

**SEABIRDS AS PROXIES FOR PAST EL NIÑO EVENTS IN COASTAL PERU:
AN ARCHAEO-ORNITHOLOGICAL APPROACH**

by

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B.A. University of California, Santa Barbara, 2015

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An Abstract of the Thesis Presented
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This thesis sets an initial foundation for an archaeo-ornithological approach to understanding past El Niño events on the coast of Peru and the use of avifaunal remains as proxies for ecological conditions. Although faunal remains from archaeological sites do not provide exact representations of past environmental conditions, and bird remains can be especially challenging environmental indicators, their presence does reflect decisions made by human occupants in response to environment. Additionally, zooarchaeological data offer a reflection of past animal availability and use, much of which is at least in part determined by environmental conditions.

Here I examine the extent to which El Niño phenomena could influence avifaunal resources and the effect this would have had on the subsistence practices of Andean coastal communities through time. Taking a human-ecodynamics approach, I also examine ethnohistoric records, including published oral histories, and early Peruvian visual culture (e.g., ceramics, geoglyphs, regalia, textiles) to further guide my understanding of the relationship between

coastal societies and their local ecology. Based on the apparent human-Aves ecodynamics between coastal Peruvian societies and local avifauna, I propose that marine avifauna could have acted as sentinels for ecological conditions, offering coastal occupants a warning of impending change. In some cases, avian responses to El Niño (e.g., massive die off, mass migrations, nest abandonment) could have presented a boon to industrious hunter-gatherers, a topic I also explore.

Further paleoenvironmental research potential lies in determining the effects that different varieties or “flavors” of El Niño Southern Oscillation (Central Pacific, Coastal) would have posed on early subsistence practices and adaptation strategies. My findings suggest that birds were a consistent staple in coastal diets. Fluctuations in the abundance of birds present at each site might be due to a variety of conditions. Connections could nevertheless be drawn between El Niño and avifaunal presence in coastal faunal assemblages, warranting further examination of these sentinel organisms.

DEDICATION

For the women who raised me.

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CHAPTER 1

INTRODUCTION

This thesis represents an exploratory archaeo-ornithological examination of marine avifauna as past sentinels of and thus potential proxies for El Niño events on the coast of Peru. Using human-ecodynamics as a conceptual framework, I also examine past traditional ecological knowledge (TEK), as expressed through coastal Peruvian oral and visual traditions, to bolster the case for the human-Aves connection in this region. It is generally agreed that marine resources were integral to the cultural development of Peru (e.g., Moseley, 1975; Quilter, 2014). In this context, learning from marine and/or coastal habitats and organisms through daily interactions and observation would have been necessary to successfully thrive in the otherwise desertic conditions characteristic of the region. Furthermore, knowledge surrounding the interpretation of ecological cues might have afforded coastal occupants the opportunity to plan for impending environmental challenges.

It is well documented that modern El Niño events negatively affect the marine avifauna that live and/or forage in the waters adjacent to the Peruvian coast (Peru/Humboldt Current ecosystem; PCE) and this likely holds true for the past (e.g., Ñiquen and Bouchon, 2004; Jaksic et al., 1997; Jaksic, 2001). On time scales of 2-7 years, these events are characterized by anomalous warming in the Pacific basin that propagates east and west. Along the western coast of Peru, this warming mixes with the normally cool Humboldt Current, suppressing primary productivity (PP) and devastating the marine food web (discussed further in Chapter 2. This would have affected coastal societies as mass out-migrations and/or mortality of pelagic fish and avifauna along with weakened molluscan communities would have led to reductions or alterations in subsistence availability in some regions, and near shore species concentrations in

others. Heightened precipitation on the coast, rather than in the highlands, would have led to coastal (or low elevation?) flooding, erosion, and landslides.

Although environmental proxy records (e.g., corals, ice cores) are limited in Peru, archaeological sites offer a new hope with the bonus of being directly associated with human activities (e.g., Sandweiss et al, 2020). Archaeological data, such as subsistence remains, offer insight into the local ecology surrounding archaeological sites and how past societies conceptualized and interacted with(in) it. Since seabirds are among the top marine predators and can therefore offer insight into the health of lower trophic levels, they are frequently considered (relatively) apt sentinels of the marine environment and it is likely that they would have acted as such in the past. Hence, I posit that these signals would have been noticed by early coastal societies and perhaps even included in traditional ecological knowledge (TEK, e.g., oral and visual traditions, rituals, etc.).

Elements of the human-Aves connection in Peru have been detailed by several authors, including Alaina (2022), Gamboa (2017), Prieto (2015), and Huamanchumo (2021). These sources provide keen observations of birds and the marine environment made and shared over time by coastal Peruvians. Clearly such observations were necessary to understanding, depicting, and emulating birds in myth, ritual, and art and show a deep reverence for these organisms.

While there are prior studies examining the importance of birds within specific cultural contexts, no one has attempted to investigate broad patterns in avifauna across time and space. Further, although it is well documented that modern El Niño events negatively affect the marine avifauna that rely on the rich fisheries of the Peru Current, much of the research linking prehistoric maritime subsistence practices and El Niño disproportionately focuses on the fish and mollusks that typically dominate faunal assemblages in this region, apart from deFrance's 2005

work examining the avifaunal assemblage from Quebrada Tacahuay. Less attention has been paid to the marine avifauna that also rank among the top taxa consumed by coastal communities.

In attempting to understand these connections, I set the stage by introducing the Peruvian coast and its paleoclimatic history (Chapter 2). Next, I broadly examine avifaunal responses to environmental disruptions to identify potential observable signals of change (Chapter 3). I also examine early Peruvian cosmologies, myths, artwork, and policy to make a case for human-Aves-eco-dynamics (Chapter 4). Then, I employ a metadata analysis of coastal archaeological faunal assemblages to examine trends in avifaunal consumption through time and to consider the extent to which El Niño phenomena could have played a role in the availability of these resources (Chapter 5). Lastly, I conclude by offering ideas on how to continue this work in the future (Chapter 6).

1.1 Methods

1.1.1 Metadata Analysis

To carry out the metadata analysis, I studied literature pertaining to various prehistoric coastal sites in Peru spanning from the Early Preceramic to the Late Horizon (and Spanish contact period). I then examined the analyzed faunal assemblages of each, focusing on birds and fish. Paying particular attention to the reported minimum number of individuals (MNI) and number of identified species (NISP), I attempted to identify any changes in specimen frequency.

In narrowing the scope of this study, I focused on the top avifaunal and fish specimen indicated by the highest MNI or NSP (with preference given to MNI when possible). Keeping in mind the general habits of each, I then attempted to correlate migratory and foraging behaviors of birds and fish to infer potential environmental conditions at each site and identify any

evidence that might suggest El Niño's influence. Generalized interpretations were made based on modern observations of everything from human and bird behavior to El Niño behavior.

1.1.2 Oral and Visual Tradition Review

Pulling from such ethnographic sources as the *Huarochoiri Manuscript* (Salomon and Urioste, 1991) and more personal tomes such as *Historias del Abuelo* (Huamanchumo, 2020), I attempt to understand how ancient Peruvians conceptualized their relationships with the non-human world by reviewing coastal Peruvian oral traditions and visual culture (ceramics, textiles, geoglyphs, etc.). While not all coastal oral and visual traditions are one size fits all, the continued presence of avifauna in both categories of shared/shareable culture suggests long held relationships and perhaps even reverence for these (and other) creatures.

1.1.3 Supplemental Analysis of Lo Demás Faunal Assemblage

This aspect of my thesis represents original data collection involving the transport, processing, and analysis of previously unanalyzed archaeological materials from the site of Lo Demás in the Chincha Valley of Peru. Column samples excavated from Sectors I (non-elite) & IV (elite) during Dan Sandweiss's 1983-84 field investigations had remained unanalyzed since arriving at the Florida Museum of Natural History at the University of Florida in the 1980s. Upon transfer to the University of Maine in 2021, samples were inventoried and subsampled. Strict sterile handling procedures were employed so that eDNA analysis of sediments will be possible in the future. This involved disinfection of all surfaces and tools in between each sample. Prior to subsampling, sample bags were gently rotated to "randomize" the materials within. One liter subsamples were then screened through a 1/8" mesh and all sediments were maintained. After screening, samples were then processed (sorted into various material categories). Plant and animal remains from each provenance were counted and weighed.

Identifications were only made to class due to lack of robust comparative collection. Future work will seek to rectify this. This analysis is still ongoing; a catalog of materials identified to date is included in the Appendix.

1.2 Limitations

The data used in this thesis are derived from various sources, employing varying methodological approaches, with varying research goals. Moreover, some of the data only represent very minimal identifications (e.g., to family or order) due to the lack of robust comparative collections or ongoing, therefore unpublished, work. This lends a level of inconsistency to the overall picture as avifaunal data are represented with varying degrees of specificity.

One of the goals of this thesis is to draw more attention to the use of avifaunal remains as a means of inferring ecological conditions. The lack of consistency in the available data thus bolsters the point that avian remains are typically treated with less priority than fish and mollusks. Inexact data limited specific understanding of avifaunal assemblages, but still support the claim for human-Aves-ecodynamics for this region.

Another limitation and inconsistency is the large mesh size ($\frac{1}{4}$ inch) used in many of the analyses examined in this thesis, which could limit the recoverability of smaller faunal remains, the inclusion of which might have offered further insight into avifaunal presence at the sites. The use of smaller mesh sizes ($\frac{1}{8}$ inch or smaller) in the field would have also allowed for additional fish remains to be captured, perhaps providing a deeper understanding of the overall subsistence economies of the sites. Future data collection should be aware of these issues and strive to improve avifaunal datasets for future environmental interpretation.

CHAPTER 2

THE COAST OF PERU

Situated in the neotropics, Peru is frequently described as a region of extreme environmental juxtapositions (Figure 1). Here, the high Andean cordillera separates east and west creating opposing climatic regimes on either side of the mountain range. This opposition is mirrored north and south as aridity on the coast increases along a latitudinal gradient, with a marked climatological divide at 12°S (Sandweiss et al., 2020; Sandweiss, 2003; Noller, 1993). Bounded by the western slopes of the Andes and the Pacific Ocean, the Central Andean coast is thus a hyper arid desert scattered with riparian oases that are fed by descending rivers and flanked by the cool-temperate waters of the Peru (Humboldt) Current (Quilter, 2014; Moseley, 2001; Wells & Noller, 1999; Lanning, 1967). Coursing along the coasts of Peru and Chile, this current drives cool-temperate water northward, accompanied by intense nutrient upwelling that supports rich coastal fisheries. Equally important is the Peru Current's influential role in minimizing atmospheric moisture, cultivating the aridity that defines this region.

Generally, precipitation occurs more frequently in the northern region and less in the south, which is characterized by extreme aridity. Andean runoff is unevenly split, with about 90 percent captured by the Atlantic watershed and 10 percent descending to the Pacific (Moseley, 2001; 26). The inter-annual climate anomaly known as the El Niño Southern Oscillation (ENSO; later discussed in more detail) often brings the only significant precipitation to the coastal desert. In modern times, it occurs at periods of 2 to 7 years and impacts the northern coast (above a climate divide at 12° S) at a different scale than the southern coast (e.g., Sandweiss et al., 2020; Sandweiss, 2003; Quinn, 1993). As beneficial as this can be to an otherwise parched region, El Niño events simultaneously devastate and displace marine resources, flood and erode the coastal

landscape, and accelerate the occurrence of vector-borne illnesses (Barber and Chavez, 1983; French and Mechler, 2017; Gaither, 2010; Ñiquen and Bouchon, 2004; Sandweiss & Maasch, 2020). As an additional consequence, all these effects have socioeconomic impacts (e.g., French and Mechler, 2017; Gaither, 2010).

