Archaeology of the Early-Modern Market Expansion into the Andes: Native Fishers, Ports, and Emerging Global Markets

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This research answers the question of how radical the changes were for the communal economy of a group of native fishermen directly exposed to the expansion of the Iberian market through the Andes during the early colonial period. A series of excavations and analyzes revealed strong continuities and subtle transformations in the communal production and consumption of the fishermen of the Loa mouth (northern Chile).

These native fishermen further deepened their ancient fishing specialization to resolve their own economic requirements and the ones from the Inca political economy now in Spanish hands. This trans-conquest community focused on net fishing on beaches and sandy bottoms during late Pre-Columbian and early colonial times, leaving behind times of seasonal and intensive capture of Chilean horse mackerel. The conversion of tributes into merchandise did not generate notable signs of overfishing.

Powerful Spaniards accessed the labor of Loa's natives and established a fishery at the early 17th century. This place functioned as a small natural, rural, and indigenous port, fueled with attached Andean labor, and devoted to fish salting. Crucible of early globalization, it had a multiethnic and cosmopolitan character. Andean fishers delivered diversified catches there to meet their tribute obligations and were rewarded with alcohol and stimulants within the context of Andean ceremonialism.

While the Spaniards of the main mining cities depended on their fish catches for different purposes, this community never depended on commercial goods for its subsistence.

Although some anthropologists point out that European colonial mercantilism triggered a rapid and almost uncontrollable productive intensification and market dependent consumption among natives (plus a recognizable ecological footprint), the Loa fish case shows a politically controlled expansion process based on traditional relations of production and coastal self-sufficiency. The articulation of a traditional tribute with new urban demands gave life to an early Andean colonial commodity.

More than a completely disruptive process, the expansion of Spanish mercantilism in the Andes required of the native communal economies and a good dose of syncretism and continuity. The participation of this community in the commercialization of fish demonstrates that ancient markets expanded heterogeneously in vital and rooted indigenous economies.

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Preface

This research contributes to the development of Andean colonial archeology in northern Chile. Among the main motivations was understanding how and to what degree the Andean fishing communities transformed their practices in response to new demands originating at the dawn of Latin America. One of the main focuses of the study corresponded to the role of fish beyond coastal subsistence, in other words, the processing of fish for inland consumption in the context of Spanish mercantilism and the native economy.

The excavations and analysis were directed at an indigenous settlement in which early evangelization efforts were deployed. Powerful Iberian settlers, taking advantage of their privileged access to native productive relations, established a fishery dedicated to the commodification of Andean fish tribute through salting and attached native labor. I called this project the “Puerto Loa Project” since the excavated archaeological site probably corresponds to the place mentioned in old documents under that name as the archaeologist L. Núñez recognized long ago (1971).

The initial test pit excavations, in which I was able to identify the fish salting layers and other activity loci, were supported by the University of Pittsburgh’s International Studies Fund (ISF) and the Pre-Dissertation Summer Funding from the Department of Anthropology at Pitt. The fieldwork was authorized by the Chilean National Heritage Council or Consejo de Monumentos Nacionales (permit # Ord. CMN N°3829 (09/03/2019)), and I am very grateful to archaeologist Dafna Goldschmidt for her help.

The main excavation campaign (2021) lasted several months and was financed by the Wenner-Gren Foundation (grant #9996[1]). The 2021 season was authorized by the Consejo de Monumentos Nacionales (permit # Ord. CMN N°0002-21 (01/04/2021)) and it was carried out successfully thanks to the work of some colleagues and friends, and archeology students from different universities.

Special thanks to the archaeologist Felipe Vargas, who with his technical cleverness, critical archaeological insight and carpentry skills allowed the excavation of the native village's core to advance enormously. Likewise, the contribution of archaeologist Carlos Uribe in the excavation of the Spanish fishery was of utmost importance. The work would not have been the same without his deep experience and elegance in excavation, plus his interest in the discussion of the ideas that guided my work.

I also want to thank the archaeologist Patricio Aguilera for his important logistical support during the months of excavation and to my dear friend and colleague Dr. Damir Galaz-Mandakovic for his help, support, and excellent conversations in Tocopilla during those months.

The excavation would not have been possible without the work of numerous colleagues who lived in Urco in two-week shifts and collaborated in some subsequent analyses. I especially want to thank the work of several archaeologists, archaeology bachelors (*licenciados*) and students from the University of Chile (Santiago), University of Tarapacá (Arica) and University Alberto Hurtado (Santiago) including Camila García, Andrea Martínez, Elizabeth Carrasco, Claudio

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Wande, Catalina Villanueva, Nicolas Ramírez, Cristopher Jaime, Francisca Gutiérrez, Hermy Leiva, Fernanda Gurovich, Luis Mansilla, Camila Jara, Ignacio Rivera, and Ana Araya.

The work of specialized analysts was key in the period after the 2021 campaign. The classification and identification of a huge sample of fish remains could only be successful thanks to the great work carried out by archaeo ichthyologist Claudia Talep. I want to thank Dr. Carlos Bustamante (University of Antofagasta) and Ignacio Contreras (University of Chile) for the advice to identify the shark species that ended up in the fishing village. Likewise, I greatly appreciate the work of Dr. Carolina Belmar (University of Chile) who led her students Camila Jara, Ignacio Rivera and Ana Araya in the classification and identification of the numerous botanical remains recovered at the site.

Another important contribution, one that allowed to overcome the biases imposed in any excavation by preservation factors, was the identification of dozens of phytoliths, starch grains and other microscopic remains carried out by the specialist Luciana Quiróz. I am also grateful for the neat and careful work of the archaeofauna specialists Cristóbal Oyarzo, the information provided by textile specialists Carolina Agüero and Barbara Cases, archaeologists Pablo Mendez-Quiros and Josefina González, ceramic specialist Itací Correa, and Nelson Gaete from the Consejo de Monumentos Nacionales.

I want to thank Dr. J. Quilter for sending me his excellent volume on Magdalena de Cao, a significant source of comparison for the sample obtained at Loa.

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Finally, I would like to thank the committee members, Drs. Van Buren, Arkush and Drennan, for their insights and advice and especially my advisor, Dr. Bermann, for his support and intelligence during the application for external funding and throughout the writing process. Dr. Mary Van Buren opened the doors of graduate studies in the United States to me. In Colorado I had the opportunity to learn about Historical and Andean archeology in her classes and to develop my knowledge in Andean colonial archaeology. The present work is a continuation of the research that I began under her guidance, and I am very grateful.

In a similar way, I want to thank the Chilean colleagues who made me part of their research projects in the north of the country before coming to the United States and who later recommended me, especially Victoria Castro, Dr. Flora Vilches, Diego Salazar, Carlos Aldunate and Varinia Varela.

I cannot close this preface without thanking the company and help of my comrades and friends in Pittsburgh with whom we shared cold afternoons away from home, especially my Latin American friends Víctor Gonzalez, Dafne Lastra, Manuel Calongos, and Amanda Suárez. Special words of affection and friendship also go to colleagues Sarah Kennedy, Ryan Smith and Courtney Besaw with whom I shared (and hope to continue sharing) very good moments.

1.0 Introduction

Contemporary study of early colonial Andean society is revealing the complex interplay of Spanish policies, native agency, and contesting cultural logics that followed the meeting of two worlds. This meeting saw indigenous economic practices, supposedly based on self-sufficiency, reciprocity, and redistribution, confront a mercantile praxis based on the commodification of labor and natural resources. For examining the initial negotiating of these worlds, where the local met the global, few settings can match that of the ocean port. This archaeological research investigates how early modern market expansion changed the economy and habitat of the native fisherfolk of Puerto Loa (coastal Atacama, Chile) as their village developed into an early colonial fishery and small-scale port in the 16th century (Figure 1). This project traces the indigenous use of maritime resources from Pre-Columbian to early colonial times and compares production and consumption patterns for the contemporaneous (early 17th century) indigenous and colonial residential components of the site. The goal of this work is to examine: (1) if native seafood production shifted and commodified under the Spanish, as compared to late Pre-Columbian times; (2) concomitant socioeconomic and consumption changes, including market access among native households; and (3) the effects of port development and changing production practices on local resources. Addressing these issues will provide a picture of an understudied settlement type, the early colonial Andean port, as a revealing, diverse workforce community, and will provide one of the first archaeological case-studies of an early commodification process for the Andes. In turn, such knowledge will refine our understanding of the dynamics of the initial commercial nodes and the hybrid nature of the early colonial market in the Spanish New World.

Figure 1: Study region with the main colonial localities mentioned in the text.

Anthropologists have defined market as a provisioning mechanism that structures access to resources (Hahn, 2018; Narotzky, 2012) based on the exchange of alienable commodities and equivalencies, whether through bartering or currencies, the effect of supply and demand (market forces) on production and consumption, and the involvement of participants in primarily transactional relationships, recognizing selling and purchasing as distinct, normative activities (Applbaum, 2012; Garraty, 2010; Gudeman, 2012; Hart, 2012). Market systems are (broadly) distinguished from non-market systems by the ways in which resources (goods, labor, land) move through systems of reciprocity, tribute, gifts, social obligation, or legal arrangements. Put simply, in non-market systems patterns of consumption and production (among many other things) are not structured by market forces such as pricing of alienable goods, supply and demand, profit maximization, competition, and buying and selling agents.

Archaeological study of the development of market activity has proven notoriously challenging. Aside from formidable definitional problems, attempts to identify market processes archaeologically can founder on the equifinality difficulty in distinguishing market processes from other forms of provisioning, the multiplicity of forms market behavior can take, and recognition that market and non-market processes operate simultaneously in many non-modern and modern societies. For these reasons, my study will focus on production, and more specifically on *commodification* in recognition that the creation of the commodity is one of the most critical aspects of a market economy. Commodities are alienable goods created specifically for exchange (Mrozowski, 1999; Orser, 2017; Wilk, 2009), born when exchangeability is its socially relevant feature (Appadurai, 1986), and commodification the process by which exchange values are assigned (Castree, 2003). Commodification, a fundamental component of early-modern mercantile expansionism (Grafe, 2014; Wolf, 1982), can be defined as an ideological shift that casts nature and labor as sellable factors of production and exchangeable commodities (Castree, 2003; Mrozowski, 1999; Zama, 2017). Commodities are key to understanding market trajectories, they signal the emergence of ancient markets and, in modern markets, include even land and labor (Appadurai, 1986; Creamer, 2000; Hahn, 2018; Orser, 2017; Rothman, 2000). Contemporary commodities are items saleable to all, whose values are determined by their prices, independent of who sells them to who (Appadurai, 2006), but commodities have featured in both monetized and barter markets since ancient times (Creamer, 2000; Rothman, 2000). Barter, or the direct exchange of objects for one another, would be another form of commodity exchange because it's object-centered and impersonal (Appadurai 1986). In ancient barter markets, commodity exchange operated under customary understandings of value, embedded in particular social relations (Stanish & Coben, 2013). Yet in the Andes, commodification has seldom assumed a prominent place in archaeological study of early native engagement with Europeans.

Some anthropologists have argued that it was only European colonialism that unleashed commodification of natural resources and labor worldwide (Mrozowski, 1999; Wilk & Cliggett, 2007; Wolf, 1982). This view proposes that among native communities, mercantile expansionism triggered productive intensification and market-dependent consumption, alongside species introductions, depletions, and extinctions, and generated recognizable material footprints of commodification (Braje et al., 2017; Deagan, 2008; Lightfoot et al., 2013; Mrozowski, 2010; 2018; Reitz, 2004). Anthropologists have highlighted colonialism as a worldwide driver of ecological impacts (Bauer & Ellis, 2018) and I explore such claims by analyzing the signature of early-modern overfishing (Reitz, 2004) in a core colonial region. My project provides a first step into future, comprehensive work on the economic and ecological footprint of ancient commodification in the South-Central Andes (SCA), evaluating European colonialism as the main historic trigger of commodification (Mrozowski, 1999; Lightfoot et al., 2013; Wolf, 1982). I've chosen to focus on native negotiation of the colonial commodification process, a crucial driver for the emergence of early-modern colonial regions and markets.

The Spanish Conquest of the Andes offers myriad opportunities to look at the most critical aspect of the birth of a market economy: the creation of the commodity. My research explores native experience of commodification in terms of economic praxis, social structures, and footprint on local ecology. By the 1570s, Andean labor and natural resources were increasingly redefined as sellable commodities. Despite conflicting ontologies, native leaders (*curacas*) and their communities engaged in commodification to meet tributary demands and for their own benefit. Spanish Conquest brought the expansion into the Andes of mercantilism, but how native populations of the South-Central Andes (SCA) engaged with this overarching market order, or conversely, how the market adjusted to native economic arrangements and new institutions and practices were born, remains an important subject of investigation. In terms of theoretical contribution, my research further aims at providing an everyday practice and actors perspective on the subject. This perspective is very often lacking from historical treatments but is one archaeology is particularly well suited to provide, critically so for subordinate, non-literate populations in such encounters. To better understand macrolevel changes (colonial conquest, incorporation into a market economy) we need to understand the grassroots mechanisms of such changes. In this thesis, I identify two categories of such actors at the small rural port of Puerto Loa and show how their positions at the junction of mercantile processes and traditional tributary systems made them critical agents in creating the unique early colonial market system in the Andes.

1.1 The Andean Background

The universality of market exchange itself has fueled a long anthropological debate: some consider it as ancient rational behavior while for others it only became central in early modern times (Polanyi, 1944; Wilk & Cliggett, 2007). The ancient Andes has long been held up as the example of large-scale, non-market societies in which market behaviors were only marginal (Morris, 1976; Murra, 1972; 1980; 1995). Among the foundational studies for this position are the highly influential works by Murra (1972; 1980; 1995) on vertical archipelago systems and the Inca economy. The notion of ancient Andean societies as monolithically non-market in nature (Murra, 1972; 1980; 1995) has been revisited from time to time from different perspectives (Hirth & Pillsbury, 2013a; 2013b; Van Buren, 1996). The most relevant to the research discussed here are several models linking surplus, resource complementary production, long-distance llama caravans, and inter-ecological trade networks (Browman, 1981; Dillehay, 2013; Dillehay & Núñez, 1988; Lazzari et al., 2017; Nielsen, 2009; 2013), perhaps beginning as far back as the Formative Period and peaking in the Late Intermediate Period (Castro et al., 2016; Nielsen et al., 2019; Núñez et al., 2010). Some of these proposed constructs specifically incorporated dried fish as a commodity, perhaps as early as 500 BC (Ballester & Gallardo, 2011).

The evidence put forward for these models is based solely on the movement and distribution of non-local items. None of them have addressed potential native commodification (production) processes. The models do remind us that early modern market expansion into the Andes did not occur in a vacuum and market penetration may have taken advantage of pre-existing market or market-like processes in the native economic structure. This is a central theme this thesis will explore. Kin-based community economies made possible diverse commodity markets with their own logics throughout the colonial Andes (Larson, 1995). Continuities in native materialities testify to the persistence of native Andean consumption and productive relations. By studying trans-conquest commodification processes, we gain a production perspective and comparative baseline into potential long-term Andean market trajectories, that complement current SCA approaches based on distribution and caravans (Lazzari et al., 2017; Nielsen, 2009; 2013).

The version of the market brought by the Spanish was “recast and negotiated” by native Andean peoples with their own economic logics, goals, and practices (Stern, 1995). A fluid, hybrid, historically contingent version of a 16th and 17th century “native Andean” market formed out of special historical circumstances. Andean market participation had multiple logics including, but not limited to, “traditional Andean” and “European.” The early colonial market -as experienced at Puerto Loa, too- was more than simply a hybrid, it was a unique “colonial Andean” construction (Stern, 1995). Spanish mercantilism itself wasn’t a totally coherent doctrine to begin with (Magnusson, 1994; 2003). It evolved from late medieval, polycentric contractual relationships with the Crown, partially predicated on the preservation of traditional rights (Grafe, 2014; Perotta, 1993; Smith ,1971; Solís, 1964). Even though the Spanish co-opted kin-based economic praxis, documentary sources show how native highland elites rapidly took advantage and benefited from the expansion of mercantilism (Choque,1987; Medinaceli, 2010). Accordingly, the distinction between market and non-market behaviors, at least in the late Pre-Columbian/early historic Andes, may have been overblown, with some populations, by virtue of their involvement in the Inca political economy, being “preadapted” for market production (if not yet for consumption).

In untangling this unique market, some scholars have taken a top-down perspective emphasizing Spanish entrepreneurship (Assadourian, 1982; Golte, 1980; Suarez, 2009); Iberian rearrangements of native labor (Bakewell, 1984; Glave, 1989; 2009), and the imposition of colonial labor and tributary regimes (Noejovich, 2009; Pezzarossi, 2015; Silliman, 2001b; Voss, 2008). Other scholars offer a bottom-up view focused on how native authorities deployed traditional agency, values and cosmology in the consolidation of early colonial mercantile networks in the Andes and other south American regions (Larson, 1995; Medinaceli, 2010; Rodríguez-Alegría et al., 2015). My project contributes to archaeological reconstructions of trans-conquest ruptures and continuities in Andean colonial praxis (Van Valkenburgh, 2019; Weaver et al., 2016; Wernke, 2013) and by doing so improve our understanding of the early-modern world's origins (Wallerstein, 1974; 1980) from daily life in loci and encounter, and outside European urban cores.

In the Americas, archaeological approaches to the study of ancient markets are based on the synchronic distribution of commodities across households and regions (Hirth, 1998; Stark & Garraty, 2010). My project brings a diachronic comparative approach to market development based on commodification processes in the *longue durée* that complements those perspectives. Much valuable archaeology of colonialism in the Americas has focused on the interplay of agency and structure (Bourdieu, 1977), and especially on praxis and identity (Hu, 2013; Lightfoot et al., 1998; Silliman, 2001a; 2009; Voss, 2012; 2015b; Weik, 2014). This approach has improved our understanding of the quotidian negotiations behind the emergence of colonial Andean socioeconomic arrangements (Kennedy et al., 2019; Van Buren & Weaver, 2014; Weaver et al., 2019). Putting these quotidian negotiations under a microscope at different points in time provides a new perspective onto pre- and post-colonial trajectories. From this viewpoint, my work engages with studies of production and community in Porco-Potosí (Van Buren & Cohen, 2010; Van Buren & Weaver, 2012; 2014), rural native communities and colonial praxis (Kennedy & Van Valkenburgh, 2016; Kennedy et al., 2019; Rice, 2012; Wernke, 2011; 2012; 2013), colonial transformations in diet and consumption (de France, 2003; 2012; de France et al., 2016; Van Buren, 1999), colonial routes (Corcoran-Tadd, 2018; 2019), lowlands' productive transformations (Rice, 1996; 2013a; 2013b; Rice & Smith, 1989; Sharratt et al., 2019; Weaver et al., 2019), and Andean colonial archaeology in general (Van Valkenburgh, 2019; Van Valkenburgh et al., 2016; Weaver et al., 2016).

1.2 Puerto Loa

The legendary mining city of Potosí (Bolivia) was a voracious consumer of regional resources from the mid-16th century (Lane, 2019). Surrounding regions provided the main staples sold by Potosí's traders including coca, brandy, wine, and dried fish (Choque & Muñoz, 2016; Tandeter et al.,1995). From historical sources one can reconstruct how this dietary self-sufficiency was achieved largely on native communal labor and massive logical arrangements, but historians agree on the lack of direct descriptions of commoner market participation in Spanish documents (Stern, 1995; Tandeter et al.,1995). Archaeology provides insight into the daily praxis of these anonymous individuals (Funari, 1999) and offers a new perspective into native household and communal economies' role in market expansion.

A port lease system was established in the early 17th century allowing ambitious Spaniards (*porteros*) to monopolize the dried fish/guano long-distance trade (Hidalgo et al., 2019). Coastal regions of Tarapacá and Atacama, Chile, Potosí's main fish source, fueled the port lease system for 300 years (Hidalgo et al., 2019). These ports also served as evangelization centers and some priests were, simultaneously, both religious authorities and fishing entrepreneurs (Hidalgo et al., 2019).

The ports were inhabited mainly by *Camanchacas* as named in early colonial documents (Hidalgo, 2012) in referring to Colesuyo's fishermen, spread between Camaná and Tarapacá (Rostworowski, 1986). Camanchacas, called "fish Indians" by the Spaniards, provided labor for dried fish production and, alongside Africans, for guano mining (Hidalgo et al., 2019; Villalobos, 1979). Camanchaca leaders, treated respectfully by the Spaniards, lived in inland towns (Bittmann, 1984) and collected the in-kind and cash tributes defined by Toledo for Loa and Tarapacá (Hidalgo, 2014; Malaga, 1974).

The port and fishery of Puerto Loa was the southernmost coastal node of the Viceroyalty of Peru and part of one of the four colonial *doctrinas* (ecclesiastic/civil units) of Tarapacá, a region administered from Arica (Odone, 1995; Urbina & Uribe, 2016; Villalobos, 1979). The Loa River mouth (Figure 2) had been occupied from at least 5000 BP by fishing hunter-gatherers (Núñez et al., 1974; Zlatar, 1983). The population and social complexity increased over time and mound cemeteries and ritual platforms were built and inland exchange intensified (Núñez, 1971). Loa's fisherfolk occupied their village on a year-round basis in the late Pre-Columbian era in the context of (supposedly) a well-integrated exchange network of regional extent (Castro et al., 2016). The village was incorporated into the Inca and Spanish empires in the 15th and 16th centuries respectively.

People of early colonial Puerto Loa would have constituted a rural, multiethnic community of Camanchacas, Spaniards, creoles, and mestizos, Mediterranean and European seafarers, and some enslaved Africans (Bittmann, 1984; Villalobos, 1979). A few Spanish porteros are mentioned in the scarce documents in which Puerto Loa appears, but almost nothing is said about the Andean fishermen that fueled the port system for almost 300 years.

Figure 2: Oblique aerial view of the Loa mouth and the cove in which the site is located in the upper center (image courtesy of Andy Charrier).

The Puerto Loa site provided an unparalleled context to explore early colonial native economic shifts because of its: (a) nearly undisturbed archaeological record of the entire colonial port community; (b) exceptional material preservation due to the hyper-arid conditions and use of salt in fish processing; and (c) stratified midden deposits allowing reconstructing diachronic change in production and consumption. The site includes an extensive shell midden with well-preserved native residential architecture (including the Sector A indigenous village); a colonial church and cemetery; and a Spanish residential sector and fishery (Sector B) with stone houses, a warehouse, kilns, salting patios, and dense middens.

Excavation (2021) took place in the main deposits of Sectors A and B. In the native settlement of Sector A four 1x1m and one 2x2m units revealed dense domestic layers and allowed the recovery of fishing toolkits, fish, faunal, botanical, ceramic and textile remains. Specialized activity areas were excavated at the Sector B Iberian fishery, including fish processing features. The rich Sector B assemblages provide a material snapshot into early colonial lifeways in the southernmost part of the Peruvian Viceroyalty with consumption of a surprising range of commodities.

1.3 Research Questions

This research focuses on changes in production and consumption among Loa's community (native and colonial) as the site developed into a colonial port. The work aimed at testing the proposition that large-scale, expansive market demands triggered commodification among local fisherfolk, archaeologically visible as productive intensification and specialization, but also as market-dependent consumption and diet for local households. A clear shift in economic praxis should be identifiable at the site if commodification of marine resources processes were part of colonial incorporation. However, an alternative possibility was that local inhabitants had, under late Pre-Columbian times already developed commodification-like production patterns for producing tribute salted fish in regional or Inca political economies. Such arrangements may have transitioned easily into market commodity production under the Spanish, so that fine-scale stratigraphic and absolute dating of economic shifts at the site was critical.

At one end of the spectrum of commodification would be a scenario in which the native population being transformed into essentially specialized commercial fishermen. If so, this would indicate that the native population was wholly engulfed by the market, becoming a mercantile workforce analogous to any other fisherman in the Spanish colonial system. Their livelihood would shift to cash/barter-based transactions with merchant seamen, highland native traders, and of course the official middlemen (*porteros*). In this case, market-moved materials would deeply penetrate their diet and lifeways.

At the other end of the spectrum would be a scenario in which the Pre-Columbian production patterns produced surpluses that entered the Spanish market via tributary arrangements only. In which case, we might see little alteration of native domestic economy and consumption with the maintenance of traditional self-sufficiency. In this scenario, the local villagers produced what became commodities in the mercantile system without themselves becoming commercial fisherman, mercantile in their own transactions, or market dependent in consumption. This scenario would involve the creation of a hybrid economy, analogous to that seen elsewhere in the early Spanish Andes, and colonial economic systems elsewhere in the world.

A third possibility would be that no surplus production/commodification took place at all before or following Conquest with the native villagers simply continuing a traditional pattern of subsistence domestic production and becoming a general port labor force. This possibility would entail the maintenance of traditional subsistence fishing but less intensively given their supply of port labor. As laborers, they may have gradually incorporated foreign items into their domestic economy, so their foodways may have ranged from traditional fishing/foraging to market food acquisition to rations. To assess these scenarios, research will center around three questions:

(1) *How did native seafood production praxis change in the colonial period?*

Specialization and intensification would be evidence for port natives commodifying fish production for the Spanish colonial market. I examine two types of specialization: (1) specialization with greater emphasis on maritime production relative to other productive activities (at native household and community levels); and (2) increased specialization in fishing/processing strategies in terms of new techniques, toolkits, and/or greater emphasis on particular species (Lyon, 2015; Prentiss, 2015), particularly practices for dried, exportable fish product. Intensification would be seen in a general increase in fishing intensity relative to earlier periods and in fish processing volume, in fish bones and processing technology and loci. In examining these issues, I compare late Pre-Columbian and early colonial midden artifacts, faunal assemblages, and features.

(2) *Were there concomitant shifts in the consumption patterns of these same households as they oriented for colonial period market production?*

Commodified production may or may not have been associated with market consumer involvement by the Loa native villagers. Hence it is important to look at their own consumption patterns to gauge if they became commercial fishermen (relying on external market commodities for household necessities), or if they largely continued Pre-Columbian domestic patterns in terms of dietary choices and possessions. To address this issue, I examine the types, proportions, and distribution of foreign foodstuffs and imported artifacts in native household contexts and compare them to those for the Spanish residents who presumably were relying more on the market for domestic needs. Domestic consumption patterns will be monitored by looking at the full range of household items, material preferences, and culinary choices, and how they vary spatially and diachronically across the site.

(3) *How did production changes and settlement development relate to local resource structure?*

One goal of the research is to assess the effects of commodification of fishing on fish stocks. Intensification is increased production per unit of land/labor and one of its potential outcomes is resource depression due to overexploitation (Prentiss, 2015). Overfishing is a potential consequence of intensification whose signatures include a decline in size, age structure, and mean trophic level (Reitz, 2004). The expansion of settlement in the colonial Loa seascape would have changed the surrounding landscape of the native fishing population, potentially removing local terrestrial and shoreline resources that figured in native subsistence. If so, these anthropogenic changes could have also pushed natives towards market provisioning.

There are several indicators to monitor changes in production and consumption from an archaeological perspective. In this dissertation, fishing specialization is evaluated in terms of greater emphasis on maritime production and from the emergence of specific capturing and processing techniques. I assess communal specialization in fishing through the comparison of bone weights and tool frequencies per productive activity and period (volume). Second, the emergence of specific capturing and processing techniques will be examined for specialization trends.

Capturing techniques can be reconstructed via toolkits and exploitation locations (Lyon, 2015) as well as from species ethology and habitat (Disspain et al., 2016). For example, nets and setlines allow passive techniques for higher fish volumes or bigger fish, respectively, while active techniques (like spearfishing) target specific species (Lyon, 2015). Fish ethology and habitat impose capturing requirements solved by fishing techniques and evolving toolkits, so I study both assessing fish behavior and spatiality to better understand capturing practices. Specialization in processing techniques can be seen in toolkits, butchery patterns, and activity areas (Reitz & Wing, 2008). Specialized processing tools incorporate specific function/morphology relations, non-local materials, expensive manufacture, careful curation, and lower discard rates in non-domestic activity areas, as opposed to multifunctional tools with multiple working edges, local materials, fast curation evidence, and high domestic discard rates (Yu & Cook, 2015).

Increase in fishing intensity over time and the correlated processing intensification is assessed through weights of fish bones per unit of excavated volume (density), cordage and net fragments, and frequencies of processing tools, hooks, and spears. Overfishing can be approached by studying otolith shapes for species identification; weight/length to calculate size via regression analysis, and growth bands for age identification (Disspain et al., 2016; Leach & Davidson, 2001). Species identification allows defining mean trophic level and species diversity, and steady decreases in both as well as in fish size and age are expected (Colaninno et al., 2017; Reitz, 2004; Rivadeneira et al., 2010) if overfishing was a consequence of early-modern fish commodification at Loa. I focus on the most important fish at the site: Chilean jack mackerel or jurel (*Trachurus murphyi*) and size changes over time in the exploitation of this important species.

The site's desert setting makes livestock and agricultural remains mostly non-local resources (and potential regional commodities) and historical sources are valuable in identifying extra-regional commodities including imports and others, forcefully sold by the Spanish as part of colonial *repartos* (Casassas, 1974; Golte, 1980; Moreno, 1977). Macro botanical and faunal remains are taxonomically identified and weighted, foodways shifts addressed with species, weights, frequencies, proportions, and its temporal and spatial distribution. A finer point is provided by micro botanical and faunal remains like phytoliths, starch grains and dung spherulites. I employ similar metrics for imported possessions and domestic items.

1.4 Thesis Organization

Chapter II scaffolds a theoretical framework of commodities and markets, and the role of ports from an anthropological perspective. This chapter discusses the current understanding of Pre-Columbian societies as non-market societies and discusses the proposed deviations from this characterization, focusing on constructs proposed for the South-Central Andes. The research at Puerto Loa is also situated in terms of contemporary archaeological approaches to mercantilism in the colonial Andes.

Chapter III contextualizes the indigenous world in which the Spanish organized the Loa fishery paying special attention to the position of Tarapacá region settlements such as the Loa village in Inca political structure and the role of the production and distribution of dried fish during the Inca era.

Chapter IV provides the reader with an experiential visit to Puerto Loa in the early 17th century. Drawing from archaeological and historical evidence, the site is reconstructed as a community and peopled, including with known historical figures such as the *portero* Juan Donoso and the camanchaca villagers. The rich materiality of Puerto Loa lifeways is described.

Chapter V explains the reason for the Puerto Loa port and fishery, the new demands from urban Potosí. The port's operation is examined in comparison with other ports and a "*cacical mercantile model*" to explain the critical role played by indigenous leaders (caciques or *curacas*) and pre-existing tributary structures in the unique market that developed in the early colonial epoch.

Chapter VI provides a traditional discussion of Puerto Loas as an archaeological site, describing the various components, the fieldwork performed there, and the site's absolute chronology.

Chapter VII details non-fish consumption patterns at the site in terms of diet, ceramics, clothing, metals and other items. Comparison of Sector A and Sector B reveals the extraordinary extent to which the local villagers maintained traditional domestic foodways and material preferences while individuals in Sector B lived a hybrid lifeway accessing global mercantile and native tributary materials.

Chapters VIII and IX cover all aspects of fishing and dried fish production at the site. This chapter details the importance of the Chilean jack mackerel in indigenous and colonial fishing. Examination of changes through time and comparisons of fishing practices in Sectors A and B provide the basis for examining issues of intensification, specialization, and overfishing. Analysis of fish remains, fishing technology, and fishing-associated features make it possible to delineate in detail the new fishing practices and goals associated with commodification of dried fish under the Spanish. Ultimately, this commodification relied on indigenous traditional technology and labor, but deployed in new ways.

Chapter X addresses the research questions and synthesizes the research findings. Indigenous fishers and their communities played a key role in the commodification of Andean resources and the so-called Peruvian economic space. Their work, mobilized by traditional agreements and through their leaders, achieved an early transformation of fish into commodified seafood. Agreements in this process were not dichotomous or unidirectional, but rather the achievement of the new regional elites, both Spanish and Andean. Puerto Loa is revealed as a stage on which to see how, at the grass roots level, indigenous people and practices engaged with an overarching colonial market. Key in this engagement were actors (both indigenous and Spanish) at critical points of articulation between pre-established tributary systems and Spanish mercantilism. These individuals, and their ability to manipulate labor and production at these nodes, were essential to the development of the unique early colonial Andean market.

2.0 Markets, Commodities and Ports

2.1 Ancient and modern markets

What's a market? To economists a market is a specific institution that regulates the supply of goods and services based on demand and price (Kurtz, 1974 as noted in Stanish & Coben, 2013). However, this definition of the modern market comes up short if applied to the broad range of contemporary and ancient cases of exchange. Anthropologists have broadly defined market as a (household) provisioning mechanism that structures access to resources and exchange (Hahn, 2018; Narotzky, 2012), based on the exchange of alienable commodities and equivalencies, whether through bartering or currencies, the effect of market forces (supply and demand) on production and consumption, and the involvement of participants in primarily transactional relationships (Applbaum, 2012; Gudeman, 2012; Hahn, 2018; Hart, 2012). Physically, market systems generate marketplaces, or physical loci of concentrated exchange, where suppliers and consumers interact with each other in the movement of commodities (Hahn, 2018). However, a variety of markets can be discerned that are detached from physical marketplaces but conform with the behavioral dimensions of market exchange (Applbaum, 2012).

Market systems can be (broadly) distinguished from non-market systems in which resources (goods, labor, land) move through systems of reciprocity, tribute, gifts, social obligation, or legal arrangements. In such systems, among many other things, patterns of consumption and production are not structured by market principles. The market principle or determination of prices by forces of supply and demand would be absent, and regular household and communal provisioning would occur mostly thanks to kin-based distribution and self-sufficiency.

The universality of market exchange has been at the core of a long-standing debate in anthropology. Some consider it as proof of rational economic behavior in ancient states and pre-state polities, while others argue that markets only became central in early modern times (Polanyi, 1944; Wilk & Cliggett, 2007). For substantivists, the modern economy was the first to be embedded in the market institution, rational economic decision-making is historically contingent and a product of modern capitalism, past economic praxis operated under religious and kinship principles (Wilk & Cliggett, 2007). The distribution of goods and services were shaped by social and political ordering (Colloredo-Mansfeld, 2012; Patterson, 2012). From a substantavist perspective, in premodern economies market exchange (if it existed) was minimal and peripheral, reserved for luxuries and status goods (Zama, 2017). Ancient trade is relegated to an elite polity-building activity by Polanyi and others, prestige items were exchanged in controlled channels to facilitate political, marital and other alliances (Blanton & Fargher, 2010; Oka & Kusimba, 2008). A European (urban) consumer society gradually emerged only because of the extensive modern market exchange (Hahn, 2018).

Pre-modern markets were institutions with rules of exchange of alienable commodities, rights of alienation and calculative cultural agencies, normally embedded in larger institutional structures, ancient states, and others (Garraty, 2010). Formalists emphasize the rational choice of maximizing individuals (*homo economicus*) over scarce ends and means, arguing that cost-benefit calculated exchange would be a premodern phenomenon visible worldwide in many early empires (Wilk & Cliggett, 2007). Ancient markets were in many cases not subject to full modern market principle, as institutions embedded in social relations facilitated exchange between producers and consumers (Feinman & Nicholas, 2010). As an allocation mechanism, ancient market exchange often coexisted with non-market allocation, communal share-outs, tributes, household production, gifts, redistribution, and kin-based reciprocity (Stark & Garraty, 2010). Classic ethnographic studies of traditional societies (i.e., Malinowski's Trobriand), for example, have shown how social relations are structured by overlapping kinds of exchange systems from pure gifts to pure trade (Oka & Kusimba, 2008). These non-modern market systems were built on normative systems that controlled the regular exchange of alienable commodities, mainly via bartering based on equivalencies (Garraty, 2010; Hirth & Pillsbury, 2013; Stanish & Coben, 2013) but also, in some cases, using ancient currencies as medium of exchange and standard of value (Hart, 2012; Haselgrove & Krmnicek, 2012). Modes of production are sets of social relations by which labor is deployed (Wolf, 1982). For example, kin relations mobilize labor in the communal mode and means of production are collective, distribution matches kin networks and leaders redistribute, among other things (Patterson, 2012; Wolf, 1982).

The spread of market systems has been linked to many factors, including urbanization, population growth, economic specialization, and agricultural intensification. Some scholars have stated that modern markets expanded in rural areas around cities because of food supplying demands from urban markets, normally in the presence of a central government, social stratification, and cash (Dalton, 1971). Coercive impositions are known (Braudel's antimarkets) as part of modern market expansion, especially in rural native regions like the western Andean lowlands during early modern times. Other scholars postulate that ancient markets would have "naturally" emerged due to urban population growth and agricultural intensification as seen in a worldwide sample of premodern states which demonstrate that the marketing mind predated more recent European capitalisms (Blanton & Fargher, 2010). For example, marketplaces regularly functioned in ancient Rome, Greece, Mesopotamia, and medieval Europe (Feinman & Garraty, 2010).

Most known ancient market systems, however, including the Aztecs or other Mesoamerican cases, didn't include land and labor as sellable commodities; these were accessed through social relations (Hirth, 2016). We could therefore talk of partial market exchange in contrast to the highly commercial, fully integrated, modern market that accounts for the most part in regular household provisioning, at least in urban settings. From the exchange model perspective, it seems more a matter of degree than categorical market versus non-market when evaluating a particular ancient market. Current economic anthropologists generally favor continuum views for premodern economies to modern markets (also embedded) rather than the dichotomic non-market versus market division. Market exchange differences among cases may differ more by degree than kind. By the same token, the non-market provisioning modes themselves may follow diverse simultaneous paths, with different scales from the domestic group, extended kin group, and local community, engaging differently with market and non-market institutions (Narotzky, 2012).

A useful alternative approach to the issue is to focus on commodities, or fungible, alienable goods subject to impersonal exchanges, as key to understanding market behaviors. As I detail in the next section, in much scholarship the existence of commodities (extended to include land and labor) signals the emergence of ancient markets and in modern markets of course (Appadurai, 1986; Creamer, 2000; Hahn, 2018; Orser, 2017; Rothman, 2000). Materialist scholars state that commodities are special kinds of goods or services for sale in the money-based capitalist market while for non-Marxist positions commodities are goods for exchange regardless of the form of the exchange (Appadurai, 1986; Mrozowski, 1999; Wilk, 2009). Ancient commodities would be kinds of goods with intrinsic exchange value, traded in institutionalized systems of exchange often by individuals other than primary producers (Rothman, 2000). Ancient commoditization would have involved the production of separated classes of goods distributed by long-distance traders outside the small-scale exchanges of primary users (Rothman, 2000).

Early commodity markets were not monetized but were based on barter exchange (Rothman, 2000; Stanish & Coben, 2013). Barter, the direct exchange of objects for one another, was maybe the main mechanism of exchange in most premodern markets, normally based on customary systems of equivalencies (Garraty, 2010; Sahlins, 1972; Stark & Garraty, 2010). For some scholars, mere barter exchange signals the presence of an ancient market (King, 2020). Other scholars require more specific mechanisms or institutions. The presence of marketplaces and traders, like the Maya's specialized traveling merchants (*p'olom*), have been recognized as representing the minimum behaviors to identifying ancient commercial economies (La Lone, 1982; King, 2020). In the absence of either of these features, some scholars have proposed ancient exchange as a low volume, almost reciprocal, trade of specific luxuries in customary channels. Only a limited range of goods was exchanged as commodities while the bulk of allocation involved various forms of reciprocity and redistribution.

Such traditional exchange, even of commodities, would have tended to involve social considerations, such as an ethos of reciprocity to avoid complaints, problems, and strengthen social relationships. For example, such exchange might be conducted in the context of pre-established "trade partnerships" or a customary exchange relation (Sahlins, 1972). Early trade would have been a constrained group activity for the exchange and acquisition of special prestige goods (not staples). Prestige or status goods were fundamentally used by elites as gifts to consolidate political and social ties with other groups. The emergence of urban markets would have triggered the regular imports of ordinary foodstuffs (Dalton, 1971). Once we turn to the tributary mode, one often sees elites claim supernatural legitimacy and political or coercive means to extract surplus tribute, this mode coexisted with mercantilism until the 18th century in Europe (Wolf, 1982). Tributes were frequently consumed rather than exchanged (Patterson, 2012 Oka & Kusimba, 2008).

One distinctive feature of ancient markets is their penetration into the domestic economy; a well-integrated market system should include household dependency on the market for staples and other needs (Hirth, 2010). Given transport costs, luxuries (including food items) appear as more likely elements in ancient exchange than staples. In ancient New World states in general, the political economy was covered by tributes, taxes and corvee labor drafts, while household and communal provisioning emphasized self-sufficiency in most cases (Hirth & Pillsbury, 2013). Finding foreign staple items would indicate the regular provisioning of households via exchange as part household subsistence strategies. This being the case, domestic provisioning can shed light on market exchange by assessing if and how everyday subsistence needs are covered with foreign resources. A fully integrated market should have produced visible market dependencies at the household or communal level. Where alimentary self-sufficiency was the principal strategy, market provisioning would have been of little importance or non-existent in terms of commoner household consumption patterns. Household economies in rural, traditional, native population regions of the Andes are not constituted by either purely market or non-market strategies, even today. Despite a couple centuries of broad national market distribution of goods and services, economic practices include a good degree of bartering among families, self-sufficiency, redistribution, and communal reciprocity (Mayer, 2012).

In sum, ancient market exchange seems to have been based on the barter of alienable commodities under customary equivalencies and with the help of specialized traders, while land and labor were allocated through other social ties. Household provisioning involved a good degree of self-sufficiency within composite allocation regimes of overlapping channels, one of them being the market.

2.1.1 Commodification

The Spanish Conquest of the Andes offers myriad opportunities to look at the most critical aspect of the birth of a market economy: the creation of the commodity. Commodities, or alienable goods created specifically for exchange, are key to market behaviors. Their creation can signal the emergence of ancient markets and, in modern markets, include even land and labor (Appadurai, 1986; Creamer, 2000; Hahn, 2018; Orser, 2017; Rothman, 2000).

Commodities are alienable, fungible goods created specifically for exchange with exchangeability as a salient socially relevant feature (Appadurai, 1986; Mrozowski, 1999; Orser, 2017; Wilk, 2009). Commodities consist of goods produced for sale in currency-based market system economic relations in which supply and demand met each other by autoregulating prices via the invisible hand (Polanyi, 1968). The market principle is then responsible for the equilibrium of supply and demand and the economic integration of regions and layers of producers and consumers. In this view, commodities and markets are modern historical entities and commodification, a fundamental novel component of early-modern mercantile expansionism (Grafe, 2014; Wolf, 1982). Commodification is also the process by which exchange values are assigned (Castree, 2003).

Historical materialist approaches portray commodities as a relatively modern invention with special kinds of manufactured goods or services intended for exchange generated by the capitalist mode of production (Appadurai, 1986; 2006). This position treats capitalist commodities as standard, identical things with a value determined by their price and not by who has given it to whom (Appadurai, 2006). Nature commodification from a Marxist point of view involves several physical and abstract characteristics: assignation of legal titles over previous communal or open-access resources (privatization); the moral and physical commodity capacity to be separated from its sellers (alienability); the act of separate discrete ontological entities to facilitate its sell and use (individuation); perceive similarities between distinct entities (functional abstraction) and treat similar things in different places as the same (spatial abstraction); displacement or the spatiotemporal separation of producers and consumers, and valuation based on monetarized labor (Castree, 2003).

Dried fish and other foodstuffs were among the first large-scale commodified substances of the early-modern world. Processing was key to preserving and distributing these foods as commodities. Substance and meaning were altered as they moved through trade networks, social values of production washed away, and interchangeable substances consolidated (Wilk, 2009). These characteristics are attached to the modern commodities that surround us; modern commodification (and ancient as well) means material transformation. Our commodities are the result of productive specialization, intensification and standardization, preservability and transportability also modify the original substances. Their distribution involves currencies, accounting, packaging, displacement, marketplaces, availability, and household dependency.

Non-Marxist approaches detach the money component from the commodity definition: a good created for exchange regardless of the form of the exchange (Appadurai, 1986). This view centered on exchangeability has permeated how anthropologists see and interpret modern and ancient markets (see Creamer, 2000; Orser, 2017). For Arjun Appadurai (1986), the production of use value for others exists in a wide spectrum of societies and exchange modes. Barter, or the direct exchange of objects for one another, is a form of commodity exchange because it's object-centered and impersonal (Appadurai, 1986). In contrast, a gift is a highly personal, special thing that solidifies a relationship, it's not impersonal and mediates sociality in traditional groups (Appadurai, 1986). Contemporary commodities are considered items saleable to anybody, whose values are determined by their prices, demand, and exchange, independent of who sells them to who (Appadurai, 1986; 2006). The regimes of value would be the product of particular systems of meaning in space and time (Appadurai, 1986) or as Stanish and Coben (2013) put it for the Andean case, customary understandings of value embedded in particular social relations structuring ancient barter markets.

Ancient commodities would consist of categories of goods pushed into a commodity situation for cultural reasons, some scholars argue commoditization must be part of any institutionalized system of exchange above the reciprocal exchange of primary users (Rothman, 2000). Ancient origins of commodification and state emergence would be synchronic, preceding true money and marketplaces, with commodities being any goods with widely recognized intrinsic exchange values (Rothman, 2000). Individuals other than the primary producer would have overseen its exchange in institutionalized exchange systems, reason why tribal gifts or tributes would not correspond to early commodities (Rothman, 2000). For some archaeologists barter and exchangeability is not enough to determine a commodity situation, the middlemen emerge as a key feature of commodification origins.

Accompanying commodification is an ideological shift that casts nature and labor as sellable factors of production and exchangeable commodities themselves (Castree, 2003; Mrozowski, 1999; Zama, 2017). This ideological shift is accompanied by tangible, material transformations of goods and landscapes. Capitalist commodification renders qualitatively distinct things as equivalent or standardized, saleable through the medium of commercial transaction at market or store (Castree, 2003; Wilk, 2009).

Accompanying commodification are ecological shifts as well. Capitalist commodification should be considered one of the great demonstrable forces to have acted on landscapes past and present. The development of these new concepts and practices altered biophysical realities by rearranging socially constructed landscapes (Bebbington, 2015; Castree, 2003; Escobar, 1999, Robbins, 2011; Wilk, 2006; 2009). The ecological footprint of capitalist commodification includes material transformations of plant and animal communities (Balée, 2006; 2018; Wilk, 2009). Materialism perspectives stress the point that commodification entails physical consequences and material transformations. New labor arrangements impact nature and its exploitation differentially, casting the natural world optimal materialities (such as resources) for market circuits (Bustos-Gallardo & Prieto, 2019). Commodification alters the materiality of nature. Natural entities are subject to production/distribution exigencies and lose “naturalness;” nature is materially and conceptually transformed (Castree, 2003) and this should be visible in the archaeological record. Historical archaeologists working in the New World have documented drastic colonial declines in native biodiversity (Astudillo, 2018; Braje et al., 2017; Lightfoot et al., 2013; Reitz, 2004) and stating that even hunting-gathering economies followed this pattern during their interaction with expanding market demands (Deagan, 2008; Mrozowski, 2010; Wilk, 2004).

2.2 The great debate and the Andes

In a nutshell, Polanyi's "Great transformation" refers to the modern subordination of social relations to market norms. Before this, societies would have been mostly self-sufficient, structured by reciprocity, redistribution, and social distribution mechanisms (Zama, 2017). Factors of production (land and labor) were rendered marketable with the Great Transformation (Applbaum, 2012). Previously, traditional peasant and tribal economies, even those with marketplaces, allocated land and labor in completely different ways (Dalton, 1971). It is frequently argued that European mercantilism produced a sharp footprint in the colonial Americas thanks to unleashed commodity production (Lightfoot et al., 2013; Moore, 2017; Mrozowski, 1999; 2014; 2018; Willow, 2018; Wolf, 1982). Surprisingly, however, commodification has seldom assumed a prominent place in archaeological study of early native engagement with Europeans, particularly in the Andes. Early modern Andean landscapes have been studied to further understand land-uses, labor regimes, and ideological shifts (Rice, 2013; Wernke, 2013), how commodification transformed native production remains understudied. The archaeology of commodities has received more attention in those areas of the world with clear ancient market development (Creamer, 2000; Rothman, 2000). In the Americas, these areas are those of the ancient Aztec and Maya. There is no need here to say much about the generations of scholarly study of Aztec and Maya market dynamics and regional commodity distributions other than to note that it remains a fruitful topic of investigation (Hirth, 1998; Stark & Garraty, 2010).

The conventional view of scholars is that in colonial regions like the Andes, this Great Transformation eventually accompanied European conquest with concomitant productive intensification and market-dependent consumption among native communities, alongside processes of species introductions and depletions (Braje et al., 2017; Deagan, 2008; Mrozowski, 2018; Lightfoot et al., 2013; Reitz, 2004). Famously, the ancient Andes has long been held up as the example of large-scale, non-market societies, to which market behaviors were only marginal (Murra, 1980; 1995). This assumption is being revisited thanks to more nuanced approaches and new information on exchange, distribution, and consumption (Garrido, 2017; Hirth & Pillsbury, 2013a; 2013b; Nielsen, 2009; 2013; Van Buren, 1996). Yet even currently, scholarly discussion of market exchange in the ancient Andes tends to be a counterpoint to Murra's model of verticality and its communal economic self-sufficiency assumptions (Hirth & Pillsbury, 2013).

What the simpler market versus non-market discussions tend to overlook are the complexities (in some places) of late Pre-Columbian production patterns and the complexities (in all places) of the Iberian colonial market system being a late-medieval mercantile system in flux rather than a modern capitalist market system. In general, Iberians accessed social positions within regional and Inca Andean hierarchies with rights over the allocation of land and labor and forced sales of goods and cash taxes; mercantile expansion at rural countryside level was not necessarily a goal in serving an urban market. Nor was market expansion the inevitable solution to facilitate trade: the early colonial market in the Andes was based, to a good degree, on what Braudel has called "antimarkets" - politically manipulated, coercive elite efforts for wealth accumulation as noted for colonial Guatemala as well (Pezzarossi, 2015).

2.2.1 Positing Ancient Andean Markets

The ancient Andes has long been held up as the example of large-scale, non-market societies, in which market behaviors were only marginal (Morris, 1976; Murra, 1972; 1980; 1995).

Murra's verticality model (1972) proposes direct exploitation (colonies) of distinct ecological niches by one group, alongside self-sufficiency, reciprocity, and redistribution as main provisioning mechanisms, exchange would have existed but to a limited peripheral scale. Spanish Conquest brought the expansion into the Andes of mercantilism, but how native populations engaged with this overarching market order, or conversely, how the market adjusted to native economic orders and new structures and practices were born, remains an important subject of investigation.

In the "no prehispanic markets in the Andes" scenario, indigenous societies represented noncommercial economies, lacking market exchange, in which economic integration occurred as the result of controlled forms of redistribution (Hirth & Pillsbury, 2013). As noted above, Murra's verticality model, also called the "antimarket position", emphasizes the direct control of vertical ecological niches and keeps barter as a secondary option when verticality fails (Mayer, 2013). The delineation of the Pre-Columbian non-market economy is based on the Inca state and the great highland kingdoms, both analyzed by Murra and both described in many Iberian historic sources. The Inca state ruled over these self-sufficient chiefdoms without being concerned with regulating discrepancies in supply and demand, In the "command economy", the state mobilized labor to finance state operations, the military and church, construction projects and infrastructure maintenance, agricultural intensification, and the support of regional and imperial elites (La Lone, 1982). Beneath this political economy of the state, individual households and communities provisioned themselves through the direct exploitation of diverse environments, the supply on command of this tributary state allowed reciprocity, redistribution, and generosity as tools of political control but not of household provisioning (La Lone, 1982). The hands of Inca officials did not directly regulate the flow of domestic staples, nor other materials outside of the tribute realm, nor the forces of supply and demand (La Lone, 1982).

Scholars have come to question the prevalence and time-depth of the verticality model, as well as the centrality of the principles of complementarity and centralized redistribution as the salient mechanisms of resource distribution (Hirth & Pillsbury, 2013b). Van Buren (1996), for example, has pointed out that exchange and colonization served different purposes, and that vertical archipelagos never functioned to provision whole populations. Instead, native elites owned the archipelago fields to produce goods critical to the maintenance of political power, such as maize for chicha.

However, questioning the verticality model (which in fairness to Murra should have pointed out that he did not argue as monolithic for all places and times in the Pre-Columbian Andes), is not the same as evidence for a market economy. With the lack of readily identifiable (archaeologically and ethnohistorically) merchants and marketplaces, Andean noncommercial economies still constitute the most likely Pre-Columbian scenario. Potential evidence for ancient market exchange is debatable and subjective. The existence of native merchants in Ecuador, at the northern periphery of the Inca empire, remains the touchstone of any discussion of Pre-Columbian market behavior in the Andes (Hirth & Pillsbury, 2013b). No traders and marketplaces have been identified in areas under fully Inca control (La Lone, 1982). *Mindalaes* were semiautonomous elite exchange specialists operating under the sponsorship of lords of major chiefdoms who conducted long-distance exchange (Topic, 2013). In this region, there is possibly evidence for primitive money, and bone beads have been said to have played that role in colonial times with barter markets coexisting with strong household self-provisioning and redistribution (Topic, 2013).

Native marketplaces in the coastal Esmeraldas region and east of Quito in the highlands are mentioned by Spaniards of the 1560s-1570s as well (La Lone, 1982).

The mindalaes have led Stanish and Coben (2013) to postulate potentially widespread Andean barter markets without currencies, price swings, or an independent class of traders. These markets would have operated through known social networks (not anonymous transactions) and customary understandings of exchange value for goods and services. Unfortunately, it is very difficult to identify the archaeological signature of such markets. Nor is there convincing evidence for currency as such. In the late 16th century, Jose de Acosta mentions the use of coca leaves in Peru as a medium of exchange (La Lone, 1982). Coca leaves are also mentioned for coastal Tarapacá in the context of the early encomienda (Villalobos, 1979). This interesting issue requires further documentary research to rule out its origins as a colonial innovation.

A stronger case may be made for recognizing commodities. Linguistic evidence from early colonial dictionaries suggests concepts and native words referred to what be termed commodities and there was a well-developed exchange of highland textiles, jerky, wool and camelids for dried fish, cotton, textiles, corn, and chili peppers from the western lowlands among Lake Titicaca curacazgos by the early 17th century (Gallardo, 2013). Market exchange among colonial Lupaca included long distance trade (*haurukutha*) and communal fairs (*ccatu*), and ruling lineages enjoyed the direct access to remote resources (Gallardo, 2013). These activities may well have been continuations of pre-Conquest patterns.

2.2.2 The South-Central Andes (SCA) Models

Moving south, Dillehay (2013) suggested two communal strategies for the late period Andes. On the one hand, there were kin-based exchange networks of raw materials, foodstuffs and utilitarian items, cyclical and informal in a wide (within curacazgo) scale. At the same time, beginning as early as the Formative era perhaps, were networks in which wealth and staple goods were among different ecological zones through extensive, long-distance llama caravans.

A key feature of the distribution-based models for the South-Central Andes are llama caravans. Camelid caravans, founded on specialized pastoralist groups, traversed well-established routes, established around passes through valleys (Clarkson et al., 2017). In particular times and regions, these caravans connected political and demographic centers, whose leaders may have controlled the caravan trade. This pattern has been called centralized circulation models (Lazzari et al., 2017).

A slightly more commercial SCA model is the “altiplano mode” model (Browman, 1981). This construct argues that ancient caravan trade networks of staples and other goods linked lowland regions to the highland politico-demographic centers of the Titicaca Basin beginning in the Formative Period. Regular trade caravans and periodic markets allowed highland leaders and populations to obtain goods from other ecological zones. Tiwanaku’s development as an urban state has been explained as the result of its leading role in regional mercantile exchange, satisfying the craft good demands of larger market areas which in turn sent in raw resources (Browman, 1981).

The “circuit mobility” model (Dillehay & Núñez, 1988), drawing heavily on ethnographic analogy, postulates specialized trade caravans and exchange fairs controlled by regional authorities operating again, from at least 1800 BC. These caravans would have supported sedentary populations of agriculturalists at axis settlements by connecting specialized communities of producers at diverse ecological zones (Dillehay & Núñez, 1988). In a similar fashion, the "zonal complementarity" model posits the existence of zonal productive specializations, long-distance llama caravans, central nodes along ancient routes and the exchange of surplus production including dried fish. In this construct, exchange networks would have existed in the ancient Atacama and nearby regions from the 1500 BC onwards in association with reciprocity and elite redistribution (Castro et al., 2016; Dillehay, 2013; Gallardo et al., 2017).

Recently, more decentralized circulation models, again drawing heavily from ethnographic analogy and ethnohistoric sources, have postulated generalized nonhierarchical exchange without political control and incorporating diverse transportation means not limited to large-scale caravans (Lazzari et al., 2017). In the "inter-ethnic exchange" model (Nielsen, 2009; 2013), locally driven trade generated long-distance movement of materials through vast, down-the-line open networks of sequential bartering, all independent from elite control. Simultaneously, specialized caravans or pedestrian transport integrated a regional market visible in significant quantities of commodities everywhere in the South-Central Andes (Nielsen, 2009; Nielsen et al., 2019). In this model, the presence of non-local items in AD 950-1450 Late Intermediate Period (LIP) routes and campsites, and in mortuary and domestic contexts, is considered evidence of a thriving regional market distribution from the Pacific to the eastern jungles (Nielsen, 2014; 2018; Núñez et al., 2010).

Any and all of these strategies could contribute to the domestic and political economies of any given SCA chiefdom, but questions remain about the extent in which goods and services exited a curacazgo's kin-networks. Diagnostics of ancient markets might be the existence of merchants (Rothman, 2000), movements of goods over long distances for distribution outside elite tribute channels, and evidence for retailing among consumers (Hirth & Pillsbury, 2013a). Therefore, in any SCA model, the existence of specialized trade agents or middlemen (a fundamental component of ancient markets), connecting dispersed nodes in highlands and valleys suggests a setting in which one might find market institutions.

Many of the models sketched above have not been very specific about the goods being moved through caravans or have discussed the movement of maize, coca or other ritual plants, or of craft goods. However, there has been some discussion of the potential role of fish in these SCA models.

It can be hypothesized that fishing communities would have been integrated into these trade networks through bartering maritime for agropastoral products, ceramics, metals, textiles and other items (Nielsen, 2013). In Atacama, for example, it has been argued that fishermen and inland agriculturalists would have been permanently connected by caravans since AD 400. A burgeoning system of dried-fish regional exchange supposedly emerged between BC 500-700 AD, thanks to intensified fishing production for export for inland consumption, and on the innovation of capturing techniques (Ballester & Gallardo, 2011; Ballester et al., 2019). The early, small-scale, inland consumption of mackerel, corvina, and anchovies would have evolved, intensified and peaked in LIP times due to mackerel fishing/processing specialization (Ballester & Gallardo, 2017; Ballester et al., 2019; Castillo et al., 2017; Castro et al., 2016). By the LIP, coastal populations would have continually received agricultural, camelid, and wild resources from the interior in exchange for preserved mackerel and other products moved into the highlands (Castro et al., 2016).

Archaeological evidence for these patterns is suggested by deposits at some Tarapacá area coastal sites. At some of these, for example, late Pre-Columbian deposits contain higher proportions of non-local foodstuffs associated with non-local ceramics, textiles, and status goods

(Palma, 2012; Sanhueza, 1985; Varas, 2014). These imports correlate, in the same layers, with high proportions of spectacularly preserved fish remains and fishing equipment. What is as yet unclear is if these associations is the result of intensified exchange distribution networks or preservational factors (earlier remains could be degraded), or a mixture of both. More research is required including AMS radiocarbon dates to rule out potential early colonial dates for such layers and correct chronological interpretations based on ceramic typologies.

While there is much evidence for non-local interaction in terms of non-food items, extant consumption studies do not point to market provisioning in food at the household level in the SCA. Isotopic analyses of coastal LIP individuals are revealing solidly marine/local diets lacking agricultural products, while individuals in highland communities were consuming camelids and local C4/C3 plants without any marine protein (Alfonso-Durruty et al., 2019; Santana-Sagredo et al., 2015; 2019). A similar picture is provided by isotopic analyses of Formative Period individuals (Pestle et.al., 2015; Torres-Rouff et al., 2012) suggesting a high degree of economic self-sufficiency in the area in both early and late eras. Yet isotope analysis of diet for some lowland LIP communities reveals internal dietary diversity with some individuals characterized by mixed terrestrial/marine diets, others mostly by marine resources, and still other individuals by more highland C3 plant consumption (Santana-Sagredo et al., 2015; 2016; 2019). The dried fish was consumed within the curacazgos of the warm valleys.

2.3 Andean mercantile archaeology

In analyzing early modern Andean mercantilism, historians have provided a necessary top-down perspective on how market expansion and commodification were driven by Spanish entrepreneurship (Assadourian, 1982; Golte, 1980; Suárez, 2009); Iberian rearrangements of native labor, the imposition of colonial labor and tributary regimes (Bakewell, 1984; Noejovich, 2009); and Potosí's market demands (Lane, 2019). Historians have also explored topics of agency, values, and cosmology of native authorities in colonial market formation (Rodríguez-Alegría et al., 2015). In the Andean case, the role of top native elites and merchants has been addressed from documentary sources (Choque, 1987; Larson, 1995; Medinaceli, 2010). Much archaeology of colonialism in the Americas too has provided enlightenment on the interplay of agency, praxis, identity, and structure (Hu 2013; Lightfoot et al., 1998; Silliman, 2001a; Voss, 2012; 2015b; Weik, 2014). In keeping with this, archaeologists have explored colonial mercantilism in the Andes from varied socio-political perspectives. One such perspective is examining Spanish top-down imposition of labor and tributary regimes as major drivers in societal change (Pezzarossi, 2015; Silliman, 2001b; Voss, 2008; 2015a). Archaeologists have not neglected issues of continuity and change in the agency of native authority, values, and cosmology (Rodríguez-Alegría et al., 2015). These approaches, among others, have greatly improved understandings of the quotidian negotiations behind the emergence of colonial Andean social arrangements (Kennedy et al., 2019; Van Buren & Weaver, 2014; Weaver et al., 2019).

Historians agree on the complexity of Andean market participation in the colonial era (and beyond) and this participation cannot be reconstructed simply by juxtaposing "traditional Andean" versus European economic logics. The early colonial economy was more than simply a hybrid of the two; it was a unique “colonial Andean” market (Stern, 1995). Two-way negotiation characterized these emergent and contested social arrangements and successive ways of colonizers had to partially reproduce (rather than simply erase) the actions they intended to replace (Wernke, 2013). Indigenous economic institutions and practices were significant factors in shaping colonization (Voss, 2015b). European goods entered networks shaped and constrained by pre-existing native authorities and cosmological orders (Rodríguez-Alegría et al., 2015). Rather than rational-actor and free-trade forms of commerce, colonial exchange and consumption, from the beginning, accommodated indigenous structural inequalities and power relations (Voss, 2015b). Van Valkenburgh (2019, p.1068) proposed imperialism as “something that comes into being through, rather than in spite of it”. This observation applies to the Andean case where Inca institutions kept functioning as a new branch of the Spanish state, encomenderos assumed analogous structural positions to those of prior Inca officials, and, in so doing, obtained tribute through paramount ethnic lords. As a graphic reflection of this pattern, and to minimize productive disruptions, some resettlement towns under the Spanish were simply built atop prior Inca administrative centers (Wernke, 2013). Kin-based community economies made possible diverse commodity markets throughout the Andes (Larson, 1995) while continuities in native materiality testify to the persistence of native Andean relationships, ethos, and economies. Archaeology, with its ability to study at the human microscale, is well poised to investigate this uniqueness.

Historians further agree on the lack of direct descriptions of indigenous commoners' market participation and consumption in Spanish texts (Stern, 1995; Tandeter et al., 1995) and here archaeology can make unique contributions by documenting the connection between everyday practices with commodification and market consolidation.

Colonial consumption patterns have traditionally been examined in terms of status and wealth, identity, and gendering and in varied contexts ranging from missionization to industrial enterprises. More recently, granular approaches have developed calling for the overcoming of dichotomies and hegemonic master narratives. These approaches, highlighting the different lived lives of colonists, natives, Africans, and mestizo categories reveal how heterogeneous socio-material orders emerged at different pace and space (Senatore & Funari, 2015). As part of such approaches, it is now recognized that labor and tribute regimes are key factors in explaining market provisioning and transformations in colonial consumption patterns (Voss, 2008). Further, the actions of individual agents can be studied as important in reconstructing entanglements through archaeological study of actor and setting.

It has been supposed, reasonably so, that European actor consumption reflected greater access to market and tribute channels, which included native products. In contrast, native non-elites, particularly in rural settings, would likely continue traditional self-sufficiency and subsistence practices. The distribution of native domestic items followed traditional social ties, hierarchies (old and new) enjoyed Andean products and some purchased imports. Early colonial Spanish accessed local distribution networks thanks to their position in the top levels of native socioeconomic structure.

There are always dangers to over-generalizing, and it is important to recognize different categories of goods, economic factors, and historical contingency in making any comparisons of materiality in the colonial period. For example, Van Buren (1999) wrote of the access of elite Iberians near Potosí to native distribution networks of fine regional goods. At Tarapaya, an elite Spanish inn near hot springs, 80% of all sherds excavated were of indigenous vessels rather than European imports. Van Buren (1999, p.17) notes that “European-style wares were more frequently incorporated into dining activities than cooking or storage." Decorated native serving vessels were in use well into the 17th century and evidence privileged access to different distribution channels (Van Buren, 1999). Surface collections at the late prehispanic/historical site of Torata Alta yielded primarily indigenous ceramics of Late Horizon tradition (Van Buren, 1993), European goods like majolica are scarce and Chucuito-Inca polychrome style sherds are distributed above and below the 1600 Huaynaputina ashfall layer (Rice, 2012). Elite residential structures were occupied by people that accessed both Spanish commodities and Inca state items. Spanish majolica was found, as in other cases, in association with religious service spaces (Rice, 2012).

Early colonial production in most domains reflected the stamp of both the Inca and Spanish states (Rice, 2013). This pattern is evident spatially and in logistics and provides a window on market expansion in the early historic period. Some of the main routes that made possible Potosí's provisioning and exporting followed earlier transport routes. The port of Cobija, on the hyper-arid coast south of our fishery, and the Loa River itself were deeply involved in one of the main terrestrial routes to Potosí as seen in the native campsites and associated pastoralist communities, as well as some Inca Road segments and inns (García-Albarido, 2022). Such campsites, including several used by people moving dried fish towards Potosí, continued to function during the colonial period. Similarly, we can see the scaling up by Spanish colonists of previous Inca infrastructure of transport on the route from the Pacific to La Paz, Oruro and Potosí. Caravan camps and colonial tambos exploded in number in the 18th century in association with an increase in mule and camelid caravans, illustrating the growing importance of animal labor over previous Andean human chargers (Corcoran-Tadd & Pezzarossi, 2018).

Any product had its own particular history and place in the early colonial economy. Product distribution must be carefully reconstructed, as consumption contexts offer some of our best chances to understand emerging and consolidation of markets. Most archaeology has focused on durable goods, but study of regional movement of foodstuffs has not been neglected. For example, hacienda productions like wine or pisco were a clear mercantile commodity produced by a system that accommodated some degree of wage labor. The movement of these beverages through a system of mercantile distribution can be seen in historical documents and by botija remains. Outside the mercantile - hacienda system, we know that there was a parallel system in which native foodstuffs filled tribute demands. Some of the tribute was consumed locally by encomederos and corregidores (a political finance expense), but other tribute material was converted into regional commodities at highland urban markets. Thus, the mercantile and traditional non-market systems joined at these urban markets. In this thesis, I argue that we can see this joining of market and non-market logics at production points as well in early colonial history - - particularly at fishing ports such as Puerto Loa.

2.4 Ports: Where Worlds Meet

It makes great sense to study the early colonial market at consumption loci such as the great urban centers, as well as at production sites such as mines or colonial bodegas. It is equally illuminating to examine early ports in exploring the engagement between indigenous economic patterns and Spanish mercantilism. Vastly understudied for the early-modern Iberian empire, ports and their communities were essential components of global mercantilism (Prata, 2010). Yet much about the vital colonial ports, including the role of their indigenous inhabitants, remains little known. As "machines" of mercantile expansionism, colonial port sites provide a yet untapped source of information on how native communities engaged with the overarching colonial market and its representatives.

The social archaeology of ports recognizes ports as culturally constructed homes to a community with fluid identities, motives and everyday experiences as resulting from its bottleneck position for a wider port network (Roger, 2013). In contrast to older emphases on the macroeconomic role of seaports in regional economies, this archaeology focuses on a port's cultural ecology, micro social dynamics, and impact on immediate hinterlands (Polonia, 2010; Prata, 2016).

Ocean ports are where worlds meet. Demographically, ports are where travelers first encounter the local. Culturally, ports are multinational, even cosmopolitan, and culturally constructed loci where global and native, alien and local, socioeconomic logics engage (Rothenberg, 2017). Economically, ports exist to serve shipping. Beyond that, ports are junctures of transformation, transactions, and transfer, where ocean-going cargos are transformed into land distributed goods and vice-versa. As such, they are natural market centers (in the abstract sense of market behaviors), whether or not they exhibit physical markets. In the ancient Mediterranean, for example, ports were one of the main locales where fairs, informal beach markets, and exchange took place. These ports were rural, not urban, just a couple of buildings inhabited seasonally by a handful of people in some coves naturally protected from winds and currents. Not necessarily serving a nearby city, the roads from these ports ascended the inland communities, small villages and dispersed farmsteads and hamlets rather than to cities (Leidwanger, 2013).

The establishment of the early Spanish colonial ports in the New World drew on a long legacy. Ancient Mediterranean navigators had taken advantage of river mouths and coves where a boat could anchor at least temporarily protected from wind and currents, and the goods unloaded and moved to the shore (Leidwanger, 2013). Ideally, a sandy beach with a gentle slope would be present to the boat could be keeled or rolled ashore on logs for repair. Such “opportunistic” ports often held little in the way of infrastructure (Leidwanger, 2013). The footprint of such ports was minimal: paths or roads to the interior; a source of fresh water; ruins of a modest warehouse or storage features; broken amphoras or jars; abandoned moorings; submerged detritus near the shore (Leidwanger, 2013). All these characteristics are present at Puerto Loa.

The waters of Peru and the South American Pacific were the home of Mediterranean-trained seafarers who sailed in open-ocean and coastal fashions. The former case, the legendary and dangerous passages or "*travesías*" (Pérez-Mallaína & Torres, 1987) is exemplified by the famous plate fleets of great deep-water cargo vessels. But coastal sailing characterized much more everyday commerce and consisted of cabotage navigation with the coast kept in sight. Sailors kept an eye out for native coastal communities settled in natural ports protected from strong southwesterly winds and with a seabed with good holding for mooring: to set an anchor and let the vessel move around according to the changing currents (Bava de Camargo, 2015). Anchoring (or setting the ship immobile with three anchors) was not necessary (Bava de Camargo, 2015). In the Mediterranean, ships stopped at each cove or town to sell and exchange; the ships were floating bazaars and the exchange carried out by everyone from the captain to the cabin boy (Braudel, 1972). In the Andes, early ports were “unimproved,” lacking anchorage infrastructure; only in 1696 was the first pier in Callao built (Pérez-Mallaína & Torres, 1987).

Generations of pilots and captains, including those of ships built in South America, kept charts of the coast and sailed with few navigation instruments (Pérez-Mallaína & Torres, 1987). The multiethnic crews in this coastal commerce reflected the complex social pyramid of colonial Peru. The pilots were Spanish, Italian or Portuguese, the crews were made up of Andean natives, Spanish Creoles, enslaved Africans, mestizos, and free mulattoes (Pérez-Mallaína & Torres, 1987). Shipboard occupations reflected social hierarchies, for example, the artillerymen were Spanish, while natives and Africans worked as grummets (Pérez-Mallaína & Torres, 1987). The rations on board combined rice from Guayaquil with grain from Chile. Dried fish was also served. When anchored gambling and prostitution occurred on board and the crew worked with native communities in unloading (Pérez-Mallaína & Torres, 1987).

In addition to a small navy, the waters of Peru were plowed by private merchant ships chartered by powerful associates of the viceroyalty. The merchants of Lima, for example, controlled the redistribution of global merchandise and organized their flows to Charcas, Chile, Quito and Tucumán (Pérez-Mallaína & Torres, 1987). As the settings for the outflow of Andean wealth and inflow of European people and goods, the humble rural ports of coastal Atacama became places of burgeoning economic opportunity, home to ethnically diverse populations with varied cultural practices and perceptions, assumptions, motivations, and strategies, all factors in a regional transformation.

Natural coves and their Andean residents became rapidly articulated into large-scale transport networks. Native coastal hamlets evolved into informal beach marketplaces and all sorts of European seafarers, corsairs, and smugglers (Francis Drake included) appeared to exchange European commodities for dried-fish, freshwater and firewood with the local communities (Bittmann, 1984; Casassas, 1974). By the end of the 16th century, some of these communities were emerging as important seafood and fertilizer (guano) producers, selling production to inland urban and mining markets. But even as larger port communities were evolving such as that of Arica, small, rural, “opportunistic” and “unimproved” ports such as Puerto Loa continued to play a role in early colonial economic that belied their small size.

2.5 Summary

In this chapter I sketched anthropological conceptions of market and non-market economies and highlighted the utility of examining commodification in addressing the Great Transformation and the longstanding notion of the Pre-Colombian Andes as a non-market world.

Idealist positions, like the one described above for Appadurai (1986), posit the commodity situation as detached from ontological distinctions and occurring when exchangeability is the socially relevant feature in particular cultural frameworks. However, archaeologists working with material remains can and should distinguish between the theoretical context of commodification and the material consequences on objects triggered by this process. Thus, rather than discussing commodification requisites, the material aspects involved in commodification itself can be used as an archaeological base line to address the degree in which ancient productive systems got involved in large-scale exchange of transformed goods. In contrast to looking for merchants, currency, or marketplace spaces, my commodity-based approach is to examine the practices of production of a commodity from a resource (fish) under the Spanish and contrast these practices with what took place prior to the Spanish Conquest, particularly during the Inca era. Puerto Loa is a case in which early modern Spaniards commodified a traditional and local foodstuff. This thesis focuses on what this process of commodification looked like. This commoditization processes of fish under the Spanish can be compared to Pre-Columbian practices involve fish to explore the nature and extent of commoditization prior to Spanish Conquest.

Andean colonial archaeology has provided a consistent picture (mostly absent from written sources) of native early colonial communities and household consumption. In this picture, provisioning of native households was not based on mercantile channels. Early colonial Andean consumption, as seen from its material remains, relied on group self-sufficiency and traditional kin relations-based production and distribution patterns. Spaniards ran their own market distribution channels for hacienda staples and enjoyed Old-World products from the warm valleys, while simultaneously accessing native foodstuffs via the tribute system to use, in many cases, in market transactions. In so doing, they commodified native production in creating a unique hybrid early colonial economy.

I also reviewed how Iberian mercantilism was grafted onto, and integrated with, preexisting fish production patterns. One expectation from this historically documented context is that we would expect the colonial fishery system to represent such a hybrid, based on encomienda and tribute rights but motivated by commodification desires. The Puerto Loa case is also interesting in that it presents a fishing community structured around overlapping allocation regimes. The community had strong self-sufficiency goals and participated in a native regional economy shaped by kin ties even into the 17th century if not later. The community also had to produce for tributary impositions of external imperial economies (probably first under the Inca, and then later under the Spanish), and engage with native and Spanish leaders of entrepreneurial mindsets intensively involved in mercantile relations.

Finally, this chapter points out the underdevelopment of social approaches to ports within maritime archaeology in general (Muckelroy, 1978; Rogers, 2013). By doing so, we can balance city-oriented models of ancient market expansion (Blanton and Fargher, 2010) and recognize ports as marketplaces and engines of regional and global transformation (Rothenberg, 2017). Port and port communities are a unique settlement type, providing a window on the microcosm where different worlds meet and how the changes associated with incorporation into mega-systems (imperialism, mercantilism) actually translate into everyday behaviors.

3.0 The Loa Mouth: The Late Pre-Columbian Setting

3.1 The Inca Province of Tarapacá

The fishing village at Loa, like other pastoralist and agricultural communities of Tarapacá, Quillagua, Guatacondo and Pica, would have been fully integrated into Inca reciprocity, tribute, and redistribution relations (Uribe & Sanchez, 2016). Radiocarbon dates the beginning of its Inca occupation in the first half of the 15th century (Núñez & Briones, 2017; Urbina et al., 2019). The original Inca governance would have included six to seven main native villages in the three main basins plus smaller hamlets at coves and highlands (Urbina et al., 2019). Silver, gold, and copper coastal and highland mining was promoted, the coastal silver mines of Huantajaya sacralized with a *Capacocha* (human sacrifice), and some groups relocated to other provinces as mitimaes (Urbina et al., 2019). The Incas resettled in the Tacna Valley a whole village of mitimaes from Tarapacá under the leadership of the curaca Tucuba, a 1548 document describes this group as natives with the habit of trading (Villalobos, 1979).

Local caciques were nominated for provincial positions, their rank dependent on how many domestic units and tributaries were under their leadership, the regional curacazgo thus being incorporated into the Inca decimal administrative system (Urbina et al., 2019). Tarapacá would have constituted a *guaranga*, a regional administrative unit of 1000 tributaries, inherited by early conquistador from Inca administrators (Urbina, 2017). Inca style ceramics were used by local communities during this era, regional curacas participated into distribution networks of imperial ceramics and high-volume ceramic containers were introduced by Inca representatives in Tarapacá (Urbina et al., 2019).

Spanish records show economic and demographic continuities for this native region. Until the 1570s, encomenderos greatly benefited from the regional economy installed by the Incas. For example, Lucas Martínez received the rights over (almost) the whole guaranga and its top curaca. Cuzco politics would have promoted previously the regional (guaranga) coalition of curacas (Urbina et al., 2019).

3.1.1 Inca Imperial Infrastructure

A couple Inca administrative nodes were built, Tarapacá Viejo and Incaguano, along with a road that connected the main sierra villages. Early Spanish accounts mention a high-level Inca authority (Opo) residing in the Tarapacá Valley (Urbina & Uribe, 2016). The site of Tarapacá Viejo, called the Tarapacá tambo in 16th century documents, has been interpreted as the main regional administrative center, one with multiple canchas, silver smelting, and quipucamayos (Uribe & Sanchez, 2016). Tarapacá Viejo was key for refining the regional silver-bearing ores appropriated by the Inca, organization of mining draft labor, storage and redistribution of goods, food, fuel, and other resources to support mining and other regional activities, and caravan logistics across lowlands and highlands (Zori, 2011; Zori & Urbina, 2014). Tarapacá Viejo's ceramics show the direct connection with Carangas, an altiplano chiefdom, plus Inca, regional Inca, and local Inca vessels; the site shows the highest proportions of Inca style ceramics, its inhabitants were sited at a key place were Inca goods converged (Zori & Brant, 2017).

Sherds from Cuzco, Inca altiplano, or local Inca represent roughly a third of ceramic types collected from Tarapacá Viejo's surface (Uribe et al., 2007). Decorated bowls, jugs, and aryballos from Cuzco were transported to Tarapacá Viejo and played a role in ceremonies involving local and foreign authorities and the ritual calendar (Urbina et al., 2019). Provincial Inca ceramics are represented by Inca Pacajes and its stylized llamas painted motif, the type is common in the Desaguadero region and associated with the Pacajes of the southern Titicaca (Stanish, 2012; Urbina et al., 2019). Authorities and the movement of goods may also have connected Tarapacá with Cuzco via routes in the Altiplano and across Lake Titicaca. Other vessels are of Inca morphology (aryballos, jugs, and cooking pots) but made with the traditional local red slip and paste (Urbina et al., 2019).

A thorough analysis of archaeological roads and associated settlements for northern Chile has shown an Inca strategy of settling important crossroads and frequent waypoints, in other words, a desire to control the flow of people and resources (Mendez-Quiros & Saintenoy, 2021). A similar approach to Tarapacá Viejo generates equivalent conclusions, the site has a centrality unsurpassed by any other regional Inca-era site in Tarapacá (Zori & Brant, 2017). An intricated mesh of roads would have served to control the region and to connect ceremonial administrative centers with productive enclaves and coastal adoratories (Uribe & Sanchez, 2016). At Tarapacá Viejo, four routes converged, the lowland road or Camino Real de los Llanos, the road descending from the northern sierra via Zapahuira in the Arica highlands, another eastward route to Carangas in the neighboring altiplano, and finally, a southward lowland road to Pica, Guatacondo and the Loa mouth (Zori & Urbina, 2014). The Inca Road connected localities of the sierra with tambos and villages in the altiplano; the Incaguano tambo had a kallanka and Collaguasi 37 represents another of these inns (Uribe & Sanchez, 2016).

The cemetery associated with Tarapacá Viejo (Tr-48) suggests the presence of Inca status orders, either provincial or above, as seen in the tunics with Inca classic motifs (four-blade whirlpool) and other status markers, as well as their accountants or quipucamayos, as seen in quipu fragments recovered from the tombs (Urbina et al., 2019). Sacks, bags, blankets, and other textiles were buried along with commoners at the cemetery, some tombs are of colonial origins, the burial ground evidence a good degree of continuity in materiality and deathways across the 16th century (Urbina et al., 2019).

The *Qapacocha* ("opulent gift" human offerings) of Cerro Esmeralda, near the Inca silver mines of Huantajaya, is the only known coastal case throughout the empire. Cerro Esmeralda was an adoratory for the mines and visible snow-capped Andean summits (Uribe & Sanchez, 2016). Ritual paraphernalia was from Cuzco, spondylus (*mullu*) was recovered and of the two women buried at Cerro Esmeralda one was clearly of noble origins (Checura, 1977; Uribe & Sanchez, 2016). The funerary ritual included ceramics from Cuzco and the altiplano (Pacajes and Carangas), possessed by Tarapacá Viejo's Inca authorities (Núñez & Briones, 2017).

One of the aims of the Inca administration of Tarapacá would have been to support the prestige goods economy through the extraction and smelting of regional silver and copper. The mines of Tarapacá or Huantajaya figures prominently in early colonial descriptions as Inca possessions inherited by Pedro Pizarro and Lucas Martinez. Other regional mining riches were Paguanta and Chanabaya (Villalobos, 1979). Silver smelting from Huantajaya and other mines occurred near Tarapacá Viejo (Zori & Brant, 2017). The remains of huayras have been found at four sites that document metallurgic continuities from Inca to colonial times (Urbina et al., 2019). At Tarapacá Viejo, loose slag, lead in pure state, and crucible fragments would represent in situ intensive Inca smelting activities that carried on into the early colonial era (Urbina et al., 2019).

3.2 Incas and Peruvian Fishing Communities

The Incas deconstructed the highest tiers of southern lowland curacazgos to divert tributes to the state, sometimes mediated through the remaining highland hierarchies (Aland, 2018). There is some evidence that local fishing organization was left in place and local lords were responsible for collecting and shipping the marine tributes (Aland, 2018). In this section, I will discuss examples of archaeologically investigated fishing communities under the Inca, from central Peru down to the Loa River.

At central Peru Lo Demas (Chincha), the Incas forged alliances with local lords and took advantage of the existing regional fishing specialization (Sandweiss, 1992). The Lo Demas fishing village was occupied during the Late Horizon and early colonial times (as seen in documents). Mats with salt crystals and fish scales mark drying/salting activity areas, Net remains were found in association with herbivorous, schooling pelagic species like sardines and anchovies, with a head vs vertebrae ratio that suggests headless fish export (Sandweiss, 1992). The community includes both commoner and elite sectors, and the stockpile of dried/salted fish would have been for regional distribution by local lords. Fishing curacas ranked high in coastal hierarchies and those who owed allegiance to them were exempted from the regular *mita* labor tax (Sandweiss, 1996).

Another specialized local fishing economy coopted by the Inca is represented by the Cerro Azul site in the nearby Cañete Valley (Marcus et al., 1999). The village features several LIP structures around an irregular plaza, some Inca buildings one with trapezoidal niches and a ceremonial public space devoted to the Pacific with imperial stone masonry (Marcus, 1987). As at Lo Demas, the village has commoner and elite compounds, one of which (Structure D) has radiocarbon dates into the 17th century with two-sigma ranges (Marcus et al., 2020). Several generations of noble families inhabited their own compounds equipped with storage structures. These spaces were intentionally filled with fine, clean sand to dry and preserve small fish, mostly anchovies and sardines for export (Marcus et al., 1999). Pre-Columbian fish salting was not observed (Marcus, 1987). Drums, bonito, mullet, some sharks, and rays were consumed locally, while preserved sardines and anchovies were exported regionally via the economic network of the Huarco curacazgo (Marcus, 1987; Marcus et al., 1999). The Incas may have diverted part of this surplus into state systems for local finance.

Further south, dried fish fueled some aspects of Inca political finance in southern coastal Peru but not at a scale comparable to the central Peruvian cases (de France, 2016). Target species from sites occupied during the Late Horizon in the area demonstrate the exploitation of diverse marine habitats: pelagic schooling fishes like anchovies or sardines and Chilean jack mackerel (*Trachurus murphyi*) were of clear economic importance, bottom dwelling drums (lorna and corvina) were also part of the diet (de France, 2016). LIP/LH fishing in southern Peru included some small-scale drying for local consumption. While Lupaqa overlords may have colonized the region on behalf of the Inca, no evidence of fish storage has been detected in coastal collcas on the Moquegua coast (de France, 2016).

At the mouth of the Lluta Valley, excavation of several of the 316 storage features of Huaylacán revealed spectacularly preserved LIP maize remains plus a wide variety of marine taxa (Mendez-Quiros et al., 2023). Chilean jack mackerel, sardines and corvina were the most common species, together with choro (*Choromytilus chorus*), clams *(Protothaca thaca)*, and loco (*Concholepas concholepas*). In the same valley but upstream from Huaylacán, the village of Millune (1370 m.a.s.l.) provided evidence for Late Horizon transportation and storage of Chilean jack mackerel, sardines, and corvina (plus some shellfish) also in low numbers at its 156 storage pits (Mendez-Quiros et al., 2023). Similar proportions of marine resources were discovered at Achuyo, a late Pre-Columbian village in the neighboring mid-Azapa Valley (1450 m.a.s.l.). Here, contents of some of the 204 circular storage pits contained some Chilean jack mackerel and sardines, clams, chorito (*Perumytilus purpuratus*) and freshwater shrimp (Mendez-Quiros et al., 2023). Even if marine taxa are not numerous nor very diverse at these settlements, these sites show the regional movement of sea food inland at least within the lower to mid-valleys, In the Lluta and Azapa valleys, communal storage infrastructure was probably administered by local groups from the 12th century AD up to the early 17th century (Mendez-Quiros et al., 2023).

From Tarapacá Viejo, the Incas controlled a string of communities down to Quillagua and Loa. At least some Inca-affiliated individuals resided at the village of Pica for the control of fishing production (Núñez & Briones, 2017). Consistently, coastal kin groups were buried with local Inca grave goods so also part of the expanding policies of Cuzco (Uribe & Sanchez, 2016). Coastal funerary contexts show Inca era materialities, such goods have been recovered from the Loa mouth, Chipana, Los Verdes and Patillos (Uribe et al., 2007).

At the Pica 7 cemetery, a local Inca elite in charge of the nearby fishing production was buried with local aryballos, decorated wooden qeros and bowls, *topus*, fine textiles and caps, in a sacred space far from local cemeteries and springs (Núñez & Briones, 2017). The existence of this cemetery might even suggest an unknown administrative site at Pica, maybe close to the modern town church and plaza (Urbina & Uribe, 2016).

At the Camarones mouth, were two extensive fishing villages of the era (Schiappacasse & Niemeyer, 1989). Inca influence in this valley would have been mediated by altiplano curacas (Muñoz, 1989). The settlement (Cam-14) on the southern terrace, extensively excavated during the late 20th century, showed the use of red-slipped aryballos, finely made bowls, smelting molds, and other tools (Schiappacasse & Niemeyer, 1989). Late Pre-Columbian and Inca dwellings consisted of light, organic materials. Rectangular cane constructions with wooden posts for the roof and semicircular huts over stone platforms covered by sealion and other marine mammal hides with roofs of totora, sealion skin and vegetal fibers in both cases (Muñoz, 1989). This community primarily targeted Chilean jack mackerel (*jurel*) and pejeperro (*Semicossyphus darwini*) with copper hooks and other unknown fishing tools. Local fishers consumed algarrobo (*Prosopis sp*.), probably as chicha and tortillas, beans, corns, and squash, hunted sealions, dolphins and cetaceans, and ate camelid meat (Schiappacasse & Niemeyer, 1989). Seabirds were also eaten, especially cormorants, pelicans, and pato guanay (*Leucocarbo bougainvillii*). Human paleofeces from the site reveal the consumption of freshwater shrimp (Schiappacasse & Niemeyer, 1989). Of the projectile points at the site, some small, stemmed points were part of harpoons.

In Camarones, another fishing village (Ca-12) of the time was identified in the hills flanking the river mouth to the north. The village has rectangular houses with stone walls, as well as circular storage pits. There is evidence for the existence of late Pre-Columbian native kilns, some of which still have fragments of smelting molds. Accumulations of local clays, polishing tools and other indirect evidence are indicative of in situ ceramic production (Santos, 1989). Such molds are characteristic of the Camarones mouth, a coastal area where native population practiced metallurgical activities during Inca times. Thermoluminescence tests indicate a 15th century occupation (Schiappacasse & Niemeyer, 1989). The site shows features for potential fish accumulation during Inca times. One LIP storage pit (Ca-07) near the village contained Chilean jack mackerel, mostly in the form of head components, with smaller proportions from the Sciaenidae (i.e., corvina) and Scombridae (i.e., tuna) families (Schiappacasse & Niemeyer, 1989, p.69). At the Camarones mouth, LIP communities targeted Chilean jack mackerel and corvina with copper hooks and stone sinkers, very similar to the ones recovered at Loa.

Local dwellers at an Inca-era cemetery (CAM-9) were buried in funerary bundles. Offerings inside the wrapping textiles included stone fishing sinkers, cactus thorn hooks and wooden harpoons, raft miniatures and oars, bows, turquoise bead necklaces, local aryballos, metal bells and needles (Muñoz, 1989).

At Los Verdes (south of Iquique), Sanhueza (1985) excavated the domestic deposits and tombs of an Inca-era coastal fishing community, with a variety of inland agricultural products arrived at the fishing village including maize (cobs, *cancha*, popcorn), quinoa, algarrobo, coca, and cotton, transported in the many polychrome bags and sacks recovered at the site. As in my Loa case, local terrestrial resources were important, wild plants like *Zephyra elegans* and animals like sealions and marine birds were fundamental part of the local economy, although camelid was rarely consumed. Los Verdes likely represents a coastal colony of an inland population south of Iquique (Sanhueza,1985).

