucurbitaceae), beans (Fabaceae), as well as a host of other tropical plants (Piperno and Pearsall 2001), including several hallucinogens (Logan 2006). Presence of any of these types in the samples will be noted.

Results

Results of grass counts are reported in Table A.3.1. Rather unexpectedly, grass density, as estimated by number of rows scanned to reach a count of 200 grass short cells, was not always higher in possible corral contexts than in other types of contexts. Locus 4077, a possible corral floor, did have the highest density, but the other possible corral context (Locus 4052), had a much lower density, similar to the sterile layer (Locus 4058). The lowest density of grasses occurred in Locus 4053, described as fill below the possible corral floor. Another rough measure of density is the extract weight, or amount of silica that was isolated from a standard amount of soil processed (5gr. in this case). Interestingly, Locus 4077 had the highest extract weight, and the sterile layer had the lowest. This suggests that both measures can help support differences in activity zones, though they are subject to error.

As expected, all samples contained a high amount of grasses, in particular, Festucoid grasses. Festucoid grasses tend to dominate Andean environments, especially above 3000 m asl. However, they also are often consumed by camelids (Duncan 2003; Kuznar 1995). Surprisingly, no clear patterns emerged in the grasses found in the different contexts. While the sterile layer contained an abnormally high number of conical phytoliths (which often characterize festucoid grasses), the differences between most of the samples are minimal. Furthermore, the proportion of panicoid (hot and wet environments) vs. festucoid (cold and dry environments) vs. chloridoid (hot and dry environments) simple short cells could be used to detect micro-environmental variation, or the presence of pasturing in higher elevations. However, these ratios are remarkably similar across samples, with the exception of Loci 4052, 4053, and 4129, which all have quite low amounts of chloridoid short cells. A more specific comparison of the phytolith record, especially the specific types identified, and camelid diet may help distinguish corral areas from other types of activity zones.

There were few other identifiable plants present. The main group was sedges (Cyperaceae), which were present in fair quantities in Loci 4131, 4077, 4070, 4069, and 4068. Hair cell bases, which often indicate the presence of dicotyledons (non-grasses) were found in 4131, 4070, 4068, and 4054. Lastly, maize could not be definitively identified in any of the samples, though several samples contained phytoliths resembling the maize diagnostic used for the Taraco Peninsula (Type 3Bf). Additional analyses from different contexts may help clarify if it is indeed present.

Conclusion

In summary, the Iroco samples present an interesting challenge, in that they contain similar grass assemblages overall at a relatively similar density. This may suggest that phytoliths are not sufficient to detect camelid presence or that the locations identified as possible corrals might have been affected by significant taphonomic damage. A possible alternative is that the animals being kept in the corrals were pastured locally, and thus ingested a grass assemblage from the immediate environment. Detailed comparison of the grass genera recovered and camelid dietary preferences and practices may help distinguish between corral and non-corral deposits. Comparison of modern off-site soil samples, as well as dung from camelids in the region today, may help further refine these techniques.

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Table A.3.1. Identification of phytolith samples from the Iroco samples.

							Cat. 1 Simple			Cat. 2 Conical													Cat. 3 Rondel														Cat. 5 Lobed				Cat. 7 Other	
Code	**Component**	**Locus**	**Event**	**Context**	**No. Rows Scanned**	**Extract weight**	**Panicoid**	**Festucoid**	**Chloridoid**	**2A**	**2Ab: *Elymus* sp.**	**2B**	**2Ba**	**2C**	**2Ca: *Piptochaetium* sp.**	**2Cb**	**2Cc**	**2D**	**2E**	**2Ea**	**2Ec: *Aciachne* sp.**	**2F**	**3A**	**3Aa**	**3Ab**	**3Ac**	**3Ad**	**3Af**	**3Ag: *Festuca* sp.**	**3Ah**	**3Aj: *Stipa* sp.**	**3Al**	**3Ba**	**3Bc**	**3Bd: *Elymus* sp.**	**3Bf: cf. *Zea mays***	**5A**	**5C**	**5D**	**5E: *Cortaderia* sp.**	**7C: *Trisetum* sp.**	**Total Count**
ALL 1	KCH21FB	4052/2	A39	Structure 1 floor center	4	0.230	16	122	4	10	3			4	1	1	2	1	5		2	2		3	1					2				12	1	8	1	1				202
ALL 2	KCH21FB	4053/3	A39	Structure 1 floor center	8.5	0.246	18	120	3	12		2		1	1			1	4		4	1	2	3				3	2	2			2	12	1	4	2					200
ALL 3	KCH21FA	4054/3	A69	Culturally sterile	3.5	0.218	8	135	17	6	3		1						3		1	1		3					5	5		1		7		3						199
ALL 4	KCH21FA	4058/3	A69	Culturally sterile	3.5	0.145	12	105	15	38				5	1			4		2	1	1		1						9		1		5								200
ALL 5	KCH21FA	4068/3	A76	Midden outside St. 1	5	0.188	25	119	17	15	1			3			1	1					4						1	6	1	4	1						2			201
ALL 6	KCH21FA	4069/3	A77	Midden outside St. 1	1.5	0.180	25	117	24	8		1	2	2				1	1		1			4						2	1	2		2		3						196
ALL 7	KCH21FA	4070/3	A78	Midden outside St. 1	1.5	0.267	24	125	23	6				1	2		2		2				2	3		1			2	3	1			3				1		1		202
ALL 8	KCH21FB	4077/3	A39	Structure 1 floor north	1	0.280	26	108	28	10		1		2					2							1				8		3		2		1			4		1	197
ALL 9	KCH21FA	4129/2	A84	Semicircular pit	1.75	0.241	31	121	7	15	1				1		1		2			2					1			6		1		9					1			199
ALL 10	KCH21FA	4131/2	A91	Structure 11 floor	1.5	0.198	23	124	15	12	2			2					1					1				2	1	7	1			1		2			1			195
				Total	**31.75**	**2.193**	**208**	**1196**	**153**	**132**	**10**	**4**	**3**	**20**	**6**	**1**	**6**	**8**	**20**	**2**	**9**	**7**	**8**	**18**	**1**	**2**	**1**	**5**	**11**	**50**	**4**	**12**	**3**	**53**	**2**	**21**	**3**	**2**	**8**	**1**	**1**	**1991**