Due to reduced water resources, vegetation on the coast is limited, occurring in three major types of distribution: lomas, algarrobo, and riparian (e.g., Parsons, 1970; Rundel et al., 2007). Lomas distribution often coincides with the heavy fog (known as garua) that develops over the Peru Current or near river valleys that drain to the coast at elevations between 250-1000 m and reaching “full development” between May and October (Parsons, 1970; Rundel et al., 2007). The dense fog and the vegetation it supports are restricted vertically to elevations below 1000 m due to strong temperature inversions (Rundel et al., 2007). They also occur in higher frequency and intensity on a latitudinal gradient, decreasing south of Lima. Known as lomas, these fog oases are made up of distinct biological communities that include over 1,300 species of flora, the most famous of which is the Lomas de Lachay, 60 km north of Lima (Rundel et al., 2007: pp.164). Further inland, harder stemmed vegetation lends stability to sand dunes. Mangrove stands are also variably present along the shoreline on the far north coast but are restricted by the availability of brackish water. Not as affected by the lack of water are the cacti and other xerophytic species which can also be found inland.

2.1 Paleoclimate

Before and throughout its occupation, climatic and geological changes transformed this coastal landscape over many millennia and presented occupants with both challenges and opportunities for continued survival. Coincident with the Younger Dryas (ca. 12,900-11,700 cal yr BP) and continuing through the Early Holocene (~11,700- 9,000 cal BP), the earliest

archaeological evidence from northern sites suggests increased coastal precipitation and warmer sea surface temperatures (SST) (Reitz et al, 2017; Richardson, 1998; Sandweiss, 2003). Southern sites, on the other hand, indicate SSTs closer to the modern range and the potential for increased seasonal runoff from the highlands (Sandweiss, 2003). Additionally, sea level was lower, and the coast was west of its current position (Richardson, 1981; Wells & Noller, 1999).

By the Middle Holocene (~9,000-4,200 cal BP), sea level stabilized and a shift from warmer SSTs and higher seasonal precipitation to conditions similar to those of today became the norm along the extent of the Peruvian coast (Sandweiss, 2003; Wells & Noller, 1999). At this time, SSTs were as much as 3-4°C warmer than today north of 10°S, with 9°S marked by an amplified seasonal signal (Andrus et al., 2002; Sandweiss et al., 1996). This change in climate from 10° S to the north may reflect the return of ENSO from a hiatus of around three millennia (between 9,000 and 5,800 cal BP) as suggested by Sandweiss and colleagues (1996; 2020; Andrus et al, 2002). At this time a transitional climatic zone bridged the northern and southern latitudes between 10° and 12°S, where warm events are reported to be more frequent than after 5,800 cal BP.

On the southern extent of the coast, below this climate divide, faunal assemblages examined by Sandweiss suggest cooler SSTs within the modern range of the Peru Current (Sandweiss, 2003; Sandweiss et al., 2004). These SSTs contribute to the hyper arid conditions typical of this region. Also within this time frame (circa 5,000 yr. BP), sedimentation rates on the shoreline surpassed that of sea level rise, enhancing coastal progradation and initiating the changes in sedimentation that would later facilitate the adoption of agriculture in this region (Wells & Noller, 1999; Wells, 1996). After 2,900 cal BP, El Niño occurs on decadal timescales (Sandweiss et al., 2001; Sandweiss, 2003; Sandweiss et al., 2020).

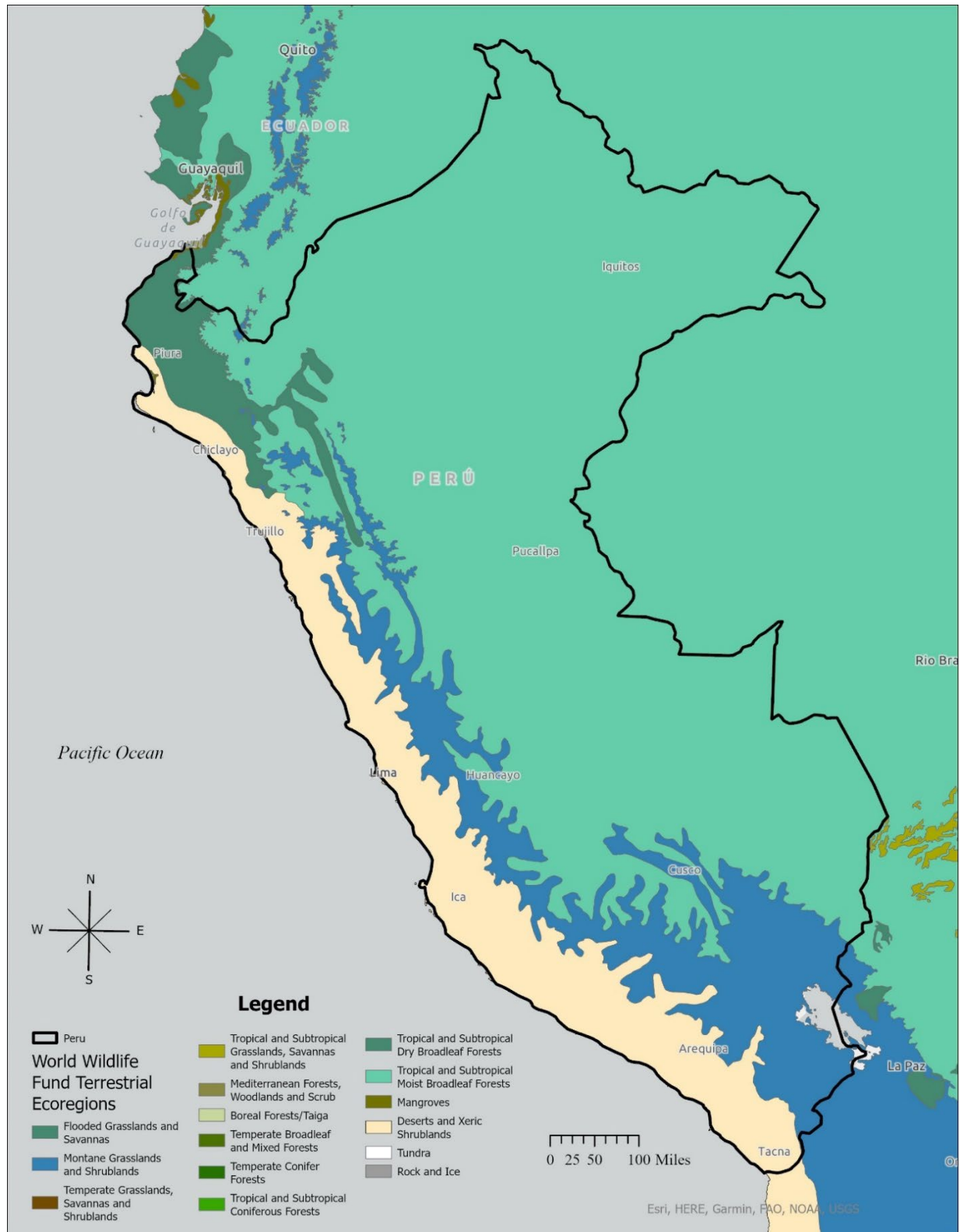


Figure 1. Terrestrial ecoregions of Peru. Data layer courtesy of World Wildlife Fund; accessed on ArcGIS Pro 10/24/2022.

Site	Terminal Pleistocene (~13,000-11,000 cal BP)	Early Holocene (~11,000-9,000 cal BP)	Middle Holocene I (~9,000-5,800 cal BP)	Middle Holocene II (~5,800-3,000 cal BP)
Siches	---	---	Warmer SSTs/ seasonal precipitation/no ENSO	Cool SSTs (modern)
Amotape	Warmer SSTs/less arid climate	Warmer SSTs/less arid climate	---	---
Quebrada Chorrillos	---	---	Warmer SSTs/no ENSO	---
Avic	---	---	---	Cool SSTs (modern)
Paiján	Warmer SSTs/less arid climate	Warmer SSTs/less arid climate	---	---
Moche Valley Late Preceramic/Initial Period Sites	---	---	---	Cool SSTs (modern)/low frequency ENSO
Salinas De Chao	---	---	---	Cool SSTs (modern)/low frequency ENSO
Ostra	---	---	Warmer SSTs/seasonal precipitation/high amplitude seasonal SST cycle/no ENSO	---
Huaynuná	---	---	---	Cool SSTs (modern)/low frequency ENSO
Casma Valley Late Preceramic Period/ Initial Period Sites	---	---	---	Cool SSTs (modern)/low frequency ENSO
Almejas	---	---	Warmer SSTs/no ENSO	---
Los Gavilanes	---	---	---	Cool SSTs (modern)/low frequency ENSO
Aspero	---	---	---	Cool SSTs (modern)/low frequency ENSO
Caral	---	---	---	Cool SSTs (modern)/low frequency ENSO
Paloma	---	---	Cool SSTs (modern)/low frequency ENSO	---
Quebrada Jaguay	Cool SSTs (modern)/greater highland precipitation?	Cool SSTs (modern)/greater highland precipitation?	Very arid (reduced highland precipitation?) ~8,100-3,500 cal BP	---
Ring Site	Cool SSTs (modern)	Cool SSTs (modern)	Cool SSTs (modern)	---
Quebrada Tacahuay	Cool SSTs (modern)/ENSO floods	Cool SSTs (modern)	Cool SSTs (modern)/no ENSO floods	Cool SSTs (modern)/ENSO floods late
Quebrada De Los Burros	---	Cool SSTs (modern)	Cool SSTs (modern)/no ENSO floods	Cool SSTs (modern)/ENSO floods late

Table 1. Environmental conditions through time on the coast of Peru, adapted from Sandweiss, 2003 (Table 1, p. 27) and edited with permission.

2.2 El Niño Southern Oscillation

What's in a name? The terms “El Niño” and “Corriente del Niño” were first coined by artisanal fishers in Peru and Ecuador to describe the seasonal warming of the Peru Current that occurs around the Christmas holiday (Carrillo, 1893; Philander, 2004; Quinn, 1992; Trenberth, 1997; Takahashi & Martinez, 2019). Earlier references to what we now call El Niño (ca. 1580 CE) by Spanish colonists and, presumably, indigenous/local populations include “los diluvios” and “las lluvias” to describe El Niño's effects on land (e.g., floods and rains, respectively) (Alcocer, 1580 in Huertas-Vallejos, 2001). In the 1980s, the term El Niño Southern Oscillation (ENSO, see next paragraph) was popularized after the devastating event in 1982-3 attracted global attention and spurred broader scientific research of ENSO (Philander, 2004).

Generally, when we talk about El Niño or the negative phase of El Niño Southern Oscillation (ENSO), we are describing the low-index phase of the Southern Oscillation (a measure of the pressure differential between Tahiti and Darwin, Australia) in which westerly trade winds weaken over the Pacific allowing for warmer western waters to move east. This shift leads to a rise in sea surface temperatures (SSTs) and sea level in the east and a fall in the west, instigating temporary climate anomalies in the eastern (wet) and western (dry) Pacific (Wallace et al., 1998). Scientific study of El Niño since the late 19th century (e.g., Arntz and Tarazona, 1990; Deser and Wallace, 1987; Dewitte and Takahashi, 2016; Glantz, 2002; Lu et al., 2018; Quinn, 1992; Rein et al., 2005; Rollins et al., 1986; Takahashi & Martinez, 2019; Wallace et al., 1998), however, has allowed for a broadened and complex understanding of ENSO, leading to the distinction between a variety of ENSO “flavors”.