At the mouth of the Loa there are a series of settlements from late Pre-Columbian times (Figure 3) that are still little studied and that could provide more information about the role of local fishermen during the Inca era. For example, at Chipana, a few kilometers north of the Loa mouth, was another Inca-era fishing community. At some point in the early 20th century, F. W. Vale excavated its cemetery and donated more than 170 artifacts to the British Museum (Ballester, 2022). Burial offerings included metal tumis and wooden qeros, smelting crucibles and molds, silver discs, gourd containers, decorated ceramics, copper hooks, bone tubes, stone sinkers, and diverse harpoons (Ballester, 2022). The funerary collection remains to be studied and domestic deposits remain unexplored.

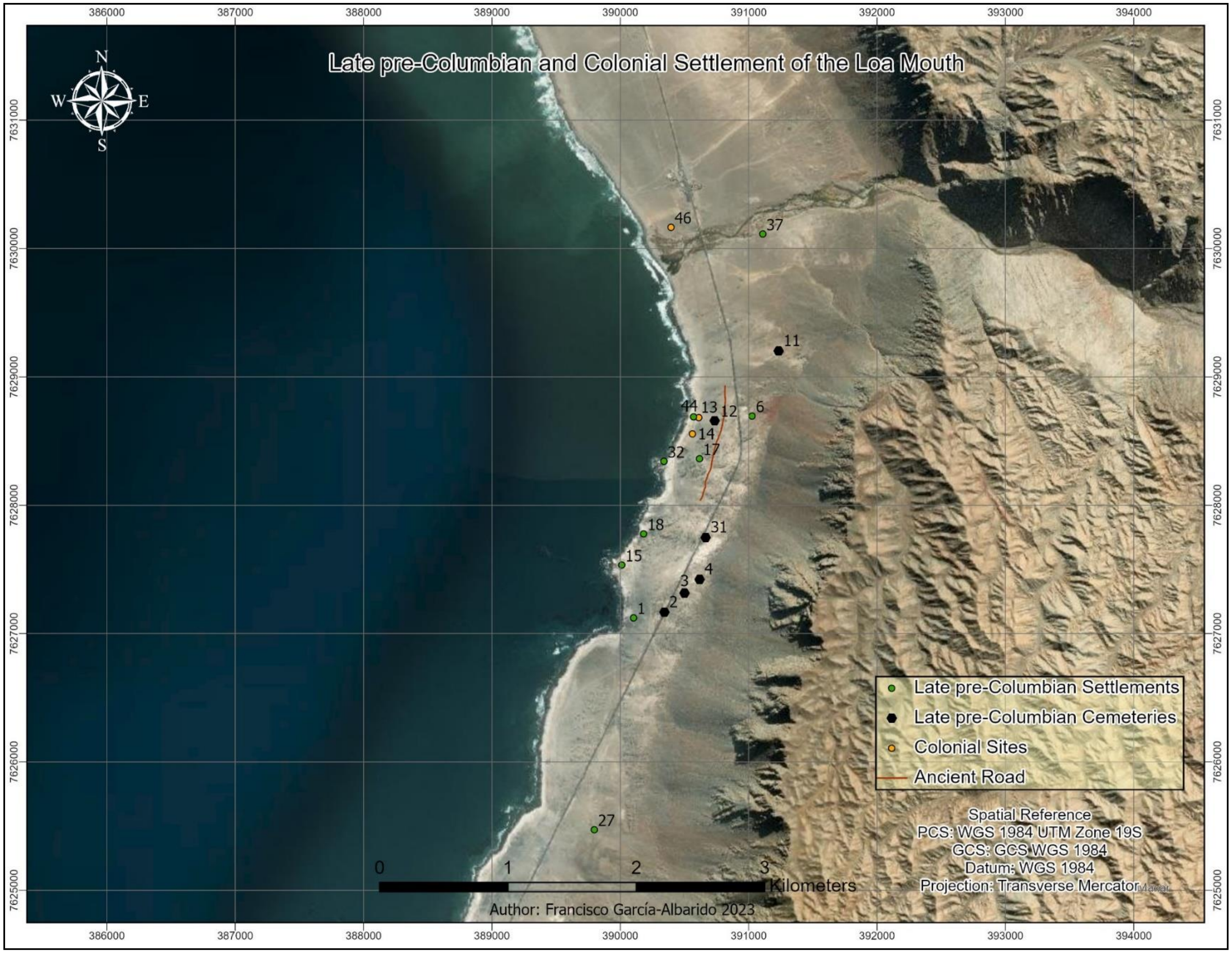

Figure 3: Late Pe-Columbian and Early Colonial Settlement of the Loa Mouth based on Núñez (1971)

3.3 Fish and Inca Political Economy

Documentary sources indicate fish was one of the tributary commodities requested by the Incas, although this remains an under-investigated topic. What was the role and extent of dried fish in the Inca political economy? Inca rule over hundreds of fishing communities along the Pacific coast, including many small ones like those described above, would have enabled production of a good deal of preserved marine foodstuff to finance Inca politics and institutions. In this section, I relate fish to the Inca storage systems in search of the fishes' travel inland to meet state needs.

More than "supply on demand", the Inca practiced a "supply on command" economy; Inca officials (freed from the vagaries of trade) introduced institutional demands to local communities, something very different form the "invisible hand" or (modern) market principle of supply and demand equilibrium (Earle, 1985; 2002; La Lone, 1982). The flow of goods served institutional finance needs and political rivalries. Thus, the flow of these materials shows the stabilities and fluctuations of political relations over time (Earle, 2002). The Inca economy was politically integrated, one of its main preoccupations was to finance state operation and projects with mobilized labor, which largely had to be fed (La Lone, 1982). The Inca sponsored ethnic productive organizations through generosity, reciprocity, and redistribution (and other less amiable strategies) in which staple goods played an important role (La Lone, 1982). As a result, the impact of the Inca political economy on distribution is visible through changes in local consumption patterns and differential access to goods (Costin & Earle, 1989).

Below the state interface, local communal economies were integrated by self-sufficiency and direct exploitation of archipelagic settlements, through exchange and redistribution. Subsistence economies were regionally variable and accommodated more exchange on the central and northern Peruvian coast than in other regions of the empire (D'Altroy & Earle, 1985). We know that dried fish played a role as an internal foodstuff at least among lowland LIP chiefdoms. To what extent did this production become part of the Inca political economy as staple finance strategy? Valuables were obtained directly from producers or produced directly through attached specialists (with tributary resources) and used to finance political services and to integrate regional hierarchies - - this kind of items were highly transportable and more resistant than staple goods (D'Altroy & Earle, 1985). Yet, the above-mentioned non-food-producing artisans might have been supported with these staples to generate wealth items.

Staple finance was fundamental for the functioning of the Inca state (Earle, 2002), products of this type were generated thanks to corvee labor or mandatory shifts but not from communities' own goods (D'Altroy & Earle, 1985). Inca personnel and representatives were maintained with in-kind tributary staples like grains or livestock, perishable resources of high transportation and storage costs (D'Altroy & Earle, 1985). Subsistence goods were stored locally to finance laborers and administrators, Inca warehouses were built to support state institutions locally and to solve unexpected problems like warfare (D'Altroy & Earle, 1985). This conversion of staples into status goods and wealth finance represented an Inca version of productive commodities (Urton & Chu, 2019). Large amounts of coca were found within one of the main storage facilities of Incawasi (Cañete Valley), this stimulant was a major Inca wealth finance product and probably represented a traditional Andean mean of exchange or primitive currency observed by early colonial Spaniards in the Andes (La Lone, 1982; Urton & Chu, 2019).

Inca storage then emerges as a window into local political finance and endeavors, differential access, and productive requirements. Tributary commodities were stored at places where its consumption was planned to occur such as administrative centers or waystations (D'Altroy & Earle, 1985; D'Altroy & Hastorf, 1984). Through comparison with previous LIP communal storage spaces (plus densities and distributions of storage vessels, sacks, baskets, and other containers) we can gain a perspective into potential intensification due to tributary demands.

Dried fish would have been an Inca in-kind staple tribute (Murra, 1980). If so, depending on its importance within Inca's political economy, its production, movement, and consumption should be visible at state warehouses in the local (coastal), inland, and highland regions.

Main administrative centers in the highlands such as Hatun Xauxa, Huanuco Pampa and Pumpu had massive storage capacity for agricultural products and other items for those working for the state in the area (Costin & Earle, 1989). Test excavations at some (6) of the 1950 storage structures around Hatun Xauxa revealed the storage of all major highland crops like maize, quinoa, and potatoes (D'Altroy & Earle, 1985). The use of these goods is listed in early documents for the Mantaro valley: the support of elites, military, corvee laborers, and agricultural retainers (D'Altroy & Hastorf, 1984). In other large highland Inca centers such as Huanuco Pampa and Paria near Oruro, storage areas are associated with chicha containers (aryballos) and textile production (Gyarmati & Condarco, 2014; Morris, 1976). The contents of the storage structures in the Cuzco heartland are mainly related to local agricultural products like maize (Covey et al., 2016). No Pacific fish or marine resources are reported, the only exception being some worked shells in Paria. The same is true for the Tambo Viejo of Sevaruyo (south of the Poopo lake) an important

Inca settlement on the Inca Road (Lima, 2014; Raffino, 1993; Sejas, 2014) and for Incaguano, in the Tarapacá highlands (Berenguer et al., 2011).

In the lowlands, Incawasi is a very important Inca administrative center in the Cañete Valley of Peru. The storage facilities here are unique for the region in terms of size and density, and agricultural products from state owned lands were stored at the center (Urton & Chu, 2019). Peanuts, chili peppers and black beans were found in direct association with quipus or accounting devices. Some fish vertebrae, mollusk and shrimp fragments were found in the corridor of a storage complex (Urton & Chu, 2015). However, no massive storage of fish is reported at this site located 27k from the river mouth.

What is the situation within our study region? Camata Tambo, with its rows of rectangular collcas is the largest storage facility of the Colesuyo, located in the upper Moquegua Valley about 3000 meters above sea level (Chacaltana et al., 2010). Five out of 31 of the storage units were excavated. Interestingly, sea urchin (*Loxechinus albus*) represented the main marine item found at the site (Chacaltana et al., 2010). In Collca 1, sea urchins were stored alongside unidentified shellfish and fishes, maize, Peruvian pepper tree (*Schinus molle*), amaranths (*Chenopodium*/*Amaranthus)*, beans, maize, potato, and chili peppers (Chacaltana, 2015).

Tacahuay Tambo is located 25 km south of the mouth of the Ilo River. This site is composed of various structures including two kallankas, an open plaza or kancha with rectangular constructions and some (circular, semi-subterranean) collca structures (Chacaltana et al., 2010). Its storage technology and capacity, in comparison with Camata, suggests a small-scale hub for moving marine products into the nearby altiplano (Chacaltana et al., 2010). Excavation at one of its kallankas (Unit 1) yielded varied marine taxa recovered from Inca-era layers, the bone assemblage included corvine drum (*Sciaena gilbert*), jurel (*Tachurus murphy*), herring

(*Clupeidae*), and anchovies (*Engraulis ringers*) among other species from various marine environments (Chacaltana, 2015). Therefore, Camata and Tacahuay demonstrate the use of marine resources within Inca finance and storage systems in our study region (Colesuyo), perhaps for the benefit of highland elites at the nearby altiplano (Chacaltana et al., 2010).

In sum, what this cursory sample of the available published data about the storage contents in highland administrative centers or waystations is that fish are not very significant pan-Inca resources at the largest of centers. Of course, the apparent limited distribution of marine resources could be an artifact of limited excavation samples from collcas, the lack of faunal analyses, the disinterest in its publication, or simply differential preservation factors. Yet the Colesuyo case (Camata/Tacahuay) is evidence for Inca-era small-scale storage and long-distance transportation of marine resources into the highlands.

The Incas siphoned some of these marine foodstuffs from the Osmore Valley, they built infrastructure at Tacahuay (tambo) for Lupaqa overseers and some buildings at the local village of Tacahuay (de France, 2021). Fish was a significant part of the diet at tambo Tacahuay (de France, 2016), and might have solved part of the state local finance requirements. Even if the tambo doesn't have a clear system of fish surplus storage for export, the highland Camata tambo evidenced sea urchin remains so Inca staple economy for the region included inland distribution of marine resources.

Fish processing features and techniques are also unclear in this coastal region of Colesuyo. Open circular rock enclosures filled with fine sand for the small-scale drying and preservation of anchovies and sardines ("tendales") have been found at some Pre-Columbian sites on the Osmore coast (de France, 2016). The use of sand for fish drying is comparable to the central Peruvian cases, the scale would not be for export but for local consumption only. Some potential *tendales* for domestic use were identified at Punta Picata, a large shell midden near the river mouth where several generations of LIP and Inca-era fishermen lived (de France, 2021). As in the Loa case, this community was especially devoted to the capture of Chilean jack mackerel or jurel (de France, 2021). A wide variety of fish taxa (n = 17) was transported to the nearby Tacahuay tambo and village, no fish processing/storage spaces are known at the sites despite on spot consumption of the resources (de France, 2021).

Inland commoners and ruling elites at the nearby *sierra* enjoyed some fish from this coastal region, but its inland distribution doesn't match the pattern expected for an everyday staple (de France, 2016; 2021). Despite its small scale, inland fish distribution was active during most of the time periods at the valley, the Incas diverted some proportion for the maintenance of local representatives (as seen in Tacahuay) and to provide culinary diversity for distant ruling elites (de France, 2016). Camata illustrates the latter.

3.4 Fish Storage and Distribution in Inca-Period Tarapacá

Chilean archaeologists have argued that regional distribution networks moved preserved fish among far-flung communities (Castro et al., 2016). Such resource was requested by Spanish colonial administrators, taking advantage of prior production and distribution tribute patterns. To what extent was dried fish distributed regionally through the Inca infrastructure in the Inca era? Is there evidence for this process at Tarapacá Inca, as discussed above, the main central Inca center of the Tarapacá region that included the lower Loa? This issue can be approached through isotopes, the focus of another section. In the following paragraphs, I compile published information about fish and storage in those main Inca settlements (including Tarapacá Inca) and non-fishing settlements connecting Loa with the Inca state and with the highlands to address these questions.

During the Inca era, the nearest agricultural communities to the Loa fishing village were in Quillagua, a fertile segment of the Loa Valley, in the middle of the driest desert on earth. Available dates indicate a regular sedentary occupation at some Quillagua villages and associated cemeteries from the beginning of the Late Intermediate and Inca periods, perhaps from the eighth century up to the early colonial period (Gallardo et al., 1993; Gallardo et al., 2021). The valley was a multiethnic enclave, inhabited by kin groups from Tarapacá and Atacama as seen from their spectacularly preserved grave goods, textiles, and tunics (Gallardo et al., 2021). Two villages and three cemeteries evidence eight centuries of multiethnic occupations. At the village of La Capilla, an LIP and Inca era settlement, archaeologists identified, among its 72 structures, small storage structures and storage pits containing maize and algarrobo seeds (Gallardo et al., 2021). Radiocarbon dates and the presence of Inca-Pacaje ceramics at the site indicate a clear Inca era occupation (Gallardo et al., 2021) even if fish was part of domestic consumption no fish storage has been reported yet. The LIP village of Chuncahuayco is formed by 20 rectangular structures of different sizes. Excavations and surface collection at the site recovered maize and gourds, ceramics from Tarapacá, Arica, and Atacama, textiles, and ceramics (Gallardo et al., 2021) but, again, there is no indication of fish storage.

From Quillagua, the nearest Inca settlements are in the Loa and Guatacondo highlands. The Incas built a large tambo (Miño) at the Loa river's headwaters, the site features a *kancha* compound, two kallankas, and alignments of rectangular rooms, among its over 60 structures (Berenguer, 2007). Comparatively high percentages of Cuzco polychrome ceramics and Provincial Inca types have been identified and intensive consumption of local wild animals reported

(Berenguer, 2007) but no detail on the contents of storage structures has been published. The Inca mining site of Collahuasi (Co-37), in the highlands near Guatacondo, features dozens of small storage structures, some of them still under construction at the abandonment episode (Urbina, 2009). Eleven circular aligned storage structures would correspond to collcas grouped in Sector C (Romero & Briones, 1999); other types of storage structures are also extant. These features mark Collahuasi as an Inca site with a considerable storage capacity, comparable with important Inca settlements like Incallajta in Bolivia (Lynch & Núñez, 1994). Inca-era Tarapacá, Cuzco and Pacaje ceramics are reported (Urbina, 2009), but, with one exception, no information has been published about collca contents.

Collahuasi would have been a mining and smelting settlement. Copper oxides and slag are dispersed at some sectors, many aryballos, bowls, and pot sherds along with guanaco, vicuña, chinchilla and vizcacha bones indicate the processing, storage, and communal consumption of food at Sector B (Berenguer et al., 2011). The area was probably a kancha and its lateral rooms would have represented food deposits for mita miners (Berenguer et al., 2011), fish remains are not reported as part of the commensality events. Another Inca-era settlement is located north of Collahuasi in the highlands of Mamiña and Pica. The so-called Collacagua tambo consists of a large settlement and cemetery of an Incanized pastoralist Caranga community (Berenguer & Caceres, 2008). Tumi knifes, copper tupus, metal discs and balls, textiles and sandals, combs, maize, and mineral powder were among the items recovered from its cemetery, however, a recent revisit of its architecture discounted the existence of any fundamental tambo architectural component like collcas and others (Berenguer & Caceres, 2008).

If we move north to the Tarapacá basin, we come to the previously described Tarapacá Viejo. The surface layout of Tarapacá Viejo, built in Inca times for some scholars or a post-Toledan initiative for others, displays no obvious storage structures (Zori & Urbina, 2014). Its visible architectural layout must be conceived as the historical product of the local native and posteriorly mestizo community which kept preserving Inca structures while remodeling others in colonial times (Zori & Urbina, 2014). Patricio Núñez (1984) conducted several excavations at the site in the 1970s. He identified several colonial contexts but also an initial LIP and Inca phase. Núñez (1984) has identified remains of built storage structures (silos) in the Inca component, one silo still filled with a large quantity of maize remains (Núñez, 1984). Several storage pits were discovered by Zori (2011) at LIP floors, some of them yielding molle (*Schinus molle*) seeds perhaps used for chicha.

Zori (2011) excavated several units at the site in the 2000s, documenting the regular consumption of camelids, probably llama and alpaca, alongside other Andean domesticates like guinea pigs, and highland wild animals, for example vizcacha (*Lagidium viscacia*) and chinchilla (*Chinchilla breviacaudata*). In the colonial component, sheep, chicken, and cows were part of the diet, as well as shellfish of diverse sorts but specially mussels, brought boiled from the coast with decolorated shells. Although not yet seen in storage contexts, moderate consumption of fish is evidenced by remains in domestic layers. A similar association between upper colonial layers and most marine resources was also noted by Núñez (1984). Shellfish and fish consumption at Tarapacá Viejo is seen in upper occupational layers mostly, with both vertebrae and fish skull bones recovered in small quantities (Zori, 2011). Some fish were transported from the coast, dried and salted, with their heads still in place, however, clustered ichthyological remains at Area 5 were constituted by vertebrae only (Zori, 2011), the movement of both whole and headless fish coexisted.

An important tambo in the highlands upstream of Tarapacá, the site of Incaguano or Incamarca (as locally known) includes 52 structures grouped into three sectors, a kancha compound, a kallanka, and a plaza where native pastoralists still hold rituals dedicated to surrounding sacred summits (Berenguer et al., 2011; Urbina, 2009). Surface ceramics are a mixture of Pica-Tarapacá vessels, altiplano types, Inca-Pacaje sherds and some Cuzco polychrome fragments. A good proportion of its structures have an internal storage capacity and constructive characteristics like collcas, one of these deposits was excavated and yielded quinoa and a textile, interpreted as the remains of stored sacks or bags with crops (Berenguer et al., 2011; Urbina, 2009). No fish remains have been identified yet.

Inca regional storage have not evidenced fish remains, but this can be an artifact of the lack of systematic excavation of potential collcas, of the analysis of some lines of evidence (i.e. faunal remains), or simply the lack of publishing about recovered animal bones. Preservation factors are part of the equation, but they don't prevent fragile organic materials from surviving as we saw in the previous case.

3.5 Summary

If Puerto Loa's late Pre-Columbian fish harvest was part of Inca tribute and distribution, I would expect indicators of fish storage at Quillagua, Pica or Tarapacá Viejo, as well as in the storage features at Collahuasi or Incaguano. Yet, there is no direct archaeological evidence for fish being stored and transported through the Inca storage system. However, at these and other sites, the lack of evidence for fish storage might also be a function of preservation factors, lack of intensive excavation of collcas, and excavations that did not involve analysis of fauna remains. Because of this, I consider the Inca fish tribute hypothesis an open one, and more excavations with faunal analysis will provide a detailed picture about tribute fish distribution in the region. In contrast, production of fish for storage and intra-regional movement can be documented for communal storage spaces in non-Inca center communities, in the Lluta and Azapa valleys. Although the data remains limited, the common species seem to be Chilean jack mackerel, sardines or anchovies, and corvina, processed both whole and headless. Inland from the Loa mouth, fish consumption has been demonstrated from the lowlands up to Calama, the upper margin of the maritime Yungas. Fish arrived in small quantities at the main late Inca center of Tarapacá Viejo and were probably consumed at low levels by some of its inhabitants.

4.0 The Puerto Loa Port Community

March 22nd. This day our boat and canoes went from the ship, well manned, to find the river Loa. They went also about two leagues to leeward of it, to a fishing village, but could find no place fit for landing; whereupon they returned without doing anything. The next day another canoe of our company went out upon the same exploit, but found the same success. Yet, notwithstanding, here Sir Francis Drake watered, and built a church, as we were told by our pilot. This church is now standing on the sea-side by the river, whose mouth is now dry. There are several huts to windward of it; and from the said church or chapel a great path goes up the hills; which leads to Pica.

Exquemeling (1924[1684], p.414).

This is how Exquemeling, one of Henry Morgan's comrades in many infamous attacks on Spanish towns, describes an attempt to visit or raid what appears to be Puerto Loa. In the 17^{th} century, buccaneers still prowled the southernmost Andean Pacific coves and ports sniffing out the legendary treasures of colonial Peru. In this earliest known eyewitness description of the port, Exquemeling mentions the main elements of an Andean colonial port: a place with freshwater; seashore feasible for landing; connection to inland towns; and a Catholic church to serve the port's residents. He found the huts empty and silent, however. One can imagine the local inhabitants had fled at the approach of buccaneers.

Port Loa lies at the mouth of the only river (Río Loa) crossing the core of the Atacama Desert. A place of considerable time-depth, port occupation was established over a large, preexisting, and multi-generational native settlement adjacent to an ancient road that leads into the interior and a potential associated Inca period waystation (*tambillo*) with corrals. The Puerto Loa site is covered by an extensive shell midden (5 hectares[2]) roughly divided into two main components (Figure 4). One component (Sector A) includes a dense shell midden up to 2.5 meters in depth. The midden is the most visible remnant of the long succession native hamlets built in Sector A by generations of Andean fishers. Sector B was the site of the Spanish fishery.

On the sighting of land, an arriving early 17th century sailor would have heard the navigator recognize Loa from the coastal and background mountain topography, following careful descriptions in the cartography used by the captain or navigator. The small port may have felt as a refuge, not only after the long and dangerous journey through the Strait of Magellan, or south along the Pacific coast, with the ongoing dangers of English pirates and buccaneers, infidels, and Protestants, as well as the usual storms. At the least, the place would represent an opportunity for fresh food and water. Our visitor would probably have seen from the rail of the ship a few dozen huts made of sea lion hides and large whale ribs behind the only clear channel to the beach at this locale (one that Exquemeling's crew apparently could not locate). Behind the huts rose an early Catholic church or chapel, standing out from the houses because of its thick and high walls of dressed stone. Its gable roof would be covered by sea lion skins tanned by the indigenous fishermen themselves.

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[2] based on the scatter of surface domestic materials between sectors A and B, not counting funerary areas.

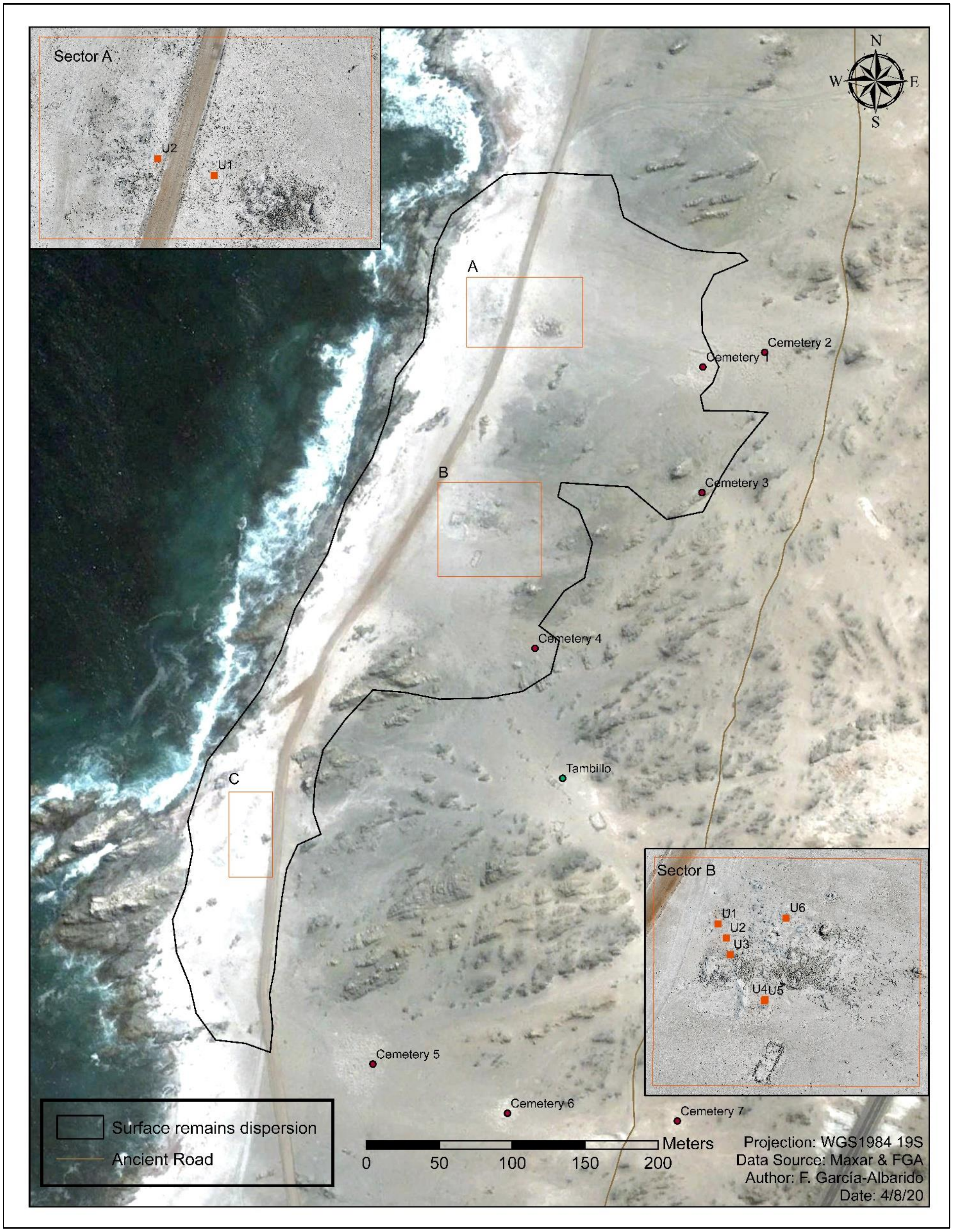

Figure 4: Sectors and cemeteries

The hamlet would be inhabited by “naked” (in usual European descriptions) fishermen and other indigenous residents dressed in worn cotton tunics. Several black inflatable boats of sea lion hides would shine in the sun while drying out between the houses. Some villagers would be repairing fishing nets, fashioning fishing tackle, or gutting the plentiful mackerel. A group of llamas loaded with algarrobo flour, and ceramic vessels may be seen coming down from the river canyon towards the town led by a shepherd from the valley. The visitor would not be able to see from shipboard two large contiguous indigenous cemeteries, places of deep Andean ceremonialism and rituals; for boats approaching through the port’s natural access channel, the cemeteries would be visually blocked by the stone church. Another two native cemeteries - one of them with individuals with cranial deformation- would be out of site east of Sector B, reminders of the deep roots of this place in the landscape.

The same buccaneer (Exquemeling, 1924[1684], p.403-404) left us a more detailed description of a comparable and almost contemporary Andean fishing community from the island of Iquique not far from Loa.

To windward of the said island is a small village of eighteen or twenty houses, having a small chapel near it built of stone, and for adornment thereof it is stuck full of hides or the skins of seals. They found about 50 people in this hamlet, but the greatest part of them made their escape at the arrival of the canoe. To this island frequently come barks from Arica, which city is not far distant, to fetch clay, and they have already transported away a considerable part thereof. The poor Indians, inhabitants or natives of this island, are forced to bring all the fresh water they use the full distance of eleven leagues, that is to say from a river named Camarones, which lies to leeward of the island. The barque wherein they used to bring it was gone for water when our men landed upon the place. The island all over is white, but the bowels thereof are of a *reddish sort of earth. From the shore is seen here a great path which leads over the mountains into the country. The Indians of' this island eat much and often a sort of leaves that are of a taste much like our bay-leaves in England, insomuch that their teeth are dyed a green colour by the continual use of it. The inhabitants go stark naked, and are very robust and strong people, yet notwithstanding they live more like beasts than men.*

Exquemeling describes for Iquique a small but connected community of about 50 people (indigenous and Spanish) living in houses clustered around a stone chapel. The residents chewed coca and were frequently visited by Arica's ships; there was a road to the interior, probably to Huantajaya and from there to Tarapacá and the highlands. One of the old Spanish men they took hostage told them local people drank wine and consumed other commodities provided by Iberian authorities, their work being also fish drying for Arica's governor:

The other old man, being under examination, informed us that the island of Iquique aforementioned belonged to the Governor of Arica, who was proprietor thereof; and that he allowed these men a little wine and other necessaries, to live upon for their sustenance. That he himself had the superintendence of forty or fifty of the governor's slaves, who caught fish and dried it for the profit of the said governor, and he sold it afterwards to the inland towns, and reaped a considerable benefit thereby.

-Exquemeling (1924[1684], p.404)

The arrangement mentioned centers on exchanging fishing and fish drying labor for wine and coca, the old Spanish man was probably the governor's steward. Exquemeling's description would likely have applied to Puerto Loa with its stone chapel, Spanish administrator, naked *camanchacas* or "fish Indians", engaged in labor exchange as well.

The arrival of a deep-sea ship would be met by a squadron of fishermen and stevedores from the village sailing up in their inflatable sea lion boats or other kind of vessels to aid unloading of merchandise, offering the fresh fruits of fishing, and transporting passengers to land. On occasion, they might also transport some Andean or Spanish nobleman to the ship to continue on to Arica or Callao. Goats, sheep, chickens, dried fish, sacks of sea salt and guano would also be carried in these boats to the ship anchored off the coast. Like any Andean port of this era, Loa was a natural port, without infrastructure, small and rural. The same type of port would be familiar to any who had sailed in in the contemporary Mediterranean.

After laboriously disembarking through the small rocky channel, our early 17th century visitor to Puerto Loa would walk through the village among Andean fishermen sitting on the floor rounding dark slate fishing sinkers with pumice abraders. Other residents would be processing fish, discarding the heads directly on the floor. Those preparing to enter the sea to fish at that time would be loading their inflatable boats with strong cotton fishing lines, sophisticated small bronze hooks, and stone sinkers of the mentioned kind. Other residents, primarily women and children, would be collecting shellfish from the shore.

The town would smell like smoke and fish; part of the fuel used would come from burning seaweed and the guano of the llamas and caprids that inhabited the place. Europeans would probably not walk barefoot through the hamlet as the ground would be covered by hundreds of sharp shells from the seafood consumed daily by the community. In the center of the hamlet, large globular pots would be resting directly on the fire under the watchful eye of other cooks and children. These people, women included, would be preparing algarrobo flour tortillas and serving chicha not far from the Catholic chapel façade. They would have relatives in other places on the coast, and every so often a Catholic priest would open the chapel to perform a mass or celebrate a marriage between a local and someone from another cove. The priest would take advantage of his intermittent visits to the church to trade fish with the local chiefs and baptize children.

The village might hold a few visitors from the interior valley and nearby oases (e.g. Pica) dressed in cotton tunics and fine camelid wool garments. Some of them would have the hereditary power, or kin ties, to collect the in-kind fish tribute from the locals as in previous times. Our sailor, if perceptive, might perceive social nuances within the native community itself and its ties with other coastal and inland people.

Passing through the village and by the chapel, the visitor would come to Sector B to the south of the church. This area constituted the Spanish sector and was dominated by the colonial fishery. Prominent in this sector would be a substantial stone house, kilns, a walled seawater evaporation pond, and other stone-walled structures of residential and economic function. A fish salting and drying patio is located here – a central feature of the economic life and raison *d'etre* of the Puerto Loa community, and a setting for the all-important interaction between Iberian elite individuals and indigenous curacas in coordinating native commoners' daily labor.

The central structure here was a residence made with tall, thick walls of carefully put together dressed stones. The gable roof would be covered by totora layers or sealion skins as was the chapel roof. Near to the house, the visitor would notice a large smoky earthen oven and several other less substantial buildings amidst covered, outdoor workspaces protected from the harsh sun. The visitor might be comforted to see his fellow Spaniards in the shade smoking cigarettes. Several olive jars or botijas with wine and freshwater would be piled in the shade against one wall of the main house, and some native globular cooking pots would be in use in the main oven, tended by Andean or African servants.

Around the large stone house would be steady activity. Inhabitants of the village would be carrying sea water from the shore to pour into an evaporation pool to obtain sea salt, one of the commercial products of the place. Other indigenous residents would be spinning cotton to repair fishing nets or repairing inflatable boats. Other individuals would be salting fish on the floor (the fish need to dry for several days in the strong Atacama sun), while others collected dried fish in bags and baskets. Some chickens would pass quickly in search of flies, insects, or food leftovers, ignoring the dogs tasked with scaring away the seabirds from drying fish.

Looking to one side, our visitor would note at least one large rectangular warehouse with tall woven fiber walls, full of bags and sacks of dried fish waiting for inland distribution or loading onto ships moving along the coast. Perhaps the visitor would recognize illicit activity. Despite official Crown bans on this activity, a large line of natives would be preparing for their grueling trek to the interior loaded with salted fish. If it was a time of official tribute movement, the sight would be one of Spanish officials' supervising a loud caravan of native and Spanish muleteers leading a dusty line of mules or loaded llamas out to begin their long journey to the altiplano and Potosí. In viewing this event our visitor would probably be joined by the Spanish mayordomo, the coastal curaca, a higher-ranking apical cacique from Pica or even Tarapacá, and a Spanish priest. For such an important event, all would be dressed in a mixture of colorful Andean embroidery and fine European garments befitting their positions.

The record keeping, loading, and departure of the caravan would be just one part of several days shared by these leaders strengthening reciprocal and redistributive relations to ensure payment of fish and taxes, and the harmonious coexistence of elite Andean-Iberian extractive institutions. The missionary friar would be present not only for ceremonial purposes, but probably also to secure his share of the dried fish business. After libations from Inca bowls, chanted phrases in Latin, and the sacrifice of some llamas, the Spaniards and curacas would retire to the shade of the house and might prepare to play cards, drinking the bad Peruvian wine (or alternately good pisco) in delicate crystal goblets (Sevillian wine would be served occasionally for the highest occasions). Coca leaves would be chewed, and tobacco would be smoked until the early hours of the morning. The next day, any hangovers would be cured with appetizing broths and stews made with corn, fish, river shrimp, chicken, llama and goat prepared by their servants and served on tableware imported from Panama or Lima.

If a worldly sailor or merchant, our visitor would not be particularly struck by the ethnic diversity of the port community. At any given time, Loa would be home to, in addition to the indigenous villagers, small crews of Spaniards and other Mediterranean individuals, enslaved Africans, mulattos, *zambos* and *mestizos*. Many would be there to load dried fish, sea salt, goats, or other products from the Quillagua valley, for their own maintenance or to be sold later at Arica and at the mine of Iquique. Small African fishing boat crews would be frequent visitors to the place where their boss or representative would reside or be temporarily present. Other polyglot sailors on their route from Valparaíso to Callao with Chilean flour and agricultural products would also stop at the mouth of the Loa to stock up local resources. Well in the future, the archaeologist would find cuttings of straight and blonde or brown, dark and long or black and curly hair, from indigenous, European, and African visitors and residents.

Some creole, Mediterranean or mulatto adventurers would stay in Loa, others coming from Santiago de Chile, Arica or Lima would stay only temporarily while they waited to begin their migration to Potosí. Some would have fleeting romances with local women and leave unrecognized children accepted by the fishing indigenous people as one of their communities. Others would negotiate business deals, deliver letters and information, ensure the unloading of their merchandise, sell wine botijas or fresh water from Pisagua, accompany a delegation of nobles to mining cities, to escape the law or to meet a loved one, some of them left a record of footprints perfectly preserved in the fishery's salting yard. Learned people resided in the house at least temporarily; these were very devout people who read about the lives of Catholic martyrs and how to be a good ruler of subject vassals. These individuals could when they wished dress in silk and drink from Chinese porcelain. Their fine manners and possession reflected a cosmopolitan world consolidated through shipping and an Andean mercantilism of truly global scale.

In sum, our visitor would have stepped into a small, rural Andean port community during its fishing heyday at the beginning of the 17th century. Based on indigenous labor, operating as a small but essential node in colonial mercantilism, inhabited by people diverse in background and logics, the visitor would be standing in a dynamic place of genesis where two vastly different political, economic, social, and cultural worlds engaged.

4.1 Andean Trans-Conquest Identity and Society

The great majority of the population of Puerto Loa was the indigenous residents in the village, perhaps several dozen in number, far more than the handful of Europeans that may have been there between the arrival of ships. The creation of Puerto Loa as a fishing port only made sense given the presence of this Andean community, a source of labor and expertise, with a deep history of regional ties. In this section, I contextualize the social reality of the fishing community that the Spaniards encountered.

The Puerto Loa maritime foragers did not exist in a void, as is sometimes portrayed in scholarly studies of such communities. They may have been "remote" in several senses, but to characterize them as isolated is to project European perceptions. The late Pre-Columbian coastal communities of Tarapacá were part of a larger and rich social network. As components of extended families (*ayllu*) of fishing specialization within lowland *curacazgos* or chiefdoms, they were members of lineages embedded in regional corporate hierarchies and tributary flows. There was frequent, if small scale, interaction with other communities, particularly inland. vital to maintaining the village's population and social ties.

First, Loa's natives were enmeshed in the regional web of curacazgo sociopolitical relations. The community's residents occupied a specific position, one assigned to fisherfolk. Their traditional and longstanding leaders and extended families could be found at inland warm valleys and oases like Pica, near other elite Andean figures. Second, these apical caciques or *curacas* from the main agricultural villages required their fish as part of tribute and indigenous gift-exchange traditional arrangements as we know from Spanish accounts for Atacama. Third, as part of its rich, dynamic ancient Peruvian history, the Loa mouth community was part of, successively, regional polity developments of Late Intermediate Period, an Inca administrative unit, and then an important colonial *corregimiento* within the colonial Viceroyalty.

The late pre-Columbian Andean community that eventually came to be known as Puerto Loa was part of a regionally integrated population known as Tarapacá (Urbina, 2017). This Tarapacá curacazgo was made up of valley, highland, and coastal groups and recorded by the *quipucamayos* (Inca record keepers) as the southernmost coastal province of the Collao in Inca times (Urbina & Uribe, 2016). The province was organized around six main settlements, each tied to secondary villages and hamlets on the coast and highlands by family relations. Later, each came to represent a *guaranga* or administrative unit of a thousand tributaries in the eyes of Inca authorities (Urbina et al., 2019). The Loa mouth community and the rest of its curacazgo was part of what was called *Colesuyo* in early colonial sources. The Colesuyo corresponded to an ancient pre-Inca Andean social and political region (Espinoza Soriano, 2015; Rostworowski, 1986) comprising *grosso modo* the main fertile western valleys that flow into the Pacific south of the Nazca desert and north of the hyper-arid core of the Atacama. Colesuyo was populated by a network of interrelated chiefdoms settled at the river drainages that cross the arid plains between Camaná (Arequipa) and Tarapacá (Rostworowski, 1986, p.128).

4.1.1 The "Fish Indians": Loa's Camanchaca

A community of Andean fishermen lived and died in Puerto Loa for generations. Economically, they represented a tributary workforce successively coveted by inland curacas, Incas and Spaniards. Loa's native fishing force went from feeding the Inca tribute to the Spanish encomienda and the system of leased ports.

In the early decades of the Spanish Empire, this fishing community of Sector A was occupied by what were termed Camanchacas. The ethnonym Camanchaca was employed in early documentary sources to specifically refer to the southern Andean fisherfolk from Camaná (Arequipa) to Tarapacá (Hidalgo, 2012; Rostworowski, 1986). They were also known as fish Indians (*indios de pescado*) by Spanish authorities, one of the main categories in early colonial *repartimientos* or the labor distribution of Andean people and resources (Villalobos, 1979, p.24). Camanchacas fished, but also crewed boats and worked as guano collectors alongside Africans and others, in providing seafood and fertilizers demanded by inland cities and haciendas in the colonial period (Hidalgo *et al.*, 2019, p.279). They also supplied the coastal mines of Tarapacá with freshwater, beginning in early colonial times.

Early Spanish observers commonly described Camanchacas as barely dressed or "naked", poor coastal people that fed mostly on fish and shellfish (Rostworowski, 1986). Their lords, however, were merited the title of "*Don*" (Mr.) and lived at inland towns amongst other apical caciques and Spanish authorities. These lords were subordinated to the curacas of the farming communities of the valleys or *coles*. They represented the fishing ayllus or extended families within this larger native regional society. For example, the ayllu of *Camanchacas del Loa* is mentioned in a document from a 1660 trial against the outgoing Corregidor of Tarapacá, and the same document indicates an ayllu of Camanchaca fishers residing in Pica (Rostworowski, 1986, p.129). By the same token, there was another ayllu of Camanchacas living in the port of Iquique at the end of the 17th century (Larraín & Bugueño, 2011).

The ethnonym is also seen in the "*libro de varias ojas* (sic)", Atacama's ecclesiastical 17th century source about births, marriages, and deaths (Bittmann, 1984). This source mentions Camanchacas in the nearby port of Cobija, about 125 kilometers to the south of Loa, as fishermen native to the region for generations (Casassas, 1974, p.40). The fishers of the port of Copiapó in the extreme north of colonial Chile, however, were called *Proanches* and not Camanchacas (Casassas, 1974). The Dominican friar Lizárraga (1916[1615]) wrote that several of these Andean fishermen had fled to small coves in the Atacama where they lived poor and almost naked or dressed in sea lion skins; their faces and bodies covered in a hard red crust from drinking sealion blood for lack of water and that this would be the origin of the name Camanchacas. He also adds that they did not eat corn, only fish and shellfish. The lack of agriculture and the strong marine diet of the Cobija fishermen is also mentioned by Lozano de Machuca in 1581 (Casassas, 1992).

In a 1575 demarcation, Viceroy Toledo had designated Pica and Loa, the village of Quillagua and the port, as one single tributary unit (Málaga, 1974). This organization was largely based on pre-existing Andean politico-administrative structures and local Camanchacas were dependent on Pica's caciques from the early years of Spanish colonialism. We know, for example, that as early as the 1550s and 1560s natives from Pica explained their failure to provide llamas to the encomendero as resulting from their full-time involvement in fishing activities (Villalobos, 1979, p.34). One of the other early mentions of Puerto Loa is from August 24th, 1578, the day when Don Alonzo de Moro y Aguirre (by order of Viceroy Toledo) landed at the port to demarcate the southern boundary of the Arica corregimiento (Paz Soldán, 1878, p.51). The port was officially marked then as the southernmost locality of colonial Peru in terms of tributary and labor considerations. The resulting encomienda of Tarapacá comprised several fishing villages from the northern ports of Pisagua and Iquique down to Puerto Loa as reported by Pedro Sande to Potosí's authorities in 1581 (Lozano Machuca [1581] in Casassas (1992, p.32)).

Published documentary references about the Puerto Loa fish Indians in the 16th century are few and fragmentary. There is a gap in references for the final years of the 16th century and future archival research is necessary to document the composition and affiliation of the Puerto Loa fish Indians in the first century of Spanish conquest. References get more precise and tributary counts more common and detailed as the colonial era progressed and there is very precise information for the early 17th century. At this time, Puerto Loa was a thriving fishing community of tributary camanchacas. Sixty-eight fishermen were subjected to tax obligations at the site as recorded in the 1619 *retasa* published by Urbina (2017). These 68 adult males represented a larger community of a few hundred settled in Puerto Loa and the adjoining river mouth. These men and their families constituted a community in the hundreds; we don't know the exact number yet but it's unlikely that the fishermen lived alone at Puerto Loa.

4.1.2 Juan Donoso at Puerto Loa

A key figure at Puerto Loa in the early 17th century was Juan Donoso. His business and estate records provide much of the rich historical information about Puerto Loa. His significance goes beyond that a brief biography can be written about him. As will become clear later, he embodies a critical figure - a crucial agent - in the commodification process. When at Puerto Loa, he would have resided in the substantial stone house in Sector B; several lines of evidence from material typologies and AMS dates are consistent with the years in which he ran the fishery. When not there, his role would be entrusted to resident Spanish stewards and perhaps their families.

This early 17th century entrepreneur and *portero* (port authority) stands out in the documents covering the years in which the Iberian Sector B of Puerto Loa was occupied. He was a Spanish *vecino* of Pica and Tarapacá, main towns of the southern Arica corregimiento, and his will is a remarkable source on the operations involving the Puerto Loa port.

Pedro de Córdoba, the encomendero of Pica and Tarapacá[3] decided to rent the ports and associated labor and business around 1619 (Aguilar & Cisternas, 2013). Newcomer Juan Donoso signed the deal in Potosí and forged a mercantile enterprise based on the fisheries and *guaneras* of the encomienda (Aguilar & Cisternas, 2013; Hidalgo et al., 2019). Juan Donoso paid 1,800 pesos annually to encomendero Pedro de Córdova y Mesia for the leasing of Loa, Iquique and Pisagua

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[3] Beneficiary of the encomienda as a pension.

for a period of four years (Hidalgo et al., 2019).The 68 tributaries at Puerto Loa probably worked for him fishing, drying, and salting, and sailing to the rocky islands and cliffs along the near coast to collect guano. Donoso ran what would today be called a "vertical integration" enterprise. He owned seven vessels of different sizes and uses (two fully dedicated to fishing, others for coastal cargo carrying), and warehousing facilities as his ports. Wine botijas, and guano were regularly transported by his fleet which also served as postal service (Aguilar & Cisternas, 2013). He also traded coca, wine, clothes, flour, mules, dried fish, guano and other commodities with leading merchant curacas from the sierra and altiplano (Aguilar & Cisternas, 2013). To further provisioning marketplaces, he possessed 70 mules for regional transportation and 20 donkeys at Loa and Iquique (Aguilar & Cisternas, 2013). The dried and salted fish for Oruro and Potosí consumption was a commodity subjected to almojarifazgo or trade taxes (Aguilar & Cisternas, 2013).

His goods were sold locally as well, the communities of Atacama and Huantajaya were buyers, the curaca of Sibaya (among other Andeans) frequently purchased for resale his wine and other commodities, and other fishery owners of Arica and Atacama, such as the priest Francisco de Otal also did business with him (Aguilar & Cisternas, 2013). Donoso's guano fertilized the warm valleys of the corregimiento; this resource was transported to Cato in the Tarapacá ravine (upstream of Pachica) and Vitor, another drainage to the north (Aguilar & Cisternas, 2013).

The names of several of Juan Donoso's most trusted, high-level stewards are known. They lived in the main highland cities and mines to manage his on-credit sales, Antonio Hernández was the main agent in Potosí, Captain Manuel Gonzalez at Tarapacá and Gaspar "*el Chino*" oversaw guano distribution at the latter village (Aguilar & Cisternas, 2013). It seems probable that the latter would have regularly visited Puerto Loa.

Following Donoso's death, the lease passed to other porteros, several of whom figure in legal disputes with the corregidores of Atacama over the southern limit of the fishing concessions (Paz Soldán, 1878). Captain Juan de los Ríos, and later, Juan Ramírez de Cárdenas were involved in such legal battles for the rights over Tocopilla and came out as winners (Paz Soldán, 1878, p.55). Each leased port Loa from the Cajas Reales of Arica, traditional lessors of the rights and payers of encomendero descendants' pensions. Port Loa is noted as leased to Captain Juan Ramirez de los Ríos of Guatacondo for 300 pesos a year in 1690 (Casassas, 1974, p.91). However, Captain Juan de Zegarra is mentioned as his steward during the 1660s-1670s (Paz Soldán, 1878, p.56), so the most likely possibility is that he held the port authority during the second half of the 17th century. Ramírez de Cárdenas suceded de los Ríos in this role. More detailed knowledge about porteros awaits more historical research; what is clear is that the position was a formal and lucrative one through the 17th century and beyond.

4.1.2.1 Activities

The salting patio's superb archaeological preservation conditions opened a limited yet exceptional window onto the rich lifestyle of Donoso, his stewards, and other wealthy and literate residents. They were key players in an Andean market network with personal stakes in nodes hundreds of kilometers apart and enjoyed the authority and wealth of their apical position between mercantile and tributary economies. They smoked cigarettes to reduce anxiety and pass the monotonous afternoons of the tropical desert, dealt with correspondence, drank wine and played cards. In keeping with the genteel fashion of the time, they also sought to be moral exemplars, funding the local chapel and drawing from biblical and "morality tales" of the great Catholic martyrs for the sake of their own souls and as part of their Christian responsibility for the well-being of their vassals.

Dozens of cigarette butts, fragments of playing cards, book pages, letters and white paper recovered from the site reflect a literate establishment with purchasing power, leisure time, and connection to the outside world. Most such vestiges are evident in Sector B fishery's glory days (occupations of B1, Layers C & F) as part of everyday activities that ended with the discarding of a wide range of things into the salting patio. Table 1 presents the distribution of paper categories by weight.

Table 1: Paper Categories by Weight (grams).

Unit/layer	*Cards*	*Plain paper*	*Letters*	*Books*	*Cigars*	*Envelope*	*Total*
1	85.16	80.76	11.65	9.81	8.29	6.53	202.2
C	60.44	47.8	5.93	2.52	6.87	6.53	130.09
D		0.13					0.13
E	7.82	3.52	0.45	0.01	0.66		12.46
F	16.9	28.61	5.27	7.28	0.76		58.82
G		0.04					0.04
H		0.66					0.66
2		0.7					0.7
C		0.7					0.7
Total	85.16	81.46	11.65	9.81	8.29	6.53	202.9

Reading

Chivalric romances and the lives of saints as portrayed in devotional literature were meaningful intellectual influences for Spanish officials, nobility, and serious members of the merchant class. This was true of those Spanish residents at Puerto Loa, including no doubt, Donoso. However, it is likely the contents of these books were not only for the cultivation and edification of the literate. Instead, passages may well have been read out to the residents in lay sermons or for entertainment (one of the purposes, after all, of such volumes). Many book pages ended up abandoned on the salting patio, they are quite different in font, style, symbols, and meaning. I was able to identify two of the sources.

One of these was the "*Espejo de Príncipes y Caballeros"* or "Mirror of Princes and Knights." A classic example of a book concerned with moral lessons and teachings about how to treat vassals fairly, such texts were a kind of prose popular among nobles of early modern Europe. This typically had a familiar plotline in which an adventurous, errant chivalric knight exhibited heroic qualities during a quest. This volume comes from a series or cycle composed by five different parts and written by different authors, published for the first time between 1555 and 1587 in Spain (Campos, 2003). The complete title is as follows:

"Espejo de príncipes y caballeros. En el cual se cuentan los inmortales hechos del Caballero del Febo y de su hermano Rosicler hijos del grande Emperador Trebacio. Con las altas caballerías y muy extraños amores de la muy hermosa y extremada princesa Claridiana y de otros altos príncipes y caballeros."

The work narrates the life of emperor Trebacio and his offspring, their power struggles, commitment to their people, and adventurous defense of the Christian faith (Campos, 2003). Astute political alliances and arranged marriages are essential through the plot to achieve religious, social, and political goals. The first part was written by Diego Ortúñez de Calahorra and printed for the first time by Esteban de Nájera in his press at Zaragoza in 1555. The story revolves around a military conflict of global dimensions used to exalt the emperor's power and the hegemony of its civilization over pagan or enemy nations (Campos, 2003). This first part contains lessons about friendship and the education of children, respect for parents, proper political behavior and education for rulers, the exaltation of justice, and offers a critique of pride in the powerful (Campos, 2003).

Ortúñez dedicates his work to the Marquis of the Valley of Oaxaca, Martín Cortés, son of Hernán Cortés, conqueror of Mexico and his Maecenas (Campos, 2003). It was conceived as a mirror for princes or *speculum princeps* in Latin, full of moral lessons and ideal conduct directed towards the reader who was to act accordingly (Campos, 2003). The success of the book motivated translation into other languages and its export to Spanish America (Campos, 2003). The saga continued with subsequent parts printed in 1587 and reprinted in 1623 in Zaragoza. The popularity of these Spanish chivalric romances faded away in the second half of the 17th century.

Figure 5: Example of a page from the book "Espejo de príncipes" found in the salting patio.

There are several passages and parts of sentences preserved from this work among the fragments found at Puerto Loa (Figure 5). One fragment from B1 Layer C mentions Hernán Cortés, conquistador of Mexico, providing further support to the presence of Part I, the version funded by the Marquis of Oaxaca. Part I was reprinted in Zaragoza in 1617[4], with the consent of religious authorities, but page 241 of this edition doesn't correspond to a fragment from the same page recovered at Puerto Loa. The Numancia passage from Loa is not the same as published in the 1580 and 1583 editions, so we may be dealing with a previous or parallel edition. Our provisional *terminus post quem* is 1555, the first edition of the Espejo's part I.

The other title represented in the salting yard strata is about Catholicism, virtue, mercy, and nobility, in the figure of Santa Leocadia, the patron saint of Toledo, and is Father Miguel Hernández's "*Vida, martyrio y translación de la gloriosa virgen y martyr Santa Leocadia*". One possibility, therefore, is that at least one Toledan resided or visited the fishery with what would have been, to them, an especially significant work: Santa Leocadia was a Catholic martyr persecuted and imprisoned by the Romans after her public confession of the Catholic faith. For the Toledans, she symbolizes virtue and nobility, having lovingly helped the destitute and consoled the afflicted, her life offering sublime lessons in moderation and virtue while her death ensured the eternal triumph of Christianity (Martín,1862). She died as a virgin and her sacred relics had to be hidden in Flanders once the first Muslim emir of Córdoba (Spain) Abderramán I started a large-scale persecution of Iberian Catholics. In 1587, the Jesuit friar Hernández (book's author) repatriates the relics to Toledo's cathedral and King Phillip II assists with the ceremony. The volume describes in detail the events that occurred during the transfer of Santa Leocadia's relics from Flanders to Toledo. Pedro Rodríguez was the printer of the book which had its first edition

[4] http://bdh-rd.bne.es/viewer.vm?id=0000047286

in Toledo in 1591. There is a total correspondence between one Loa's fragment and page 280 of the first edition providing a *terminus post quem* of 1591 for the events that originated Layer C.

Loa's colonists, hardly high-ranking officials, thus had before them many lessons about moral conduct and ideals and how to see oneself reflected in the mirror of princes or *speculum princeps*. Of course, there are differences between ideals and realities, but these findings, at a small rural port, make us recognize the complexities of the Black Legend, particularly for actors at the grass-roots level.

The Letters

While Puerto Loa might seem today, and even then, as "remote" in many ways, the residents not only read, but they also wrote letters and communicated with other Iberians of the main Spanish towns of the region and beyond. Literate Iberians probably kept sheets of white paper in Loa's fishery to write letters, keep records, and produce contracts. The archaeological findings complement the historical accounts of an early extensive postal system linking the elite of Tarapacá and the southern Andes. In 1582, Viceroy Martin Enríquez strengthened the coastal mail or Arequipa postal service by extending the active routes of the native Andean *chasquis* to the coast to report, among other things, the presence of enemy sails (Casassas, 1974). The chasquis ran through the sands of the Atacama as in Inca times but now distributing letters and other items. During the height of the Loa fishery, for example, the inland towns sent a chasqui to Cobija every two months with letters and communications (Casassas, 1974, p.86).

Sector B at Puerto Loa yielded dozens of fragments of letters written in different styles and with different inks, and even envelopes with wax seals, all preserved in the salting patio. The letters were written mainly with black ink, but red ink appears as well. Calligraphies vary, indicating different authors and some fragments have signatures. Residents signed documents to verify authorship and indicate agreement to tasks. The handwriting is hard to read without paleography expertise, even for a Spanish native speaker. The task is complicated by the reduced dimensions of the sheet fragments, some loose words and transcription of partial sentences were successful.

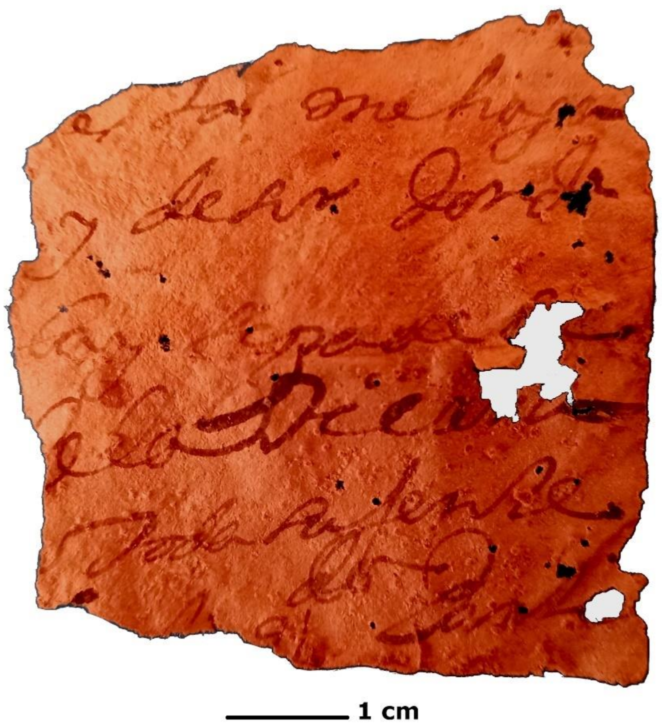

Figure 6: Example of a letter from Loa.

I didn't find any dates among the letter remains; the fragments mostly reflect communication of practical matters to other Spaniards across the region. No "non-business" examples were recovered. I recognized individual words and phrases referring to ships ("*nao*") and containers ("*botijas*"), possession ("*al que tiene*") and acquisition ("*que se saca*") from 10 legible letter fragments of Layer C. A larger preserved fragment (Figure 6), with part of an envelope sealed with red wax, mentions localities such as Pica and San José plus the phrase "*toda su gente*" which could refer to some productive or religious activity. Most Layer E fragments are illegible; one says “*Jesu*(…)” and probably carried a Catholic message. The word “*causal*” is present among the letter fragments from F; it could evidence some legal document written with a calligraphy that resembles that of Arabic. Much of that paper shows the characteristic grooved texture of the laid paper originated during the drying of the pulp in a metal mesh. Fragments of white paper are pervasive, and white paper is one of the most frequent categories by weight (part of it could come from letters and disassembled playing cards).

Quilter and collaborators (2021) recovered thousands of paper fragments at Magdalena de Cao in northern Peru. Cao was an early colonial town in the north coast of Peru, inhabited by natives, European town residents, priests, and others. Much of the Cao material culture is like that of Loa, the two cases represent comparable pictures of the early colonial daily life at both extremes of coastal Peru. Most of Cao’s handwritten textual fragments are about town and local church administrative issues. By the same token, printed text was about ecclesiastical matters, including missals, indulgences, compilations of biblical passages, and accounts of the Saints' lives (Quilter et al., 2021).

Significantly, not a single fragment of paper was found in the nearby village (Sector A) even in the uppermost layers with good preservation. The most likely picture is one of coexistence of elite literate individuals with illiterate native fishers.

Drinking and Gambling

Felipe Guaman Poma de Ayala [1615] penned a penetrating look at various aspects of contemporary, early 17th century life in Peru. In addition to his critical account of ecclesiastical and Inca matters, he complained of a society in which blurred limits and rampant corruption involved mayors and priests. One of his famous vignettes features priests and corregidors playing cards for money against each other. This social ill was noted by other observers. Andean curacas and local corregidors had a personal relationship that included, among many other things, gambling and drunkenness as clearly described in a document about Atacama (Sanhueza, 1992). I found many wine botijas and playing cards in the fishery as testimony to such recreation and camaraderie (and perhaps boredom). It's perfectly possible that gambling and bets were part of the daily life among Europeans and even elite Andean visitors at Puerto Loa.

German and Dutch printers started production of playing cards in Spain after 1472; launching a massive early global commodity fabricated in New Spain and Panama as well (Mc Anulty, 2021, p.384). I recovered dozens of playing card remains from excavation plus some whole cards in variable states of preservation. Some preserve their original designs while others are completely altered by salt adherences.

All are recognizable as cards thanks to their composition. Each card was made of many layers of paper with parallel horizontal striations (like modern rolling paper). These layers make up a sort of thin cardstock that separates into several sheets. Designs were printed in black and filled with red or green ink. One complete card (Figure 7) is equivalent in style to the one recovered at Cao (Mc Anulty, 2021, p.390). There are other fragmentary green motifs that could correspond to swords or wands.

Mc Anulty (2021, p.388) reports complete playing cards from Cao measuring 70mm long and 37mm wide. More than one deck was used at Loa over time: measured widths (n = 29) ranged from 33 to 41mm while lengths within the 66-69mm range, the mean width was 38mm. Cards from Loa and Cao are equivalent in dimensions; designs and color are very similar. Cao's cards would correspond to the Latin Deck style made in Spain during the 17th century and very popular in the Mediterranean (Mc Anulty, 2021, p.391). Some of Cao's examples were found in midden heaps associated with papers with written dates in the 1612-1665 range (M[c] Anulty, 2021, p.392). Most Loa playing card remains came from the main early 17[th] occupation (B1, Layer C).

Figure 7: A playing card or *naipe* from Loa.

The same people dressed in European fashion that wrote letters and learnt moral lessons played with imported cards and other early global commodities like their fellow Spaniards in Cao, about 1,700 kilometers away. The Andean colonial market reached remote outposts but not all participated in this aspect; not surprisingly playing cards were completely absent in the indigenous village's excavated assemblage.

Cigarettes

While enduring the torrid afternoons on the Loa mouth, the Spaniards and their subalterns smoked. They probably also smoked while supervising the salting patio labor or the load of llamas and mules, while looking at the horizon waiting for a ship, and with wine and cards at night. The fishery occupants were heavy smokers and as a result cigarette ends can be found everywhere: more than 50 ends were retrieved from B1 alone, a 2x2 excavation unit (Table 2). This is testimony to how common tobacco was. Cigarettes were rolled using letters and plain paper: people folded a narrow lengthwise tab, pasted with saliva to roll the cigars. The smokers recycled letters as rolling paper: sometimes handwritten words are readable, one case says "*que bengan*" (let them come), for example. The ends are tubular and have one burnt extreme (Figure 8), a couple of them still preserve the organic remains of what I suppose are tobacco leaves. I do not have precise information yet on the origin of the tobacco but it's likely that it was cultivated in any of the low valleys on both sides of the Andes.

Table 2: Distribution of Cigarette Ends by Unit, Count and Weight (grams).

Layer	*Count*	*Count %*	*Weight*	*Weight %*
C	42	79.30%	6.87	82.9%
E	6	11.30%	0.66	8%
F	5	9.40%	0.76	9.2%
Total	53	100%	8.29	100%

Cigarette remains were common at Magdalena de Cao where card games and nicotine were also part of life. There, even local priests smoked cigars as most ends were recovered from the church. The Cao specimens received specialized microscopic identification and demonstrated 17th century tobacco consumption among coastal colonists in the Viceroyalty of Peru (Quilter et al., 2021).

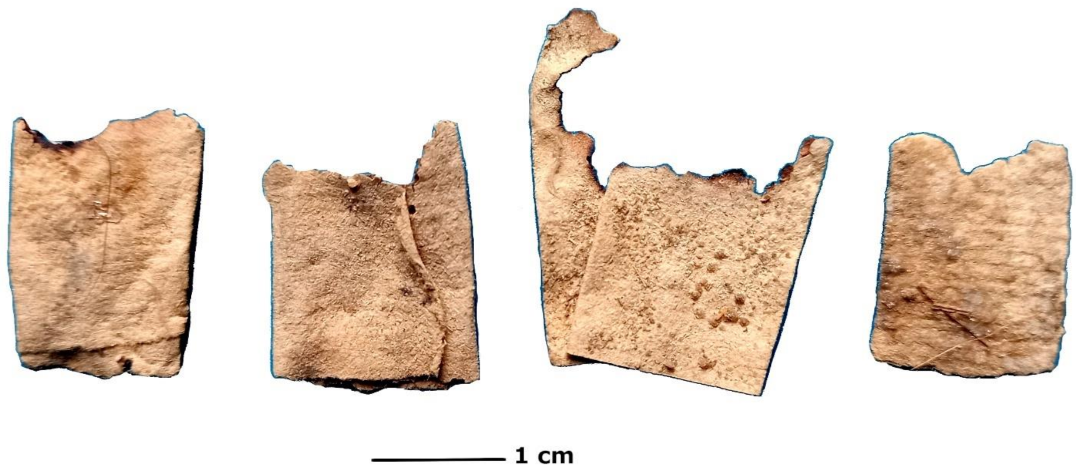

Figure 8: Examples of cigarette ends from Loa.

Despite a great geographic distance, Iberians from Loa and Cao had close consumption habits and similar vices. The daily consumption of nicotine in Loa is just another expression of a Viceroyalty society that shared similar practices structured around a well-established market distribution, but one mainly for Spaniards and native elites.

4.2 Native Authorities

Andean social structures remained vigorous and dynamic through colonial times. They were never fully replaced, despite many transformations (Medinaceli, 2010). The Spanish leaders were not alone in the Andes: the new colonial elite, especially at regional and local levels were a mixture of Europeans and native curacas, related by mutual need and interest although not necessarily on a level of equality. Native elites manipulated and directed ethnic production relations for their own sake without any questioning from their communities up to the early 17th century and beyond (Medinaceli, 2010). Tarapacá was no exception. The available ethnohistoric information shows that some indigenous families and their descendants occupied ruling positions at the regional level. In addition to leveraging their traditional authority, these families initially converted to the Catholic faith and participated actively in the new social and economic order brought by the Crown to Colesuyo.

Spanish documents show an interlocked traditional dual structure of native authorities, appointed from traditional ruling lineages at Tarapacá during the early colonial era (Urbina, 2017). The lords that ruled over the main upper valley and *sierra* agricultural communities in the 1540s and after had authority over other communities dispersed through Tarapacá. The native leadership hierarchy is outlined by 1540s encomienda records: regional hierarchies accommodated lords (*señores)*, caciques and principals (*principales*), each level with nested jurisdictions over groups of hamlets at different altitudes and ecotones, sometimes including fishers and coastal villages (Urbina, 2017). Early documentary sources depict fishing leaders as lesser authorities while the leaders of the highland pastoralist partiality are only listed as principals in the 1541 encomienda grant to Retamoso (Urbina, 2017).

There is very precise data about trans-conquest Tarapacá's native leaders when the Spaniards first arrived with Quilquisana noted in 1535 as the ruling lord of the whole Tarapacá province. The traditional Andean dual structure is also outlined in 1540 documents, Opo was the lord of three villages in the Cato Valley: Guaviña, Puchurca and Pachica, in the upper Tarapacá ravine basin, while Tuscasanga ruled over the lowlands and fishing villages (Larraín, 1975). Tuscansanga continued to develop his promising career with the Spanish. By the 1550s, he ruled the entire repartimiento aided by his principals Ojacayo and Oxa. He was already converted, baptized, and called Don Pedro by the Spanish (Urbina et al., 2019). The word "Don" (from Latin *dominus* or lord) was an honorific reserved for those of high social rank[5] and signals a respectfully treatment. However, for reasons yet unknown, other lineage figures emerged to prominence as the native ruling class from the 1560s onwards. The Lucaya lineage rapidly converted and were baptized under Catholic names. They ruled from the town of Tarapacá for about two centuries (Urbina, 2017). Alonso Lucaya was one of the two main dual authorities of the region in 1565, he resided at Tarapacá Viejo and with Juan Cahachura oversaw the affairs of dozens of communities (Urbina et al., 2019). His leadership reached the Pica oasis through relatives and intermarriage, Martin Lucaya figures as the *alcalde* in 1570 and by the early 18th century a Joseph Caque Lucai is mentioned as the governor cacique (Urbina, 2017). The Lucaya shared responsibilities with other families as seen in the list of authorities compiled by Urbina (2017). Some proper names are mentioned in the late 1550s for Pica's caciques: Pedro Calanche, Amastaca and Ynatue. Of these, only Pedro would have been converted and baptized at the time. Amastaca figures as Joan

[5] https://dle.rae.es/don

Hamastaca in the early 1570s, indicating a conversion at about that time (Urbina, 2017). From that point on, all Pica caciques have a Spanish name although there was not a single lineage in power and last names changed decade to decade. The Caque family figures as an important 18th century lineage of caciques at Pica, and the last name Oxa (Tuscasanga's assistant) is listed again as one of the principals of cacique Juan Caucoto in 1649.

We can be sure that some of these leaders would have visited the Loa fishery to ensure the delivery of tribute fish, the redistribution of coca and wine, Catholic rites, and Andean libations. The operation of the encomienda and the fishery must therefore be understood as the fruit of a nascent articulation, new worlds springing up, unimagined interconnections of the new with the traditional, to the extent possible, without stopping a vigorous and full motion society.

4.3 Encomienda of Local Fishermen

The new elites, and particularly the encomenderos, received complete Inca tributary units as a reward for their services to the Pizarro and later to the Crown. This practice would not have been unfamiliar to Iberian nobility brought up in a system of feudal estates and obligations. The true spoils of the Conquest were thus the Andean tributary structures, enabling many curacas to continue in the accommodating role of pivot of the empire and feeding its political economy. Ximena Medinaceli (2010) states that under the Inca, tributes were based on labor shifts, requirements were revised yearly, and native authorities personally oversaw collecting and delivering of goods. A similar system obtained tributes among the conquistadors as well. In 1537 the Crown sent precise tribute instructions to Pizarro demanding censuses from the conquistadors down to the village level and interviews to record the traditional tribute rates paid to the caciques (Villalobos, 1979).

On the Pacific coast, dried fish as an indigenous regional tribute was one of the main items that fueled political economies at the regional scale. Local caciques were responsible for its production and had to organize the fishing moieties of Puerto Loa and other coastal settlements. Writing of a locale not far from Loa in 1581, Juan Lozano, Potosí's "*factor*[6]" or royal official in charge of collecting revenues and in-kind tributes belonging to the Crown, mentioned that the fishers of Cobija tribute fish to the Atacama caciques but are still free and not controlled by any Spaniard:

"*En la ensenada de Atacama que es donde está el puerto hay cuatrocientos indios pescadores uros que no son bautizados ni reducidos ni sirven a nadie, aunque a los caciques de Atacama dan pescado en señal de reconocimiento.*"

Lozano Machuca [1581] in Casassas, 1992, p.32

The Andean fishermen of Tarapacá did not enjoy this freedom; the colonizers maintained the tributary flow of in-kind fish. Colonial tributary data provides a very detailed picture of its role within the developing early colonial economy. Colonial authorities carefully kept track of tribute numbers and categories alongside the names of those responsible for providing them. Tarapacá and its tributaries were handed over to a very powerful conquistador and Pizarro's trusted man, Lucas Martinez Vegaso, and then to other prominent Spaniards (see Trelles, 1982; Urbina, 2017).

[6] https://dle.rae.es/factor

Simón Urbina (2017) has deeply studied this transition for Tarapacá and subsequent paragraphs mostly draw from his seminal work.

An almost complete *guaranga* constituted by 900 tributaries was granted as the first encomienda, and subsequently again in the 1550 and 1575 rates or *tasas*. Quipucamayos were still in charge of tax accounting in Tarapacá and Pica into the 1570s and probably later, which explains the finding of quipus in the colonial site of Tarapacá Viejo (Urbina, 2017). The second (acting) viceroy of Peru, bishop Pedro de la Gasca, conducted a general census in 1549 and produced a detailed tax rate based on the testimony of the Andean lords and face-to-face inspections at each town. Named Arequipa vecinos directed the inspection in Tarapacá and their report was approved in 1550 in that city (Urbina, 2017). Cotton and woolen clothes, maize, llamas, ceramics, salt, fish, sealion fat oil, and personal service represent traditional-type tributary categories generated from indigenous producers. Old-world cultivates and animals were also required from the communities including wheat, pigs, poultry and eggs, and pigs as new additions (see Appendix A). These would either be produced locally by the indigenous people or purchased to fulfill the requirement.

Historical record keeping shows the role that provision of fish has assumed by the 1550s in this tribute scheme inherited from the Incas. More than half a ton (615 kg) of fish was required from the native fishing communities, half sent to the mines of Tarapacá, and the rest collected from the coastal villages for other destinations[7]. Pica's quipucamayos recorded the tributes delivered in 1565 by the locals (Urbina, 2017). Amasttaca and his subjects, including fishermen of the Loa's mouth, were required to tribute 150 arrobas of dried fish (~1725 kg), an unknown

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[7] Trelles (1991, p.189) published a slightly different quantity for tribute fish, instead of fresh, his data refers to dried fish in arrobas[7] (150), convertible (arroba=11.5 kg) to almost 2 tons (1,7 kg) per fiscal year.

number of sealion ropes, 100 chickens and 20 llamas, clothes, and sacks (20 each), plus 150 fanegas of maize, 10 baskets of chili pepper and some quantity of ceramic vessels (Urbina, 2017, table 6.10). The quipucamayos revealed half of the maize tribute from Puerto Loa (or Iquique) was intended for the market in Arica and the other half to support the mines. Silver cash paid for the required llamas so that as early as 1565, local curacas had worked out some sort of market arrangement involving local ayllus to pay tributes in cash. Puerto Loa would have had a potential role as a tribute collecting place with hard currency from shipping and Spanish merchants for the buying and selling of products: an actual spatial marketplace.

Viceroy Toledo ordered another general census between 1570 and 1575 throughout southern Peru (Urbina, 2017). Results indicate that at the beginning of the 1570s Pica and Loa were inhabited by 264 women of all ages, 160 men of 18 to 50 years old (the tributaries), 56 elderly men and 156 boys (Málaga, 1974, p.114). Two adult men played the role of caciques for these communities. At Puerto Loa people were drying and salting fish as part of their tributary obligations and Toledo kept dried fish and chicken as an in-kind tribute for Pica and Loa. Pica and Loa communities tributed 460 kg of preserved fish a year, this repartimiento was required to tribute dried and salted fish. The requirement for Tarapacá, on the other hand, was for only dried fish.

The Crown recalculated taxes for the region in 1646. The same Toledan items were kept but dried fish quotas doubled from the 1570s quota for Pica. The 1646 *retasa* indicates the continuous supply of dried fish to the mines of Tarapacá by Camanchacas, a process already required by the 1550 appraisal (Urbina, 2017). Tributes were collected by caciques and given to corregidors; tributaries or men between 18 and 50 years were responsibly for tributes, *repartos*, church obligations, communal feasts, and family self-subsistence (Hidalgo, 2014, p.415). As much as two thirds of communal production was sold to cover Crown requirements which produced complaints visible in the written records (Hidalgo, 2014, p.399). This situation may have forced Camanchaca caciques to reorganize communal production and to sell the collective surplus for cash when needed in a similar fashion to what was described by Tristan Platt as the "cacique mercantile model" (Tandeter et al., 1995, p.196). But fish was kept as an in-kind category tribute for over a century, perhaps reflecting a special arrangement or traditional role for coastal groups.

4.3.1 Evangelization at Loa

As noted above, the colonial political economy included support of the Catholic church. Puerto Loa was a designated part of formal ecclesiastical units, and its leaders were expected to materially support the saving of souls. Arequipa's bishop, the Augustine friar Pedro de Pereda, established Pica as an independent Curacy in 1620 (Urbina, 2017) and Puerto Loa was one of the nodes that constituted this ecclesiastical unit.

Among the four Curacies of Tarapacá, the *doctrina* of San Andrés de Pica was comprised of the towns of Pica, Guatacondo (San Salvador), and Quillagua (San Miguel), as well as Puerto Loa, consecrated to the "*Señora de la purificación de las pesquerías de la costa*" (Odone, 1995, p.559). Other repartimiento's ports were incorporated into different curacies: Iquique was evangelized from San Lorenzo de Tarapacá and Pisagua from Camiña (Larraín & Bugueño, 2011, p.17).

Today the church remains at Puerto Loa are striking: a large mound of boulders and cobbles. The ruin is mostly covered by its collapsed stone walls, the exceptions being the façade and those places where looters dug up internal areas and desecrated tombs (pelvic and long bones were left strewn over the walls and in the looting piles). The lower portions of the walls are still in place, showing the structure had a rectangular layout (15x5m) and was well-constructed with regular stone/mortar walls. Its position in the town is probably not accidental. Early Spanish evangelists often situated churches to interpose between a native settlement and its associated traditional funerary areas. The Puerto Loa church's entry faced the ocean, specifically the natural channel traditionally used to access the ocean by inhabitants. By the same token, the church blocked the view of the large native cemetery when coming from the ocean that way.

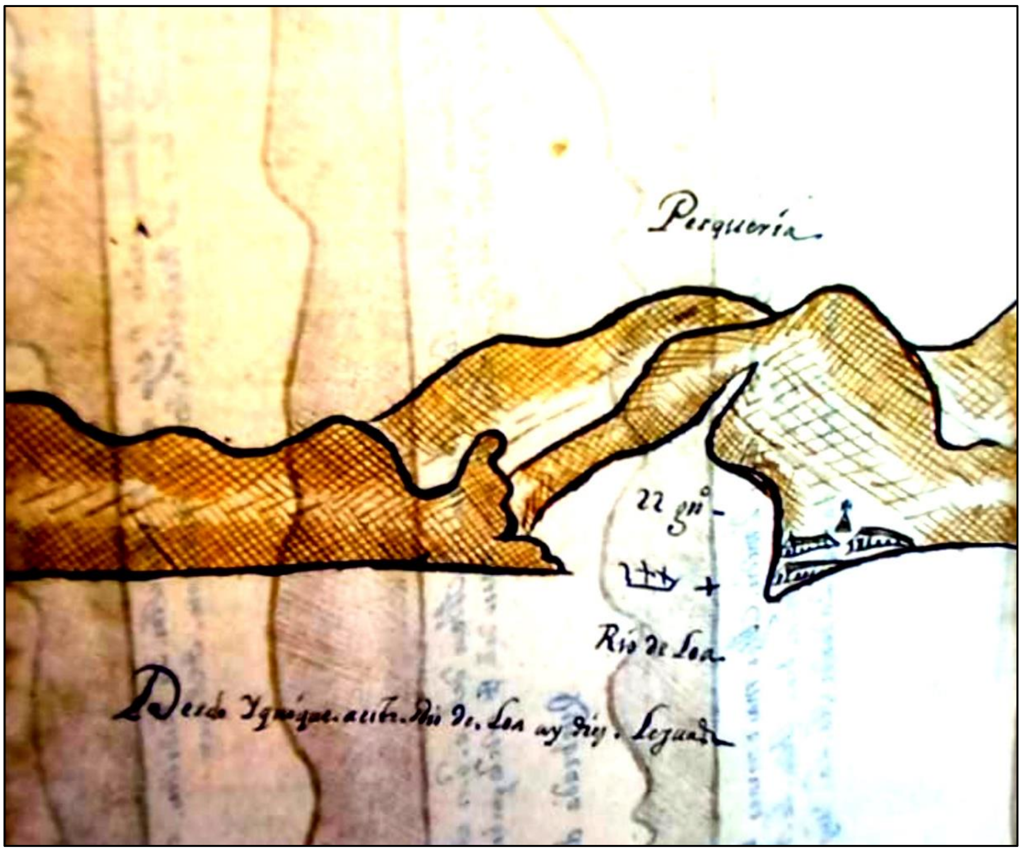

Figure 9: Drawing of the 17th-century Loa fishery with houses and a possible chapel in a navigator's route (Moreno & Ortiz, 2018, p.403). The document mentions: "fishery", "Loa River" and "From Iquique to this river of Loa there are 10 leagues."

This structure was not built by Drake as Exquemeling supposed. Instead, it was the fruit of early Spanish evangelization efforts, but the age of the Puerto Loa church is not known. The church was originally identified by Núñez (1971) on his pioneer archaeological survey of the Loa mouth, and described as a large, isolated precinct (CaH-13) built on a native settlement. He interpreted the structure as a 17th century colonial church given its close association with colonial ceramic remains (surface collections were done) and with the ruins of Port Loa to the south (Núñez, 1971, p.23).

I agree with his interpretation given (1) the construction and support of early port chapels by encomenderos and especially port lessors, Donoso included; (2) construction and stylistic similarities with the nearby Spanish main house; (3) the active evangelization role in Loa of Catholic priests like Francisco de Otal; (4) the presence of colonial extended burials in front of the Loa's chapel façade; and (5) the representation of a large cross and possibly a chapel in the only known drawing of the Loa fishery (Figure 9).

4.3.1.1 Francisco de Otal and Sector A

Evangelization and Andean mercantilism advanced hand in hand connecting elites, ports, and cities. Missionaries and evangelizers brought the word of Christ to indigenous coves while securing a place for business. A small group of men consecrated to Christ swarmed along the coast giving life to the Catholic religion in close partnership with Spanish fishing merchants. Priests would have celebrated mass at this temple of stone and sealion skins, and sermons could be preached by lay people. One name stands out among the priesthood. Francisco de Otal was a clergyman from Aragon of prime importance in the 17th century Atacama for his part in extirpation of idolatry campaigns (Hidalgo et al., 2013). The port of Atacama - Santa María Magdalena de Cobija - was a very active evangelization center. Cobija became a center of coastal evangelization where priests and missionaries carried out their work. A description of the early Cobija church gives a good sense of the basics of the early 17th century church. A solid European-style building completed before 1620, the Cobija church had fine tablecloths from Europe. Silver ornaments acquired in Potosí adorned the altars and tables, native fishermen of Cobija gave fish as alms, silver cash charity was generously provided by those native people involved in regional shipping. A similar situation can probably be documented for San Lorenzo de Tarapacá and the 17th century port of Iquique.

From Atacama la Baja, Francisco de Otal and other priests travelled to administer the holy sacraments to the Camanchacas of Cobija, Iquique and Loa during the first half of the 17th century (Hidalgo et al., 2019). Otal frequently travelled to Loa and other ports to save the souls of the fishing Andeans. In his own words, Francisco de Otal notes a visit to Loa sometime before the 1620s:

"[...] enseñando e industriando a los indios de este beneficio de atacama la baja y camanchas chiangos auitadores de estos puertos de mar por auer mas de veinte un años que aquí les administra Los santos sacramentos y trabajar con ellos enseñándoles en estos dichos puertos como son Cubija Colupo, Yquique y loa y demás partes"

(Francisco de Otal [1641] in Hidalgo et al., 2019, p.285).

Another name stands out among the lay people. Not surprisingly, this is Juan Donoso, the best known portero of Loa, Pica and Tarapacá. He financed the evangelization of his coastal communities, part of the duties involved in renting encomienda rights (Aguilar & Cisternas, 2013). This Extremaduran, a very active and devout Catholic at Oruro and Pica too subsidized religious services for his port communities and kept coastal chapels equipped with the essentials for mass. The chapel in Iquique, for example, had a silver chalice and plate plus *vinajeras*, a manual and missal, all provided by Donoso (Aguilar & Cisternas, 2013).

Otal and the lay person Donoso were commercial associates in fishing and other businesses (Hidalgo et al., 2019). Otal went regularly to Donoso's ports to evangelize local families, a task not completed among coastal communities even during the mid-17th century. Coastal populations seem to be singled out for evangelizing efforts emanating from the larger regional ports. The *Libro de Varias Ojas*, an exceptional baptisms and marriages record from the Atacama la Baja parish, shows the Church's goal of converting 1640s regional coastal port community residents into the Catholic faith:

> *"(...) en los otros puertos de mar y puntas hay muchos indios y muchachos sin saber la doctrina cristiana, por descuido de estos indios sus padres"*
>
> (Libro de Varias Ojas, hojas 62 and 62 vta in Casassas, 1974)

Gabriel de Sande, La Plata Archbishopric's 1641 visitador, continues with the request to priests of obliging other port communities to travel to Cobija and get closer to the Catholic faith:

> "(…) *comparecer a este puerto de Cubixa para que sean industriados y enseñados en nuestra santa fe*"
>
> (Libro de Varias Ojas, hojas 62 and 62 vta in Casassas, 1974, p.83)

Maybe because of this call, the highest numbers of baptisms and marriages recorded in this source for Cobija occurred in the 1640s-1660s decades (Casassas, 1974, p.82). The small 17th century port of Cobija some years saw the celebration of up to 6 marriages and 9 baptisms. Natives from Puerto Loa and other coastal localities are explicitly mentioned in the record. Even if this picture is made incomplete by preservation factors (some pages are damaged or lacking), the book suggests a significant upswing in numbers compared with earlier decades such as the 1610s (Casassas, 1974, p.82). In sum, ports were discontinuous spots of interrelated evangelization where coastal priests and lay porteros worked together. Dried fish made their way into religion as alms, while away from the town, priests saw to bring God and the sacraments to coastal Andean peoples in the remote rocky points and coves.

5.0 Puerto Loa in a Global Setting

The community at Puerto Loa (native and non-native) was articulated into vast overarching systems, first that of the Inca Empire, later the Spanish. This articulation shaped Puerto Loa's composition, economic patterns (production and consumption), social structure, and engagement with the outside world. Particularly under the Spanish, the key driving forces in this articulation can be readily identified. These forces, and the happenings at the microcosm level at Puerto Loa, must be understood in the turbulent context of Spanish 16th and 17th century imperial mercantilism.

When the Spaniards carried out the coup against the Inca, their economic system -mercantilism- was more a dynamic, evolving set of economic thought and policies than a monolithic, totally coherent doctrine (Magnusson, 1994; 2003). It evolved from late medieval, polycentric contractual relationships with the Crown, partially predicated on the preservation of traditional rights (Grafe, 2014). Spanish mercantilism was directed towards the exploitation of the empire's natural resources, consolidation of an integrated domestic market, and securing of metropolitan rents (Grafe, 2014). Spanish mercantilists left a rich literature documenting how these goals were expressed: domestic production and protection, domestic manufactories, the effects of the great inflow of silver and gold from the colonies, limitations on the import of goods and export of raw resources, among other topics (Magnusson, 1994)

Market formation was then an important evolving concern of the Iberian elite since the late 16th century. Initially, Spanish mercantilism was focused inwardly on the consolidation of an integrated domestic market as part of state formation, and less concerned with international competition (Grafe, 2014). At the empire's core region, massive inflows of silver and gold from the Americas triggered unexpected price rises for local commodities, cheaper foreign commodities were imported, and severe money outflows to other European countries occurred. Ironically, this wealth from the Americas created a novel national inflation cycle leading to ruined Iberian industries (Magnusson, 1994; Smith, 1971). The accumulation of precious metals and stopping such metal hemorrhaging from the peninsula, as well as a favorable balance of trade, inspired most Iberian productive enterprises, import bans and taxation appraisals (Solís, 1964).

The turbulent late 16th to early 17th centuries in the Iberian Peninsula was one of social oppression, economic crisis, and corruption; mercantilists blamed Iberian aristocracies for disinterest in productive investments, for their deep involvement in moneylending to the crown, and for their defense of primogeniture (Perotta, 1993). This feudal system of blood purity and birthright inheritance prevented land from being sold (and worked), justified abuses, and contained an aristocratic disdain for merchant activities (Sánchez, 2011). The mercantilist sector wanted land sales, encouragement of nobles to work, lessened military expenditure, agriculture intensification, and the growth of local industries, among other issues (Perotta, 1993). By the end of the 16th century, a powerful merchant social and intellectual trend emerged that intended to break with the seigniorial privileges of the Iberian nobles (Sánchez, 2011)

After debates at Toledo and other universities, dependence mechanisms and associated problems were identified and the King's court decided to push for favorable trade balances, subsidized domestic production, banning many imports, and strengthening of national trade (Perotta, 1993). This market-friendly position translated into the colonies as political support to entrepreneurs for local manufacturing initiatives and the prohibition of foreign and inter-colony trade. A notable result was the emergence of diverse industries around major mining cities (Solís, 1964). The western Colesuyo valleys were shaped by this situation as industry and trade gradually emerged as two elements seen as the drivers of economic progress (Smith, 1971). Mining enterprises had to be supplied and protected to keep nationals in control of mineral extraction. Initially, integrated markets didn't exist, imports were costly, and authorized manufacture developed around the area and needs of individual centers (Solís, 1964). But by the early 17th century a serious foreign competitor appeared. The Dutch controlled several emergent markets and threatened Spanish possession of South America through violent commercial inroads in Brazil and southern Chile. In response, Conde-Duque de Olivares pushed for a mercantile Spain as state policy and the monarchy mobilized troops and mercantile forces to drive out the Dutch from these colonies and markets (Sánchez, 2011).

From the Iberian side, market expansion was characterized by internal disputes, seignorial privileges and diverging mercantile agendas; the Spaniards came from a polycentric world of regionalisms and diverse contractual relationships with the Crown that included the preservation of traditional rights in local territories (Grafe, 2014). Even if mining riches were one of regional market triggers, each region had its own trajectory and actors, both immigrant and natives. As a result, these Iberian markets didn't grow naturally to optimize exchange; in modern parlance, they exhibited lots of "imperfections." Nor were pure "market forces" consistently dominant. The Crown secured silver revenues for political finance and gave latitude for entrepreneurs to act and profit while imposing coercive market measures like the forced sales of goods to native commoners to mobilize a cash economy. As this commercial system dealt with regional elites, histories, preexisting economies, and geography, Iberian mercantilism expansion could and did take very different forms in different colonial regions.