Beyond distinctive spatial patterning and intensity, each flavor presents various challenges, and sometimes opportunities, to coastal communities in the Pacific (Sandweiss et al.,

2020; Maasch & Sandweiss, 2020). In addition to the “classic” eastern Pacific El Niño (EP) and its counterpart La Niña (LN), are the recently identified central Pacific (CP) El Niño (also known as El Niño Modoki) and coastal El Niño (COA) (Sandweiss et al., 2020; Sulca et al., 2018; Takahashi & Martinez, 2019; Timmermann et al., 2018; Weng et al., 2007). The following sections offer a brief description of each flavor.

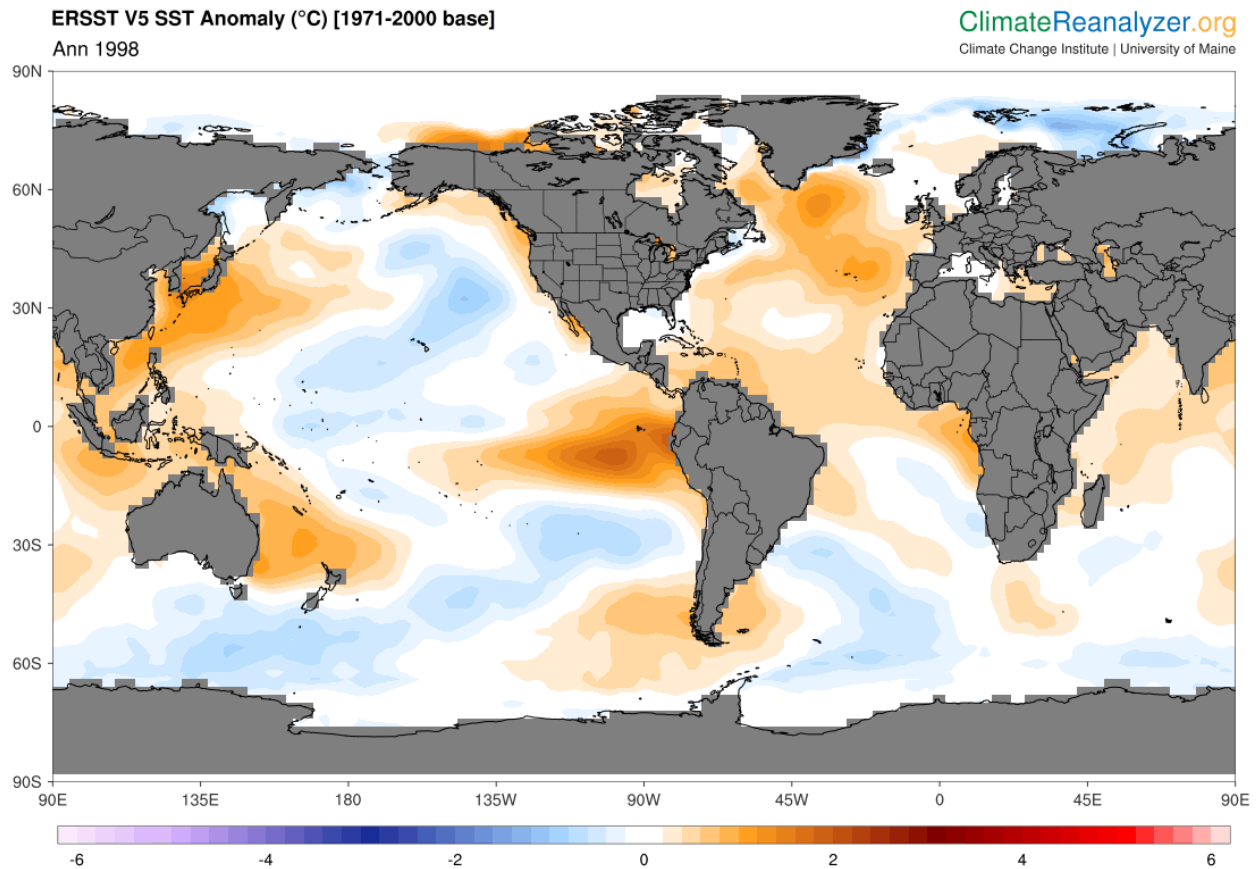


Figure 2. Eastern Pacific El Niño events become concentrated on much of the western coast of Central and South America, with the coast of Peru exhibiting the highest SSTAs.

2.2.1 Eastern Pacific (EP) (Figure 2)

The “classic” or canonical El Niño, now categorized as an eastern Pacific El Niño (EP), is the most researched flavor of ENSO to date and develops as a result of the series of interactions between the ocean and atmosphere described above. These effects occur with the

greatest intensity on the coast of Peru above the climate divide at 12°S and weaken moving south (Sandweiss et al., 2020). The intrusion of warmer waters in the east during EP weakens coastal upwelling systems and further amplifies SSTs in the region. Tracking the movement of warm waters, deep atmospheric convection that usually occurs in the western Pacific brings heavy rains to the eastern Pacific (e.g., McPhaden, 2003; Takahashi & Martinez, 2019; Sandweiss et al., 2020; Quinn, 1993). Following the heavy rains, flooding erodes some areas while bringing river sedimentation that covers the floodplains and creates temporary delta formations; all these processes are destructive to irrigation systems, infrastructure, and agriculture (Sandweiss et al., 2020). Additional hazards include crop rot from standing water, increased pests (rats, locusts, mosquitos, etc.), and vector-borne illnesses (Sandweiss et al., 2020; Gaither, 2010).

Meanwhile, reductions in nutrient upwelling, increased SSTs, and the depression of the thermocline and nutricline lead to a temporary decrease in primary productivity (PP). The reduced PP incites distress throughout the marine food web and has been linked to regime shifts, mass migrations, reproductive disruptions, and mortality in pelagic fish (particularly anchovy) as well as their avifaunal and mammalian predators (Ñiquen et al., 2014; Sandweiss et al., 2004; Barber and Chavez, 1983). Conversely, tropical fish species expand their range and intrude into northern waters (Jaksic, 2001; Barber and Chavez, 1983).

Mollusks also suffer greatly during EP events in response to the depression of the oxycline and reduction of PP. Increased SSTs also take their toll, amounting to massive die offs as seen with *Mesodesma donacium* [surf clam] (Arntz et al., 2006; Carré et al., 2014; Jaksic et al., 1997; Jaksic, 2001; Rossi and Soares, 2018; Sandweiss et al., 2020). Likewise, sea mammals (such as pinnipeds) begin to decline as feeding forays exceed normal durations and the time spent looking for food leads to energy deficits compounded by drastically reduced food

resources (Jaksic et al., 1997; Jaksic, 2001). Massive die-offs of pups during events and migrations of Peruvian sea lions into northern Chilean waters, considered an early warning sign of oncoming ENSO, ensue (Jaksic et al., 1997; Jaksic, 2001). Marine vegetation is also impacted negatively resulting in kelp die offs that have led to extinctions of kelp in some regions (Jaksic et al., 1997; Jaksic, 2001).

On land, incursions of small rodents abound within months of an event, with larger rodents irrupting about a year after (Jaksic, 1997; Jaksic, 2001). This has been shown as far back as 1580 CE, just two years after the devastating El Niño of 1578 CE, wherein many of the witness statements from Alcocer's investigation mention masses of Eurasian rats the size of rabbits that repeatedly ate through sowed plots (Alcocer, 1580 in Huertas-Vallejos, 2001).

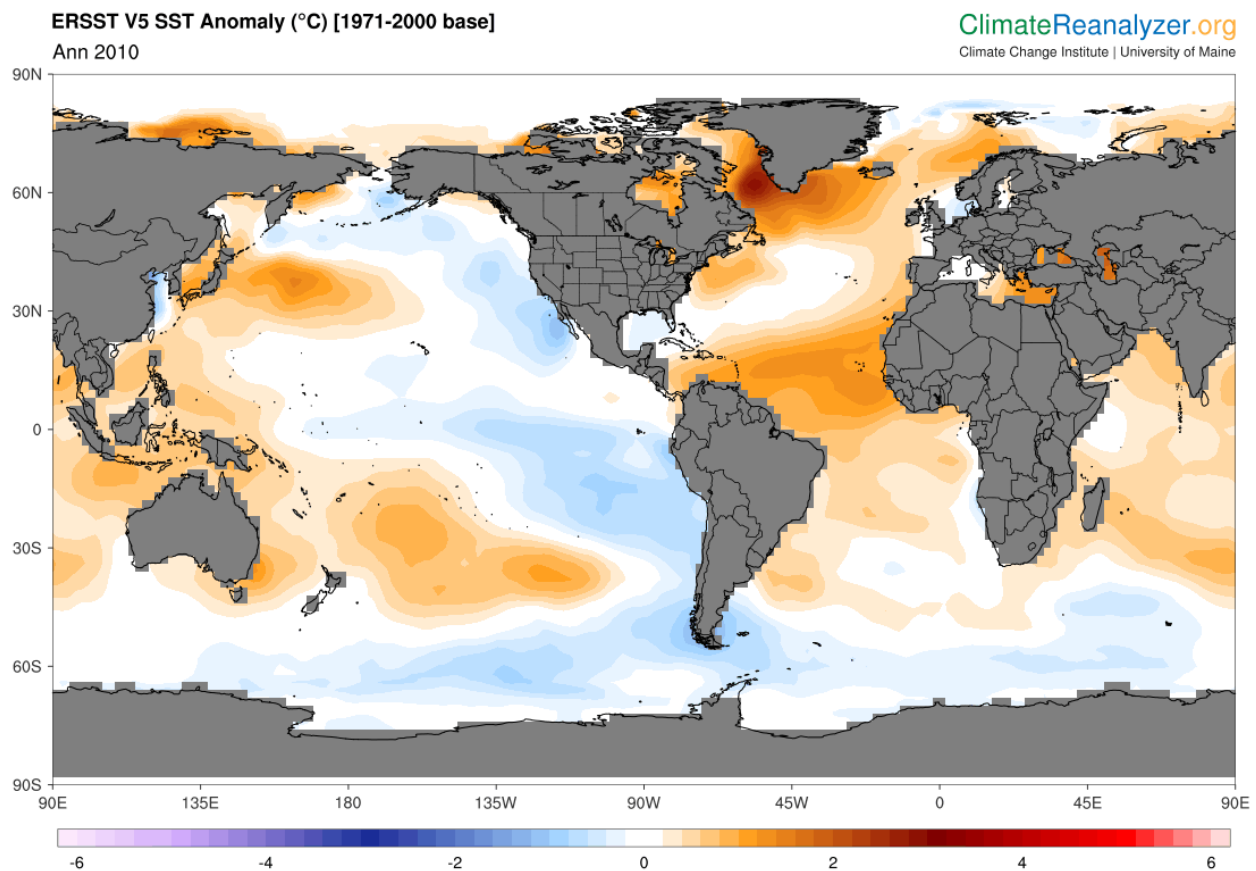


Figure 3. La Niña manifests as an amplification of “normal” conditions and is characterized by cooler SSTs on the Peruvian coast.

2.2.2 La Niña (LN) (Figure 3)

Before the late 1990s, La Niña (LN), the cold phase of ENSO, was relatively understudied. Glantz (2002: 6) suggests that the rapid termination of, and forecasted summer (northern hemisphere) “cold event” following the infamous 1997-98 El Niño catalyzed scientific interest in LN. LN amplifies “normal” conditions wherein a warm pool in the western equatorial Pacific drives heavy precipitation in that region while in the eastern equatorial Pacific and along the coast of Peru and Chile, cold upwelling leads to “atmospheric subsidence” inhibiting cloud formation on the desert coast of Peru (Glantz, 2002: 10).