5.1 Potosí, the Demand, and Ports

Potosí, legendary highland mining city, envy of kings, was a conflicted harbinger of globalized modernity as Kris Lane (2019, p.2) has put it. Its miners and refiners produced nearly half of the global silver supply in its first century under the Spanish. The world's first global currency was assayed and marked at Potosí, its "pieces of eight" crossed all frontiers and fueled war, trade, and religion (Lane, 2019).

By the early 17th century, Potosí was one of the largest cities in the world with about 100,000 inhabitants, native open-air markets, European style-commerce of various types, apparently a cash economy. Socially, Potosí held twenty churches for devoutly Catholic communities, and a diverse population of Iberian ethnic and regional factions, Italians and Greeks, enslaved Africans, plus extended neighborhoods of indigenous peoples (local and immigrant) of many different ethnic groups (Lane, 2019). The city was a hotbed for technical innovation and negative environmental externalities. European, Chinese, and Indian demand for pieces of eight meant local purchasing power. The heyday of this boom town occurred after Toledo's introduction of quicksilver amalgam and the reprocessing of ore tailings in the 1570s, yet by the 1630s the decline was evident, and prospectors trekked incessantly across this rugged region to find another Potosí (Gil, 2017).

An early Spanish observer, Pedro Cieza de León, called Potosí's market in 1549 as the greatest in all of Peru:

> *"And as they extracted silver every day, and these Indians are great eaters and drinkers, especially those who trade with the Spaniards, everything brought for sale was consumed."*
>
> (Pedro Cieza de León [1549] in Lane, 2019, p.15)

Potosí housed voracious consumers of all sorts of local, regional, and foreign products (Lane, 2019). Beginning in 1545, Spanish exploitation of silver deposits unleashed demand for all sorts of goods from nearby regions and beyond. Native communities, willingly or not, contributed a good portion of the demanded commodities and labor. Among the imported manufactures, Chinese luxuries such as silk and porcelain adorned the local display. Powerful native caciques saw opportunities to act as intermediaries transporting and selling diverse products. Several major trade routes, partially based on preexisting Inca roads, were the arteries of these major commodity flows. European and Asian clothes and luxuries, Iberian iron and mercury, Peruvian wine and brandy, Chilean grains, and livestock from Tucumán, are among the diverse resources and products that reached Potosí. The demands from this city, as well as other urban centers like Oruro or Chuquisaca, the major nexuses of the regional economy, shaped patterns of production and consumption through the southcentral and southern Andean landscapes. Crucial to this system were Pacific ports. As the settings for the outflow of New World wealth and inflow of European commodities the ports of the coastal Atacama Desert became key nodes in the operation of this new, Potosí-dominated colonial market.

Carlos Assadourian (1982) coined the Peruvian economic space concept to explain how silver mining transformed surrounding rural native economies moving forward from previous studies focused on the consequences of Andean mining on the European markets. Assadourian (1982) identified silver mining as the main driver of change of the Andean countryside. In colonial Latin America, mining products represented 85% of exports by 1601. Potosí's powerful mining sector demanded an unusual volume and array of logistical support for its functioning, given its location in a remote agriculturally limited landscape and the close association with a large urban aggregation of voracious consumers. To satisfy the needs and desires of such an unparalleled economic engine the Crown had to promote internal mercantile relations in Potosí's hinterlands, agrarian ethnic economies were respected or left little altered, but were now linked in complicated ways with market distribution and subordinated to the production of exchange values under Iberian control (Assadourian, 1982). Potosí became then a driver of regional productive specializations, dictated Andean commodity prices, and fluctuations there made Andean industries appear and disappear.

Even if mining labor was supplied by the obligatory draft of common Andeans for the infamous mita (Bakewell, 1984), regional native elites rapidly positioned themselves in other ways, one of these being a role in supplying Potosí's consumers, particularly with native resources.

The Andean colonial mercantilism was strongly self-sufficient; foodstuff, textiles, alcohol, and coca from nearby regions were the main goods sold by Potosí's traders at the city markets (Tandeter et al., 1995, p.209). A good proportion of the major Potosí's merchants were devoted to importing regional goods. European, Chinese, and even Mexican products arrived but were proportionally less important (Choque & Muñoz, 2016, p.83; Tandeter et al., 1995, p.209). The Arequipa-La Paz-Cuzco region produced the brandy-coca-clothing triad, one of the most lucrative trades of the early colonial era (Tandeter et al., 1995). Alongside clothes, alcohol and stimulants, foodstuffs were an essential part of the exchange, the Cuzco region, for example, sent sugar to Potosí (Tandeter et al., 1995). The western lowlands were deeply enmeshed in selling edible products, alcohol, and drugs: from the Arica corregimiento Potosí's consumers obtained dried fish and jerky, livestock, corn, beans and chilies, olives, olive oil and wheat, wine, brandy, and coca (Choque & Muñoz, 2016). Commodities from Chile and other colonial regions disembarked at Arica, for example mules, tanned hides, jerky and wheat from the Aconcagua valley, copper artifacts from Coquimbo and dried fish from Copiapó, plus wine from Pisco and tobacco from Callao (Choque & Muñoz, 2016).

Potosí's demand had cascading effects, fueling the thriving of colonial haciendas in western valleys which, in turn, demanded fertilizers such as guano from nearby coasts on a scale never seen before. Guano was another key resource for regional maize and wheat agriculture. In 1636, Vasquez de Espinoza mentioned that 1 fanega cost 12 silver reales and fueled a prosperous trade for porteros and mule drivers (Hidalgo et al., 2019). The resource was sold at Arica and other ports, its extraction beyond the 18th centuries, during which many foreign European ships illegally mined and distributed the fertilizer outside colonial Peru (Hidalgo et al., 2019; Villalobos, 1979). Iquique's guano fertilized Arequipa, Moquegua, and Arica countryside in the midst of the 18th century (Larraín & Bugueño, 2011).

5.1.1 Fish at Potosí

Among foodstuffs, dried fish was a regularly available popular commodity for urban consumption. In the Titicaca Basin, caciques from Copacabana, Machaca and Guarina ran fisheries and the production of dried freshwater fishes (like pejerrey, boga, omate, suches, and chinichallua) was sold at La Paz and Potosí and was used to pay tributes (Choque, 1987). As already noted, the Pacific coasts of Loa, Pica and Tarapacá produced high volumes of marine dried fish, the resource was obtained as in-kind tribute and sent to Potosí, Oruro, Sucre, Arequipa, Cuzco and Lipez (Aguilar & Cisternas, 2013) where it transformed into a cash commodity. Dried fish from places like Puerto Loa were transported to Huantajaya, Potosí, Arica, and probably sold to passing ships too; highland sierra caciques also bought the commodity for reselling like the one from Sibaya mentioned by Hidalgo et al. (2019).

Iberians and growing numbers of natives and Africans were devoutly Catholics thus had to observe weekly alimentary abstinences. Every Friday was a penitential day of abstinence from consuming terrestrial meat, and every Ash Wednesday imposed the same restriction (Ramirez, 2020, p.403). Fish was also a rich, regular source of nutrients, so for religious and diet reasons the resource represented a staple for the markets of burgeoning inland cities.

Carmelite friar Vásquez de Espinoza referred to the high volume of dried fish from Tarapacá available at Potosí in the 1620s, and its regular and continuous consumption:

"y en el (pescado) seco, que se lleua(sic) alguno de Arica, y gran cantidad de Atacama Tarapacá, y otras partes, que es en grande cantidad el consumo, que de todo se haze en esta babilonia (Potosí)"

(Vásquez de Espinoza, 1948 [1630], p.587)

Crucial information on how fish were distributed comes from accounts of another major silver mine, Huantajaya (near Iquique), which also acted as a local center with similar (but smaller) economic ripple effects as Potosí. This former Inca possession required the work of native tributaries (it had its own mita) and enslaved Africans and was supplied with all sorts of resources such as dried-fish, wine, coca, water, corn, and others.

Native Camanchacas fishers transporting fresh water and fish by sea from Arica to the mine were paid on the spot with coca, and corn was also used to pay other Andeans to transport the same resource (Hidalgo et al., 2019). The miners also received coca as part of the compensation for their work, while from early times African silversmiths converted local silver into export ingots (Urbina, 2017). The Huantajaya case illustrates how part of the exchange, at least the local intracorregimiento one, continued practiced through the bartering of valued native resources, in this case corn and coca. In the southern Peruvian Viceroyalty, fish were part of the diverse kinds of nested exchanges that made possible larger mercantile relations centered at Potosí. The region was a palimpsest of economic transactions, ethnic and mercantile, native, and Iberian, and local encomienda structures (such as colonial Puerto Loa) fed the largest Andean economic relationships.

5.2 The Cacical Mercantile Model

Andean curacas or caciques emerged as key players within colonial social networks, connecting two worlds: that of their indigenous, rural communities and that of the Iberian colonists (Medinaceli, 2010). In many cases their role was official as they were appointed by the Spanish as governor caciques and sought to profit from their engagement with the new market economy through old and new means (Choque, 1987). The cacical mercantile model deals with the extensive role of top curacas in organizing, supervising, and commercializing surplus in the market (Tandeter et al., 1995, p.196). Top merchant caciques were powerful, they fueled trade, amassed fortunes, had debtors and went to trial, and even married the daughters of their trusted Spanish men (Medinaceli, 2010). Native merchant caciques left comparable records (correspondence, notary transactions, litigation, wills) to those of Spanish origin (Tandeter et al., 1995). Family ties governed Iberian and Andean enterprises in Charcas, intermarriage was a common practice between both elites (Medinaceli, 2010).

Although we still do not have detailed data on the curacas involved in the sale/provisioning of the Loa fish, there are fragmentary insights on other curaca. Amasttaca from Pica (in charge of Loa's fishermen) was able to pay in cash for the llamas owed as tribute in 1565. The caciques of Sibaya, upstream from the town of Tarapacá, profited from the resale of fish and wine in the highlands. These examples pose an interesting scenario: (1) apparently certain caciques were potential buyers of tributary commodities produced by encomenderos; and (2) even second-order caciques could market a part of their community's production to obtain cash to pay taxes and other expenses. In these examples, two commercial roles involving curacas are visible. The first role is entrepreneurial participation into the colonial market as powerful merchants. The second role is as seller of community-produced commodities to pay tributes.

At the base of the so-called cacical economy lay the traditional tenancy of lands and resources and the political power of curacas over ethnic productive relations at valleys, coasts, and highlands (Medinaceli, 2010). A cacique's lands, livestock, personal possessions, and properties, together with the obligations owed him by his people, were respected by the Spanish and formed a cacique's capital in early colonial times (Medinaceli, 2010). Their social capital was crucial: entrepreneurial curacas even utilized traditional labor relations for monetary profit through sending commoners to work in market activities (Medinaceli, 2010). Possession of traditional productive means and command over Andean workforce led to successful businesses: a 1619 Lupaca cacique, for example, was a major distributor of native commodities in Potosí, those included abasca clothing, llamas and alpacas, chilies, dried fish, and potatoes (*chuño*), as well as large quantities of wine botijas (Medinaceli, 2010).

Native production at different altitudes was the responsibility of specific ayllus and their own local hereditary leaders. As resources were dispersed, transportation was necessary, and the large caravans moving goods to Potosí and elsewhere required the coordination of local leaders and top caciques (Medinaceli, 2010). As a result, most of the rich early colonial merchant caciques emerged from the large pastoralist societies of the altiplano with their capacity of organizing large llama caravans of up to 150 animals (Medinaceli, 2010).

Top merchant caciques in Alto Peru were wine and coca wholesalers, they had the right to free trade and were exempted from sales taxes (alcabala) by colonial regulations (Choque, 1987; Tandeter et al., 1995). Their businesses included moving thousands of wine botijas, in amounts comparable to those handled by the Spanish merchants, and bought by their representatives at Moquegua and Arequipa vineyards (Choque, 1987). Our Tarapacá study region was rich in wine; the caciques from Sibaya also resold regional wines elsewhere (Hidalgo et al., 2019). In the Tarapacá region, it may have been the case that the Pica caciques delivered in-kind tributes for Spanish long-distance commercialization or the direct trading of local goods with highland native Andean merchants. Even after Toledo's tax appraisal (1570s), dried fish kept its previous status as an in-kind tribute rather than one that could be met with a cash or other equivalency. Fish was always delivered in-kind into the hands of encomenderos/porteros/priests.

The Toledo demand for cash tribute was undoubtedly an uncomfortable motivation (or opportunity) for the minor curacas to commercialize part of the production of their people while continuing to provide the traditional surplus to higher-level curacas. Native tributaries had fiscal and religious monetary requirements. For example, each community had to cover cash tribute, the forced redistribution of goods (*repartos*), ecclesiastical tithes and communal religious fiestas or rituals (Hidalgo, 2014; Tandeter et al., 1995). Hidalgo (2014) has proposed for Arica that two thirds of the communal production was commercialized to solve fiscal requirements, the remainder was used for living and other expenses. At least since the 1570s, local curacas had to take an entrepreneurial role to extract money out of ethnic production. Rather than simple tax collectors, they had to manage their communal economies to generate cash.

The colonial state imposed a recruitment mechanism of community surplus, and caciques were a key component of the system (Platt, 1978). Andean leaders were tax collectors and (mita) labor providers. Leaders had to collect in-kind tributes at their villages and commercialize the goods in nearby urban markets to reach the total cash amount established by Crown officials for each product (Platt, 1978, p.43). This occurred soon after European conquest, in the highlands since at least the mid-16th century (Platt, 1978, p.40). Commoners never directly saw the pecuniary return for their work, caciques appropriated their communities' production to satisfy fiscal obligations but also for their own material benefit (Platt, 1978).

An interesting question for future scholarship is whether the southern Andean native elite's mercantile conduct emerged solely as a response to colonial market impositions, or if these individuals had acted similarly in Pre-Columbian times (in the absence of cash). Some early Spanish documents (1548) refer to the habit of bartering among some native groups of the study region, the so-called "*indios de rescate*" (Villalobos, 1979). It will be necessary to research that term and what it meant for early colonial Spanish writers to address the issue.

5.3 Sailing Tarapacá: Port and Fishery

Maritime routes were the backbone of early-modern imperialism. Coastal Andean communities lived at the juncture of maritime and terrestrial flows and rapidly got involved in economic and distribution dynamics. A continuous and massive influx of silver travelled from the southern Andes to the Iberian Peninsula and elsewhere through the Potosí-Seville route. Silver represented the most precious commodity that fueled Andean Pacific routes in its northward movement. As the main global currency of the era, Spanish silver reales were impatiently awaited by Italian bankers and Venetian merchants, Chinese and Indian traders, Levantine spice dealers, and English and German businessmen, among others (Braudel, 1972, p.481). But reales and ingots had to be shipped from the agitated waters of the southeastern Pacific Ocean departing from Arica to Callao, Guayaquil, and Panamá. The South Sea fleet escorted merchant ships that moved the treasure of the King of Spain from Arica to Panama, at the end of the year it crossed paths with a couple of cargo ships that moved merchandise from Callao to Valparaíso (Villalobos, 2009).

The Caribbean was a contested maritime space where other European powers, privateers and pirates tried to deviate the flow of Andean and Mexican silver. In contrast, the Pacific coast of South America was conceived by Iberian leaders as the "Spanish lake", unknown and remote, naturally protected by its massive geography and its two accesses: the strongly controlled Panamanian gate and the deadly southern Magellan strait (Pérez-Mallaína & Torres, 1987, p.205). In this section I contextualize the Pacific coast of the early colonial southern Andes as a maritime space, traversed by fluxes of sailors, migrants, commodities, and practices.

The Andean ports of this time (16th-17th centuries) were typically neither urban nor heavily developed in terms of infrastructure such as quays or repair facilities. They had minimal warehouse facilities. Instead, the small rural port took advantage of natural features and was occupied by relatively few people, and in some cases, even only seasonally. The Loa River mouth shared the 16th-century conditions of preferred ports in the contemporary Mediterranean. There, conditions included: a point naturally sheltered from the dominant ocean currents; access to a sheltered anchorage; fresh water; and forage, among others (Leidwanger, 2013). Geographically, the Loa native fishing village provided a preexisting community, and there was already a set of Pre-Columbian tracks leading to the interior and into the highlands. Thus, Loa was a good option for any starting point in crossing the driest place on earth. Loa and Cobija were the southernmost coastal port outposts of the Spaniards, further south Camanchaca fishermen fled from the colonial power bravely inhabiting arid coves and the occasional presence of some European traveler. If you sailed south, the Loa mouth was the last point with a substantial amount of fresh water until the next point on the Copiapó river mouth. What was between these two points was the hyper-arid coast of the driest desert in the world.

The early colonial ports did not always witness population nucleation; for example, this occurred at some of the famous Chilean port cities only in following centuries. The towns and cities the small ports served were far from the reach of corsairs and pirates in the interior. The native fishing villages in their sheltered coves, especially associated with freshwater sources, could be rapidly converted into opportunistic ports, securing maritime communication and trade but also seafood and fertilizer extraction (Hidalgo et al., 2019, p.280). In Tarapacá, there were long-term villages of indigenous fishers at three locations: Pisagua, Iquique and Loa were rapidly recognized by early conquistadors and encomenderos as future ports and promoted there the evangelization of marine lineages (Hidalgo et al., 2019). In this manner, Loa, Iquique, and Pisagua represented fundamental opportunities paving the way for Iberian colonialism and mercantilism.

The Colesuyo maritime economy as a whole and the operation of ports in particular shifted from the initial encomienda basis, especially after the 1570s (Hidalgo et al., 2019). Encomenderos, and later, entrepreneurs held rights over native labor at coves and cliffs. Fishing and guano extraction were not clearly regulated by the Crown and customary rights and some authority-given concessions structured both activities (Villalobos, 1979, p.65). As mercantile relations consolidated around Potosí, ports and fisheries evolved from a business controlled by local encomenderos and allied caciques to a lease system of similar rights over labor and marine production. Spanish encomenderos held the rights over port and fishing labor up to the late 16th century. Subsequently, century-long leasing of exploitation privileges were obtained by the highest bidder from the Crown and with pensions paid to encomendero' descendants (Hidalgo et al., 2019). The winning bidder became the port authority or portero, who controlled coves and natural ports, guano cliffs, islands, and islets, and monopolized the dried-fish and guano trade during the lease term (Hidalgo et al., 2019). Details of the legal mechanism for these activities are still somewhat obscure, and fisheries could also be run by Spanish corregidores whom accessed them via political means or even direct sales as shown by some documents (Aguilar & Cisternas, 2013). The port lease mechanism, based on inherited entrustment rights, remained in place during the 18th century for Loa, Iquique and Pisagua (Hidalgo et al., 2019). Seigniorial and entrustment rights over Andeans were abolished by the Cadiz court in 1812, and the centennial-concessions on native port labor declined and disappeared consequently (Villalobos, 1979).

Tarapacá's ports fulfilled some specific roles during their colonial heydays. Pisagua was centered on the distribution of local wines and represented the main source of freshwater for sailors and miners. Iquique was the port serving the nearby coastal silver mines of Huantajaya and focused on guano extraction at its rocky island (plus some dried congrio for Arica). Puerto Loa was the place of specialized communities of fishermen, initially exploited by Pica's porteros and later coveted by Atacama's corregidores, who obtained the 18th century rights (Aguilar & Cisternas, 2013; Choque & Muñoz, 2016).

Mediterranean sailors accustomed to coastal navigation kept the coast in sight and stopped at each coastal settlement to buy and sell (Braudel, 1972). Spanish, Italian, and Greek pilots with multi-ethnic crews navigated the cold Humboldt Current on the Peruvian coast in similar ways, carefully observing geographical landmarks, anchorage places and locations of commercial or logistical interest (Pérez-Mallaína & Torres, 1987, p.193), so that a succession of natural, Andean, and Spanish ports made possible the trip from Callao[8] to Tarapacá and beyond. Varied ship types and crews arrived at these places, from 3- and 4-mast galleons packed with people heading to Panama or the Strait, to small boats (*pataches*) and guano frigates that sailed the region, to fishing fleets managed by porteros and encomenderos.

As these ports lacked docks, much cargo moved through lighterage. The larger ships would anchor off the beach and land people and goods via their own small boats or via inflatable boats rowed by natives with wide-bladed oars. The inflatable boats were made of sea lion hides, sewn with the seams facing up and a bone tube to maintain pressure and air. The larger inflatable boats could carry two people. From these inflatable boats, people fished out to sea up to six leagues according to Lizárraga (1916[1615]). Rafts may have been used in port activities as well. Models of three-beam rafts have been AMS dated to the Inca and early colonial era and recovered from funerary contexts at cemeteries from Arica to the mouth of the Loa (Ballester et al., 2023). Among the many items that would have been transshipped at Loa, one category of item provides a valuable archaeological lens on the flow of goods: the ubiquitous maritime container called the *botija*.

[8] Even Callao -the main port of the Viceroyalty- did not have a wharf until the very end of the 17th century (Pérez-Mallaína and Torres, 1987, p.192).

5.4 Botijas, Global Shipping Containers

Botijas or olive jars were one of the earliest global shipping containers, somewhat akin to the Roman amphora. Their movement and distribution provide a material proxy for the Spanish empire's logistics and early modern global mercantile flows. They can be studied to understand the early expansion of mercantile ties throughout the Andes.

Diverse goods, foodstuffs, and alcoholic beverages were shipped in reusable botijas into any Spanish port destination. Loa's Iberian colonists enjoyed control of these shipping containers and access to their contents when first brought ashore. Botijas with diverse commodities were unloaded and delivered to the people that lived at the fishery. Red wine, pisco, and olive oil were probably carried this way to supply Puerto Loa. They could then be repurposed in all kinds of ways ranging from local water, wine, and oil storage, to filling with other products for local and regional trade. I recovered more than 25 kg of botijas (n = 458) fragments, from small fragments to well-preserved large sherds. Virtually all sherds were recovered from the Spanish sector of the site (92.1% by count; 99.2% by weight), indicating that they were not incorporated into indigenous domestic practices or vessel preferences.

The distribution of these early commodity containers thus reveals differential access to the early colonial trade networks at Puerto Loa. Natives were clearly excluded from direct access to the vessels' contents. Surface remains hotspot analysis showed the same differential access and discard patterns between sectors. Occupants in Sector B discarded many botijas, and all portions from bases to lids are represented in Sector B's assemblage (Figure 10). In contrast, only body sherds and eroded bits were found in the village which might suggest some expedient use of broken or discarded botijas for expedient utilitarian purposes.

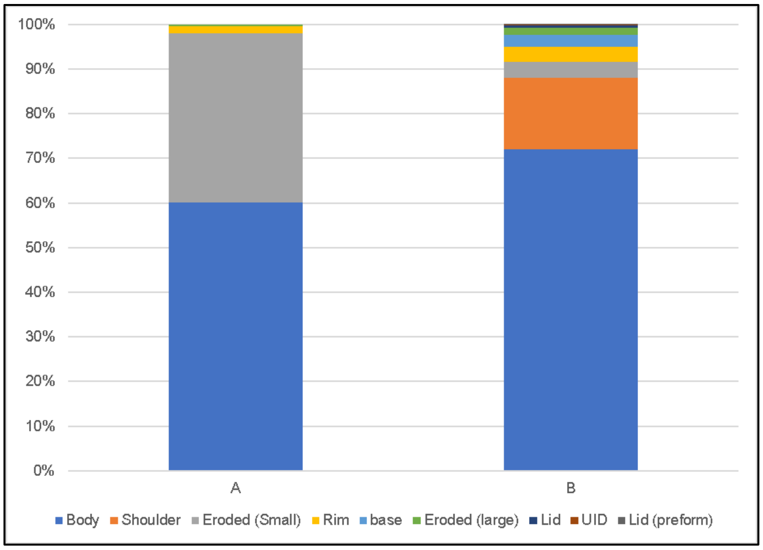

Figure 10 Compared botija portions among sectors.

However, spatial analysis in the native Sector A village reveals that activities involving botijas (and their contents) clustered in two spots. One spot is associated with early evangelization practices and the presence of Iberian friars near the church. Over 60% of the Sector A sherds (n = 123g) were recovered from Unit A5. Activities near the church may have involved a more intensive consumption of botija commodities if counts (rather than weights) are considered (n = 29, 81%). Visting friars would have accessed the same Andean Iberian materials as did their neighbors and fellow Spaniards in Sector B. Documents mentions that each encomendero was responsible for the evangelization of his natives, so the most likely possibility is that some botijas of wine and oil ended up at the church.

The other spot of higher botija density is associated with accidental breakage: the access channel to the open ocean. Most botijas in the native village ended up broken near the channel due to loading/unloading port activities: for example, Unit A1 yielded 38% (n = 77.6g) of total botija sherds excavated in Sector A. Proximity to the ocean in A1 led to badly water-eroded fragments (producing very friable, breakable small bits).

5.4.1 What arrived in botijas?

Botijas were made in three main forms (Types A – C) and botija forms had an official, standardized internal volume and use for specific products like wine or olive oil. With dimensions and rim morphologies as the main indicators to identify these botija forms, it is possible to be more specific in reconstructing their role in market activities in Loa.

A group of large body sherds (n = 38) from Loa allowed diameter calculations. These are sherds with perfectly preserved walls, no profile inflections, no variation in curvature/thickness, and no internal residues. Results indicated a median exterior diameter of 317 millimeters, minimum and maximum values of 217 and 423 millimeters, and a wide range of 207 millimeters. Large samples of complete botijas of known dates were used as the comparative baseline. If we plot Loa's diameters spread against known exterior diameters from entire jars recovered from well-dated Caribbean shipwrecks and Iberian examples (Busto-Zapico, 2020, p.44; James, 1988, p.50; Kingsley et al., 2014, p.43-45; Marken, 1994, p.69), we can see the overlap of interquartile ranges between Loa and mostly Type A's diameters (Figure 11).

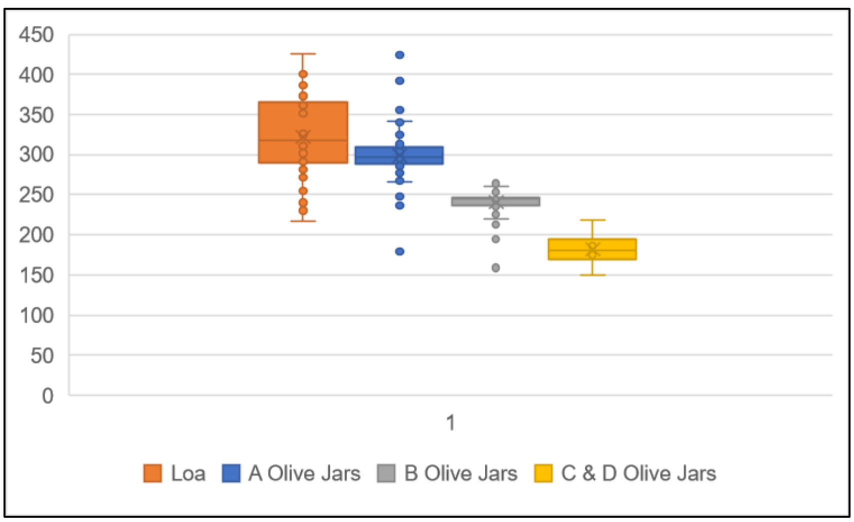

Figure 11 Loa botijas diameters versus whole botija diameters per type.

Thus, the most likely possibility is that colonists had greatest access to large Type A botijas, the type that contained wine/pisco and were also used to ship freshwater from Pisagua. Most rim fragments have the same morphology as Type A rims. Some olive oil vessels in smaller Type B globular botijas reached Puerto Loa as well. Most of shipwreck type B's diameter variation overlaps Loa's lower quartile while its associated rim morphology is also present in the fishery. Finally, the smallest carrot-shaped Types C and D botijas for honey and other commodities would not be represented at Loa.

The unloading of large wine and water botijas would have been a common activity at the fishery, possibly with natives rowing their inflatable boats and three-beam rafts with one or more of these containers from larger Iberian ships to the village's access channel. Loa's Iberians reused the containers for their own everyday needs: people rounded off botija sherds to make lids (n = 4) with diameters[9] that fit well into the mouths of both Type A and B containers. Stoppers made with other materials like cork were also documented at the Sector B fishery, but not at the native village. The long-term use of the containers is also visible in the notable wear and tear to the exteriors.

5.4.2 Origin of Loa's botijas (Spain or the Viceroyalty)

The fishery's residents were accustomed to consuming Peruvian wines and brandy as well as some occasional acquisitions of Sevillian or Iberian products bottled in Andalusian botijas. Paste colors and inclusions of the Loa specimens are mostly consistent with botijas made in either the Panamanian Isthmus, Peru, or both, underscoring the importance of colonial manufacture and

[9] They range between 4.6 and 5.9 cm in diameter.

commerce. The Loa botijas assemblage clearly leans towards the red (Panamanian/Peruvian) end of the spectrum, the most characteristic paste hue is 2.5YR (65%) never reported for chemically sourced Iberian cases (Kelloway et al., 2019). Details about colors and inclusions are provided in appendix B.1.2.

Yet while the Puerto Loa fragments indicate the overall dominance of coastal trade, paste and exterior colors suggest that at least a few Iberia-sourced botijas arrived at the Loa mouth as well. Paste colors reported for Iberian sherds exclusively (10YR6/3 and 7/3) are present, but only add up to less than 1% in the excavated sample. The intermittent arrival of Spanish foods cannot be ruled out because of the 13% of gray zone cases with hues recorded in both Iberian and Latin American vessels. Inclusions corresponded mostly to medium or very fine sand, which is consistent with the latter origin.

5.4.3 Dates of Loa's botijas?

Some of the botijas arriving at Puerto Loa bear the stamp of early global traders. Botija rim markings are diagnostic of the first half of the 17th century (Marken, 1994, p.133). These same marks have been found at widely disparate locations around the globe as proof of early global commerce (Pasinski & Fournier, 2014, p.1346). One well-preserved Loa botija rim bore a stylized hexagonal stamp (Figure 12) of the acronym "E L d" or "p 2 3" (if read upside down). This exact stamp is present among whole botijas recovered from the legendary 1622 Atocha shipwreck in the Florida Keys (Marken, 1994, p.77). Another stamp features a circle containing the letters VB or 8A (if read upside down). The two stamped rims were uncovered at the main colonial occupation of the fishery (Unit B1, Layer C). The stamps could correspond to the mark of large-scale merchants, refer to the contents, or represent the vessel manufacturer, among other possibilities. Loa's rim profiles (n = 29) are also equivalent to the triangular rims of the 1590-1622 period for Type A botijas (Avery, 1997, p.120). The same is true for rim diameters, as detailed in an appendix (B.1.3).

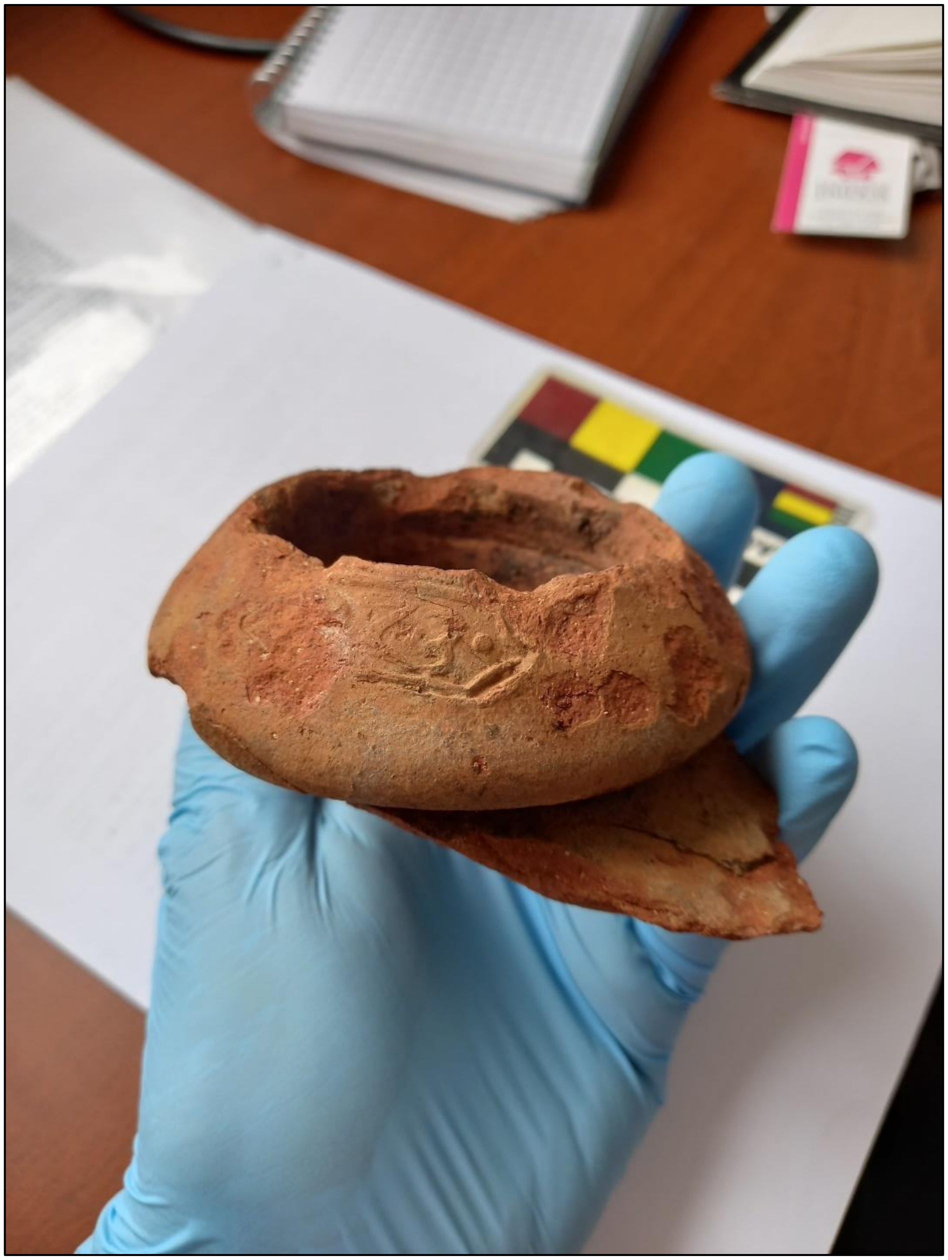

Figure 12 Stamped botija rim from Loa

5.5 Cordage, vegetal fibers, and sacking

Another essential material for any port or nautical operation was cordage. Examples of cordage are ubiquitous at the Sector B fishery, evidence of intensive activities involving tasks such as boat rigging and mooring, net fishing, or animal lashings for transportation inland.

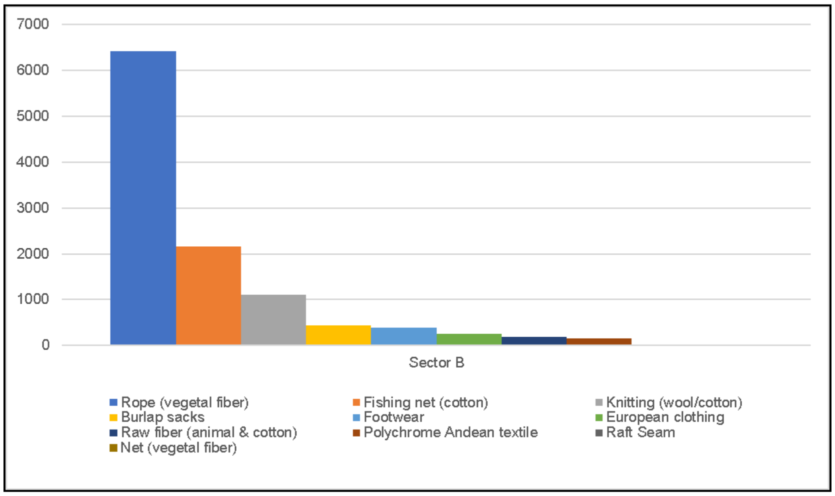

Figure 13 Textile categories by weight (g) from Sector B

Ropes were made of twisted vegetal fibers normally woven with 3 to 4 smaller strings, each made of two large, twisted fibers. Some tasks were clearly related to heavy weights and required the use of a good deal of force and very strong cordage; I identified very thick ropes made up of 7 strings (Figure 14). Not all cordage is complete, there are loose twisted fibers and innumerable small fiber fragments from decomposed ropes.

Ropes were employed by past Andean fishers to tie together their three-beam rafts, with an arrangement of ropes with moorings in the bows and sterns plus a central rope joining both moorings (Rubio et al., 2023). Additionally, beach trawling required dragging the fishing net with a rope handle (Rubio et al., 2023). Both tasks could also be related to the large number of ropes used at the fishery. I excavated shreds of cotton nets tied to a main rope in a systematic fashion, every 5 or 10 centimeters depending on the case. These nets were thrown and collected from their cordage edges from boats or beaches; one in situ net cell measured 7.5x6 centimeters.

The main salting contexts (Unit B1, Layer C and F) contained over 90% of such cordage remains. The same vegetal fiber was employed to make baskets or vegetable mats. Some meshes of simple tied strands were potentially used to secure loads on mules or other cargo animals. Vegetal fibers represented an important materiality for local production and distribution, it's unclear at this point if these were regional goods or imported artifacts from other colonial regions.

Textile fragments from the uppermost occupations of Sector A village can be divided into two main categories: very dark brown fine tunics and ropes. A highly eroded, whitish piece of rope, probably made of vegetal fiber (of the same type described above) was excavated at A3, Layer C. It disintegrates easily when handled, showing that preservation conditions probably determine the low representation of this category when compared to the enhanced conservation of the fishery salting patio. Other very resistant ropes, like the ones used even today by highland Andean communities, were neatly woven with light and dark brown wool (Figure 15). One case from the fishery served as a woolen bag handle. Others were employed to stow cargo on mules and llamas on their journeys to and from the warm valleys.

Finally, the fishery's operation involved the use of very strong sacks made of whitish vegetal yarn, maybe jute or hemp. Their appearance is like that of burlap sacks and their coarse but narrowly weaved fabric was especially suited for the requirements of long-distance transportation. The sacks may have included strong cordage handles lined by burlap (Figure 16). These sack fragments were found in the main salting context (Unit B1, Layer C) in direct association with dried fish and cordage reflecting the shipping and distribution stage of this tributary commodity. Burlap sacks sewn to cordage were probably employed to load mules, llamas or native porters and distribute dried fish across Tarapacá, Atacama, and on to Potosí.

Figure 14 Colonial mooring line from the fishery

Figure 15 Andean wool rope excavated in the colonial salting patio.

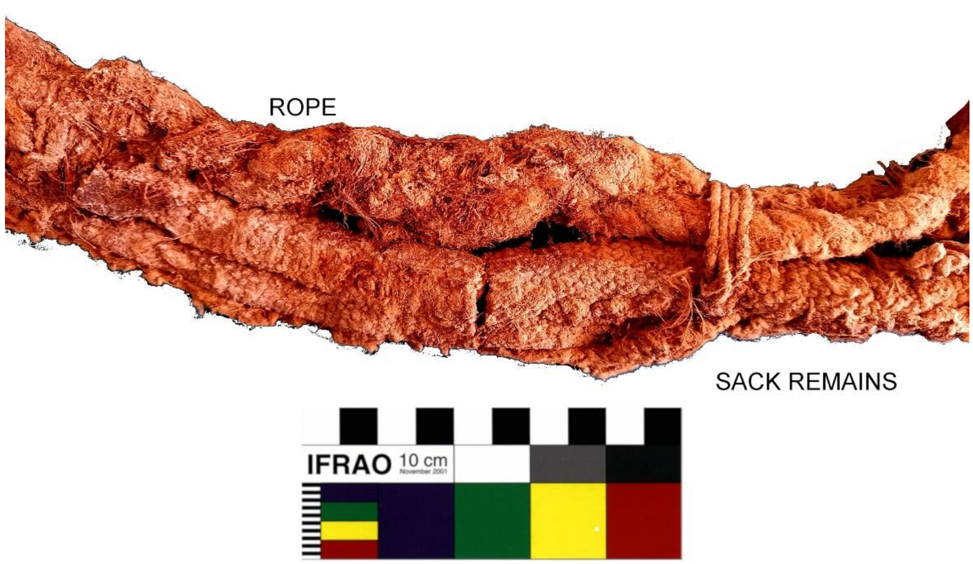

Figure 16 Detail of colonial sack with mooring rope

6.0 The Puerto Loa Site

Port Loa is located at the mouth of the only river (Loa) that crosses the core of the Atacama Desert. The Loa mouth was intensively occupied for millennia by maritime hunter-gatherers (Santoro et al., 2016) before developing into a colonial port (Castro et al., 2016). Previous archaeological research has focused on the late archaic domestic occupations and funerary mound sites. Little is known about middle or late Pre-Columbian domestic occupations. The excavation carried out in the Loa fishery and the nearby native fishing settlement constitutes the first research endeavor about the trans-conquest era in this coastal region.

The site consists of an extensive shell midden and surface occupation and can be divided into some main sectors (Figure 17). The settlement of native fishermen in sector A and the Spanish architectural component or Sector B are the focus of this research. The historical occupation was established over a preexisting native settlement connected to an ancient road and an Inca-style waystation. Surface ceramic and architectural evidence indicate the contemporaneity of both sectors.

6.1 Site Description

Sector A includes a dense shell midden with native pit houses in front of an early Catholic church plus a large funerary area. Stone foundations and slight depressions are visible on top of the densest part of the shell midden. There is a heavy surface artifact density at the cemeteries including human remains, sherds, textiles and even painted oar fragments.

The core of the native settlement at Sector A is visible as a large whitish shell midden with an elevation that subtly contrasts with the natural general topography of the area. Fishing folks chose to live hundreds of meters away from the river for three evident reasons: a) surges strike more fiercely at the river mouth and to the north; b) the southern rocky shoreline adds extra protection from bad conditions, and c) a natural access channel crosscut the shoreline in this specific point (Figure 18).

The settlement's core is at the closest spot possible above tidal level and bad surge conditions. Its surface is covered by a relatively dense scatter of large, selected boulders, some of which are portions of circular walls of single or double stone alignments. The area is partially altered by modern activity which makes it hard to interpret in functional terms (Figure 19).

The circular stone foundations could be fixed vestiges of native light material dwellings. Some of these foundations were made of separated double rows of vertical boulders, as if they had been occupied to embed posts and assemble the aerial part of the hut.

A late archaic tradition of circular pit houses built on circular or oval foundations made by single alignments of elongated vertical boulders is characteristic of the Loa mouth and the Atacama coast in general. These alignments enclose circular pit houses of relatively large diameter (at least in the Loa case) which contain hard, prepared floors.

Even if Sector A's surface remains are too altered to compare, prepared floors weren't observed nor excavated, and a couple well-preserved cases showed smaller diameters (<2m) than its late archaic counterparts.

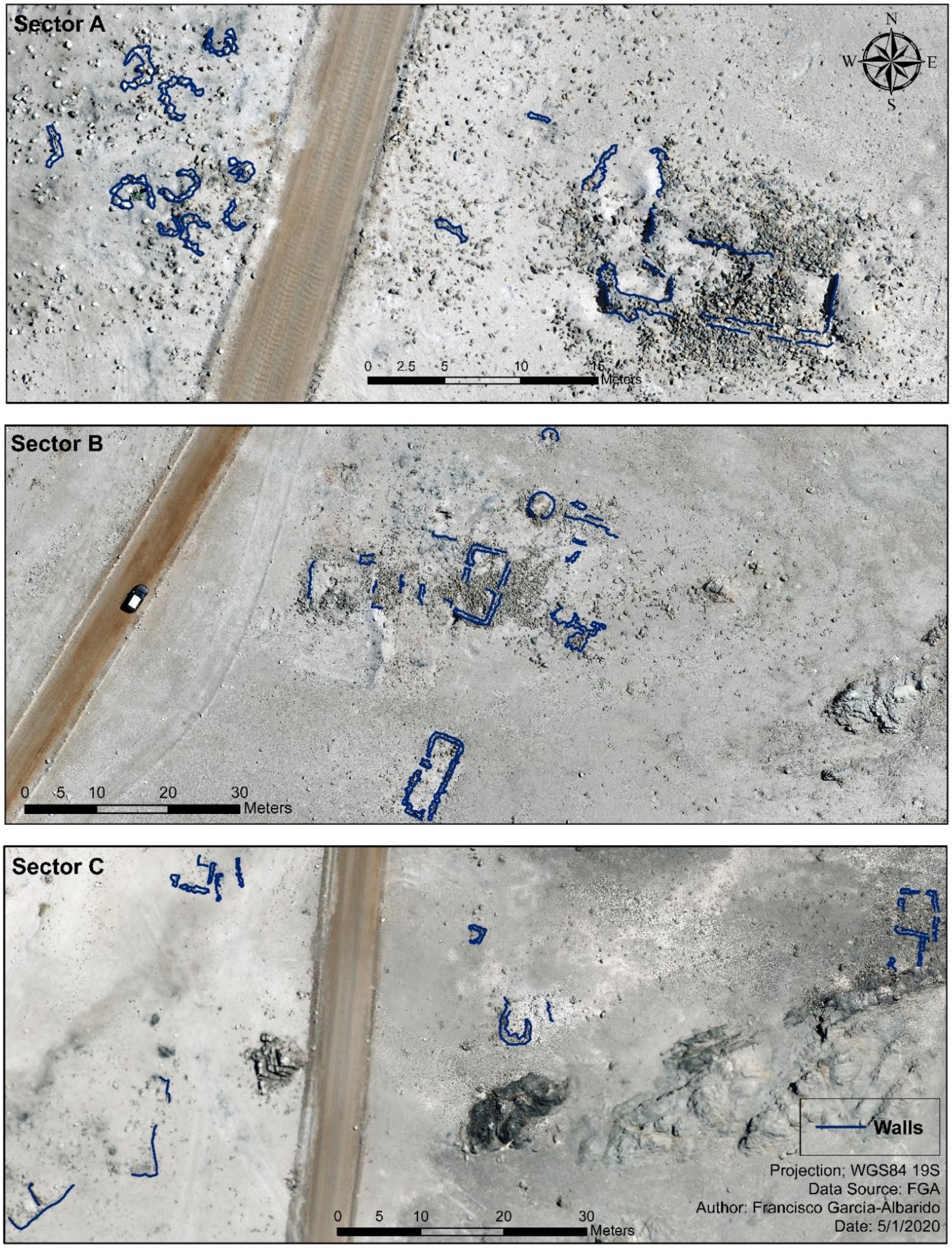

Figure 17: Architectural features in the site's main sectors.

Figure 18: The access channel (foreground), the white shell midden (sector A) and the church (where the white tent is located).

This native settlement was originally identified by L. Núñez (1971) and described as a campsite (named CaH-44) with habitational structures and dense domestic deposits. He mentioned the existence of visible quadrangular structures with dense surface deposits of ceramic sherds and other late Pre-Columbian indicators (Núñez, 1971).

Late Pre-Columbian coastal sites on the Colesuyu region have tendales or rock concentrations associated with fish remains and scales interpreted as fish drying features (de France, 2021). Fish scales are absolutely lacking from excavated assemblages at Sector A so the presence of drying features at the native village is just another possibility.

The native community buried their dead into a large funerary area divided into two adjacent halves, one outrageously looted (Figure 20) the other archaeologically excavated in the 1960s. It's not clear at this point if the two halves were contemporaneous, in other words the funerary representation of moieties, or just the aggregation of tombs over time into a more recent area. I'm calling them cemeteries 1 and 2 for simplicity's sake on the map.

Figure 19: Disturbed surface architecture in the fishing village's core (sector A).

The west half has an irregular, organic shape with a northeast-southwest axis (40x37m in maximum extents) and occupies an area of 0.09 hectares. The east area is also organic and irregular in shape (but more rounded), has similar dimensions (44x43m) and area (0.12 hectares), and the same cardinal axis.

Figure 20: The looted funerary area of the native community that inhabited Sector A.

Immediately to the east lies the ancient native road that descends from the Llamara springs into the river mouth and ran south reaching structures and corrals near the Iberian fishery and beyond.

The cemetery corresponds to Núñez's (1971) CaH-12 site[10]. He mentions two sectors, one already disturbed in the late 1960s and other still intact This researcher mapped the site, conducted

[10] Monochrome sherds and textiles of the so-called Pica Tarapacá late Pre-Columbian chiefdom are visible at looters' piles, I recovered equivalent materials from upper occupations of sector A and colonial layers of the fishery. One individual buried in CaH-12 yielded an AMS colonial date recently (Francisca Santana, personal communication, 2023).

surface collections, and excavated 52 tombs, mostly collective (Núñez, 1971). An oblique aerial photograph indicates the west sector with the letter b (Núñez, 1971, p.15). This sector was probably chosen for archaeological excavation, square excavation units are visible in my orthophoto.

The presence of San Miguel decorated ceramics from Arica made him to assign the cemetery to late Pre-Columbian times. He also recovered types from the middle Loa basin (Dupont), altiplano (Huruquilla), and Tarapacá (Chiza, Pica monochrome) alongside other Arica types like Maitas, Gentilar and Pocoma but in low frequencies (Núñez, 1971). The associated church is visible as a large rubble mound with thick dressed stone walls (Figures 21 & 22).

Figure 21: View of church's collapsed walls from the east.

Figure 22: View of one of the façade corners (50cm scale bar).

Sector B or the Spanish architectural conjunct (Figures 23 & 24), lies south of the church. It can be described as a productive establishment conformed by a main elite residence and surrounding activity areas for fish salting and sea salt production. Main dimensions of the observed architectural spaces are presented in Table 3.

Table 3: Dimensions of Architecture and Features

				Layout (m)			Walls (cm)	
Sector	structure #	Functionality	Form	Length	Width	Ø	max height	width
A	1	church	rectangular	15.6	5.4		70	50
	1	house	rectangular	10	6		115	50
	2	structure	rectangular	12	4.6		80	70
B	3	Evaporation pond	square	9.7	.		20	54
	4	kiln	circular			3.2	114	60
	5	structure	L shaped	2	.		34	50

The main rectangular house (Figure 25) was worked stone/mortar covered 10x46m and is associated with a large kiln (3.2m in diameter); an ash covered area of 540m2 (west of the kiln);

another lesser altered kiln; a large domestic midden (Figure 26); a 10m side walled seawater evaporation pond; a large rectangular structure of 55.2sqm (12x4.6m); a L-shaped wall of a partially dismantled structure; plus some circular enclosures. Collapsed stone walls cover an area of 134sqm and may hide other structures.

Another 2 native cemeteries -one of them with individuals with cranial deformation- are located 80m east of this sector.

The main house has internal subdivisions, although heavily covered by its large collapsed walls, at least two rooms are discernable. Its entry faces the ocean (northwest) and the fish salting patio. Wall debris indicate a solid, well-built building occupied by elite individuals, probably the portero or his representatives. The presence of regional curacas at this place is also probable, assemblages obtained at excavation units indicate native domestic and fishing labor.

A walled seawater evaporation pond is located a few meters west (Figure 27). This feature is filled with rock-solid salt white layers. A tall wall would have enclosed the pond by the east judging by the debris fallen in that direction. Between the house and the pond some a few wall segments suggest some remodeling of the built space over time. The pond was tangentially bulldozed in the 20th century, as a result an area in which heavy combustion took place was destroyed (there's a pile of hard, dark crusts).

The major kiln east of the house originated the dark ashy sediments west of it. Some slags were recovered from domestic deposits at the fishery, but the excavation of a test pit in the gray area didn't yield any clear evidence for a specific functionality exceeding everyday domestic activities. Excavations near the pond and the kiln uncovered postholes, light roofing or walling materials may have included fiber mattings, cactus wood and beams.

Figure 23: General view of the Iberian fishery.

Figure 24: Collapsed walls of the main house (upper left) and main kiln (upper right).

Figure 25: Main house wall (foreground) and kiln (background).

Figure 26: Looted colonial midden showing great organic preservation.

Figure 27: Seawater evaporation pond and salt layers (center) at the fishery.

Figure 28: Rectangular building foundations with vertical paired boulders (forefront).

Some meters south of the main house there is another large building evidenced by its rectangular stone foundations (Figure 28). This structure was probably made with light materials, dismantled, or decomposed after abandonment. Its excavation may yield a better insight into its functionality (potential warehouse) and constructive characteristics, but the preserved foundation corresponds to a double row of heavy selected boulders (as in the native dwellings of sector A). Posts were probably embedded between the two rows to give the construction stability. Two large, paired boulders[11]of unknown functionality are part of the foundation.

Núñez (1971, p.10) described sector B as a conjunct of residential structures with a large kiln and ore smelting evidence. The researcher mapped what he called CaH-14 and conducted surface collections, considering documentary sources and the identification of colonial ceramics he interpreted the ruins as the vestiges of Puerto Loa and assigned the occupation to the 18th century (Núñez, 1971, p.23).

A couple hundred meters to the southeast, there are the remains of a potential waystation of late Pre-Columbian and early colonial times (Figure 29). A rectangular structure formed by a row of three rooms is associated with three large, dismantled corrals and the ancient road that comes north from sector A's cemeteries. Not the focus of this research, it could provide a window into regional economic distribution.

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[11] Two large, paired rocks associated to Andean ritual practices are at a central space in the late Pre-Columbian archaeological locality of Iluga in the Tarapacá drainage. It may represent huancas or sacred stones (M. Uribe, personal communication).

Figure 29: Aligned quadrangular rooms (forefront) and corrals (background).

Sectors A and B constitute the core of the site and focus of my excavations. Both are connected by a significant cluster of surface materials and have clear colonial surface indicators. These two characteristics were absent at Sector C, so it wasn't sampled in excavations.

6.2 Excavation and Significant Features

Excavation took place in the main deposits of sectors A and B (Figure 30). in the native dwellings several 1x1m and 2x2m units recorded domestic fish processing and consumption loci and other activity areas with subtle differences. Diverse productive activities were identified from excavated contexts at Sector B (i.e., large-scale burning or seawater evaporation feature), I discovered a notorious fish salting activity area in association with the main architectural remains.

Initial test pits in two successive field seasons at the site (2019-2020) allowed me to target rich deposits of a variety of materialities. Subsequent excavation units (2021) yielded expanded assemblages for all lines of evidence, totalizing 18.75 meters^2 of excavation so far.

As a result of the three seasons, the Puerto Loa Project revealed stratified deposits spanning from late Formative to early colonial times. Lines of evidence are varied from fragments of colonial books and manuscripts to Inca, Panamanian, Ming, and native ceramics, dolphins, sharks, and Old-World animals and plants, all described in subsequent chapters.

This chapter offers data about the occupation of the main two domestic sectors of the site that eventually became Puerto Loa. The goal is to address the main activities that took place at the site from a contextual perspective, in other words, from what was recorded at excavation units and features, and which cannot be known from the analysis of independent assemblages.

The chapter starts with the description of excavation methods, units, features, and spatial layout. The main aim was to record productive, and consumption remains that could shed light on fishing-processing transformations due to supra community level demands.

Test Pits (2019/2020)

A small sample of test pits was excavated during 2019-2020. This intervention was designed to test surface visible features and areas detected during previous (2016) archaeological reconnaissance. The strategy was then judgmental, and the digging of the pits proceeded in natural layers. One of the main results of this stage was to confirm the existence of a fish salting activity area at sector B and the presence of possibly colonial tombs in front of sector A's chapel. Main results and characteristics are presented in Table 4.

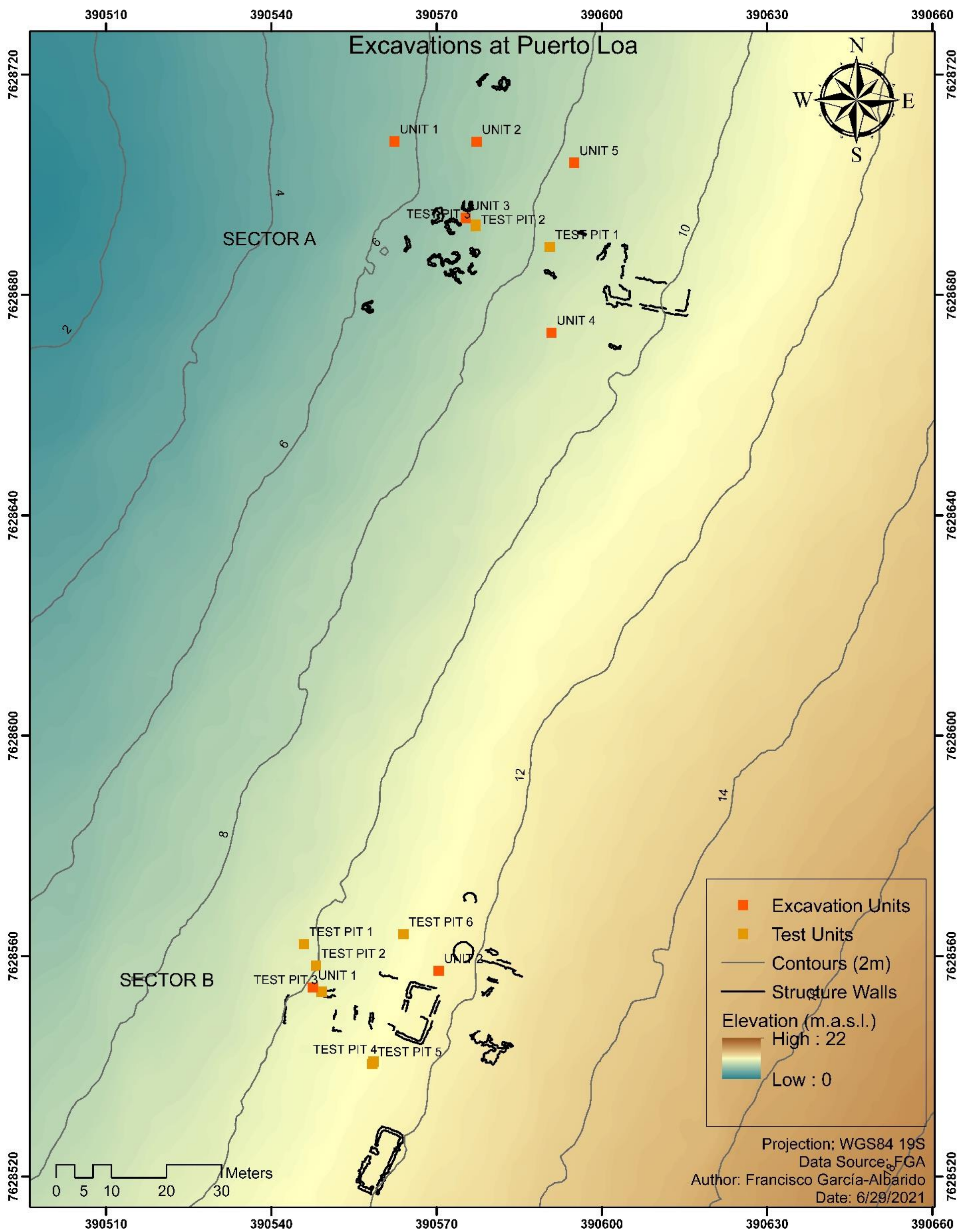

Figure 30: Excavation units and test pits in sectors A and B.

Table 4: Test Pits Excavated During 2019-20

Sector	*Unit*	*Context*	*Buried architecture*	*Salting layers*	*Dimensions*	*Area (m^2)*
A	1	midden	absent	absent	50x50	0.25
	2	midden	absent	absent	50x50	0.25
	3	midden	absent	absent	50x50	0.25
B	1	midden	present	absent	50x50	0.25
	2	midden	absent	absent	50x50	0.25
	3	midden	absent	present	50x50	0.25
	4	midden	absent	present	50x50	0.25
	5	midden	absent	present	50x50	0.25
	6	midden	absent	absent	50x50	0.25
					Total	2.25

Figure 30 shows the location of each test pit and its relationship with larger excavation units. Pit 3 at sector A was the southern extension of pit 2 so also called “test pit southern extension” or “*ampliación sur*” in the CMN results report. Pit 5 from sector B was also the southern extension of pit 4 (originally called pit 4b).

Excavation (2021)

A flexible, problem-oriented set of units in hotspots for each main sector was excavated in the 2021 field season. In the native dwellings core area, a grid of units searched for non-domestic fish processing loci and other specialized activity features. One 2x2m unit was dug in a known fish heavy area (Unit A3) for a large ichthyological sample to study intensification over time.

Diverse productive activities were hinted on surface deposits of Sector B (i.e. large-scale burning and seawater evaporation), and I discovered others (fish salting) by excavating the mentioned test pits. To reconstruct the whole range of activities of colonial dried fish production that took place near the Spaniards, I focused on the large potentially industrial kiln and in the main identified fish salting patio.

Excavation was in natural layers which were individually recorded in context sheets with soil and shell information, excavated depths, types of recovered materials, plan sketches, and general observations. Profiles were (scale) drawn in graph paper and photographed, architectural remains were also drawn if found in excavation. Context sheets were digitized to ensure preservation of primary excavation data and to foster shareability.

Both A3 and B1 were chosen for soil sampling and posterior dry screening to better characterize small botanical remains that could escape field sampling. Two soil sampling columns were excavated, layer by layer, at selected profiles of A3 (east) and B1 (north). Columns were 50x50 centimeters each and named A3 East Column and B1 North Column. Its excavation from the adjacent original unit allowed a very stratigraphically controlled extraction of whole layers.

All deposits were field-screened with 1/4” (6 mm) dry-screen mesh. Excavated volume was calculated thanks to the use of 12l graduated construction buckets (“*balde concretero*”). Fish remains recovery is very sensitive to mesh size so fine screens were employed. The team was told to devote time and effort to this task and carefully picked up even the smallest pieces, special attention was paid to the remains of Clupeiforms (e.g., sardines, anchovies) given their reduced dimensions.

Recovered evidence was separated by material type and provenience, bagged, and labelled at place. All sediment from the A3 and B1 columns was bagged, labeled, and shipped to Santiago for dry sieving. A3’s soil sample was bulky and costly because came from a 2.5m depth column. Flotation wasn’t a viable option due to the fragility of some lines of evidence (e.g. paper) and the elevated costs of freshwater on this part of the coastal Atacama Desert.

2021 Units and Features

Based on surface in situ analysis and test pit results, I decided to place excavation units at the core of sectors A and B (Table 5). Units were named with the sector's prefix followed by a correlative number. At the village (sector A), units were placed in a grid of points 15 meters apart from each other. Four out of five were 1m^2 in area (e.g. units A1-2, A4-5), all have complex sequences of domestic and natural stratigraphy that require careful consideration.

Table 5: Excavation Units of the 2021 Season

Sector	*Unit*	*Context*	*Buried architecture*	*Salting features*	*Dimensions*	*Area (m^2)*
A	A1	midden	present	absent	1x1 (m)	1
	A2	midden	absent	absent	1x1 (m)	1
	A3	midden	present	absent	2x2 (m)	4
	A4	midden	absent	absent	1x1 (m)	1
	A5	midden	absent	absent	1x1 (m)	1
B	B1	midden	present	present	2x2 (m)	4
	B2	kiln	absent	present	2x2 (m)	4
					Total	16

Unit A3, located at the native domestic space core was 4m^2 in area for anthropological and practical reasons. The spot is in front of the church's ruins and has a slightly higher elevation than surrounding areas, as a central place of concentrated human activity over time it hosts a sequence of multi-period domestic layers and some potential natural events. We reached 2.7m of depth after almost one month of careful excavation by a team of five people, the village's core required excavation areas of at least 4m^2, otherwise it would be impossible to reach lower levels of Formative times.

I placed two large 4m^2 units at sector B in activity areas identified by the 2019 test pits. Unit B1 was placed to target a rich deposit conformed by colonial trash disposal over fish drying and salting features placed on top of previous native architectural remains. B2 targeted the area adjacent to the mouth of the large kiln to understand its potential role for colonial productive activities.

6.3 Sector A Excavations

Five units were dug in the native settlement (Sector A) from March 2021 onwards. I knew this to be the core of the shell midden because of a notable hotspot of surface materials and decided to place a focused grid of units there. A couple of selective test pits had confirmed two things: (a) deep stratified deposits at this hotspot, and (b) a funerary area with no surface indication in front of the colonial chapel.

One goal was to find special productive loci, specifically fish salting features like the one already detected for sector B, and any large deposits of fish by-products that could signal supradomestic production. My strategy also sought to provide five columns of vertical change over time. The settlement is a massive shell midden with little surface indication of native architecture, I placed a 15x15 meters grid at the mentioned hotspot and was able to excavate five of the possible units (the core ones).

Sector A Stratigraphy

All units revealed a rich succession of primarily domestic-generated occupations of variable composition and thickness. The shell midden formed over time as a domestic mound with several generations of occupation. Some occupations generated well defined domestic stratigraphy, other layers are a mixture of more sparse human activity and natural constituents, while others seem to represent pure natural events. Some strata appeared as broad horizontal layers, others as discrete deposits of variable tilts. As a result of the everyday activities of native dwellers, shells, sand, ashes, debris, garbage, and other elements accumulated over the remains of previous occupations.

Stratigraphy is not equivalent across units but all of them share a similar dynamic succession of domestic, mixed and natural events. There were some distinctive strata. Among the upper late Pre-Columbian and early colonial layers of heavy domestic activity, are some with a major proportion of charcoal and would have been areas where heavy combustion activities took place. For example, a regular thick layer constituted by ash and charcoal (A3, Layer C) evidenced a concentrated locus of human activity of early colonial times (Figure 31). It's not clear why the local native community burned fuel at the village core, no indications of metallurgy were recovered from this layer. Other occupations left dense strata generated by everyday activities that involved fires and food consumption. These layers turned out to be mostly of late Formative-Middle Period times (~ *cal* AD 300-600). Layer S (A3), for example, is another heavy burning deposit from which all sorts of materials were recovered.

Sector A was occupied from the late Formative through early colonial times, the densest and richest domestic layers excavated correspond to the Middle Period, the LIP or the early colonial period. Layers, some of them probably of natural origins, hint a settlement that also had abandonment events despite its continuous occupation in the long run. There are fine, horizontal silt layers with no material culture nor indication of human activity on them. At A3 at least two were excavated. One likely possibility is that they correspond to natural events, maybe due to the heavy rainy of El Niño events and its associated mudslides (*huayco*), a cyclical phenomenon that today impacts coastal cities on northern Chile. Rather than well-defined domestic spaces and activity areas, like the ones one might find at a short-lived site with stone structures, the panorama here is more consistent with multiple episodes of domestic activity over time and space that rotated across sector A through time.

Figure 31: The team excavating A3. Layer C is visible as a thick, heavy combustion layer near the surface.

Among the features were remains of residences. A few layers revealed traces consistent with the floors of pit houses, without rock foundations or other architecture. In these cases, the slight floor depressions, created inside by everyday activity, were ringed by accumulated soil around the exterior of the dwellings, probably representing exterior refuse zones. These remains suggest that native houses were made of light, perishable and transportable materials. Two main possibilities are: large tents made of sealion leather and whale bones, as described by the first European observers; and/or houses with thatching and walls of woven totora reed mats. Both probably coexisted, I recovered sedge remains and recorded a couple buried rock alignments. The latter would have served to secure the wooden posts or whale ribs that formed the base of the structure. The settlement was repeatedly occupied over time as seen in its dense domestic deposits. Its light material houses could represent ephemeral seasonal occupations, but some degree of sedentarism is signaled by several associated cemeteries.

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Two clear buried structures were uncovered in two different units (A1 and A3). At A1, the corner of a circular/ovoidal stone alignment was recorded below 50cm of depth. As seen elsewhere in the prehispanic occupation in the Loa area, it was constructed by aligning large angular boulders in vertical positions. The structure was filled with a mixed domestic deposit (Layer F) with sand, ash, some charcoal, and a few ceramics, mostly from Late Formative times (QRP/QTC).

At the village's core (A3), another structure was identified covered by a dense domestic deposit (Layer S) of heavy burning of black sea snail (Tegula atra), an edible species that inhabits the nearby rocky shore. Ceramics are of Late Formative times (QTC-SPNP-QRP) and radiocarbon date of a burnt sealion bone provided an age of *cal* AD 298-594 for layer S at 95% confidence level if calibrated with the Marine 20 curve (Heaton et al., 2020). It corresponds to the imprint of a tent or hut evidenced by the clearing of rocks that make up an alignment of circular/oval shape of over 2m in diameter/length. These two structures, together with some features visible on the nearby surface indicate small circular or ovaloid rock alignments of small dimensions (for individual use if not storage). No long alignments were observed.

Figure 32: Native burial revealed by test-pit 1 (sector A).

Finally, an early colonial funerary area was detected in front of the colonial church's façade. In the 2019 fieldwork, during the excavation of test pit 1 a native colonial tomb was identified. The individual had hair and some scalp tissue (Figure 32) thanks to the exceptional conservation conditions of the area, the skull faces southwest, and he was probably buried extended and on his left side (no coffin). The visible part of the body in the 50x50 cm pit was covered by a funeral shroud and a large botija sherd was placed to protect the head by the relatives. I decided to cover back the tomb and to stop the excavation.

6.4 Sector B Excavations

Two 2x2m units were placed at the Iberian fishery based on previous test pits results. Unit B1 was in a colonial midden that in turn overlapped colonial fish salting layers, B2 in an open corridor between the oven's mouth and the main colonial house. My goal was to study productive activities and consumption assemblages over time. It turned out that B1 included Pre-Columbian architecture and old occupations at its lower levels and B2 dense colonial salting layers below strata with domestic activity evidence.

The seawater evaporation area and B1 are adjacent, the later unit was sealed by a hard salty layer shared with the rest of sector B (current surface). An organic-rich deposit of all sorts of colonial and native materials lies below that. Layer C included (among many elements) domestic debris and large baskets or sedge mattings from nearby collapsed walls and roofing. This deposit may have formed as an informal midden at the salting patio contiguous to a light material construction.

A layer (E) of salt grains with salted fish remains was uncovered below the previous deposit. This context evidence that fish was placed on the floor within salt beds for drying near the main Iberian house. An olive pit recovered at this salting activity layer dated cal AD 1622-1662 at the 85% probability if modelled with a 1573 *terminus post quem* in OxCal (see radiocarbon section below). It's highly probable that the fishery was commodifying fish at least during the early to mid-17th century.

Part of a probable sealion skin raft lied directly on the mentioned salting floor (B1, Layer E, Figure 33). It corresponded to a couple large, worked pieces of skin finely stitched together by a seam made with sinew carefully and regularly knotted into cactus thorn rivets (Figure 34). A subtle reddish tone was observed in the exteriors due to caulking with red pigment (iron oxide probably). It was badly preserved and fused with the underlying (rock-hard) saline crust. I recovered a large cotton net, some rope, and salted fish in direct functional association.

My excavations demonstrated the presence of salting features around the main Spanish residence and evaporation pond.

Near the kiln, unit B2 evidenced a grey ash layer (B) originated by everyday domestic activities, I recovered in direct association native Pica-Charcollo (PCH) cooking pots with serving majolica forms, plus European clothing remains (pins) and nails, probably the only surviving part of barrels or other wood artifacts dismantled for fuel. Below the domestic activity, another layer (C) corresponded to another salt bed with a great number of salted fish scales and fins as well as some fish bones.

A similar salting activity area was identified by test pits 4 and 5, not far from the pond. As in B1, these two contiguous pits (100x50cms) revealed dense and very hard to excavate salt layers in which salted fish (Figure 35) and net fragments were recovered in direct, functional association. It's highly likely that fish was salted and dried all around the pond and main house, under direct guidance of colonists or its representatives.

Two postholes were recorded in B2 near the main Spanish house' collapsed wall. Both posts were buried a short distance apart, as if two roof construction events had occurred. Their diameters were 16.5 and 20 centimeters. The postholes were filled with organic silt from decomposed wood plus some colonial garbage from the surrounding dirt used to fill the hole and secure the post. Some dried cactus wood may represent the remains of ceiling beams, this material was traditionally used in the nearby highlands in this way.

Figure 33: Remains of a probable sealion skin inflatable boat.

Figure 34: Detail of the seam, it corresponds to the same kind described by Bibar (1966) for sealion inflatable boats.

Coming back to B1, below the salting feature there is another important deposit of domestic residues contained by a crust of salt and silt. Layer F yielded Iberian and Andean materialities but in lower quantities than the main occupation revealed at B1 (Layer C).

Figure 35: Colonial salted fish (vertebras, spines, meat, and scales) in a salt crust excavated at B1.

Artifacts are equivalent to the ones observed at upper colonial deposits, but a decorated Inca style bowl was recovered from Layer F. A posthole was identified at this layer filled with organic material, some sort of light material structure roofed or enclosed this part of the patio if not the pond itself.

Layer G is another salt bed with countless fish scales. A reddish silt underlying layer (H) yielded a good quantity of organic remains, mostly PCH and DUP regional LIP ceramics but a few small botija sherds. An algarrobo seed dated *cal* AD 1319-1419 at 95% probability. This potential LIP or Inca era occupation didn't contain salting elements.

Another hard layer (I) with some salt in its composition was excavated below the previous occupation. It corresponded to a compact floor of ash and salt, hard to excavate, that doesn't correspond to a fish salting feature. Materials were scarce but some black polished ceramics were recovered, an AMS date place its occupation between the late 6th and middle 7th centuries AD. The presence of salt may be due to the filtration of salt water from posterior occupations; this issue requires a detailed approach to be resolved anyway.

A similar rock-hard floor of salt and ashes (Layer K) with little materials was identified below and dated back to *cal* BC 400-200. This floor is associated with a collapsed and partially dismantled structure built by a single row of vertical boulders. By characteristics and antiquity, it resembles another Loa mouth's site of the Formative period (CaH-42). Prepared hard domestic floors are characteristic at the latter site as reported by its excavators (Zlatar, 1983). A similar structure's base was gazed during the 2019 season at test pit 1, not far from B1.

In sum, the Sector B fishery was built over the disperse remains of a Formative village reoccupied during the middle period and late Pre-Columbian times before the Spanish establishment at the site. Occupation may have been intermittent, with episodes of non-occupation, or occupation may shifted around Sector B during this time. With only two deep test pits, it is not possible to reconstruct the spatial patterns through the time of the occupation. It's hard to know the extent of the oldest known occupation of sector B, much more excavation and representative sampling are required to elucidate this issue. My excavations showed that at starting with Layer G and above, the locale had been used for fish processing with salt.

6.5 Radiocarbon Dates and Modelling

Radiocarbon dating was fundamental to determining when the main economic changes occurred at the site. Fifteen high precision radiocarbon AMS dates (Table 6)were obtained for Puerto Loa, eight at the native village (Sector A) and 7 from the Iberian fishery (Sector B). Collectively, through Bayesian modelling, the dates reveal the long-term occupation of this part of the Loa mouth and situate native economic dynamics within the occupational sequence.

Calibrated dates evidenced human occupations at the site at four main timespans: (1) a Late Formative settlement during the last five centuries *cal* BC (sector B only); (2) a longer duration occupation during the middle centuries of the first millennium AD; (3) Late Intermediate Period deposits at both sectors; and (4) the clear early colonial occupation of the village and fishery (~ *cal* AD 1550-1650).

Historical archaeologists underutilize radiocarbon dating due to the availability of time-sensitive artifacts and documents (Wesler, 2014) plus ambiguities in chronological estimations for the AD 1650-1800 period (Ames & Brown, 2019; Malainey, 2011; Renfrew & Bahn, 2016). Colonial requirements at Loa, however, relied for the most part on traditional native technologies and materials, so high-resolution European artifact typologies didn't work particularly well to differentiate occupations chronologically.

Calibration corrects past variations in the radiocarbon content of the atmosphere (Renfrew & Bahn, 2016), modern burning of fossil fuels and atomic weapons, important causes of secular variation of the ^{14}C spectrum, produce ambiguous dates to samples less than 300 years old (Malainey, 2011). The last centuries are exceedingly difficult to calibrate, probability distributions reflect curve plateaus and spikes, and age spans can encompass many decades (Ames & Brown, 2019).

Even if the modern era sits along parts of the calibration curve with multiple intercepts and probabilities (Thompson et al., 2019), the problem is not as acute for samples predating circa AD 1650 (Wesler, 2014). At early historic native sites, radiocarbon is successfully used to rule out prehistoric origins and is largely effective for refining site chronology (Braje & Rick, 2015; Wesler, 2014). Radiocarbon dates and Bayesian modelling are successfully used together to add precision and accuracy to early modern age determinations (Ames & Brown, 2019). Such modelling combines radiocarbon, calibration, stratigraphic and other time-sensitive data (e.g., dates in coins) to constrain probability distributions and improve site chronology to decadal level at its best (Ames et al., 2019; Bronk Ramsey, 2009; Thompson et al., 2019).

Questions about sites' timing/span of activity can be answered satisfactorily with Bayesian analysis of as few as a dozen well-chosen dates (Hamilton & Krus, 2018), and even smaller samples (7 dates) have successfully allowed the identification of historical Native American occupations (Braje & Rick, 2015). Such modelling allows for generational narratives, detailed settlement histories, and precise approaches to social dynamics (Hamilton & Krus, 2018), and It's being successfully applied in historical archaeology (Ames & Brown, 2019; Thompson et al., 2019).

The power of Bayesian modelling rests on adding essential stratigraphic and contextual relations to constraint probability distributions (Ebert et al., 2016), these are relative dates that can be added as priors to the model alongside calendar dates on an absolute timescale allowing the influence of the documentary record in the resulting likelihood (Bronk Ramsey, 2009). New probability distributions are produced by Bayesian analyses, in simple words the more dates and prior assumptions the more precise and constrained the resulting chronologies (Renfrew & Bahn, 2016).

Puerto Loa represents a good scenario for Bayesian analysis: it has a continuous sequence (stratigraphic and material records do not suggest any substantial break), a clear stratigraphic record, and the associated documentary record (Ames & Brown, 2019; Thompson et al., 2019).

To directly address the research objectives concerning the trans-Conquest economic shifts, I ran eight samples from a carefully excavated unit at the core of the native village (A3) and seven from another key unit at the core of sector B (B1).

Table 6: Radiocarbon Dates from Sectors A and B

Sample ID	Sector	Unit	Layer	Lab code	Sample type	Sample Description	Radiocarbon age	1σ	cal 2σ range
1	A	3	B	D-AMS 050277	organic (plant)	Algarrobo seed	989	21	AD 1030-1153
2	A	3	C	D-AMS 050278	organic (seed)	Chañar seed	294	20	AD 1511-1794
3	A	3	M	D-AMS 050279	organic (wood)	Charred twig	1700	24	AD 258-468
4	A	3	Ñ (II)	D-AMS 050290	bone (collagen)	Camelid bone	1581	22	AD 435-585
5	A	3	R	D-AMS 050280	organic (charcoal)	Charred twig	1570	27	AD 435-599
6	A	3	S	D-AMS 050291	bone (charred) - soluble fraction	Bone (possible sealion)	2102	23	144 BC- AD 18
					bone (charred) - insoluble fraction		2096	20	139 BC- AD 18
7	A	3	U	D-AMS 050281	organic (charcoal)	Charred twig	1644	23	AD 391-535
8	A	3	W	D-AMS 050282	organic (charcoal)	Charred twig	1617	24	AD 419-569
9	B	1	C	D-AMS 050283	organic (seed)	Corn grain	336	23	AD 1503-1649
10	B	1	E	D-AMS 050284	organic (seed)	Olive pit	315	23	AD 1508-1661
11	B	1	F	D-AMS 050285	organic (plant)	Maize cob	407	23	AD 1454-1625
12	B	1	H	D-AMS 050286	organic (plant)	Algarrobo seed	615	23	AD 1319-1419
13	B	1	I	D-AMS 050287	organic (charcoal)	Charcoal	1479	24	AD 584-653
14	B	1	J	D-AMS 050288	organic (charcoal)	Charcoal	2379	24	538-207 BC
15	B	1	K	D-AMS 050289	organic (charcoal)	Charcoal	2318	24	399-200 BC

6.6 Radiocarbon Samples and Calibration

Samples were collected according to lab specified best practices with sample amounts 3 times the one indicated for submission (Taylor & Bar-Yosef, 2014), and after full consideration of type, size, and provenance context (Malainey, 2011).

When possible, I favored short-lived cultivated and edible non-local wild species from undisturbed deposits to avoid the "old wood" offset. Well-preserved shells and bones from marine animals were almost completely avoided as samples because of reservoir effects. Charcoal from well-defined hearths (without bioturbation evidence) and short-lived woods (Malainey, 2011; Taylor & Bar-Yosef, 2014) was employed but only in the absence of cultigens.

My sampling criteria considered dating key time points from secure stratigraphic positions (Taylor & Bar-Yosef, 2014). Based on my research questions, I tried to target intensive fish processing events and salting loci, well defined hearths, and food consumption deposits that could illustrate production/consumption changes over time.

Samples were sent to DirectAMS lab facility in Bothell, WA (US) for AMS radiocarbon estimation. Radiocarbon dates were calibrated using calibration curve SHCal 20 (Hogg et al., 2020) for the southern hemisphere in the online version of OxCal 4.4.4 software (Bronk Ramsey, 2009). Calibrated dates are presented in Table 6.

There are some aspects of the radiocarbon sequence that merit further discussion, although we can be confident, particularly because of the nature of the deposits in sector B (due to the use of salt) that they generated a clear sequence of dates over time.

In Sector A, the sandy matrix of the shell midden and more intensive human activity on the modern surface allow more mixed deposits, and possibly more opportunity for intrusion. A dirt road was constructed with bulldozer at some point in the 20th century traversing the site and redepositing some material over the colonial top layer. This could explain why an algarrobo seed with a LIP date (D-AMS 050277) was obtained from above a layer of early colonial times (D-AMS 050278).

Date D-AMS 050291 is a potential outlier (A3 Layer S), it corresponds to charred bone of marine mammal (possibly sealion) so affected by the marine reservoir effect (MRE). Marine carbon reservoir is constituted by dissolved carbonates that are ^{14}C depleted, marine organisms in equilibrium with such reservoir incorporate the carbonates into their tissues and date older than expected (Malainey, 2011). Four hundred years are the global average marine offset, regional reservoir models are required for more precise corrections (Hamilton & Krus, 2018; Malainey, 2011). To avoid this potential source of bias, sample D-AMS 050291 was left out of the following modelling of Puerto Loa's occupational history.

The same version of the OxCal software was used to conduct a Bayesian modelling of site's occupation, such analysis allows for the use of very precise calendar dates in historical archaeology to constrain posterior probability distributions which mitigates the effects of curve's plateaus and spikiness via density estimates (Thompson et al., 2019).

6.6.1.1 Terminus Post Quem Considerations

Two concepts, more common to historical archaeology, are worth presenting here. *Terminus post quem* (TPQ), "limit after which", refers to the latest calendar year obtained from the evidence or documentary sources for a site or occupation (South, 2002). Conversely, *Terminus* *ante quem* (TAQ) or "time before which" corresponds to the dating endpoint for subjacent layers and occupations.

The ash layer from the Huaynaputina volcano eruption (1600 AD) acts as a very powerful TAQ and TPQ marker for contemporaneous sites in modern southern Peru and northern Chile. It was not present in Loa's excavated deposits, however. I included in the Bayesian modelling another specific calendar date as TPQ.

Among sector B assemblages, two calendar dates were TPQ candidates. One possibility was to use the book "*Espejo de Príncipes y Caballeros*", constituted by five subsequent volumes, the series was first published between 1555 and 1587 (Campos, 2003). Given that it's not clear which volume(s) was read at the fishery, 1587 represented a suitable TPQ to compress colonial samples probability distributions.

But the latest secure calendar date must be used in search of precision. People at the fishery had Chinese Ming porcelain as part of the tableware, these fine ceramics were part of the Manilla galleon trade. Ming porcelain, fine silk, and other Asian luxuries were disembarked in Acapulco on the Pacific coast of Mexico in 1573 for the first time, and from there distributed to other locations (Canepa, 2014). Both the book and Ming remains were recovered in association for the same layers (B1, Layers C & F), and represent the kinds of elite materials curated by the Spaniards of Tarapacá for their descendants as read in their wills. Both are precious personal and household items carefully preserved over the years, the date AD 1573 is a conservative TPQ then, it was included to compress the probability distribution of the colonial phase.

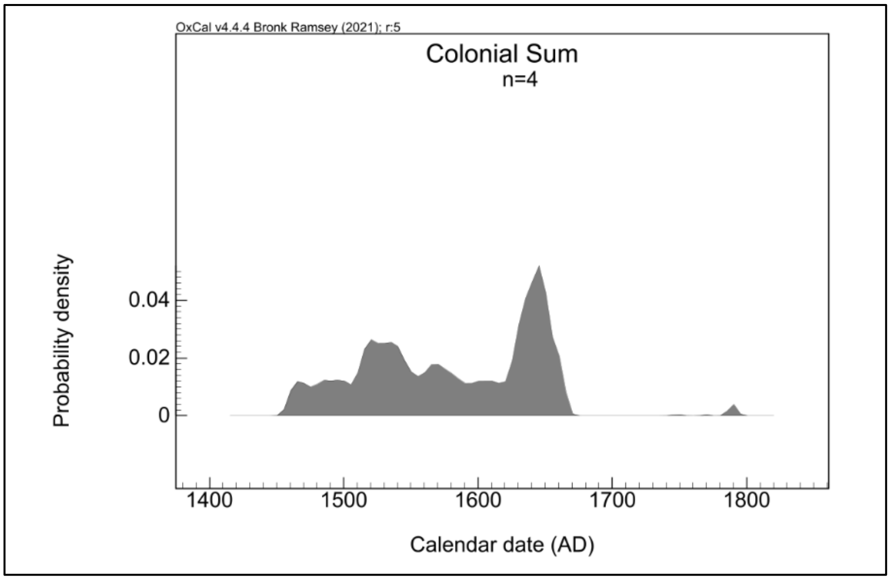

Figure 36: Summed probability distribution of colonial radiocarbon dates.

The probability density function shows how some dates are much more likely than others (Bronk Ramsey, 2009). Even without the powerful effects of the 1573 TPQ, summed probability distribution of all four calibrated colonial 14C dates show a main peak in probability density for the *cal* AD 1630-1650 range (Figure 36). A secondary peak above the first decades of the 16th century should be ruled out as an effect of calibration curve's plateaus. At the native village, layer C represents a well-defined colonial stratum with good preservation and high organic contents, it's very distinctive in stratigraphy because of a high proportion of ash and combustion remains. I didn't recover porcelain nor book pages from this layer, materiality is mostly native with some subtle indications of mixture in ceramic productive traditions. It was radiocarbon dated and despite the lack of a clear TPQ there is a 77.4% probability of an occupation occurred between *cal* AD 1623-1670 (Figure 37), the 16th century first half is way less probable (13.9%) and produced by a horizontal plateau in the SHCal 20 calibration curve.

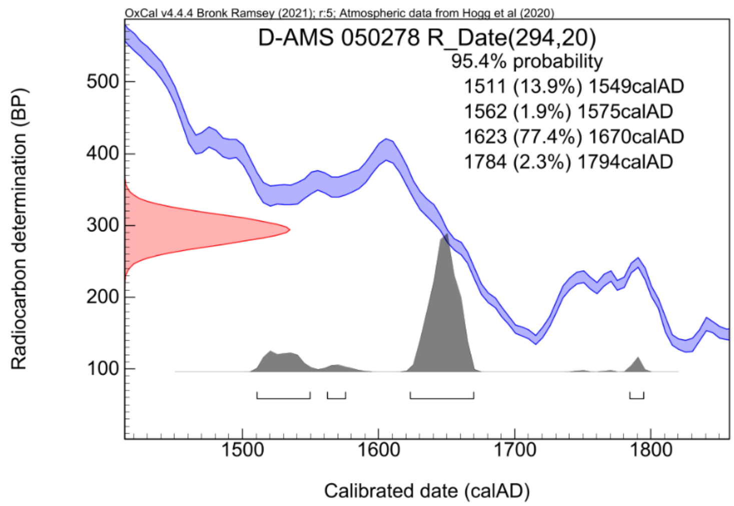

Figure 37: Calibrated colonial date from upper occupation at the native village (Unit A3, Layer C).

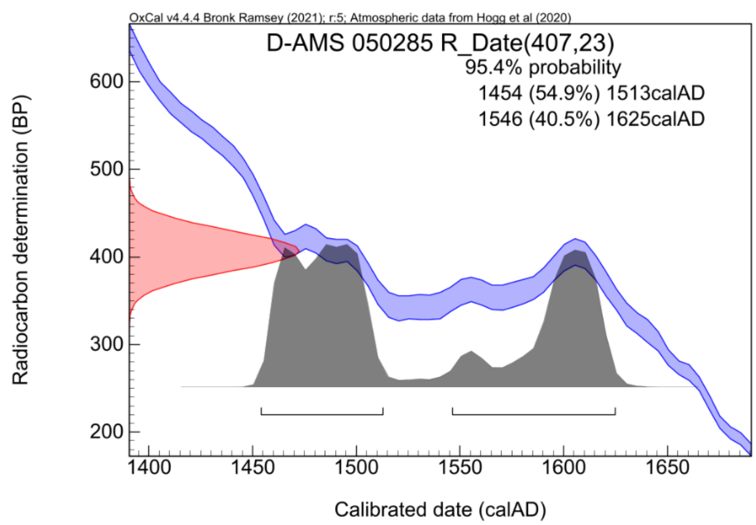

Figure 38: Earliest dated colonial occupation at the fishery (B1, Layer F).

Sector B Layer F (B1) is the oldest clear colonial layer, European cloths, Old-World animals, and plants, as well as majolica, porcelain, botija sherds and other colonial materialities were recovered in great numbers. Its calibrated radiocarbon date assigns more probability to late fifteen-early sixteen century occupation than to a purely colonial era occupation (Figure 38). But the AD 1450-1600 range sits on a plateau in the calibration curve, in other words, calibration of

16th century dates will encompass broad time spans in terms of probability. There is a 40.5% probability that this occupation occurred between *cal* AD 1546 and 1625: the highest peak touches the latter years of the 16th century and very early years of the following century. This layer contained the 1573 TPQ which confers more weight to the second range and clearly shows the importance of Bayesian modelling for early historical sites.

The sum of probability densities (Figure 39) for Middle Period[12]available dates evidence a consistent settlement of Puerto Loa between *cal* AD 400-650 (both sectors). This time is consistent with changes in ceramic typologies.

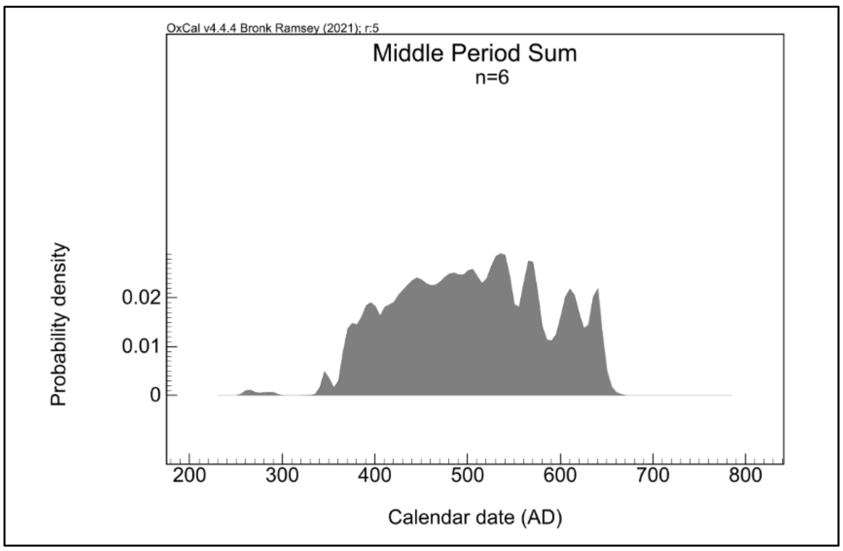

Figure 39: Middle period summed probability distribution in both sectors.