Some indications of La Niña, according to Glantz (2002), include anomalously cool SSTs in the central and eastern equatorial Pacific, amplified easterlies, enhanced upwelling and PP along the Peruvian coast, and changes in sea level (a rise in the western Pacific and decline in the eastern Pacific). In marine environments, fisheries become enriched because of the amplified/prolonged cooling. On land, LN has mixed effects on agriculture and presents some public health risks in the form of respiratory illnesses (Glantz, 2002; Sandweiss et al., 2020). Nevertheless, LN is considered preferable to EP and owing to that often takes a backseat to it and the other flavors of ENSO (Glantz, 2002).

2.2.3 Central Pacific (CP) (Figure 4)

First recognized in the early 2000’s, Central Pacific El Niño (El Niño Modoki) events (heretofore CP) occur as a result of anomalous warming in the central Pacific, flanked on the east and west by cooler SSTs, that shift atmospheric convection and circulation and subsequently alter the location and intensity of precipitation in areas affected by ENSO globally (Ashok et.al, 2007; Freund et al., 2019; Sandweiss et al., 2020; Weng et al., 2007). The result is an arid Pacific rim bounding a warming, rainy central tropical Pacific (Weng et. al., 2007). In Peru, CP is

associated with a decrease in highland precipitation and prolonged drought-like conditions in both the highlands and on the coast due to attenuated water flow from the highland sources of rivers (Sandweiss et al., 2020; Sandweiss, A., 2019; Takahashi et al., 2011; Tedeschi et al., 2016; Weng et al., 2007). CP events have been shown to reduce streamflow to the Chicama River to about 50% of normal, non-El Niño years, resulting in water shortages (Sandweiss, A., 2019).

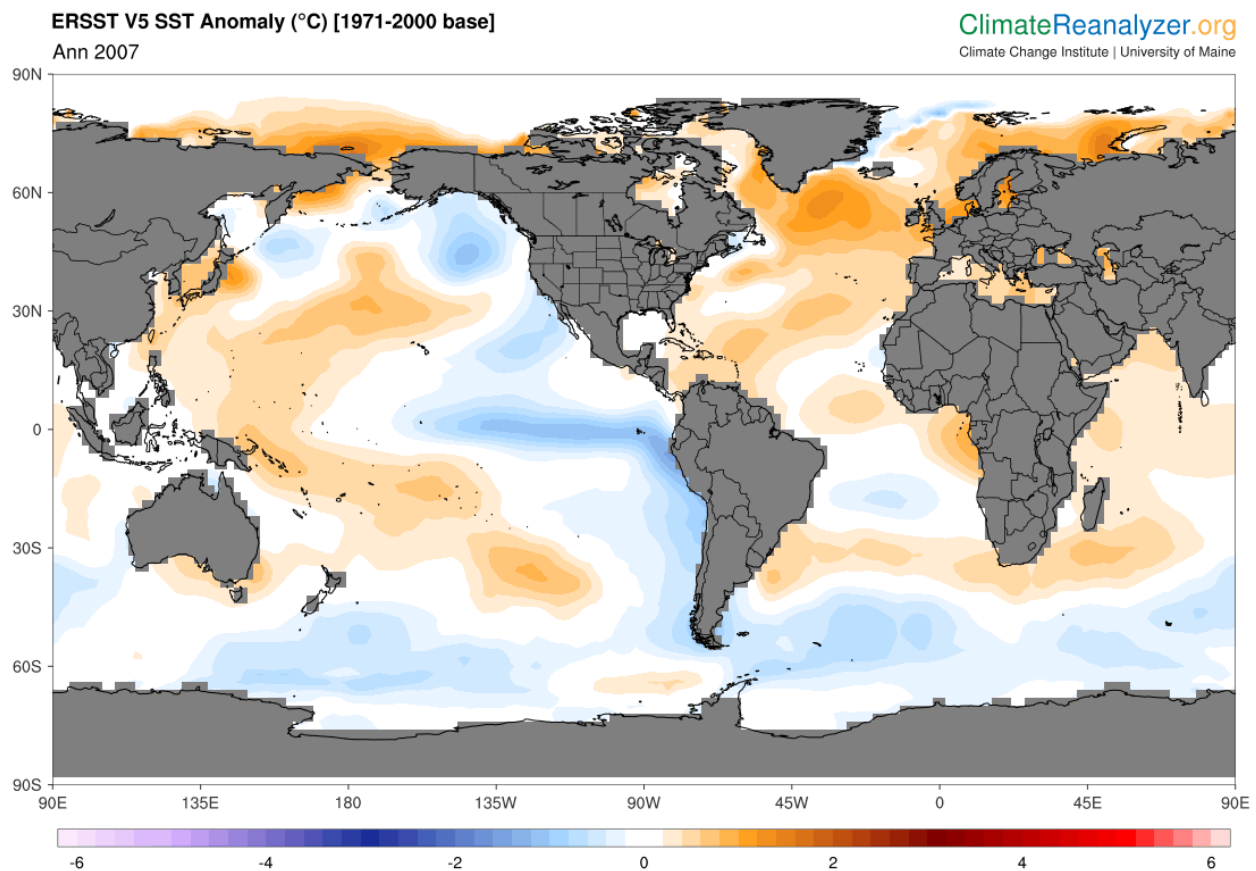


Figure 4. Central Pacific El Niño events typically develop and remain in the Central Pacific Ocean

Research focused on CP dynamics and impacts is ongoing. Freund et al. (2019) have expanded the history of CP events to the early 17th century using a network of seasonally resolved coral data, leading to an improved understanding of its frequency and growing intensity over the last four centuries. They found that since the late 20th century there has been an

unprecedentedly high number of CP events (more than double preceding centuries) compared with EP events, but it remains unclear whether this is the result of natural variability or of anthropogenic climate change. Overall, over the last four centuries, CP events occurred at a rate of 1-6 events every 30 years with EP events occurring as frequently prior to the 1980s (Freund et al., 2019). It has been suggested, based on this analysis, that a projected increase in the ratio of CP to EP (5:1) could occur under a high emissions scenario (Freund et al., 2019: 454).

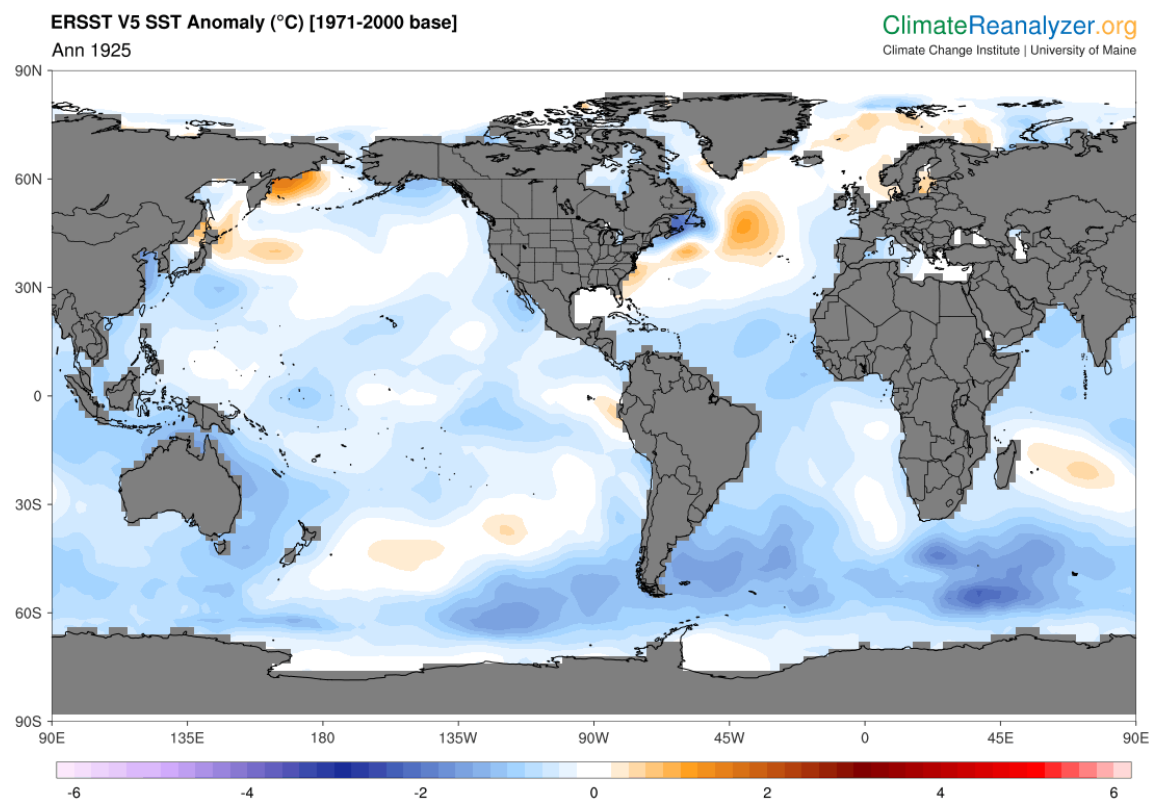


Figure 5. Coastal El Niño events typically develop and remain along the northern coast of Peru.

2.2.4 Coastal (COA) (Figure 5)

In the austral summer of 2017 (January-March), the northern coastal region of Peru was devastated by severe rainfall and flooding resulting from what many thought was an EP El Niño. Considered one of the most severe disasters in Peru since the 1997-98 EP, the 2017 event caused

extensive flooding leading to massive landslides, loss of life, loss of infrastructure, exposure to disease, and more, affecting upwards of six hundred thousand people (Rodríguez-Morata et al, 2019). Ranking among some of the most extreme EP events in recent human history (1972-3, 1982-3, and 1997-8), it would later be determined that this extreme El Niño was not EP. Though virtually indistinguishable on the ground in north coastal Peru, what differentiated this event from an EP was the centralization of anomalous (positive) SSTs on the northern coast of Peru (in the Niño 1+2 region, and especially above 12° S) (Rodríguez-Morata et al., 2018; Sandweiss et. al, 2020; Takahashi & Martinez, 2019). Representing a “new flavor” of ENSO, it has since been given the distinction of “Coastal El Niño” (COA) and the work of disentangling it from the long history of ENSO events is ongoing. For instance, Takahashi & Martinez (2019) propose that the extreme El Niño of 1925 was likely a COA (see Figure 6). During this infamous event, crocodile carcasses as well as tree debris from the north (above 3° S) were reported as far south as 8° S (Takahashi & Martinez, 2019).

2.3 ENSO Future

Global warming has a direct effect on the physical processes that determine the characteristics of ENSO, leaving some ask what effect a changing climate will have on ENSO intensity and frequency. Predictive modeling for ENSO has been ongoing since the 1980’s, but accuracy remains a limiting factor due in part to the short time spans of events, limited availability and timespan of relevant instrumental data to check model results against past conditions, restricted model resolutions that do not sufficiently distinguish small-scale physical processes, and our evolving theoretical understanding of ENSO (e.g., Timmerman et al., 1999; Collins et. al., 2010; Liu et al., 2017; Lu et. al., 2018; Freund et al., 2020).

Thus far, predictive modeling for future ENSO scenarios under increased anthropogenic greenhouse forcing does suggest an expected enhancement, but it remains difficult to say definitively whether ENSO will be enhanced or diminished or whether frequency of events will change (e.g., Timmerman et al., 1999; Collins et al., 2010; Liu et al., 2017; Lu et al., 2018; Freund et al., 2019). This emphasizes the importance of developing a robust history of El Niño events in response to past climate change. However, it should be noted that there are no direct paleo-analogues that replicate the rapidity of greenhouse gas-related climate change currently occurring.

Further research on other ENSO flavors is also needed to determine the impacts of global warming on their frequency and intensity. Though CP events appear to be on an upward trend since the late 1990's, the connection to anthropogenic warming remains inconclusive (Freund et al., 2019). Liu et al. (2017) also suggest that the instrumental record for SST in the central Pacific is not yet robust enough to detect trends. However, their results do indicate some connection between anthropogenic greenhouse forcing and the increase in CP events (Liu et al., 2017).

Specific climate change trends projected for Peru include a greater volatility in the availability of water associated with a possible increase in the frequency of EP and COA EN, which would increase the volume of precipitation in the north of Peru while reducing it in the south (e.g., French and Mechler, 2017; Lavado-Casimiro et al., 2013). Additionally, diminished glacial volume due to temperature-induced glacier retreat has already led to reductions in fresh water accessible to water-scarce coastal zones during dry seasons and excess water during rainy seasons, leading to flooding (USAID, 2011). Moreover, changes in the hydrological system of Peru impact the functionality and growth potential of hydropower, which currently makes up

around 52% of the country's energy consumption (USAID, 2011). Beyond the energy sector, water sanitation systems are among the most affected infrastructural elements impacted by both El Niño and glacier-related flooding, with rural sectors being the most vulnerable (French and Mechler, 2017).

Secondary impacts because of these disruptions include increased consumption of polluted water and subsequent water-borne illnesses. Further, accumulated standing water becomes a breeding ground for mosquitoes and is associated with a rise in diseases such as malaria, Zika, and dengue (French and Mechler, 2017). These occur in tandem with a prevalence of skin, eye, and respiratory infections.

Ecosystems in Peru will also likely be impacted by continued and increasing climate change. As it stands, temperature-induced migration of "lower-elevation" ecosystems into higher elevations (~9 m/yr in altitude) is encroaching on endemic "high-mountain" species (e.g., Andean condor), increasing their risk for extinction and with them the loss of an important totem in Peruvian cultural heritage (USAID, 2011). Moreover, drastic fluctuations in rainfall increase the susceptibility of forests to disease and fires, causing even more losses in Andean cultural and ecological heritage.

Marine ecosystems are similarly affected by climate change as rising SSTs disrupt primary productivity, leading to ripple effects throughout the marine food web. This is particularly true for highly sensitive species such as anchovy (USAID, 2011; Alheit & Ñiquen, 2004; Ñiquen & Bouchon, 2004). Along with massive die-offs, coastal fisheries can experience mass migrations of fish, birds and mammals; all of which have varying impacts on Peru's famed fishing and guano industry and extend to other sectors of the economy. Disruptions to this system will have varied effects throughout the region in the form of impacts on food and job

security as well as the cultural heritage of fishers (López de Lama et al., 2021; Palacios & Abrantes et al., 2022).

There is some hope to be found in the inclusion of ancestral knowledge in both environmental and disaster management. As exemplified in numerous studies (e.g., Alcocer, 1580 in Huertas-Vallejos, 2001; Caramanica et al., 2020; Nesbitt, 2020; St. Amand et al., 2020) ancestral knowledge and response measures were integral to the continued occupation of the coast and could serve as models for present and future management practices. In the next section, I explore this further by examining the history of coastal adaptations and El Niño resilience in this region.

2.4 Coastal Adaptations and El Niño Resilience

Human occupation of the Peruvian coast began during the Terminal Pleistocene (prior to 12 ka) and endured despite the sometimes harsh conditions presented by climate change, natural disasters (e.g., earthquake, landslide, tsunami), and El Niño (e.g., Moore, 1991; Roscoe, 2008; Sandweiss et al., 2007; Satterlee et al., 2000; St. Amand et al., 2020; Van Buren, 2001).

Adapting to the environment depended upon access to fresh water and a reliable subsistence base. Additionally, an ability to cope with abrupt changes in resource availability would be important to continued resilience. Diffused over generations ancestral knowledge facilitated the proliferation of coastal societies and shaped Andean culture.

At the time of their arrival to the region, coastal hunter-gatherer-fishers had access to sufficient resources from both marine and terrestrial habitats and showed high adaptive capacity in making the most of these resources. Low populations and high mobility reduced the challenges of local resource fluctuations for these groups.

Challenging the idea that agriculture was the sole subsistence system capable of supporting complex societies, Moseley (1975) proposed that early coastal inhabitants thrived in their desert environment due to the rich marine resources available to them via the Peru Current. Supporting this idea, archaeological evidence shows a persistent focus on marine resources throughout cultural development on the coast. Faunal remains from early sites support this hypothesis, indicating a largely marine-based diet consisting primarily of warm-water species (e.g., Sandweiss et al., 2004; St. Amand et al., 2020; Reitz et al., 2019). Under these relatively stable conditions, with a quasi-absent El Niño at least from about 9000 to 5800 cal BP, humans continued adapting to their new home. Later, along with sea level stabilization (ca. 7 ka) and changes in the coastal ecosystem, plant domestication became more common, increasing subsistence resources as well as providing materials (e.g., cotton, gourds) for intensified exploitation of marine resources (e.g., Beresford-Jones et al., 2017; Caramanica et al., 2020; Goodbred et al., 2020; Ortloff and Moseley, 2009; St. Amand et al., 2020). As populations grew, sedentary and monumental sites appeared along the Peruvian desert coast, particularly after 5800 cal BP.

After the 5800 cal BP transition and return of El Niño (albeit at a lower frequency than modern), permanent shifts in the marine environment changed which species (tropical vs. temperate vs. mixed warm/cool water) and where they were located (north vs south of 10°S) (Sandweiss et al., 2020; Reitz et al., 2019; St. Amand et al., 2020). Changes to this resource base were met with a variety of strategies including diversification of diet such as taking advantage of temporary influxes of tropical species, opportunistic foraging, and food preservation/storage (e.g., fish drying and meal) (Jackson and Stocker, 1982). Disruptions were not exclusively detrimental to coastal communities. While oftentimes devastating, El Niño events also presented

opportunities to industrious coastal dwellers. As mentioned above, the expansion of warmer equatorial waters during EP and COA EN events would also temporarily diversify coastal waters with tropical fish. To better cash in on these temporary resources, fishing technologies became increasingly advanced (e.g., net gauges to make different sized nets to accommodate various fish sizes, using gourd net floats, etc.). Central and Southern coastal inhabitants, for instance, may have benefited from migrating species tracking their prey (e.g., fish, bird, pinniped migrations) during El Niño (Marcus et al., 2020).

Agriculture on the coast was primarily supported by runoff from the western watershed via stream flows or built irrigation canals drawing from the highland-sources streams (e.g., Caramanica et al., 2020; Moseley, 2001). Hence during times of drought, coastal irrigation would become increasingly strained (Moseley, 2001). Heavy precipitation and flooding as a result of El Niño, however, was also a threat, as they commonly damaged/destroyed irrigation systems as well as agricultural plots (e.g., Alcocer, 1580 in Huertas-Vallejos, 2001). Attempts at replanting were frequently bombarded by plagues of pests such as locusts, birds, mice/rats (e.g., Alcocer, 1580 in Huertas-Vallejos, 2001). Contrary to this, in some areas, pre-Hispanic irrigation systems were built to accommodate increased flood waters, as seen at Pampa de Mocán (Caramanica et al., 2020). These flood waters quite literally turned the tides for post-El Niño agriculture, allowing early farmers an opportunity to continue sowing and storing crops using a variety of field types (e.g., rock pile, embankment, and border-strip) (Caramanica et al., 2020).

More drastic responses to El Niño events can be seen at sites such as Huanchaquito-Las Llamas (Prieto et al., 2019). There, some 140 children and 200 camelids were sacrificed circa 1450 CE, per orders of the Chimú State. Though the impetus for this has not yet been confirmed, evidence at the site suggests it was associated with heavy rainfall/flooding, likely due to El Niño.

As we see in modern times, these events often lead to economic disruptions, which in this context could have impacted the stability of the Chimú state (Prieto et al., 2019).

As observed in this brief overview, changing environmental conditions on the coast of Peru have influenced the establishment and continued development of human occupation and culture throughout history and into modern times. Marine resources also continue to play a vital role in societal development on the coast. Included in this are the marine avifauna, which are similarly impacted by environmental change and ENSO, which may offer insight into past conditions. In the next chapter, I focus on avifaunal species commonly found archaeologically on the coast and examine the ecological conditions that support them, with special attention paid to the impact of the different ENSO flavors.

CHAPTER 3

AVIAN ECOLOGY IN COASTAL PERU

Peru contains a plethora of ecosystems, species, genetic resources, cultures and 84 of the planet's 117 life zones, all of which contribute to its designation as one of 10 mega diverse countries in the world (Angulo, 2009). Additionally, Peru is ranked as having the second highest number of avian species in the world with 1,861 identified species (139 of which are endemic) (BirdLife International, 2022; Devenish et al., 2009). This diversity is at least partially attributed to the 8 different climate types identified by the Ministerio de Agricultura for the region that include arid warm, humid to very humid warm, temperate to sub-humid, cold to frigid, and snowy (World Bank Group, 2013; Angulo, 2009).

To meet the goals of this thesis, I restrict my analysis to the climates and habitats that characterize the coastal region west of the Andes that are influenced by the Peru (Humboldt) Current. This coastal upwelling system is recognized as one of the most productive regions of the world's oceans. This is because the Peru Current is characterized by strong benthic upwelling that transports nutrients to the surface of the ocean. The nutrient rich waters support high primary productivity (PP) which in turn supports a diverse marine food web including pelagic fish, mollusks, marine birds, and sea mammals (e.g., Murphy, 1936; Passuni et al., 2016). This is also noted archaeologically as a factor in human settlement (e.g., Quilter, 2014; Moseley, 1991). Additionally, this system contributes to the hyper-arid (or sometimes foggy) climate of the coastal region with disruptions (i.e., El Niño) having varying effects north to south.

In this chapter, I examine avian ecology in the coastal region of Peru, paying particular attention to those species identified archaeologically. Sections are organized geographically and include descriptions of each habitat and the avifauna found there. Top species (determined by

highest archaeological presence) for each habitat will be discussed in full detail whereas less common species will be summarized by family in a table. It is important to note that, since the following information is based on modern observations, the assumption is that the ecology and behavior of a species today is similar to what it was in the past. By comparing modern and archaeological faunas, we can provide greater support for paleoenvironmental reconstruction than is typically offered by the simple quantification of taxonomic abundance (Grayson, 1984).

3.1 Marine Habitats

The coast of Peru stretches some 2,500 km from Tumbes at the northern border with Ecuador south to Tacna at the border with Chile. Flowing parallel and north along the coast, the rich benthic upwelling of the northern segment of the Peru Current supports a diverse marine food web from primary producers “up” through top predators. Here, marine habitats can be further subdivided into categories including coastal cliffs, rocky and sandy beaches, mudflats, coastal waters (out to about 20 km from the shore), and deep pelagic waters that extend beyond the continental shelf (Begazo, 2002). While some seabird species occupy nearby islands and rocky cliffs, many nest in large colonies along the shore and forage over shoals making them readily available for intentional (and unintentional) capture (McInnis, 1999; Schreiber & Burger, 2001). Many of the species within this habitat subsist on fish, crustaceans, squid, krill, and plankton. Foraging is a common procurement strategy among seabirds while others rely on scavenging or theft to sustain themselves. Additionally, fresh water is not a requirement for many seabirds as they are able to biologically filter salt water through specialized glands to hydrate themselves (Freedberg, 2018; Schreiber & Burger, 2001).