So, for potential occupations of Inca times, among the available sample of radiocarbon dates Sector B offers a couple cases. Algarrobo remains from B1 Layer H have comparable probabilities of being from *cal* AD 1319-1355 (48.2%) or from *cal* AD 1385-1419 (47.2%) but

[12] The so-called (extended) “Late Formative” by local archaeologists due to the scarcity of Tiwanaku’s materials in Tarapacá .

the presence of a few botija sherds might evidence disturbance. The above-mentioned corn cob from the colonial layer F has 55% probability of being from *cal* AD 1454-1513 but the plateau complicates the matter. It could be that both dates indicate an Inca time occupation of sector B mixed with early colonial occupations through layers F-H, or simply an LIP layer with some intrusive materials followed by an early colonial occupation.

6.7 A Puerto Loa Bounded Phase Model.

The "Phase model" or "Bounded Phase model" is one of the most applied Bayesian models, a phase is an unordered group of radiocarbon dates without any defined ordering such as stratigraphic relations (Hamilton & Krus, 2018). The main assumption here is that all dates within a phase represent a single period of activity, start and end boundaries are added for each phase ordered as a sequence (Hamilton & Krus, 2018). Many phases can exist in an ordered sequence.

OxCal's standard boundary parameters apply a uniform prior distribution to the phase's radiocarbon dates, activity goes from zero to max intensity and switches back to nil (Hamilton & Krus, 2018). Other boundaries and functions within a phase constitute informative priors that alter probability distributions based on archaeological or other criteria (Hamilton & Krus, 2018).

I use a bounded phase model with a colonial TPQ constraint to better define currently dated occupations at Puerto Loa. To enter dates from both sectors in a single model, I had to disregard stratigraphic relations and conform phases based on chronological equivalence of AMS and ceramic typologies. All radiocarbon dates (except one MRE outlier) were structured in an ordered chronological sequence of internally unordered phases. The model has a simple structure of start boundary, phase, end boundary, start boundary, phase, end boundary. Colonial samples were ordered as a sequence after the mentioned TPQ.

Oxcal produces agreement indices as internal measures to indicate the extent to which parameters and data are consistent with one another (Ames & Brown, 2019). Agreement indices above 60 indicate robust results and a good fit between model's assumptions and data (Bronk Ramsey, 2009), the model presented here produced high agreement indices (Amodel=105, Aoverall=104.1). Modelled phases are not contiguous but are contained in a general sequence structure. Each phase has start and end boundaries that encompass large time spans at the 95% confidence level, a more precise sense of the beginnings and ends is gained, however, if boundary probability densities are considered.

The Puerto Loa model (Figure 40) shows the initial occupation of this part of the river mouth since the last centuries *cal* BC. The late formative phase may have started either at 450 or 300 BC (two peaked probability distribution), the phase would have ended about 240 BC. Middle occupations probably occurred from AD 360 to AD 620-640, while the LIP phase would have begun around AD 1030 and ended about AD 1350-1415. People continued to occupy the site between the two periods. As I said above, some occupations yielded dates with a probability of falling in the Late Horizon (e.g. B1, Layers F and H); it is possible that the Spanish fishery was established on an Inca era settlement dedicated to fishing tasks. Peaks for the probability distribution of colonial era boundaries in the model are AD 1565 (start) and AD 1650 (end).

In sum, calibrated dates evidenced human occupations at the site during several periods: late formative occupations during the last five centuries *cal* BC (sector B only); a consistent and regular occupation during the middle centuries of the first millennium AD; late Pre-Columbian occupations at both sectors; and a clear early colonial occupation of the village and fishery, the last occupation before the site's abandonment.

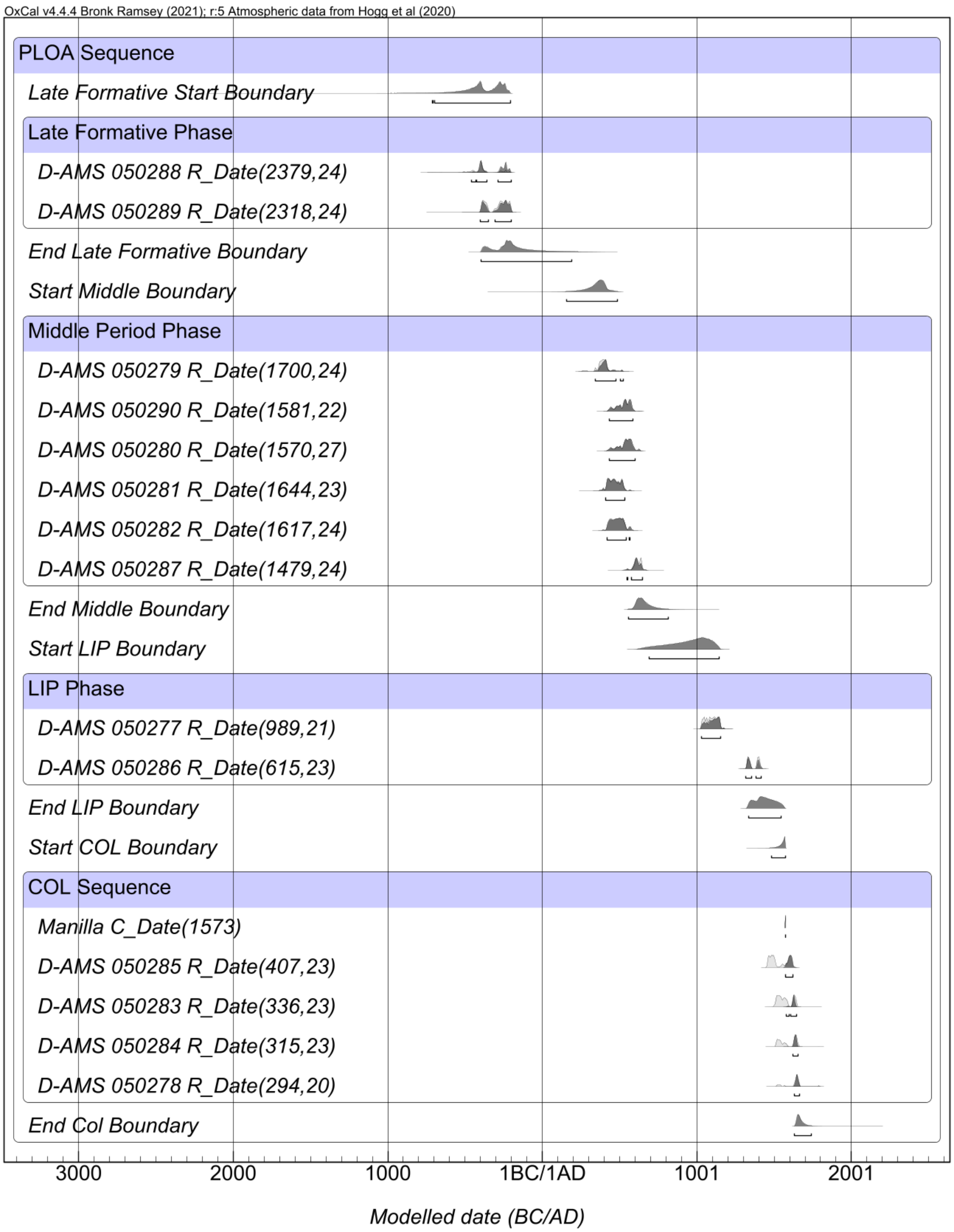

Figure 40: Puerto Loa bounded phase model (no stratigraphy considered, layer S excluded as outlier)

7.0 Puerto Loa Life

Chapter 4 provided an overview of the organization, persona, and activities at Puerto Loa. This chapter delves more deeply into consumption patterns at the site save for fish which will be described in detail in a later chapter.

7.1 Subsistence

Long-term human adaptation to the Tarapacá - Atacama region can be classified as maritime agroforestry in nature. Rio Loa residents exploited diverse terrestrial and marine habitats, from underwater kelp forests to verdant oases in the challenging tropical desert nearby. The southeastern Pacific Ocean waters near the Loa mouth host a highly productive marine ecosystem thanks to the paired effects of coastal upwelling and the nutrient rich Humboldt Current coming from the subantarctic region. Pelagic fish are very abundant and fish biomass per unit area is among the highest in the global scale (Disspain et al., 2017). Native people along this arid coast took advantage of this maritime richness from early on, targeting mackerel, corvina, and anchovies as well as exploiting rock shellfish (abalone, mussels, and others) and marine bird species (Ballester et al., 2019; Castillo et al., 2017; Castro et al., 2016).

Atacama's Pre-Columbian forests concentrated in a few inland oases and lower river basins, including the Loa River. The extent and density of these vegetation patches would have increased after 1000 BC with the onset of a more humid climate regime. Coastal inhabitants made use of algarrobo species with edible pods introduced from the eastern Andes (Santoro et al., 2017), tamarugo, and wild plants with edible pods, seeds, and fruits (chañar, molle, and pacay) from early on. Storage areas for maize and algarrobo were built by ancient villagers of Tarapacá in Quillagua or Guatacondo (Santoro et al., 2017) and today locals still know how to use the desert's extant forests for chicha (beer), flour, animal fodder and other resources. This pre-Columbian agroforestry and maritime economy were supplemented by the cultivation of maize, beans, cotton, peanuts, gourd, chilies, and many other plants in the lowlands, warm ravines, and oases (Muñoz et al., 2016; Núñez & Santoro, 2011).

7.1.1 Stone Tools

Lithic technology provides an indirect line of evidence for looking at changes in meat consumption patterns through time. In this section, I discuss aspects of general stone tool production and use. Specialized fishing lithic technology will be reviewed in a later chapter.

Site residents made a limited and well-defined lithic toolkit representing long-term specialization in particular butchering practices for specific animals. Dwellers sharpened or resharpened bifacial edges from Middle Period times and maintained the same practice at the fishery's patio even in early colonial times. Seen broadly, most of the lithic technology from the site relates to the processing of smaller prey. Expedient chert knives were made to process seabirds or fish, and small bifacial points could have been used as harpoon tips for medium to small animals (birds, terrestrial animals and fish) or, alternatively, as the blades of more elaborate hafted knives for sealion butchering (Figure 42). Absent from the assemblage were the very large bifaces capable of penetrating the thick skin layers of whales. Some bifaces may have been used in the village itself as hafted knives, fishing sinkers, in turn, were exclusively employed and more likely lost outside the village. Despite this spatial difference, the discard rates of sinker blanks were overwhelmingly higher than bifacial blanks (Figure 41) indicating that the blank industry as a whole was focused on fishing rather than hunting technology.

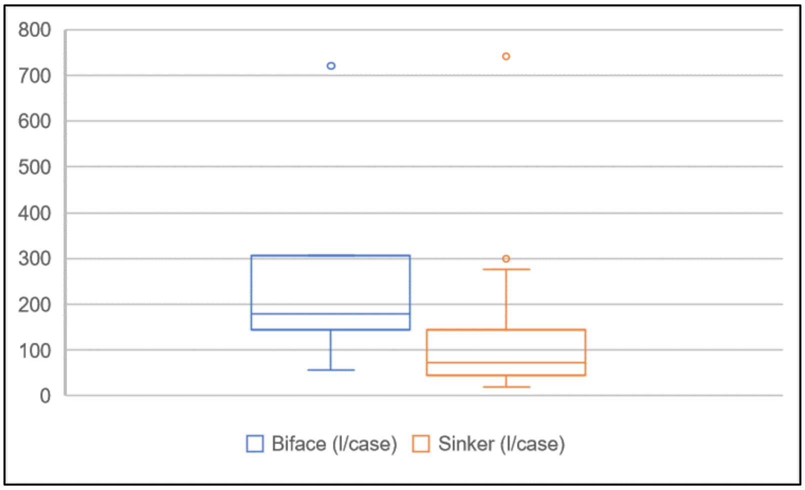

Figure 41: Biface versus sinker blank discard densities (l/case) in Sector A.

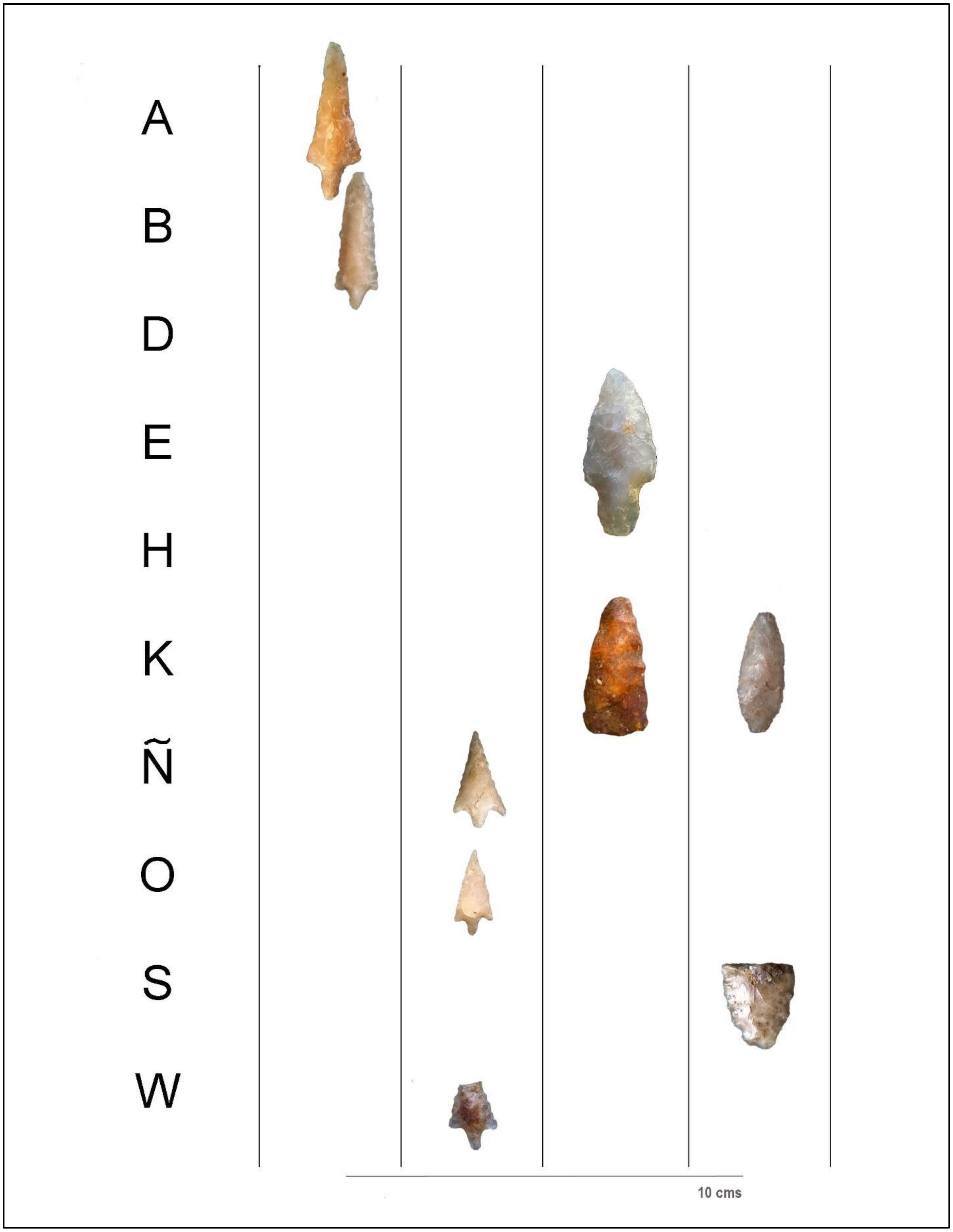

Figure 42: The four kinds of bifacial points recovered from the village's core (A3) by layer

The signature tool of the local lithic industry was the expedient chert knife (Figure 43), the primary flakes originated by the fashioning of its bifacial edge are the most common discarded flake type through time and across occupational zones. The typical source material were whole nodules from nearby desert sources. Residents regularly accessed the same traditional inland quarries, with macroscopically equivalent chert coming into the village from the Middle Period through colonial times. From these were made simple tabular knives used daily to slice up seabirds, fish, sea lions and plants.

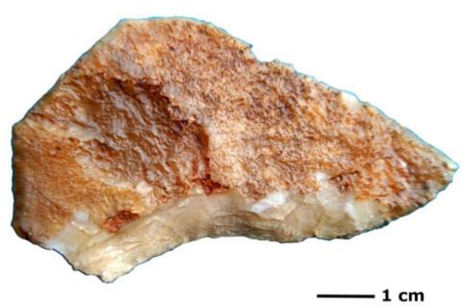

Figure 43: Example of a chert tabular knife from the fishing village

Chronological analysis reveals some of the relationships between lithic and faunal assemblages. There's a positive correlation between the remains of hunted wild prey (sea birds, marine mammals, and sea turtles) and the manufacture of sharp cutting edges of processing chert tools. The presence of these animals explains 58% of the variation in chert debitage ($r=.761$, $p=.000$, $Y=0.070(X) + 4.236$). Similar proportions of chert debitage variation are explained by marine mammals (sealions and others) or seabirds alone and can be seen in comparing wild animals versus chert tools, blanks and debitage all together. Some correlation exists between fish bones and chert knives plus bifaces, 47% of the variation in knives is explained by fish bones (r=.638, p= .000, Y=0.001(X)+1.748), the processing of fish with the simple knives also gets support.

The lithic industry was easy to produce, multifunctional, and associated with the cutting of multiple animals (fish, mammals, birds, and reptiles).

Middle Period residents discarded flakes (all rock types) more intensively than in other periods as can be seen in the density values (Figure 44). Occupations before and following the Middle Period show comparable densities to one another. The intensity of stone tool production, if measured simply through tool rock consumption, would have been greatest in the Middle Period before declining sharply in the late Pre-Columbian and colonial periods.

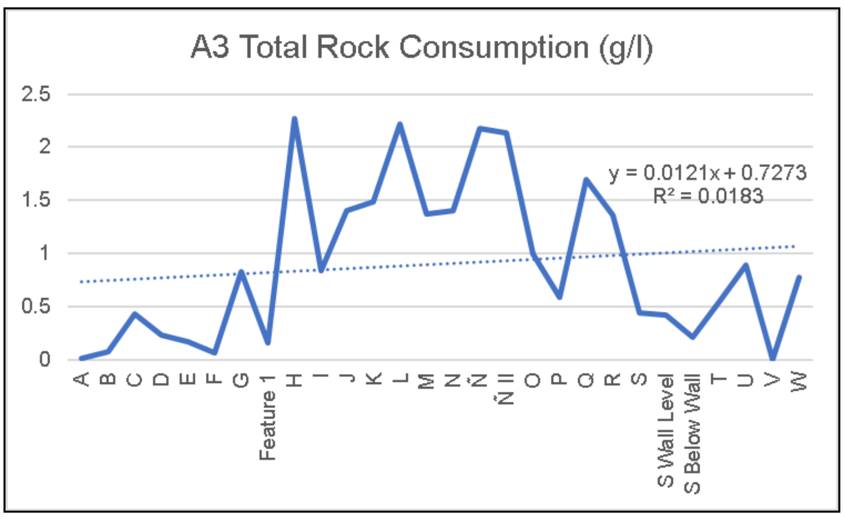

Figure 44: Total rock consumption in grams per liter in unit A3.

Middle Period residents left more retouch and secondary flakes, chert points and blanks as testimony of the intensive production of hunting components. They manufactured more points than their late Pre-Columbian descendants as well as more chopping tools capable of dismembering sea lions or other large prey. These Middle Period fishermen, in addition to hunting a greater variety of animals than their descendants used stronger cutting tools to hit and dismember animals and left a very varied set of flakes that illustrate more advanced stages of chert reduction (Figure 45).

Retouch of bifaces occurred more in the Middle Period than in later periods, although the general preference for expedient knives continued.

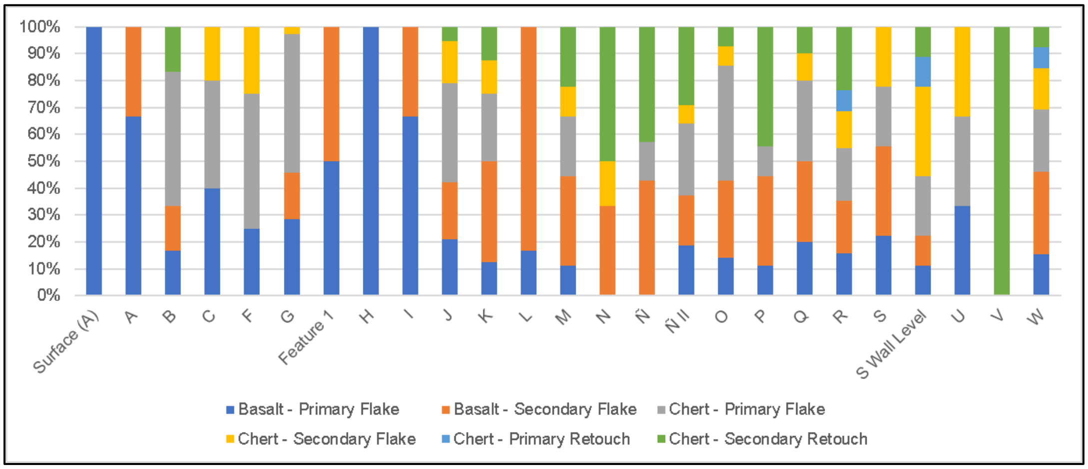

Figure 45: Flake types over time at the village core (unit A3).

With Conquest, traditional tool production continued as part of colonial-period animal processing practices but with important differences between the Sector A native village and the Sector B colonial fishery. The evidence indicates that metal knives did not replace stone tools in a significant way.

The center of knapping activity may have moved towards the early colonial chapel. Early colonial and late Pre-Columbian Andeans discarded flakes there in high densities comparable to the Middle Period assemblages. Community residents kept producing their traditional chert toolkit in the Sector B salting patio. The villagers working here discarded flakes in densities comparable to what was observed in later occupations of the Sector A village, including tiny primary retouch flakes from the sharpening of the knives' bifacial edges.

The colonial fishery assemblages show a greater diversity of animals than those they consumed at the same time in the nearby village. In diversity the fishery assemblage is comparable to those of the Middle Period. This difference is paralleled by bifacial production patterns. The fishery shows markedly more knapping of bifacial instruments for hunting and animal processing than was going on at the same time in the nearby village. The level of biface knapping here is comparable to that taking place in the Middle Period. The making of chert bifaces for hunting/processing tasks was among the intensive activities conducted by the local Andeans in the fishery. This could represent another expression of colonial period intensification.

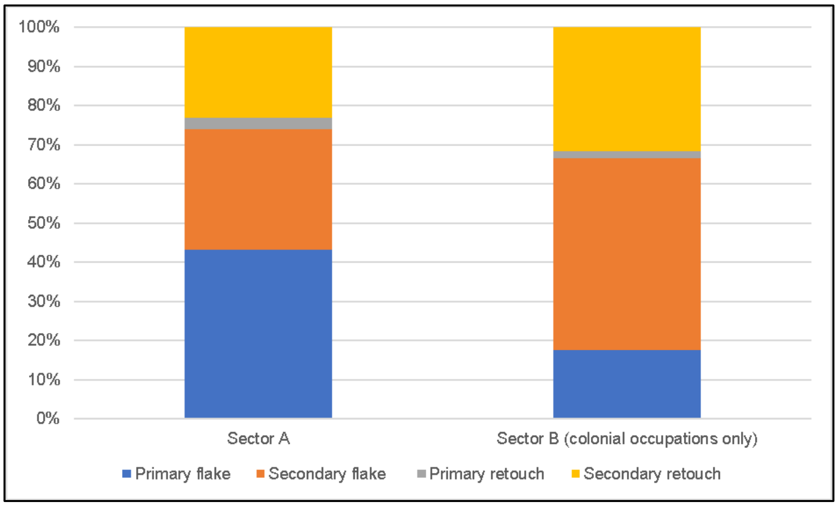

Figure 46: Stacked proportions of flake types.

The colonial fishery chert flake assemblage shows higher proportions of advanced stages of bifacial reduction and thinning (Figure 46) oriented towards the production of harpoons, arrows, or other hunting components. Secondary flakes, for example, always outnumber primary and were densely discarded in rates even higher than for the village's Middle Period (Figure 47). Secondary retouch flaking shows a similar pattern.

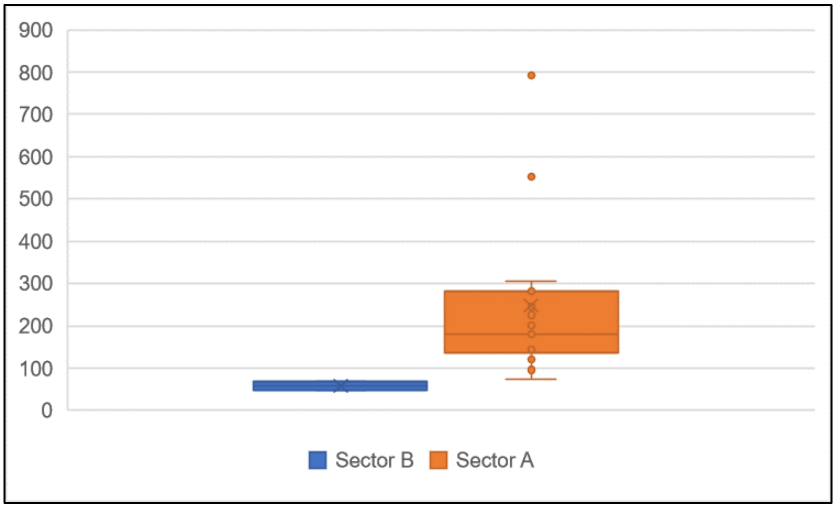

Figure 47: Discard densities (l/case) of chert secondary flakes per sector.

Villagers butchered fish and seabirds or even larger animals with chert knives in the Sector A village as an intensive, perhaps daily activity. The village's core was a place of clustered animal processing activities where the fishers used and discarded high volumes of chert knives. The production and use of similar knives in the fishery was markedly less intensive and important (Figure 48).

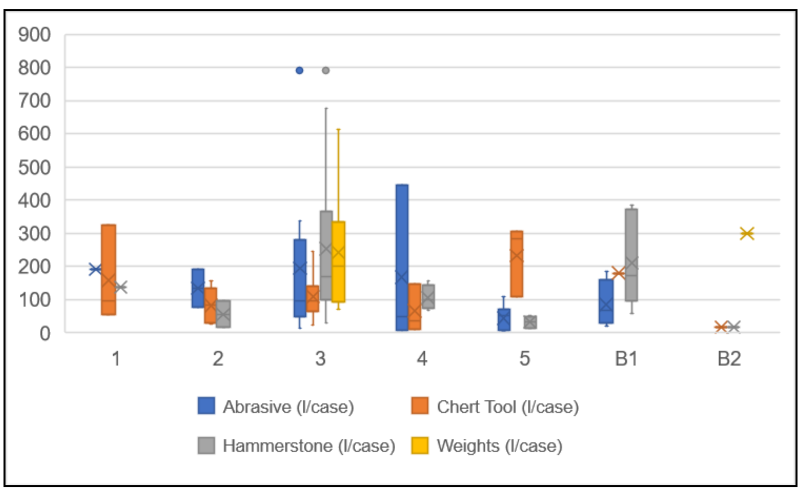

Figure 48: Discard densities (l/case) by lithic tool and sector.

Most of the lithic assemblage for the fishery was connected to fishing equipment, as I discuss in a later chapter. For example, abraders represent a significant proportion of the lithic tools excavated from one of the main colonial occupations of the fishery (B1, Layer C).

No basalt chopping tools were found in the colonial fishery. It may be that this ancient technology was replaced by metal knives for heavy cutting duties. Basalt debitage at this locus is scarce and likely stemming from hammerstone percussion of other hard materials (i.e., ore). Overall, discard densities show less use of basalt in the fishery. In Sector A village during the colonial period, deposition of basalt flakes (mostly primary plus some secondary) near the chapel was at intensities in line with those of Pre-Columbian occupation. But like the fishery, the uppermost occupations of Sector A contained some basalt hammerstones but no basalt chopping tools. Compared to their Middle Period ancestors, later residents hunted a smaller variety of animals, invested less in stone tool production, used less basalt, stopped using large chopping tools to dismember large prey, and devoted most stone tool making to expedient chert tabular knife production.

7.1.2 Hunting and Animal Husbandry

Hunting marine, and to a much lesser degree terrestrial, animals was an important subsistence activity. The Atacama coasts offered an inexhaustible source of red and white meat for fishers and their families. Family sustenance was not only fish and shellfish, but meat from marine mammals, especially sea lions, turtles, and sea birds.

The Sector A sample showed a moderate level of faunal identifiability and units closer to the shoreline showed a slightly higher degree of alteration. Bone alteration can be calculated based on NISP/NSP: a high level of fragmentation is expressed by values closer to 0, good preservation is closer to 1 (Lyman, 2008). Units from the village ranged from 0.32 to 0.44. Comparatively, the Sector B fishery sample is smaller (*n* = 683), however it exhibits a higher level of faunal identifiability (50.4%; *n* = 344 was classified below class level). The identifiability (NISP/NSP) average 0.5 was then slightly higher than in Sector A, probably because of the preservation effects of the salting process.

We recovered a very large sample of animal (non-fish) bones in the village (*n* = 13,519). Most were identified[13] at the at the class level or above (62.6%; *n* = 8462), a good proportion (37.4%; *n* = 5057) was classified into more specific categories. At the class level, mammals are the majority (55.1%; *n* = 7449), followed by birds (43.7%; *n* = 5909), and reptiles (0.93%; *n* = 126), plus some unidentifiable bones (0.26%; *n* = 35).

The Sector B salting patio near the evaporation pond received a great deal of food debris from by the Spanish and their local workers when cooking or after eating. The bulk of the Sector B sample (87%; *n* = 597) came from the patio, and specifically from the main salting layer (B1, Layer C) dated *cal* AD 1503 to 1595 (71.2% probability). About 40% of the Sector B non-fish faunal assemblage was recovered from that layer which also exhibited a wide taxa variety.

The most striking difference between the non-fish faunal assemblages of Sectors A and B are: (1) a strikingly lower proportion of sealions in Sector B than Sector A; and (2) the striking difference in consumption of European domesticates. This latter difference will be discussed later

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[13] Zooarchaeological analysis and taxonomical identifications were conducted by zooarchaeologists Cristóbal Oyarzo and Sebastián Yrarrázabal.

in this chapter. Figures 49 and 50 present the breakdown of the main categories of animals identified by sector.

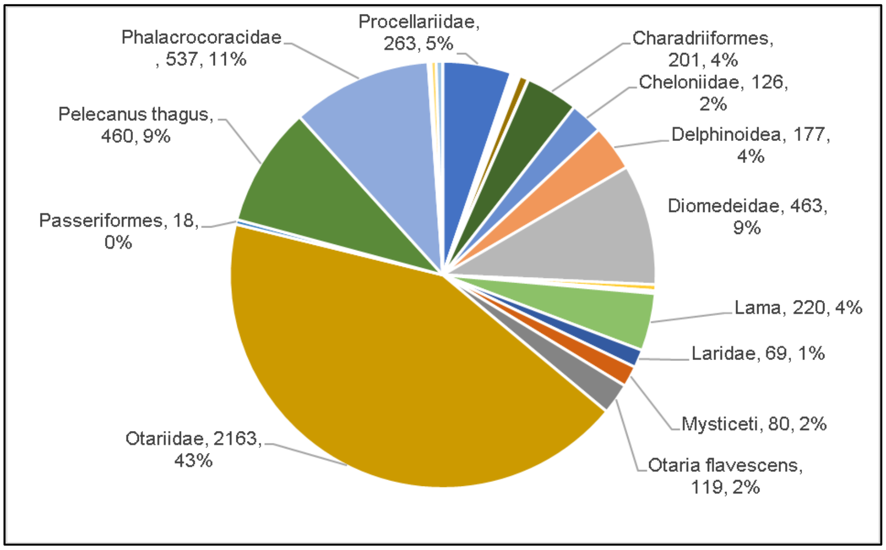

Figure 49: Identifiable taxa below Class level at Sector A

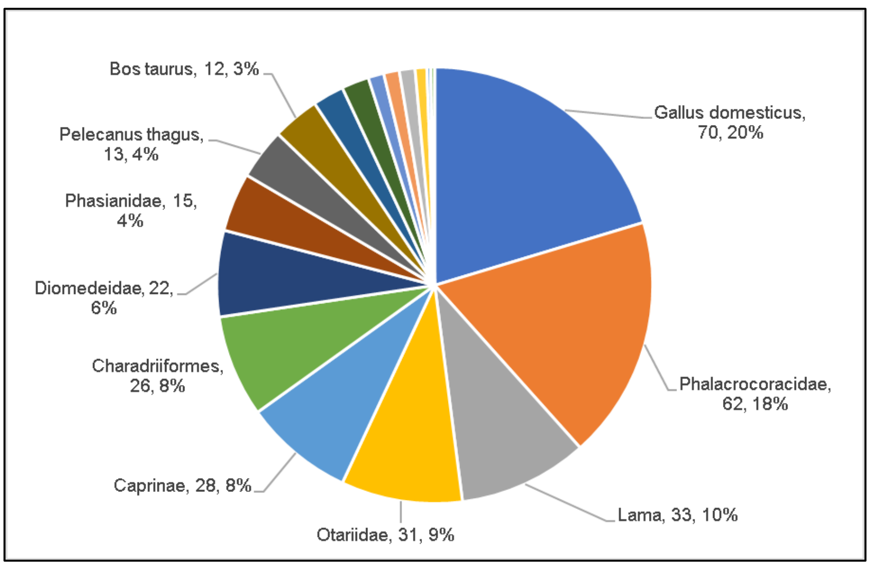

Figure 50: Identifiable taxa below Class level at Sector B.

Shellfish

Shellfish would have been one of the most important non-fish food items at the site, available year-round, easily located, and easily harvested. This thesis does not incorporate analysis of the vast shellfish assemblage at the site (much of the site appears as shell midden). The river itself was another area in which local people captured edible aquatic animals. During the final occupations, residents exploited Loa's freshwater shrimp (*Cryphiops caementarius*). The highest proportions of these are in colonial occupations in Sector B. Fragile remains of this species were also found at the village's core (A3, Layers E & D, A2, Layer B) and near the church (A5, Layer D). People from a native association in Quillagua told me that these shrimps are especially abundant even today in the lower Loa River basin.

7.1.2.1 Sea Mammals

Native villagers mostly relied on certain kinds of mammals. Their main animal over time was the sealion or *lobo marino* as known in the Atacama and represented the most frequent taxa below the class level. Rio Loa residents took the species *Otaria flavescens* or the South American sea lion, a permanent resident of the rockeries near the Loa mouth even today. A primary marine entity for the coastal communities of the southern ancient Andes, the sealion played a protagonist role in the myths and beliefs for residents as reflected in coastal rock art. Sealions (*Otaria flavescens*) were regularly harvested from the rocky islets and points with harpoons and clubs. A common sight at the village would have been people dismembering and gutting the animals, followed by the careful separation of the skin from the muscles and the discard of head and feet bones. Meat could be roasted, while a whole tanning industry for inflatable boats, tents, and water bags – described in a later chapter – took place among the dwellings. Sealion hunting was a stable, regular activity throughout the site's history, with the highest proportions of sea lion bones occurring in the Middle Period occupations.

Other sea mammals represented at the site include dolphins of the Delphinoidea superfamily and whales of the Mysticeti parvorder. Delphinoidea comprises six families of toothed whales from killer whales to small porpoises and dolphins. Exploiting any of these taxa requires great labor, specialized strategies, and, in the case of whales, hunting technology not present at the site. The rarity of dolphin/whale bones and the technology needed for their harvest indicates they were obtained infrequently and in expedient ways, often perhaps through carcass scavenging. Most whale remains from the village seem to come from the same eroded vertebral column, several of which were used as a seat or architectural component in the buried structure of the Middle Period era (A3, Layer S).

Sealions and dolphins were roasted by the villagers. Their remains revealed combustion signs in about a fifth of the cases (Figure 51). As with the turtles, these common mammals showed higher proportions of burnt bones at the center of the fishing village (A3).

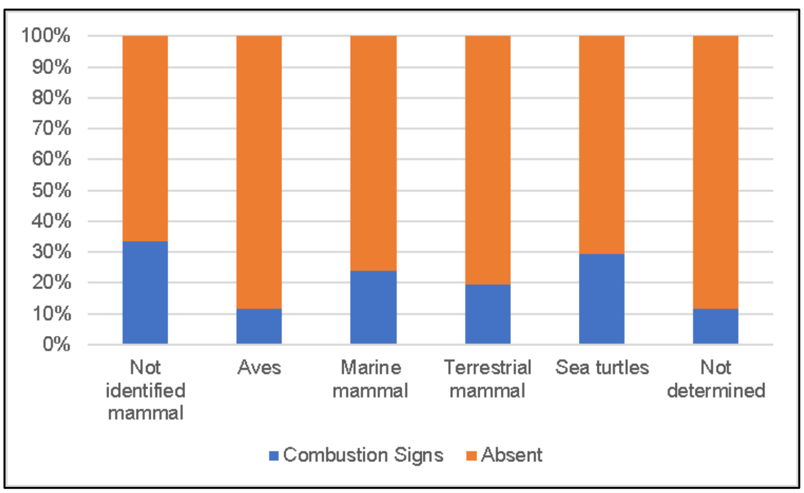

Figure 51: Proportion of burnt bones by animal Class in Sector A.

7.1.2.2 Camelids

Llamas (*Lama glama*) are the largest of the domestic camelids and reach weights between 130-150 kilograms in adulthood. Alpacas (*Lama pacos*) are slightly shorter than llamas and markedly lighter (50-65 kilograms). Guanacos, a wild camelid, are smaller and lighter. The presence of guanacos as game in the village is hard to rule out: even today their geographical distribution is not limited to the highlands, their distribution extends to the ocean in the southern Atacama Desert in coastal areas north of La Serena. The wild vicuña (*Lama vicugna*), the shortest and lighter camelid, is an exclusive inhabitant of high-altitude landscapes, and does not appear naturally on the coast.

Archaeological and historical sources suggest coastal peoples would have maintained small flocks of llamas at vegetation centers associated with river mouths and seasonal lomas. Village residents could also have maintained flocks at inland locales, or regular access to them with inland agropastoral relatives. Llamas would also have been entering the community as pack animals with the caravans linking coastal communities to inland locations. In any of these scenarios, some of the camelids would have died on the coast through natural causes or been slaughtered by the villagers for rituals or when an animal was at the end of its working life.

The Loa and Pica communities were obliged to give llamas as mentioned by the 1565 quipucamayocs. Even if these animals are not listed in the 1570 Toledan tasa, their bones represent the main category among identified mammal taxa at the Sector B fishery. Sector B displays twice the proportion of llama bones as the native village. Sector B is where caravan llamas would have been loaded and unloaded. The local elite had privileged access to the meat and labor of these emblematic Andean animals.

Dung spherulites are very small (normally 5 to 20 μm) crystallized bodies of calcium carbonate produced by the digestion of ruminants and others (Canti & Nicosia, 2018). These particles are produced in the intestines of pseudo ruminants like the South American camelids (Korstanje, 2005) as well as Old-World herbivores such as caprids and bovids. Spherulites are visible under cross-polarized light and are widely used in archaeology to detect herbivores given their characteristic microscopic morphologies (Canti & Nicosia, 2018).

A total of 45 spherulites were detected by specialist Luciana Quiróz on sherd surfaces. Most (60%; n = 19) didn't allow for any taxonomic identification due to shape redundancy. Seven spherulites were, in turn, indicative of camelid dung (Figure 52). Most sampled sherds with spherulites were from cooking pots. This association suggests the use of llama dung as fuel (a well-known Andean practice) along with the use of wood and seaweed. The discovery of llama dung spherulites on sherds and in soils is evidence that llamas arrived at and lived, at least temporarily, in the fishing village. One camelid spherulite was found in a sherd from a Middle Period occupation (A3, Layer U) of the village core dated *cal* AD 391-535. Remaining cases were found in sherds from late Pre-Columbian and early colonial occupations of the fishing village.

That the coast is a poor natural habitat for camelids would have meant that large flocks could not have been supported and camelids would have been a relatively rare, high value, meat. Not surprisingly, camelid bones, while pervasive in the Sector A assemblage through time, only make up 7.8% (n = 220), well below the sealion. Through time, densities of llama bone in the village's core (unit A3) fluctuate between 0 and 0.5 grams per liter (Figure 53).

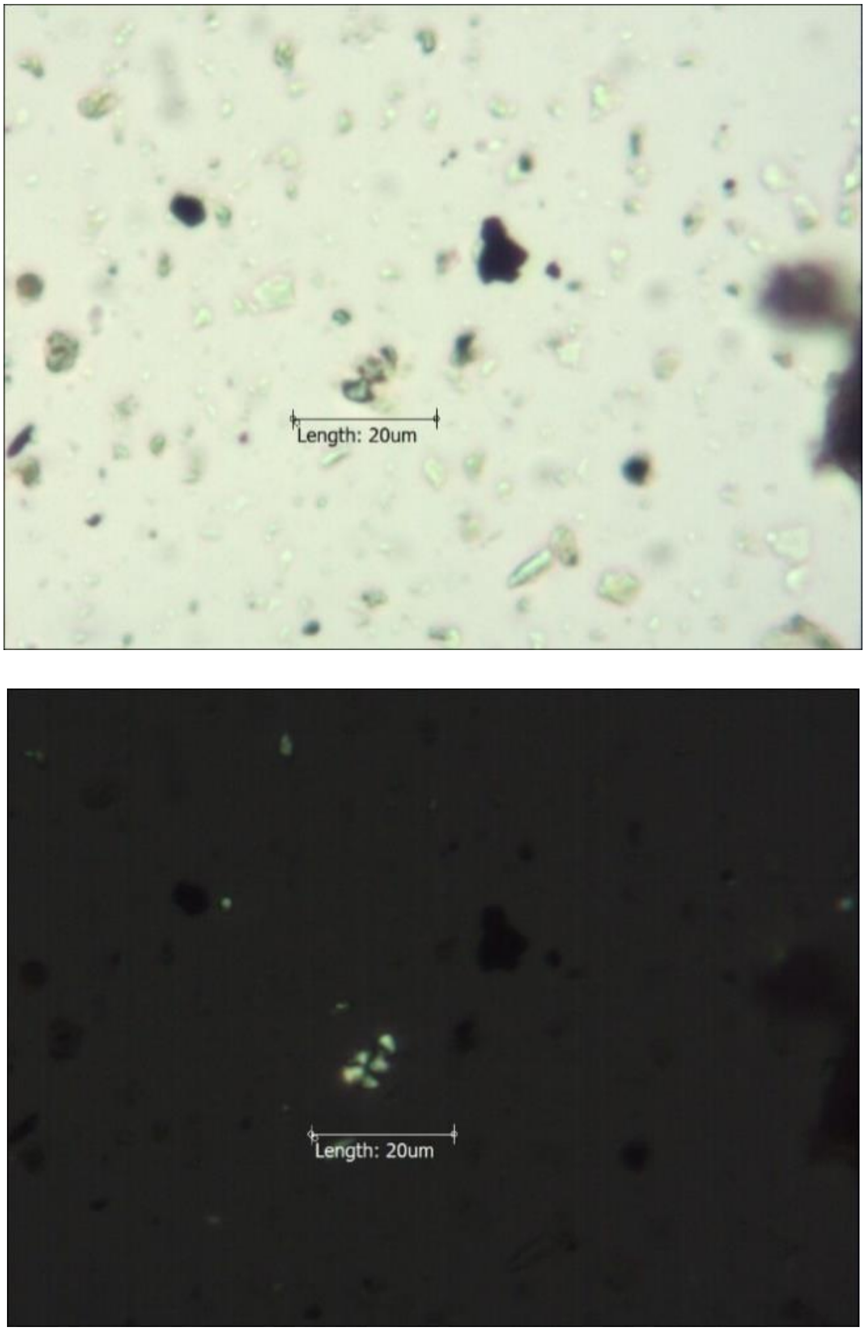

Figure 52: Example of camelid dung spherulite (A3, Layer U) under transmitted (top) and polarized light (bottom). Magnification 400x.

The Middle Period regional economy had already developed the necessary agropastoral resources to supply its coastal settlers with inland resources by llama caravans that also moved jack mackerel and other fish to interior villages. There is one early event of intensive camelid consumption and bone discard below the Layer S wall. This was followed by consistent llama consumption during the Middle Period (Layers Ñ II – G), and then an absence of llama until the colonial epoch (Layers A – B).

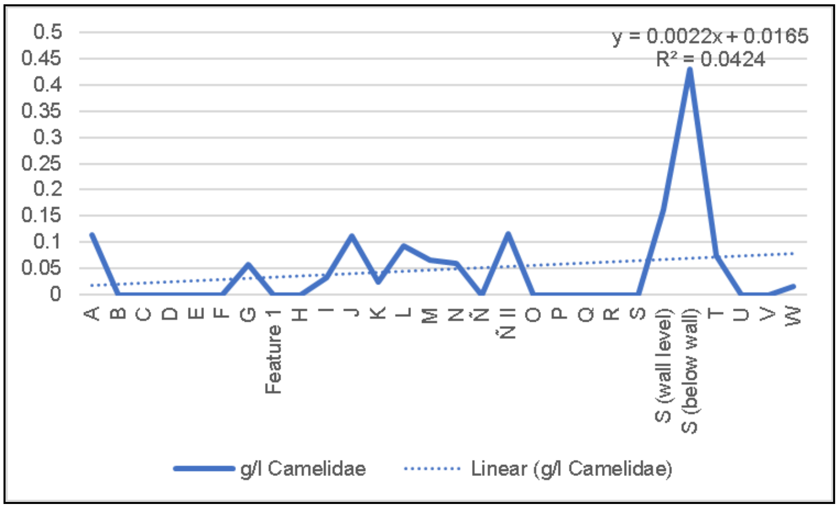

Figure 53: Camelid bone discard densities (g/l) over time (unit A3).

7.1.2.3 Carnivores

Dogs may have been kept in the village as suggested a few Canidae bones in both sectors (Table 7). The animal bone assemblage suggests the keeping of dogs or hunting of foxes. Gnaw marks were recorded on several mammal bones and we did not find bones of rodents (for example of the family Octodontidae family) that might be responsible for bone gnawing.

7.1.2.4 European Livestock

Llamas and European caprids coexisted in this remote cove during the early 17th century. Medium-sized bovids like goats and sheep of the Caprinae subfamily represent another important category among the bone assemblage of identified mammals at the Sector B fishery (Table 8). They are represented by wool and skin and not only by bones. Goats and/or sheep were locally raised by Andean herders to satisfy the culinary preferences of the elite Iberians that inhabited or visited Puerto Loa. Dung proves the presence of living flocks at the fishery. Llama and caprid feces are macroscopically very similar and I assume they represent both categories. This is supported by the identification of llama and caprid dung spherulites at the village and the fishery's faunal assemblage.

Table 7: NISP of Mammals Identified below Class Level in Sector A

Taxa	***NISP***	***NISP %***
Otariidae	2163	76.9%
Lama	220	7.8%
Delphinoidea	177	6.3%
Otaria flavescens	119	4.2%
Mysticeti	80	2.8%
Carnivora	34	1.2%
Canidae	7	0.2%
Arctocephalus australis	6	0.2%
Rodentia	2	0.1%
Caprinae	1	0.0%
Equus ferus caballus	1	0.0%
Sus scrofa domestica	1	0.0%
Lontra felina	1	0.0%
Total	**2812**	**100%**

Table 8: NISP of Mammals Identified below Class Level in Sector B.

Taxa	***NISP***	***NISP %***
Lama	33	26%
Otariidae	31	24.4
Caprinae	28	22.0
Bos taurus	12	9.4
Canidae	7	5.5
Mysticeti	4	3.1
Sus scrofa domestica	4	3.1
Artiodactyla	4	3.1
Delphinoidea	3	2.4
Carnivora	1	0.8
Total	**127**	**100%**

Some of the main colonial occupations released a very strong odor of animal feces during excavation which suggested the Spanish may have had a pigsty in the site. Smell is part of the preserved information by this amazing window into the past. However, pig bones were rare, and could have arrived at the site already butchered (as hams or salted pork). A signature of Iberian cuisine was the "*jamón serrano*" (ham) which includes leg bones and could have reached the tables of the rich fishery owners.

The level of agriculture that the mouth of the Loa may have supported did not justify the use of oxen for large plots. Cattle bones are scarce (5.3%; $n = 12$). Although the raising of the occasional cow cannot be ruled out, the arrival on ships of fresh beef quarters as well as some circulation of pieces of salted or cured meat (beef jerky) could account for these bones.

Mules and horses, the main Iberian pack animals, are virtually lacking within the assemblage (only a single bone from Sector A) which suggests the reliance on llama caravans for regional transportation from and to the Loa mouth.

Caprid (sheep/goat) dung spherulites ($n = 3$) were detected at the native village despite the scarcity of Old-World animals' bones (Figure 54). Two came from a colonial occupation (A3, Layer C) dated *cal* AD 1623-1670 (77.4% probability). These cases might represent the use of caprids' dung by native people or just the product of such animals passing by the site.

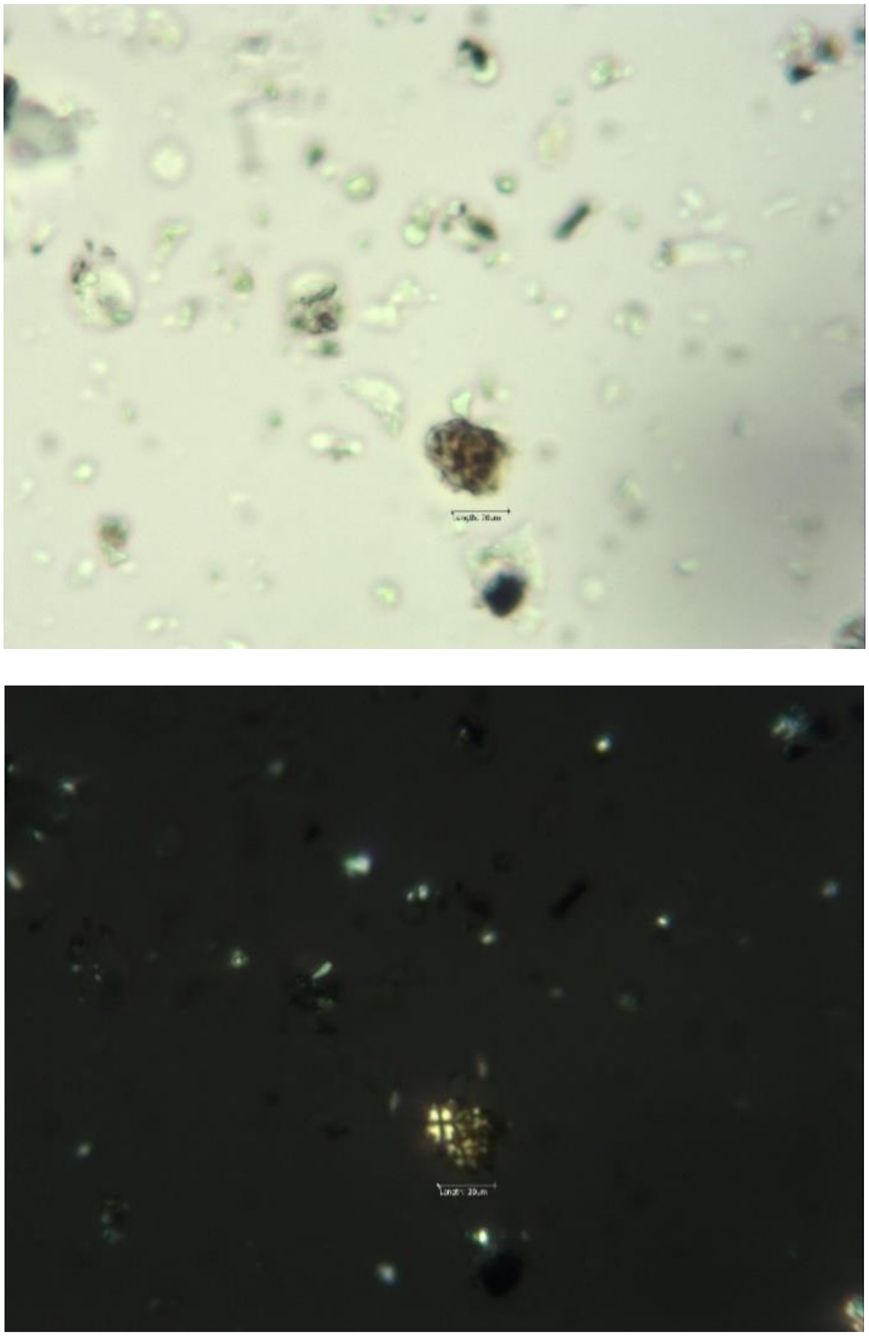

Figure 54: Example of caprid dung spherulite (A3, Layer C) under transmitted (top) and polarized light (bottom). Magnification 400x.

7.1.2.5 Mammal Consumption Differences Between Sectors A and B

Comparing mammal bone assemblages reveals significant dietary differences between Sectors A and B. Sector B differed from Sector A in a much lower consumption proportion of sealion and in the consumption of European domestic animals: sheep/goat, cows, and pigs. Sealions were the core “big animal” food for the local villagers since the establishment of the village but were not so for the Sector B colonists. Sealion consumption as food may, in fact, be over-represented in Sector B. The abundance of sealion skin fragments in the salting patio in association points towards the butchering and processing of sealions in the fishery for construction and/or fixing of inflatable rafts.

The proportions of the European domesticates represent about 20% of the assemblage, a significant portion of the meat diet. Notably, these European domesticated animals are all but absent from Sector A. Only a single sheep/goat bone found near the church (A5, Layer A) , single horse bone, and single pig bone (recovered from the surface of A2) were identified in the entire Sector A assemblage. As noted above, llama was consumed in twice the proportions in Sector B than Sector A. This difference could reflect culinary preferences for large meat meals, more “feasting” events where camelids were consumed, or the greater involvement by Sector B residents with camelids in general as part of receiving and putting together llama pack trains. Sector B provided the most textile evidence relating to cargo animals and transportation such as sacks, ropes and *chuspas* or bags.

7.1.2.6 Birds

Loa’s Andean fishers, like many ancient coastal residents, ate a wide range of seabirds (Table 9). Cormorants, shags, albatrosses, pelicans, and petrels were frequently exploited by the villagers for their meat but also for their feathers and bones to be used as raw materials. Locals manufactured feathered clothing and made tubes with their bones to inflate their boats, as snuff tubes. There is no direct evidence of the use of cormorant fishing in the Andes, but some northern Peruvian Chimú textiles have been interpreted as representing fishing cormorants with cords around their necks (Leicht, 1960, p.58). Historically, residents trapped them here by throwing nets.

Table 9: NISP of Aves Identified below Class Level in Sector A.

Taxa	***NISP***	***NISP %***
Phalacrocoracidae	537	25.3%
Diomedeidae	463	21.8%
Pelecanus thagus	460	21.7%
Procellariidae	263	12.4%
Charadriiformes	201	9.5%
Laridae	69	3.3%
Sula variegata	24	1.1%
Fregatidae	23	1.1%
Spheniscus humboldti	20	0.9%
Passeriformes	18	0.8%
Galliformes	11	0.5%
Rallidae	11	0.5%
Poikilocarbo gaimardi	9	0.4%
Sternidae	5	0.2%
Accipitriformes	3	0.1%
Cathartidae	2	0.1%
Total	**2119**	**100%**

Sea bird hunting was an everyday activity that took place at the rocky shoreline, beaches and even from boats with fishing nets or other devices. Cormorants were probably stalked while drying their wings in the sun on the nearby rocky shoreline.

Four orders make up most of the wild birds consumed at the site: (1) cormorants of the Suliformes order and the Phalacrocoracidae family; (2) shorebirds of the Charadriiformes order (gulls, waders, auks, etc.); (3) albatrosses and petrels (Procellariiformes) of the Diomedeidae and Procellaridae families; and (4) Peruvian pelicans (*Pelecanus thagus*) of the Pelecaniformes order.

In the Sector A bird bone assemblage, cormorants and shags are the most common taxa from the sample of birds classified below the class level (35.8%; *n* = 2119). Cormorants are ubiquitous in the village occupations and their proportions remain relatively constant over time. Also represented in the assemblage are albatrosses (Diomedeidae), Peruvian pelicans (*Pelecanus thagus*) and Procellariidae (petrels, shearwaters, and others) along with unclassified shorebirds of the Charadriiformes order.

The presence of some ground-living birds of wetlands -the Rallidae family- indicate hunting in the Loa River mouth itself a few kilometers to the north. Some Galliformes were also recovered from the village. This order includes popular poultry and game, ground-feeding birds like chickens, turkeys, and quail. It is not always possible to distinguish the bones of domesticated Galliformes from native wild birds. However, it was possible to recognize in colonial contexts the domesticated chicken (*Gallus domesticus*).

7.1.2.7 Chickens

There are marked dietary differences in bird consumption between the Sector A native village and the Sector B Spanish fishery, most dramatically in terms of chicken.

Chickens represented, alongside dried fish, one of the lasting in-kind tributary items in the southern lowlands of colonial Peru. The new colonial elites demanded from the communities of southern Peru the tribute of domestic native and Old-World animals. La Gasca (1550) was very early on demanding from the people of Tarapacá the tribute of hundreds of chickens, dozens of llamas and *ovejas* (possibly referring to alpacas), and even some pigs (Urbina, 2017). Tarapacá's quipucamayocs reported in 1565 the effective tribute of a hundred chickens and twenty llamas by the communities of Pica and Loa (Urbina, 2017). Five years later, the Toledan tasa didn't demand llamas but elevated the number of chickens from 100 to 144 from these same communities. The 1646 *retasa* still obliged the Pica and Loa communities to tribute chickens (72) as one of its in-kind tributes (Urbina, 2017).

While villagers may have been charged with raising chickens, their raising and consumption only took place in Sector B. Large amounts of chicken (*Gallus domesticus*) bones, eggshells and feathers were found together in its main colonial occupations. In Sector B chicken is the most represented bird (20%; n = 70) taxa below class level. Not a single secure chicken bone was recovered from the village. The Galliformes (0.5%; n = 11) in Sector A are almost certainly from ground-feeding game birds like quail.

Notably, as seen with the mammals in the diet, the local villagers maintained a cuisine without European domesticated items: no chicken bones were found in Sector A. While cormorants were consumed in Sector B it was in lower proportions, and there was significantly less consumption of albatross. The Sector B assemblage is also less diverse than that of the village, showing consumption of a narrower variety of birds (Table 10).

Table 10: NISP of Aves Identified below Class Level in Sector B.

Taxa	***NISP***	***NISP %***
Gallus domesticus	70	32.4
Phalacrocoracidae	62	28.7
Charadriiformes	26	12.0
Diomedeidae	22	10.2
Phasianidae	15	6.9
Pelecanus thagus	13	6.0
Procellariidae	8	3.7
Total	**216**	100%

Roasting was a common cooking method but the site's faunal assemblage hints at less roasting of birds than mammals. Although their small size would make them more likely to leave burned bones, this class showed the lowest proportion (12%) of burnt bones among all faunal categories in Sector A. However, most seabird bones from the domestic refuse of the buried structure at the village core (A3, Layer S) showed combustion signs. Several bird taxa showed higher burnt proportions than Andean camelids at the village core as well.

7.1.2.8 Turtles

Locals didn’t miss the opportunity to eat large marine turtles of the Cheloniidae family. These turtles have paddle-like front flippers and a rounded hydrodynamic shell. They spend most of their time swimming in open waters to feed but they also get close to bays and estuaries. Females come to beaches at nights to bury their eggs away from the high tide line. Sea turtles entered the local diet as an opportunistic seasonal food item. Their relatively low representation in the faunal (non-fish) assemblage suggests occasional consumption maybe in the context of El Niño (ENSO) years. Turtles exhibit the highest proportion of burnt remains; almost a third or the bones show burning signs in the village while at the village core this proportion goes up to almost 70%.

7.1.2.9 Multidimensional scaling of wild animal consumption

Multidimensional scaling (MDS) was used to analyze wild animal dietary preferences over time. For this analysis I assigned a period to each village occupation where the well-known diagnostic ceramic types were present (Appendix C.1). The multivariate analysis illustrated strong continuous dietary preferences as well as some subtle shifts of chronological significance.

First, sealions and cormorants emerge as fundamental food items for the communal economy in the long-term. Pelicans are less pervasive but also cluster together with sealions and cormorants in occupations of different periods as seen by MDS. The consumption of dolphins occurred as a special, complementary conduct of long-term existence. Second, the number of wild taxa eaten by the native villagers decreases over time as shown by a gradient in all dimensions observed. Middle Period residents caught and ate a wider variety of seabirds and marine mammals, as well as sea turtles, than later residents. The late Pre-Columbian and early colonial descendants relied on a more limited range of wild animals. For example, sea turtles, are not represented in trans-conquest faunal assemblages from the village but do appear in the contemporaneous colonial salting yard, where the range of wild animals consumed was wider than that for the village at that time.

7.1.3 Comparing Sectors A and B

Were there shifts in animal consumption in Sector A? As discussed previously, camelid consumption took place during the Middle Period before dropping out until the colonial occupation. If we look at the volume of meat consumption, in each Sector A unit we see a relatively constant level of consumption punctuated by faunal deposition events (Figure 55). The elevated g/l in the Middle Period reflects the intensified fishing, turtle, seabirds, and camelid consumption of those occupations.

Overall, the pattern that emerges is one of continuity in meat consumption among the natives. A similar picture is seen when marine and terrestrial mammals and seabirds are plotted independently.

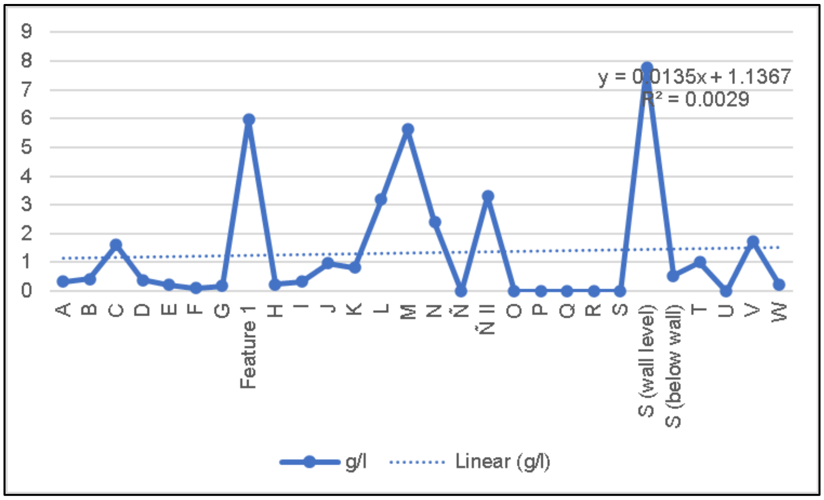

Figure 55: Total animal consumption in Sector A (A3) over time.

How did the arrival of the Spanish, the transformation of the site into a port, and the entrance into an overarching mercantile economy change the traditional subsistence patterns of the villagers? In the village, cuisine hardly changed following Spanish arrival. The Loa villagers, in their household settings, maintained dietary choices based on their traditional preferences, just as took place in other early colonial communities of the southern Andes, for example Torata or Cruz Pampa (de France, 2012; de France et al., 2016). Loa's natives practiced economic self-sufficiency strongly based on fish, shellfish and sealion. European introduced animals were only consumed in Sector B. Stews and soups made of chicken and caprids, rather than roasting, may have been part of their cooking repertoire as suggested by the lack of direct fire exposure on the bones.

The Iberian settlers of Loa (like those of Torata, Moquegua) supplanted their fish, shellfish, and sealion diet with a preference for chickens and caprids. Cattle and pigs were of secondary importance. The same Iberian colonists and elite Andeans ate Andean camelids during the fishery's heydays (e.g., B1 Layer F). Although proportionally more a part of the Sector B diet, camelid consumption was nonetheless less intensive consumption than in the nearby village as expressed by the median density values in the assemblages of these occupations.

Median discard density values (l/case) for llamas at Sector A versus llamas plus Old-World domesticates at B are quite similar. However, we are comparing a community of dozens of indigenous people versus a handful of settlers who may have eaten domestic animals daily. The picture changes if we plot the discard densities of all consumed animals, both domestic and wild. What is observed is the intense communal consumption of hunted animals and some llamas by the native inhabitants in the center of the village(Figure 56).

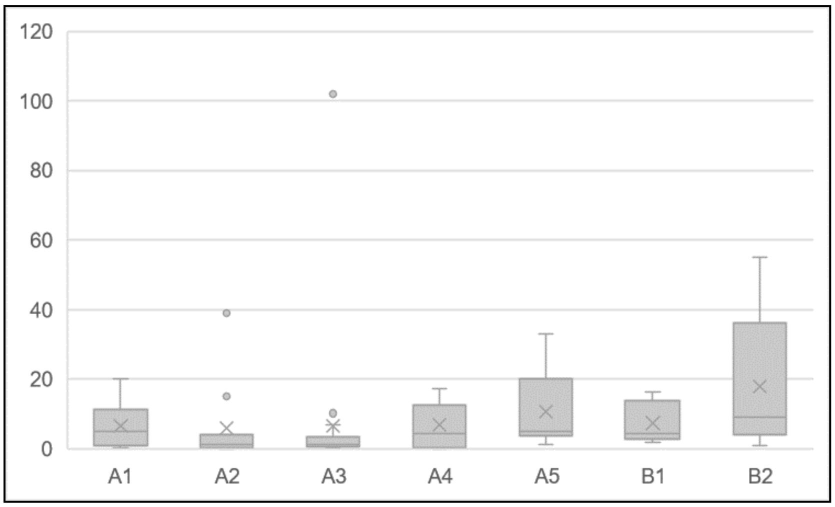

Figure 56: Discard densities (l/case) of animal bones by unit and sector.

Spanish consumption in Sector B was based on market and tribute processes. In contrast, there is no evidence at all for market-based provisioning, in the form of Old-World animals, for domestic consumption in the village. The indigenous residents working in the salting patio may have consumed part of the cormorants, seabirds, and marine mammals recovered there. By the same token, they could have eaten a diversity of tributary and market foodstuffs in the fishery in return for their fishing and salting labor.

7.1.4 Plant Consumption

Gerónimo de Bibar was a chronicler that accompanied conquistador Pedro de Valdivia in his 1540 travel by from Peru to Chile. Their journey included Tacna, Tarapacá, and Atacama and followed the Inca Road of the lowlands via Pica and the Loa basin. Bibar created an almost ethnographic portrayal of some aspects of Andean life in my study region only a few years after the Conquest, his amazing description of regional foodways is worth noting here:

> "*Tiene este valle (Atacama) muy grandes algarrobales, y llevan muy buenas algarrobas de que los indios la muelen y hacen un pan gustoso de ella. Y hacen un brebaje con esta algarroba molida y cuécenla con agua; es brebaje gustoso. Hay grandes chañarales, que es un árbol a manera de majuelo. Llevan fruta que se dice "chañar" a manera de azofaifas, salvo que son mayores*."
>
> Gerónimo de Bibar (1966[1558], p.13)

The passage describes how locals used algarrobo flour to make bread, as well as the use of the same ground and boiled plant to make chicha, a very valued beverage by the thirsty Europeans. Bibar compares chañar (*Geoffroea decorticans*) with "*azofaifas*" (from Arabic *azzufáyzafa*),a Mediterranean fruit that resembles a datil when dried. The Spaniard also mentions how Atacama's people store corn, potatoes, beans, quinoa, algarrobo and chañar at their houses.

He notes that small white algarroba pods represented a kind of staple regularly used across Tarapacá. He further observed that freshwater was carried in sea lion belly bags and calabashes when available and that people travelled the region with textile bags full of toasted corn grains. Maize was another staple: it was consumed fresh, as loose toasted grains (*cancha*), and as a flour made with toasted grains, a format frequently mixed with water (Bibar 1966[1558], p.9). This mixture was consumed everywhere transported in skin bags (wineskins) made from a llama thigh of about two to four liters of capacity or in his own words one or two *azumbres*[14].

The natives of Loa were seasoned collectors who knew very well the few points from which to collect roots, pods and seeds at the river canyon and mouth, on coastal steep slopes, the seasonal "lomas", and at remote brackish springs of hidden ravines and rockeries. Atacama's coastal vegetation included herbs and small bushes like *Euphorbia lactiflua*, *Solanum* spp., *Zephyra elegans* (among others), distributed in open patchy locations with marked seasonality (Maldonado et al., 2016). Patches of large woody cacti (*Eulychnia iquiquensis*) were traditionally important economic plants for fuel and thorns (Maldonado et al., 2016). Villagers likely also ate maize in boiled or toasted preparations, as well as flour and water mixtures (including chicha) as suggested by Loa's microscopic results.

Residents at Puerto Loa probably made the bread described above with algarrobo seeds and pods. Algarrobo was the most important plant staple for both the villagers and the fishery inhabitants. The Chilean algarrobo (*Prosopis chilensis*) tree is one of the most important species consumed by populations in northern Chile, southern Peru, Bolivia, and northwestern Argentina. The genus comprises about 45 species of subtropical or tropical spiny trees and shrubs with sugary fruits and pods, very resistant to arid conditions and accommodated to soils like those of the Atacama Desert. An extensive algarrobo coverage existed in Quillagua, and peoples from Tarapacá and Atacama held traditional possession of this forest resource. Some trees may have grown and been tended at the Loa River mouth itself.

[14] https://dle.rae.es/azumbre

7.1.4.1 Sector A Botanical Remains

Field-sieving yielded remains from six plant taxa including wild plants and cultivated Andean crops (Figure 57). Further macro botanical recovery took place through the lab dry sieving[15] of soil samples using a geological sieve, magnifying glasses, and a microscope. Soil came from two 50x50cm columns excavated contiguous to the main units of both sectors (A3 and B1). Gravel, sand, and clay were separated using 4, 2, and 0.25 millimeters meshes. Each level was carefully observed in search of very small plant remains not recovered by field sieving. Lab dry sieving of a soil column was conducted to recover easy to overlook taxa like quinoa or rice, but for Sector A, this lab work only produced specimens from these six categories and in similar proportions.

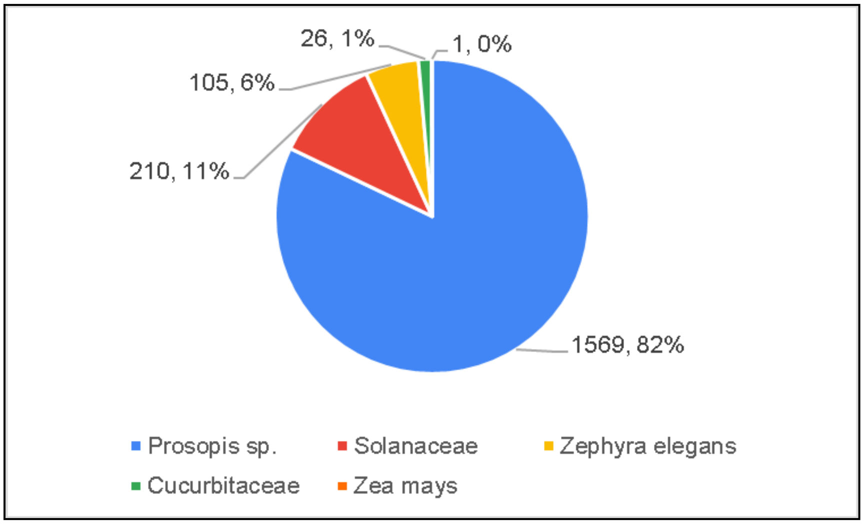

Figure 57: Macro-botanicals recovered in field-sieving in Sector A.

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[15] Identification of botanical remains was carried out by University of Chile students (Camila Jara, Ignacio Rivera, and Ana Araya) under the guidance of Dr. Carolina Belmar.

In line with diets of other coastal Peruvian peoples, local villagers consumed a great deal of algarrobo pods and seeds in flour, tortilla, and chicha preparations. Over 80% of the macrobotanical sample corresponded to this Andean forestry resource. Andean cultigens (including maize) arrived at the village only as a secondary, special food source and are proportionally less important than in the Sector B fishery.

Late-Pre-Columbian and Colonial village residents transported algarrobo pods and seeds to the fishing village along with other edible forestry resources like the delicate and sweet fruit of chañar. The second most important plant category represented, that of the Solanaceae family, consists of both native cultigens and wild resources. This broad family of nightshades includes many flowering plants from trees to herbs, some edible like potatoes, tomatoes, groundcherries, or chili peppers while other members have medicinal uses or are just wild "weeds." A wild edible coastal plant, *Zephyra elegans*, was gathered by the locals in keeping with findings from other ancient communities of the coastal Atacama. This endemic herb of the Tecophilaeaceae family sprouts in rainy years and forms flowery patches in sandy areas[16]. From archaic times, coastal populations of the region ate the edible underground fibrous component.

A few Andean cultigens were also part of the villagers' diet. The gourd family or cucurbits encompasses pumpkins, squashes, and calabashes, either locally raised or obtained by the community for eating as evidenced by the recovery of examples of the innermost layer (endocarp) that covers the seed. The hard epicarps (outermost layer) specimens from the village did not exhibit decoration (unlike some from the fishery) and would have been unadorned drinking or serving

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[16] https://fundacionphilippi.cl/catalogo/zephyra-elegans/

vessels. Early colonial Andeans as well as their Inca-era grandparents employed plates made from dry calabashes called *meca* (Bray, 2003). Loa's villagers used these plates during the late Pre-Columbian and colonial periods. The hard and resistant calabash epicarps were only found in upper occupations. Even if more cultigens were available, the last generations that inhabited the Loa village continued their traditional focus on wild resources at inland mesquite woodland locales, lomas, and the river mouth wetland.

In the Loa mouth, late Formative communities exploited cucurbits, maize, and cotton, as well as *Prosopis* sp., *Zephyra elegans*, and Cyperaceae (Cabello & Estevez, 2017). This is evidenced at funerary sites like CaH-7, 10, and 20, not far from the fishing village. Roughly the same species were found in Sector A, so a good deal of continuity characterized plant usage in the area.

Maize (*Zea mays*) was represented only by a single cob (0.05%) in the Sector A macro botanical assemblage. As noted below in discussing phytolith and starches, the relative lack of maize macro specimens suggests maize was being imported as flour or chicha, during late pre-Columbian and early colonial times. Its microscopic residues are present in ceramic sherds in the form of starch grains, as we will see.

The macro botanical assemblage from Loa is very similar to the plants found at other late Pre-Columbian coastal communities of Los Verdes (Iquique) to the north of Loa. Identified here were algarrobo, *Zephyra* and maize, corn was also consumed as *cancha* or toasted grains, popcorn, loose dry grains, cobs, and flour (Sanhueza, 1985). Some plants not seen at Loa included quinoa and coca (Sanhueza, 1985). To the south of Loa, 15th to 16th century coastal populations ate algarrobo, chañar, and maize at Mamilla 7 and Guanillos 1 (Palma, 2012). A few cucurbits were recovered from the latter as well. Earlier occupations at each did not yield macro plant remains

(Palma, 2012). The late Pre-Columbian communities of Cobija (Guasilla 2) also ate algarrobo, *Zephyra* and chañar while maize, as usual, was scarce and limited to upper occupations (Varas, 2014). Microscopic analyses are essential to overcome the bias imposed by the non-preservation of macro remains in early occupations.

7.1.4.2 Phytolith and Starch Analysis

Microscopic plant vestiges were sought from cooking pot sherds (n = 30) from the village's core (A3) and a soil column attached to its east profile (A3 East Column). One goal was to determine if any Old-World cultigens were incorporated into the native diet and domestic allocation. A second goal was to control preservation biases so that the sample was drawn from one of the earliest and from the final occupation in Sector A. Archaeologist Luciana Quiroz, specialist in phytolith and starch studies, conducted the analysis. Methods included dry and wet scraping of both sides; my discussion is based on her results.

Out of thousands of micro plant, animal, and fungal remains (mostly charred plants), both phytoliths (4.3%; n = 244) and starch grains (2.5%; n = 140) were found. Most phytoliths only made possible a very general classification (Table 11). They represent either cultivated or wild plants, for example, maize (part of the Panicoideae subfamily) belongs to the Poaceae family that also includes region's wild grasses.

Phytoliths of the Poaceae family, one of the largest on earth with thousands of species of flowering plants including grasses, were found and potentially signal the transport of cereal grasses and related plants to the village. Specimens from the Panicoidea, Bambusoideae, and Pooideae subfamilies represent the most identified categories. People from the Andes traditionally used some plants of this family to feed guinea pigs and camelids. In the Loa case, a high prevalence of carbonized phytoliths suggests potential fuel use as well.

Table 11: Phytoliths Identified inSherds from Sector A.

Taxa	*Count*	*%*
Panicoideae	38	37.6%
Bambusoideae	18	17.8%
Poaceae/Cyperaceae	10	9.9%
Poaceae	7	6.9%
Pooideae/PACMAD	5	5.0%
Pooideae/Bambusoideae/PACMAD	4	4.0%
Pooideae/Bambusoideae	3	3.0%
Pooideae (Aveneae, Triticeae)/Bambusoideae/PACMAD	3	3.0%
Chloridoideae	3	3.0%
Bambusoideae/PACMAD	2	2.0%
Cucurbita sp.	2	2.0%
Bambusoideae/Chloridoideae	1	1.0%
Arundinoideae	1	1.0%
Arundinoideae/Chloridoideae	1	1.0%
Triticeae	1	1.0%
Arecaceae/Fabaceae	1	1.0%
Cyperaceae	1	1.0%

Some highly diagnostic phytoliths were observed. A sherd from a Middle Period occupation (A3, Layer G) yielded intact remains of two Cucurbita phytoliths (Figure 58). This genus of herbaceous fruits in the gourd family native to the Andes (called *zapallos* in Chile) may have been cultivated locally taking advantage of coastal guano fertilizers or transported from the interior. Another sherd from one of the earliest excavated occupations of the village (A3, Layer U) yielded a phytolith of the Triticeae tribe that comprises many Old-World domesticated edible species (e.g., wheat, barley, rye) but also New World grasses. The Loa results are consistent with that from other coastal sites suggesting access to agricultural resources at least since Formative times. A comparable phytolith analysis was conducted on 9 formative (LCA) ceramics from nearby cemeteries: identified phytoliths evidenced the consumption of beans (*Phaseolus* sp.), *Zephyra elegans*, the Amaranthaceae family and the Chenopodiaceae subfamily that includes quinoa (Carrasco & Belmar, 2017).

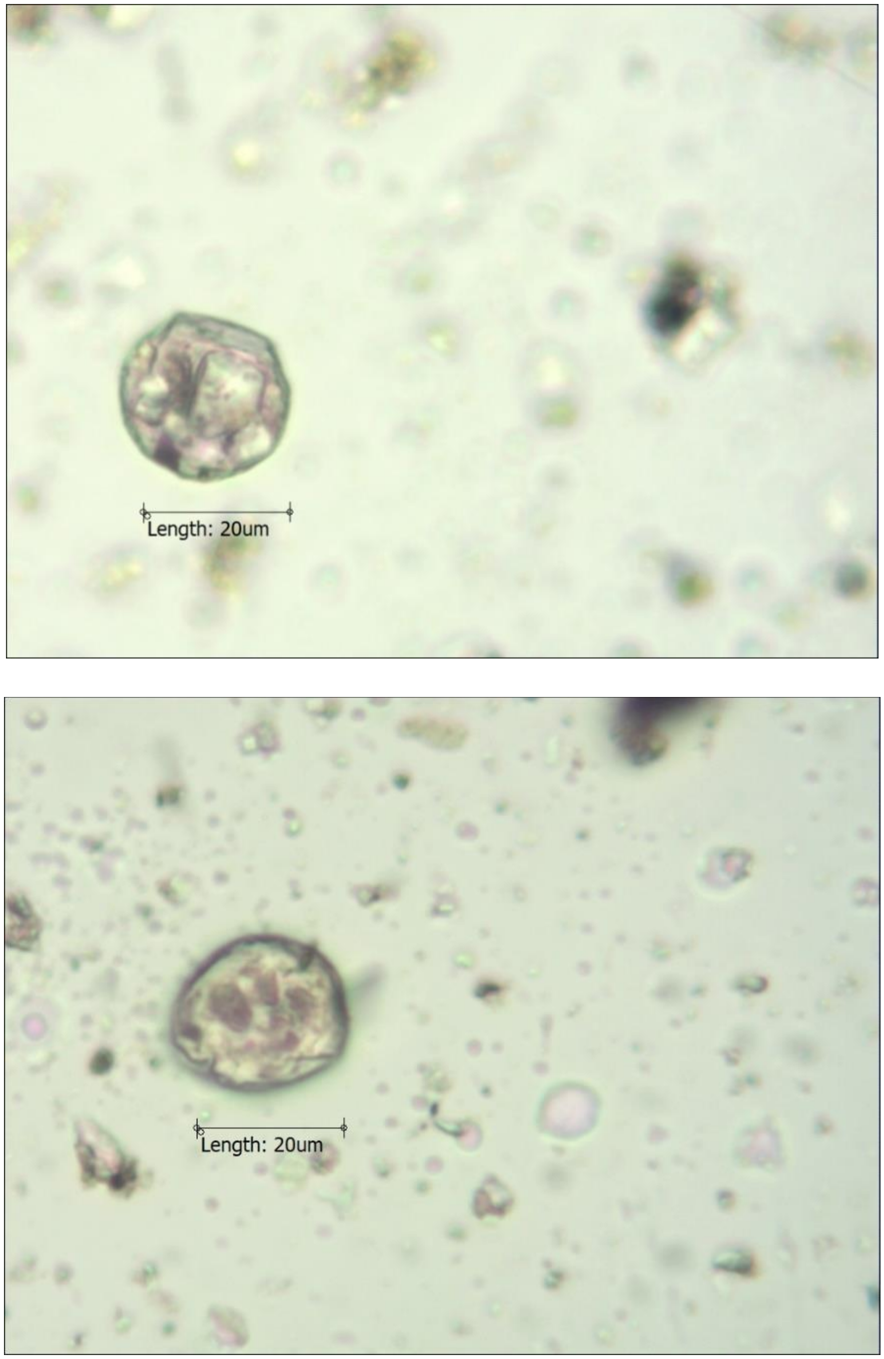

Figure 58: Phytoliths of *Cucurbita sp.* (sample #23)

Maize stood out among the identified starches as an important resource consumed by the local community although rarely preserved in macroscopic form (Table 12). Corn starch grains were observed in sherds from the upper layers of the east column and from Layer C of A3 (Figure 59). Its origin could be semi-local, there's one potential cultivation field in the river canyon near the mouth and maize could have been transported from the Quillagua valley.

Table 12: Starches from Loa by Taxa.

Taxa	*Count*	*%*
cf. Zea mays	18	62.1%
Zea mays	3	10.3%
Poaceae/Triticeae	3	10.3%
Cyperaceae	2	6.9%
Tuber	1	3.4%
cf. Cyperaceae	1	3.4%
Fabaceae	1	3.4%

Several other starch grains may correspond to maize, but their attributes are not totally diagnostic. They could represent other taxa as well. All came from sherds from A3 Layer C. Starches of the Cyperaceae family, mostly wetland grass-like plants, may indicate the human consumption of totora tubers from the Loa River mouth. These reeds can be also used as bedding and thatch or as animal fodder. These were identified on one sherd from the uppermost layer of the east column. One tuber starch grain was recovered from a sherd from A3 Layer G; it's not possible at this point to assign it to potatoes or other taxa. One Fabaceae starch grain of the legume family of beans, peas, chickpeas, peanut, and algarrobo, was found on a sherd from an early occupation (A3, Layer U) of the village.

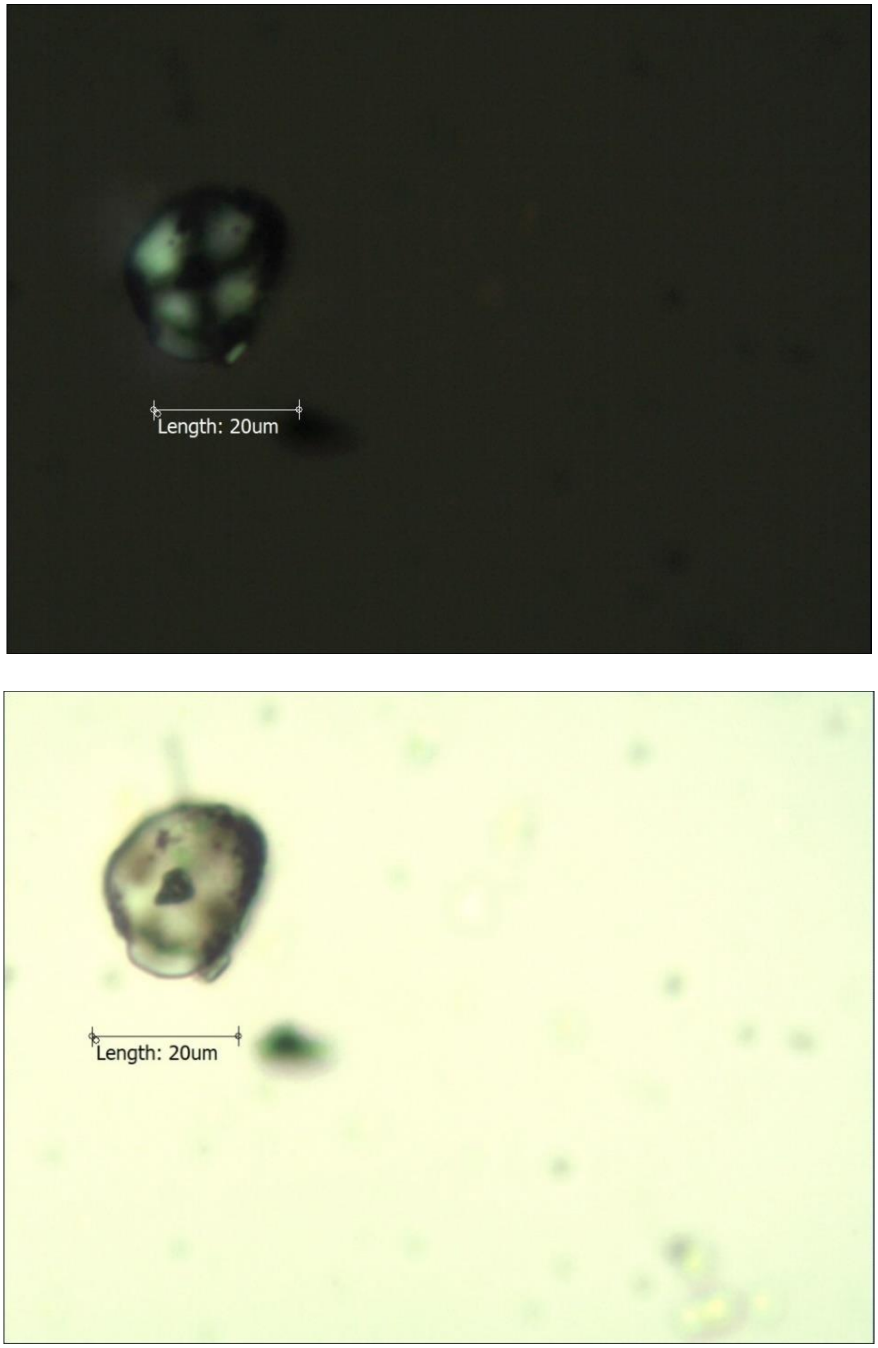

Figure 59: Zea mays starch grain from A3 layer C (polarized light above, transmitted light below), 400x magnification.

In examining the sample, the analyst noted that starch grains at the site have a high degree of damage. Surfaces and birefringent characters show roughness, perforations, cracks, grooves, darkening, and emptying of contents. These attributes could reflect the effects of processing, grinding, boiling, and fermentation. In addition, there were masses of agglomerated, viscous, gelatinized starch assemblies normally interpreted as the result of boiling. Maize and Cyperaceae (totora) starches from the latest occupation at the village exhibited these characteristics. Small perforations of enzymatic attacks and other fermentation and malting traces were also observed in maize starches suggesting processing for chicha (maize beer). Sample #20 from Layer C had a considerable number of starch grains in fermented state. Other starches (Fabaceae and Triticeae) from an early occupation Layer U) presented openings around edges and other damages attributable to grinding into flour. The scarcity of grinding stones at the village may indicate the arrival of flour from inland.

In sum, not a single secure Old-world macro nor microscopic remain was identified in the village. The general breakdown of categories shows that Old-world plants were exclusively consumed at the fishery. In turn, wild edible plants from the local coastal range were more important among local fishers. Maize and cucurbits were among the local domesticated plants consumed as previously indicated by its macroscopic remains. This consumption may have been as flour or chicha. The most important local plant was algarrobo.

7.1.4.3 Plants in Colonial Period Sector B

Macro botanical preservation was better in the fishery than in Sector A but even accounting for this, the plant taxa are more varied in Sector B. The privileged position of the fishery's occupants at the crossroads of mercantile and tributary distribution channels resulted in an amazing range of Andean and Old-World crops (Table 13). The colonial occupations of the fishery yielded a very high taxa diversity, for example, reaching even 14 categories (e.g., B1 Layer F), indicating a broader diet in Spanish Sector B than in the Sector A village or seen previously at the site.

Table 13: NISP of Macro Botanical Remains from Sectors B and A.

Taxa	*Sector B*	*Sector A*	*Total*
Prosopis sp.	4646	1569	6215
Cucurbitaceae	481	26	507
Gossypium sp.	374		374
Olea europaea	341		341
Solanaceae	46	210	256
Geoffroea decorticans	150		150
Zephyra elegans	14	105	119
Erythroxylum coca	112		112
Zea mays	42	1	43
Prunus persica	22		22
Prunus dulcis	22		22
No identified	19		19
Medicago sp.	18		18
Jubaea Chilensis	10		10
Cucurbita maxima	6		6
Lagenaria sp.	5		5
Olea sp.	2		2
Vitis vinifera	1		1
Cortaderia sp.	1		1
Schinus molle	1		1
Total	6313	1911	8224

Forests were a major food source for both the villagers and the Sector B residents (Figure 60). The communities of the lower Loa were responsible not only for producing dried fish and tributes, but also for supplying the mayordomos with regional resources collected in the warm inland forests of Quillagua, a locality in dispute between Andeans from Tarapacá and Atacama in later colonial times precisely for its forestry and agricultural potential (Paz Soldán, 1878). The pods and seeds of *algarrobo* and other trees from the nearby warm-valleys and oases were intensively consumed, even by the local Iberians, transformed into flour, bread or *tortillas*, and chicha as detailly described for the region by Gerónimo de Bibar (1966[1558]). Sector B yielded very high volumes of algarrobo indicating intensified consumption of this plant. Prosopis sp. is the main taxon (74%) in Sector B. The Iberian house was regularly supplied with this staple food. Here, native cooks (probably Andean women) processed pods and seeds and made tortillas and chicha. Although median discard densities (g/l) are comparable between sectors, the most important colonial occupations yielded this staple in significantly higher densities than seen in Sector A.

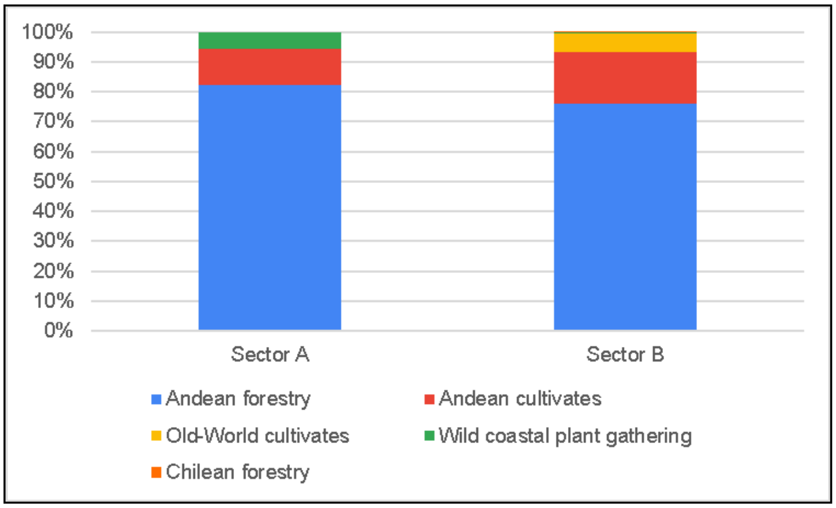

Figure 60: Stacked proportions of botanical remains classified by productive activityat both sectors.

Consumption of regional or local resources in Sector B differed in other ways. Cucurbits were proportionally more important at the fishery than in Sector A and there was less consumption of Solanaceae and *Zephyra Elegans.* Although present in Sector A, no specimens were found in Sector B of the Cyperaceae family, the already mentioned grass-like (*totora*) plant of the river mouth that has edible C3 roots and one of the traditional wild carbohydrate sources of coastal peoples in this part of the Andes.

Other forestry fruits and seeds contributed to Sector B meals: some very sweet and pleasant fruits of *Geoffroea decortican*s or *chañar* and of Peruvian pepper (*Schinus molle*), traditionally used for beverages, represented early colonial dietary choices of the local Spaniards and curacas. Cucurbits, a cultivated south American squash called *zapallo* (*Cucurbita maxima*), and calabash or *Lagenaria* sp. reached the colonial fishery as well and were probably consumed in stews and soups.

Figure 61: Example of unworked cotton and animal wool from the fishery.

The colonial local elite accessed traditional Andean tributary goods like maize, coca, and cotton to a greater degree than seen in the village. Maize is the only of these agricultural tribute items recovered in the village and there is a higher proportion of Andean agricultural products in the fishery. Maize was initially requested in kind by the new Iberian authorities and the Iberian establishment enjoyed a regular provisioning of this meaningful Andean crop. Sector B residents may have had differential access to maize cobs; 34 cobs were recovered, whereas the existing evidence suggests maize primarily entering Sector A as meal. Cotton cloth was among the in-kind tributes ordered by Toledo in 1570 to the communities of Pica and Loa. Many cotton specks and seeds (*Gossypium* sp.) were also found at the Sector B fishery (Figure 61). It is possible that native weavers worked there with this raw resource on nets and/or clothes.

People in Sector B also chewed coca leaves while working or overseeing salting patio labor. Coca seeds were recovered in the hundreds from the main colonial occupations but not found in the Sector A village. Coca leaves at the Loa mouth may have traversed the same networks circulating dried fish travelling in opposite directions. As an in-kind tribute in the eastern Andean Yungas or Peruvian *sierra* valleys, coca was sold by Spaniards and powerful curacas in highland urban and Pacific lowlands markets.

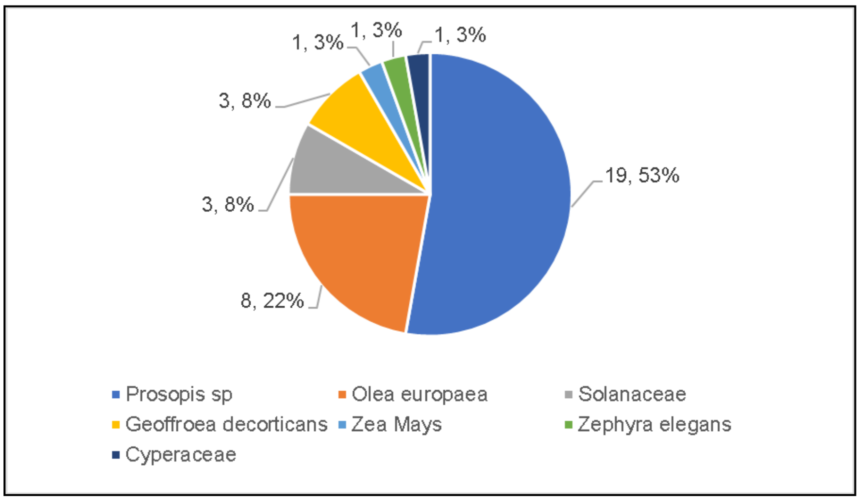

Figure 62: Edible plants recovered through dry sieving in Sector B.

Old-World plants were consumed only at the fishery. Most of these plants were probably purchased via market channels, some could possibly have been grown in gardens by the local Spanish themselves. No quinoa, wheat, or rice were recovered in the lab dry sieving (Figure 62). Many small twigs, wooden chips, and charcoal fragments were found this way at the fishery. The Spanish establishment had a steady supply of wood for fuel, and carpentry activities took place in its patio. The fragments may alternatively represent the vestiges of a fallen roof.

Despite Puerto Loa's remote location, the Sector B residents enjoyed a varied diet in the first half of the 17th century. Some of the edible commodities produced in Peruvian haciendas were locally available including olives (*Olea europaea,* 5,5%), almonds (*Prunus Dulcis,* 0,3%), peaches (*Prunus Persica,* 0,3%), grapes/raisins (*Vitis vinifera,* 0,02%). Alfalfa or horse fodder might be represented by some *Medicago* sp. (0,3%) remains. Coming from colonial Chilean producers further south (in the fertile valleys around the Aconcagua River) was the native Chilean wine palm (*Jubaea chilensis*), a traditional source of edible coconuts and palm sap syrup.

Gastropolitics, feasting, hospitality, and reciprocity, were fundamental characteristics of Inca and early colonial political economy. Coca and maize were used by Tarapacá's encomenderos to pay back the mining labor of Camanchacas at the silver mines of Huantajaya not far from Loa. Both plants were delivered as tributes then commercialized by Iberian merchants and highland paramount curacas and finally used as primitive money by regional Spanish authorities of Tarapacá. Maize was much more common in Sector B than in Sector A, and coca was only found in Sector B. This distribution may signal the accumulation of these and other valued resources for reciprocity and the payment of fishing services, consistent with other evidence for potential feasting and redistribution having taken place in Sector B. Food served in clay (*pucu*) or dry calabash plates (*meca*) likely had a special significance (Bray, 2003). Iberians and curacas may have served chicha and water in some of the decorated gourds recovered from the fishery's patio. Decorated gourd fragments were only found in Sector B. This kind of gourd is typically found at Inca-era burials as offerings across Tarapacá. Other gourds were used to manufacture lids for botijas. Their presence may signal Andean rituals of political commensalism. The vessels were engraved with a hot tip and motifs include representations of the sun (*Inti*) and geometrical designs (Figure 63).

Figure 63: Fragment of one of the decorated gourds excavated at the colonial fishery.

The production of salted fish at Loa may have entailed provision of coca and wine, a process described in detail by Exquemeling for a very similar community (that of Iquique). The use of Inca-style polychrome bowls and decorated gourds may signal the participation of paramount curacas along with elite Iberians in traditional ceremonial situations with economic implications. In sum, the botanical evidence points to the continuation of indigenous reciprocity foodways into the colonial labor – commodification system.

7.1.4.4 Chronological Changes in Plant Consumption

There is a marked disparity in the densities of crops, plants and seeds (edible plants) between the village and the Iberian fishery (Figure 64). This difference may be partially due to the enhanced preservation of the salting layers, but it likely indicates a more plant-based diet in Sector B. Pre-Columbian occupations of Sector B consumed edible plants in densities comparable to the ones at the nearby native village, as seen in the colonial A – F layers in the profile from B1.

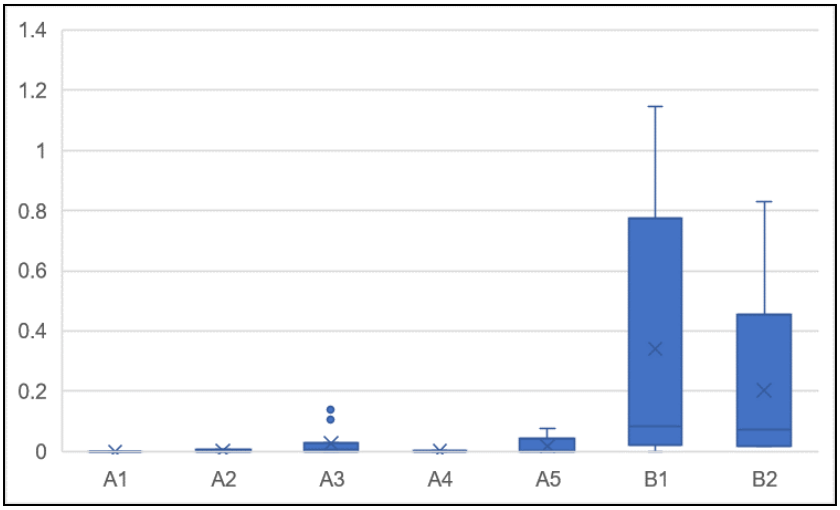

Figure 64: Compared edible plants densities (g/l) by unit and sector.

At the Sector A village core, *Prosopis* sp. consumption peaked in the uppermost occupations if measured with discard g/l densities (Figure 65). Macro botanical remains of other plants, such as the Solanaceae family, have a deeper temporal distribution in the village's core (A3) than algarrobo, indicating that the paucity of algarrobo before the late Pre-Columbian and high proportions following could be true dietary trends, rather than an artifact of preservation. In the village, algarrobo consumption shows a marked increase in the late Pre-Columbian that continued into the colonial period.

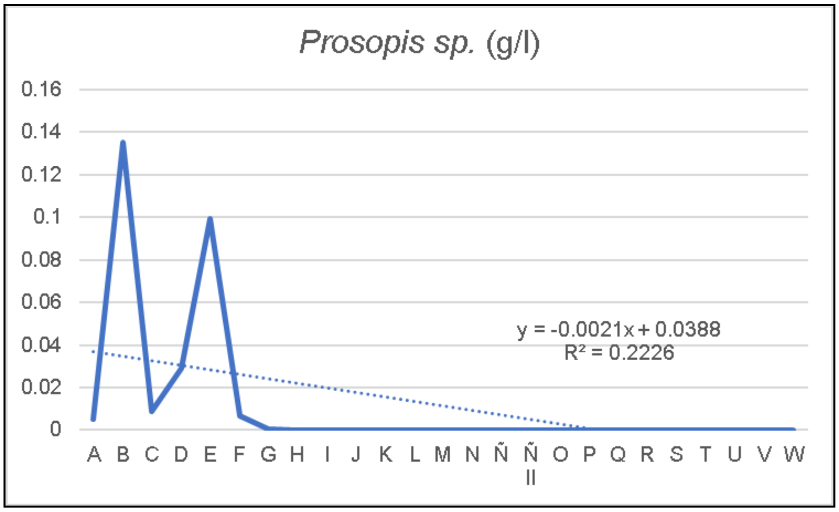

Figure 65: Algarrobo (*Prosopis sp*.)densities over time at A3.

7.1.5 Bone Isotopes and Diet

Stable bone isotopes open a window on individual diet, including critical information on consumption of marine protein and maize. A note of caution must be mentioned in using isotope data to generalize about the proportion of marine meat in the diet. Seabird guano and fish heads were used as fertilizer in the late Pre-Columbian (Santana-Sagredo et. al, 2017). However, even if the use of these resulted in elevated marine nitrogen levels for inland consumers, this elevation would still be evidence of the movement of "marine products" inland. Isotope data is currently being used to address one very well-established idea of Chilean archaeologists, that of significant economic interdependence between mountains, valleys, and deserts since the Late Intermediate Period (~AD 900-1450). Isotopes have shown LIP marine diets for Tarapacá's coastal people (settlements between Pisagua and Iquique) with high δ13C and δ15N values consistent with a marine-oriented diet. C4 resources were mostly unimportant, even if people accessed sone maize (Santana-Sagredo et al., 2019). A bit further north, the same homogeneous marine signature has been detected in people from the Camarones mouth and, again, C4 crops appear as a minor dietary component (Alfonso-Durruty et al., 2019).

Bone isotope data is available from Loa basin sites. Inland from Loa (~120 km away), at the late Pre-Columbian Pica 8 cemetery isotopic analysis revealed significant dietary diversity among individuals with three potential dietary groups: some people relied on marine resources and maize/C4 plants; others mostly on C4 with some marine protein intake (high δ13C values and lower δ15N values), and a third, small group of people on C3 diets with nonlocal δ18O values (Santana-Sagredo et al., 2015). The first two clusters suggest diets with a significant component of marine proteins, with one cluster eating fish and shellfish more regularly than the other. The third cluster is interpreted as people from the nearby altiplano (Santana-Sagredo et al., 2015).

Upstream from the Loa River mouth, in the lower Loa valley, people buried in Quillagua revealed a similar agro-maritime subsistence with maize (C4) and seafood as contributors, a pattern consistent with that of a large sample of inland Tarapacá individuals (Santana-Sagredo et al., 2019). Macroscopic fish/shellfish remains are perfectly preserved alongside maize flour in Quillagua LIP villages, including the La Capilla village (AD 720-1315), the main node of the lower valley (Santana-Sagredo et al., 2016). People buried here had local δ18O isotopic signatures and δ13C and δ15N bone collagen values consistent with regular fish consumption and local maize agriculture (Santana-Sagredo et al., 2016). Much further inland, at the Loa headwaters, zooarchaeological assemblages lack marine species. C3 and C4 plants isotopic signature is characteristic of a maize diet with no significant marine input in the highland samples from Caspana (Santana-Sagredo et al., 2015). As we move inland from the Loa coast, LIP consumption of marine resources falls off with distance, with negligible contributions at headwater or highland elevations. This pattern can also be observed for the Lluta and Azapa valleys (Alfonso-Durruty et al., 2019).

Overall, local economic self-sufficiency and lowland movement of marine resources and maize are suggested by the LIP isotope findings from the Loa and other areas. Marine resources moved into the lower valleys, but not beyond. Highland diets did not include dried fish or other marine resources as regular, stable resources. Accordingly, maize was not commonly consumed by coastal people. This isotope pattern has significant implications for two larger issues. First, the pattern indicates that in the LIP, the movement of seafood inland from communities like the Loa village was a sub-regional scale process, perhaps taking place through face-to-face interaction, and provisioning of inland relatives or leaders. The exact mechanism and channels of such regular distribution remain yet unknown. I argue that kin-based, lowland ethnic economies were behind the small-scale one-way inland distribution of marine resources maybe as a tribute to the paramount lowland curacas and their moieties. Coastal people, in turn, lived with a high degree of economic self-sufficiency with some subtle differences (C4 signature in some coastal individuals) relating to local inequality and the presence perhaps of low-level coastal elite curacas. In this reconstruction, the Tarapacá LIP curacazgos developed a regional ethnic economy based on mixed marine–terrestrial (C4) resources at the main warm valleys and oases. Coastal groups, in contrast, were largely self-sufficient and consumed marine animals and C3 plants mostly, only some of them accessed C4 and maize (Santana-Sagredo et al., 2021).

Second, the pattern calls into question the currently popular LIP scenarios of extensive, large-scale exchange caravans or well-developed vertical archipelagos with colonies at different elevations provisioning highland communities. Instead, the picture that emerges from isotopes is one of self-sufficient local communities that hosted some caravan exchange, and small-scale human migrations (Santana-Sagredo et al., 2019).

The Formative Period for the region shows similar marine resources movement regimes. Formative individuals (1500 BC–AD 400) of San Salvador and Calama (Villa Chuquicamata and Topater) in the middle Loa basin consumed some marine protein which contrasts with the diets of contemporaneous coastal (marine) and highland (no marine food) peoples (Pestle et. al, 2015). At the further inland Formative Loa San Salvador cemetery, isotopic data suggest a lack of uniform marine contribution to individuals' diet and heavy reliance on C3 local carbohydrate such as algarrobo (Torres-Rouff et al., 2012). Formative Loa coastal communities had a marine and local wild plant diet, while middle Loa Basin communities consumed some seafood. Communities further inland and upland did not regularly consume seafood. Correspondingly, there is no evidence for the regular consumption of agricultural staples on the coast.

The existence of altiplano colonies in Tarapacá is not indicated by available isotope data, and there is no evidence for altiplano-like diets heavy on C3 quinoa, potatoes and camelids anywhere in the lowlands of Tarapacá (Santana-Sagredo et al., 2021).

7.1.6 Situating Puerto Loa Consumption in the early colonial Andes

This section briefly places the meat foodways documented at Puerto Loa, for both villagers and Iberian residents, against existing discussion of early Andean colonial foodways. How do the dietary choices at Puerto Loa compare with those of populations in other, nearby regions? In addition to issues of cuisine and identity, Andean colonial archaeology focused on foodways has examined cuisine in terms of ethnic, class, spatial and chronological differences in the articulation of households and communities with mercantile distribution channels (Van Buren, 1999).

Some of the studies most relevant to Puerto Loa are those near Potosí, Bolivia, the great highland urban market the port at Loa served. In Tarapaya (near Potosí), elite 17th century Spaniards consumed significant proportions of European domesticated animals, mostly chicken and caprids, along with a range of Old-World resources. Highland elite Iberians at Tarapaya consumed diverse marine bony and cartilaginous fish from the Pacific Ocean: eels (*Genypterus sp.*) and *Bodianus sp.* (Viejo) were popular, alongside sharks of at least two taxa (Carcharhinidae and Lamniformes) in occupations of the first half of the 17th century (de France, 2012). The presence of head bones indicates the preservation and transport of whole fish into Tarapaya and Potosí (de France, 2012).

In contrast, indigenous people residing at Cruz Pampa (Porco) during the same century, and not far from Tarapaya, maintained native Andean dietary choices with minimal inclusion of European cattle (de France, 2012; de France et al., 2016). Here, the cattle bones represent low utility cuts of old animals (oxen) with work pathologies (de France, 2012). Strikingly, no marine fish were found in the native settlement of Cruz Pampa; this native community did not access the mercantile inland distribution networks of commodified dried salted fish. At Malata, in the Colca Valley, Peru, faunal assemblages show the persistence of indigenous husbandry and hunting practices (llamas and alpacas, guinea pigs, and deer) into the colonial era with a dearth of Eurasian animals as a regular staple for native commoners.

In a western valley, Moquegua, Peru, chicken and caprids, are well represented at the lower elevation reduction site of Torata, with smaller quantities of cattle and pig (de France et al., 2016). Here, a layer of the 1600 Huaynaputina volcano eruption provided a useful dating horizon revealing the rearing of sheep/goats before and after the ashfall (Rice, 2012). Large European cargo quadrupeds (horses, donkeys, mules) were not found (Rice, 2012; Van Buren, 1993). Old-World botanical remains in Torata were scarce and limited to grapes, castor bean, peach, and some apricot (Rice, 2012).

Further north, one can recognize a comparable pattern of Spanish versus Andean meat preferences at Carrizales (northern Peru). Here, Iberian high-status foodways are evident in private ecclesiastical areas. Caprids, chickens and pigs were consumed predominantly near the church where only a few bones of Andean domesticates (camelids, guinea pigs and ducks) were found (Kennedy et al., 2019). The Carrizales native community kept their traditional lifeways, with fishing as the main productive activity and (as in Loa) cormorant, ibis, booby, penguin, pelican, and other marine and aquatic birds were the main birds consumed, although here there was limited consumption of chicken and geese (Kennedy et al., 2019). Near Carrizales, the site of Mocupe Viejo shows the prevalence of Old-World domesticates in 16th and 17th century Spanish occupations and at Carrizales there was a slight increase in the consumption of desert-adapted Eurasian animals over time (Kennedy & Van Valkenburgh, 2016; Kennedy et al., 2019). At Carrizales, edible plants and cultigens show a similar pattern of native self-sufficiency and Iberian Old-World preferences. Iberian cultivates like lentils, black pepper, and grapes were scarce and, again, associated with ecclesiastical areas (Kennedy & Van Valkenburgh, 2016). Colonial period middens of the site yielded mostly native plants: maize, algarrobo, chilies, chirimoya (Kennedy & Van Valkenburgh, 2016).

The trans-conquest era triggered some dynamics that modified the fishing practices of the Carrizales native community. People here ate drums, anchovies, and sardines (Kennedy et al., 2019). A colonial period decrease in fish species richness and diversity was identified and interpreted as the result of less intensive and less diverse fishing activities (Kennedy & Van Valkenburgh, 2016). As in Loa, there was a drop in the colonial era in sharks and rays, accompanied by the increase of nearshore fishing and shellfish collection (Kennedy & Van Valkenburgh, 2016).

These examples illustrated the general process by which Old-World agriculture and livestock gradually achieved momentum in places with appropriate ecological conditions and resident Spanish communities. Through daily interaction with Andean natives and Africans, dietary choices gradually merged over time in the context of cultural interaction and ethnogenesis. Developments in the warm valleys of the western lowlands illustrate this process. Here, haciendas or agro-industrial establishments run (often by the Jesuit order) hosted multiethnic enslaved and wage workforces devoted to the production of pisco (brandy) and red wine (Sharratt et al., 2019; Weaver et al., 2019). Like Puerto Loa, these were mercantile catholic enterprises built up to satisfy the demands of Potosí and other highland mining cities, in other words, commodity production centers for urban clusters of rich (mostly) Iberian consumers, not for the everyday supply of rural Andean communities. In the haciendas of Nazca, excavations of 17th and 18th centuries occupations have shown the amalgam of Old and New-World dietary preferences and the allocation of lentils, olives, grapes alongside maize, chilies and aguaymanto (Weaver et al., 2019). By this time, Old World livestock was well-adapted to New World conditions and extensively raised in the hacienda valleys. The most consumed meats (alongside fish, shark [*Mustelus sp.*] and wild birds), were caprids and chickens with cattle and pork having a secondary role, as at Puerto Loa (Weaver et al., 2019). Purchase of salted beef (*charqui* or jerky) is mentioned in hacienda archives and sharks (*Mustelus sp.*) were also part of the supply, no camelid remains were found (Weaver et al., 2019).

While native populations eschewed, or lacked access to, Old World meat during the early colonial period, Iberian elites took advantage of their pivotal role in the consolidation of an Andean colonial market (made of a mixture of tributes and commodities) to eat a hybrid diet with significant amounts of non-Andean foods. Even elite Spaniards in the proto-industrial city of *Panamá la Vieja*, at the crossroads of all mercantile flows between the Spanish colonies and Spain, consumed a good deal of native foods. A detailed study of starch from grinding tools at the main Spanish houses around the plaza showed the everyday consumption of corn, beans, yuca, and other native cultigens (Aceituno & Martín, 2017). Elite Iberian faunal assemblages are constituted by a mixture of chicken, pork, cattle, iguana, turkey, peccary, white tail deer, and other native animals (Aceituno & Martín, 2017). A similar mixed allocation would be expected as part of Spanish household provisioning in early colonial settings within the Viceroyalty of Peru.

7.2 Household possessions and lifestyle

Colonial Puerto Loa residents articulated with a global market in more than food. Both luxury and utilitarian items were moving into the site for transshipment up to Potosí and to satisfy the lifeways of local leaders (both Spanish and native). We have seen that in the colonial period villagers at Puerto Loa eschewed European origin foods and pursued a traditional, pre-European diet. But did they have a desire for/access to other European goods? In other words, how did the arrival of Spanish mercantilism affect their everyday materiality? We know that the Iberian residents at Puerto Loa dressed in European fashion, enjoyed imported cigars, brandy, red wine, and European foods. What other items mark their position in the market?

7.2.1 Early Global Merchandise

The domestic life in Sector B provides rich evidence for the role of global merchandise in the habitus and daily home life of that sector.

7.2.1.1 Majolica Tableware

Throughout the New World, consumption of fine imported majolica was one of the markers of early global Iberian commerce and mercantilism. Majolica, called *loza* (tableware, China) by early modern Spaniards, was a wheel-thrown, tin-lead glazed earthenware with painted decoration of colored motifs over a light opaque glaze (Deagan, 1987; Rice, 2013; 2013b; Kelloway et al., 2018). Use of majolica expressed upper-class Spanish table manners and represented a luxury possession among Andean Iberians (Rice, 2011). As the tableware of colonial elites, majolica was a part of both status and Spanish ethnicity in the 16th- and 17th century, less common in the Andes than in the Caribbean or Mesoamerica (Jamieson, 2001; Jamieson & Hancock, 2004). In Quito, Moquegua, Arica or Santiago, majolica was always scarce and spatially concentrated in Iberian residential areas. Most Andean majolica vessel forms were meant for serving stews, soups, hot beverages (coffee, cacao) and other boiled items. Their flat bases presuppose a dining situation with flat tables. Majolica ware was expensive and generally treated with care and often only used on special occasions, which would explain its curation and low breakage rates throughout the early colonial Andes. In South America, majolica is normally found, albeit in low quantities, in the main colonial cities and ports. In the Andes an along the Pacific, Panamanian-produced majolica characterizes early colonial occupations. Iberian or Italian majolica is virtually absent.

In the southern Andes and colonial Chile, majolica is found mostly in Spanish urban early colonial materiality. Majolica is rarely found in early colonial native rural contexts. While rare, its usage nonetheless reinforced ethnic and class differences within the small Andean communities of the early modern era. At colonial Peruvian towns like Mocupe, Cao or Torata, majolica sherds are almost exclusively associated with clergy, religious service, and churches (Kelloway et al., 2018; Rice, 2013; Van Valkenburgh, 2021). This association is due, in part, to towns like Torata lacking significant Spanish merchant or administrator occupations. Yet some colonial indigenous communities in the Zaña and Chicama valleys (northern Peru) exhibit more regular access to this Panamanian tableware because of their direct involvement in trade (Kelloway et al., 2018; Van Valkenburgh, 2021). Therefore, understanding the distribution of this marker of elite and Spanish status requires nuanced approaches based on intra-site and inter-regional comparisons to understand native access or exclusion.

Majolica at Puerto Loa

Virtually all the majolica found at the site was in Sector B and of Panamanian style. Panamanian potters almost certainly sieved the clay to remove larger grains (Pourcelot, 2017). The Puerto Loa majolica paste exhibited few natural mineral inclusions the paste is very fine and only includes fine sand (<0.25mm) in very low proportions (<5%). As with known Panamanian majolica, the paste is characterized by very fine, highly spherical, well rounded clear/dark grains of similar size. One fifth of the sherds exhibit no inclusions even at a 20x magnification. Construction methods achieved a high level of consistency: walls were extremely regular, their thicknesses only have a narrow spread and coefficient of variation (0.28), thickness mean, median and mode are all the same (5mm). These artisans perfectly controlled kilns and temperatures: firing produced a homogeneous paste color (red (2.5YR4/6, 4/8, 5/6) or light red (2.5YR6/6), mostly), and there are no cores or margins from uncomplete firing or other irregularities. The glaze is high quality, thick, and evenly applied on both sides, and includes crazing and pin-holing, all characteristic of Panamanian majolica. Its color is normally white (9/N or 9.5N) but some cases have a light greenish gray tint (Gley1 8/5GY, 10GY).

Nearly all the majolica sherds were found in the midden and near the kiln, in very low proportions in each. Majolica sherds only represent 1% (n = 43) by count within Sector B's ceramic assemblage. The one possible non-Panamanian fragment may be a Sevillian dark blue on white ware with pale brown paste (10YR7/4) that could date to 1530-1650. The only example of majolica found in Sector A was near the church (n = 1), probably used by the visiting friar. Most of the majolica, 70% of the sherds, were from plates (Figure 66). Some brimmed plates were represented, likely used for stews and soups. There were a couple of examples of majolica bowl fragments (n = 2) as well, and a single cup fragment.

Figure 66: Panamanian style brimmed plate from sector B

The Puerto Loa majolica sample includes both plain and polychrome pieces showing residents were able to acquire even the most expensive painted kinds. Most sherds are plain majolica (44%; n = 19) of the Panama Plain type (1575-1650). Painted cases (30%) show fine or thick strokes, both fuzzy and regular, conforming motifs hard to define given sherds' small sizes. Most strokes are linear or represent a portion of a floral or leaf motif, anyway. Willow leaves imitating contemporaneous Chinese porcelain were present on one sherd. Blue and brown are the colors in the Loa sample, while majolica with green decoration is absent. A smaller sample (19%; n = 8) with blue and brown motifs over white is of Panama Polychrome A style (1600-1650). Some sherds show blue on white decorations (9%; n = 4) of the Panama Blue on White style from the 1st half of the 17th century. The remainder in the sample is Panamanian style majolica but fragments too small for type classification. People from Loa didn't readily discard majolica, wares were heavily used and show extensive wear marks.

7.2.1.2 Chinese Porcelain

The early colonial elites of Andean Latin-America were avid consumers of Chinese high-status goods. and porcelain played a similar role in colonial urban lifeways, class, and ethnic reaffirmation. Chinese porcelain was ten times more expensive than its Panamanian majolica, so it is represented in very small proportions of ceramic assemblages in urban colonial sites of the Americas (Deagan, 1987; Junco & Fournier, 2008). Prominent colonial Peruvian families carefully preserved and passed on generationally this luxurious dishware. For example, the will of Joseph Basilio de la Fuente, an illustrious resident of colonial Tarapacá, lists Chinese porcelain among his most important possessions, together with fields, ores, enslaved Africans, and Spanish majolica from Talavera (Hidalgo & González, 2019).

How did Chinese porcelain end up at small, dusty rural communities like Puerto Loa with only a handful of European residents? As is well known, Europeans at this time had not learned how to produce porcelain at all, so that porcelain equally served as a distinctive luxury item in both the Old World and the New. The famous Manilla Galleons arrived in Acapulco (Mexico) beginning in 1573 loaded with silk, thousands of Chinese porcelain vessels, and other luxuries (Canepa, 2014). The Spanish requested permission from the Ming court to trade with Chinese merchants from their entrepot in Manilla as part of unleashing the intensive export of porcelain and the golden era of the Manilla Galleon trade in the late 16th and early 17th centuries (Wang, 2019). Unlike silk, porcelain was heavy and made good ballasting. The flow to Chinese officials of Peruvian and Mexican silver solved the monetary needs of the late Ming dynasty (1368-1644) imperial economy (Kuwayama, 2002). The thriving pottery industry of the era exported great volumes of porcelain under the Ming, and to a lesser extent, under the subsequent Ch’ing dynasty (Kuwayama, 2002).

The dominant Ming porcelain in Hispanic colonial assemblages falls mainly into the Wanli reign (1572-1620) and consists mostly of blue on white wares plus some polychrome varieties (Deagan, 1987). The name Kraak is the Dutch translation of the Portuguese word *carraca* (carrack), one key kind of contemporaneous merchant ship for the trade of Chinese luxuries (Kuwayama, 1997). The most conspicuous Kraak forms of the Wanli period found in non-shipwreck sites in the Americas are plates, cups, and bowls with molded scalloped rims and foot rings (Canepa, 2014; Deagan, 1987; Kuwayama, 1997).

Early modern Chinese commodification and industrialism are embodied in the remains found in the Loa mouth: the product was standardized and of rigorously consistent quality. The molded walls are thin and extremely regular: max thickness is 3 millimeters only, while median and mean values are virtually the same (2.9 and 2.7 millimeters, respectively). The paste is extremely hard and glossy, standard white (White 8.5N or 9/N) and refined (inclusions not visible at 20x). The glaze is perfect (unlike majolica) and a thick white (8.5N, 9/N) or light greenish gray (GLEY2 8/10BG). Imperfections (e.g., pores) are virtually absent. Underglaze cobalt blue motifs were gracefully painted in both exteriors and interiors, typically in dark blue outlined plants, fruits and fish fins filled with lighter blue washes (Figure 67).

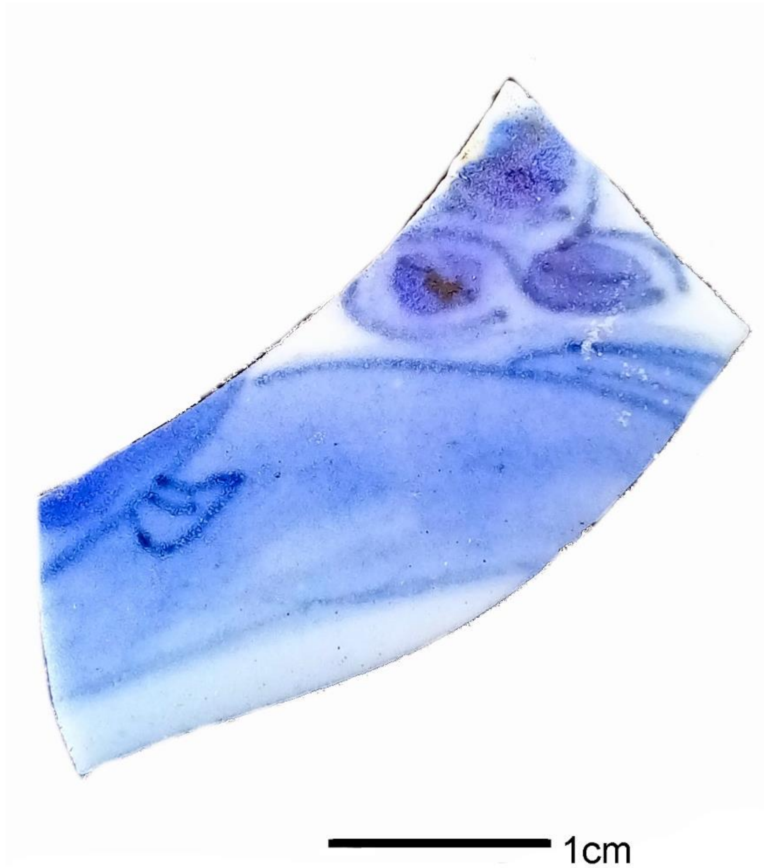

Figure 67: Example of a Ming porcelain sherd excavated in Sector B.

Ming porcelain is scarce at Puerto Loa, and distributed as would be expected. Porcelain is represented in Sector B in very low proportions (0.1%; *n* = 6) and with the lowest density rate among all classifiable ceramic sherds (>0.08 g/l). One sherd showed black stems and blue leaves, part of an as yet undescribed design. Scalloped or backet-lobed rim plates are common among Wanli era porcelains. An example recovered at Loa bears an underglaze design of a branch with leaves and a flower or fruit. The design occupies the rim only and is limited by two blue lines, the cavetto in turn was left plain white. Similar rim-cavetto configurations (Rinaldi's type II) would represent Kraak plates of the 1565 to 1600 range (Kuwayama, 1997, p.199).

Similar plates with white cavettos and decorated scalloped rims containing outlined floral and bird designs (without panels) normally feature a central scene of one or two deer in a natural landscape (Kuwayama, 2002, p.382-383). The so-called "deer plates" are a typical product of the Wanli reign (1572-1620) and found frequently in the Manilla Galleon shipwrecks along the maritime route (Kuwayama, 1997, p.52). I found traces of decorated molded rim-white cavetto of early Kraak plates (types II and III) mostly exported between 1570 and 1605 (Von der Porter, 2016) and examples of phoenix plates also consistent with the Wanli era (1572-1620). A sherd found at Loa, even though lacking the same floral motifs as in published examples, does display the cavetto-molded rim configuration of a "deer plate," and its open blue designs doesn't crowd the plate's interior as in mid-17th century Kraak (paneled) plates (Von der Porter, 2016). It's probably a late 16th or early 17th century plate. Another sherd depicts a short, pointed plant over blue land, a motif characteristic of the central design of the so-called "phoenix plates". These wares feature a central roundel decorated with a phoenix in a garden of bamboo and peonies and have been found in Wanli era Manilla galleon shipwrecks that also contain deer plates (Kuwayama, 1997, p.61).

The presence of Ming porcelain at Loa provides a 1573 *terminus post quem* (the start of the Manilla Galleon), a terminus ante quem or end date is more elusive. The stratigraphic distribution at the site offers further clues. That porcelain is present on the surface and in bottom colonial layers, given the known dates for production, argue for a short importation window for the fishery spanning only a few decades in the late 16th or early 17th centuries. No examples of plates with thick blue dividers of the 17th century first half were identified.

No porcelain was recovered from systematic surface survey and excavation in the Sector A native village (not even near the church). The presence of *any* Ming porcelain in Loa speaks to the purchasing power, status, and cosmopolitism of its colonists. The servants of the Iberians and the Andean curacas who visited the mouth of the Loa would have sat at a table replete with elegant Chinese plates, bowls and cups among the majolica service.

7.2.1.3 Glass

Iberians at the fishery used glass bottles and drank wine and brandy from delicate crystal goblets on special occasions. Glassware was a risky (because of its fragility) and high value trade item. As with porcelain, glass in the early colonial Andes was mostly an urban and elite material. Accordingly, only a small sample (n = 19) was obtained in Puerto Loa, all from Sector B, principally from B1 Layer F or the salting patio (Table 14). Most fragments are small, thin pieces of body (n = 15), rim (n = 3), and heel (n = 1) parts of fragile goblets and glasses, and a couple bottles. One example is from a flat-sided liquor bottle of the kind found in colonial shipwrecks. The access to varied glassware is evidenced by a range of glass colors. For example, greenish glass with embossed rims was found near the main kiln (B2) while a free blown "onion" bottle is hinted by other fragments.

Table 14: Distribution of Glass in Sector B by Unit and Layer.

	B1		*B2*		*total*	
Layer	Weight (g)	%	Weight (g)	%	Weight (g)	%
B			2.97	32.5%	2.97	32.5%
C	0.37	4.1%			0.37	4.1%
F	5.21	57.1%			5.21	57.1%
H	0.58	6.4%			0.58	6.4%
Total	6.16	67.5%	2.97	32.5%	9.13	100%

Several glass fragments are from a clear, blown crystal goblet form with miniscule, elongated bubbles and delicate stretching marks. These goblets would have had very thin walls (thickness ranges between 1-2 millimeters). The settlers also drank from extremely fine, decorated crystal goblets with embedded white stripes. Other glass fragments show embossed horizontal rings. Fragments from these more elaborate goblets were found in association with the fragment from the bottle, decorated drinking gourds, and an Inca style decorated bowl or *pucu*. The mixture of foreign and local luxury items is characteristic of Sector B suggesting the way in which the Iberian residents and local elite curacas were positioned at a nexus of Spanish and native hierarchies.

Some of the glassware types have counterparts in colonial sites and shipwrecks across the Americas. Such is the case with *latticinio* glassware with embedded stripes. Catalonian glass makers of the 16th and early 17th centuries made fine Venetian-style glassware with Moorish influence (Deagan, 1987, p.39). Their glass was pure, crystalline, and free of impurities; one of their decorative techniques was *latticinio* or the addition of white, opaque glass stripes into the crystal (Deagan, 1987, p.142). Murano glassblowers developed *latticinio* during the 15th century. This technique spread to Spain with Catalonian production taking place by the end of the 16th century. This glass became very popular during the early decades of the 17th century (Deagan, 1987, p.142). Goblets with this kind of decoration have been excavated at Panama la Vieja, proof of their transportation to the Pacific (Deagan, 1987, p.149). The presence of this global commodity in Loa further supports an early 17th century time frame. Other cup fragments might be of Andalusian origin as well, with their characteristic yellowish tint and bubble abundance.

The Atocha's assemblage is an exceptional window into early 17th century glassware. This shipwreck, occurred in 1622 off the coast of Florida, yielded an interesting assemblage of flat-sided dark glass bottles (Malcom, 1990) and embossed grooved drinking glasses (very similar to the ones from Loa) and in similar colors. Another Florida 1622 fleet shipwreck, the *Buen Jesús y*

Nuestra Señora del Rosario, also carried flat-sided dark bottles as well as goblets and flasks (Stemm et al., 2013). Tapered flat-based cups with engraved decorations were popular in the 18th century (Apestegui et al., 1997) but no examples were excavated at Loa.

7.2.1.4 Metals

The colonists accessed the market for European metal goods as well as other economic relations for the traditional products of Andean metallurgy. As seen below, a much wider variety of metal items were found in Sector B, including items of adornment and utensils. Andean villagers only used their own metal artifacts, largely represented by fishing hooks, in Sector A (Figure 68). Iron nails are the most common metal category at the fishery. Colonists on occasion likely dismantled barrels or other large wooden artifacts for fuel leaving bent nails as a residue. The settlement would have seen a regular supply of commodities transported in wooden crates and barrels. Nails were found only in Sector B, not a single nail was found at the village.

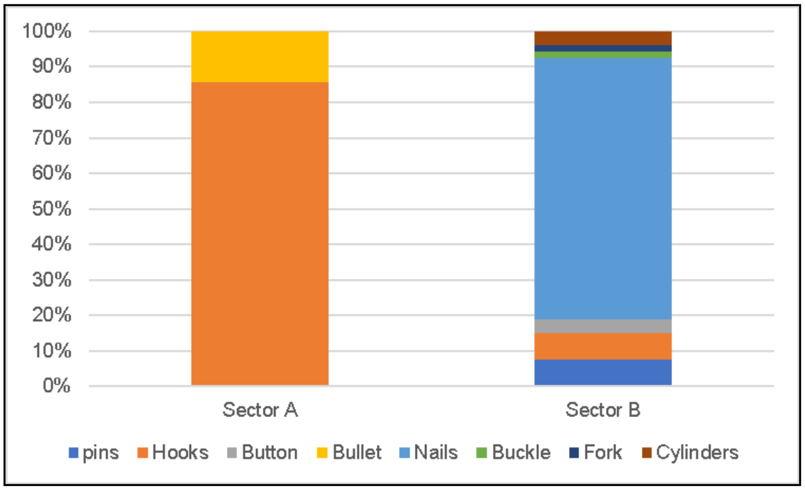

Figure 68: Compared metal artifact proportions by count

Low-scale metallurgy occurred at Puerto Loa: slag is rare but present at both sectors. Copper ore, hooks and slag were mostly found in the upper layers of the village. Alongside abraders, some locally produced copper-alloy fishhook remains were found in Sector B.

7.3 European and Andean Fashion

The enhanced preservation conditions of the salting patio open a rare window onto how people dressed in remote coves and natural ports of the viceroyalty in early colonial times. Clothing traces show how multiple identities converged in this remote community. The fishery had multiple actors and visitors, from resident Spaniards and native fishermen to sailors and curacas as revealed by a broad diversity of garments. Weaving was an important quotidian activity seen in both sectors of the site. Animal fibers and cotton entered the community to be turned into clothing, fishing nets, bags, and rope or cord. Fishing nets and cordage are described elsewhere. Here I focus on how people dressed and the implications for social interaction at the site, tastes, and access to market commodities.

7.3.1 Native Commoner Dress

In the colonial era village people wore the same traditional Andean tunics as their Pre-Columbian ancestors had. This everyday clothing was made of fine brown camelid wool fabrics or light -colored cotton tunics. Similar early colonial tunics and shawls of camelid, including alpaca, and cotton fiber have been recovered from the northern Peruvian site of Magdalena de Cao

Viejo (Brezine, 2021, p.175). Spanish clothing at Cao was made with wool or linen while the Andean wore alpaca and cotton fibers (Brezine, 2021, p.163). Natives wore cotton tunics, sometimes with bottom trims in dyed alpaca, and beige, tan, or light brown cotton shawls (Brezine, 2021, p.178). Cotton was the primary fiber, but wool was also important. Andean weaving persisted into the early colonial era in the Cao region, ensembles could have included both indigenous and European garments, the arrival of European imports was accompanied by various hybridizations of fabric materials and weaving techniques (Brezine, 2021, p.185).

Textiles are rare in Sector A and limited to the uppermost occupations and the village core (A3, Layers A-C, G). Their absence from earlier layers is a function of preservation. At all times, clothing would have had a very low discard rate. Commoners repaired garments until they were unsalvageable, and examples show extreme wear and repair. In Sector A, indigenous clothing represents the main category (75%) within the excavated sample of weaving materials followed by unworked animal fibers (24%), a rope fragment and a single small piece of Old-World fabric (Table 15). Villagers likely wove at least some of their clothing as is suggested by the raw fibers.

Most of the fabric shreds recovered are made of fine dark wool; there are also light brown yarns, probably cotton (Carolina Aguero and Barbara Cases, personal communication). The majority are light brown yarns of S or Z torsion. A finely woven, large piece of beige fabric made of delicate yarns was recovered. A variety of yarns was excavated near the chapel: beige and brown intertwined cotton and wool yarns were found in A4 (Layers B & D) along with very fine, beige (probably cotton) cases and very dark brown woolen yarns of fine camelid fiber, others were coarser woolen specimens. The same dark brown fine camelid fabric was recovered from colonial occupations of the fishery and from the other unit (A5) near the chapel as part of a piece of fabric and loose yarns. Here, a single example of a very distinctive red yarn (Layer C) hints at the use of European clothing near the early Catholic chapel.

Table 15: Distribution of Textiles in Sector A (grams).

	Native fabrics & threads	*Raw animal fiber*	*European fabric*	*Rope*	*Total*
Unit 3	15.5	0.2	0.1	0.1	15.9
A	0.1				0.1
B	15.2				15.2
C	0.1			0.1	0.2
F		0.1	0.1		0.2
G	0.1				0.1
S -Wall Level		0.1			0.1
Unit 4	0.6				0.6
B	0.5				0.5
D	0.1				0.1
Unit 5	0.4	5.2			5.6
B	0.2	0.1			0.3
C	0.1	5.1			5.2
D	0.1				0.1
Total	16.5	5.4	0.1	0.1	22.1

7.3.2 European clothing

The Spanish tenant of the port and his steward and their family members resided at least periodically at Puerto Loa. Aside from the Spanish residents, ships brought European visitors and priests would have visited regularly. These residents left vestiges of colorful, high value, European attires. We cannot yet determine if the remains of European dress included female clothing. Upper-class European male daily dress at the time consisted of a linen shirt, wool trousers and jacket, stockings, shoes, a cloak, and a hat. Women wore dresses, full-length skirts and underskirts of linen, silk, and wool (Brezine, 2021, p.169). The outfits worn by European colonists were ensembles of fabrics produced in Europe, the Americas and Asia as is visible in colonial paintings in Andean towns in the Arica region.

Some components of this dress are evidenced at Puerto Loa. Fragments of linen indicate the wearing of thin, light shirts ideal for the humid, hot weather of the Loa mouth. The use of linen pants is indicated by a large piece of a pant edge. Also represented at Loa are ornamented jackets of fine but compact wool. These would have been desirable during the winter nights or in the evenings when cooler southwest winds blow. The jackets were heavily used and repaired as evidenced by many polygonal or triangular patches of blue, green, and dark brown colors.

Figure 69: Colonial jacket lapel with eyelets excavated at the salting patio

A well-preserved jacket fragment is the blue lapel (Figure 69) found in B1, Layer C. It displays a series of contiguous dangling grommets to fasten the lapel to a cloak or other piece. A spherical button delicately wrapped in cord, of the type reported for the coastal colonial site of Cao by Brezine (2021), was found in association. Another style of jacket made of black and white wool was identified both at Loa and at Cao. Other colorful garments (not yet identified) are represented by many fine blue, red, and violet threads.

The garb of the fishery's occupants may have included fine silk clothes. A few very delicate thin-fibered fragments of fabric made with an extraordinarily dense weft and warp are consistent with Asian silk. Their fragility and discoloration suggest a weaker resistance to environmental conditions than cotton or linen. Green, yellow, and red tones are still perceptible in these threads, however. The suspected silk fibers come from Layers C to F of B1. Asian or Mexican silk was also part of Spanish clothing at Cao, alongside with wool or linen (Brezine, 2021, p.163). Socks were also recovered, showing patched heels with recycled cloth. One example made of white wool had a blue fabric patch. Another sock was made of cotton.

Early modern European attire had metal pins as fasteners in addition to buttons (Lorey and Quilter, 2021). The Spaniards inhabiting the fishery lost some (n = 4) finely made pins of copper alloy. These pins have narrow cylindrical bodies and spherical heads. They have different lengths and body diameters; dimensions are presented in Table 16.

Table 16: Dimensions of Metal Pins from Sector B.

Unit	*Layer*	*Weight (g)*	*Length (mm)*	*Diameter (mm)*
2	B	0.74	56	2
2	B	0.24	39	1
1	C	0.16	31.5	1

All the visible characteristics show them as identical to ones found in Cao. Portable XRF data indicates the use of copper and zinc alloys for the Cao cases (Lorey & Quilter, 2021, p.272). Decorated metal buttons were also found in Sector B. One is a complete spherical button with beautiful geometrical decorative designs of the exact same type and dimensions as examples published by Deagan for the Spanish colonies in Florida (2002, p.163). Published diameters and heights vary between 12-14 and 13-14mm, respectively (Deagan, 2002, p.163). The diameter and height of the Loa's case is 12.5 and 13mm, respectively. Another specimen represents a button's eye/shank fragment. These gilded buttons, made of copper alloy, were very popular among Spaniards during the second half of the 16th century and the early decades of the following (Deagan, 2002, p.163). Similar pins and buttons have been found in distant colonial sites of the Spanish empire, whether in northern Peru or southern Florida. Examples of European clothing are virtually absent from Sector A. The only exceptions are the above-mentioned red fiber near the chapel and an extremely fine, dark brown silk yarn recovered from the village's core (A3, Layer F).

Finer Andean textiles were also found in Sector B (Table 17). A cotton tunic of Tarapacá's or Loa's tradition (C. Aguero, personal communication) was represented by a fragment of white cotton with red and yellow stripes (Figure 70). Another fragment corresponds to a lateral edge of a Pica-Tarapacá tunic and has very fine light brown wool (perhaps alpaca) with a delicate multicolored embroidery covering an edge consisting of blue, red, yellow, and brown threads (C. Aguero and B. Cases, personal communications). Yet another tunic fragment had red and blue stripes over a light blue base. The only example of a V weft came from Layer J, made of blue and brown fine yarn. Polychrome native textiles were not found in the village.

Raw textile materials were found in both sectors: some textile production took place in the uppermost occupations of the village from which wool or cotton fibers were found.

Table 17: Distribution of Textiles per Type and Weigth (g) in Sector B.

	Vegetal fibers (ropes)	*Fishing net (cotton)*	*Knitting (wool/cotton)*	*Burlap sacks*	*Footw ear*	*European clothing*	*Raw fiber*	*Polychrome Andean textiles*	*Raft Seam*	*Net (vegetal fiber)*	*Total*
Unit B1	6413.1	2135.7	1081	446.6	381.6	262.1	171	160.9	11.2		11063.2
Surface		0.1		16.3							16.4
B	100.8	9.9	2.6			0.1	0.4	23.4			137.2
C	5289.8	1691.5	864.4	371.6		164.4	94.6	135.9	6.8		8619
D	1.3	5.7	0.1			0.7		0.1			7.9
E	154.4	56.4	64.9			21.7	0.7		1.9		300
F	803.6	318.9	122.9	23.9	381.6	75.1	74.2		2.5		1802.7
G	2.2	1.6	0.1								3.9
H	61	48.6	25.3	34.8		0.1	1				170.8
I		3	0.5				0.1				3.6
J			0.1					1.5			1.6
M			0.1								0.1
Unit B2	8.9	19.5	19.7			0.6	13			8.9	70.6
B	1.8	10.1	0.4				0.7				13
C	7.1	9.3	0.1				6.6				23.1
D			13.4								13.4
E		0.1	5.8			0.6	5.7			8.9	21.1
Total	6422	2155.2	1100.7	446.6	381.6	262.7	184	160.9	11.2	8.9	11133.8

Figure 70: Cotton tunic fragment from the lowland curacazgo.

Raw textile materials were found throughout the fishery marking it as a place of woven item production, from clothing to bags to nets and cord. The colonial occupations yielded cotton balls, some with seeds and hulls still in place, as well as raw wool from light and dark brown animals. The presence of wool-bearing animals (caprids and camelids) either locally raised or brought in from the interior is evidenced by paleofeces and dung spherulites. People cultivated cotton in the inland warm valleys and oases as well as around coastal springs. Historical maps name the nearby city of Tocopilla as “Algodonales” or cotton trees. Too, Viceroy Francisco de Toledo’s demanded from Pica and Loa communities the tribute of cotton clothes (Málaga, 1974); a demand that probably existed in Inca and previous colonial times.

7.3.3 Items of Adornment

Local indigenous dress included necklaces made with semiprecious stones and shell beads. All the recovered beads (n = 5) came from the uppermost occupations of the village, none from Sector B. In the village, the simple monochrome garments were worn with a variety of copper and shell beads of circular, discoidal and tubular form. Table 18 presents bead's relevant characteristics.

Table 18: Beads from Sector A.

Unit	*Layer*	*Type*	*Material*	*Weight(g)*	*Ø (mm)*	*Thickness (mm)*	*Length (mm)*	*Width (mm)*
2	B	Tubular	Copper ore	0.34		3	11	7
3	C	Circular	Shell	0.03	5	1.5		
3	D	Circular	Copper ore	0.03	5.3	1.4		
5	B	Discoidal	Chalcedony	0.05	6.5	1		
5	H	Tubular	Spondylus?	0.15	5	4		

There are indications that some of these beads were produced through low-scale lapidary and metal working at the village. One tubular copper ore bead was broken during its drilling and discarded by the artisan. Nearly all the beads are of regionally available resources: copper, mussel and chalcedony. The development of occasional lapidary work in the village during its latter occupations, a complementary activity that shared the stage with low-scale, domestic metallurgy, signals indigenous craft specializations even in the small, remote coastal hamlets of Tarapacá. Some necklaces may have arrived as gifts or through other mechanisms from distant coastal or inland locations. One of the shell examples, a tubular red and white bead may be made from spondylus shell or a similar northern warmer water species.

Indigenous regional elites may have worn metal bead necklaces in combination or directly sewn to their polychrome tunics. These beads are small cylinders made of a delicately rolled sheet of copper or bronze. One complete specimen has a length of 34mm while diameters vary in the 3-4mm range. Equivalent metal cylinders were found in nearby funerary sites and interpreted as beads by specialists (Latorre, 2017, p.180). Such metal beads were absent from the village assemblage. The presence of these beads, together with the higher-value polychrome tunics, reinforces the presence of native elites in Sector B.

7.3.4 Footwear

A complete espadrille (Figure 71) was retrieved from an early colonial occupation (B1, layer F). The shoe was skillfully manufactured of various materials: a V-top of white cotton fabric on the instep is surrounded by other fabric at the sides and woolen yarns of two different colors. The heel is covered by hard dark brown cloth and the sole of coiled vegetal fiber is covered by leather (length 26 centimeters). A regional (rather than European) origin is likely. What is as yet unclear is if the shoe represents native or Spanish footwear, or if both groups wore similar footwear.

Figure 71: A complete colonial espadrille excavated at the fishery. This kind of footwear was another tributary item in southern colonial Peru.

7.4 Regional Andean Goods

Exchange items, of high relative value, consumed at the site, included a range of Andean products. The durability of ceramics put pottery at the forefront in examining residents' engagement with these exchange networks.

7.4.1 Native Ceramics

The distribution networks of the Andean regional economy made possible the consumption of wide-spread ceramic wares in the fishing village during its entire sequence of occupation.

7.4.1.1 Polished Interior Bowls (Dupont)

The residents of Loa used unrestricted ellipsoidal bowls, one of the basic vessels in regional late Pre-Columbian and early colonial production. These serving vessels, called *Dupont* by local archaeologists, have black polished interiors and smoothed (brown) exteriors. They are characteristic of domestic and funerary contexts of the ~AD 780-1430 era but especially after AD 1000 (Uribe, 1997; Uribe & Ayala, 2004), and are regionally distributed across the Loa basin, Quillagua, Pica, Tarapacá, and Atacama (Uribe, 1997; 2004; Zlatar, 1984). Most Dupont sherds were retrieved from Sector A, but a couple specimens were found in Pre-Columbian occupations under the fishery (B1, Layers H and J).

The Loa specimens were hand formed and have very fine to fine, highly spherical, and well-rounded sandy inclusions, in percentages below 5% These inclusions are probably natural sandy particles in clay (Rice, 2015). Firing conditions were held long enough to fully oxidize the core of the vessels (Orton & Hughes, 2013) in about a third of the cases. Section colors included light yellowish brown (10YR6/4), reddish brown (5YR4/4), and brown (7.5YR5/3). The remainder exhibited grey or dark cores of short or low temperature firings or special firing atmospheres (Orton & Hughes, 2013, Rice, 2015). The interiors were polished to harden and waterproof the surface for beverages, soups, and stews and blackened (probably from firing the pot upside down). Locals used the bowls near the fire, so external surfaces are often smudged brown or greyish/blackish because of dirty hands. These vessels were individual serving bowls as seen from calculated diameters. Some rim sherds (n = 9) allowed diameter calculations: minimum and maximum diameters were 154 and 289mm while the mean was 222mm. Loa's bowls showed diameters well within published ranges (89-280mm) for the type (Stovel & Echenique, 2015, p.477; Uribe 1997; Uribe, 2004). Similar bowls from the Pica 8 cemetery have minimum and maximum diameters of 110 - 245mm, with a mean of 160mm (Zlatar, 1984). Bowls from Loa are slightly larger but still within the individual serving range.

7.4.1.2 PCH Wares

Another characteristic indigenous ceramic of broad regional distribution are vessels of the so-called *Pica-Charcollo* (PCH) ceramic tradition, constituted by its characteristic striated bottles and bowls. Bottles are globular and short-necked while bowls spheric and striated (Uribe, 2009). PCH vessels were made by coiling and smoothing with hard tools that left broad lines in exteriors and/or interiors. Some vessels exhibit small handles on opposite sides of the neck and/or remnant red slip (Uribe & Vidal, 2015). Fabric is sandy with quartz, some mica, and white inclusions, cores indicate well-oxidizing homogeneous firing (Uribe et al., 2007).

This tradition is distributed through Tarapacá's lowlands and coastal settlements between Loa and Iquique (Ayala & Uribe, 1996; Uribe et al., 2007). This pottery is found in domestic or funerary sites of Quillagua, Pica, Tarapacá, Camarones, and other warm lower valleys (Agüero et al., 1999; Gallardo et al., 1993; Uribe, 2009; Uribe & Vidal, 2012; 2015). Available TL dates cover a period of one millennium (AD 575-1615), but its manufacture intensified after the ninth century becoming predominant between AD 1000-1250 (Uribe et al., 2007; Uribe & Vidal, 2012; 2015).

The emerging picture from archaeometry is that PCH became gradually more popular in the region with manufacture by evolving specialized potter communities. Petrographic analyses have identified less mineral variability in the latter pottery than in previous QTC regional types (Uribe & Vidal, 2015). PCH and previous regional traditions share some of the same clay sources as shown by neutron activation analysis so long-term continuity in manufacturing traditions has been proposed (Uribe & Vidal, 2015).

The PCH specimens from Loa are primarily from bottles of restricted globular form with a narrow, slightly everted short neck and rim; striated serving bowls were represented by a couple of rim sherds only. Striations occur in the interiors mainly (72%) in association with smoothed brown exteriors or with remnant red slips. Such bottles would be useful for serving, but also for the transport and temporary storage of liquids. Rim diameters in the 94-125mm range suggest that these bottles were of medium size.

Pastes or fabrics included medium to very fine sand of high sphericity with white quartz and some mica in most cases (in proportions up to 20%). Inclusions varied more than in other pottery types, and some sherds show very angular to sub-angular mineral grains (13%). that could have been added as temper. Fabric color depends on clay's iron content and distribution, plus duration and stability of firing conditions (Orton & Hughes, 2013) such that sherds with brown cores and margins were incompletely to relatively well oxidized, or contain iron in a ferric state (Rice, 2015, p.289). The Loa specimens fit this description with the darker gray/black colors may indicating shorter firings and variability in production practices. Most cores and margins are homogeneous (77%). Clay color varies greatly, ranging from dark reddish brown, reddish brown, red to light red (2.5YR3/3, 4/3, 4/4, 4/6, 5/4, 5/6, 7/6), reddish brown to yellowish red (5YR4.5/4, 4/3, 5/4, 5/6), to dark brown, brown, strong brown to light brown (7.5YR4/3, 4/4, 5/3, 5/6, 6/4), and to blackish and grayish tones.

7.4.1.3 Inca Style Ceramics

One decorated Inca-style polychrome bowl (Figure 72) was found among the colonial materials of the salting patio (B1, Layer F). Bowls of this kind, called *pucu* or *puco* in Quechua (Bray, 2003), were essential materials of Inca ceremonialism and politics along aryballos, characteristic footed-pots, casseroles, jugs, and carved gourds. It's a finely made tableware piece, not for everyday use (it appears to show very little use and is quite clean without scratches). The recovered bowl has an ellipsoidal body, flat and thick lip and an almost concave base, and it has a diameter (151mm) suited for individual serving. Oxidation was incomplete during firing; fabric is gray (2.5Y6/1) and margins are lighter. Inclusions are tiny, probably the clay's natural sandy particles.

The design elements and its arrangement are characteristic of Inca style ceramics found in Cuzco and the provinces. Geometric and zoomorphic motifs were painted in the interior over an underlying red slip base color (7.5R5/6). The potter drew a quadruped in very dark gray (5YR3/1) with a curved back and a rolled tail on a pale brown (2.5Y7/3) vignette. Rectangular spaces were delineated near the animal in very dark gray and contain the clepsydra motif (solid triangles joint by their tips). Concentric circles in faint red are visible on both sides of the triangles.

Figure 72: Regional Inca style bowl found in Sector B.

As noted elsewhere, carved gourds were also found in Sector B (Bray, 2003). That Inca bowls and decorated gourds were represented in an early colonial occupation of the fishery may indicate that Spaniard overseers and priests were accompanied by the regional caciques, sharing practices that translated Inca regional administrative hierarchies into the colonial one.

7.4.2 Early Ceramics: The Late Formative-Middle Horizon

Early ceramic assemblages from the site also reveal participation in regional ceramic exchange networks. Study of these assemblages can reveal potential changes in culinary practices as well.

7.4.2.1 Red Straight Flared Cups and Bowls (QRP)

Residents during the Middle Period ate and drank in carefully made red-slipped straight flared mugs and bowls. The crafters creating this pottery had a clear interest in appearance and comfort of use: walls are consistently red and smooth, bases flat and regular, rims perfectly everted and lips thinned to facilitate drinking. Red polished/burnished ceramics are regionally known as QRP or *Quillagua Rojo Pulido* (Uribe & Ayala, 2004; Uribe, 2009; Uribe & Vidal; 2012, 2015). This pottery is found in settlements and cemeteries of the warm valleys and coves of the region including Tarapacá, Quillagua, and coastal villages between Iquique and Loa (Correa et al., 2017; Uribe, 2009). QRP ceramics commonly co-occur with QTC ceramics, just as in our fishing village. People buried in the Loa mouth funerary mounds had QRP vessels as well as other Quillagua-Tarapacá wares (Correa et al., 2017). Contemporary domestic occupations north of the river mouth yielded many QRP serving vessels with unrestricted mouth diameters in the 80-120mm range (Uribe, 2009).A broad thermoluminescence chronology within the Middle and early LIP periods characterizes both traditions and the AD 510-1160 range has been proposed for QRP (Uribe & Vidal, 2012; 2015, p.22).

Most of the sherds from the site were recovered from the village core (A3) and correspond to individual serving (*qero*-like) cups or mugs (as suggested by mouth diameters below 180mm).

But the existence of some larger cases indicate variability from *qero*-like cups to group serving-size bowls. A small subset may be from globular QRP bottles with straight cylindrical necks and everted lips, their mouth diameters are in the 54-89mm range.

The surfaces were burnished with some hard, rounded instrument. Interior surfaces are red or fabric color. Abrasion marks and wear are concentrated there due to everyday use. These vessels were occasionally used to reheat food, as soot was recorded near the base in some cases. Paste is good quality with only a minor proportion of fine to very fine naturally occurring sand. The vessels were regularly fired, and sections show homogeneous oxidation and brown or light brown (7.5YR5/4, 6/4) colors in most cases. Well-preserved slips are of red (10R5/6), light red (10R6/6), or weak red (10R4/4, 5/4) colors. A high level of chemical and petrographic variability characterizes QRP ceramics in comparison to earlier pottery productions (Uribe & Vidal, 2015, p. 29). Sherds from the Loa mouth and Quillagua show a higher degree of chemical similarity than with the rest of the region, however (Correa et al., 2019, p.157).

7.4.2.2 Thick Everted Straight Bowls (QTC)

Quillagua-Tarapacá Café Amarillento (QTC) forms include bowls, cups, and miniature vessels, all distinguishable by their sandy gray fabrics and light grey or very pale brown surfaces, spatula marks and basketry imprints at bases, among other features (Uribe, 2009; Uribe & Ayala 2004; Uribe & Vidal; 2012, 2015). QTC bowls differ from QRP bowls in having an unrestricted cone contour morphology (Rice, 2015, p.241) and everted straight walls. They are larger, thicker, and coarser than the red type. QTC and QRP ceramics are frequently found together as part of domestic and funerary serving assemblages throughout lower valleys, ravines and on the coast around Tarapacá, Iquique and Loa. TL dates indicate a broad time span, especially on the coast, from most popular during the second half of the first millennium AD through LIP times.

Rims are normally flat and thick; walls are smooth and robust with scratch marks left by some instrument (a hard brush perhaps) that can be multidirectional and thick, always coarser than in LIP types. Some of the flat bases have basketry imprints, it's possible that these pots were formed inside baskets as molds and basketry marks in walls erased afterwards with hard brushes (or just over a flat basketry base). In the samples from this site, the paste is sandy and light grey. Surfaces colors include very pale brown (10YR7/3, 8/2, 8/3; 2.5Y8/2), light gray (10YR7/2; 2.5Y7/2) or even whitish (5Y8/1) colors. Sometimes sherds are dirty because of food serving and manipulation near the fire. Surfaces are normally regular and well-made, they show very pale brown (10YR7/3, 8/2, 8/3; 2.5Y8/2),light gray (10YR7/2; 2.5Y7/2) or even whitish (5Y8/1) colors. Most sherds (78%) evidenced almost complete oxidation, so the open firing of these large bowls is likely.

QTC bowls have wider mouths than the associated red mugs/bowls and interquartile ranges and median values are quite different (Figure 73). Calculated diameters for these bowls exceed individual serving sizes in most cases suggesting consumption from family size vessels. One possibility is that a household used these large bowls to serve food and the red mugs and cups to drink maize or algarrobo chicha or other beverages.

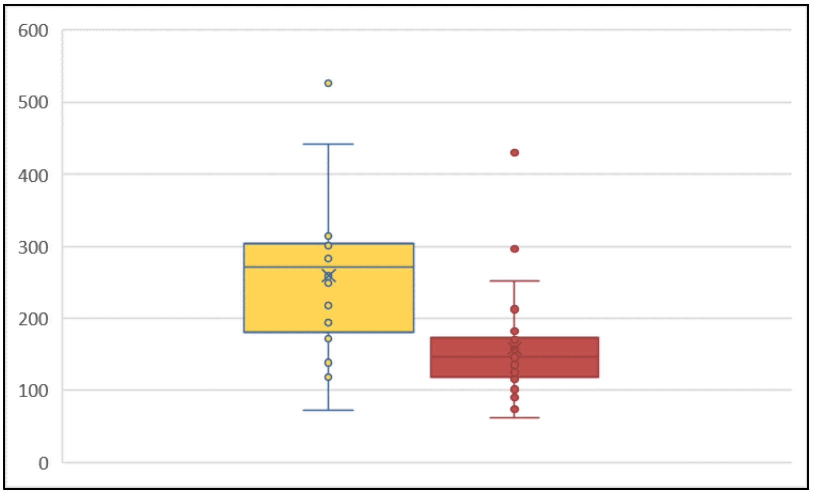

Figure 73: Mouth diameters (mm) of thick everted straight bowls (yellow) and red cups/bowls (red).

Another QTC bowl form is the *Flat Inverted Bell-shaped Bowl*. Loa's QTC bowls include larger unrestricted conic bowls of similar characteristics to the previous type but lower quality and more variability. Their contour morphology is like a flattened inverted bell, rims are slightly convex and rounded, surfaces poorly smoothed, and bases are convex. An almost complete example was published by Uribe and Vidal (2012, p.218). Paste is light colored and sandy, while walls are thick and external surfaces of very pale brown color (10YR7/3, 7/4, 8/3). The intentional addition of sandy temper to achieve larger and more resistant vessels is suggested by inclusion size variability and proportion. Potters fired these large wares in open atmospheres and complete oxidation is visible in most cases.

This bowl type comes in larger diameters, it could correspond to a group serving form, maybe a sort of platter to share food with family members. Calculated median and mean diameters are above the central half of values of the previous two types. Some specimens show dirty exteriors due to handling, others eroded interiors produced by use.

Miniatures are also characteristic of the QTC funerary and domestic ceramic traditions (Uribe & Vidal, 2012; 2015). The villagers used miniature globular and open vessels for unknown purposes. These miniature vessels could have served very specific functions as containers, maybe for special substances in/or for special practices, and as such accomplished serving/storage functions. Phytoliths, starches and biomolecules could provide a more specific answer to functionality in the miniatures case.

The most common fragments (*n* = 26) are from globular short necked miniature bottles. Walls are irregular, reddish brown (5YR5/3), and thin (mean, mode and median of 4mm). Some miniature bowl fragments were also found. They were carelessly manufactured, and their uneven surfaces have visible potter's fingermarks. Mouth diameters are small (median of 82mm). Firing was variable with oxidized as well as reduced cores. Sandy inclusions didn't suggest intentional addition. Most sherds (56%) showed grayish or blackened exteriors due to domestic handling; light grey (2.5Y7/1, 7/2), gray (10YR6/1), light brownish grey (10YR6/2), very pale brown (10YR7/3) or pale brown (2.5Y8/3) were recorded in clean well-preserved sherds.

7.4.2.3 Black Polished Vessels (SPNP Style)

This group is equivalent in morphologies and attributes to the iconic *San Pedro Negro Pulido* (SPNP) black polished vessels of Atacama's late Middle Period (Tarragó, 1976). This ceramic industry flourished between AD 400 and 950 and is represented by tall, straight-sided cups, bowls, and short constricted pots and casseroles (Stovel & Echenique, 2015). Bottle forms are more common in funerary contexts than bowls and cups (Stovel & Echenique, 2015). Open bowls (Form IV), straight flared bowls (III), and slightly constricted tall cups (II) characterize all periods of black polished ware production in San Pedro de Atacama as seen in AMS dates of associated human remains in tombs (Stovel, 2013; Stovel & Echenique, 2015). These black polished vessels are of the late Formative or Middle periods. However, the production locales for this pottery remain poorly known. In addition to San Pedro de Atacama, production might also have taken place in Tarapacá (where the *Caserones Negro Pulido* type has been recorded) or elsewhere. Specific provenience chemical analyses are still awaited.

Table 19: Black Polished Diagnostic Sherds from Loa.

N	Sector	Unit	Layer	Rim Type	Vessel Type	Ø Range	Rim Ø
1	B	1	I	B-D	II	60-170	98.1
2	B	1	I	B-D	II	60-170	150.2
3	B	1	J	B-D	II	60-170	94.3
4	A	3	Ñ II	E	VII-IV	8-28	116.4
5	A	2	G	E	VII-IV	8-28	141.6
6	A	3	J	G2	III	9-32	134.6
7	A	3	J	G1	IIIcAH	9-32	125.8
8	A	3	U	G1	IIIpAH	9-32	158.4
9	A	4	F	J	IVplv	8-28	141.0
10	A	3	Q	J	IVplv	8-28	98.7

This ware shows that village residents had access to fine imported pottery such as tall drinking cups, constricted vessels, and ellipsoidal and flared serving bowls. The fact that most body sherds (70%) have both sides polished points towards open serving bowls as the most common form, which is also indirectly supported by the virtual absence of flat bases (2%) and protuberances like the ones present in black polished straight-sided cups (Types I and III). Black polished SPNP vessels were made of refined clay, with thin walls and highly burnished dark surfaces. The late forms favor strongly everted lips rather than straight contours (Stovel, 2013). Fabric color varies from black to grey to brown due to variations in the firing process (Stovel & Echenique, 2015). Sherds from Loa mostly had black (5YR2.5/1) paste but some specimens had gray to light brownish gray (10YR6/1, 6/2) colors recorded in homogeneous sections without cores or margins. Black surfaces and cores indicate reduction firing, gray cores some degree of oxidation during the process (Orton & Hughes, 2013; Rice, 2015, p.289). They have no indication of intentionally added temper.

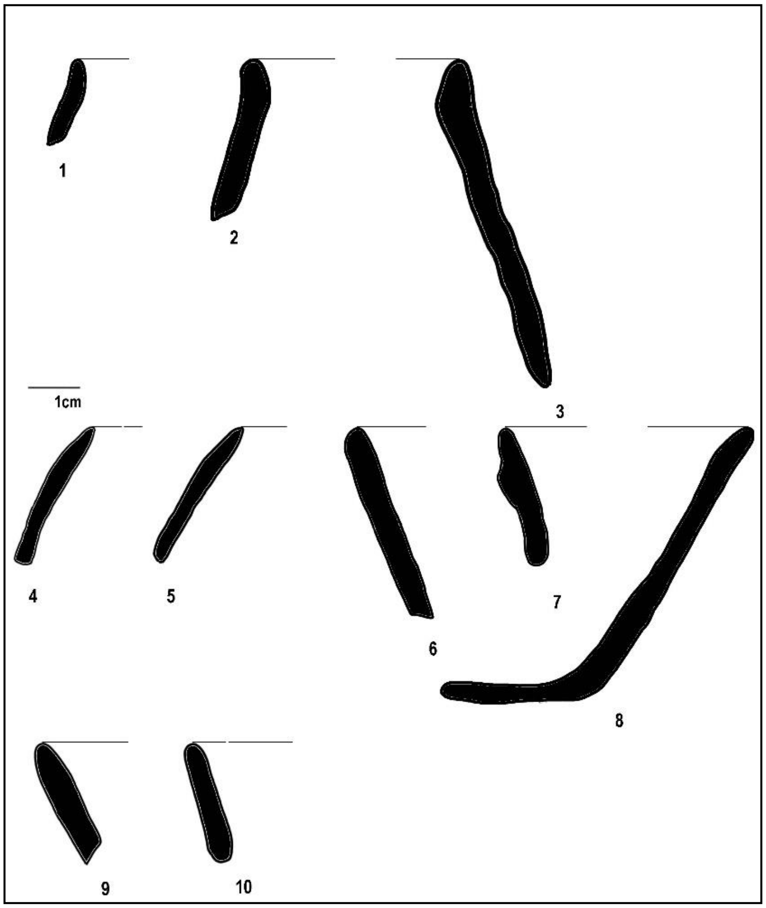

Figure 74: Black polished pots profile drawings.

Vessels from the Loa sample allowed for diameter calculations: these were small vessels; minimum and maximum diameters were 94 and 205mm. Three of the Loa diameters would be in the funerary cup range, the rest in the bowl range (see Tarragó, 1976). Domestic SPNP vessels have larger diameters (Stovel & Echenique, 2015, p.477). Fortunately, rim and lip morphologies from the Loa assemblages can be readily correlated with some forms and antiquities. Some slightly constricted rims (*n* = 3) from the village (Figure 74, 1-3) correspond to Types B and D in the classification of Stovel and Echenique (2015) and come from tall straight-sided cups (Type II in

Tarragó's 1989 typology). There are two Type E rims of the Type IV/VII constricted bowls (Figure 74, 4-5) and some straight flared bowls (Type III) with Type G rims in the Loa sample (Figure 74, 6-8). General unrestricted bowls (Type IV) are represented by J rims (Figure 74, 9-10). Calculated diameters lie well within published ranges for each domestic type also (Table 19).

7.4.3 Pottery Trends

First, the villagers had regular access to regional ceramic styles over time[17] reflected in a constant discard of sherds throughout the whole occupational sequence. The same serrated line ranging within a few grams per excavated liter was documented at most units including the core (Figure 75).

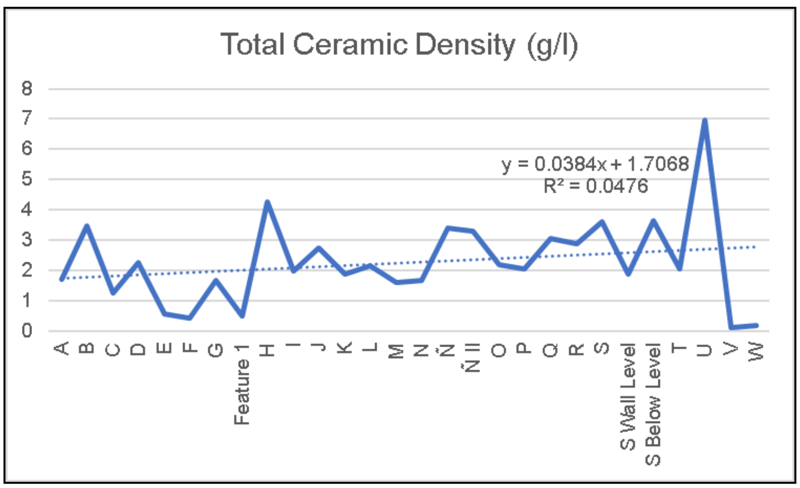

Figure 75: Ceramic density over time in unit A3.

The Sector B fishery was increasingly supplied with indigenous pottery. This increase reflects the importance of storage in Sector B as a place where materials of diverse origin

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[17] Excepting A5 where an increasing trend was found.

converged. The presence of a regional elite is also likely associated with accumulation of goods and wealth. Thus, even discard of regional ceramics shows increasing densities (g/l) in the salting patio (Figure 76). The interquartile range of sherd densities at the village core is higher than that of most units; the central unit has the highest median (2g/l) sherd discard rate (Figure 77). The Sector B main colonial occupations yielded densities comparable to the average density at the village's center.

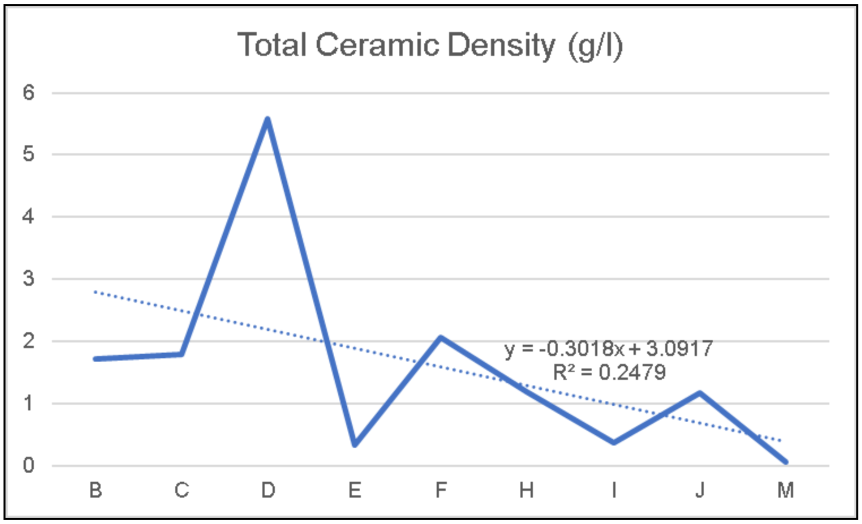

Figure 76: Ceramic density over time in unit B1.

Aside from the well-defined regional types described above, the pottery used by the late Formative – Middle Period residents was varied in terms of production, style, and sources. Clay matrices from Puerto Loa show a great range of hue and values in the case of sherds that doesn't belong to any of the well-defined regional types. They came from multiple sources and pertained to heterogeneous ceramics. Brown clays are common with yellowish matrices more associated with earlier occupations and reddish ones to LIP occupations. Middle Period pottery tended to have the smoothest surface finishes (smoothed, burnished, polished), while Late Pre-Columbian and early colonial villagers used scrapped, smoothed, or slipped wares mostly. The regional

Andean potters put more effort into shaping serving forms than in making very regular, standardized cooking pots. Serving recognizable types (conical mugs and *qero*-like cups to ellipsoidal unrestricted bowls) characterized the Middle Period assemblage.

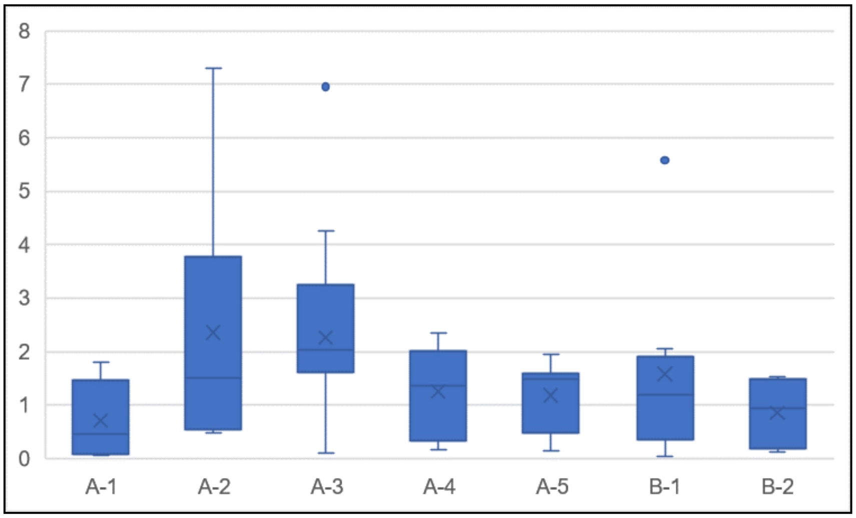

Figure 77: Comparison of ceramic densities (g/l) by unit and sector.

To what extent were any of these changes accompanied by a more standardized production? This can be answered from the variability in vessel size. Mouth diameter is one dimension that can be calculated from rim sherds of the serving vessels. The coefficient of variation (*V*) is useful to compare the spreads of two or more distributions. It employs a fixed scale from 0 to 1: values towards 0 have a very narrow spread and vice versa (Flechter & Lock, 2005, p.48). Serving vessels of the QTC and SPNP wares from pre-LIP (Middle Period) times show higher coefficients of variation for calculated diameters than LIP diameters as seen in Table 20. Late Pre-Columbian potters in the region may have produced more standardized vessels than their Middle Horizon counterparts. If this has to do with indigenous commodification processes for intensified regional exchange over time requires a good deal of archaeometry and comparability.

Late Andean potters made more standardized vessels from the point of view of diameters than their predecessors. What can be learned if we compare regional late assemblages? Pica 8 is one of the largest LIP and Inca cemeteries of Tarapacá. Its serving bowls are well-described by Zlatar (1984) and are useful for comparisons. Unrestricted ellipsoidal and spherical bowls with black polished interiors (n = 28) are part of the assemblage and comparable to Loa's bowls and thus can be used to assess the degree of size standardization in the region. An extra case from the Quillagua Oriente cemetery was also included in the analysis.

Table 20: Coefficient of Variation of Diameter by Type.

Type	*V (Ø)*
Miniature Bowls (QTC)	0.5444
Red Straight Flared Mugs and Bowls (QTC)	0.4552
Flat Inverted Bell-shaped Bowls (QTC)	0.428
Thick everted straight bowls (QTC basketry base)	0.4058
SPNP	0.2434
Pica 8 (LIP)	0.1758
Dupont (LIP)	0.1587

Total standardization of dimensions wasn't the norm in late Pre-Columbian times even if variability in diameters of serving vessels was lower than in previous periods. Loa and Pica's bowls are very similar, and some cases are within the range of each other, but their mid-spreads are not comparable (Figure 78). Despite both having very narrow distributions (low V values), Loa's bowls are larger and probably taller than cases from Pica.

Regional Andean potters made variable cooking pots in terms of size, they had less standardized more variable mouth diameter sizes. Loa's and Pica's spherical cooking pots have a wider coefficient of variation of V=0.49 and 0.42, respectively. Loa's pots (n = 16) exhibit variable mouth sizes with a bimodal distribution (17-18 and 20-22cm). There is a temporal trend, however:

late Pre-Columbian/early colonial occupations concentrate large diameters (>20cm). Earlier pots tend to be smaller with mouths less than 20cm in diameter. As with serving vessels, Loa's cooking pots have larger mouths and were bigger than cooking pots deposited in Pica as part of funerary rituals. At the Pica cemetery, 2 out of 18 spherical cooking pots have a mouth diameter larger than 20cm. Only two quartiles of Pica's diameters are within Loa's mid spread, the other two are below (Figure 79).

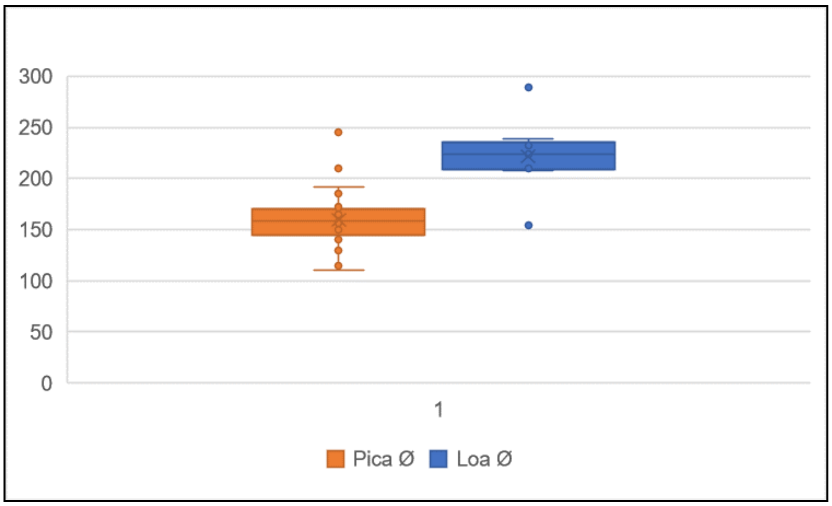

Figure 78: Compared diameters (mm) from Pica 8 and Loa for bowls with black polished interiors.

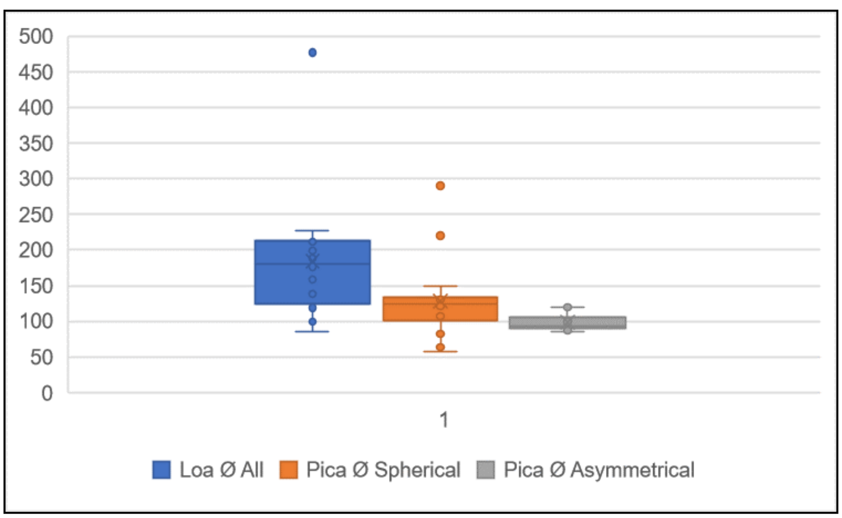

Figure 79: Compared mouth diameters (mm) of cooking pots.

The asymmetrical cooking pots from Pica 8 were small globular pots with asymmetrical bodies, short necks and a single handle attached to the rim. The disparity of diameters and the virtual lack of handles suggests that asymmetrical pots were uncommon at Loa. Asymmetrical pots have a narrow coefficient of variation (V=0.12) and were more carefully shaped for funerary rituals.

In sum, regional Andean potters standardized the dimensions of the individual serving vessels of late Pre-Columbian times in comparison to the more variable, less standardized bowls used during the Middle Period. But these late Pre-Columbian and early colonial potters made bowls in sizes that varied in size from community to community, so the production of these regional goods was not highly centralized in the later periods either.

With the assemblages from Loa, it is possible to examine diachronic changes in the regional styles and to reconstruct the extent of the resident's access to the regional distribution of these styles. The earliest ceramic component at the site is the set of Tarapacá types that include QTC, QRP, and black polished ceramics. Their discard through time presents as serrated lines with density peaks at lower and intermediate layers. Bell-shaped and thick everted (QTC) bowls were found in most of the occupations and units of the village except for the upper layers. Their main discard densities occur at the village core, and there is not a clear increasing or decreasing trendline over time here. They are absent from units near the fishery's kiln in Sector B and have insignificant discard rates (0.02 and 0.05 g/l) in Pre-Columbian layers of B1. Both are present, however, in a Pre-Columbian occupation of sector B dated *cal* AD 584-653 (95% probability). QTC miniature ceramics occur only at the village's core (A2-3) in the middle and lower occupations. Red mugs and bowls (QRP) are mostly present in low densities in middle to lower occupations of the village. Their higher discard intensities were detected at the village's core as with miniatures. Rates are, in turn, lower if we move away from the center, where chicha consumption could have taken place in communal gatherings. A slight decrease over time (Figure 80) was revealed at most village units, they are almost absent from pre-Columbian occupations at the fishery.