Changes to avian habitats have cascading effects at all trophic levels. Disturbances such as pollution, overfishing, or El Niño events can deplete or even “reset” the entire system (Bakun

& Weeks, 2008). El Niño events, for instance, suppress primary productivity (PP), which restricts fish populations and causes them to migrate or perish en masse. This tracks through the marine food web with mass migrations of seabirds and sea lions in search of food or safety (Ñiquen and Bouchon, 2004; Jaksic et al., 1997; Jaksic, 2001). Populations decline as resources continue to be restricted and reproductive success becomes more uncertain. As conditions begin to return to “normal” and PP flourishes, so too does the rest of the ecosystem. This complex balance relies on the ability of local marine organisms to adapt to changing conditions and can be observed in population dynamics. Here, I discuss endemic and visiting species on the Peruvian coast and its adjacent waters that are found archaeologically. There is some overlap wherein marine species also visit/inhabit wetland areas, this section includes only those species who predominantly rely on marine habitats. Table 2 outlines remains that were identified to family.

3.1.1 *Sula variegata* (Peruvian Booby)

One of the most common guano-producing species in coastal archaeological assemblages, Peruvian boobies can be found year-round from northern Peru to central Chile. They are relatively sedentary and breed on small coastal islands, cliff ledges, or bare ground. They feed on schooling fish and forage in groups of around 30-40 (mixed) individuals, capturing prey by plunge-diving from moderate heights (Ancona et al., 2012; Carboneras et al., 2020; Coker, 1919; Duffy and Havs, 1984; Schulenberg and Parker, 1981). Though they predominantly consume anchovy, they have been observed to switch to other fish such as sardine and mackerel when collapses occur (Carboneras et al., 2020). El Niño, as an inter-annual driver of fisheries collapse, can trigger massive migrations of boobies north to Colombia and south to southern Chile in search of food (Ancona et al., 2012; Schulenberg et al., 2010). Nest abandonment is also commonly observed during these events (Duffy, 1984). Though boobies are not considered a

threatened species, some threats to their preservation include commercial overfishing and guano exploitation (Carboneras et al., 2020).

3.1.2 *Leucocarbo bougainvillii* (Guanay Cormorant)

The Guanay Cormorant is as common, if not more so, as the Peruvian Booby in coastal archaeological assemblages. Also one of the top guano-producers, Guanay Cormorants live and feed in the open waters of the Peru Current off the coast of Chile and Peru. Their range extends as far north as Isla Los Lobos de Tierra (6°S), where they are known to breed. They typically feed cooperatively in flocks during the day and rely almost entirely on anchovy, Peruvian silverside, and mote sculpin, diving to depths of 20-30 m from the surface of the water to fish (Baran and Harvey, 2021). They nest and breed on islands and coastal headlands in large colonies, competing for space with boobies and pelicans. Breeding success is heavily dependent upon food availability, which can vary dramatically between years. During El Niño years, birds are observed to disperse north to Panama and south to Cape Horn, often migrating in search of food. Nesting during these events ceases and nest abandonment is common (Duffy, 1984; Schulenberg and Parker, 1981). As a result, their populations often suffer massive reductions (Baran and Harvey, 2021; Duffy, 198). Due to its strong reliance on anchovy, declines in its population are strongly tied to reduced anchovy stock because of fisheries exploitation and El Niño (Baran and Harvey, 2021).

3.1.3 *Poikilocarbo gaimardi* (Red-legged Cormorant)

Red-legged Cormorants are geographically restricted to the Peru Current region and the Atlantic coast of southern Argentina. They are uncommon on inshore islands and rocky headlands and typically are found individually or in small groups nesting on rocky cliff faces. They forage opportunistically inshore diving to depths of less than 10-15 m and remaining within

3 km of the breeding colony (Frere and Millones, 2021). Their diet is diverse and is composed primarily of benthic species, with fish being their primary prey. Sardines are especially important during the breeding season which occurs during austral spring/summer. They also feed on cephalopods, bivalves, polychaetas, and crustaceans (Frere and Millones, 2021).

3.1.4 *Pelecanus occidentalis* (Brown Pelican)

The Brown Pelican is widespread in the Caribbean, Central America and the northern coasts of South America, extending south to Peru. Here, they enjoy the warmer waters off Tumbes and Piura. They breed in large colonies of several thousand pairs on islands or in remote coastal locations (though not commonly in Peru where they are non-breeding visitors), nesting on the ground, on cliffs, or occasionally in shrubs or small trees. They feed largely by plunge-diving in shallow waters (<150 m depth) within 20 km of nesting areas during the breeding season and up to 75 km from land during non-breeding seasons, foraging fish (predominantly anchovy and sardine) and shrimp (Duffy, 1984, Schulenberg et al., 2010; Shields, 2020). They are unable to remain in the water for long periods without becoming “waterlogged” and are known to return to shore after foraging to “loaf” (Schreiber and Schreiber, 1982; Shields, 2020); making them potentially easy prey for industrious human predators. Like the other guano producing birds in this analysis, pelicans are also negatively affected by El Niño and are commonly observed migrating south as far as Ica in search of food during El Niño disruptions ? (Schulenberg et al, 2007). They are also very closely related to the Peruvian Pelican.

3.1.5 *Pelecanus thagus* (Peruvian Pelican)

Peruvian Pelicans are the most abundant and widespread pelican along the Pacific coast of South America. They are partial to the cool waters of the Peru Current but are known to disperse north to Ecuador and breed on the islands from Piura south to Chile (del Hoyo et al.,

2020). As noted earlier, they are very closely related to the Brown Pelican, but are physiologically twice as large. Populations have been in decline due to the influence of strong El Niño fluctuations that have altered the availability of anchovy, their main food source. They forage further out than their close relative (*occidentalis*), though there is some overlap, and are known to congregate around fishing vessels (del Hoyo et al., 2020). They breed in self-contained groups of tens to hundreds on rocky coasts and offshore islands during the austral spring/summer. Due to their reliance on anchovy stocks and their vulnerability to the effects of El Niño, they are considered near threatened (del Hoyo et al., 2020).

3.1.6 *Larosterna inca* (Inca Tern)

The Inca Tern inhabits the Pacific coast from northern Peru to Central Chile. It breeds primarily inshore on rocky cliffs and “guano islands”, digging small tunnels or burrows to hide their nests. They do not produce guano but are instead valued by locals for their meat (Coker, 1919; León, 2013). They feed primarily on small fish such as anchovy and are known to employ a wide variety of foraging techniques including shoal fishing and scavenging (Coker, 1919; Duffy, 1984; Gochfeld and Burger, 2020). To achieve the latter, they are often seen following sea lions, with which they are known to associate closely and to scavenge off leftover scraps (Gochfeld and Burger, 2020). Like some of the other avifauna in this analysis, nesting viability is periodically reduced because of El Niño. Like the other species in this study, they are considered near threatened due to the negative impact El Niño has on the marine food-web (Gochfeld and Burger, 2020).

3.1.7 *Spheniscus humboldti* (Humboldt Penguin)

Humboldt Penguins breed in small colonies on islands and rocky coasts near Peru and Chile, burrowing holes in guano and sometimes occupying scrapes or caves. Foraging in shallow

water (<30 m depth) by “pursuit-diving”, they subsist primarily on schooling fish (particularly anchovy, sardine, and herring), squid, and crustaceans (Martinez et al., 2020). There are many studies on the effects of El Niño on Humboldt Penguins, attributing changes in penguin abundance (i.e., species abundance distribution or SAD) to the phenomenon (Vianna et al., 2014). Additionally, changes in SAD have also been associated with a marked increase in nest abandonment due to the flooding brought on by El Niño rains (Martinez et al., 2020; Simeone et al., 2002; Vianna et al., 2014). Because of this, Humboldt Penguins have been given the conservation status of “vulnerable”.

3.1.8 *Ardenna grisea* (Sooty Shearwater)

Sooty Shearwaters are considered the most common shearwater in Peru. They can be reliably found in large flocks near shore throughout the year, and most abundantly between May-October. They breed in massive colonies that commonly exceed 2.5 million pairs on islands off the southern coast of South America (near Tierra del Fuego) and elsewhere in all major oceans except the northern Indian ocean (Carboneras, Jutglar, and Kirwan, 2020). During the non-breeding season, they are known to embark on one of the largest mass migrations on record (Carboneras, Jutglar, and Kirwan, 2020). Mainly subsisting on shoaling fish, cephalopods, and crustaceans, they forage by pursuit-plunging and diving to depths around 30-40 m below surface in the company of other marine birds.

3.1.9 *Larus Belcheri* (Belcher’s Gull)

Belcher’s Gull, formerly the band-tailed gull, has a range restricted to the Peru Current region, extending from southernmost Ecuador to northern Chile. Sticking to the coast, they are most commonly found foraging for “hard-shelled prey” among the rocks at low tide and sometimes forage several km offshore (Burger et al., 2020). Typically, they breed on the islands

north of Lambayeque (6.6° S) as well as the mainland year-round, remaining close to breeding colonies. (Burger et al, 2020; Schulenberg et al, 2007). Their diet predominantly consists of fish, crabs, shellfish, and carrion: however, they are known to eat the young and eggs of other avifauna (e.g, Blue-footed Boobies) during the breeding season. They do not often follow ships in search of food.

3.1.10 *Leucophaeus modestus* (Gray Gull)

Gray Gulls are one of the most common species on the Pacific coast and are greatly influenced by the Peru Current. Their range extends from the Atacama of northern Chile to the south of Peru, with some individual foragers/non-breeders going as far as Ecuador (Burger et al., 2020). While they can be found in large (often mixed) groups onshore and foraging offshore and along sandy beaches, they nest in colonies deep in the deserts of southern Peru and northern Chile (Burger et al., 2020). Rather than make their home on the coast, they commute daily from their inland colonies in the desert out to sea. They predominantly feed on mole crabs, sometimes exclusively, and less frequently on fish, nereid worms, and offal. Typically, they feed in a manner similar to sandpipers in the littoral zone, but they are also known to scavenge in harbors and follow fishing boats (Burger et al., 2020).

3.1.11 *Leucophaeus pipixcan* (Franklin's Gull)

Franklin's Gulls are non-breeding migrants to coastal Peru and can be found "wintering" October-May occupying coastal marshes, nearshore waters, and irrigated agricultural lands. They are rare, but not absent, from altiplano lakes or Amazonia. Colonies are known to shift breeding sites in accordance with water availability and rely heavily on marsh/wetland habitats (Burger and Gochfeld, 2020). In Peru, they predominantly operate within the littoral zone, bays, and estuaries, and offshore up to 50 km. As opportunistic feeders, their diet is varied and includes

plant (e.g., wheat, oats), animal (e.g., mice), marine (e.g., shellfish), insect (e.g., larva, grasshoppers), and waste materials (e.g., fish waste, garbage). This opportunism has led some to consider it “economically beneficial” alluding to its removal of undesirable pests and waste from areas such as agricultural lands and fisheries (Burger and Gochfeld, 2020).