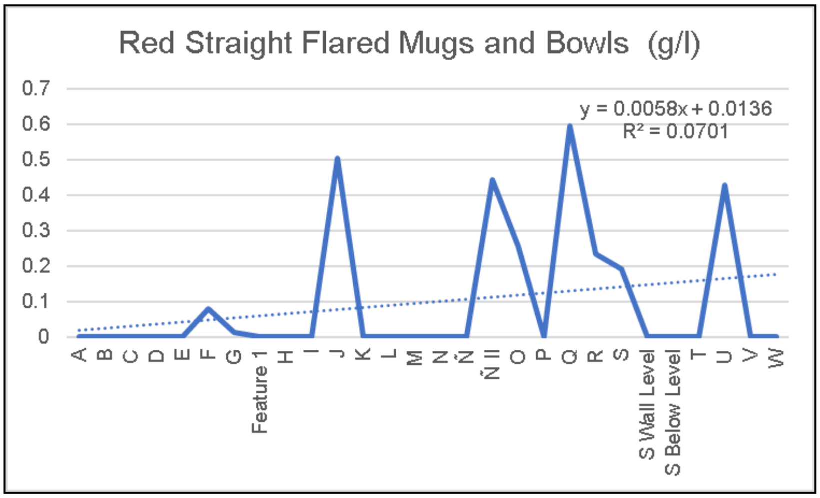

Figure 80: QRP discard densities over time in A3.

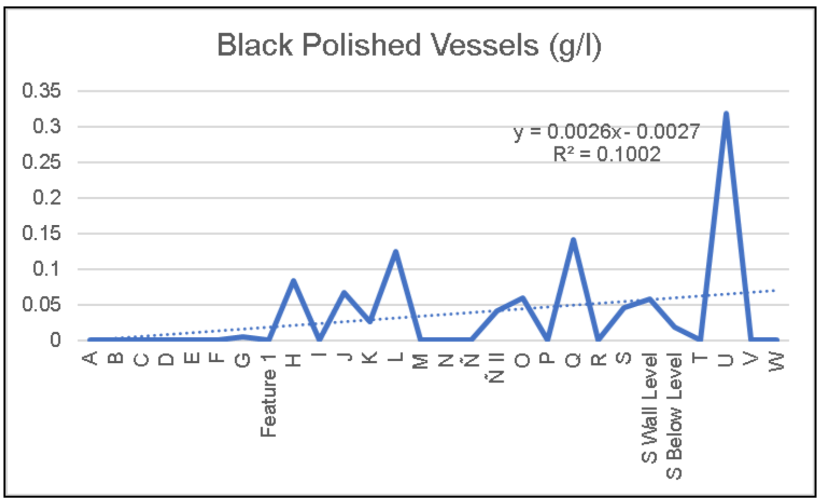

Figure 81: Black polished sherds discard densities over time in A3

Black polished vessels (SPNP style) were recovered from the village center. Their higher discard rates occurred during lower and Middle Period occupations in close association with red-slipped wares. Black polished wares were not discarded in more peripheral units of Sector A, and only appeared in a Pre-Columbian layer of Sector B. They show the same slight decrease over time at A3 as red wares (Figure 81).

The replacement of the Middle Period ceramic assemblage by LIP-early colonial types is gradual and subtle without steady increasing nor decreasing trends. The latter component included at the site included serving bowls with black polished interiors and striated bottles of the PCH type. Both are concentrated in the upper layers of the village. They show very subtle slight increases over time. These bowls were used and discarded with similar intensities (0.5 g/l) at the center of the native village and during Pre-Columbian occupations below the salting patio. One sherd was found at a late Pre-Columbian occupation below colonial layers (B1, H) dating to *cal* AD 1319-1419 (95% probability).

The Spaniards didn't use Dupont-style bowls for serving food and these wares abruptly disappeared from Sector B during the colonial period. Contemporaneous native inhabitants of the village used them for daily food consumption, however. Ellipsoidal bowls with polished interiors (Dupont style) were mostly discarded at low rates at upper occupations in the village, with an increasing trend occurring near the church in Unit A5 (Figure 82).

The sherds from striated vessels (PCH) occur in higher densities in Sector A than in Sector B. These sherds may have come from globular bottles used for liquids. Clear density peaks form in the Middle Period, and in upper late Pre-Columbian (D – F) and early colonial occupations of central units such as A3 (Figure 83). Fragments of Andean striated bottles were scarce in the main colonial occupation of the fishery (B1, Layer C) but their occurrence around the Spanish kiln points toward the presence of villagers working in Sector B. Discard intensity peaks are clearly lower than at the village (0.47 g/l maximum) and occur at one 14th and 15th centuries late pre-Columbian occupation and in one of the earliest colonial layers (B1, Layers H and F, respectively).

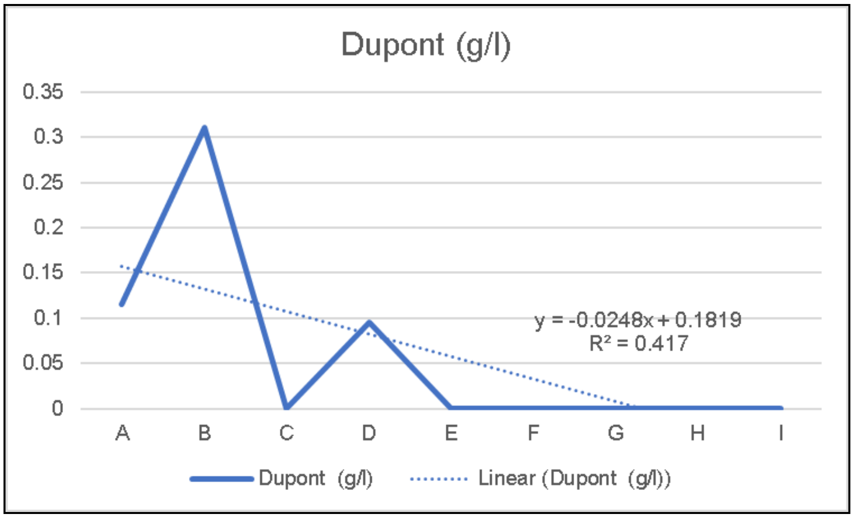

Figure 82: Black polished interior bowls discard rates over time in A5.

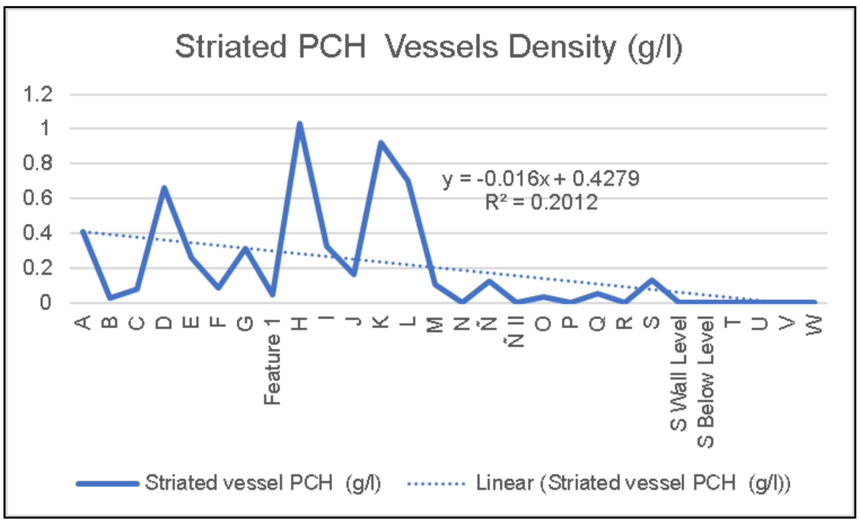

Figure 83: Striated sherds discard densities over time in A3.

Another possible trend in Loa village pottery consumption related to serving practices was a shift from larger, shared or family serving vessels to more use of individual size plates/bowls. This was accompanied by an increase in the size of cooking pots that made use of new tempers. In place of waterproofing slips on storage vessels, the late Pre-Columbian-early colonial commoners devised storage vessels with textured surfaces to enhance grip and transportation. Serving bowls from the early occupations of Sector A have very variable mouth diameters and some far exceed individual serving sizes. Some QTC cases, for example, reach diameters of 40 or even 50cm. Bowls from late pre-Columbian and early colonial occupations and cemeteries (e.g., Pica 8) have less variable and smaller mouth diameters. Cooking pots were stable through time in morphological terms: globular or spherical restricted pots are pervasive across occupations. However, over time the native pots seem to be larger and thicker, sometimes with robust handles as well (lacking from earlier occupations). Although not a strong trend, the village core (A3) yielded higher proportions of cooking pots in its uppermost occupations and a very mild density increasing trend was present there as well, with a spike in Layer B (Figure 84). Both measures suggest concentrated cooking activities not far from the church façade during the colonial era.

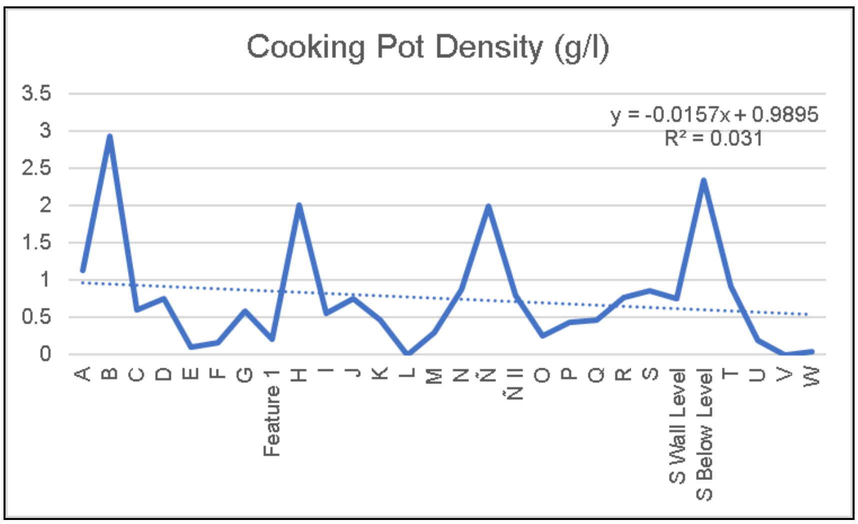

Figure 84: Pot discard densities over time in A3.

7.4.4 Pottery Spatial Patterning: Comparing Sectors A and B

Not surprisingly, the regional ceramic assemblage from domestic Sector A differed from that of workplace/elite residential Sector B in the colonial period (Figure 85). Some of these differences are described in the above section. The extent of these differences can be hard to interpret because proportion measures sometimes provide a different picture than density measures.

The Sector B assemblage is dominated by cooking vessels, at more than twice the proportions of cooking vessels in Sector A, where service/storage vessels are predominant. The explanation for this difference in foodways is not easy to discern. The best explanation may be that the difference indicates a greater degree of specialized food production and serving in Sector B. This specialized food preparation may have leaned towards higher quantity production for communal and feasting events involving workers from the village and Iberians, curacas, mayordomos and other authorities. Greater quantities of food may also have been prepared in Sector B to be taken by workers into Sector A for consumption.

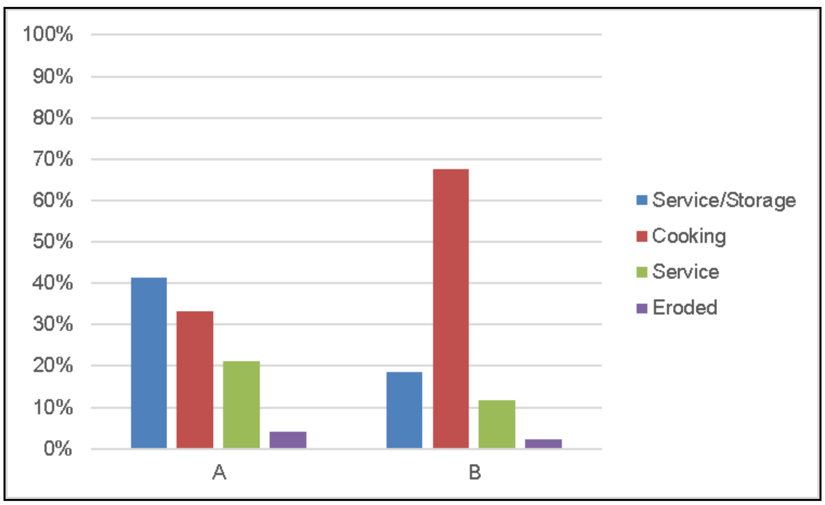

Figure 85: Ceramic functionality by sector.

However density measures by unit offer a slightly different view: (i) the village core has higher median discard values (g/l) for cooking, serving and serving/storage; (ii) discard rates for native cooking pots in the salting patio (B1) are very high; and (iii) the median value for cooking pots here is comparable to the one at the village center (A2) (Figure 86). Villagers intensively cooked (or discarded) at their village's center as was going on at the fishery; discard rates are comparable despite the relatively short occupations representing the Iberian period. What is remarkable is the high density of native cooking pots discarded during the main colonial occupations in B1. This may represent a short episode of intensified cooking in Sector B, as discussed above, or may even be a series of commensal events.

The use of native serving bowls at the fishery was less frequent; their median densities are very low especially near the Iberian kiln. In Sector B the Pre-Columbian occupations show overlapped peaks of functional categories just as in Sector A.

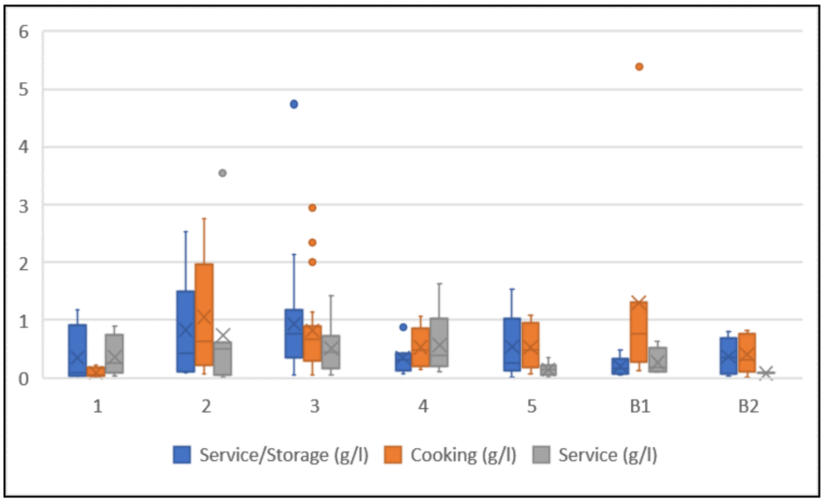

Figure 86: Densities (g/l) by ceramic function unit and sector.

In sum, indigenous service in the colonial kiln is hinted by ceramic functionality in different ways. Local Andeans probably gathered in front of the chapel for festivities and other group activities involving drinking and food consumption. As with fishing, the villagers likely also provided the labor necessary to cook for the Iberian colonists, representing another expression of subalternity and local tributary demands.

7.5 Commodities Distributions in Puerto Loa

In addition to the dietary and ceramic consumptions differences between Sectors A and B, we can investigate differences in the spatial distribution of known commodities. This investigation is important in evaluating the extent of market interaction by the Sector A villagers. In general, excavation showed that the Sector B inhabitants enjoyed access to Andean goods and tribute as well as to diverse European mercantile commodities ranging from luxury items to chicken. The villagers, however, barely consumed any such commodities in the village. This pattern is documented in surface distributions as well. Only two fragments of European style coarse earthenware plates were found in the uppermost native occupations of the fishing village. One could come from a large serving dish and was found near the church (A5, Layer C), the other from A2, Layer 2. As with food, the Sector A village domestic culinary practices eschewed European influences, retaining tradition cooking/serving vessels along with diet.

Systematic surface analysis[18] at the site (using point clustering stats and 10m spaced pedestrian transects) revealed a hotspot of aggregated monochrome ceramics connecting Sectors A and B (Figure 87). There is another, independent hotspot of such ceramics in a dense shell midden with partially buried structures to the south (Sector C). Majolica, porcelain and iron (imported commodities) cluster in Sector B. Fragments of *botijas*, the iconic Iberian maritime container, were concentrated around the Spanish houses and right in front of Sector A ocean access

[18] Getis-Ord Gi* statistic was used in ArcMap 10.7.1 to identify where point clustering was unusually (statistically significant) intense or sparse.

channel. The latter distribution almost certainly represents breakage during the loading/unloading of ships.

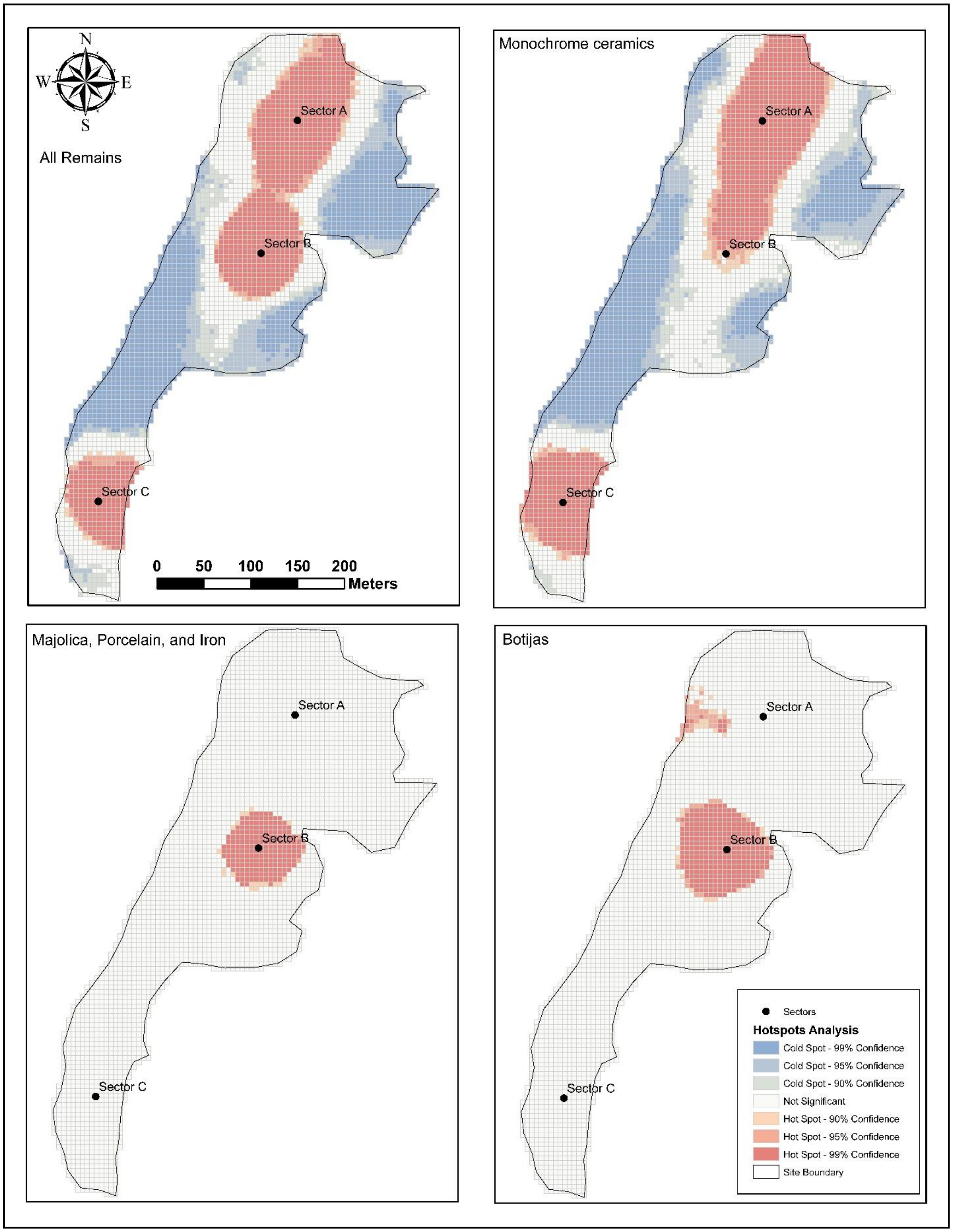

Figure 87: Surface distribution hotspots of commodities and regional ceramics

Sector B received a continuous volume of botijas containing red wine, olive oil, water, and other products. The fishery's surface is covered by hundreds of botija sherds tightly clustered around the Iberian structures and features. The discard/breakage of botijas indicates the focus of their use in and around the salting patio: their median discard rate at the salting patio is over ten times higher than at the village (Figure 88).

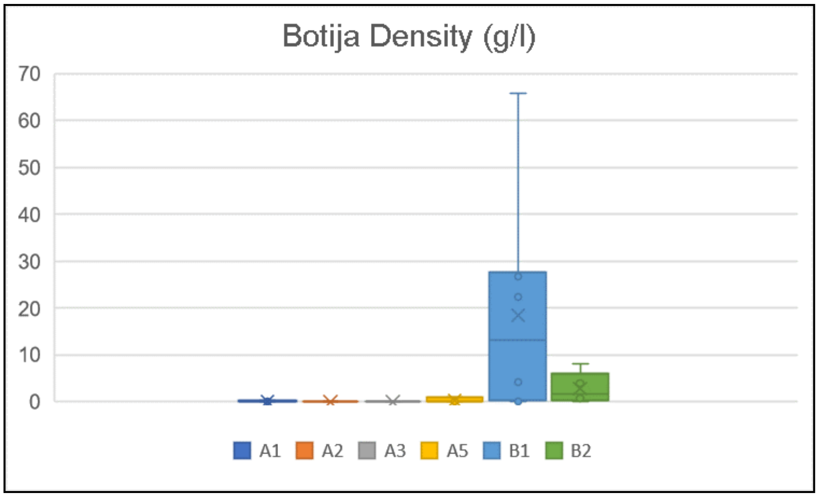

Figure 88: Botija sherds discard densities by unit and sector.

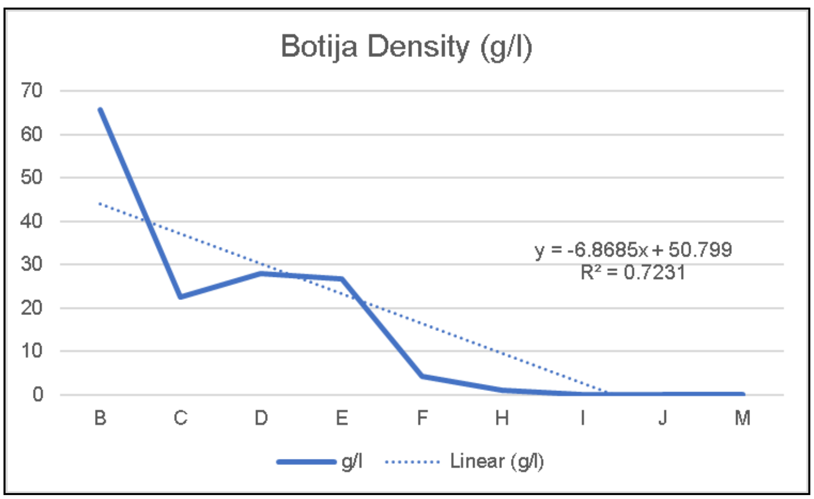

Figure 89: Botija density over time in B1.

That Sector B received increasing quantities of botijas suggests the ports development through time. There is an explosive increment in their presence, first from Layer F through Layer C, then from Layer C to Layer B, reaching 66 g/l (Figure 89) in this terminal colonial occupation.

Villagers only accessed some botijas, the few excavated sherds came from near the chapel (A5) where their contents could have been occasionally consumed probably in connection with chapel activities or by the priest. Discard intensities at the village are very low: the maximum density, for example, was 1 gram per liter. Two units (A1 and 5) show moderate increases over time, but one of these (A1) is in front the natural channel used to load and unload vessels.

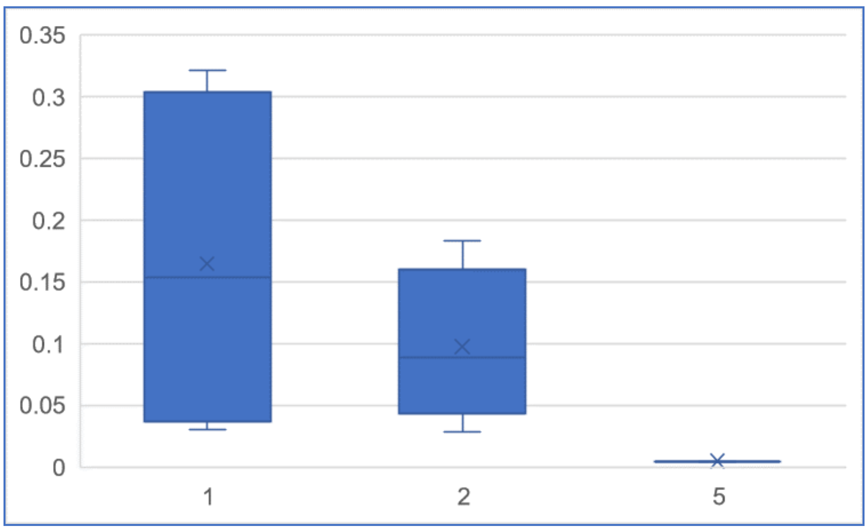

Figure 90: Majolica density (g/l) in sector B (Units 1 and 2) versus sector A (A5)

Panamanian style tableware was consumed only in Sector B by the Spanish and curacas. The earliest Panama plain vessels were found in the early colonial occupations of the fishery while latter occupations yielded either Polychrome A or Blue on White types. Unlike botijas, there was no increase through time in the consumption of these imported commodities. Natives did not use Panamanian tableware. As with other foreign resources and commodities, the only exceptions were a few sherds found near the church (Figure 90).

Similar dynamics were part of the social life of Chinese porcelains at Loa. Their discard densities are the lowest (always below 1 gram per excavated liter) and their surface distribution is even more clustered around the Iberian houses than majolica.

7.6 Tributary Allocation and Commodities

It is essential to recognize that Spanish mercantilism and market processes alone do not explain consumption at Puerto Loa. The unique market system created in the early colonial period incorporated traditional tributary relations and products that were in some cases converted into commodities. Many Andean goods may have reached the fishery as tributary items. Colonial elites received most of the in-kind tributes listed by early requirements for the region (Table 21). The items include maize, poultry, llamas, clothing, sacks and ceramics, and dried fish. The fishery transformed tributes into commodities, but its own functioning was based on previous tribute agreements.

Table 21: Pica and Loa mid-16th Century Tributary Categories (Urbina, 2017, Table 6.10) and Items Excavated at Sector B.

Item	*Fishery*
Maize	✓
Dried fish	✓
Poultry	✓
Llamas	✓
Clothes	✓
Sacks	✓
Chili pepper	x
Sealion ropes	?
Ceramic vessels	✓

In 1570 Viceroy Toledo ordered the peoples from Pica and Loa to make payments in cash (assayed pesos) and in in-kind tributes (Table 22). Dried fish, poultry, and cotton clothes were part of the second category. Each was provided by Loa residents: they intensively created dried fish in the salting patio, probably raised chickens at the fishery, and weaved the requested cotton clothing locally (raw cotton is pervasive in colonial occupations of the fishery).

Table 22: Toledan Tributary Requirements for Pica and Loa (Malaga, 1974) and Items From the Fishery.

	Pica and Loa	*Fishery*
Caciques (exempted)	2	
Tributaries	158	
Assayed pesos tax	711	
dried fish (arrobas)	40	✓
Poultry	144	✓
Cotton clothes	60	✓
per capita cash tax	4.5	
Tasa total	869	
per capita total tax	5.5	

7.7 Summary

In this chapter I've shown that Sector B inhabitants enjoyed access to Andean goods and tribute as well as to diverse European mercantile commodities ranging from luxury items to chicken. The villagers, however, barely consumed any such commodities in the village. While native villagers' work practices may have changed in keyways in the colonial period, domestic practices and materiality changed very little.

The colonial period Sector A villagers maintained their traditional foodways in domestic contexts. In contrast, the Sector B bone assemblages show a "hybrid" diet in which significant proportions of the meat diet consisted of European domestic animals and plants. Where villagers would have been consuming these products was in visits to Sector B as workers or for ceremonies. The few colonists living at the site benefited from access to both the indigenous foods of the Andean tributary apparatus and the imports of the mercantile network. During the fishery's heyday, those living and working in the Spanish fishery ate native products, but also European plant and animal domesticates. Reconstruction of foodways shows:

- Hunting was more intensive in the Middle Period village than in later occupations. Sea turtles, dolphins, and large albatrosses of the Diomedeidae family were mostly recovered from village's Middle Period occupations but reappears among early colonial refuse in Sector B.
- The villagers consumed small quantities of llamas since the site's founding but not as an important meat source. These animals were probably more valued as fiber providers and transportation means to the interior.
- There is slight evidence for an increase in hunting of wild animals (birds and sea mammals) during the colonial period. Two traditional essential prey for the villagers show opposite trends: cormorant consumption dropped in colonial times while sealions achieved very high discard rates in the Sector B fishery.
- Cormorants and sealions in Sector B were consumed in lower proportions than in Sector A, the difference being made up by chicken and sheep/goat, cow, and pig. The Sector B assemblage indicates efforts to create a more "European-like" diet for the Spanish residents. It is not known if these domesticated animals were consistently being raised at the site, but it seems likely. Even if not, the residents' involvement with ship cargos would have allowed regular access to European animals.

- A significant portion of the meat consumed in Sector B was poultry and caprid, but a wide range of local animals (domestic and wild) were also consumed. The representation of European original animals in the village was negligible. The lack of these food items in the village could indicate the inability of villagers to "access" European animals but is more likely to reflect strong culinary preferences. The meat of European animals was not wanted in the traditional food preparation practices of village homes.
- The most important plants in the village domestic diet, from the foundation of the site through the colonial period were algarrobo used in flour, bread or tortilla, and chicha preparations, and a few Andean cultigens like pumpkins or squashes.
- Old-World plants were consumed only in Sector B. Most of these plants were probably purchased via market channels, some could possibly have been grown in gardens elsewhere by the local Spanish themselves. Despite Puerto Loa's remote location, the Sector B residents enjoyed a varied diet in the first half of the 17th century.
- Many lines of evidence argue for the village labor in the salting patio and village laborers bringing their traditional meals to the fishery for their daily maintenance or eating a traditional diet prepared there for them.

Iberian Loa colonists had the purchase power and ability to access trade goods of long-distance maritime mercantilism; native inhabitants, however, were excluded from or eschewed this exchange channel as seen in the absence of European clothing, ornaments, and mundane domestic objects (tableware, glass, iron nails, etc.). The spatial distribution of market commodities shows:

- The Sector B residents had access to elite European trade goods including majolica, porcelain, silk, and wine. As markers of status and ethnicity, these materials further marked the social distinction between the site's Spanish and native residents.
- Food serving practices were equally divided. Sector B residents ate their hybrid diet from a combination of imported and local dishware, including fancy lead crystal goblets, whereas villagers ate from traditional vessels.
- Villager clothing and adornment reflect traditional material preferences. Traditional woven tunics were everyday dress along with copper, stone, and shell beads. Sector B Iberians dressed in Spanish style including linen shirts and elaborate wool jackets.

The presence of coca, decorated Inca-style bowls and decorated gourds and high-value native polychrome textiles (e.g., *chuspa* bags) in Sector B suggests traditional ceremonialism as part of the early colonial negotiations among curacas and Iberians. The self-sufficiency of the village communal economy included the mobilization of labor for surplus dried fish production to feed both traditional tributary obligations and market demands. This process was in many ways a one-way street; the market did not materially penetrate the village domestic sphere. Household foodways and materiality in the village changed little during the colonial period, while the Sector B residents enjoyed a "hybrid" diet and material world at a nexus of Spanish mercantilism and traditional tribute systems.

8.0 Fishing Patterns

What were the most significant changes in fishing practices at Loa under the Spanish? More specifically, in what ways did fishing by the native villagers change as Loa developed as a Spanish port? Once becoming "fish Indians," did native villages fish in new ways? Did fishing increase, intensify, or specialize under the Spanish as a response to colonial commodification? Is there evidence of over-fishing? In answering these questions, I will turn to two main lines of evidence: fish remains themselves, and then changes in fishing technology. In this analysis, I will compare the assemblages from Sectors A and B, as well as looking at changes over time in both Sectors. This chapter will conclude with a summary of the evidence for commodification, and the form that commodification took in terms of both products and organization to create these products.

8.1 Habitats Fished

The Loa indigenous people were superb fishers with a long-term specialization in nearshore pelagic fishing. Over many generations, these Andean fishers landed high volumes of Chilean jack mackerels (*Trachurus murphyi*) rowing their traditional inflatable boats into surf and beyond and casting with metal hooks, lines, sinkers and probably nets.

They also spent part of their days fishing from rocks or beaches for other appreciated species (Table 23). The massive landings of Chilean jack mackerel somewhat overshadow the pervasive consumption of corvinas or cabinzas as meaningful complementary resources in the long-term. Loa's fishermen worked at both rocky shorelines and beaches but the associated demersal and benthopelagic fishes only represents low percentages of the overall catch (20%). They generally didn't adventure far offshore too often for large prey like swordfish. As will be discussed later, much of the native fishing technology reflects the nearshore orientation to relatively small fish such as jack mackerel. Stone sinkers are pervasive, the weight and size of finished cases would be especially suited for relatively small fish, upper water layers and mild conditions.

Some local species swim freely in the water column while others inhabit the bottom, sometimes preferring rocky or sandy surfaces. Demersal fish spend most of their time on the bottom feeding on benthic organisms. Benthopelagic species (a type of demersal fish) swim near the bottom, midwater and near the surface (but normally above the bottom) and feed on benthic and free-swimming organisms. Both types were taken by the native fishermen of the site. No doubt past Andean fishers could read submarine landscapes from the surface, just like local modern fishers do, and target fish and adjust fishing technology accordingly.

Demersal species identified at Loa were found at the shallow waters of local rocky shorelines and sandy beaches. Nowadays these are called *peces de roca* or rock fish, and greatly appreciated by consumers in Chilean high-end restaurants. The capture of rocky demersal fish is normally done from the shore with fishing lines. Other species like corvinas or lenguados are normally captured by the same means but from the beach. Benthopelagic fish from the site live nearshore, in kelp beds, rocky areas, or mixed sandy/rocky bottoms. Fishing lines and nets are commonly employed to target benthopelagic species.

Table 23: Habitat of the Identified Fish Species

Habitat	*Species*
bathydemersal	*Merluccius gayi*
benthopelagic	*Cheilodactylus variegatus*
	Isacia conceptionis
	Mugil cepahlus
	Myliobatis peruvians
	Seriola lalandi
	Thyrsites atun
demersal	*Anisotremus scapularis*
	Aplodactylus punctatus
	Bovichtys chilensis
	Callorhinchus callorynchus
	Cilus gilberti
	Genypterus sp.
	Graus nigra
	Labrisomus philippii
	Paralichthys microps
	Pinguipes chilensis
	Scartichvys viridis
	Semicossyphus maculatus
pelagic-neritic	*Sarda chiliensis*
	Sardinops sagax
pelagic-oceanic	*Carcharodon carcharias*
	Isurus oxyrinchus
	Prionace glauca
	Trachurus murphyi
	Xiphias gladius

Most demersal and benthopelagic identified species identified at the site point to nearshore fishing from land and rafts, for example, sierra (*Thyrsites atun*) a benthopelagic fish that doesn't live near the shore is proportionally insignificant. By the same token, bathydemersal species, fish that live near the bottom but at great depths (below 200m), are virtually absent from the site's assemblage.

Pelagic fish, in turn, inhabit the water column in open waters away from the shore where they swim freely in any direction. Pelagic-neritic fish concentrate over the continental shelf (<200 m deep) as part of nearshore ocean ecosystems[19] while pelagic-oceanic fish inhabits the open ocean beyond the continental shelf. Anyway, most species get close to the shore at some point of their feeding or reproductive cycle.

One interesting common thing between all identified pelagic fish (neritic and oceanic) is that are oceanodromous; they migrate cyclically and predictably over long distances between spawning and feeding areas. As resources, they aren't available year-round, at least in high numbers. Of course, past native fishers would have known very well fish ethology in temporal, spatial and bathymetric terms.

8.1.1 The Chilean Jack Mackerel

Among all these resources, one fish – the horse or Chilean jack mackerel – stands out as one of the economic pillars for the many generations that occupied the Loa site. Chilean jack mackerel or *Trachurus murphyi* (Nichols, 1920), known as "Jurel" on Pacific South America and sometimes called "Inca scad" in English[20], represented a major staple for Loa's natives and keeps playing that role even today for impoverished sectors of the Chilean society as an accessible widespread canned marine protein source.

Chilean jack mackerel is a pelagic-oceanic, schooling species that migrates for reproductive and trophic reasons. It moves around the so-called "jack mackerel belt" off the coasts of Chile, Peru, New Zealand, and southern Australia. Pelagic fish swim freely in any direction in

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[19] https://www.fishbase.se/search.php

[20] https://biogeodb.stri.si.edu/sftep/en/thefishes/species/2577

the water column of open water away from the shore. Pelagic-neritic fish lives over the continental shelf (<200 m deep) as part of nearshore ocean ecosystems[21]while pelagic-oceanic fish inhabits the open ocean beyond the continental shelf. However, most species get close to the shore at some point of their feeding or reproductive cycle. All pelagic fish (neritic and oceanic) are oceanodromous: they migrate cyclically and predictably over long distances between spawning and feeding areas.

As resources, jack mackerels are not available year-round, at least in large volumes. Chilean jack mackerel reproductive and trophic behavior produces seasonal availability even for modern fisheries. It can spawn wherever environmental conditions are suitable, this means places of low currents and water warmer than 15º Celsius. In South America it normally spawns during spring and summer, the main season being from October to December. I have seen how their presence at the mouth of the Loa is announced by an impressive number of seabirds, and the resultant incessant activity of fishing boats, not far from the shore. This fish is nowadays predominantly caught by purse seine and midwater trawl from boats, but contemporary Antofagasta fishermen occasionally catch it with fishing rods from land in the spawning season.

Its daily ethology involves different depths: this fish swims deeper during the day (50-180 m) than at night (1-40 m). Nowadays, Chilean fishermen use fishing lines and light sinkers to capture Chilean jack mackerel from rockeries and piers when they occasionally ascend the water column near the shore. The fact that Loa’s sinkers are light indicates fishing at low depths, so probably conducted at dusk. Jack mackerel was probably more abundant from the end of spring

[21] https://www.fishbase.se/search.php

for Loa's native fishermen and could be caught from both rafts and shorelines, this fish would have been scarcer during the winter and fall.

Its feeding behavior is also very informative about past Andean fishing. Jack mackerels conform a critical node in the southeastern Pacific fish predator-prey network: it's at the same time a large predator pool and a large prey resource. As a generalist feeder, Chilean jack mackerel eats diverse prey like anchovies, sardines, shrimp, and fish larvae. Sardines are a coastal species that form large schools and feed mainly on planktonic crustaceans and phytoplankton. They live in open water but usually come into bays and other protected areas. As a schooling fish that preys on other schooling species, schools of Chilean jack mackerel also get close to the shoreline chasing sardines and others; mackerel's larger predators (tunas, billfish, sharks, and bonitos) follow them closer to the coast as well.

Does the ubiquity of pelagic-oceanic fish at Loa mean far off-shore fishing by the inhabitants? This kind of fishing by Loa's native fishermen is unlikely. Jack mackerel and some shark species caught by the villagers are pelagic-oceanic, they normally swim freely beyond the continental shelf but visit shallow coastal waters for different reasons. For example, Jack mackerel approaches the shore for spawning and blue sharks are common at estuaries, like the Loa's mouth.

As I will detail later, both fish remains and fishing technology indicate that Loa fishers exploited this particular predator-prey network not far offshore. Even though Jack mackerel is occasionally captured from the beach with fishing lines and light sinkers, the association of bonitos, Jack mackerel, and sardines in the assemblage, all part of the same feeding interaction, strongly suggests raft fishing. The predator-prey network of pelagic species like sardines, Jack mackerel, bonito, and others was an essential resource for Loa's Andean fishers. The network was easily spotted from land by native fishermen: fish jumping, birds diving, and sea lions swimming agitated the surface and change the water texture for the experienced eye. They would have sailed fast on their rafts into the natural tumult.

8.2 Comparing Species: Sectors A and B

A very large sample of fish remains (almost 30 kilos) was recovered from the Sector A native village[22]. Unfortunately, the assemblage was mostly comprised of non-taxonomically identifiable fragments (75%, *n*= 33,733). The identifiable part of the sample showed a rich taxonomy composed of different orders (*n*= 10), families (*n*= 21), and species (*n*= 24).

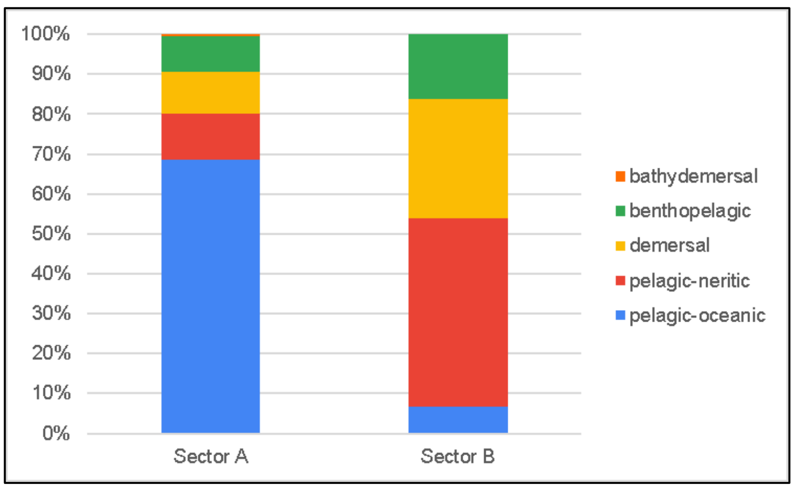

Figure 91: Compared proportions of the identified fish species per habitat.

[22] Ichthyological analysis was conducted by zooarchaeologist Claudia Talep (2022) who sought to identify species, quantify NISP and MNI, and calculate fish size through regression for Chilean Mackerel Jack (the most abundant fish at the native village). All remains were weighted in grams, this section is based on her data and results.

Figure 91 above clearly shows the difference between habitats traditionally exploited by the native villagers (A) and the Spanish fishery (B). As I will explore below, the shift to pelagic-neritic fish reflects the post-Conquest emphasis on sardines/anchovies caught with fine mesh nets.

As I said, the maritime economy of the local natives depended on the predator-prey network of pelagic/oceanic species. They represent 80% of the fish assemblage at Sector A overall. The rocky shoreline and nearby beaches provided a small amount (20%) of demersal and benthopelagic fish combined. This panorama is more marked at the village's core than near the church where proportions get a bit closer (Figure 92).

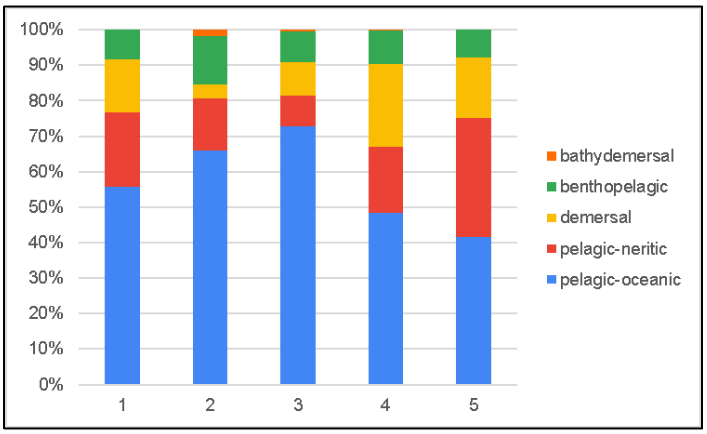

Figure 92: Proportions of identified Sector A fish species per habitat and unit.

8.2.1 Sector A Patterns

Loa's Andean fishermen targeted the described predator-prey network not far offshore. Raft fishing is suggested by the association of sardines, Chilean jack mackerel and bonitos disposed together in the same occupations and all part of the same feeding interaction. Both line and net fishing are very probable and would have ended in similar results (predators might have taken the bait while trying to eat Chilean jack mackerel too).

Table 24: Identifiable Fish Remains from Sector A (by NISP)

Order/species	NISP	NISP%	Weight (g)	Weight %
Perciformes	**8,981**	**75.2%**	**10,004.6**	**88.0%**
Trachurus murphyi	6,886	57.7%	8,837.3	77.7%
Cilus gilberti	635	5.3%	421.88	3.7%
Isacia Conceptionis	614	5.1%	229.28	2.0%
Sarda chiliensis	525	4.4%	259.35	2.3%
Cheilodactylus variegatus	149	1.2%	53.91	0.5%
Semicossyphus maculatus	83	0.7%	131.18	1.2%
Thyrsites atun	33	0.3%	22.45	0.2%
Seriolella lalandi	31	0.3%	27.52	0.2%
Pinguipes chilensis	8	0.1%	4.21	0.0%
Graus nigra	7	0.1%	1.75	0.0%
Bovichtys chilensis	5	0.0%	0.54	0.0%
Scartichvys viridis	3	0.0%	1.19	0.0%
Xiphius gladius	2	0.0%	14.04	0.1%
Lamniformes	**1,690**	**14.2%**	**883.47**	**7.8%**
Not determined	1,612	13.5%	826.67	7.3%
Isurus oxyrinchus	67	0.6%	54.94	0.5%
Carcharodon carcharias	11	0.1%	1.86	0.0%
Clupeiformes	**651**	**5.5%**	**58.38**	**0.5%**
Sardinops sagax	651	5.5%	58.38	0.5%
Pleuronectiformes	**324**	**2.7%**	**166.95**	**1.5%**
Paralichthys microps	324	2.7%	166.95	1.5%
Carcharhinifomes	**165**	**1.4%**	**153.61**	**1.4%**
Not determined	121	1.0%	133.54	1.2%
Prionace glauca	44	0.4%	20.07	0.2%
Mugiliformes	**76**	**0.6%**	**59.16**	**0.5%**
Mugil cepahlus	76	0.6%	59.16	0.5%
Gadiformes	**37**	**0.3%**	**15.9**	**0.1%**
Merluccius gayi	37	0.3%	15.9	0.1%
Rajiformes	**6**	**0.1%**	**10.05**	**0.1%**
Myliobatis sp.	3	0.0%	5.8	0.1%
Myliobatis peruvians	3	0.0%	4.25	0.0%
Ophiidiformes	**6**	**0.1%**	**12.26**	**0.1%**
Genypterus sp.	6	0.1%	12.26	0.1%
Chimaeriformes	**5**	**0.0%**	**7.86**	**0.1%**
Callorhinchus callorynchus	5	0.0%	7.86	0.1%
Grand Total	**11,941**	**100%**	**11,372.24**	**100%**

Table 24 presents the results of the taxonomical identification from Sector A. As can be seen, Loa native fishers successfully harvested fish ranging from large sharks to tiny sardines, but Chilean jack mackerel stands out as the most significant fish for the local community by far (Figure

93). Other species like sardines, corvinas or bonitos followed in importance but in smaller proportions.

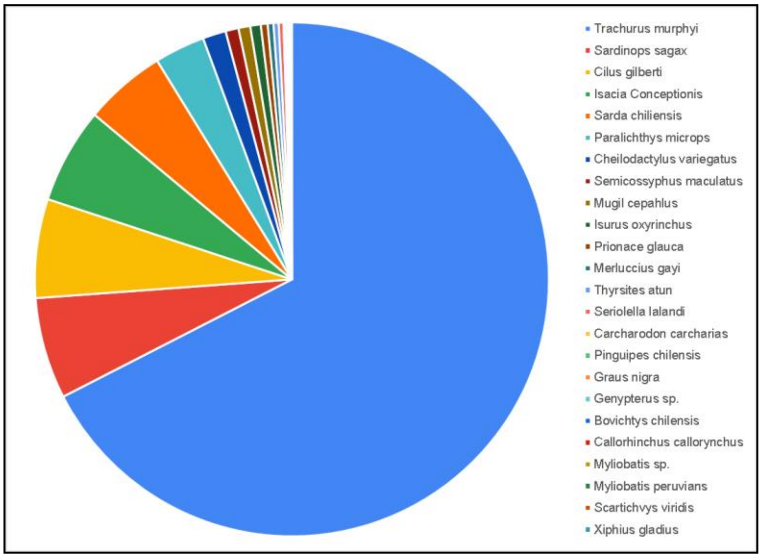

Figure 93: Sector A identified species by count.

Sardines were captured with fine meshes (or harvested by hand) from the initial occupations of Sector A. These tiny fishes are represented by vertebrae only (other parts are likely missing due to preservation issues) and were recovered from all units but not from all layers. They came from both upper and lower occupations but mostly from early occupations of the village core (A3). The intermediate occupations show the clear interest of the community that inhabited the site around 500 AD. for the capture of large volumes of Jack mackerel.

Corvina drum (*Cilus gilberti*), a larger and valued fish in Chilean cuisine, are represented by otoliths and vertebrae mainly. Some more delicate cranial bones were recovered from early layers, head are not as affected by preservation issues as in the case of sardines. In many cases otoliths are associated with vertebrae so domestic consumption is likely, at others, in turn, otoliths are the only remaining part. As with other species, preservation and identifiability issues complicate the detection of fish (head) processing for exchange. Yet units near the church (A4 &

5) show higher proportions of cranial components than units at the village core. The area around the church was intensively occupied during late Pre-Columbian and early colonial times, the native fishermen of these era were devoted to the year-round capture of drums and sardines as we will see later.

Cabinzas (*Isacia conceptionis*) and bonitos (*Sarda chiliensis*) were of importance for the local native diet through time without big fluctuations. They are ubiquitous across layers and units so must have been systematically targeted by native fishermen. These species are also represented by vertebras mostly, the most likely possibility is therefore domestic consumption.

An interesting thing to note is the presence of different kinds of sharks, some of them large and aggressive, represented by their vertebrae and teeth and widely distributed across units and layers. Intermediate occupations yielded the highest numbers of shark remains. Their vertebrae were identifiable at the order level while their teeth at the species level[23]. The identified orders corresponded to Lamniformes and Carcharhiniformes. Lamniformes (from Greek lamna, fish of prey) represented the most frequent of the two and includes familiar species of sharks. In specific, two species of the order were identified thanks to its teeth: mako (*Isurus oxyrinchus*) and great whites (*Carcharodon carcharias*).

Great whites are pelagic inhabitants of the continental shelves, that feed on seals, sharks, and bony fishes, they often get close inshore to the surf line. Makos are also large predators that

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[23] Thanks to the collaboration between Claudia Talep and two shark specialists: Dr. Carlos Bustamante (University of Antofagasta, Chilean Shark Conservancy Program), and Ignacio Contreras (University of Chile, NGO Núcleo Pintarroja).

can be found close inshore, both species were prey (if not occasionally scavenged) of local fishermen that had the skills and techniques necessary to capture these aggressive animals. At the village, the remains of makos are more abundant and distributed than the great whites, the latter were excavated almost exclusively from early layers of the village core. Lamniformes are known as mackerel sharks.

Ground sharks or Carcharhiniformes are the largest order of sharks with hundreds of species from cat sharks to hammerheads. At the site are less ubiquitous than the previous order. Their remains weren't recovered from upper layers and most bones came from the village's core (A2 & 3). The presence of blue shark (*Prionace glauca*) remains at the site was evidenced by their teeth. This is a large oceanic shark that rarely bites humans, it feeds on squids and fish (mackerel, for example). They can be found close inshore where the continental shelf is narrow and near estuaries, both conditions are met at the Loa mouth.

Other cartilaginous fish of the Chondrichthyes class (like sharks), for example eagle rays (*Myliobatis Peruvians*) or pejegallos (*Callorhinchus callorynchus*) are less common but characteristic of early occupations of the village core. In contrast to the archaic communities of other coastal Atacama localities, here conger eels (*Genypterus sp*.) and swordfish (*Xiphius gladius*) are scarce and only found at specific early deposits.

If minimal number of individuals (MNI) are considered, Chilean jack mackerel was the most fished species in the Sector A native village with 2409 individuals or 79% of the MNI assemblage (Table 25). Even if their robust and very diagnostic sagittal crests are in part responsible for better preservation and identifiability, and could even facilitate overrepresentation in analysis, the weight of the recovered fishing sinkers, as explained in a subsequent section, points towards the intentional and systematic targeting of this fish by local natives over time. Therefore, both differential preservation and economic intentionality are responsible for the dominant proportion of mackerel individuals among the recovered sample. The next highest percentage is Corvina at only 8%.

Table 25: Fish Species MNI at Sector A

Species	*Common name*	*MNI*	*%*
Trachurus murphyi	Chilean Jack Mackerel	2409	79.4%
Cilus gilberti	Corvina	242	8.0%
Isacia Conceptionis	Cabinza	158	5.2%
Sarda chiliensis	Bonito	39	1.3%
Paralichthys microps	Lenguado	39	1.3%
Cheilodactylus variegatus	Bilagay	30	1.0%
Sardinops sagax	Sardina	26	0.9%
Prionace glauca	Tiburón azul	18	0.6%
Semicossyphus maculatus	Pejeperro	18	0.6%
Isurus oxyrinchus	Marrajo	14	0.5%
Merluccius gayi	Merluza	7	0.2%
Carcharodon carcharias	Tiburón blanco	6	0.2%
Mugil cepahlus	Liza	4	0.1%
Thyrsites atun	Sierra	4	0.1%
Graus nigra	Vieja negra	3	0.1%
Pinguipes chilensis	Rollizo	3	0.1%
Myliobatis sp.	Raya águila	3	0.1%
Scartichvys viridis	Borrachilla	2	0.1%
Genypterus sp.	Congrio	2	0.1%
Callorhinchus callorynchus	Pejegallo	2	0.1%
Bovichtys chilensis	Torito	2	0.1%
Seriolella lalandi	Dorado	1	0.0%
Xiphius gladius	Albacora	1	0.0%
Myliobatis peruvians	Raya peruana	1	0.0%
	Grand Total	3034	100.0%

8.2.2 Changes Through Time in Sector A

If we look at changes through time, we can see that in the native village proportions of pelagic/oceanic species waxed and waned (Figure 94). Pelagic/oceanic species proportions went from around 30% in the oldest occupations to making up over 80% of the fish in Layers R - Ñ of A3 (~500-600 AD) before dropping to around 50% in the youngest occupations. The most intensive fishing events (Layers R – Ñ) targeted the mentioned predator-prey network probably with fishing lines/nets from rafts and not far offshore. Chilean Jack mackerels of over 30 cm represented a particular target.

Species normally available at sandy/muddy bottoms of beaches and estuaries like corvinas and lenguados are also proportionally less important within the Sector A domestic occupations of the native village. As with fish from rocky shorelines, these are always present but rarely in proportions over 20%. Even if the locals went to nearby beaches for corvinas or lenguados, their main effort was likely made from rafts.

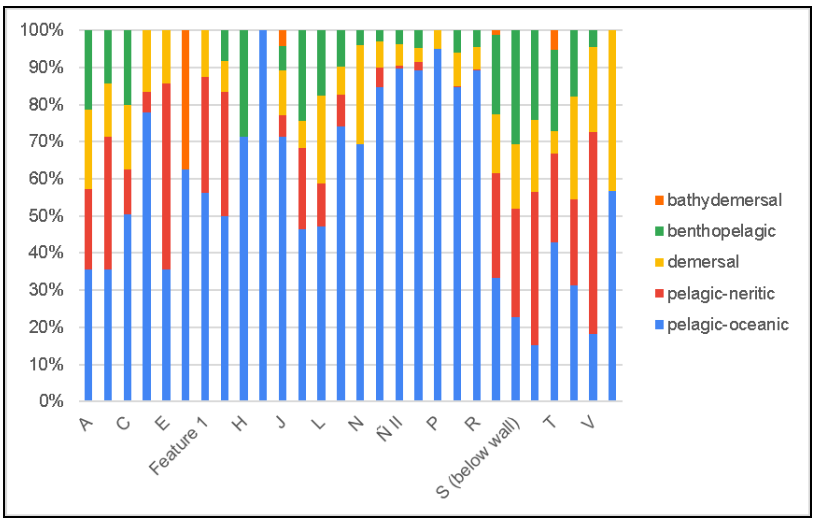

Figure 94: Proportions of identified fish species from unit A3 over time by habitat.

The last native colonial occupants of the village (Layer A) fished both on beaches, rocks and from inflatable boats, the proportions of identified fish taxa is much more balanced than in some occupations dated between 430 and 600 AD. in which Andean fishermen caught Jack mackerel in proportions greater than 80%. These last occupations could have occurred during spring-summer when Jack mackerel is very abundant, while the final occupations could represent winter occupations or a more stable year-round fishery.

8.2.3 Sector B: A Commodified Assemblage

The fish assemblage from the colonial fishery differs from the Sector A village assemblage in several ways. In terms of archaeological preservation, the drying and salting in Sector B fish processing greatly enhanced preservation, producing a spectacular assemblage made up of bones, scales and fins, and even almost edible dried fish meat. Too, as I discuss below, the assemblages also differed in species proportions, so that in addition to processing fish differently in Sector B, the Sector B fishers were catching a different mix of fish.

In Sector B, the excavated sample shows a more even representation of both shoreline and pelagic species. Benthopelagic and demersal species, captured at beaches and rocks, have proportions of 40% or above at the main colonial salting layers (B1, C and F). Demersal fish can only be captured with fishing lines and hooks (or harpoons) near the bottom. The well-preserved colonial assemblage of B shows fishing as an extensive activity that equally demanded work from rafts, beaches, and the rocky shoreline. Although pelagic – oceanic dominate early on, these fish decline in layers G – B (unit B1) during the historical period. Sandy bottom fish are present in the Sector B fishery in an overall proportion that duplicates the one identified among the natives.

It's more than evident that fish commodification as seen in Sector B involved salting and drying processes not found in Sector A. For example, no scales were recovered from the native village and dried fins were only found near the church in an upper layer (A5, layer B). Most of the Sector B assemblage (79% by count, 87% by weight) came from an open patio area (B1) dedicated to fish salting and drying.

Out of a total of 5.5 kilograms and 10,187 recovered specimens, a large proportion (76,2%, *n* = 7764) could not be identified taxonomically. The remaining 24% (*n* = 2423) were identified mostly at the species level.

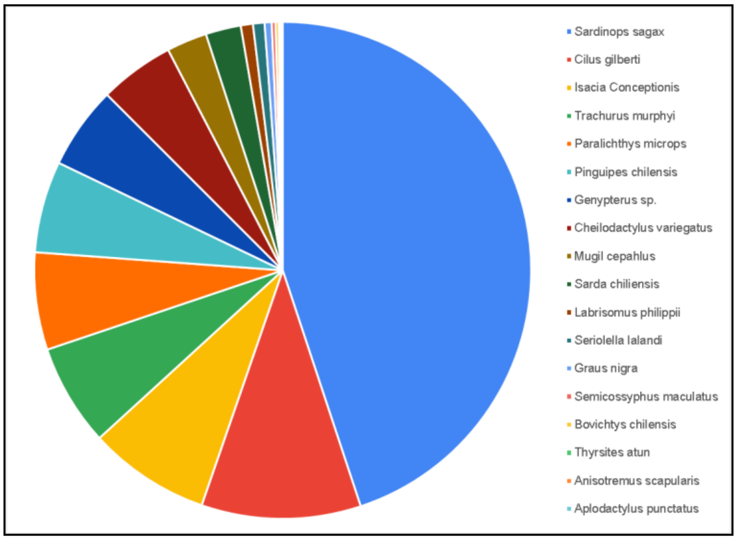

Figure 95: Identified species by count in Sector B.

The list of Sector B identified taxa is represented by 7 orders, 15 families, and 18 species. Chilean jack mackerels weren't the primary prey in Sector B, coming in only in 4th place in the count at 6.6%. Instead, sardines represented 45% (*n* = 1078) of the fishery assemblage by count (Figure 95). While I recovered mostly vertebras, the enhanced salting conditions yielded well-preserved hyomandibular, opercular and other sardine head bones.

A higher percentage of corvinas (10,4%, *n* = 249) was also identified in this sector than in Sector A. As for the previous taxon, corvinas were represented by head bones and vertebras. Whole sardines and corvinas would have been dried and salted for transportation and inland consumption.

The exceptional preservational factors of desert and salting meant that the very product of commodification was also found here: over a kilogram (1142g) of dried fish meat (*charquecillo*) was associated with bones, scales, and fins at early colonial salting features like B1, Layer C. The recovery of charquecillo with articulated vertebrae in place facilitated the identification of three fish species: sardine[24], corvina, and conger eel (*Genypterus sp.)*. Another interesting difference is the scarcity of sharks here.

Table 26: NISP and Weight of Identifiable Fish Species in Sector B

Species	NISP	NISP %	Weight (g)	Weight %
Sardinops sagax	1,078	44.9%	647.49	42.6%
Cilus gilberti	249	10.4%	149.27	9.8%
Isacia Conceptionis	190	7.9%	84.02	5.5%
Trachurus murphyi	159	6.6%	209.37	13.8%
Paralichthys microps	152	6.3%	98.05	6.5%
Pinguipes chilensis	143	6.0%	55.61	3.7%
Genypterus sp.	129	5.4%	144.34	9.5%
Cheilodactylus variegatus	117	4.9%	33.85	2.2%
Mugil cepahlus	63	2.6%	14.42	0.9%
Sarda chiliensis	55	2.3%	50.67	3.3%
Labrisomus philippii	19	0.8%	3.53	0.2%
Seriolella lalandi	18	0.8%	15.4	1.0%
Graus nigra	11	0.5%	4.29	0.3%
Semicossyphus maculatus	6	0.3%	7.08	0.5%
Bovichtys chilensis	5	0.2%	0.89	0.1%
Thyrsites atun	2	0.1%	0.57	0.0%
Anisotremus scapularis	2	0.1%	0.16	0.0%
Aplodactylus punctatus	2	0.1%	0.46	0.0%
Total	2,400	100%	1,519.47	100%

If MNI data are compared, corvina represents the most abundant fish in Sector B partially thanks to its durable and diagnostic otoliths (Table 27). The same is true for Chilean jack mackerel MNI (16%; n = 38) calculated based on its characteristic and perdurable crest. However, it is important to point out that most of the Sector B Chilean Jack mackerel was found in Sector B's Pre-Columbian occupations. Sardines occupy the third position in MNI terms.

[24] Sardines, despite their small size, are not underestimated in ancient Pre-Columbian occupations such as those in sector A; a large part of the sardine vertebrae recovered from the native village were found in its earliest occupations.

Table 27: MNI of Identified Fish Species in Sector B

Species	*Common name*	*MNI*	*%*
Cilus gilberti	Corvina	53	22.6
Trachurus murphyi	Chilean Jack Mackerel	38	16.2
Sardinops sagax	Sardina	31	13.2
Isacia Conceptionis	Cabinza	22	9.4
Cheilodactylus variegatus	Bilagay	21	8.9
Pinguipes chilensis	Rollizo	21	8.9
Genypterus sp.	Congrio	14	6.0
Paralichthys microps	Lenguado	12	5.1
Sarda chiliensis	Bonito	6	2.6
Labrisomus philippii	Tomoyo	2	0.9
Semicossyphus maculatus	Pejeperro	5	2.1
Seriolella lalandi	Dorado	1	0.4
Mugil cepahlus	Liza	4	1.7
Graus nigra	Vieja negra	1	0.4
Anisotremus scapularis	Sargo	1	0.4
Bovichtys chilensis	Torito	1	0.4
Aplodactylus punctatus	Jerguilla	1	0.4
Thyrsites atun	Sierra	1	0.4
	total	235	100

Sardines, corvinas and congers are proportionally more important at the fishery than at the village. Sardines represented 45% at B versus 6% at A among the identified species. Clupeiformes (sardines and others) are small, schooling species of forage or prey fish part of the marine food chain's base. Ethnohistorically, these were normally captured in high volume using fishing nets like the ones found in association at the main salting features of the Iberian fishery. Clearly, colonial fishing activity targeted sardines with nets for higher landing volumes.

Corvinas spend most of their time near the bottom of beaches in search of sea fleas or sandy bottom rockeries for crustaceans and other organisms but can swim midwater to eat sardines and other grass fish. It can therefore be captured with fishing lines and nets along with sardines and other species it would be feeding on.

Congrio or conger (*Genypterus sp.*) corresponds to an eel that inhabits shallow and deep rocky bottoms (from ~20m down). It's normally targeted with bait, hooks, lines and sinkers from the rocky shoreline and boats. The presence of this eel in the assemblage points towards bottom line fishing.

Cabinzas, lenguados and rollizos show comparable proportions between sectors with only subtle differences.

Interestingly, faunal analyses conducted by de France (2012) with the sample recovered from the colonial Iberian inn of Tarapaya (near Potosí) indicate Genypterus sp. (conger eels) as the main marine taxa in what would be one of the main market destinations for our seafood commodities. Clupeiformes are not reported, however. Sardines and anchovies are easy to break during salting and drying, their small size and fragility could be causing overrepresentation at the fishery and underrepresentation at more humid high elevation sites like Tarapaya. Another very likely possibility is that they were consumed whole in the highlands, however.

8.2.3.1 Changes Through Time in Sector B

The excavation of the salting layers showed that the catches evolved from interest in Chilean Jack mackerel and species associated with sandy or rocky bottoms, as testified by AMS dated Pre-Columbian occupations excavated in B1 (Layers H-J) to a clear interest in the massive capture of neritic pelagic species (e.g. sardines and Clupeiformes) plus the desirable corvina drum.

Chilean jack mackerel although present in colonial salting occupations, only represent a small proportion in total number of identified specimens (Figure 96, pelagic-oceanic in blue). In the fishery it only represents a modest ~7% in comparison to the 58% of Chilean jack mackerel in the nearby native settlement Sector A. This difference in Chilean jack mackerel NISP is one stark difference between sectors. Preservation is not a factor here because Jack mackerel crests are robust, and salting enhanced the conservation of even more fragile parts. This fish was salted in colonial layers but in small proportions.

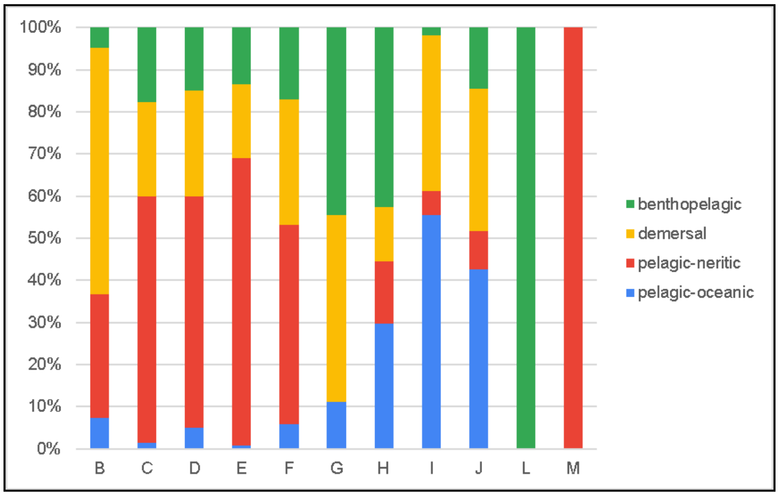

Figure 96: Proportions of identified fish species from unit B1 over time by habitat.

I interpret the assemblages, heavy in fish taken from the nearby rocky shoreline and beaches to indicate the more even deployment of time and effort to provide the elite dwellers of the fishery with diversified and massive captures. Such demersal/benthopelagic fish are proportionally less important at the native settlement, at least for its most intensive ~500 AD Middle Period fishing events.

8.3 Evaluating Intensification

Intensified fishing, processing, consumption, and discard can be measured by densities of fish bone per unit of volume at each occupation. If people devoted more effort to this productive activity, then the resulting densities should be higher. All things being equal let's say 100 fish vertebrae in 1 liter of soil is higher intensity than 10 fish vertebrae in 1 liter (functional or preservation caveats apply, of course). I calculated count and weight-based densities to address a potential fishing intensification over time. In essence, these are measures of the volume of fish coming ashore per unit of time.

In evaluating these findings, we must keep in mind a spatial variability bias caveat. One occupation within a test pit may happen to contain a fishbone rich feature (for example a refuse pit) whereas other layers do not. This would create the impression of a spike in fishing intensity in the former occupation, even though fishing intensity may have been the same throughout all the occupations. This bias is difficult to counter without extensive spatial sampling. However, we can also consider formation processes for each layer to recognize when there might be specialized high density fish features (such as the salting features in Sector B) and take this information into account in interpreting results.

8.3.1 Comparing Consumption in Sectors A and B

Not surprisingly, the native village's core was a place of high levels of fish consumption over time. Fish bones discard rates in grams per liter (g/l) show a median density at the central unit (A3) that is well above the interquartile range of the other units. Likewise, those in charge of the Iberian fishery obtained a comparable volume of fish for their salting operation (Figure 97).

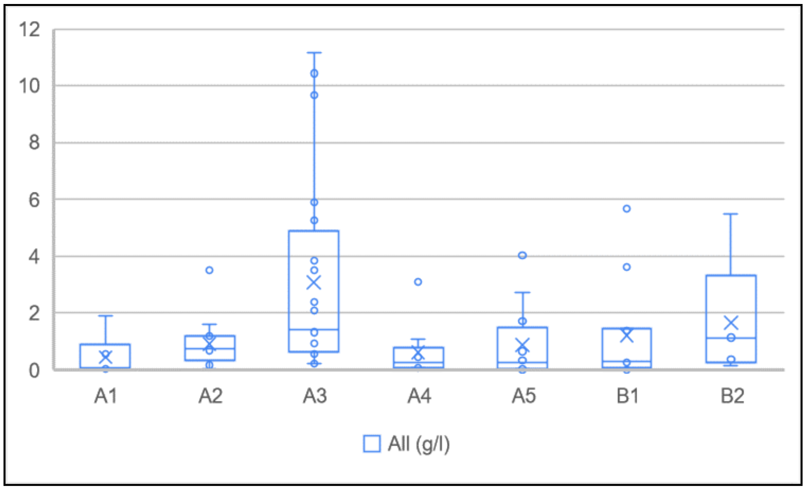

Figure 97: Total fish density in grams per liter (g/l).

In the Sector A fishing village units, we do not see a steady intensification trend over time in terms of density. First, what I found is a jagged density line through time, and across units that likely expresses a process of rotating daily domestic consumption activities that ended up in the large shell midden that accumulated in Sector A.

The most intensive fishing occurred during the Middle Period (*cal* AD 435-600). Total fish remains were notoriously concentrated in high densities by weight (g) in the domestic layers below, with, and immediately above the dismantled household of layer S of A3 (Figure 98). These occupations of the village's core (Layers ÑII to R) revealed fish bones densities of 5g/l or above. All other excavated units at the village are well below the 5g/l mark. The fact that the highest densities were detected in *cal* AD 400-600 occupations in A3 in the village core could be due to the very intense activity of a smaller Middle Period community (or native fishery) on that spot. This issue requires further excavations and a different sampling strategy.

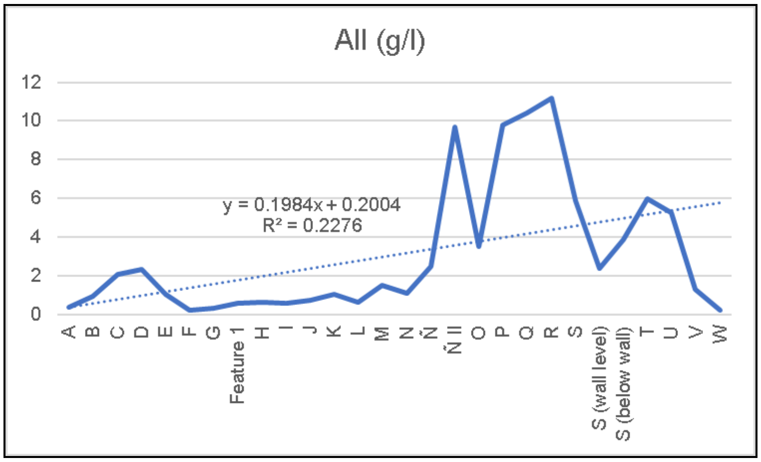

Figure 98: Total fish density (g/l) over time in unit A3.

After higher levels in the late Pre-Columbian (Inca), densities declined sharply in the colonial period (Layers C-A). The decline seen in later occupations in A3 is not matched in other Sector A units near the colonial chapel (A4 and 5) where fish bones were more intensively discarded over time. This area around the chapel saw more concentrated activity (and deposition of all categories of artifacts) generally in late Pre-Columbian and early colonial occupations. These differences remind us of the spatial variability bias. The increases in A4 and A5 are modest but are evidence that fishing intensity didn't decline in Sector A (as seen in A3).

Overall, the ancestors of Loa's colonial native Andean population were responsible for the most intensive (3-11 g/l) fishing revealed at the site, taking high volumes of mackerel and other fish in the Middle Period. Their descendants living in Sector A caught less fish or at least this is what is observed in the available sample. There is certainly no intensification of fishing following the Middle Period, and the "plateau" seen in Layers D – C is nowhere near the intensity of the Middle Period. If more fish were coming ashore during the colonial period, it simply would not end up in the native village.

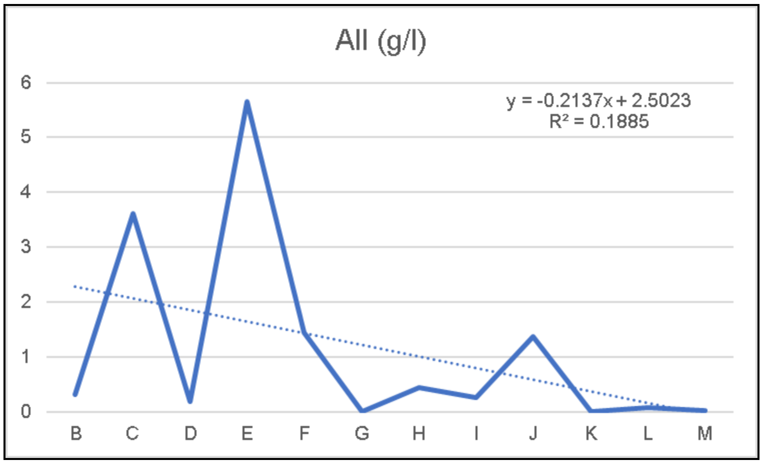

Figure 99: Total fish density (g/l) over time in unit B1.

Spanish managers achieved sizable fish landing in Sector B: the median fish density of colonial occupations of the fishery (B1, layer F and above) is equivalent to the overall median density revealed at the village core (1.4g/l) and markedly higher than in all other excavated units at the Sector A native settlement.

Intensity clearly peaks in Sector B (B1) in the colonial periods (F – B) as shown in Figure 99. But these values - - which include specialized fish processing features - - show a comparable discard intensity regarding late Pre-Columbian Sector A. Colonial densities at B1 are higher than contemporaneous native colonial occupations of the native village (Figure 100), anyway. Put simply, fishing was intensified under the Spanish through Sector B, not through intensifying fish production or consumption in the Sector A native village.

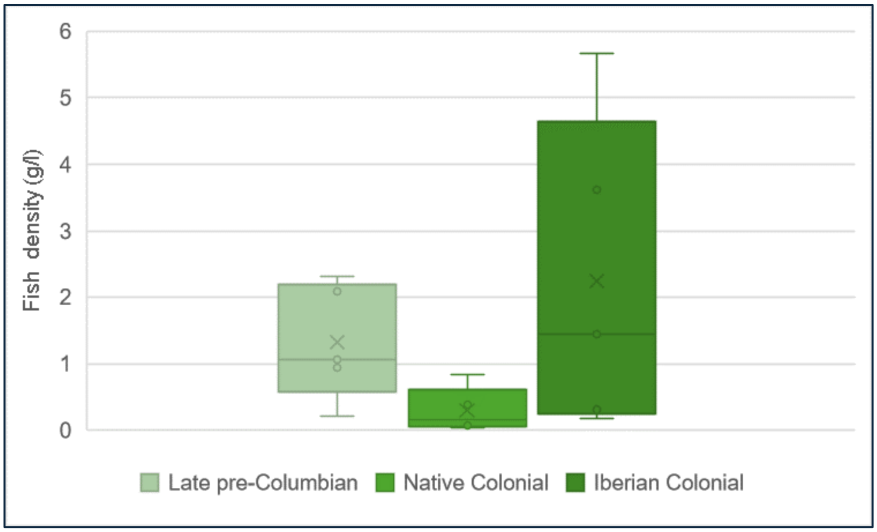

Figure 100: Compared fish densities (g/l) for late Pre-Columbian and native colonial occupations (Sector A) versus Iberian colonial salting (Sector B).

An examination of fish species offers a deeper understanding of the nature of colonial fishing intensification. One can calculate fishbone density by weight or by count. Either method offers advantages and disadvantages. I use density by weight (g/l) to compare a single species across layers, units, and sectors because is less influenced than counts by trampling-effects multiplication. However, weight cannot be used to calculate densities for comparison across fish species. Heavy boned large fish such as swordfish will produce high densities in comparison to small light fish like sardines, biasing analysis. Counts, in turn, can be used for this purpose: one vertebra is one vertebra, it doesn't matter if from a tiny anchovy or a large albacore.

For instance, was the decline in density seen over time in Sector A simply less fishing in general, or reflecting a decline in interest in the Chilean jack mackerel (a focus change)? The answer is both but primarily the second, as can be seen in comparing the overall fish density curve with the Chilean jack mackerel curve for A3. In other words, the residents of Sector A seemed to be fishing in pretty much the same fashion (excepting A3, Layers Ñ - R) and with the same proportion of species caught, throughout nearly all Sector A's history, until the last occupations. In these last Sector A occupations, Chilean jack mackerel makes up a slightly smaller proportion of the Sector A catch. Earlier local fishers brought to their village high volumes of Chilean jack mackerel which was the most common fish in grams per liter terms (Figure 101). The density ranges for this fish across units evidence an intensive capture and broad consumption in comparison to other major species.

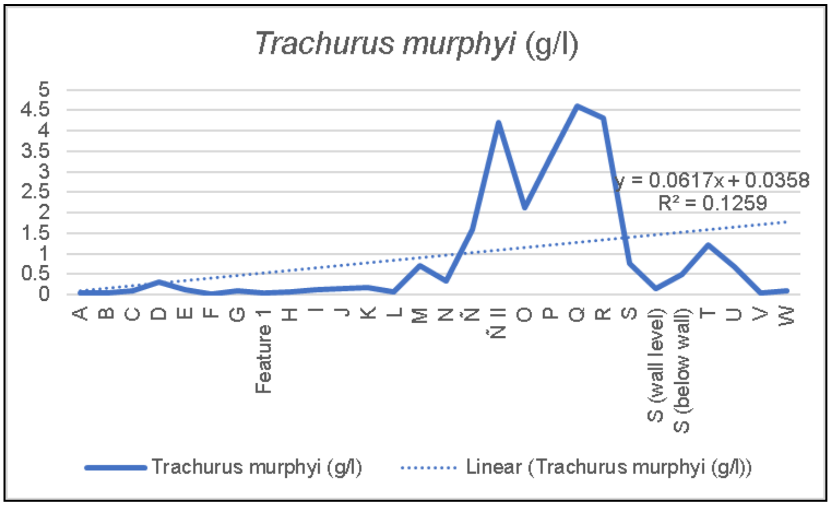

Figure 101: Total jurel density (g/l) over time in unit A3.

Not surprisingly, Chilean jack mackerel was also the most intensively discarded fish in the village in liters per case (l/case) terms (Figure 102). One could hardly sieve any amount of fill without at least one Chilean jack mackerel bone. For this reason, its case/l values are low overall and concentrated below 30 l/case. They peak at 10l per specimen or less if plotted in a steam-and-leaf, or in other words, most buckets (12l) contained one or more bones. The mackerel was intensively fished, and its remains (mainly heads) were intensively discarded in the village. The resource was fundamental for domestic consumption and for inland distribution beyond the Loa mouth.

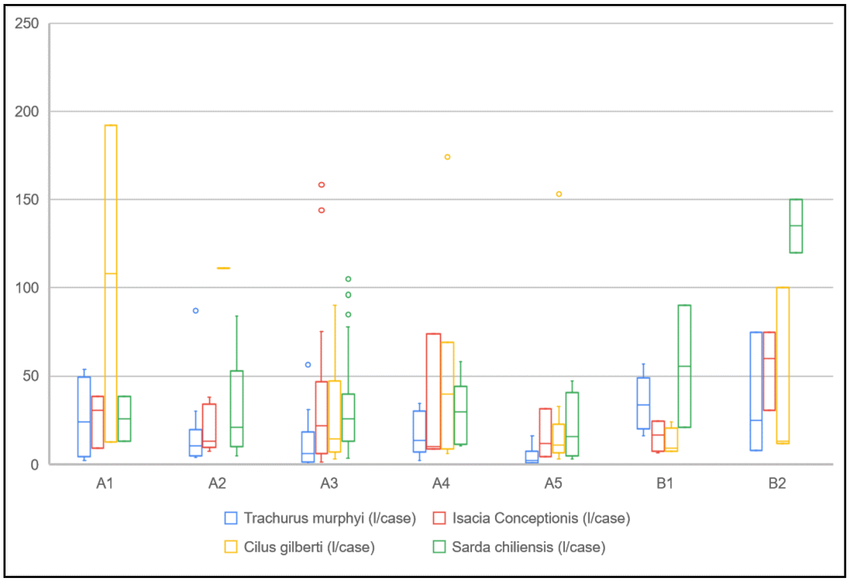

Figure 102: Discard densities (l/case) of the main fish species, both sectors.

The densities for other fishes are very variable in the Sector A village: corvina have variable and bimodal values, concentrated below 40l/case; cabinza densities are also variable, and bonito densities are a little less spread and normally distributed below 50l/case. These three species were therefore less intensively and regularly landed and discarded at the village.

At the same time, mackerel decreased in density and importance with the onset of the colonial occupations especially in Sector B. In the fishing village there was a decrease over time in the proportions[25] of mackerel (MNI) compared to other species (Figure 103). Differences in proportions between Middle Period, late Pre-Columbian and the final colonial occupations of the village with respect to jurel MNI proportions are very significant but of limited strength (x^2=6.915, p=.032,V= 0.139). Corvina and demersal shoreline species grew in importance in colonial times;

[25] This calculation is based on a selection of representative occupations: layer A of all units in Sector A constitutes the native colonial category. The late Pre-Columbian occupations are from unit A3, as are those that make up the Middle Period category (layers ÑII-R). The remains from B1 (layers F to B) make up the Colonial Iberian category.

however, mackerels were still important for colonial Andeans, the difference between native colonial and Iberian colonial occupations with respect to jurel MNI proportions is very significant and strong (x^2=95.507, p=.000,V= -0.743). This species is not important at all in the colonial samples recovered at Spanish settlements in Moquegua and Potosí (de France, 2012; 2021). One possibility is that the centrality of mackerels within native economies was negotiated by the Andeans and untouched by the Iberians as part of trans-conquest negotiations.

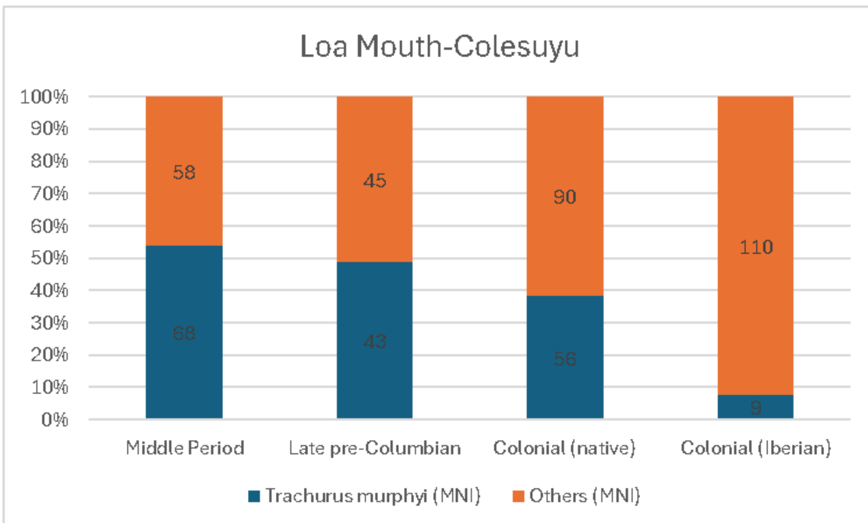

Figure 103: Chilean Jack Mackerel MNI proportions over time.

In Sector B and colonial fishing, corvina was a very desired fish among those landed for urban markets. This sandy bottom beach fish was of particular interest for the early colonial fishers at Loa, not only for local consumption but also for exporting to distant mining cities. Corvina was highly represented in Sector B's salting operation; its discard intensities are comparable to those of the Chilean jack mackerel in the native village. Median discard values for Chilean jack mackerel at A and corvina at B represent the highest densities for the four main species for the two sectors. Corvina is also more numerous in MNI terms than sardines in the Spanish fishery. In other words, colonial fishing efforts for Donoso or others allocated corvinas for salting and consumption in an intensity comparable to jack mackerel in the case of natives. The Spanish and the colonial curacas and stewards demanded a high volume of corvinas which represented the most intensively discarded fish (sardines apart) at the colonial salting patio. My sample shows a density (g/l) increasing trend over time in corvina density in both the Sector B fishery and near the early colonial church in the Sector A village.

Corvina was the most intensively discarded fish at the colonial salting layers of the fishery as shown in weight-based density. The same importance is suggested by count-based density: its rates are concentrated below 20l/case with a peak in the 10s. The mainstays of the native fishing economy (Chilean jack mackerel, cabinzas, and bonitos) were discarded in variable and lower densities at the colonial fishery.

This change in species proportions would certainly have been accompanied by different fishing techniques. One possible technique employed in the colonial intensification and mass-capture of sardines and corvinas is *chinchorreo*, or trawl net fishing at beaches that would collect these species but not fish that only occasionally get close to the shore such as the Chilean jack mackerel. Colonial near-surf trawling fishing is one likely possibility from boats or beaches: corvinas and sardines (the Iberian fishery's two main taxa) would be targeted by this technique. Corvinas and jack mackerel are only occasionally found together when the former goes into deeper water to feed on sardines and Clupeiformes. Therefore, colonial corvina beach trawling seems likely from the fish behavior perspective.

8.3.2 A Multidimensional Analysis

I analyzed a set of variables indicative of fishing intensification over time through multidimensional scaling for the case of the native village. Each occupation with diagnostic ceramic types was assigned a period of occurrence. For further methodological details and the graphical representation of the multidimensional solution, see Appendix C.2.

The results show a strong degree of grouping and fishing continuity, the differences are subtle and do not show the capture of more fish over time. The comparison of dimensions 1 and 2 evidenced early occupations with Middle Period ceramics by fishermen capable of capturing large volumes of various taxa of fish, with mackerel already being a key species heavily consumed from the beginning. Likewise, fishermen dedicated to the intensive capture of mackerel - some of which were large- lived at the village during late Pre-Columbian and early colonial times. Compared to their ancestors the catches were smaller and there is a small local metallurgy industry for hooks. The general picture is one in which early inhabitants were intensively dedicated to fishing while the generations that followed them did not increase the number of fish.

The occupations of the earliest fishermen at the village are grouped (dimensions 2 and 3) around the capture of a greater variety of species discarded in the town at high densities. Mackerel were also caught with an intensity comparable to later times, but they are medium in size. Late Pre-Columbian and early colonial fishermen, on the other hand, captured a smaller quantity of fish. Their involvement in the metallurgical production of metal hooks is more evident, although always on a small domestic scale. Sinker production was a very stable activity over time. In general, the comparison of dimensions 2 and 3 between both periods shows: i) a lower volume of fish for late fishermen, and ii) some reduction in the diversity of species (in comparison to a few very early occupations in which they captured a lot of variety).

Dimensions 1 and 3 show something similar: early intensive fishing of more fish, full sinker manufacturing and potential raft caulking (iron oxide); intermediate occupations characterized by the fishing of large mackerels landed in great quantities and the intensive production of sinkers, and the interest of late Pre-Columbian and early colonial Andeans for the specialized line fishing of mackerels with copper-alloy hooks.

8.4 Evaluating Specialization

Native fishermen maintained a strong traditionalism and continuity in their fishing work, with mackerel as an important resource. But a good part of their catches fed the Iberian fishery during the colonial era with a wide diversity of species landed in good numbers. What was the relationship between this colonial intensification and diversification? In other words, how was this intensification achieved? First, I will examine the patterns seen in the indigenous Sector A, then present those seen in the Spanish fishery.

8.4.1 Native Focus on Chilean Jack Mackerel

The local native fishermen developed a strong Chilean jack mackerel fishing specialization beginning since before the Middle Period. This focus was especially clear from the occupations in the village core unit (A3). As discussed above, when species proportions are considered, the take of the earliest occupants of the village was characterized by diverse species with Chilean jack mackerel representing about 40% (Figure 104). But the most intensive fishing time period, the Middle Period is associated with the highest Chilean jack mackerel proportions. Chilean jack mackerel proportions went up to over 80% in some of these occupations. The proportion of this fish decreases in late Pre-Columbian and early colonial times (as it also does in the Sector B fishery).

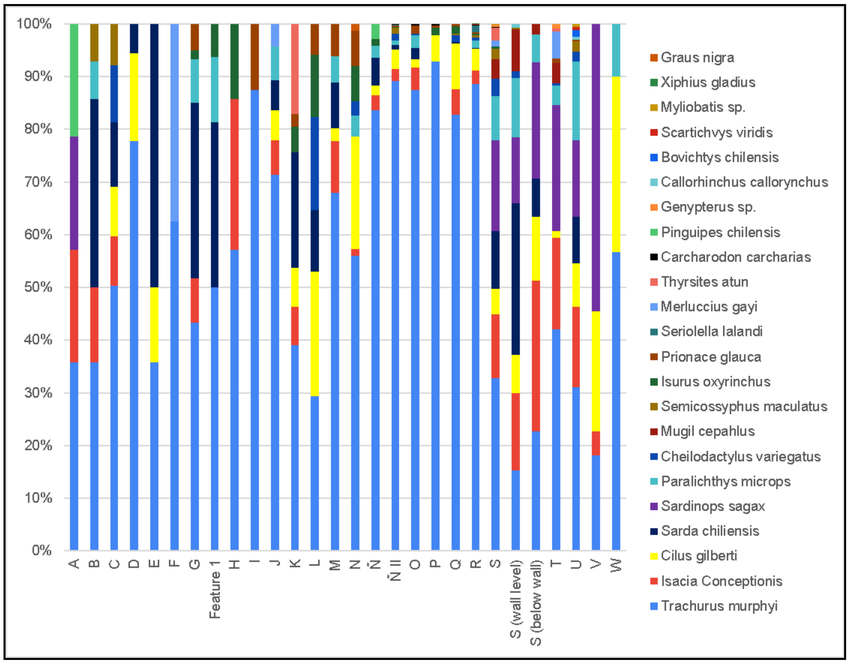

Figure 104: Chilean Jack Mackerel preponderance over time among fish species in unit A3.

Although present, Chilean jack mackerel were not heavily represented in the salting at the Sector B fishery, but the Spaniards (or those working there for them) did cook and eat Chilean jack mackerel (among other fish) as seen from domestic deposits near the kiln (B2). Not unexpectedly Chilean jack mackerel is proportionally more important in the lower - - Pre-Columbian - - occupations of Sector B with Formative and Middle periods (Figure 105). Therefore, in Sector A and the prehispanic layers of Sector B, Chilean jack mackerel represents the primary fish of native consumption, a preference stretching over many centuries.

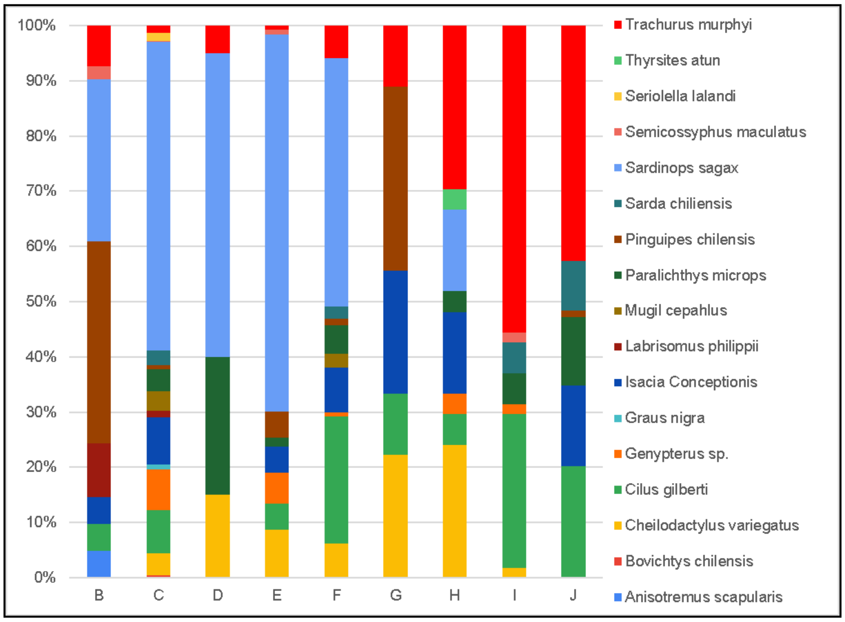

Figure 105: Fish species from unit B1 over time, Pre-Columbian occupations lie underneath Layer G.

Calculated Chilean jack mackerel size shows the systematic harvest of individuals of three years of age or above. This hints at two things: the desire for adult mackerels of a given size and accordingly the potential use of fishing nets of a specific minimum grid-size. Chilean jack mackerels are commonly 45 cm (18 in) long, though they can grow up to 70 cm (28 in). Adult Chilean jack mackerels of ages three or above are over 30 centimeters in size (Leal et al., 2013). Out of 3363 Chilean jack mackerel crests recovered from the village, 69% (*n* = 2336) allowed for calculation of individual size. Calculated sizes are normally distributed (Figure 106), they range from 22 to 62 centimeters. Mean, median and mode are comparable (43, 43, and 40cm, respectively). Most cases are within 5cm of the mean size. Only five cases from Sector A are below that size (0.2%), the most probable interpretation is that capturing practices targeted adult individuals. Nets of a certain mesh size are a possibility, as well as selective capture with fishing lines and sinkers.

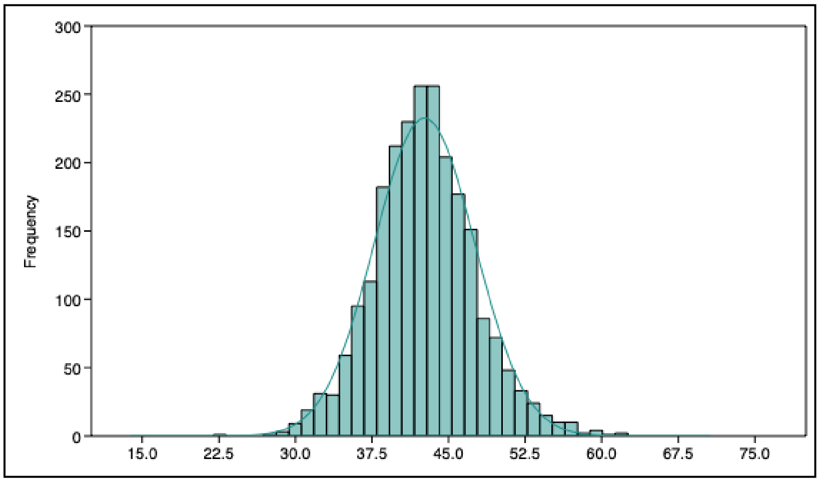

Figure 106: Jurel size distribution at sector A (cm)

Later I will discuss the fishing technology developed at Loa, but it is clear that in this native fishing specialization, juveniles, and small prey (e.g., sardines) were not of interest and not caught. Neither juvenile sized Chilean jack mackerel crests nor sardines are common within the village's assemblage. Fishing nets and lines are totally absent among the excavated sample, but metal hooks and stone sinkers are present. Line fishing is evidenced, but nets for Chilean jack mackerel or larger fish cannot be ruled out.

One technique and specialization not evidenced in our sample is harpoon hunting of large predator fish. Swordfish (*Xiphias gladius*) is an oceanodromous species that migrates toward temperate or cold waters in the summer. They are occasionally found in coastal waters and feed mainly on fish like mackerels mostly at nights. Locally known as albacora in the coastal Atacama, they are traditionally hunted with large harpoons. Both swordfish bones and large harpoons are nearly absent from Loa's assemblage.

Although we can be confident in identifying the strong long term native specialization on Chilean jack mackerel, it is more difficult to discern other diachronic patterns. This difficulty stems from the nature of the Sector A midden deposits, which, as I discussed earlier in this thesis, grew unevenly, probably as the focus of occupation (and discard locations) shifted around through time in Sector A. Density measures suggest fish processing and consumption activities concentrated in A3 at the village's core (as seen archaeologically) through time. And fish processing and consumption activities here resemble other Sector A units in terms of number of identified species. Yet while A3 shows a decrease in the range of targeted species over time (Figure 107), the pattern is not seen in other Sector A units. Some species are ubiquitous across units and layers, others occur infrequently, only at some points in space and time.

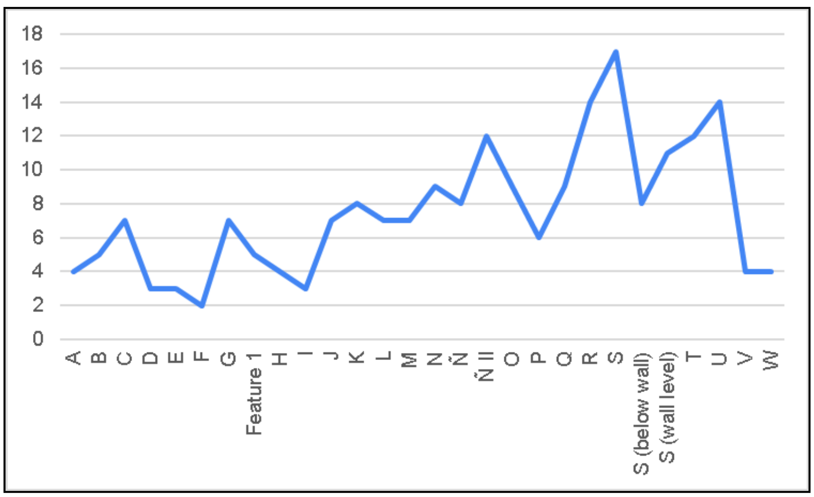

Figure 107: Number of species per layer in unit A3.

Sardines are a good example of the second case. Over 50% of their vertebras (n = 348) were found at early occupations of the core (A3). This tells us the use of nets was likely taking place when the settlement was founded, and they were used extensively early on. Sardines are not represented in intermediate occupations of the village (when proportions of Chilean jack mackerel are highest), but they reappear in considerable proportions (36%, n = 234) at upper occupations near the church (A5). This suggestive distribution of sardines in the historical period could be reflecting the vagaries of sampling or be the product of Inca and Spanish tributary mass-capture requirements given that sardines were a key resource at the Iberian fishery.

8.4.2 Diversity and Evenness Measures

Diversity and evenness comparisons show that the Spanish and their representatives in Sector B frequently dealt with a more diverse catch in both domestic consumption and processing for commodification than is seen in the native village remains.

The Shannon–Weaver function (*H'*), a diversity index, considers the number of species in a sample (richness) as well as their abundance within the sample (evenness). Samples constituted by many taxa with even relative abundances have higher diversity than samples with less categories and disproportionately presence of few species (Reitz & Wing, 2008). The operating assumption is that archaeological diversity reflects animals intentionally targeted by site's occupants or incidentally incorporated with preserved, recovered and identified remains (Reitz & Wing, 2008).

Diversity was calculated following the $H'=-\sum[(pi)\times\log(pi)]$ formula (Reitz & Wing, 2008), MNI were calculated by ichthyology specialist Claudia Talep, the natural logarithm ($\log_e$) was employed as the base. Higher *H'* values are indicative of a greater breadth of species diversity, even distributions of taxa within a given sample are represented by equitability *V'* values close to 1 (Reitz & Wing, 2008). In other words, the higher both values the more diverse the fish species contained by a sample. In this case, I calculated both values layer by layer.

Results show a clear difference between the Spanish fishery and the native village contexts. The Spanish and their representatives frequently obtained more diverse fish species for commodification and consumption as seen in comparison to the village's sample. Samples from Sector B have higher *H'* values, the mean diversity index is 1.4 (versus 0.97 at A), median values show an even more marked difference (1.7 and 1, respectively). Sector B fishery samples are more evenly distributed than the samples from the village: *V'* ranges between 0.7 and 1 at Sector B overall and between 0.1 and 1 at Sector A overall. Mean values indicate that units A1 and 4 have on average the most diverse fish assemblages within the village. One interesting result is that the most important colonial salting feature (B1, Layer C) yielded the maximum value among all excavated samples.

There is not a clear temporal trend of diversity reduction over time due to overfishing, for example. What these values are indicating is a broader exploitation of species in the context of colonial commodification, something that is also mentioned by Spanish witnesses.

At the village's core (A3) for example, we see a jagged pattern over time in terms of species diversity mimicked by associated evenness values (Figure 108). Both values don't indicate any temporal trend over the long occupational sequence. An interesting issue is posed by layers Ñ (II) to Q, a series of fishing occupations with lower comparative diversity and evenness. These are the occupations of fishers interested in capturing large volumes of mackerel.

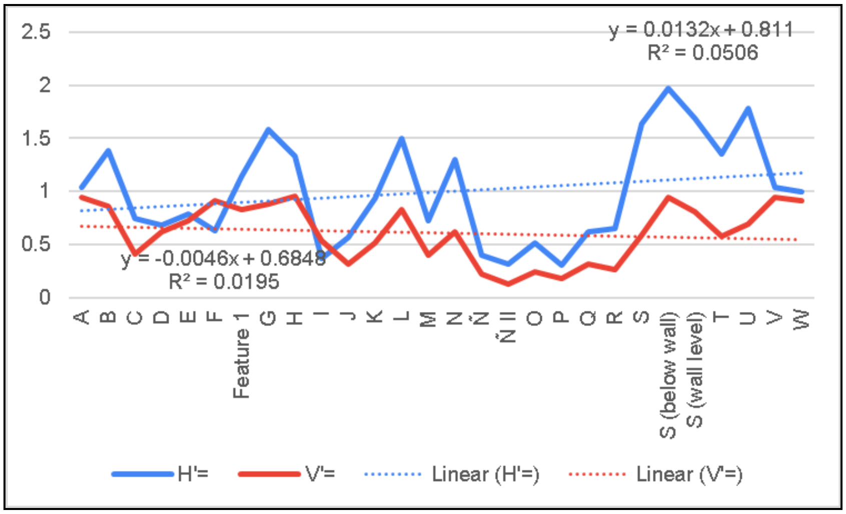

Figure 108: Shannon–Weaver diversity (H') and equitability (V') over time in unit A3.

If fishers specialized in just a few species over time, we would expect a steady decline in *H'* values associated with *V'* values close to 1. What we see at A3 are fish assemblages that form diversity peaks over time of a given range of species in proportions that peak into evenness. Each unit shows a different pattern, the village was formed by hundreds of discrete episodes of domestic occupation. Therefore, much more excavation is required to have a better grasp on this issue. The expected decline in *H'* and *V'* values of 1 was observed, however, at units A1 (Figure 109) and A4 which could be due to fishing specialization into fewer species over time, resource depletions, or sampling vagaries.

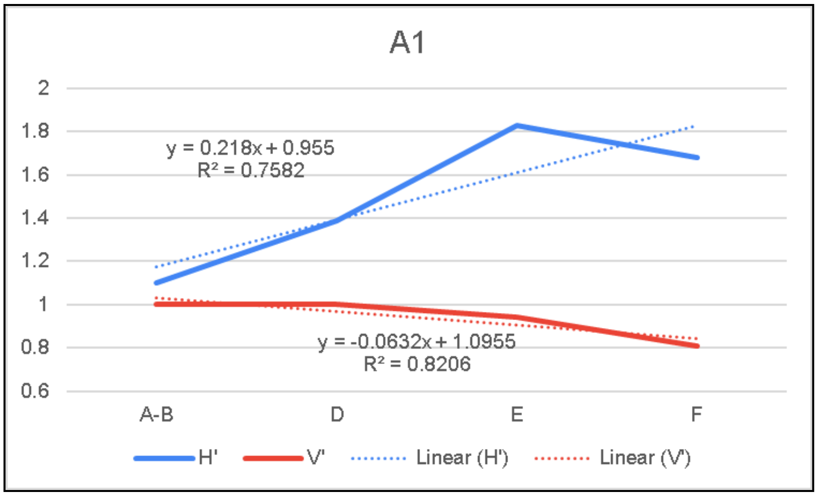

Figure 109: Shannon–Weaver diversity (H’) and equitability (V’) over time in unit A1.

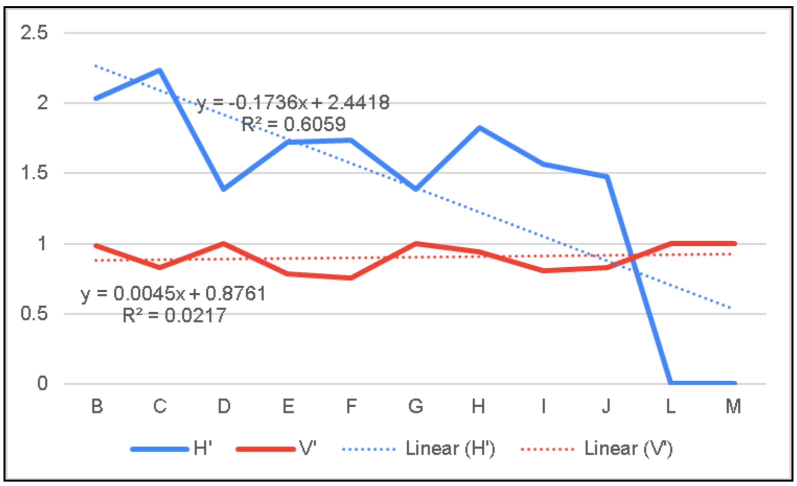

Figure 110: Shannon–Weaver diversity (H’) and equitability (V’) over time in unit B1.

The main point highlighted by this analysis is the more diverse fish species representation associated with the Iberian architecture. At the colonial salting feature (B1) upper layers show an explosion in diversity of fish obtained in even proportions for the purpose of preservation and inland distribution. This is represented by a trend over time in diversity and high evenness values (Figure 110). Near the kiln (B2), layers have *H’* values near 2 (rarely seen at the village) and equivalent relative abundances of fish species. Overall, residents of Sector B consumed and sold more diverse fish over time, in contrast to the patterns seen in Sector A. This differential access would be related to the elite social position, taste preferences and control of traditional production relations by the residents of Sector B.

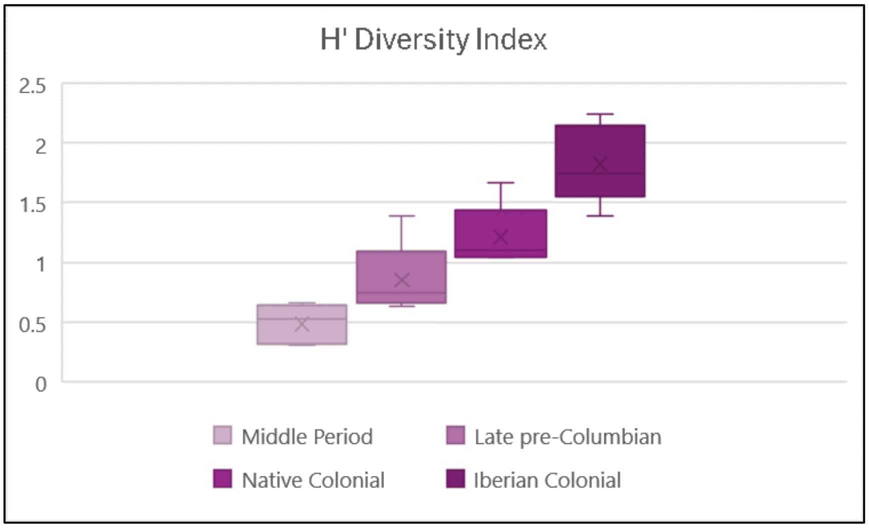

Figure 111: Shannon–Weaver diversity (H’) over time in unit B1.

The Spaniards of the fishery processed a greater variety of species than the contemporary natives of the fishing village. As I said, higher *H’* values are indicative of a greater breadth of species diversity and the values[26] of the colonial salting layers are above the most significant occupations of Pre-Columbian times in Sector A (Figure 111).

The Spanish directed fishery exploited a broader range of fish than did the native fishers creating the Sector A fishbone assemblage. Therefore, specialization over time was not a part of the Spanish port’s commodification processes. The higher diversity suggests new emphases in the

[26] As in a previous figure, the calculation is based on a selection of representative occupations: layer A of all units in Sector A constitutes the native colonial category. The late Pre-Columbian occupations are from unit A3, as are those that make up the Middle Period category (layers ÑII-R). The remains from B1 (layers F to B) make up the Colonial Iberian category.

suite of existing fishing practices, for example as part of fishing "intensification" in colonial times natives had to fish more diverse marine habitats to provide the whole range of species the Spanish may have required (either directly or more likely working through local caciques).

8.4.3 A Multidimensional Analysis

Multidimensional scaling was used to illuminate the degree and nature of fishing specialization in terms of greater emphasis on species and new techniques or toolkits.

From the multidimensional analysis it can be observed that comparing dimensions 1 and 2 express how earliest occupations with Middle Period ceramics display large volumes of various taxa of fish, with Chilean jack mackerel constituting a key species, heavily consumed from the beginning. Likewise, it can be observed that some transitional occupations with Middle Period and late Pre-Columbian ceramics or late Pre-Columbian ceramics alone were generated by fishers dedicated to the intensive capture of pelagic-oceanic fish and Chilean jack mackerel (Figure 112-a), some of which are large.

The early occupations of fishermen from the Middle Period are grouped (dimensions 1 and 3) around the capture of a greater variety of species discarded in the town at high densities. Medium-sized mackerels were also caught with an intensity comparable to later times.

The activities of Sector A village's early colonial residents, on the other hand, captured a slightly greater diversity and smaller quantities of fish (Figure 112-b). There was less emphasis in Chilean jack mackerel. Their fishing praxis was diversified in terms of habitat, just like what was observed in the Iberian fishery's sample. The native colonial assemblage is relatively more diverse and even than in late Pre-Columbian occupations, and mean trophic levels are low.

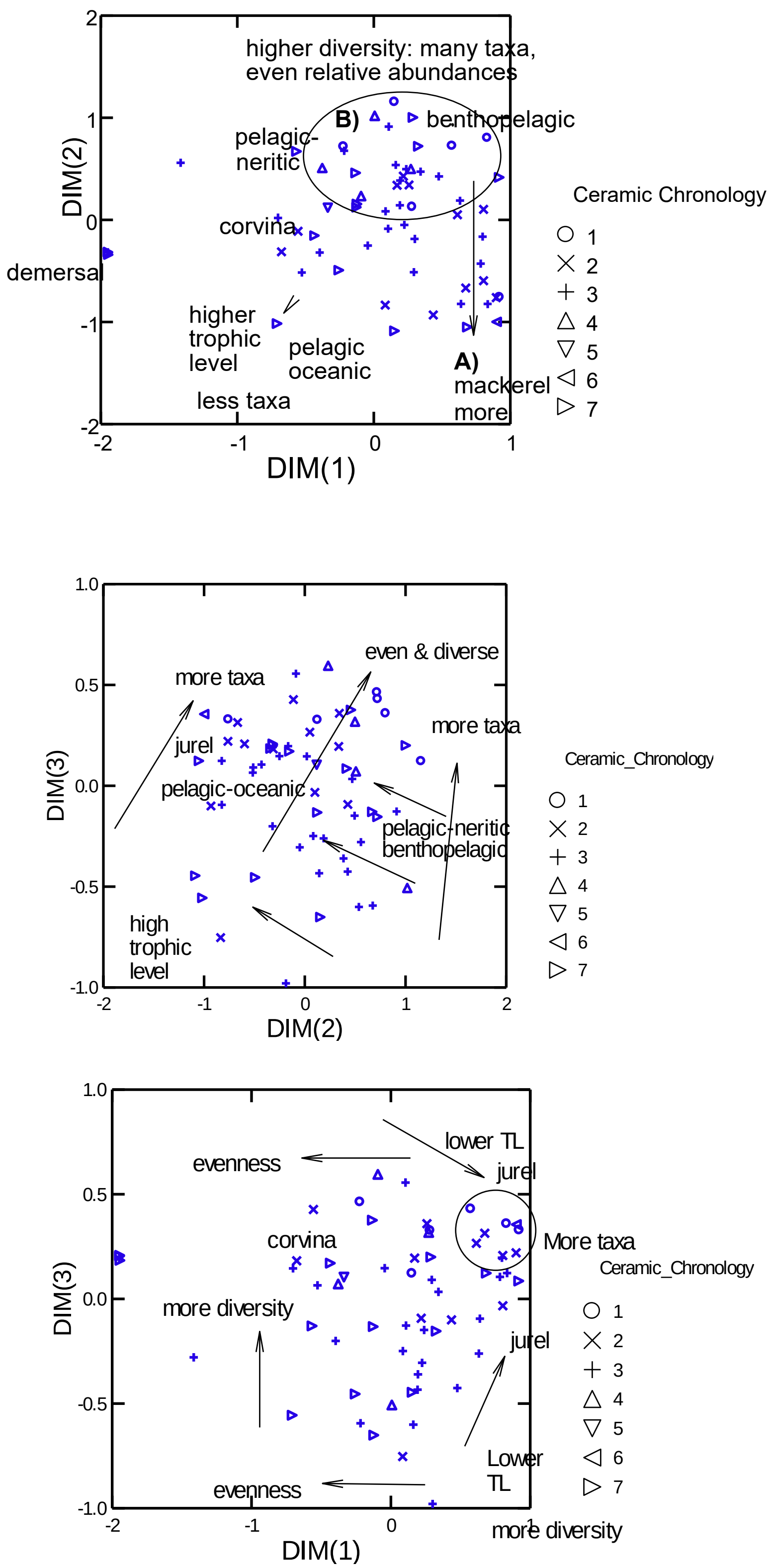

Figure 112: Multidimensional scaling of specialization in fish species among natives.

8.4.4 Comparing Processing: Sectors A and B

Fish were processed in more than one way at Loa. Of course, fresh fish was consumed in everyday meals such as stews, soups or roasted. Burned fish bones were far more common in Sector A than in Sector B. The main species consumed in Sector A all presented evidence of burning. Almost a third of the lenguado (*Paralichthys microps*) bones had signs of burning, as did, in lower proportions, jack mackerel, cabinza and bonito. Few bones in Sector B showing signs of burning. The only burnt fish bones in Sector B (Chilean jack mackerel and sargo) were recovered from a Middle period occupation (B1, Layer I).

The late Pre-Columbian circulation of dried Chilean jack mackerel, corvina and sardines along the Lluta and Azapa valleys of Arica has been demonstrated by Mendez-Quiros et al. (2023) in their excavation of storage features within local agricultural villages and Inca collcas. That production for this sort of exportation was taking place at Loa in Pre-Columbian times at the site is very likely.

8.4.4.1 Commodity Fish: Headless or Whole?

Fish remains were sorted into identifiable and non-identifiable fragments (typically minute fragments), with identifiable bones consisting of those that were taxonomically classifiable. Non-identifiable fragments made up around 76% of the total assemblage at both sectors. The identifiable fragments can be sorted by anatomical position, for example into cranial vs postcranial. Differences between Sectors A and B should reflect native consumption (and prehispanic export practices) versus colonial period export practices. More specifically, comparing Sectors A and B should reveal whether Spanish commodification of fish (drying and salting) involved head removal. If so, this comparison involves the familiar “butchery/transport” effect in zooarchaeology. The least desirable parts should be highly represented at the butchery site as the more desirable parts have been transported out. The differential discard of little-value animal by-products, like fish heads in our case, has been proposed to apply to animal processing specifically in the context of market commodification (Whittaker, 1999). The ideal archaeological situation would be to find a cache of such by products discarded together in high densities in delimited features or pits.

Therefore, the expectation is to see high proportions of cranial bones in Sector B. Of course, if fish were salted and exported whole, there should not be disproportionate amounts of cranial bones in Sector B, instead the proportions should be closer to a normal consumption figure (represented by Sector A).

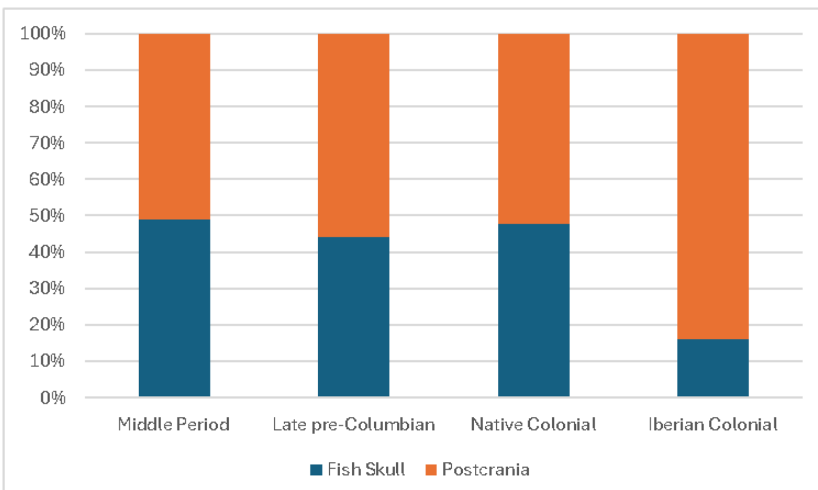

Figure 113: Cranial versus postcranial fish proportions over time.

Strikingly, head fragments make up 40% in Sector A of identified parts as opposed to only 18% in Sector B. Postcranial components dominate the colonial fish assemblage. More heads were discarded among the Andean fishermen than in the colonial salting patios. Sector A represents an area of domestic fish consumption and potential fish processing for export at certain times as well, particularly in the Inca epoch. There is a strong positive correlation between heads and bodies in the village: 96.1% of variation of crests is explained by body bones (r=.980, p= .000, Y=0.626(X) + -7.740). Overall, the assemblage from Sector A exhibited an even representation of fish heads and body parts. Both portions were found together in the fish remains layer after layer; with only a slight predominance of body parts (if all species are computed together).

We can hypothesize that if Sector A value represents a normal consumption ratio, then the Sector B value can be seen as under-representation - - something other than normal consumption. As seen in B1, heads are lower proportions in the colonial F – B layers than in the prehispanic and native colonial Sector A occupations (Figure 113). Alternatively, we can hypothesize Sector B as closer to the no head-removal pattern, and processing in Sector A involving greater head deposition. Logically, as a specialized fish processing sector, it is more likely that Sector B represents the alternative to normal consumption. Given this, what does the relatively low proportion of head bones in Sector B indicate? This poses an equifinality problem to my analysis: fish head scarcity at Sector B could reflect the salting of headless fish or the processes and transport of whole fish.

There are three possibilities, keeping in mind these are not mutually exclusive:

(1) An obvious scenario is that the assemblages from Sector B represent a processing stage (drying and salting) in which the fish heads had already been removed. The test units, such as B1, exposed the salting and drying facilities. Not surprisingly, given the limited number of test excavations in Sector B, none happened upon the place where these fish heads may have been discarded. Given the smell, the discard site would likely not be around the buildings of Sector B. Alternatively, heads may have been thrown into the sea or consumed in soups and stews in both Sectors A and B.

(2) Many fish were beheaded at the village before being taken to Sector B for processing.

(3) In Sector B fish were being processed whole for export. The corollary of this interpretation must be that somehow the assemblage from Sector A reflects processing that selected for greater head discard, perhaps as in the butchery/transport effect.

In evaluating these alternative scenarios, we must keep in mind that these are not absolutes. We should not assume that colonial practice of processing headless fish for transport meant that no fish were ever processed with heads. Nor that the presence of some fish heads at Potosí mean that the fish processed at Loa must have been processed whole. Equally, the presence of high proportions of heads in Sector A does not mean that this is a signature only of local consumption. As discussed previously, the evidence for Pre-Columbian processing for fish export from Loa argues for processing for export as well, which may or may not have involved head removal. Additionally, differential preservation of anatomical elements raises another issue. The robustness of the crest compared to vertebrae will lead the former to be over-represented (for the individual Chilean jack mackerel the ratio is 1:24 (0.041). Preservational processing such as drying and salting should select for greater post-cranial representation.

Although the evidence from Sector B is consistent with a scenario of processing headless fish, there is archaeological and ethnohistoric evidence for the circulation of whole fish as marketable products in the colonial highlands. Whole individuals were distributed through Potosí's market channels: de France (2012, p.19) identified numerous fish cranial elements (presumably of eels and *Bodianus sp.*) among the sample from the elite colonial inn of Tarapaya.

Scenario 3 seems more plausible if we can also consider species differences in processing. Corvinas and conger eels, two of the most important within the excavated sample, are represented by both cranial and postcranial elements in the main colonial salting features of the fishery (B1, layers C and F). Accordingly, conger eels recovered at Tarapaya by de France (2012) were represented by head and body bones. The same is true for the small sample of colonial jack mackerel from Sector B. For these reasons, the salting and drying of whole fish at the colonial patio seems likely.

However, to complicate matters, our key resource, the Chilean jack mackerel, behaves differently from other species at Sector A, suggesting not all species were being processed in the same way. Chilean jack mackerel represents a regionally distributed dried resource since ancient times. The storage features excavated by Mendez-Quiros et al. (2023) in late Pre-Columbian villages of the lower and mid Arica valleys contain jack mackerel remains. In Tarapacá itself, jack mackerel was transported and allocated in the core settlements of the ravine and nearby Pampa Iluga agricultural lands during late Pre-Columbian times.

In the Arica case, the remains of dried jack mackerel include head and body bones in the storage features in the Huaylacán and Achuyo cases but only body components in the Millune village (Mendez-Quiros, personal communication). The lack of heads for the jack mackerel remains in the (small) sample from Millune indicates the regional distribution of some headless dried jack mackerel. Pampa Iluga (Tarapacá) is an extensive Pre-Columbian agricultural landscape with large mounds, dispersed dwellings, irrigation canals and agricultural plots occupied during late Pre-Columbian times and before. Here, excavations have yielded Chilean jack mackerel crests (showing some whole dried fish was transported) but the differences in proportions between crests and vertebrae is different than at Loa (Josefina Gonzalez, personal communication). Samples show far more vertebrae than crests so, again, this opens the possibility of inland distribution of headless fish.

For most species in Sector A there is no evidence for a pattern of disproportionate head deposition. The exception is the Chilean jack mackerel. The representation of this species included high proportions of sagittal crests (cranial) bones against very low proportions of vertebrae (postcranial). In layers with both cranial and postcranial components the representation is disproportionate: hundreds of vertebrae are missing given the number of complete crests (the jack mackerel has 24 vertebrae for its one crest). In some layers (A3, layers E, G, I, K and L), this species was represented only by head fragments. Corvina remains show a similar pattern. In contrast, in Sector B the assemblages are generally dominated by postcranial components, the exceptions are corvina and jack mackerel in layers C and F (B1) with head bone proportions over 50%. Thus, there is not a consistent pattern for all species in either Sectors A and Sector B, nor a consistent pattern through time even for jack mackerel in Sectors A and B. Further, corvina were mostly represented by otoliths (that perhaps naturally detached when dried) whereas jack mackerel was more commonly represented by crests.

Synthesizing the different lines-of-evidence, I argue that the local villagers (Sector A) were processing a surplus for export (particularly of jack mackerel) from at least the Middle Period, accounting for the disproportionate jack mackerel head percentages over time in the Sector A levels. This is not a surprise to anyone, archaeologists have found postcranial remains or whole mackerels in inland formative sites not far from the mouth of the Loa (Ballester et al., 2019; Gallardo et al., 2017).

In contrast to the anatomical patterns in the fish assemblages (which are ambiguous and subject to alternative interpretations, we have the most direct evidence for colonial commodification practices in the processing features themselves - - the salting features of the Iberian fishery in Sector B.

8.4.4.2 Colonial salting preferences

The main salting layers (B1, C and F) in Sector B constitute a unique window into early colonial fish commodification praxis, including the preferred species for this process: sardines, corvina, cabinza, and conger (Figure 114). It is notable that jack mackerel, while remaining more popular in Sector A, was only represented in low proportions in this commodification process.

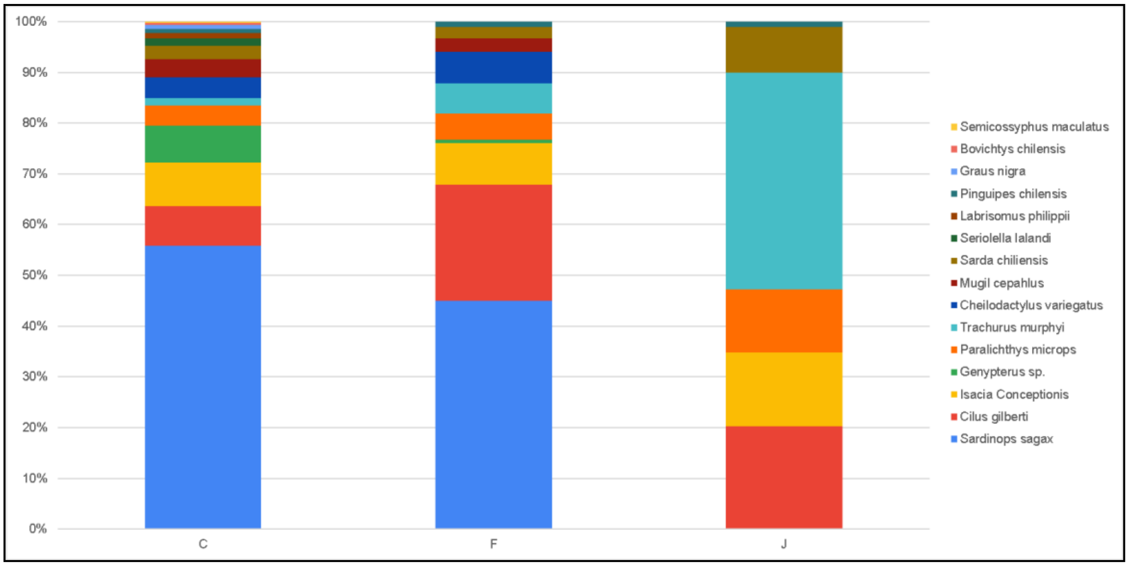

Figure 114: Comparison of main species proportions at colonial layers of unit B1(C and F) versus its Pre-Columbian occupation (layer J).

The avoidance of mackerel for salting is clearly colonial. Jack mackerel, corvina, cabinza, and bonito are among the main species in Pre-Columbian B1 Layer J, just as in contemporaneous Sector A layers. And of the two salting features, jack mackerel occurs in highest proportions in the earlier feature (Layer F), a materially "hybrid" early colonial layer when Sector B residents were using decorated Inca pottery alongside Panamanian majolica.

Upper domestic layers near the kiln (B2) reveal the local consumption of diverse species at the Sector B fishery, in turn, sardines growing in importance from roughly 43% in Layer E and F to over 50% in Layer C.

8.5 Evaluating Overfishing

Colonial fishing intensification resulting in overfishing (or the depletion of fish stocks) at Loa could be indicated by: (1) increased landings of low food web level fish or ("fishing down the food web"), (2) decline in fish size by species, and (3) increased shark harvest.

8.5.1 Fishing down the food web?

Trophic-level analysis is a way to approach long-term changes in the capture of marine resources from zooarchaeological data (Reitz, 2004). The degree to which a given fish feeds directly on producers (phytoplankton and plants) determines its trophic level, with the first level consisting of producers, the second of zooplankton, benthic herbivores, and detritivores (eat decomposed plants, animals, and feces), and carnivores, in turn, making up levels three to five (Reitz, 2004). Marine scientists have demonstrated a correlation between overfishing and the decline in mean trophic level for 20th century commercial fisheries. The phenomenon is termed "fishing down the marine food web" and describes a shift from high-level piscivorous fish to small, pelagic fish (like herrings) due to a decline of higher-level species (Reitz, 2004).

In an example from 18th century occupations in Florida, a pattern of capture of high-trophic-level sharks alongside low-trophic-level mullets and other fish followed by the decline in the mean trophic level has been interpreted as representing fishing effects on fish stocks (Reitz, 2004).

In the trophic-level analysis of Puerto Loa's fish assemblages mean trophic levels were calculated for each layer based on the formula provided by Reitz (2004) and MNI was calculated by zooarchaeologist Claudia Talep. Each fish category was assigned to a specific trophic level based on FishBase[27]. Trophic level assignation and MNI calculations were conducted at the species level for more precise results. In Figure 115 you can see the model that would be expected if Loa's native and colonial fishing had strongly impacted the fish stock over time.

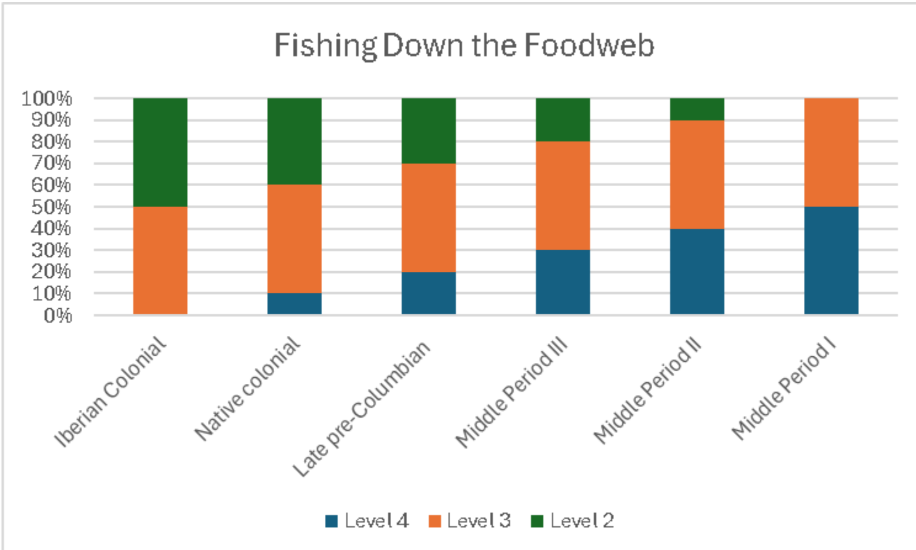

Figure 115: An idealized picture of fishing down the food web over time at Loa

All units from both sectors have comparable total median trophic levels in the 3.4 to 3.8 range, values that represent secondary consumers (carnivores such as corvina drums that eat herbivores) in the third level of the marine food web. Almost all native occupations in Sector A have secondary consumers, that is, carnivorous fish that eat herbivores (mackerels for example), as their mean trophic level fish. If each unit is considered separately, there is not a single trend over time in terms of declining mean trophic levels. At the occupation (layer) level, units at the native village have ranges within the third level or within levels 3 - 4. Level four is constituted by tertiary consumers or carnivores that feed on other carnivores like the great white shark.

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[27] https://www.fishbase.se/search.php

No trend emerges if MNI by trophic level per layer is plotted in stacked proportion graphs. As can be seen, in most occupations people captured mostly level 3 fish and some variable proportion of level 2 and 4 species (Figure 116). This is not unexpected as most fishing techniques will result in a multispecies catch, even when people want to capture a single specific species. The village's core (A3) shows relatively stable mean levels of secondary consumers (level 3) over time (Figure 117). The only exception was found near the church (A5) where the decline is clear and includes tertiary consumers (sharks) in intermediate layers. The picture that emerges for Sector A is one of relative stability over time in the 3.2 – 4.1 range, nothing like "fishing down the food web".

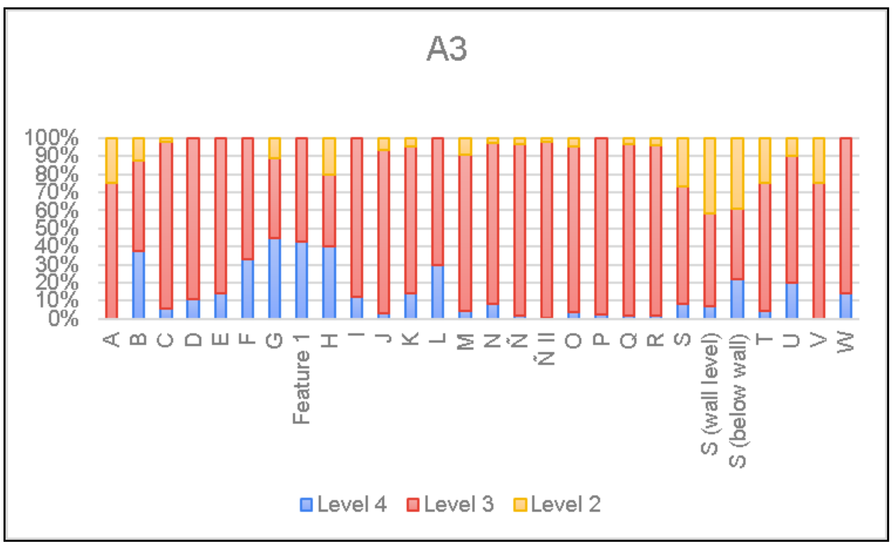

Figure 116: Trophic level proportions over time at unit A3.

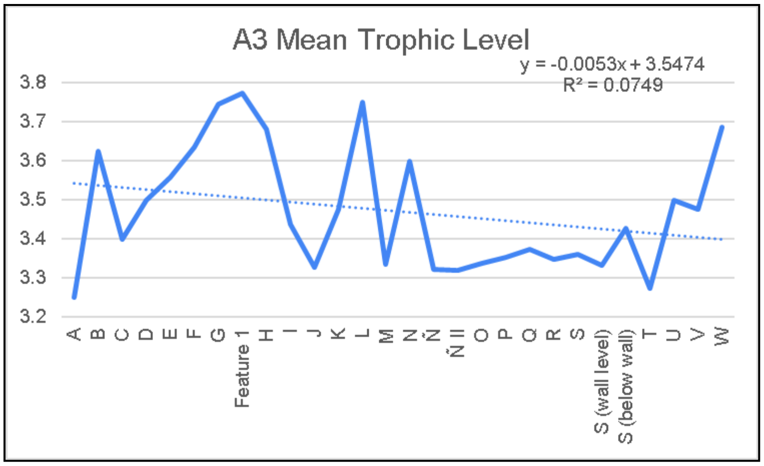

Figure 117: Mean trophic level per layer at unit A3.

In Sector B, those units near the kiln representing domestic consumption are within level 3, while the colonial salting feature (B1) is between levels 2 and 3. Both units excavated at the Spanish fishery show some a trend over time towards valuated tertiary fish at the expense of lower-level species (Figure 118). No colonial period assemblages are in the primary consumers (herbivores) level or the shark level. Instead, the focus is on tertiary predators (e.g., bonitos, dorados). If the few sharks identified at the order level are included, this increasing trend is a little more marked. High MNI for corvina drums suggests a focus on this as a preferred fish. The mass-capture of small, pelagic species like sardines also occurred, so diverse fishing strategies must have been in place to harvest these fish types. Both Sector B units show the same trend over time, the inhabitants of the Sector B architecture both ate and salted very tasty fish (e.g., corvinas and conger eels); species that are very valued even today in the markets of Chile and Peru.

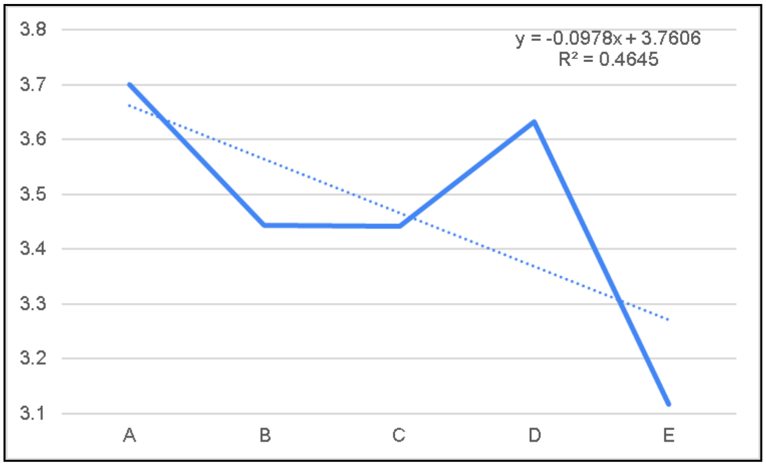

Figure 118: Mean trophic level per layer in unit B2.

Here as well, no fishing down the food web trend over time was detected. The pattern is one of relative stability and specialized exploitation of level 3 carnivorous fish, with other fish perhaps used as bait in line and hook fishing (along with net fishing).

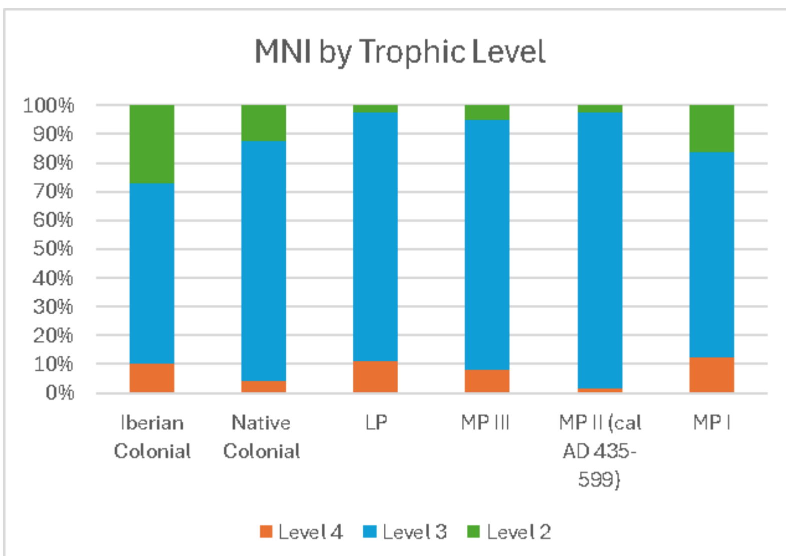

Figure 119: Fish by trophic level over time at Loa, Pre-Columbian occupations are from Sector A (3).

If we return to the idealized figure of "fishing down the food web" and compare it with our data grouped by period (Figure 119), we see a reduction in level 4 aggressive predators (e.g. sharks) and a slight increase in the proportion of level 2 fish (e.g. sardines) from late Pre-

Columbian (LP) to colonial times among Sector A natives. But the differences between late Pre-Columbian and native colonial occupations with respect to trophic level proportions are not very significant or strong (x^2=4.870, p=.088, V= 0.215).

8.5.2 Decrease in Chilean jack mackerel size?

The decrease of fish size over time is another important overfishing indicator (Reitz, 2004). The spectacular preservation of Chilean jack mackerel sagittal crests allowed size calculation for this central resource at the Sector A village.

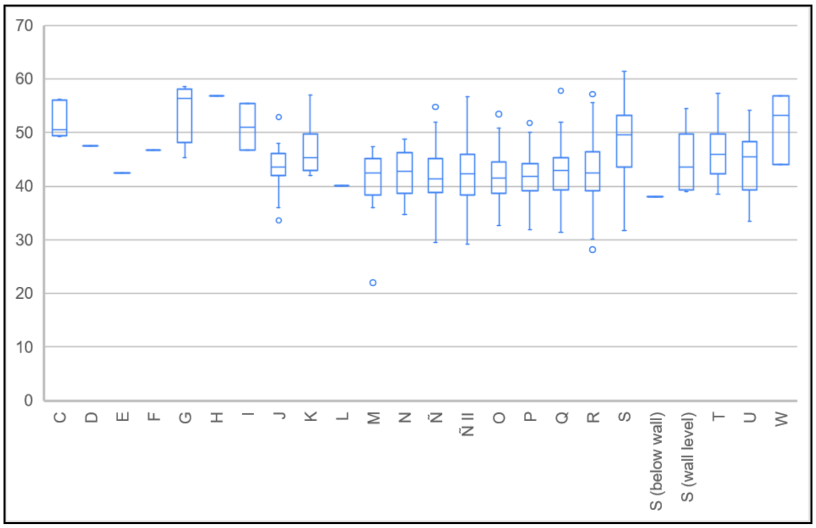

Figure 120: Jurel length range per layer at unit A3.

Unit A3 reveals a decline in fish size during the Middle Period (cal AD 435-600) rather than a steady decline in jack mackerel size over time. Even if most interquartile size ranges are within the 40 to 50 centimeters marks across units, there's a slight depression in the central half of values at lower intermediate occupations (A3, Layer M – R) of the village's core (Figure 120). Early and later occupations show more variability and larger central sizes. Their mean sizes are also larger (closer to 50 cm) than the jack mackerel (mean size closer to 40cm) harvested during the Middle Period. Note that the same Middle Period occupations (M – R)exhibits the most intensive fishing of jack mackerel in terms of density (g/l). The findings could reflect some size reduction due to ancient overexploitation, or alternatively, changes in capturing technologies, for example the weaving and use of nets with smaller grid to maximize yield.

Larger Chilean jack mackerels were landed during colonial times for the Sector B fishery as well. Fishery's median and mean sizes are higher, min and max values too (Figure 121, Table 28).

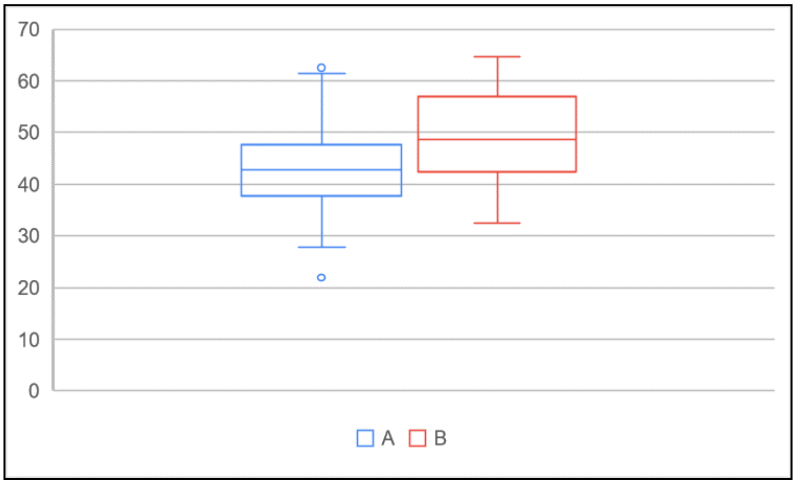

Figure 121: Compared jack mackerel length (cm) range between sectors (all occupations included).

Table 28: Chilean Jack Mackerel Length (cm) Descriptive Statistics at Both Sectors.

	A	*B*
Mean	42.8769	49.4558
Standard Error	0.235	1.71099
Median	42.7108	48.7146
Standard Deviation	6.6092	8.72436
Sample Variance	43.6816	76.1145
Kurtosis	-0.4107	-0.7292
Skewness	0.16422	0.13952
Range	40.5567	32.193
Minimum	21.9829	32.5534
Maximum	62.5396	64.7464
Sum	33915.6	1285.85
Count	791	26

Overall, there is no observed decrease in size during the colonial rea. Instead, something of the opposite is seen with capture of large jack mackerel during early modern times. Large jack mackerels are characteristic of salting layers at the Iberian fishery. Just as in upper layers of the Sector A village, individual processed at such features have a mean size of 50 cm. This could indicate another expression of fishing intensification: targeting larger fish instead of a higher volume of smaller individuals, as might have taken place during the Middle Period.

8.5.3 Goodbye aggressive predators?

A sign of potential overexploitation is the harvest of high trophic level predators such as sharks that are easily exploited given their aggressive behavior (Reitz, 2004). Reitz (2004, p.79) describes "use of high-trophic level fishes (sharks)" as a "characteristic of fishing down the food web."

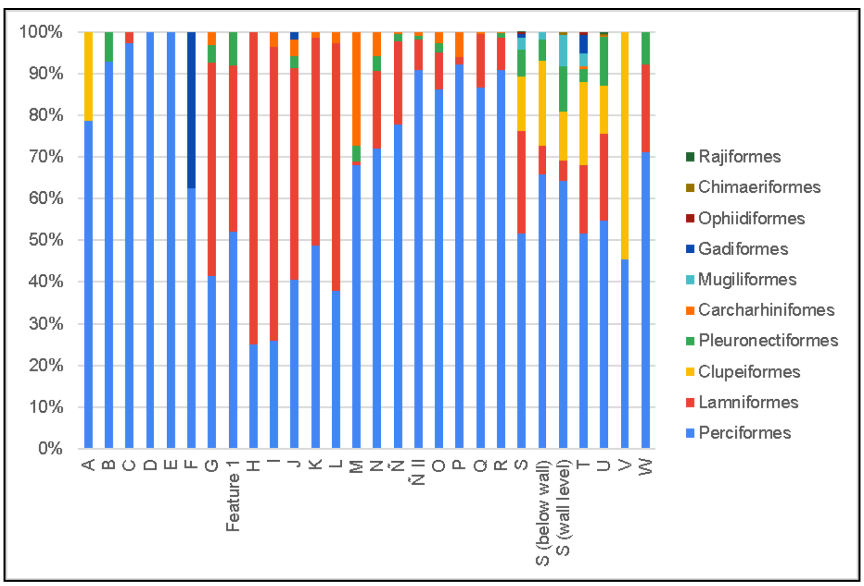

Figure 122: Shark proportions over time at unit A3 (based on identified orders).

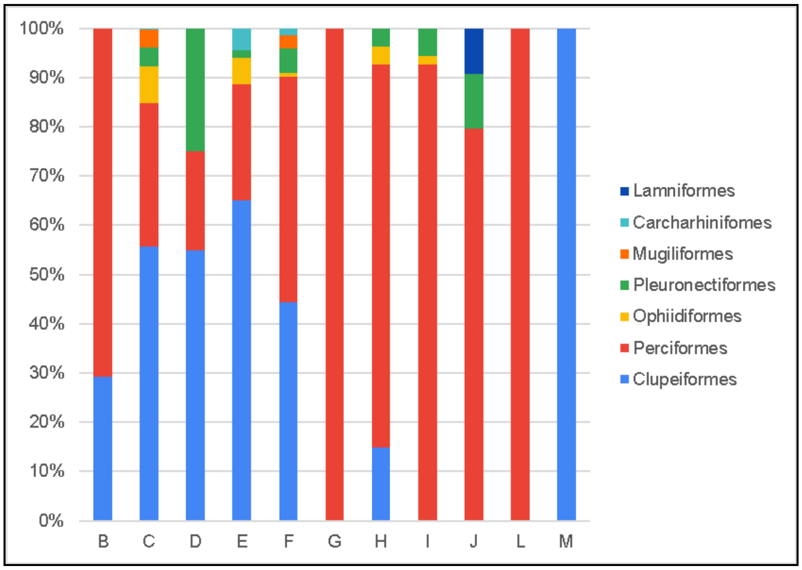

Figure 123: Shark proportions over time at unit B1 (based on identified orders).

Locals captured sharks of different sizes during most periods, but their relative importance declined during the most intense fishing activity (A3, Layer Ñ – R) in the occupations of the Middle Period. Little shark remains were recovered from upper layers in Sector A as well. But fishermen caught many sharks between these two times (Figure 122, layers G - L). This occurrence is the opposite of what would be expected if the intensive Middle Period fishing involved fishing down the food web. Of the sharks represented, the dominant orders in the native settlement core (A3) were the Lamniformes and Carcharhiniformes at upper intermediate occupations. These (Lamniformes and Carcharhiniformes) orders were virtually absent in the village's later occupations. The last layer of (colonial) occupation of the fishing village (A) did not yield shark remains. In all the units excavated in the fishing village, the shark remains are mostly associated with initial and intermediate occupations and not with late Pre-Columbian or colonial occupations.

Although colonial shark consumption is evidenced at Tarapaya where colonists ate small, dried sharks of the Carcharhinidae and Lamniformes taxa (de France, 2012), the proportion of shark remains in Sector B Iberian fishery are insignificant (Figure 123). Only a small number (*n* = 13) of them were recovered at its colonial salting layers.

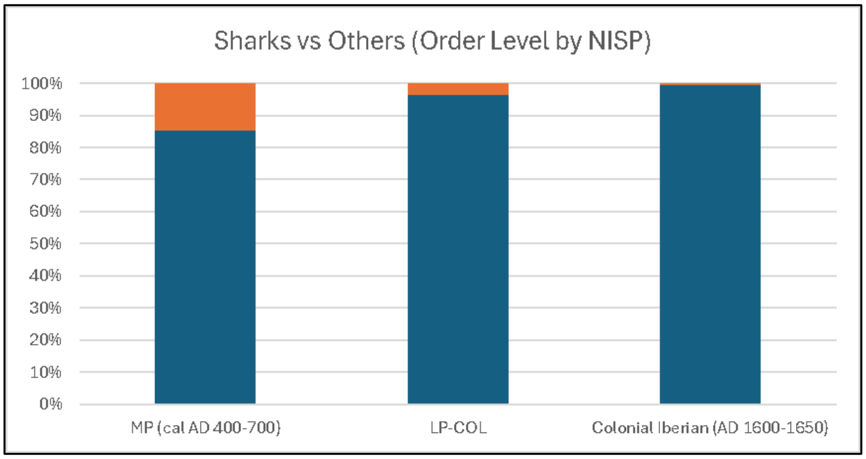

Figure 124: Shark (orange) versus other identified fish orders (blue) during the Middle Period (MP) and late Pre-Columbian plus colonial (LP-COL) of Sector A, and the colonial era in Sector B (Iberian Colonial).

Shark proportions show a clear decrease over time (Figure 124). The difference between shark versus other orders proportions in Middle Period occupations (*cal* AD 400-700) versus late Pre-Columbian plus native colonial occupations[28] is very significant but weak (x^2=87.842, p=.000, V= 0.092). The same is true if we compare these latter occupations with the colonial salting occupations of the Iberian fishery (x^2=30.975, p=.000, V= 0.107). Andean and colonial fishermen may have depleted sharks in the area, but we cannot yet determine if this shift was the result of colonial or late Pre-Columbian overexploitation or changes in fishing practices (e.g. year-round beach trawling).

[28] Sector A, layers A-C (all units).

8.6 Summary

Loa's mouth people were superb fishers of the water column with a long-term specialization in nearshore pelagic fishing. Our community practiced a very specialized fishing economy since early times based on a well-defined set of species and techniques and there was some specialization into fewer species over time. The most targeted fish species came from nearshore coastal waters or the neritic zone. This is the sublittoral zone or the shallow (<200 m deep) pelagic region over the continental shelf, the stripe in which the oceanic system interacts with the coast. Over generations, their main target was the predator-prey mesh of species like sardines, jack mackerels, and bonito. One of their most appreciated resources, since at least the Middle Period, was the Chilean jack mackerel. Loa's fishers captured adult individuals with lines, hooks, and (probably) nets. They also spent part of their days fishing from rocks or beaches for other species. The massive landings of jurel overshadow the pervasive consumption of corvinas or cabinzas in the long-term. The village's late Pre-Columbian and early colonial fishers kept their interest in mackerel but increased the capture of species from beaches and surf corvinas or sardines.

The ancestors of Loa's colonial Andeans were responsible for the most intensive fish landings uncovered at the site. Local fishers successfully captured high volumes of mackerels and others as far as *cal* AD 435-600. Their late Pre-Columbian descendants also achieved good landings but did not intensify fishing production. Their fishing was a small-scale, continuous everyday communal practice responsible for a succession of overlapped domestic deposits without increasing density trends. Activity concentrated near the early colonial chapel during the colonial fishery's heydays, anyway. Colonial Andean fishers brought more corvinas, a tasty fish from sandy bottoms to both places. The exploitation of nearshore open waters and shorelines began to equalize during colonial late Pre-Columbian (Inca) times. The upper colonial layers at Sector A showed this trend. We see evidence for a more extensive exploitation of habitats as a response to new external fishing demands departing from the traditional specialized targeting of Chilean jack mackerel and its pelagic predator-prey network associates.

Under the Spanish, both Spanish overseers and native curacas seized on this expert well-established fishing workforce demanding more even deliveries of shoreline and pelagic species. Iberian fishing demands translated into a more extensive exploitation of habitats and regular native labor on beaches and rocky shorelines. A wide range of species ended up salted in the fishery. Here, intensification did not involve a super specialization in particular species. Instead, intensification under the Spanish took the opposite form: diversification of fishing. More than diversity reduction over time what we see is the commodification of a broader assortment of fishes.

Corvina was a very desired fish by urban markets: intensively processed, its discard intensities at the fishery are comparable to the ones of mackerel in the native village. One likely technique employed in the colonial mass-capture of sardines and corvinas is chinchorreo or trawl net fishing from beaches. In stark contrast, mackerel was not the key resource for the Sector B colonial operation. Colonial natives harvested high volumes of corvinas and especially schools of sardines thanks to the regular use of fishing nets.

The Spanish fishery established a revolutionary commercialization technique: the salting of this enormous and diverse volume of fish. The dried and salted fish could, in this way, travel up the Andes to Potosí, preserved especially for sale far from the lowlands. The evidence is ambiguous but suggests that most salted fish may have been preserved whole for shipment inland. Although my excavations did not reveal areas of fish drying or salting in the village, a notable disproportion of mackerel heads in relation to body parts was discovered. In the interior, although there are not many detailed studies yet, the opposite pattern is reported: fewer heads and more bodies for this fish in late Pre-Columbian storage features and domestic deposits. Locals beheaded part of the mackerels prior to transport. Fish then followed two paths to the interior: one of clear and evident commercialization for distant markets and another, less noticeable, through kinship Andean channels within the lowlands.

Finally, even if no fishing down the food web pattern was found, the colonial extended exploitation (diversification) in food chain and habitat terms is a type of fishing intensification. Middle Period fishers may have impacted the stocks of Chilean jack mackerels, I identified a decline in mackerel size in the same occupations in which fish densities are extremely high and sharks were less abundant. For the colonial fishing heydays, some degree of impact could be expressed by the reduced availability of these aggressive marine predators, the fishing intensification's first casualties.

9.0 Fishing Technology

The local Andean fishers reached the nearshore pelagic trophic network by rowing inflatable skin boats to locations to target Chilean jack mackerel and other fish with an array of metal hooks, stone sinkers, fishing lines and cotton nets.

9.1 Inflatable Sealion Skin Boats

As mentioned previously, the Andean communities of the coastal Atacama -Tarapacá included- based their fishing practices in a very special kind of vessel: the sealion skin inflatable boat. We are fortunate in having a very detailed passage about the manufacture of these boats written by Gerónimo de Bibar (1966[1558], p.10-11) in the very early years after Spanish invasion:

"Usanse estas balsas desde el valle de Arica hasta el valle de Coquimbo, que son más de doscientas leguas. Y estos que habitan en los puertos y caletas de la mar son sus navíos con que navegan cerca de la tierra y salen a pescar."

(…)

"Y cosen de esta suerte las costuras: toman las dos junturas del cuero o canto y ponen muchas púas juntas de espinas de cardones que son tan gruesas como agujas de ensalmar y muy recias; y puestas en el cuero van cortadas que sobre poca espina de una parte y de la otra y de los nierbos [nervios] de carnero y de ovejas hacen ciertos hilos; con estos prenden las puntas y cabezas de las púas que en el cuero están y van ligados de tal suerte que jamás se desligan. De

la sangre del lobo y de resina de los cardones y de barro bermejo hacen una manera de betún que suple por alquitrán ceto [excepto] ser colorado; y por de dentro alquitran y brean el cuero."

His description precisely illuminates some otherwise random and unconnected archeological findings, documenting that the Andean fisherfolks of the region used sealion skins and blood, cactus thorns and resin, camelid tendons, and red bitumen. The latter was made with red mud (*barro bermejo*), blood and resin and used to waterproof and protect the interior side of the skins that made navigation possible.

The manufacture of Andean sealion skin inflatable boats was a specialized, complex activity performed by Loa craftspeople. They mined red iron oxides in the high nearby coastal ranges and gathered large cactus thorns from steep rocky slopes. The ore was then crushed and powdered, mixed with other vegetal and animal substances to create a resistant bitumen to waterproof and protect leather. An inflatable boat consisted of two or more sealion skins sewn together with trimmed thorns and animal tendons. It was inflated by blowing through an animal gut section topped with a seabird bone tube. The gut was tied, and the boat was ready to sail. The manufacture of such fabulous craft is evidenced by red ore, pigment bearing hammerstones and rubbing tools, thorns, and bone tubes found in the village. During the colonial period, the native fishers beached their inflatable vessels near the Sector B fishery. It is here we found evidence for the manufacturing and maintenance done to the boats. I found the possible remains of one of these inflatable boats in one of the colonial occupations of Sector B fishery (another sign of the use of native fishing labor by the Spaniards). Many loose remains of the seam were recovered in the salting yard (Figure 125). Associated were the indirect traces of the manufacture of such vessels: red iron oxides, pigmented hammerstones and rubbing tools, and cactus thorns.

Figure 125: Sealion inflatable boat seam remains.

The production of red powder, also used for coastal rock art over time was documented in various occupations in the Sector A village. Similar raw iron oxide was excavated at Middle Period occupations of the village's core (A3, layers R & S). Iron oxides were used on the coastal Andes for raft caulking, to protect the skin of native fishers and divers, and perform rituals with the dead, as well as for rock paintings of social and symbolic significance. This mineral was a key resource in the preparation of red mineral powder with hammerstones and rubbing tools.

Hammerstones were mostly recovered from the fishing village (81.3%; n = 52) and correspond to local basalt or granite beach pebbles with pitting and/or flake scars at ends or sides.

People used these hammers to strike hard materials, macroscopic wear is typically visible at one or more locations on each specimen.

Hammerstones were broken frequently (48.4%; *n* = 31) but others survived the work so their main dimensions can be summarized. These are of variable weights, lengths and widths, a variability that suggests diverse tasks and associated percussion requirements. Its median weight is 250g, but the values are multipeaked and very spread out. Lengths range from 50-110mm, widths are normally distributed with a peak between 60-70mm.

Some of the hammerstones (12.5%; *n* = 8) still have red mineral powder in their active surfaces from the crushing of coastal iron oxides. The local fishing community may have devoted part of their time to the mining of such iron oxides in the nearby coastal range. Interestingly, these red-powdered hammerstones were found in early to mid-occupations of the village (several units) but are absent from the uppermost Sector A occupations.

The percussion of hard materials, either minerals or shells, was a daily activity across the village and especially at the village core that exhibits the highest concentration of these tools (52%; *n* = 27). Middle Period occupations evidenced slightly higher frequencies while, as in the case of the pigment-stained hammerstones, later occupations didn't yield a single case (in any of the Sector A units). However, equivalent hammerstones are part of early colonial assemblages from the Sector B fishery. In both sectors, the percussion of hard materials is also expressed by its byproducts: hundreds of secondary and primary flakes of basalt or granite detached from the active edges.

Another group of basalt pebbles was used to pulverize and rub soft delicate materials. These are small, smooth, almost round tools for tasks that, in some cases, involved the final grinding and rubbing of fine red powder. As a result of friction, one or more edges flattened over time. These rubbing tools also have delicate parallel striations on the sides, plus small percussion pits on the extremes sometimes. Some of the flattened grinding edges (39%; n = 7) still contain fine red iron oxide powder.

The fine processing (and use) of red ore seems to be an activity common at later occupations of the settlement. At the village core (A2 & 3) rubbing tools were recovered from intermediate and uppermost occupations, while near the church (A4 & 5) they only came from upper layers. The only rubbing tool from the Spanish midden came from a colonial layer as well. The use of red ore was still active in colonial times as evidenced by its presence in the main layers of the fishery.

Anvils are an associated tool type found in low numbers, broken or whole, in both sectors. Anvils were used for hard hammerstone percussion but especially for grinding iron oxide with pebble rubbing tools. All examples of anvils show red powder on their active surfaces. They came from intermediate occupations of A3, Pre-Columbian layers below the Spanish midden (B1) and from a colonial layer near the kiln (B2, Layer D).

Cactus thorns were key for the sophisticated seams that made successful inflatable vessels possible. Dozens of large, thick, straight cactus thorns of coastal origin are part of the macro botanical assemblage excavated at Loa. The vast majority (n = 51) came from the colonial occupation of Sector B while the 8 thorns excavated at the village (Sector A) were found in upper occupations only. None of them were found at the village core (A3), a locus of clustered communal production and consumption.

Similar thorns were popular in previous eras as a raw material to produce fishing hooks (Disspain et al., 2017; Santoro et al., 2017). However, among Loa’s sample not a single curved thorn was identified so their use as fishing hooks is unlikely. Local inhabitants used cactus spines as barbs for type A harpoons, a small harpoon (for small prey) with a llama bone tip, normally recovered from funerary assemblages (Ballester, 2017; 2018). I cannot rule out this usage; it would express another fishing method for specific demersal species in that case. Similarly, Spahni (1967) recovered from late Pre-Columbian tombs of the Loa mouth a series of wooden combs made with aligned straight cactus thorns. Their concentration in the fishery thus may reflect a personal self-care item and maybe the presence of women as well as a component of small-scale harpooning.

In sum, the continuous use of iron oxide powder through time is illustrated if anvils and rubbing tools are considered together. This industry was probably producing one of the components (red bituminous mud) used to treat and improve the inflatable raft skins. Its use over time is accompanied by potential seam materials such as the above-mentioned thorns. The rafts were an essential technology to target the predatory-prey network central to which was the Chilean jack mackerel, a fundamental resource for the local communal economy.

9.1.1 Trends in Inflatable Boat Production

Two categories of artifacts can be examined to assess patterns in inflatable boat production: cactus thorns (necessary for the seams of the sealion skins) and bone tubes (used for inflating the boats).

Given that Sector B appears as a colonial period locus of skin raft production and maintenance, we would expect to find the highest densities of thorns here. This is indeed the case. If densities (l/case) are compared among sectors, the median discard rate at the fishery is well below 50 liters per case, while most median values at the village double the required volume of excavation to find one case (Figure 126). The same l/case measure for the layers of B1 shows a moderate density increase (l/case) over time in colonial occupations of fishery during the early 17th century (Figure 127).

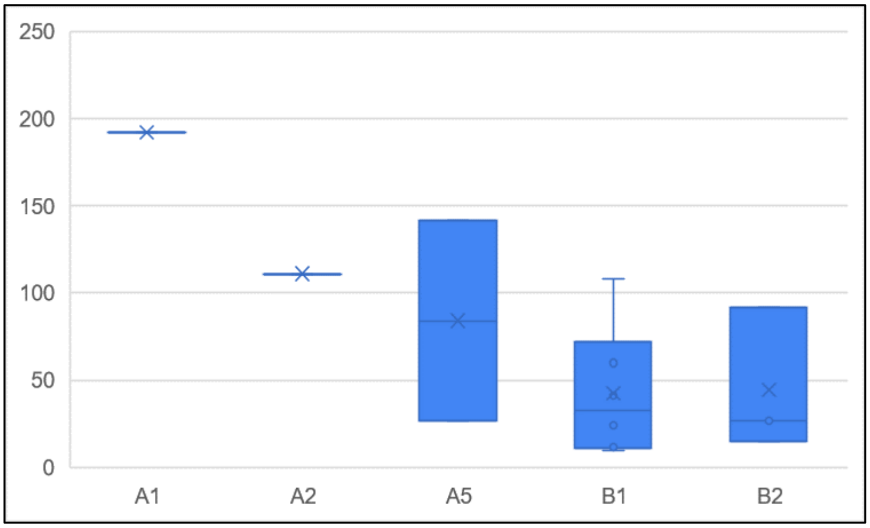

Figure 126: Cactus thorn densities (l/case)

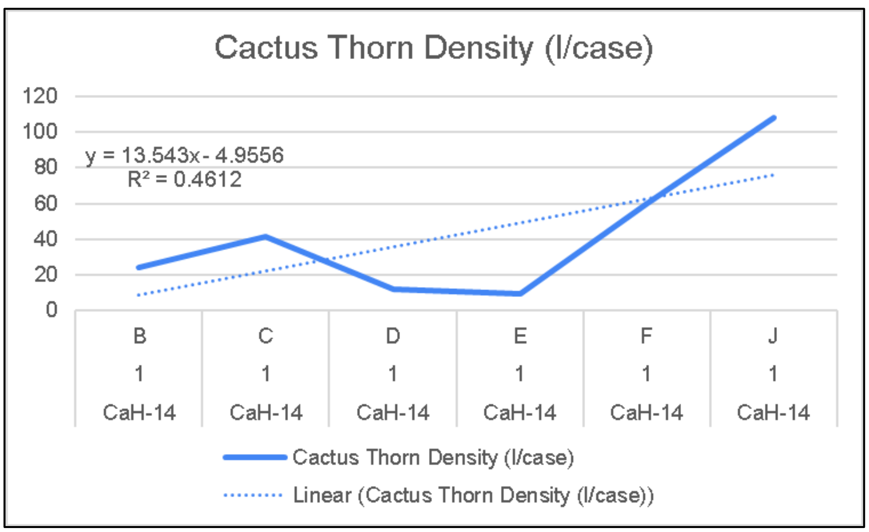

Figure 127: Cactus thorn densities over time at B1

Overall, the densities in which cactus thorns were found at the Spanish fishery indicate a colonial intensification of sewing (of seams) activity in those same occupations in which raft remains and nets are most present. As always, some caveats must be mentioned: a) the same thorns were used for harpoons and wooden combs; and b) the clear differential preservation between sectors due to salting in Sector B.

The bone tubes used to inflate the sealion skin boats offer another indirect line of evidence of fishing intensity. The production of bone tubes was a common bone industry activity of long continuity. Long bones of seabirds, mostly cormorants and pelicans, were trimmed to produce tubes, recognizable thanks to its rounded, polished ends and some transversal incisions left by the cutting of the diaphysis. Some abrasive (maybe pumice) was then used to file down protruding parts leaving behind groups of fine parallel grooves. Their average length and diameter are 10 and 1cm, respectively.

Such bone tubes have been found associated with spatulas and tablets, the assemblage for hallucinogen drug ingestion and are often archaeologically interpreted as snuff tubes (Labarca et al., 2017, p.103). A few specimens showed one epiphysis intact, they could represent containers of some sacred, special powder (if not evidence for the fabrication process). Such drug paraphernalia tubes are sometimes decorated, unlike the Loa specimens. From this perspective, the Middle Period occupations pertain to a time in which the consumption of hallucinogenic substances peaked with the influence of major religious centers in the altiplano. In Atacama, the ideological influence of Tiwanaku is associated with the apogee of tablets and bone tubes to snore magic powders. Residue analysis would be necessary to detect any substances in the tubes' interiors.

However, thanks to Bibar (1966[1558], p.10-11) we know that a pelican tibia tube was attached to an animal gut and used to keep inflated the boat while offshore. Some of the tubes recovered in excavation show a dark residue near one end so this is a likely function. Almost all tubes were recovered from the native village. None were found in the earliest occupations of the settlement. Most were recovered from the Middle Period or late Pre-Columbian occupations. With the proportionally denser fish remains in Middle Period occupations of the village, we could hypothesize that more inflatable boats were manufactured by the local people in this period of high landings of mackerel and other species. The tubes were still in use during the early colonial era as seen from their presence in the main salting layer of the fishery (B1, Layer C).

9.2 Hooks and Metallurgy

Village residents may have obtained finished metal hooks from other localities (i.e. Camarones) as well as producing them themselves within the village from early times. Such hooks were recovered from both Sectors A and B. Sector A yielded six hooks, consisting of straight shank (*n* = 4) and curved fragments (*n* = 2). The excavated sample came from the upper layers of the village. Three cases came from a single locus near the church (A5, Layer D) while at the village's core (A3) I only recovered one hook from Layer B. Hook remains of the same type can be found on the village's surface. In Sector B, four hooks (two straight shanks) were recovered, as well as some metal cylinders. The hooks came from an early colonial layer (B1, Layer F). Their width range (3-4mm) is consistent with those of the village.

Given that this site is a specialized fishing village whose residents were line-catching jack mackerel in quantity for centuries, the relatively low number of hooks found is worth commenting on. Because of the littoral environment, metal preservation is poor. Metals are in a very dynamic state of transformation here and almost all recovered metal objects were heavily corroded or oxidized. Too, any metals would have been subject to recycling and recasting.

Figueroa et al. (2015) have demonstrated how hooks from the western valleys (Arica to Loa) differ from the coastal desert southern tradition in using the straight shank form and the metal alloy used. Chemical analyses have always identified tin bronze as the material of metal hooks from the Loa mouth to the north (Salazar et al., 2010, p.17). In form, the Puerto Loa hooks were in keeping with the straight shank-curved body hooks characteristic of the western Andean valleys (Figure 128). One Puerto Loa case had flat sides. The Puerto Loa hooks were likely made of tin bronze as we could verify through a recent pXRF analysis[29]. Tin would likely have been sourced from the highlands 250 kilometers away (Figueroa et al., 2015, p.695).

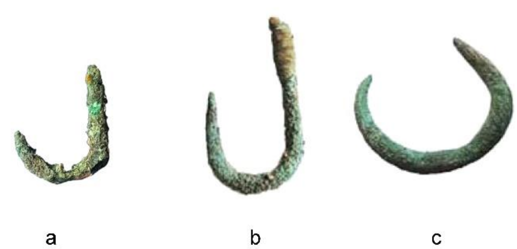

Figure 128: Examples of straight shank hooks (a – Sector A, b – Taltal-Paposo) and curved hooks (c – Taltal-Paposo), b and c redrawn from Salazar et al. (2010, p.15).

Metal hooks were recovered only from late Pre-Columbian and early colonial occupations at the site. I analyzed all the fishing technology data obtained in the native village by

[29] Conducted by Dr. María Teresa Plaza (Anthropology Department, Universidad Católica de Chile, Santiago).

multidimensional scaling, the results showed a clear association between hook metallurgy and late Pre-Columbian and early colonial occupations (Appendix C.3). However, there is other evidence that metallurgy was taking place at the site earlier in time in the form of copper oxide fragments and potential slag. Most copper oxide and slag were found in late Pre-Columbian and early colonial occupations. For example, 80% of the slag found (by weight) was recovered from upper layers at the site. As with hooks, most slag came from near the church (A5, Layers B-C) but some was found in the village's core (A3, Layer C). Small bits of green copper oxides were excavated in late Pre-Columbian and colonial occupations of both sectors. These copper oxides are high-quality mineral ores, carefully selected before transportation by the native miners of the nearby coastal range. Their scarcity (only a few grams) can be explained by their value and the recycling nature of metallurgy.

However, some slag was retrieved from a couple intermediate occupations of the village's core. One of them (A3, Layer L) dates to the Middle Period – this layer lies above Layer M dated *cal* AD 258-468 and below Layer G dated *cal* AD 600-762. In Sector B, specimens of copper ore and potential slag were found associated in an occupation dated *cal* AD 584-653 (B1, Layer I), possibly indicating Middle Period small-scale local hook production. Some slag (9.2g) was found in an even older Formative Period occupation dated *cal* 538-207 BC (B1, Layer J). Even if not an intensive, regular activity, metallurgy was present before the late Pre-Columbian era in the Loa mouth. It is reasonable to propose that metal hooks were being produced at the site in Formative and Middle Period times, although I found no hooks in occupations of those periods. In a contemporaneous funerary tumulus from the Loa mouth, Latorre (2017) identified metal objects including fishing hooks and fine cylinders, the former made from a small, hammered bar.

Although no molds nor crucibles were unearthed, the slag and oxides indicate a long tradition (at least from the Middle Period and probably from the Formative) of small-scale copper metallurgy taking place at Loa. The higher frequencies of metal production (hooks, copper oxides, slag) in the later levels could, again, reflect recycling and preservational factors. But this distribution could also reflect broader regional metal-working trends. Metal hooks are more common in late Pre-Columbian settlements in the region. It has been argued that intensified metallurgical activities occurred at coastal settlements during Inca times. In the Camarones mouth, for example, Alvarez (1992-1993) excavated *wayra* combustion features, crucibles, molds, and Inca ceremonial knives or *tumis*. Native metallurgists made copper wire in molds there, the raw material to hammer and shape the characteristic regional hooks.

9.3 Sinkers

Stone fishing sinkers are one of the most conspicuous lithic tools from Puerto Loa. The lithic components of fishing gear represent the main preserved evidence for the technology of fishing. While most lithics came from the village, the same types of tools, blanks and debitage were recovered in colonial layers of the fishery and this includes fishing gear of the types explained below.

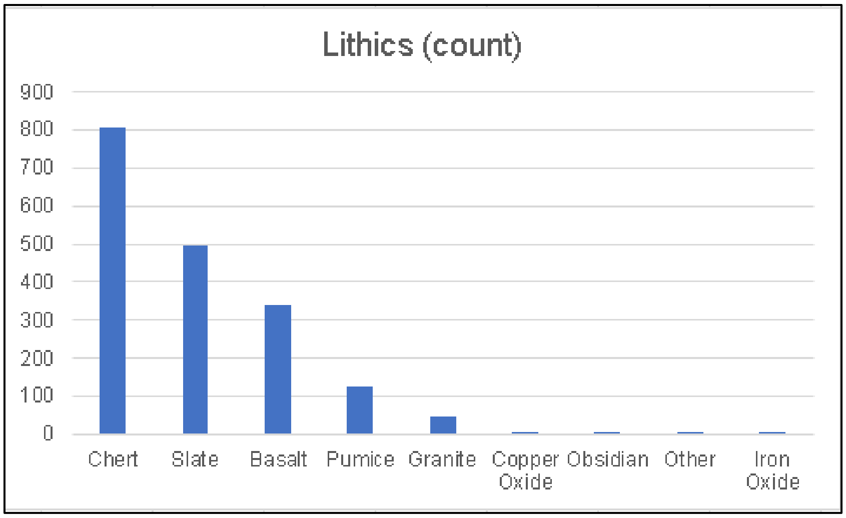

Figure 129: Main rocks used at the site

The consideration of lithics at the site is helpful in situating analysis of stone in fishing technology. In the lithic assemblage from Sector A (84.3%; *n*=1539); chert was the main rock but basalt, pumice, granite and especially slate were of economic relevance (Figure 129). Slate is a foliated metamorphic rock with parallel cleavage (Andrefsky, 2005, p.81). In this part of ancient Peru, this rock was the preferred raw material for sinker manufacturing since at least the archaic era (Blanco, 2017, p.85). Some researchers state the hyper arid core of the desert and the Mejillones coastal area to the south as the probable material source (Blanco, 2017, p.85) but I've seen major naturally occurring boulders of this rock at the Loa mouth. Mined resources like raw copper or Iron oxides are very scarce. Obsidian from the Andean highlands was seen in a handful of specimens (0.2%; *n* = 4).

Lithic debitage represents the main artifact category (73%; *n* = 1331) followed by tool blanks, pumice abraders, and chert tools. Table 29 lists each category by count and proportions.

Most village's lithics were recovered at its core (65.2%; *n* = 1004), the remainder was recovered from A4 and 5 (13.3%; *n* = 204 and 12.9%; *n* = 199, respectively), A1 and 2 provided small proportions (6.1% and 2.5%, respectively). Within the Spanish sector, the vast majority of lithics were recovered from B1 (91%; n = 261), the salting patio.

Table 29: Lithic Assemblage both Sectors by Category

Category	*Count*	*%*
Debitage	1331	72.9%
Tool Blank	158	8.7%
Abrasive	125	6.8%
Chert Tool	85	4.7%
Hammerstone	64	3.5%
Sinker	24	1.3%
Rubbing tool	18	1.0%
Pebble Tool	7	0.4%
Anvil	5	0.3%
Bead	3	0.2%
Copper Oxide	2	0.1%
Iron Oxide	2	0.1%
Lithic Shovel(?)	1	0.1%
Pyrite	1	0.1%
Total	1826	100

9.3.1 Sinker Manufacture

The sinker manufacture assemblage is composed of finished weights, blanks, debitage and pumice abraders. These sinkers are cylindrical and elongated with rounded ends, they were made with dark slate of laminar fracture. Chilean archaeologists call these sinkers "cigar sinkers" due to their elongated morphology.

The whole *chaîne opératoire* of sinker manufacture was revealed at the native fishing village. Sinker production involved detaching a laminar fragment of slate from a rock, pressure knapping to obtain a desired elongated shape, rounding off the piece with a pumice abrader and engraving grooves at one or the two ends (Figure 130).

Figure 130: Pumice abraders (left), a rounded sinker blank (center) and a finished slate sinker (right)

The rounding stage in sinker production entailed the use of pumice abraders. This material is a light brown porous light volcanic rock. Pumice could be of high Andean origin (Blanco, 2017, p.86), equivalent volcanic rocks are known in the Atacama salt flat, but the lower Loa gorge could host pumice as well. Specific geological studies are necessary to precisely determine its source.

Many small-sized pumice fragments (*n* = 125) were employed by these Andean fishermen to round off the slate sinkers. As a result, pumice abraders are themselves rounded and, in most cases, show a tear-drop morphology. The delicate rounding off of the sinker ends is also visible in many abraders with conical cavities and elongated grooves. People frequently discarded the abraders once the size became too small for comfortable handling. Most abraders weigh less than 10g, median weight is 2g. Lengths peak between 20-40mm and widths at 10-20mm.

The large sample of sinker blanks is very interesting (*n* = 151; 95.6% of all lithic tool blanks). Local Andean fishers developed a very consistent industry, they always chose the same dark slate (except for one granite case). Many blanks got broken in half sometime during the pressure flaking phase, halves that do not match are the majority among sinker blanks (71.3%; *n* = 107). The remainder are entire blanks either at the pressure flaking or rounding stages. This high discard rate illustrates the desire to produce a very specific final product in weight and form. Roughly a quarter of all lithic debitage (24%; *n* = 324;) recovered at the site corresponds to the small laminar flakes of slate detached during the early stages of sinker manufacture.

Sinker blanks are very abundant at the settlement and open a window into the real diversity of fishing practices and settings. I recovered 40 complete blanks and 99 blank fragments in the village that show variable length, width, and thickness (Figure 131). The shape is the same elongated cylinder as in the finished examples, the weight, key attribute for a sinker, is more variable.

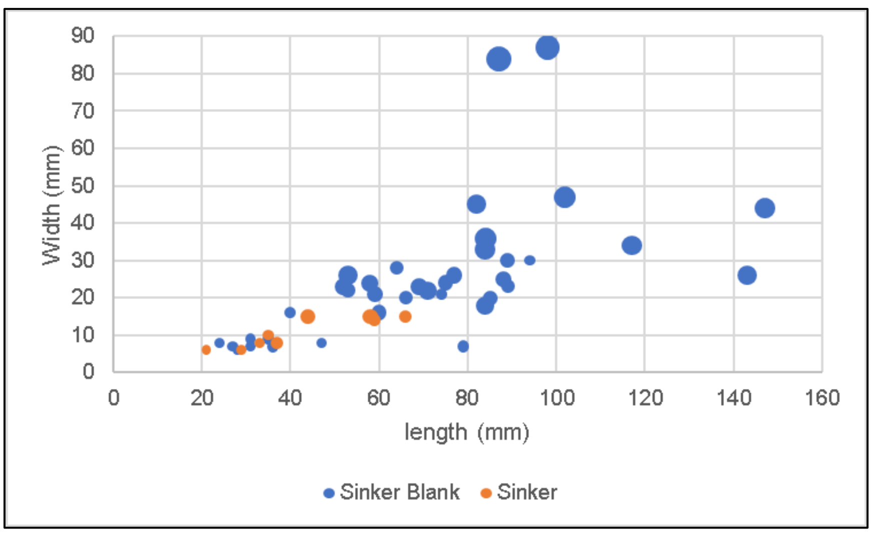

Figure 131: Dimensions of complete blanks and finished sinkers from Sector A, bubble diameter represents thickness (mm).

9.3.2 Sinker Weight and Morphology

Stone sinkers were produced to reach specific layers in the water column. Thus, intact sinkers are informative of fishing targets, conditions, and other elements. Nowadays, factors like the size or ethology of a given fish, size of the required bait, currents' strength, waves, winds, and tidal flows, or even the fishing line, determine what type of sinker is to be used. In general, light sinkers work better for small fish and light bait, mild ocean and wind conditions, and current fishers consider those sinkers to be in the 30-50g weight range.

Loa's finished sinkers have rounded ends with one or two grooves for tying a fishing line. Specimens with grooves in the two extremes are more frequent: instead of a fishing line that ends in a weight, the sinker was tied at the fishing line in two points. Specimens with only one grooved extreme may reflect the so-called "paternoster" rig: one or more hooks and their respective line segments are tied to the fishing line above the sinker. Its advantage is that the fish feel less hook resistance after biting the bait. Single grooved sinkers were probably meant to stay at lower depths while the hooks floated above more freely. The two-grooved ends sinker were probably attached to the same line: both types could have been used in combination to gain more depth.

Examining the Loa sinker assemblage reveals clearly that a very specific weight was sought by the native fishers. Sinkers are very light: if the median weight for finished sinkers was 3.3g, blanks had 29g as this central tendency metric. By the same token, maximum weight was 15g for finished cases while blanks weighed up to 356g. Even if most blanks group below 40g and the main peak are extra light sinkers (<10g), as in the case of finished examples, there is another peak around 100g of heavier sinkers for bigger fish and heavier wave ocean conditions.

The light sinkers would be specially suited for small fish at intermediate/upper water layers in good conditions with moving bait. This is exactly where and how the onshore fishing of Chilean mackerel jack is done in northern Chile, nowadays. Chilean mackerel jack changes depth depending on light conditions and feeding activity, current fishers target different zones in the water column using very light sinkers of different weights (~2 - 3.5g). Light sinkers allow them to reach intermediate depths and to slowly move the bait. Loa's sinkers were probably used near the surface, in a paternoster rig to target one or more mackerel.