3.1.12 *Pelecanoides garnotii* (Peruvian Diving Petrel)

Peruvian Diving Petrels are endemic to the coasts of Peru and Chile and remain the predominant diving petrel in this region, with some slight overlap with the Magellanic Diving-Petrel in Chile (Carboneras et al., 2020). They can be found individually or in small groups atop the water in areas of upwelling, diving below to depths of up to 80 m to capture prey. Their subsistence base primarily consists of planktonic invertebrates and fish larvae, but also includes small fish and crustaceans. This varies seasonally with planktonic invertebrates being the predominant prey during the summer and fish larvae becoming more important during the winter. SST anomalies affect this diversity, with warmer conditions decreasing availability of some prey. They breed in colonies on rocky, barren, offshore islands, of which Isla San Gallán (off the southern Peruvian coast) is home to roughly 80% of their population (Carboneras et al., 2020). Overfishing of Peruvian anchovy as well as habitat degradation due to guano harvesting threaten this species, and incidental bycatching during large-scale fishing activities is also known to occur. El Niño poses additional threats, affecting prey availability (Carboneras et al., 2020).

Family Name	Common Family Name	Habitat	Diet	Assoc. Sites	Citation
Charadriidae	Plovers and Lapwings	Open near shore habitats	Insects, invertebrates, and small crustaceans	Samanco, Huaca Santa Clara, Huaca Gallinazo, Huaca Prieta	Helmer, 2015; Johns, 2017; Dillehay, 2017
Procellariidae	Petrels and Shearwaters	Offshore, pelagic waters, rocky islands	fish, cetaceans, squid	Samanco, Los Gavilanes, Ring Site, Huaca Gallinazo	Helmer, 2015; Bonavia, 1982; Reitz et al., 2017; Kennedy and Van Valkenburgh, 2016; Johns, 2017

Table 2. Avian taxa identified to the family level for marine environments.

3.2 Wetland Habitats

Also spanning the distance from Tumbes to Tacna is a chain of over 90 identified coastal wetland areas comprising lagoons, river inlets, estuaries, and intertidal flats, all of which provide critical habitat to both resident and migrating birds of the Pacific Corridor (Atlas de Humedales Costeros, accessed 07/01/2022; Aponte, Gonzales and Gomez, 2020). Wetland habitats are vital hubs for biodiversity and provide shelter, breeding, nesting, drinking water, and forage for birds (Stewart, 2016). They are also a valuable economic resource to human societies, providing subsistence, water, and construction (e.g., reeds) resources (Cardenas and Hurtado, 2019; Cruz, Burger and Borgesa, 2007; Quiñones and Hernandez, 2017; Rostworowski, 1981). While much of the water that feeds coastal wetland habitats comes from Andes surface streams, some subsoil flows from the highlands also factor into water availability (Aponte, Gonzales and Gomez, 2020). The presence of food, water (and its depth), soil moisture, and even duration and timing of flooding can have an important impact on whether a wetland will be suitable for some bird species; therefore, occupation of these habitats varies greatly (Stewart, 2016). The types of forage available in wetlands vary and include vertebrates (e.g., fish), invertebrates (e.g., crustaceans, insects), and vegetation such as fruits, tubers, and leaves.

As with marine habitats, changes to this system tend to affect many if not all trophic levels. El Niño's effect on wetlands is complex and can also be interpreted as cyclically restorative. During El Niño events increased precipitation, flooding, and landslides can be destructive to crucial breeding and nesting habitats. As the El Niño event passes, however, wetlands often experience a flourishing as a result of the much-needed hydration before returning to their "normal" state (Carlos Elera, personal communication, July 2022). Here, I outline endemic and visiting species to coastal Peruvian wetlands that are found archaeologically. There is some overlap wherein marine species also visit/inhabit wetland areas, this section includes only those species who predominantly rely on wetland habitats. Table 3 outlines remains that were identified to family.

3.2.1 *Nannopterum brasilianum* (Neotropic Cormorant)

Neotropic Cormorants are broadly found in Peru below 1000 m as well as on the altiplano at 3200-4300 masl in southern Peru. This species is considered highly versatile in its climatic and environmental tolerance, inhabiting a wide variety of brackish, freshwater, and saltwater wetlands at varying elevations (Telfair and Morrison, 2022). During breeding season, it is a generalist, taking prey opportunistically through pursuit-diving. Some prey sources include fish, frogs, tadpoles, dragonfly nymphs, and shrimp. Egg-laying occurs from October to November on the Patagonian coast (Telfair and Morrison, 2022).

3.2.2 *Podiceps major* (Great Grebe)

Great Grebes are distributed widely throughout southern South America, with a discrete population in Peru. They are rare visitors to the Andes, frequenting estuaries, and coastal lagoons where they can forage for kelp. They congregate in flocks on protected bays and breed in marshes (Llimona et al., 2020; Schulenberg et al., 2010). Beyond the breeding season they move

to coastal waters, occasionally spending time on the open ocean. Their diet is primarily composed of fish, insects, crustaceans, and mollusks. Fish prey include both open water species as well as species associated with aquatic vegetation. Prey are captured opportunistically via “rapid diving” for which they are highly adept. Breeding season can vary but is typically around September to October (Llimona et al, 2020; Schulenberg et al., 2010).

3.2.3 *Pardirallus sanguinolentus* (Plumbeous Rail)

Plumbeous Rails are widespread throughout southern South America and can be found in marsh and lake environments along the coast as well as in the Andes, sometimes wandering out to forage on mudflats and near the outskirts of wetlands (Taylor, 2020; Schulenberg et al., 2010). They typically prefer reed-marshes, muddy creeks, and ponds with plenty of floating vegetation, but can also be found in irrigated/agricultural areas where water and vegetation cover are sufficient. Their diet includes grubs, worms, and insects (Taylor, 2020; Schulenberg et al., 2010). Breeding season occurs in October, with nesting occurring on bush and reed covered grounds bordering water.

3.2.4 *Calidris minutilla* (Least Sandpiper)

Least sandpipers are a regular non-breeding visitor, a boreal migrant commonly found occupying coastal beaches, mudflats, drainages, flooded agricultural fields, and marshes from September-March (Nebel and Cooper, 2020; Schulenberg et al., 2010). Their diet primarily consists of small benthic and terrestrial invertebrates, with timing and duration of foraging regulated by tidal cycles/depth of water. Food is captured via surface pecking or probing (Nebel and Cooper, 2020; Schulenberg et al., 2010).

3.2.5 *Gallinula chloropus* (Eurasian Moorhen)

The (Eurasian) Moorhen is endemic to the marshes of the coast and in the Andes (ca. 2200-4400 masl). They are particularly present in the Andes north of Lake Junín and in Amazonia, exploiting a wide range of natural and man-made freshwater wetlands. They feed while swimming by skimming the surface of the water for food. Their diet primarily consists of algae, moss, grasses, orchard fruits, earthworms, mollusks, crustaceans, small fish, tadpoles, and occasionally the eggs of other birds (Taylor, Christie, and Kirwan, 2020; Schulenberg et al., 2010). Nests are typically built near water (up to 1 m above) on emergent vegetation or platforms made of branches or vegetation (Taylor, Christie, and Kirwan, 2020; Schulenberg et al., 2010).

3.2.6 *Fulica ardesiaca* (Andean/Slate-colored Coot)

The most common coot in Peru (especially in central and southern coastal regions), Andean Coot are widespread from Ecuador to NW Argentina and Northern Chile (ca. 2500-4600 masl). They inhabit ponds, lakes, rivers, and marshes, moving to the coast of Peru during the breeding season (Taylor, 2020; Schulenberg et al, 2010). Their subsistence base consists primarily of aquatic vegetation and they feed in shallow water, sometimes diving to depths of up to 5 m. Breeding typically occurs in April, as well as from June-November during the peak of the dry season (Taylor, 2020; Schulenberg et al., 2010).

Family Name	Common Family Name	Habitat	Diet	Assoc. Sites	Citation
Anatidae	Ducks, geese, waterfowl	Variable open wet grassy habitats	Insects, invertebrates, vegetation	Cerro Azul, Huaca Gallinazo, Huaca Prieta	Marcus, 2015; Johns, 2017; Dillehay, 2017
Rallidae	Rails, gallinules, coots	Marshes, grasslands, forests	Grubs, worms, insects	Cerro Azul, Los Gavilanes, Huaca Gallinazo, Samanco	Marcus, 2015; Bonavia, 1982; Johns, 2017; Helmer 2015
Scolopacidae	Sandpipers, curlews, snipes	Open, wet, grassy habitats; intertidal zones; mudflats	Small invertebrates	Cerro Azul, Los Gavilanes, Samanco, Gramalote	Marcus, 2015; Bonavia, 1982; Helmer, 2015; Prieto, 2015

Table 3. Avian taxa identified to the family level for wetland environments.

3.3 Arid Western Lowland Scrub/Lomas/Open Woodland Habitats

Moving inland from the coast towards the western slopes of the Andes from Tumbes to Ancash, there lies an expanse of arid lowland scrub that forms an almost continuous cover of vegetation including shrubs, scatters of small trees, and cacti that transitions into montane scrub above 1,000 masl (Stotz et al., 1996; Schulenberg et al., 2010). In the southern coastal deserts of Peru and Chile, fog oases called “lomas” contain winter-green annuals, bulbs, and perennials that grow in otherwise harsh conditions where fog is heaviest in the winter. Some isolated patches of trees such as Long-spine Acacia and peacock flowers are characteristic of this habitat. Here, vegetation is greatly seasonal and a divergence exists between Peruvian and Chilean lomas flora (Paredes, 2011). Typically, the climates experienced here are characterized by long dry spells during the austral summer followed by a short period of humidity, and more frequent fog, during austral winter. Anomalies brought on by El Niño conditions include greater precipitation in the northern regions than in the southern regions, which increases water availability in lomas. Here, I provide an overview of the avifauna found archaeologically from this habitat. Table 4 outlines remains that were identified to family.

3.3.1 *Zenaida meloda* (West Peruvian Dove)

West Peruvian Doves are well distributed along the Pacific coast of South America from southwest Ecuador to northern Chile, with flocks frequenting coastal valleys, plains, gardens, and open woodlands and savanna up to 2000 masl. They have also become increasingly well-adapted to agricultural land and urban areas, dramatically expanding their range (Baptista et al., 2020; Schulenberg et al., 2010). Not much is known about their diet but, like others in its family/genus, they likely subsist on seeds, fruits, mast, and grains. In urban settings, their diet is expanded to include cast-off human food (e.g., bread). They breed non-colonially in pairs,

nesting on shallow platforms or in trees (up to ~6 m above ground). In southwest Ecuador, the breeding season occurs from February to March (Baptista et al., 2020; Schulenberg et al., 2010).

3.3.2 *Zenaida auriculata* (Eared Dove)

Eared Doves are widespread in South America (particularly in the southern part of the continent) and frequent the coast, west slope of the Andes, and the intermontane valleys up to 4000 masl. They are rare on the east slope of the Andes and common in the arid Huallaga Valley. Flocks can typically be found in open semi-arid fields, scrubland, patchy woodlands, and urban areas. They also thrive in agricultural areas rich in grain crops where they are known to breed multiple times a year. An opportunistic feeder, grains and cultivated seeds make up the bulk of their diet (Baptista et al., 2020; Schulenberg et al., 2010).

3.3.3 *Columbina cruziana* (Croaking Ground Dove)

Croaking Ground Doves are widespread in western South America from Ecuador to northern Chile and frequent dry intermontane valleys, sub-tropical scrub, riparian thickets, agricultural land, and urban areas. They are social and congregate in small groups to forage for seeds. Similar to others in their family, they feed primarily on seeds and grains. Breeding occurs in all months except September-October in southwest Ecuador, with increased breeding activity 4-6 weeks after the first substantial rains. Nests occur in bushes, trees, and sometimes on the ground, banks, low cliffs, or on ledges of buildings (Baptista et al., 2020; Schulenberg et al., 2010).