A few meaningful blank outliers are above 300g and may have served for unstable oceanic conditions, beach fishing and/or deeper waters, plus different fish species, size, and ethology. Early occupants of the settlement produced these extra heavy blanks so different target zones and species were exploited from the beginning. The heavy weights are not limited to bottom layers only, their finding across layers indicates the expert knowledge and versatility behind these vestiges of Andean fishing equipment.

Sinker shape has to do with several factors like the ability to hold position at the bottom, to avoid getting stuck by rocks and other obstacles, hydrodynamic requirements to move in the water, and aerodynamic requirements to be launched while fishing from the beach, among other considerations. The weight and shape of finished sinkers are optimally suited for targeting small fish (like jack mackerel) in upper open water layers and shallow rocky bottoms and during mild wave conditions. But finished sinkers were frequently lost in action so are least likely to be found in domestic contexts excepting small and easy to lose examples.

In the Loa assemblage, sinker length shows a normal distribution and peaks around 30 millimeters, min and max values are 18 and 83mm, respectively. Widths have a unimodal distribution with a clear peak between 10 and 20mm, these are very light, almost standardized sinkers. Recovered sinker blanks show larger sizes as well, but the morphology is always the same, however, regardless of size.

Loa sinker morphology suggests that they were not meant to hold position at the bottom or to be used at depth or in turbulent water. Nowadays, fishers use elongated sinkers like Loa's to avoid getting stuck in rocky bottoms. Its hydrodynamic shape facilitates covering more water in search for fish. Loa's natives manufactured a specific kind of sinker that remained relatively stable through time. Most blanks are within the light or extra light categories, so a regular intention was transmitted through generations. Many blanks group together with the finished sinkers. In the case of length, the main peak for finished sinkers lies below 7cm while many blanks are concentrated in the 8-9cm range. In other words, sinker manufacturing shows a desire for the specialized capture of mackerel in the mid-water column or from rocky shores.

The large, heavy grooved sinkers called *poteras* (Blanco, 2017, p.85) known from elsewhere were not found at the site. These would be ideally suited for heavy wave conditions given their use with large bone spikes that hold at the ocean bottom. Beach fishing employs this kind of heavy and stable sinker type for drums and other species.

9.3.3 Sinker Evidence for Intensification and Specialization

As discussed above, sinker weight and morphology indicate targeting of jack mackerel and associated fish in the mid-water column or from rocky shores.

The most components of the Andean sinker assemblage (blanks, abraders and slate debitage) were recovered from the Sector A village but components were also found in the salting patio of the Sector B fishery (B1, Layer C & F). The initial shaping of sinkers took place everywhere: the discard densities (l/case) of debitage in colonial layers of the fishery and the village core are comparable in interquartile ranges terms (Figure 132). Slate debitage was discarded with similar high densities (in values in the 10s l/case) in both areas. Local natives conducted the initial shaping of sinkers in Sector B fishery (blanks and debitage in F and rounding off blanks and abraders in C))and in the village core.

Most abraders were found at the village (76%; n = 95) but some specimens in colonial occupations of Sector B are evidence for sinker manufacturing there as well. Nevertheless, the final rounding of the sinkers was a task that took place mostly at the village. Abrasives were discarded in the fishery in rates well below the highest densities seen at the village (20l/case or less).

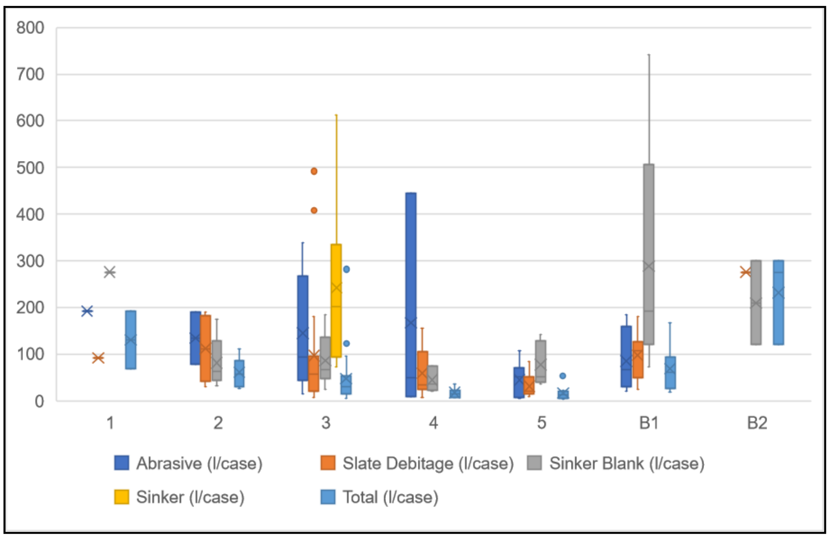

Figure 132: Compared sinker-related evidence per unit and sector.

Units near the colonial chapel of Sector A yielded high proportions of abraders despite totaling only $1m^2$ in area (23% and 35% in A4 and A5, respectively). The shell midden's core concentrates 37% of cases (n = 35) but measures $4m^2$ in area. Sinker production was moderately more intense near Sector A church in colonial times. The village's core (A3) yielded the most finished sinkers (58.3%; n = 14). Discard rates of sinker blanks at the fishery are lower than those in the village. Not a single finished rounded sinker case was recovered from Sector B.

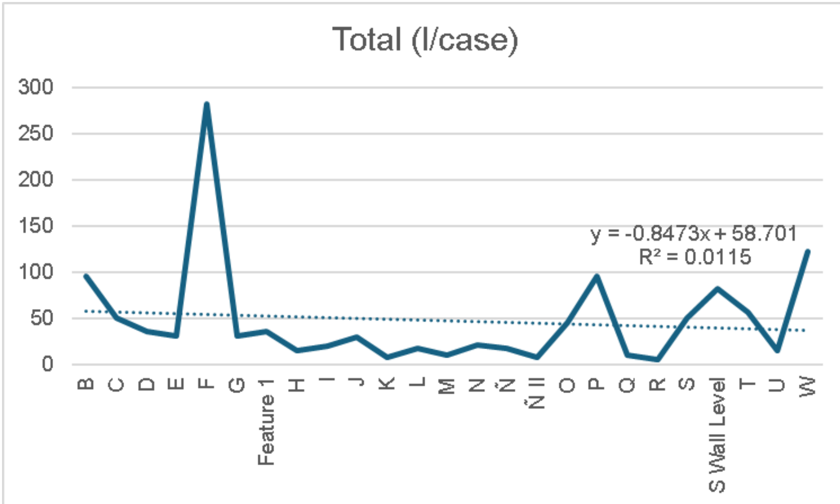

Figure 133: Densities of sinker-related evidence (abrasives, debitage, blanks and sinkers) over time at A3.

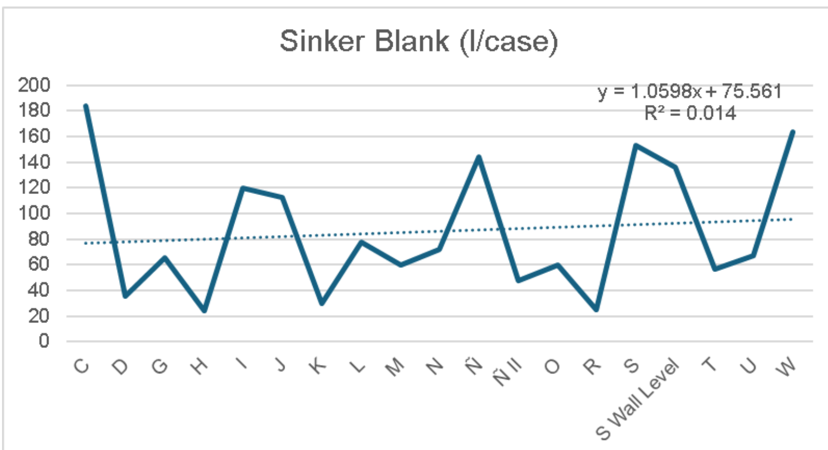

Figure 134: Sinker blank discard rates over time in A3

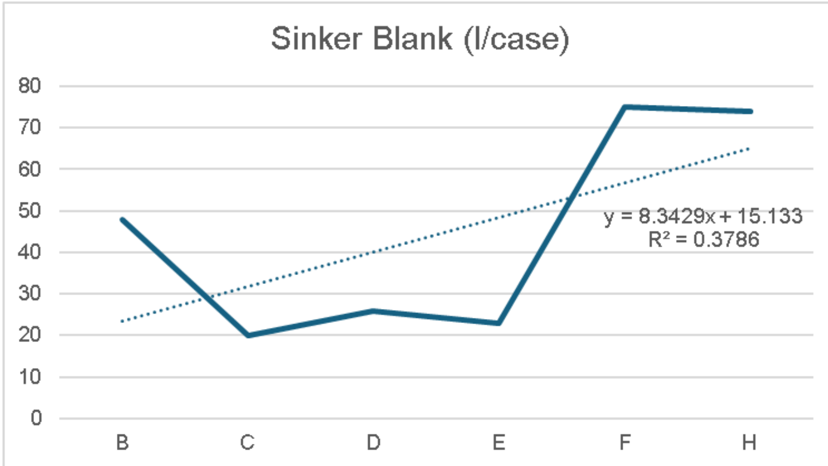

Figure 135: Sinker blank discard over time in A4

Among the Andean fishers, sinker density calculations (l/case) reveal no single increasing trend over time for intensified fishing as seen by regular densities of abrasives, debitage, blanks and sinkers (Figure 133). What I found are different trends and a good deal of continuity in the production and use of these materials. One interesting thing to note is the intensive discard of sinker blanks during Middle Period occupations (Figure 134), a time in which fishing was high intensity as seen in other lines of evidence. There were also increases in discard over time near the church[30] (Figure 135), again, something seen in other fishing lines of evidence as well. These patterns suggest that the village core was a place of intensive productive activity during the Middle Period, but that activity shifted in Sector A to near the church in the colonial period.

In the village, the final stages of sinker manufacturing represented a regular productive activity conducted by these Andean fishers with no significant general trends. Discard rates varied but overall present a flat trendline. Pre-Columbian layers (H-J) in Sector B showed the highest pumice discard intensities, but abraders were only deposited at low densities in colonial times.

[30] In both units A4 and A5.

One diachronic shift in sinker production assemblages indicates subtle changes in fishing intensity and specialization. Abraders were more densely discarded in middle and upper occupations of the village; the rounding of sinkers grew in importance from previous occupations.

The production of hooks and sinkers tracks fishing intensity in Sector A. The majority (60%) of fish bones variation is explained by the sinker industry ($r=.775$, $p= .000$, $Y=62.195(X)+136.406$). In other words, the more sinkers, blanks, slate flakes, and abraders (all together) the more fish bones within the excavated native occupation. Further, this sinker industry explains 75.4% of the variation in total Chilean jack mackerel quantities ($r=.868$, $p= .000$, $Y=14.844(X) + -53.547$) and 70% of the variation in Chilean jack mackerel crests count ($r=.834$, $p= .000$, $Y=5.575(X) + -23.528$) so hook fishing of mackerel was a long-term core activity for native village residents.

9.4 Fishing Nets

No net remains were uncovered at the village, perhaps for preservational reasons. The salt in the Spanish fishery clear helped preserve organic material in Sector B. That fishing with nets was taking place prior to Spanish arrival is suggested by a few fragments from Pre-Columbian occupations of the Sector B fishery. For example, one late Pre-Columbian occupation dated *cal* AD 1319-1419 (B1, Layer H) yielded such remains while another dated *cal* AD 584-653 (B1, Layer I) weighed a few grams. It's likely that the Spanish fishing intensification involving increased net fishing simply drew on and expanded prior native net practices. Most net fragments were recovered from early colonial occupations (B1, layers F and C), anyway. People salting fish in Sector B clearly worked on nets in that location, and net fishing accounts for the high volumes and densities in grams of fish such as sardines and corvina. One large, folded shred still contains *in situ* articulated fish vertebrae (Figure 136).

Figure 136: Fishing net with articulated fish vertebrae from the salting patio.

Fishing nets were made of cotton, mostly white or light brown. Some nets exhibit repairs with darker, fine vegetal fibers. No doubt fishers continuously worked on the maintenance of nets using both cotton (found raw in great quantities at the fishery) and other vegetal fibers. Some of the bone awls (classified as Type A harpoons) could correspond to the instruments used by the weaver for such tasks. Spinning activities are evident in some hand-spun fibers, but no spindle whorls were recovered.

Natives made nets in two mesh sizes as seen in a good sample (n = 18) of cases that allowed the measure of grid cells. One group showed a narrower weft of around 3x3 centimeters while the other had larger more open cells around 5x5 centimeters or above (Figure 137). In general, twine thickness varied randomly, there are large cells with thin twines and vice versa.

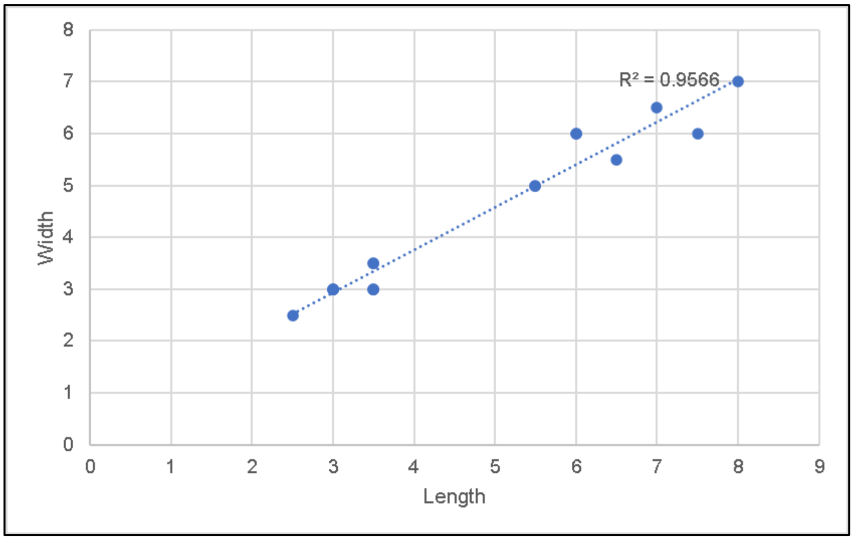

Figure 137: Measured (cm) grid cells in colonial nets from B1.

The smaller grid size would be perfect to capture small schooling fish like sardines and anchovies plus bigger animals. Obviously, the larger size was aimed at larger fish (leaving free small or juvenile fish). Sandweiss (1989, p.323) recorded ethnographic data about mesh size and target species in Peru: nets with a 3x3 centimeters grid were used for cabinza (*Isacia conceptionis*) and others of similar size; the larger mesh size for bonitos and corvinas. The nets were pulled and collected from the boats thanks to the use of strong lines or ropes, which allowed large hauls of fish to be captured in colonial times (Figure 138).

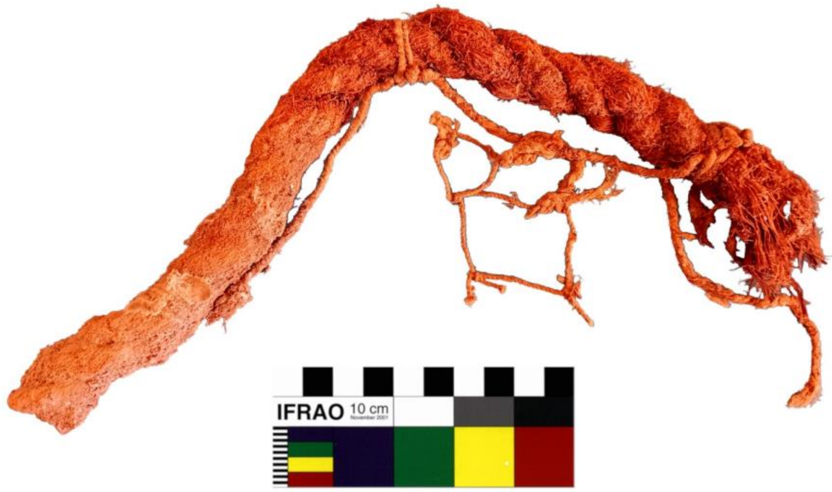

Figure 138: Colonial fishing net with rope handle from Sector B

9.5 Small Harpoons

Fishing would also have involved harpoons. Certainly, the harvest of sea mammals would have required harpooning. The long bones of seabirds or terrestrial mammalians, most likely camelids, were filed down to obtain a harpoon point and/or a bone awl. The harpooning of prey of varied sizes and behaviors represents an ancient Andean fishing practice in the region. Atacama's maritime communities targeted large prey since about 4500 BC with harpoons and processed them with characteristic large bifacial lithic knives (Ballester et al., 2017, p.189). A large Atacama funerary assemblage of harpoons (n = 129) showed that men of all periods were buried with such tools on this coastal region (Ballester, 2017).

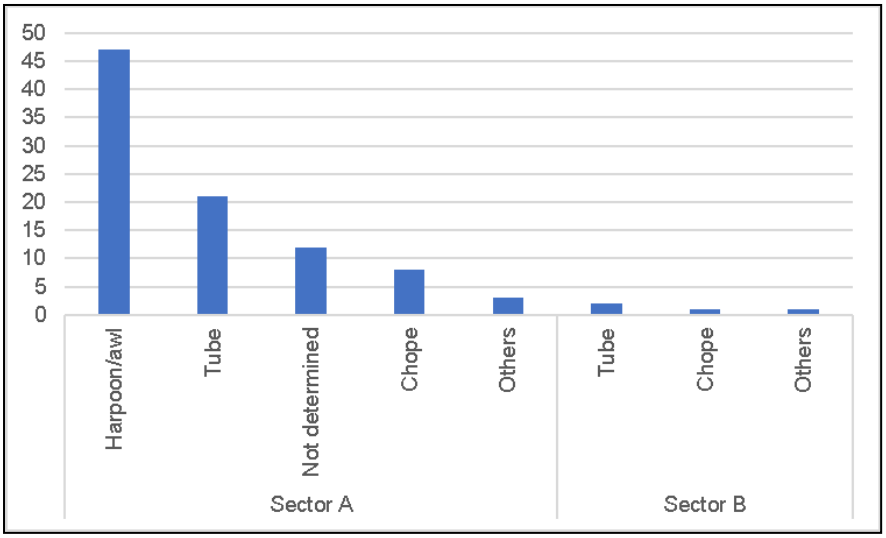

Figure 139: Count of bone tool types per sector.

Type A corresponds to delicate harpoons for small prey with a pointy bone head of lama metapodium of flat sides (~150mm long) and cactus thorn barbs (Ballester, 2017). I recovered many points made of bone in Sector A (Figure 139). The Loa small harpoons had sharpened Lama sp. bones points for penetrating relatively soft materials. These bone points were the most common bone tool in the village (49%; n = 47), most of them correspond to broken tips, and diameters average 5mm. These tools could correspond to Type A harpoon heads (Ballester, 2017; 2018), but in some cases they might also represent bone needles and awls for sewing clothing, sealion skins, and tents used as dwellings. The type has a long history at the Loa mouth: people of late Pre-Columbian and Inca era were buried with type A harpoons while equivalent specimens were found at a previous settlement (CaH-42) of complex hunter-gatherers and fishers (Ballester, 2022).

People would have used Type A harpoons for millennia to target flounders and other demersal species in the region (Ballester, 2022). I identified the whole productive sequence at the site: blanks corresponded to *Lama sp.* metapodium with deep V-shaped incisions in the diaphysis direction. People would trim large pieces of the diaphysis as preforms from which create a pointed harpoon head. These small points are absent from the Spanish fishery.

Finally, a couple bone tool cases could correspond to a different type of barb: type E barbs (Labarca et al., 2017, p.99) with a serrated straight profile were recovered from Layer G in the village core (A3).

In the case of harpoon/awl tips, we do not see any discard density trends over time across units in Sector B. The village's core (A3) only shows a slight decrease over time for such tools. Sharp ends of Type A harpoons and/or bone awls have their main densities at the village's core (A2 & 3).

9.6 Large Harpoons

There is another harpoon type characteristic of the era on this coast. Type D was a larger and stronger late Pre-Columbian form for the capture of large prey consisting of a wooden shaft with a bifacial point and bone barbs (Ballester, 2017). The barbs are characteristic: they have a curved sharp end and a flat bevel for attachment to the harpoon (Ballester, 2017). These features are absent among Loa's sample of bone tips mentioned in the previous section. People at this settlement made fine bifacial points with the same clear regional chert used for producing knives. The Loa assemblage constitutes a reduced (n = 6) albeit meaningful sample of stemmed points with either lanceolate or triangular blades (Figure 140); locals knapped barbed shoulders in most cases (n=5) to secure the catch. Their reduced dimensions suggest the capture of small prey (Table 30).

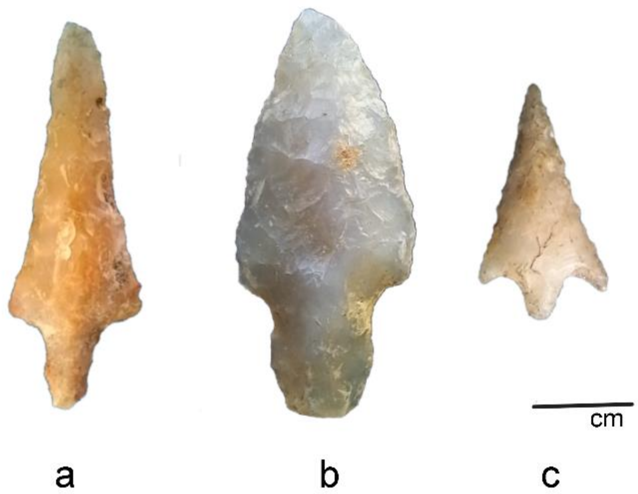

Figure 140: Examples of lanceolate chert points (a & b) and a triangular barbed point (c) from Sector A (A3).

These points would be ideal as projectiles given their barbed shoulders. Archaeologists have found similar points at other sites of the region still hafted as wooden harpoons and darts (Berenguer, 2008; Bird, 1946; Ballester, 2017). Their use as knives is less likely if we consider that known cases of hafted bifacial knives with wooden shafts have straight or concave bases (see Berenguer, 2008, p.72).

Table 30: Lithic Points from Sector A

Point type	Weight (g)	Length (mm)	Width (mm)	Thickness (mm)	Unit	Layer
Lanceolate stemmed barbed	2	42	14	5	A3	A
	1.4	37	12	4	A3	B
Lanceolate stemmed not barbed	4.8	43	19	5.5	A1	E
Triangular stemmed barbed	0.9	26	14	4	A3	Ñ II
	0.5	10	24	3	A3	O
	1	25	11	5	A5	D

The same lanceolate and triangular blade morphologies are present in finished points fragments (*n* = 10). The only exceptions are three cases of leaf shaped points with pointed ends and no stems. I recovered the point fragments from intermediate and early occupations of the village core (A3). Equivalent points with lanceolate blades and concave, straight or convex bases (no stems) are characteristic of Late Formative mound cemeteries of the Loa mouth; locals used them, opportunistically, as harpoon components or as knives (Blanco, 2017, p.82).

The sizes of the points in my sample point towards the scarcity of large harpoons (points and blades) capable of tackling large animals. For example, not a sole case of the Type I point -a broad lanceolate blade with a wide elongated stem- used for large prey during the Formative (Blanco, 2017, p.87) was found in the village. Therefore, my sample suggests the harpooning and processing of small to medium-sized prey was most common. However, there must have been weapons capable of harvesting sea lions, perhaps not made of stone but of metal that has long been remelted and recycled. Bibar (1966 [1558], p.10), for example, points out that natives harpooned sea lions with copper harpoons while they slept on windless days.

9.7 Shellfish Harvesting Technology

The Puerto Loa site consists of a massive shell midden. Obviously, one of the main activities for the community was the continuous harvesting of shellfish at the rocky shoreline and along the main peninsulas of the area. In harvesting shellfish, they made use of a bone tool, generally made from an animal rib, as a “toggle” or “*chope*.” These tools, sometimes wrapped at one end with textiles or fibers, would be intentionally thinned and rounded at the other end.

Specimens frequently showed flaking at the working end from the pressure in using the tools to pry shellfish off rocks. Most specimens came from the village's intermediate occupations. Their scarcity (n = 9) contrasts with the economic importance of the subsistence activity in which they were used. Perhaps as with fishing sinkers, their discard occurred outside the village, in this case on the rocky shoreline itself.

It is worth making a special mention of the massive deposits of shells accumulated because of the regular consumption of shellfish in the village throughout the entire occupation sequence. Although this research focuses on fishing, the local community regularly fed on the resources that the rocky and sandy coastline offered them, from barnacles to clams. Shells are one of the main elements in many layers, although in some occupations and especially in sector B they seem not to have been so important. Three species of shellfish were of special importance to the different generations of Andean fishermen who occupied the village. The star trio of Loa is made up of mussels ("*choros*"), Chilean abalones ("*locos*") and lack sea snails (*Tegula atra*). The people of the village consumed these three species on a regular basis, their shells were found associated in almost all excavated occupations.

In Sector B Iberian fishery, shell remains do not constitute an important element in the excavated deposits as if the economy of shellfish collection had not had the same importance among the colonists. The recovered shells were found mostly whole, the species correspond to another selection, one mediated by the taste of Europeans. The inhabitants of the fishery did not eat the trio of seafood mentioned above so regularly. Apparently, these people were more interested in eating mussels than abalone, but what is most striking is the presence of scallops and river shrimp. These species were recovered mainly from colonial occupations in sector B - apart from some specific remains excavated in the upper layers of the village. I provide information on the present and absent species at each occupation in Appendix D.

9.8 Specialization and Subsistence: A Bone Tool Perspective

We can roughly assess the importance of various forms of bone technology used in subsistence pursuits by comparing their proportions across the site and through time. I found tubes and chopes in both sectors, although most bone tools came from the village (96%; *n* = 91), Harpoon tips and tubes have similar densities by count at the village (Figure 141) while the core have slightly higher densities for chopes.

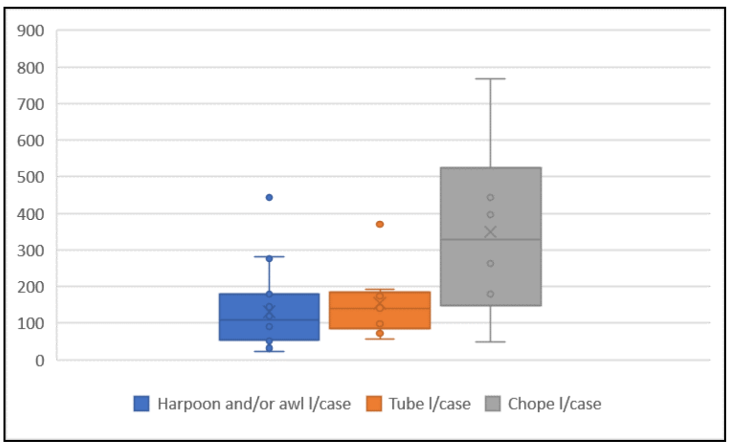

Figure 141: Discard densities of the main bone tools at unit A3.

What were the discard rates of these bone tool types? Tubes and harpoon tips exhibit remarkably similar densities. Chopes were discarded less frequently at the settlement after the Middle Period, perhaps because they were being lost at their natural use location at rocky areas with shellfish. Another possibility is a shift in the harvest techniques or shellfish species exploited following the Middle Period. Evaluating these hypotheses will have to await an analysis of the site's shell assemblage. Activities involving tubes and pointy end tools like harpoons or awls occurred on site. From this angle, it seems less likely that all the latter were harpoon components. The use of awls to work skin for tents and rafts is a logical possibility. The natives may also have broken the harpoon points during manufacturing, thus at least two types of activities generated the sample.

Rather than shifts in specialization over time, the pervasive presence of potential Type A harpoon tips illustrates strong continuity in fishing practices over time. The lack of these harpoons in the colonial occupations of Sector B could therefore reflect continuity in the domestic foodway traditions (jack mackerel, harpooned flounder) and sea lion skin sewing in the native community (Sector A) as well as a Spanish fishery more committed to net fishing.

9.9 Summary

This chapter examined fishing technology to reconstruct fishing practices for Sectors A and B to discern chronological trends, particular those following the establishment of the Spanish fishery.

A good deal of technological continuity characterized fishing practices in the community from its founding through the colonial period. This continuity is seen in the discard and densities of artifacts related to manufacture of skin boats, specific sinker forms, and small Type A bone harpoons. For centuries, locals employed hooks in tandem with a specific mid-water sinker. Its design, shape, material, and weight remained stable through time in the village. They devised larger and heavier sinkers for other conditions, habitats, and species. Continuity in the harvest of shellfish is seen in the bone “toggles” or chope although for unknown reasons these are absent from colonial layers in Sector A.

These activities continued in the colonial period, with in some cases changes in their spatial distribution. The site residents devoted a similar effort to the shaping of sinkers in Sector B as they did in the village (densities are comparable). As the new elite redirected fishing efforts and skills, the salting patio became a locus of intensified boat production and maintenance. Alongside seams and boat remains, cactus thorns -an essential raw material- were recovered in remarkably high densities in Sector B. The boats used in conjunction with intensified net fishing yielded high volumes of sardines and other species for the Spanish run fishery. However, small harpoon manufacture and use remained restricted to the village. The frequent harpooning of small prey likely coexisted with specialized hunting of specific large marine animals.

A meaningful change in fishing technology was the increased use of cotton nets of two mesh sizes during the colonial period. While nets were certainly used at Puerto Loa earlier (some fragments were found in Pre-Columbian layers of Sector B), their use seems to have been more common during the colonial period. The extent of this change is hard to evaluate because of preservational factors. However, the highest fish species proportions in Sector B (such as sardines) would have been a species harvested with nets.

Traditional Andean fishing practices and labor fueled the colonial seafood business. Local natives worked in the salting patios under the colonial managers with their traditional toolkits and vessels.

10.0 The Forming of New Worlds and Commoditization

The inhabitants of Puerto Loa were part of a boiling new world in which certain indigenous households and communities were put at the nexus of traditional, enduring Andean institutions and an overarching, unstoppable Iberian mercantilism. The port was this nexus and was an engine for socioeconomic transformation. It was here, at the grass roots level of a remote village, that things were transformed into commodities. This process entailed novel encounter for the indigenous villagers: new social personas (the entrepreneur) and new logics and valuation (that of the market). The process also involved transformation of indigenous leadership, if not exactly into *compradores*, at least into critical actors in the unique, hybrid market economy of the colonial period.

Examination of this transformation at Puerto Loa reveals the extent to which this transformation involved continuities and negotiation rather than abrupt replacement. It would be inaccurate to generalize the spread of the Spanish market economy in colonial Peru as a grafting onto existing Pre-Columbian economic patterns, but much of the commoditization of fish production had this character. In some ways, the economic synthesis at Puerto Loa echoes the transitional interpenetration of other aspects of Spanish colonial consolidation: a gradual succession of alliances, marriages, strategic exercise of power, and kinship; "something that came into being *through*, rather than in spite of it" as Van Valkenburgh (2019, p.1068) puts it. Some encomenderos were the children of conquistadors and noble Andean women creating a mixed indigenous/Iberian elite leadership stratum. Even at Puerto Loa, leadership and decision-making were shared between the Spanish portero and the native curaca.

The Puerto Loa research documents other kinds of continuities as well. The Inca tribute system, for example, changed hands and even then, not completely. The individual indigenous households there continued to solve their own material needs in the most traditional ways possible, there consumption patterns barely touched by market materiality. The colonial mercantilists of the 1570s studied, mapped, quantified, and redirected the preexisting Andean tributary flow, modifying some aspects of it of course in turning surplus tributes into commodities. At Puerto Loa, fish remained as tribute in kind in the turbulent waters of the transition between empires.

10.1 Specialization, Continuity, and Change

(1) *How did native seafood production shift and become commodified under the Spanish? Did this commodification represent an expansion or intensification of late Pre-Columbian production?*

Spanish commodification of fishing involved specialization, intensification, and use of partially "dis-embedded" native fishing labor. The specialization took the form of construction of a dedicated locus for dried fish production - a fishery – built around a particular new preservation technique: salting, as manifested in an ample salting yard in the fishery. The evidence (both ethnohistoric and archaeological) is ambiguous but suggests that most Sector B salted fish may have been preserved whole for shipment inland. The salting process reinforced alienability, enhancing the physical capacity of the fish to be separated from its producers. Juan Donoso and other Spanish entrepreneurs reconfigured fishing production in Puerto Loa with a new mercantilist character, the archaeological record clearly shows how novel were certain elements of the commodification process. The salting process represented a revolutionary technique of commercialization of fish tissues designed for distant markets and deferred consumption. Through this process, a standardized marketplace commodity, salted fish, was created subject to market prices and distribution. Commodities are alienable goods born when exchangeability is an item's salient, socially relevant feature (Appadurai, 1986) and commodification the process by which exchange values are assigned (Castree, 2003). This process was a fundamental component of early modern mercantile expansionism (Wolf 1982), and Puerto Loa's fish exemplifies how commodities were created in the early colonial Andes.

Fishing intensification can be conceived simply as the amount of fish coming out of the sea. From a density measure (grams of fishbones per liter), Spanish commodification and the fishery represented an intensification of fishing, although not a great intensification. Densities in the colonial fishery were somewhat higher than late Pre-Columbian densities, and densities in the colonial village somewhat lower the in the late Pre-Columbian densities. However, if we add the two colonial densities of Sector A and B (as the fishers were feeding both themselves and the fishery), there clearly was significant intensification.

The archaeological evidence is clear that the Spanish fishery drew on the fishers of the indigenous village to catch and process the fish. This process represented a partial "dis-embedding" of native labor (including spatially) rather than a marked transformation of native labor. In the fishery villagers worked under the eyes of Spanish managers. All elements of traditional Andean maritime production (nautical, fishing and processing technologies) were uncovered in the salting patio. But in the colonial native village (Sector A), all activities, including fishing, continued very much as they had before with no evidence of significant shifts in domestic economy or household production practices. The indigenous fishers did not become a hired, proletarian, labor force. The archaeological evidence strongly argues that they did not work in the fishery for cash or barter. Instead, it is much more likely that the arrangements underlying their laboring for the Spanish fishery managers were traditional tributary ones, and they may even have seen themselves as working for their regional curacas directly. These curacas in turn provided the Spanish fishery with fish and labor.

The colonial commodification of fishing was built on indigenous labor and traditional indigenous fishing practices. The Sector B fishery revealed on-site manufacturing and continued use of traditional native technology, in terms of nets, sinkers and hook types, chert knives for gutting fish, and use of inflatable sealskin boats.

10.1.1 Differences in Colonial Fishing

While generally built on traditional Andean fishing practices, the fishery (Sector B) fishing was distinct, differing in significant ways from the subsistence fishing patterns seen in the Sector A village both in Pre-Columbian and contemporaneous colonial periods. Among these differences were:

- The Spanish fishery focus on corvina (*Cilus gilberti*) and high volumes of small schooling Clupeiformes (sardines, anchovies) in place of Chilean jack mackerel (*Trachurus murphyi*) which was the mainstay of indigenous fishing.
- Diversification of varieties taken. Commodification involved harvesting a broader assortment of fish which is demonstrated by the diversity indices.
- A more extensive exploitation of habitats other than that of the traditional Chilean jack mackerel and its pelagic predator-prey network. Fishery fishing made greater use of near

shore habitats along the beach and rocky shorelines. Represented in Sector B were almost all capture methods, from large cotton nets with reinforced handles to sweep large schools of fish like anchovy and sardine, to the traditional Andean metal hooks used together with light sinkers to capture mid-column species in rockeries and kelp forests or directly from inflatable boats.

- More netting of fish. Concomitant with the differences in fish proportions and variety was significant change in fishing technology with the increased use of cotton nets of two mesh sizes during the colonial period. While nets were certainly used at Puerto Loa earlier (some fragments were found in Pre-Columbian layers of Sector B), they seem to have become more common in the colonial period, although this impression is hard to evaluate because of preservational factors. Colonial net fishing involved massive capture methods using strong fishing nets with reinforced handles, with which large volumes of herbivorous fish and their larger predators were extracted. Some of the highest fish species proportions in Sector B (such as sardines) would have been species harvested with nets rather than lines and hooks.

10.1.2 Long-term Fishing and Hunting Trends

Pre-Columbian fishing by the villagers was not static over time. The long history of village occupation saw significant shifts in fishing, hunting of sea mammals, and consumption of seabirds. From the beginning the maritime adaptation was oriented towards shellfish (not discussed in this study) and a range of fish, of which the Chilean jack mackerel was the most important, and sealions, both for food and for skins for inflatable boats. Other resources ranged from sea turtles to sharks to a variety of seabirds. The most apparent fishing technique from the first occupations until the colonial era was line and metal hook fishing. Sinkers demonstrate a clear interest in the upper layers of the water column in open water and were designed with Chilean jack mackerel in mind. As noted above, nets were probably always used as well, but net fishing became more important in the late Pre-Columbian occupations in the village and featured in colonial fishery fishing.

Fishing intensity peaked in the Middle Period at levels only approached later by the colonial fishery. During this time Chilean jack mackerel was the focus, representing more than half of the fish landed. Sharks were also captured in small but significant numbers. The focus on pelagic species relied on line and hook fishing from sealion skin boats and/or other kinds of vessels. The stone tool assemblage of the Middle Period indicates steady production of bifacial knives and points for gutting and hunting large specimens.

Domestic fishing in the village changed prior to Spanish Conquest, with the late Pre-Columbian assemblages showing marked shifts. One shift was a significant decline in fishing intensity; fish densities dropped in the late Pre-Columbian occupations. It is not yet known if this drop reflects reoriented subsistence, a smaller community, or spatial shifts in the demographic center of the community. Although Chilean jack mackerel remained the predominant fish, more corvina were taken and the variety of species taken diversified, with more exploitation of beach, rocky shoreline, and kelp forest habitats for demersal fish. In terms of hunting (sea mammals and birds), the late Pre-Columbian/Late Horizon assemblages reveal slightly less hunting, and less diversity in prey, with proportionally greater focus on sea lion and cormorant. Sea turtles and dolphins are not found in late assemblages of the village. There was some intensification in the crafting of copper alloy hooks during occupations of late Pre-Columbian times accompanied by greater manufacture of sinkers for line fishing.

Some of the trends seen in late Pre-Columbian intensified under colonial rule. The intensity of fish consumption in the colonial period village declined markedly, to about one-half of what it had been in the late Pre-Columbian. Chilean jack mackerel consumption dropped from roughly 50% of species taken to 38%, with a concomitant increase in corvina and sardines. Diversification of species taken increased significantly (although still not comparable to that seen in the contemporaneous Spanish fishery). Sinker and hook production increased. Changes in hook material and technology suggest village fishers targeted larger Chilean jack mackerel but in lower volumes, a specialized capture of bigger individuals may signal the desire to meet the tributary weight threshold defined by trans-conquest authorities. The apparent density decrease over time of fish at the village could be due to the transferring (as tribute) of part of the yield to the growing tributary Andean/colonial structure.

10.1.3 Native Consumption Trends

(2) *How did consumption patterns change for indigenous villagers in the colonial period? What was their acceptance of, and access to, market goods?*

For many centuries, the ocean was the main source of resources for the handful of families that inhabited the village. The residents' maritime economy was based on fish and shellfish, sea lions, marine birds such as cormorant, wild plants, and algarrobo pods grown nearby. Maize, llama and other mostly non-local resources were regularly present but in small proportions. During this long duration, their economy was markedly self-sufficient. This strong subsistence self-sufficiency was coupled with a much greater degree of regional exchange as seen in durable goods in local household provisioning. The Loa community always had access to the goods and resources of the regional indigenous society. For example, the continuous supply of vessels, specifically of all famous inland types from the Middle Period onwards. The ancient and sustained presence of Andean camelids in the village tells us of widespread circulation and distribution of travelers, llama caravans and loads of food and manufactures among lowland and upland communities of relatives or ethnic authorities.

Domestic consumption patterns in the village barely changed in the colonial period despite the growth of the site into a port, the establishment of the Spanish fishery, and the village residents labor to support the latter. While native villagers' daily social interactions and work practices may have changed in important ways in the colonial period, domestic practices and materiality changed very little. European origin goods that distinguish the Sector B assemblage (and lifeways) are virtually absent from Sector A.

Foodways in the village saw great continuity through the colonial period. Local villagers continued fishing for mackerels and drums, and hunting sea-lions for meat, blood, and liquid fat. Like their ancestors, they still relied on the nearby Atacama forests for their staple algarrobo flour and chicha. Subtle subsistence shifts seen in the late Pre-Columbian period continued into the colonial period: somewhat greater use of forest resources and less diversity in species fish. Most notably, villagers continued a traditional cuisine uninfluenced, or little influenced by Spanish preferences. European origin foods (from cow and chicken to olives, grapes, and almonds) were essentially limited to Sector B, barely appearing in the indigenous village (Sector A). This exclusion from - or more likely rejection of - European materials characterized other aspects of village stylistic preferences and domestic lifeways. Sector B residents consumed utilitarian

European products (iron, glass) and elite European trade goods including porcelain, majolica, and silk. None of these items were found in Sector A. Colonial period villagers ate from traditional vessels while Sector B residents used a combination of local and imported dishware, including lead crystal goblets and Panamanian-style majolica. The only exceptions to the lack of European goods in Sector A are fragments of colonial botijas, or transport jars, which are distributed throughout the surface of the village in low density but concentrated at the beach access channel to the sea. This concentration probably represents breakage in offloading these vessels from ships or, alternatively, access to wine by local Andeans. A mere handful of other European goods, such as majolica, were found in Sector A, but all were recovered in the vicinity of the colonial chapel. Village dress and ornamental fashions were equally separated spatially. Everyday dress in the colonial village were the traditional woven tunics and copper, stone, and shell beads necklaces. Remains of fancy indigenous clothing (likely to be worn by elites such as curacas) and European clothing, including linen shirts and elaborate sheep wool jackets were limited to Sector B.

Given the dearth of European material in the colonial period Sector A village, if one did not have absolute dates, or any knowledge of the church or the Sector B fishery, one could easily mistake the village for a Pre-Columbian community. That European origin and mercantile goods were not found in Sector A indicates no market-based provisioning of village households in the colonial period. This lack of consumption engagement with the market, in turn, suggests that the villagers had a profoundly "non-market" articulation with the overarching market. I argue that this articulation was through traditional tributary demands, articulated through still powerful regional curacas working in tandem with Spanish fishery managers. As the settlement at Loa went from native fishing village to colonial port, the indigenous villagers were not transformed into a wage labor force or workers in the market sense. Instead, Spanish officials and entrepreneurs were able to tap indigenous labor through traditional non-commercial structures of Pre-Columbian origin. This process, as documented at Puerto Loa, represents a vital insight into the growth and operation of the early colonial market in the Andes.

10.1.4 Hybrid Consumption in Sector B

The articulation between indigenous labor and commoditized fish production described above was embodied by the personas and activities documented in Sector B. Investigations in Sector B revealed hybrid consumption patterns, reflective of the positions of those who lived and worked there. The village inhabitants who worked in around the salting patio and other areas of the Spanish fishery processed sealion skins into boats, shaped fishing sinkers, manufactured stone cutting tools, all traditional activities common in village life. Yet their work in Sector B also involved engaging with critical new technology or fish salting, and with new objects, such as wooden barrels and many others. Native weavers worked cotton and camelid wool from the initial stages in the fishery and probably produced fabrics in addition to repairing and producing a large volume of fishing nets used on site. This activity is little evidenced in the contemporary fishing village. Although the native villagers did not consume European foods at home, it is very likely that they experienced these when working in or visiting Sector B.

It is as if two consumption circuits were superimposed, the Andean and the Spanish mercantile, but they only touched each other at some points and for a few privileged people. The assemblages from Sector B also suggest the presence of indigenous elite (curacas) in Sector B to coordinate with the Iberian fishery managers, oversee the delivery of required tribute, and engage in traditional Andean commensal ritual. The remnants of this presence include fragments of elite-quality, polychrome native textiles, coca, decorated gourds, and Inca-style *pucu* serving vessels. The serving vessels suggest gastropolitical ceremony linking indigenous people (villagers and their traditional regional ethnic lords) with the Iberian residents and visitors. The traditional Andean authorities and their new Spanish companions may have served maize chicha, coca, wine and other foods to cement agreements and work negotiations in the decorated pucu and meca plates found in early 17th century occupations of the fishery.

The Spanish inhabitants of Sector B enjoyed privileged access to a wide range of Andean goods and tribute as well as to diverse European commodities ranging from luxury items to chicken. These residents were in a unique position to consume from both the traditional tributary flow and the port's position in global mercantilism. These powerful colonists had at their disposal imported goods and regional products, the same ones that traveled to Potosí, but also all the items that had to be delivered by the communities of Tarapacá, Pica and Loa as part of the trans-conquest tax obligations. The traditional tributary flow brought for their consumption local pottery, maize, coca, llamas, and other items. The Iberian residents relied on a supply of algarrobo flour, bread and chicha and other fruits of the forest. The position of the Sector B residents at the crossroads (structurally and spatially) of tributary and commercial streams allowed them access to marine, agricultural, and wild resources produced through indigenous labor and to global commodities and manufactures. At the same time, their foodways included a range of European-origin staples and delicacies via the extensive colonial coastal trade and inland agriculture. The residents accessed other global commodities and European goods including Spanish style clothing of wool and silk, dishware, iron items, books and playing cards. Even the visiting friar celebrated mass and enacted Mediterranean ceremonies with Iberian materialities.

10.1.5 Ecological Footprint

(3) *Did colonial port development and changing production practices impact local resources?*

Scholars have proposed that European colonialism would have a strong ecological footprint in colonized regions and Puerto Loa provided an opportunity to examine this idea. I was interested in whether commodified colonial fishing would affect fish stocks. I was also interested if the port setting resulted in shifted indigenous use of the landscape. All relevant lines of evidence indicate that the introduction of mercantile fishing practices had no measurable impact on local resource structure. One reason for this lack of strong impact was that colonial fishing was diversified, aimed at capturing fish of every level from the entire food chain and in so doing, spread their fishing over a diversity of underwater habitats. The impact of fishing was therefore spread out among many different species.

Previous archaeological and historical studies have identified several signatures of overfishing: (1) a decrease in the individual size of fish within the same species; (2) a shift from higher level piscivorous fish to smaller, lower-level pelagic fish or "fishing down the food web"; and (3) increase in the capture of aggressive predators like sharks followed by their decline due to overexploitation. My results met none of these expectations. As noted, Spanish fishing was characterized by diversity, more so, in fact than had previously existed in Pre-Columbian Loa fishing. The size of individual Chilean jack mackerel specimens was used to evaluate the first expectation base on measurement of sagittal crests. There were no clear unidirectional trends over time in the village occupations. However, as part of their focus on Chilean jack mackerel, the intense Middle Period fishing captured more smaller size specimens than before or after. Although this cannot be described as "overfishing," the smaller size fish may be an expression of pressure on mackerel stocks as Middle Period fishers went after more rather than bigger in their intensification. Significantly, colonial harvesting of mackerel showed no such drop in fish size.

The mean trophic level of fish didn't show significant and strong decreasing trends in the colonial fishery and colonial village. At all periods and in colonial fishing, the emphasis was on taking level 3 carnivorous fish. Colonial fishermen salted many sardines and anchovies of low trophic level in the fishery and yet the diversity of carnivorous fish recovered from the colonial salting features makes the average trophic level of those occupations comparable with the averages for the contiguous native village. The catches of Andean fishermen at their settlement also show a strong stability manifested in averages that remain at level 3 of fish that feed on other fish in all periods. Both village and fishery sectors have comparable averages. One sign of potential fish overexploitation is the harvest of high trophic level predators such as sharks that are easily exploited given their aggressive behavior. We know that sharks of orders Carcharhiniformes and Lamniformes were exploited in colonial times on the coast of Tarapacá and commercialized for the consumption of the urban residents of Potosí and Tarapaya (de France, 2012). However, sharks, taken in highest proportions in the Middle Period, declined in the late Pre-Columbian period and were very rare, almost absent, from early colonial (in both the village and the fishery) assemblages. In sum, there are no indications of a colonial market impact on fish stocks.

10.2 Commoditization and Transformation

Colonial documents make clear that the residents of villages such as that of Puerto Loa were required to produce more than just fish as tribute. The variety of the required items highlights the importance of the indigenous tributary system to the early colonial period market. This is not surprising; even in Europe the advance of mercantilism kept long-standing tributary modes until well into the 18^{th} century (Wolf, 1982). Seven out of nine categories that the communities of Pica and Loa were required to provide as tribute to the encomendero in 1565 were present in Sector B fishery. Some, such as llamas, sacks, or vessels, could have been brought from the interior. Others such as textiles or maize, were produced in the valleys or on the coast by indigenous hands, while chickens and dried fish were clearly obtained locally. The last category of "sealion ropes" were also produced in the fishery. These products were created or stored in the fishery. This role as a tributary node is logical. The portero leased the tribute rights of the encomendero and such tributes would be delivered or paid in locations where the encomendero or portero had businesses in operation. The port function of Puerto Loa would make it a logical location for delivery of tribute products other than fish.

We know from Exquemeling that the Spaniards of Iquique back paid their “fish Indians” with stimulants and alcohol; the reciprocal exchange of fish for wine and coca would be another complementary mechanism to the tribute of dried fish that could ensure the work of Andean fishers in both Iquique and Loa. The fishery’s owners acquired, consumed, and redistributed stimulants such as coca, wine and tobacco. Coca was a tributary item from other Andean regions of the colonial period and became the “green gold” of the Andes when it was sold in the highlands and the coast. In this manner, the fishery may have represented a kind of store, a concentration point, in which to obtain stimulants, chicha, wine, imported food, clothing, dried red meat, fish, and salt in exchange for *corvée* work. The work of Catholic missionaries, the availability of wine and coca for the fishermen, the involvement of regional curacas in the organization of Andean tributary mercantilism, continuities in ritualism and traditional negotiation all oiled the new system, in which the monetary benefits traveled in one direction. The portero Juan Donoso and his colleagues crossed social boundaries by converting tribute into merchandise and merchandise into currency, generating immense fortunes and paying fabulous pensions to the descendants of the encomenderos. These privileged individuals had representatives in the main cities and as trading partners in the highlands, great curacas of the altiplano who also participated in the opportunities that Andean tributary mercantilism provided to arbitrageurs with vassals, monetary capital, and social connections.

The role of local fishermen in tributary channels and access to redistributive return was maintained even in early colonial times as a mechanism of communal supply and regional economic integration. The Spaniards and high-ranking indigenous leaders changed control of the tax system of the Inca Empire, redirecting its enormous flow of products to new applications, including market sales. Such was the case with the fish tribute from Puerto Loa. But this lucrative transformation of Andean goods into market commodities does not seem to have benefited local community members. Nor did the new role of supporting Spanish fishing did not transform the indigenous village fishers. They did not become wage laborers or a specialized mercantile workforce. In contrast, the market world of the colonial era changed the native curaca class. Important Andean curacas had enjoyed privileged access to production from other ecological zones from earlier times and the vertical archipelagos they dominated were not horizontal in social access (Van Buren, 1996). The market could have represented an additional and complementary tool to continue building difference within the indigenous world. The great curacas profited enormously from the opportunities of the new market and enjoyed luxury consumer goods and lifestyles tinged with European materiality. Some great Andean curacas, for example from Atacama, resided in the city of Potosí, consuming European products, while others successfully claimed their right to dress like Spaniards. The humble local curacas had to market part of the surplus of their communities following Viceroy Toledo’s demand in the 1570s that a large part of the tribute be in cash. Thus, while some curacas might voluntarily, even eagerly, enter the colonial marketplace, others were also being forced to do so. Their new role as arbitrageurs must have further increased the matrix of social inequalities between the Andean leaders and their base communities.

10.3 The Early Colonial Market: a Puerto Loa Perspective

The subordination of social distribution relations to the modern market constitutes what Polanyi called the "Great Transformation". The Spanish commodification of fish and its material transformation to feed distant dependent consumers in the first Andean cities shows us that this transformation was gradual and was supported by pre-existing indigenous economic dynamics. More than the natural expansion of a free market, the new era continued to be in significant ways an economy on command just as in Inca times as proposed by La Lone (1982). The New World was then born by adding another level of inequality in the native ports of ancient Peru: the conversion of tribute into currency. The fishing communities remained vassals, self-sufficient and paying service and in-kind tribute. Puerto Loa fish production, rather than transforming completely to meet the demands of Potosí and other markets, was redirected to the service of the new regional elite while retaining the traditional means of production and technologies. The expert knowledge of the villagers of currents, depths, seasons, fish, and fish behaviors was utilized to ensure the desired volume to sell to the voracious Potosí and other markets. The system of knowledge, practices, materials, and results was fully operational generations before Spanish arrival, it was not necessary to change the means of Andean fish production, but it was necessary to access a position of control in the production relations alongside curacas. The effort and commitment of these fishermen was one of the factors that enriched Donoso and other Spaniards, the other the addition of a stage of transformation of the marine substance to convert it into merchandise for distant and delayed consumption.

Pezzarossi (2015) concluded that the expansion of the colonial market in Guatemala was less of a grassroots groundswell to facilitate trade and more of accumulation of a succession of coercive political efforts on the part of the elite to accumulate wealth. A similar, agent-based, characterization can be presented for Puerto Loa and Peru generally. Here, the forced sale of commodities and the implementation of a cash tax generated the debt necessary for the market to expand through rural, self-sufficient and indigenous regions in the long-term. Toledo's obligation to pay cash salaries to the indigenous people was largely ignored here to maintain the conversion of taxes into money and a greater accumulation of wealth. In their role as arbitrageurs, both Spanish entrepreneurs and top native leaders took advantage of all the opportunities of an emerging market, the economic practices of the local indigenous society, and the heritage institutions of the Inca political economy. Some anthropologists have indicated that markets expanded in ancient times, long before the birth of capitalism, as the natural effect of the growth of non-food-producing urban populations in regions with strong agricultural production (Blanton & Fargher, 2010). In the

Andes, although the appearance and growth of large colonial cities revolutionized demand, the market was not a "natural" product of cities, but the fruit of forced strategies pushed by the Spanish elites and supported by great indigenous leaders. An amalgam of native and mercantilist economic practices allowed the Andean colonial market to be forged with an unequal territorial distribution and variable temporal trajectories. The modern market was born in the Andes formed by overlapping distribution channels and indigenous mechanisms coexisting with the increasing promotion of exchange for dependent communities of non-producers in the cities.

At Puerto Loa we can identify how Andean fishermen operated, together with other actors, a fishing establishment where marine tributes were transformed into an urban commodity thanks to the alchemy of preservation with sea salt and the strategic work of regional elites moving the product between types of distribution, social relations, and geographical areas. Intensive fishing occurred to solve tributary demands for mercantile desires. The work of indigenous fishermen was central to the Spanish fishery; one of their objectives was the generation of preserved fish as payment for long-standing tribute agreements. My results support the notion that traditional Andean production relations continued to be the main source of supply for Andean communal economies, as can be seen in several insightful studies of Andean colonial archeology (de France, 2012; de France et al., 2016; Van Buren, 1999). In other words, the Andean communities largely kept their pastoral, agricultural, hunting or fishing practices well into Spanish hegemony. The dependence on the market for the supply of domestic units, far from a natural and spontaneous process, was an elite supported distribution mechanism that would have to wait a couple of centuries of transformation to consolidate outside the southern Andean cities. The first expanding Andean market was a complex fabric of new and old interdependent relations linked to the evolving economic and political conceptions of associated regional elites.

What this research clearly demonstrates is the degree to which the commodification of fish in the mouth of the Loa was the historical product of European colonialism yet underpinned by indigenous praxis. The Spaniards together with the regional curacas operated in Puerto Loa an establishment for the material transformation of fish to meet the market demand for a high value protein product capable of long-distance transportation and deferred consumption. The preserved seafood business demanded redoubled efforts from the fishermen and even made certain fish scarce, but it did not give way to widespread exchange or market dependence for these producers. From the Puerto Loa "micro-perspective" we can see how the colonial market thus developed as an elite economic practice that recycled native institutions, maintained productive rhythms, and expanded unevenly throughout the natural and social landscapes of the Andes. The natives participated in the new and traditional demands on their work, equipped with their expert knowledge and specialized technologies to supply the voracious inhabitants of Potosí and other consumers.

10.4 Future Research

Beyond the obvious additional excavation that could be performed in unsampled components of Puerto Loa, additional research of various kinds could aid in exploring some of the findings very specific to Puerto Loa fishing. Among these are issues relating to the potential surplus production of fish for export during Pre-Columbian occupations. The information available on the archaeological distribution of Chilean jack mackerel in Tarapacá is incomplete and scarce. We know that mackerel was distributed in the immediate interior and that both whole and headless mackerel were transported to the lowlands of Tarapacá. We also know that mackerel appeared in communal storage systems in late Pre-Columbian villages in surrounding regions, yet it has not been reported to date from the collcas of the Inca era in our study region. The disproportion between heads and bodies of mackerel in the Sector A and B assemblages raises interesting questions. If they have been transported headless and dry, the disproportionate number of heads in the village of Loa would clearly suggest a surplus for the interior in the form of headless fish. Further information on the regional distribution of mackerel, and how it was processes, could be gained through analysis of the ichthyological samples already obtained from the main domestic contexts of the inland villages, especially Quillagua to understand whether the mackerel arriving there were headless or whole, dried, or salted.

Further, examining the extent to which fish was a Pre-Columbian tributary commodity means tracing distribution channels into the interior under control of the local leaders as well as the Inca state. To understand whether its distribution in the interior was controlled by the elite (like other tributes), it is necessary to study the storage systems of the interior villages and their relationship with leaders' homes. From this perspective, excavation of the Inca storage systems of Tarapacá can provide data on the role of mackerel as tribute. Ethnohistoric accounts indicate that vertical archipelagos were controlled primarily by Andean leaders (Van Buren, 1996) and their fruits enjoyed by certain social segments. We know that the curacas of Tarapacá kept fishermen in Arica for their own benefit, for example.

Fish consumption also needs to be better situated in class and status frameworks. The available isotopic data suggest that each Tarapacá community, whether coastal or inland, relied on what its local ecosystem provided. There was nothing like a massive regular exchange of food staples (e.g. fish for maize) between the coast and the interior implied in certain “verticality” or caravan models. Only a social segment ate fish regularly in Pica and only a few individuals buried on the coast had access to maize and C4 resources. In addition to studying available inland fish collections and local and Inca storage systems, information on grave goods and funerary offerings from individuals with a mixed (C4/fish) diet of Pica 8 could be compared with those with a terrestrial diet to better understand differences in status or of another type through multivariate analysis. In this way, a detailed image of the diet of common and high-status individuals could be obtained, controlling the effects of time and distance from the coast on fish distribution and consumption in the interior.

Changes in native consumption in the fishing village of Loa would benefit from expanding the microscopic and chemical analysis of pots and ceramic service forms to increase our knowledge about the consumption of plants and foods that are rarely preserved at a macro level. This should be done by analyzing the residual biomolecules in ceramics and by experimental archaeology to identify processing differences of starch grains and phytoliths. This would allow us to deepen our picture of differences in culinary practices between both sectors, the degree and format of villagers' access to corn, the spatiality of wine or chicha consumption and the commensalism activities that could have occurred in the colonial fishery and nearby village.

The consumption window on the local indigenous society should also be expanded through the paired study of radiocarbon dating and isotopes applied to individuals buried in the main (CaH-12) cemetery of the fishing village. After all, villages do not eat, people do, and the burials are the village people. In stable isotope analysis, we could recognize dietary variability by lifespans, gender, and status. We could determine whether there was unequal access to particular resources within the village, such as C4 plants, or variability in the proposed marine and forest (C3) self-sufficiency for the local villages. In general, the dozens of tombs excavated by archaeologists decades ago in and around Puerto Loa can also be studied by adding social information on offerings and grave goods as well as other bioanthropological variables using multivariate statistics to understand in social terms the consumption of inland food and the marine diet.

Much more broadly, the construct for commoditization and market expansion presented for Puerto Loa would benefit from comparative study of these topics in other settings. I have presented an agent-based construct in which entrepreneurial figures (both European and indigenous) worked in conjunction to convert traditional tribute into commodities for a marketplace. Small rural ports were not the only settings in which such a process took place. Nor would we expect in all, or even most, cases to observe the lack of market engagement (as seen in household life) of the producing villagers. There may have been very different processes by which commodification developed in the colonial Andes. To determine this, investigation needs to identify the individuals involved in the uniquely early colonial “Great Transformation,” their relative motivations and the institutions they could manipulate, and their relative relationship to the market as both producers and consumers.

Appendix A Tributes

Table 31: La Gasca's 1550 Yearly Tasa for Tarapacá . Source: AGN. DIE. L2. Cl5. f.266r-268r in Urbina, 2017 (table 6.6).

			delivery places					
Type	Item	Unit	*Villages/ lands*	*Mines of Tarapacá*	*Port of Tarapacá*	*Valleys or Tarapacá*	*Tambo*	Total
In kind	Fresh fish	arrelde	170	170				340
	Salt	fanega			30		10	40
	Sealion Oil	vessels		15				15
	Maize	fanega	400	400				800
	Wheat	fanega	6	6				12
	Llamas	piece						80
	Alpacas	piece	40	40				80
	Pork	piece	10	10				20
	Hides	piece						15
	Tallow	arrobas	20	20				40
	Poultry	piece	120	120				240
	Eggs	piece	650	650				1300
	Cotton clothes	piece						75
	Woolen clothes	piece						75
	Pots	piece						100
Service	Service	indios	20					20
	Cattle keeper	indios				10		10

Table 32: Pica and Loa mid-16th Century Tributary Impositions and Effective Payments (1565). Based on Urbina, 2017, table 6.10.

Item	*Unit*	*~1550 Tasa*	*1565 Payments*
Maize	fanega	150	100
Dried fish	arrobas	150	60
Poultry	piece	100	100
Llamas	piece	20	20
Clothes	piece	20	20
Sacks	piece	20	20
Chili pepper	baskets	10	10

Sealion ropes	piece	?	?
Ceramic vessels	piece	?	?

Table 33: 1570 Toledan Tasa for Tarapacá , Pica and Loa. Based on Malaga (1974)

	Tarapacá	*Pica and Loa*
Caciques (exempted)	6	2
Tributaries	755	158
Assayed pesos tax	3591	711
dried fish (arrobas)	278	40
Poultry	400	144
Cotton clothes		60
per capita cash tax	4.756	4.5
Tasa total	3780	869
per capita total tax	5.007	5.5

Table 34: The 1646 Retasa for Tarapacá, Pica and Loa. Based on Urbina (2017, table 7.6)

	Tarapacá	*Pica and Loa*
Tributaries	601	96
Assayed pesos tax	2754	388
dried fish (arrobas)	140	91
Poultry	309	72
Cotton clothes		31
per capita cash tax	4.6	4
Tasa total	2863	506
per capita total tax	4.8	5.3

Appendix B Ceramic Analysis: Botijas

Appendix B.1 General Types and Morphology

Botijas' ovaloid to spherical restricted bodies, thick strong walls, and well-designed closures had a long history in the Mediterranean, from Roman times onwards: they are the direct descendants of amphorae within traditional Mediterranean seafaring (Avery, 1997; Deagan, 1987).

The containers were regulated by the Crown in terms of contents, volumes, and forms and played an essential role in the distribution of high volumes of bulk dry goods olive oil, wine, pitch, tar, gun powder, and water (Avery, 1997; Rice, 2011).

All types have amphora-shaped bodies and restricted necks (Deagan, 1987). In his pioneering study, Goggin (1960) proposed three styles of chronological significance, relying on a mixture of form and paste characteristics (James, 1988). His Early Style (1500-1580) is no longer a botija type, in turn, his Middle (1580-1780) and Late styles (1780-1850) remain and are at the base of analyses (James, 1988).

The Middle and Late Style botijas diverge by rim morphology and other characteristics but share three types of body morphologies. Body type A botijas have an elongated, restricted ovaloid body; type B a shorter[31] , rounded and more spherical one, while type C has a carrot-like, small body (Marken, 1994). Types A and B are the most common at shipwrecks and terrestrial sites.

Type A's rounded body and convex base was devised to fit hull curvature when piled horizontally inside the ship (Deagan, 1987; Rice, 2011). Woven mattings of vegetal fiber wrapped each botija for extra protection on board, the woven bands incorporated two handles of the same material for manipulation (Pasinski & Fournier, 2014, p.1346).

Rim morphology is one useful chronological indicator as seen from botija assemblages from Spanish shipwrecks of known dates. A clear pattern of triangular rims emerges for type A botijas during the late 16th or early 17th centuries, it remained stable until the 18th century when triangular forms were replaced by larger rectangular rims (Avery, 1997).

Type B botijas kept their circular bodies and rounded rims (Marken, 1994, p.137), their rims reduced their sizes by the 18th-century (Avery, 1997). Type C botijas of the 18th century had larger and glazed bodies with more exaggerated pointed bases than in the previous century.

Botijas were made following Crown's regulations expressed in specific units of length and volume (Busto-Zapico, 2020; James, 1988). A robust and very specialized community of Andalusian potters scaled-up the production of standardized Sevillian olive jars for global markets as statistically demonstrated by Busto-Zapico (2020) with whole vessels found in Spain.

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[31] According to Goggin (1960), type A's have height and diameter ranges of 520-580mm and 220-295mm, respectively, while type B's 230-290mm and 200-230mm, and a height and diameters of 266mm and 126mm for one type C case (Deagan, 1987).

The system of measures and volumes was meant to govern trade: documents from the General Archive of the Indies (Seville) echo the same size categorization from larger to smaller vessels: botijas peruleras, botijas, botijas medias, to botijuelas (James, 1988).

There's also a relationship with specific commodities. Sevillian shipping ordinances reflect that wine was packaged in type A botijas and olive oil in type B containers (Avery, 1997). Type A botijas had an average volume of 17l and contained the Castilian wine arroba of 16l[32] while type B jars contained 6.6l in average and perfectly accommodated the ½ Castilian arroba (6.2l) of olive oil (Marken, 1994). However, size and content didn't have a unique, fixed relation, there was some degree of variability (see Avery, 1997, Appendix 4).

It's also important to consider that botijas were strong, reusable containers and their life cycle didn't end on the first voyage. Seafarers, for example, caulked their ships with dark pitch stored in botijas (James, 1988) while the supply of fresh water on the hyper arid coast of Tarapacá was achieved thanks to the use and reuse of these containers by sailors and traders.

Botijas were anyway the most successful early modern containers for liquids as essential for people as wine and water.

[32] But Avery (1997) says, based on a detailed documentary analysis, that 1.25 arrobas of wine were normally shipped in type A vessels, and honey in 0.33 arroba C olive jars.

Appendix B.2 Origin from Color and Inclusions

Published Munsell soil color codes for sherds of known chemical provenance show how botijas made in the Americas (either Panama, Peru, or both) have reddish paste hues (10R-5YR), Iberian cases pale browns to yellow hues (10YR) and overlapping pinkish to brown hues (5YR-7.5YR) for both cases (Kelloway et al., 2019). What's the place of Loa's jars fabric color in this spectrum?

The Loa assemblage clearly leans towards the red (Panamanian/Peruvian) end of the spectrum. Most of the botijas containing the foodstuffs eaten at the fishery were red or orange in paste color (Table 35). Almost all (87%) have hues (7.5R-2.5YR) only reported for sherds of the Americas. The most characteristic paste hue is 2.5YR (65%) never reported for chemically sourced Iberian cases.

Table 35: Loa's Botija Fabric Hues.

Hue	*count*	*%*
7.5R	3	0.8
10R	84	21.5
2.5YR	252	64.6
5YR	35	9.0
7.5YR	13	3.3
10YR	3	0.8

Inclusions are consistent with paste color and chemical source. Iberian jars have a flecked appearance due to large mineral inclusions (Kelloway et al., 2019). Very coarse inclusions were recorded in sherds of Iberian color paste (10YR7/3), but the vast majority showed medium to very fine sand more in line with an origin in the Americas. Thus, even if Loa's sample waits for a chemical provenance study, its macroscopic characteristics speak of a manufacture in the colonies.

Another proposed signature of Andalusian jars -a light-colored exterior efflorescence- doesn't work well in the Loa sample. This efflorescence, a byproduct of kiln high temperatures, was recorded in 22% of Loa cases.

Table 36: Table 4: Exterior Colors of Andalusian Botijas from 1622 and Loa. Data from Kingsley et al. (2014).

Hue	*Value/Chroma*	*Spain*	*Loa*	*Hue*	*Value/Chroma*	*Spain*	*Loa*
2.5YR	6/6	X		10YR	7/2	X	X
	7/2	X			7/3	X	X
	7/3	X			7/4	X	X
	7/4	X			8/2	X	X
	8/2	X			8/3		X
	8/3	X			8/4	X	
5YR	5/6	X		2.5Y	3/8	X	
	6/4	X			6/3		X
	6/6	X	X		7/2	X	
	7/3	X			7/3	X	X
	7/4	X			7/4	X	
7.5YR	6/4		X		8/2		X
	6/6	X			8/4		X
	6/8	X		5Y	7/2		X
	7/3		X		7/4	X	
	7/4	X	X				
	7/6	X					

Half of Loa's sherds with efflorescence show have the same hue as recorded in a sample of type A Andalusian botijas from a 1622 shipwreck in Florida (Hughes, 2014; Kingsley et al., 2014). In specific, the most common (41%) hue at Loa (2.5Y7/3) is also present in the shipwreck assemblage while the remaining cases have very similar hues (Table 36).

However, these efflorescence colors were recorded in sherds that have paste colors that only match with chemically characterized Panamanian/Peruvian sherds. Thus, it seems possible that Viceroyalty kilns also produced the mentioned efflorescence. Data from Kingsley et al. (2014).

Appendix B.3 Type and Date from Rims.

Rim profile morphology also contains sensitive chronological information. Based on whole jars from known shipwrecks, Avery (1997, p.120) made a detailed chronological framework of type-A rim profiles from the mid-16th to the early 18th centuries. Loa's profiles are consistent with the triangular rims of the 1590-1622 range of his diagram.

This further supports the inference of a majority of type A botijas based on body diameters. At Loa 29 rims were recovered, they ranged from whole rims to small fragments. All but one came from the main Spanish midden (B1).

Rim dimensions also confirm the transport of type A botijas. As in the case of diameters, most rims have equivalent dimensions to the ones published by Avery for 17th century type A jar rims (1997, p.123). Loa's min/max rim diameter values (8-11 centimeters) equal to min/max values for 17th century shipwrecks sample (Tables 37 and 38). Vessels from the 18th century have slightly larger rim diameters.

Diameter ranges for "throats" and "lips" (mouth) are also consistent with ranges for 17th century shipwrecks. Mouths at 18th century rims constitute a larger range, over Loa's diameters.

Table 37: Loa Rim Dimensions (cm), Unit B1

Type	*Layer*	*Throat Ø*	*Lip Ø*	*Max.Ø*	*Rim Height*
A	B	4.9	ER	9.3	ER
	C	4.5	5.9	9.2	2.7
		5.3	ER (~6.1)	10.2	ER (~2.9)
		5.6	5.4	8.5	3.1
	F	4.7	4.6	ER	3.3
		ER	ER	ER	3.1
	H	ER	ER	10.4	ER
		ER	ER	11.3	ER
		ER	ER	7.5	ER

B	D	2.8	3.2	6.9	4.3

Table 38: Rim Dimensions (cm) from Shipwrecks' Olive Jars. Data from Avery (1997, p.123)

		Type-A Rims			*Type-B Rims*		
Year		Throat Ø	Lip Ø	Max.Ø	Throat Ø	Lip Ø	Max.Ø
1622 (Unknown)	Mean	4.89	5.81	9.43	4.67	6.30	8.56
	Range	3.76-5.6	5.23-6.62	8.80-10.81	4.20-5.39	5.85-7.28	7.90-9.42
1641 (Concepción)	Mean	4.97	5.79	9.72	4.62	6.02	8.85
	Range	4.5-5.9	5.19-7.00	8.89-10.52	4.40-4.84	5.7-6.33	8.85
1724 (Guadalupe and Tolosa)	Mean	5.19	6.58	10.35	4.60	6.49	9.00
	Range	4.78-5.50	5.81-7.13	9.78-10.51	3.63-5.35	4.82-7.51	8.12-10

One type B rim was identified in Loa based on Avery (1997, p.120) rim morphological classification. As in the case of body diameters, it shows that some olive oil was potentially consumed by the fishery's colonists. Its dimensions are systematically smaller than shipwreck known ranges, however.

Appendix C Multidimensional Scaling

Table 39: Key of Secure Ceramic Types by Period.

CODE	*PERIOD*	*ID TYPES*
1	MP (middle period or late formative)	QTC/QRP/SPNP
2	MP/LP	Code 1 & 3 sherds
3	LP (late pre-Columbian)	PCH/DUP/TRR/INK
4	LP/COL	Code 3 & 5 sherds
5	COL (colonial)	BOT/MAJ
6	MIXED	LCA+ previous
7	NID	Non-identifiable

Appendix C.1 Hunting Specialization

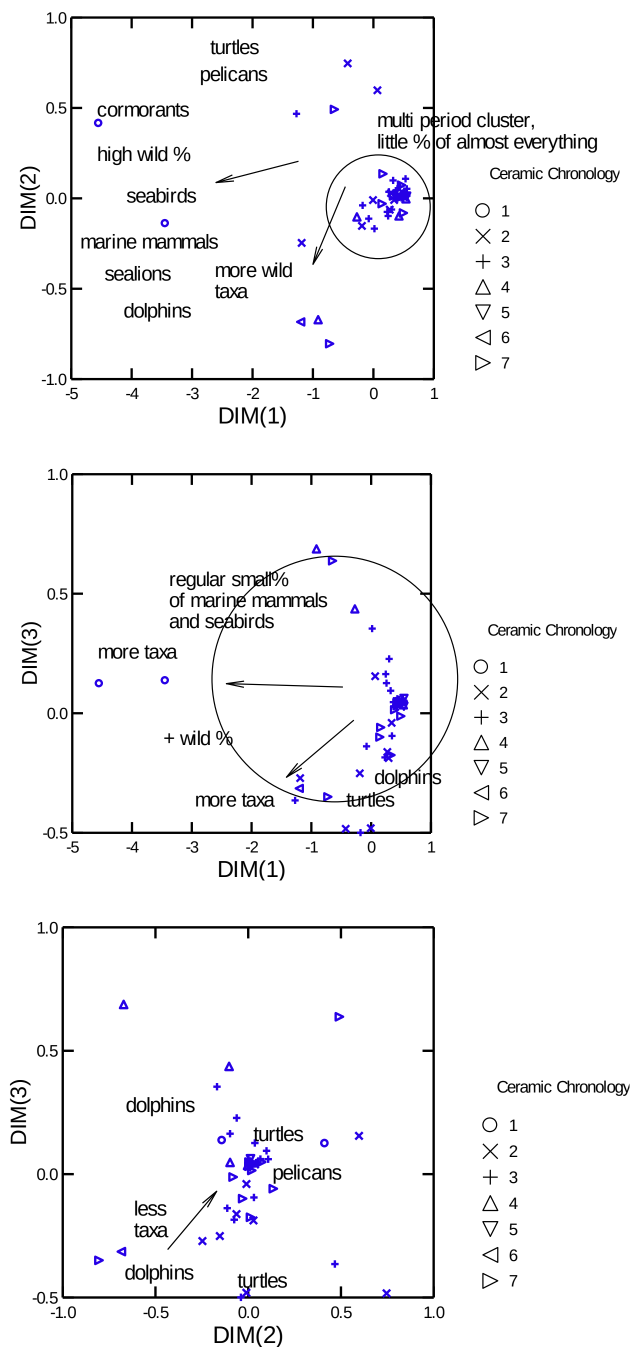

Figure 142: MDS of hunting specialization

Appendix C.2 Fishing Intensification:

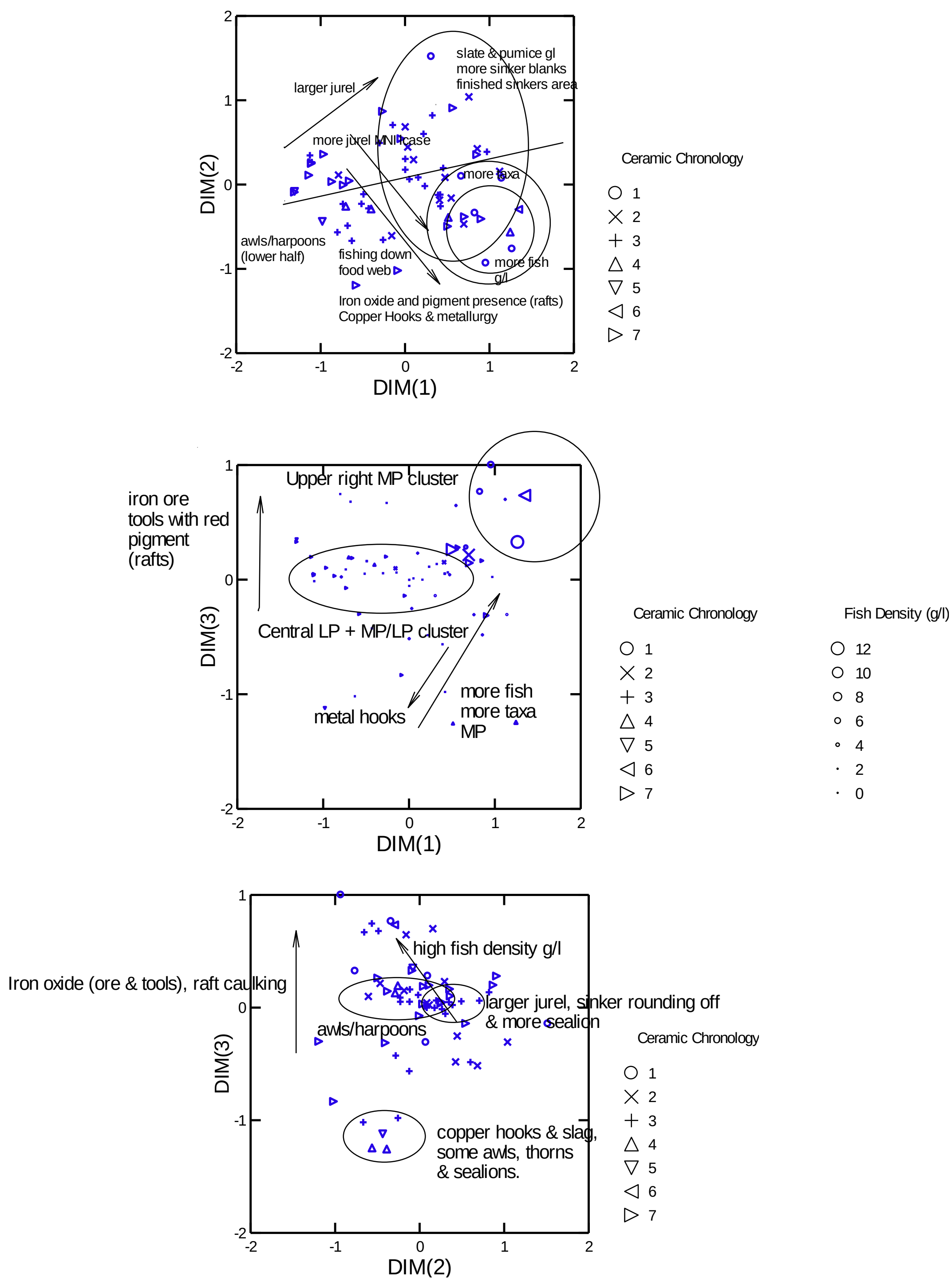

Figure 143: MDS of fishing intensification

Table 40: Variables considered

Variable	*Type*	*Codes*
Fish Density (g/l)	Ratio	measurement
Mean Trophic Level	Ordinal	rank
Jurel_MNI_Density (l/case)	interval	count
Mean Jurel Size	Ratio	measurement
Fish_Head_Total_Proportion	Nominal	proportion
Total_ID_Taxa	interval	count
Sharks	Nominal	0.-Absent/1.-Present
Total Slate Density (g/l)	Ratio	measurement
Total Pumice Density (g/l)	Ratio	measurement
Sinker Blanks Density (l/case)	Ratio	measurement
Sinker_Density(l/case)	Ratio	measurement
Copper_Ore	Nominal	0.-Absent/1.-Present
Slag	Nominal	0.-Absent/1.-Present
Metal_Hooks	Nominal	0.-Absent/1.-Present
Bone_harpoon/awl_Density (l/case)	Ratio	measurement
Cactus_Thorns	Nominal	0.-Absent/1.-Present
Iron_Oxide_Ore	Nominal	0.-Absent/1.-Present
Red_Pigment_Tools	Nominal	0.-Absent/1.-Present
Otariidae_Density (g/l)	Ratio	measurement

Appendix C.3 Fishing Specialization from Toolkits and Techniques:

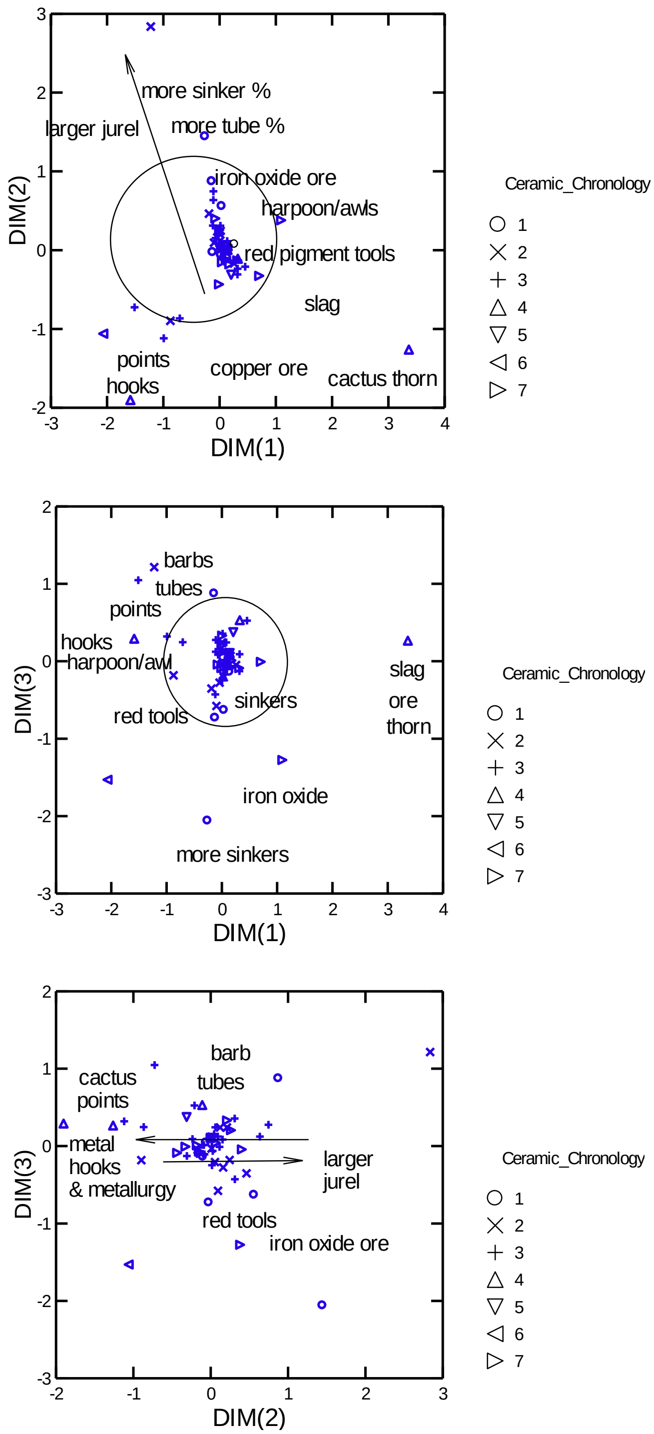

Figure 144: Fishing specialization from toolkits and techniques

Appendix D Shellfish

Appendix D.1 Sector A

Table 41: Unit A1 Shellfish

		A1					
Scientific name	Common name	A-B	C	D	E	F	G
Choromytilus chorus	Mussel - Choro	✓	✓	✓	✓	✓	
Concholepas concholepas	Chilean abalone - loco	✓	✓	✓	✓	✓	✓
Tegula atra	Black snail - Caracol negro	✓	✓	✓	✓	✓	
Chitonidae (Family)	Chiton			✓	✓	✓	
Fisurella (genus)	Lapa	✓	✓	✓	✓	✓	✓
Austromegabalanus psittacus	Giant barnacle - Picoroco		✓	✓	✓	✓	
Venus (genus)	Clam - Almeja	✓	✓	✓	✓	✓	
Argopecten purpuratus	Scallop - Ostión						
Cryphiops caementarius	Freshwater shrimp - Camarón del Loa						

Table 42: Unit A2 Shellfish

		A2										
Scientific name	Common name	A	B	C	D	E	F	G	H	I	J	K
Choromytilus chorus	Mussel - Choro	✓	✓	✓	✓	✓	✓	✓	✓	✓		

Concholepas concholepas	Chilean abalone - loco	✓	✓	✓	✓	✓	✓	✓	✓			✓
Tegula atra	Black snail - Caracol negro	✓	✓				✓	✓	✓			✓
Chitonidae (Family)	Chiton	✓	✓	✓				✓	✓			
Fisurella (genus)	Lapa	✓	✓		✓	✓	✓	✓	✓		✓	
Austromegabalanus psittacus	Giant barnacle - Picoroco	✓	✓		✓	✓	✓	✓	✓			
Venus (genus)	Clam - Almeja								✓			
Argopecten purpuratus	Scallop - Ostión											
Cryphiops caementarius	Freshwater shrimp - Camarón del Loa											

Table 43: Unit A3 Shellfish

							A3					
Scientific name	Common name (English - Spanish)	A	B	C	D	E	F	G	H	I	J	K
Choromytilus chorus	Mussel - Choro		✓		✓	✓	✓	✓	✓		✓	✓
Concholepas concholepas	Chilean abalone - loco	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓
Tegula atra	Black snail - Caracol negro				✓	✓		✓			✓	
Chitonidae (Family)	Chiton											
Fisurella (genus)	Lapa	✓	✓	✓	✓		✓	✓		✓	✓	✓
Austromegabalanus psittacus	Giant barnacle - Picoroco											
Venus (genus)	Clam - Almeja									✓	✓	✓
Argopecten purpuratus	Scallop - Ostión											
Cryphiops caementarius	Freshwater shrimp - Camarón del Loa			✓								

Table 44: Unit A3 Shellfish (early occupations)

							A3 Cont.								
Scientific name	Common name (English - Spanish)	L	M	N	Ñ	Ñ II	O	P	Q	R	S	T	U	V	W
Choromytilus chorus	Mussel - Choro	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		
Concholepas concholepas	Chilean abalone - loco	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		
Tegula atra	Black snail - Caracol negro	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		

Chitonidae (Family)	Chiton				✓					✓			
Fisurella (genus)	Lapa			✓	✓	✓	✓		✓		✓	✓	
Austromegabalanus psittacus	Giant barnacle - Picoroco	✓		✓	✓		✓	✓	✓	✓	✓	✓	✓
Venus (genus)	Clam - Almeja		✓	✓	✓	✓			✓			✓	
Argopecten purpuratus	Scallop - Ostión												
Cryphiops caementarius	Freshwater shrimp – Camarón												

Table 45: Unit A4 Shellfish

		A4								
Scientific name	Common name	A	B	C	D	E	F	G	H	I
Choromytilus chorus	Mussel - Choro	✓	✓	✓	✓	✓	✓	✓	✓	
Concholepas concholepas	Chilean abalone - loco	✓	✓	✓	✓	✓	✓	✓	✓	
Tegula atra	Black snail - Caracol negro	✓	✓	✓	✓	✓	✓	✓	✓	
Chitonidae (Family)	Chiton	✓	✓	✓	✓	✓	✓	✓	✓	
Fisurella (genus)	Lapa				✓		✓		✓	
Austromegabalanus psittacus	Giant barnacle - Picoroco	✓		✓	✓	✓	✓	✓	✓	
Venus (genus)	Clam - Almeja	✓		✓	✓		✓	✓	✓	
Argopecten purpuratus	Scallop - Ostión									
Cryphiops caementarius	Freshwater shrimp - Camarón del Loa									

Table 46: Unit A5 Shellfish

		A5											
Scientific name	Common name	A	B	C	D	E	F	G	H	I	J	K	L
Choromytilus chorus	Mussel - Choro		✓	✓	✓		✓	✓				✓	
Concholepas concholepas	Chilean abalone - loco		✓	✓	✓	✓	✓	✓	✓			✓	✓
Tegula atra	Black snail - Caracol negro		✓	✓	✓	✓	✓	✓	✓			✓	✓
Chitonidae (Family)	Chiton		✓							✓		✓	
Fisurella (genus)	Lapa		✓	✓	✓		✓	✓	✓	✓	✓	✓	
Austromegabalanus psittacus	Giant barnacle - Picoroco		✓	✓	✓								

Venus (genus)	Clam - Almeja	✓
Argopecten purpuratus	Scallop - Ostión	
Cryphiops caementarius	Freshwater shrimp - Camarón del Loa	

Appendix D.2 Sector B

Table 47: Unit B1 Shellfish

		B1												
Scientific name	Common name	A	B	C	D	E	F	G	H	I	J	K	L	M
Choromytilus chorus	Mussel - Choro		✓	✓	✓		✓		✓	✓	✓	✓	✓	
Concholepas concholepas	Chilean abalone - loco			✓			✓		✓	✓	✓	✓	✓	
Tegula atra	Black snail - Caracol negro		✓	✓	✓		✓		✓	✓	✓			
Chitonidae (Family)	Chiton													
Fisurella (genus)	Lapa			✓							✓			
Austromegabalanus psittacus	Giant barnacle - Picoroco										✓			
Venus (genus)	Clam - Almeja			✓			✓				✓			
Argopecten purpuratus	Scallop - Ostión			✓			✓							
Cryphiops caementarius	Freshwater shrimp - Camarón del Loa			✓			✓							

Table 48: Unit B2 Shellfish

		B2				
Scientific name	Common name	A	B	C	D	E
Choromytilus chorus	Mussel - Choro	✓	✓	✓	✓	✓
Concholepas concholepas	Chilean abalone - loco			✓	✓	✓
Tegula atra	Black snail - Caracol negro					
Chitonidae (Family)	Chiton					

Fisurella (genus)	Lapa	✓		
Austromegabalanus psittacus	Giant barnacle - Picoroco			
Venus (genus)	Clam - Almeja		✓	✓
Argopecten purpuratus	Scallop - Ostión			
Cryphiops caementarius	Freshwater shrimp - Camarón del Loa			

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