3.3.4 *Vultur gryphus* (Andean Condor)

A steadily declining inhabitant of northern Peru, the Andean condor is presently restricted to more remote parts of the country. Their range extends from Venezuela to Tierra del Fuego, from the coast to the highest reaches of the Andes. An important symbol to early coastal

societies, they are still considered an evocative symbol of the Andes (Brown, 2016; Houston et al., 2020; Sault, 2020). They typically are found in open habitats such as grasslands, alpine regions, and along the coastal desert, roosting on high cliffs separate from human activity (Houston et al., 2020; Schulenberg et al., 2010). As a carrion eater, they spend much of their time in search of carcasses which range in size and variety including, but not limited to, guanacos, domestic livestock, stranded whales, seals (as well as seal placentas), and seabirds. Smaller food items include eggs from seabird colonies, sharks, and dead and live seabirds. Feeding mostly occurs during the midday hours (with some regional variation), covering large distances to scavenge. Little is known about their breeding habits, but breeding season tends to run from February to June in Peru (Houston et al., 2020; Schulenberg et al., 2010).

3.3.5 *Cathartes aura* (Turkey Vulture)

Turkey Vultures are far more ubiquitous than the Andean condor and can be found in open habitats along beaches (coasts and rivers), fields, and pastures. They are known to travel in small groups as well as individually. Scavenging for carrion is their primary form of foraging behavior and they rarely take live prey. Typically, foraging is done solo; however, it is not uncommon for a group of vultures to congregate around a carcass (Kirk and Mossman, 2020). They sometimes roost in communities (from a few birds to several thousand), which facilitates group foraging and socialization and often includes other vulture species (e.g., Black Vultures, see below). Their preferred habitats include agricultural lands (particularly those with pastures) and undisturbed forested areas. Nesting sites occur on cliff ledges, hollow trees, and abandoned buildings (Kirk and Mossman, 2020). It should be noted that much of the research on this species is based on observations from North America.

3.3.6 *Coragyps atratus* (Black Vulture/ Gallinazo)

Black Vultures range from the eastern U.S. to South America. They are mostly found at lower elevations in Central and South America, inhabiting open landscapes such as agricultural areas, savannas, pastures, clearings, mangroves, and urban areas (e.g., garbage dumps, parks, abandoned buildings). They are scarce in closed canopy forests, except along waterways (Buckley et al., 2020). They feed almost exclusively on carrion and spend much of their day scavenging for carcasses, but will sometimes expand their diet to include garbage, offal, and edible waste. Lacking a keen sense of smell, they often exploit the olfactory abilities of Turkey Vultures by following them to carcasses (Buckley et al., 2020). They roost communally in undisturbed stands of trees typically located near water, which is important to their socialization and helps them maintain strong community bonds throughout their lives (Buckley et al., 2020). Nests occur in dark recesses, caves, hollow logs, rock crevices, abandoned buildings, and in thickets or brush piles.

3.3.7 *Geranoaetus polyosoma* (Variable Hawk)

Variable Hawks are the most common and widespread large hawk found from the coast to the Andes. They prefer drier climates and are rarely found on the humid eastern slopes of the Andes. Occupying open and semi-open habitats, their range rarely exceeds elevations above 5000 masl (Bierregaard, Marks, and Kirwan, 2020). They generally prey upon rodents, birds, and lizards. Breeding occurs from December through July in Ecuador, and September through January in Chile. Nests are built with sticks and are located on the ground, on cliffs, cacti, trees, and shrubs (Bierregaard, Marks, and Kirwan, 2020).

3.3.8 *Glaucidium peruanum* (Peruvian Pygmy Owl)

The Peruvian Pygmy Owl lives in a variety of terrestrial habitats including, deciduous forest, riparian forest, arid lowland scrub, arid montane scrub, agricultural areas with large trees, gardens and town plazas. (Schulenberg et al., 2010; Schulenberg and Batcheller, 2020). Their diet is also varied and includes a mix of invertebrates (e.g., caterpillars, moths, beetles) and vertebrates (e.g., frogs, birds, rodents). There is still much to be learned about the behavior and breeding patterns of these species.

3.3.9 *Athene cunicularia* (Burrowing Owl)

Burrowing Owls can be found throughout the southern extents of North and South America. They inhabit open, treeless areas including grasslands, steppe, and desert biomes (Poulin et al., 2020). They rely on other burrowing animals, inhabiting abandoned burrows. Breeding habitats include agricultural fields, golf courses, cemeteries, vacant urban lots and fairgrounds (Poulin et al., 2020). Their diets are varied due to the opportunistic nature of their foraging behavior and primarily include insects (e.g., grasshoppers, crickets, moths) and small mammals (e.g., mice, voles, shrews).

3.3.10 *Tyto alba* (Barn Owl)

Barn owls are widespread throughout the world but are relatively uncommon in western Peru both on the coast and in the Andes. Generally, they occupy a range of low-elevation open habitats that are set in both rural and urban landscapes (Marti et al, 2020). Nesting locations are also variable and include trees, cliffs, caves, riverbanks, church steeples, barn lofts, and nest boxes. Breeding occurs year-round where climate and resources permit. They primarily subsist on small mammals, including rodents, shrews, bats, birds, reptiles, amphibians, and (sometimes) arthropods. Hunting is typically done individually, occurring at night just after sunset and before

sunrise. Occasionally, they can be seen hunting during the day (Marti et al, 2020). Owls appear iconographically in a variety of media throughout coastal history (e.g., Brown, 2016).

3.3.11 *Dives dives* (Melodius Blackbird)

Melodius Blackbirds are typically found in Central America. They are tolerant of various habitats and are found through out dense or closed forests. They thrive in agricultural areas with nearby shrubs and have an omnivorous diet that consists of insects, small vertebrates, fruit, nectar and seeds (Fraga, 2020). These songbirds were sometimes kept as novelties in early Peruvian societies (Johns, 2017).

Family Name	Common Family Name	Habitat	Diet	Assoc. Sites	Citation
Columbidae	Pigeons and doves	Variable; arid deserts to tropical rainforests	seeds, fruits, insects, flowers, and snails.	Huaca Gallinazo	Johns, 2017
Corvidae	Crows, jays, magpies	Highly variable, all terrestrial	highly variable; fruits, nuts, seeds, etc.	Sitio Siches	Reitz et al., 2019
Cracidae	Guans, chachalacas, curassows	Variable; tropical rainforest to arid scrub and montane forests	fruits, seeds, leaves, flowers, and insects.	Ring Site	Reitz et al., 2017
Fringillidae	Finches, euphonias, allies	dense tropical rainforests to arid lowland scrub/savanna	seeds, fruits, other vegetation	Quebrada Tacahuay	deFrance, 2005
Mimidae	Mockingbirds, thrashers	woodlands, shrublands, desert, second growth, and primary forest	insects, arthropods, small vertebrates, eggs, and fruits	Sition Siches	Reitz et al., 2019
Passerellidae	New World sparrow	Variable; marsh, grassland, desert scrub, savanna	invertebrates, fruits, and seeds	Carrizales, Huaca Gallinazo, Samanco, Quebrada Tacahuay, Sitio Siches	Kennedy and Van Valkenburgh, 2016; Johns, 2017; Helmer, 2015; deFrance, 2005; Reitz et al, 2019
Psittacidae	New World and African parrots	dense forest and open woodlands	fruit and seeds	Cerro Azul	Marcus, 2015
Strigidae	Owls	All terrestrial habitats	Invertebrates and vertebrates	Samanco	Helmer, 2015
Tinamidae	Tinamous	Rainforests and grasslands	fruits, seeds, plant matter (e.g., leaves, buds), and insects	Quebrada Tacahuay	deFrance, 2005

Table 4. Avian taxa identified to the family level for terrestrial environments.

3.4 Environmental Impacts on Coastal Avifauna

Seabirds inhabit highly diverse environments with variable climatic conditions (Brooke, 2002; Schreiber & Burger, 2001; Schreiber, 2002). Because of this, it is believed that the evolution of life history traits in seabirds (including their geographic distributions) must have been strongly influenced by weather/climate patterns on all scales. Yet piecing together a cause-and-effect relationship between seabird life histories and weather/climate remains extremely difficult, if not impossible. Since environmental variability is a fact of life for many seabirds, there is no sense of “normal” to compare to when examining the effects of abnormal climatic conditions or environmental stressors on a population. Rather, sea birds have evolved to exist in stochastic systems described as being “...consistent only in [their] inconsistency” (Schreiber & Burger, 2001: 181). For example, the Farallon Islands study provided long term evidence that population instability is normal for some bird species (Schreiber & Burger, 2001; Schreiber, 1989; Ainley, 1990).

Naturally going unaffected by their local climate, seabirds are most apparently impacted by abnormal climates/events which can affect all aspects by which their “fitness” is typically measured (Schreiber & Burger, 2001: 182). Further, not all seabirds in an area exhibit the same responses to adverse conditions, which can be attributed to differences in habitat, subsistence resources, or foraging techniques. Schreiber (2001) identifies some of the impacts of weather on bird populations as follows: food availability and cost of catching and transporting food, timing, participation in and success of the breeding season, thermoregulation, and adult survival (also see: Visser, 2001). Indirect effects are also possible, such as losses or changes to nesting habitats, or in food stock and/or location. Impacts can be long or short term, with long term effects shaping their unique demographics (Schreiber & Burger, 2001).

Shorter term effects often manifest in nesting decisions (e.g., whether to, where to) and success (e.g., growth rate of chicks, adult survival). Most seabirds are able to avoid adverse weather conditions by flying elsewhere, but it can be difficult for birds to find reliable food sources outside their usual habitats, leading to increased mortality via starvation (Schreiber & Burger, 2001). Moreover, when storms are strong enough to destroy nesting habitat, it can take years before that area is used for the same purposes again.

Population levels are not always the most direct indicator of fitness because they can be affected by many parameters. As top marine predators, sea birds are especially susceptible to changes in food availability, hence they show potential as monitors of marine productivity (see Furness and Camphuysen, 1997). Given that much of primary productivity is driven by ocean-atmosphere interactions, could sea birds serve as sentinel organisms for specific climate phenomena such as ENSO? In the following section, I discuss the impacts of El Niño on seabird populations and their potential as sentinels for these events.

3.5 Weathering El Niño

Changes in oceanic and atmospheric conditions during El Niño can impact the ability of seabirds to forage for prey, support themselves and/or their young, devastate breeding and nesting habitats and displace entire populations (Alheit, 2009; Ancona et al., 2012; Barber & Chavez, 1983; Duffy, 1984; Garate, 2013; Jaksic et al., 1997; Niquen & Bouchon, 2004; Schreiber & Burger, 2001). Marine avifauna are especially susceptible to the ecological changes associated with El Niño, and experience population crashes, malnutrition, changes in abundance, distribution, and mass mortalities concomitant with events (Alheit, 2009; Ancona et al., 2012; Barber & Chavez, 1983; Duffy, 1984; Garate, 2013; Jaksic et al., 1997; Niquen & Bouchon, 2004; Schreiber, 2002). These can have ensuing effects such as delays in breeding due to

insecure food resources, reductions in clutch size, nest abandonment, and mortality of chicks and adults, leading to further instability in population sizes.

Still, impacts are highly variable in type and duration, and generally need to be strong to have a lasting effect on their populations (Jaksic, 2004; Schreiber & Burger, 2001; Schreiber, 2002). Moreover, no two areas, colonies, or populations necessarily experience the same effects and it's not uncommon for one species to struggle while others survive. Survival disparities exist between age groups, breeding decisions, body size, and prey choice. For instance, juveniles and young adults are generally more likely to travel farther from their natal colonies than mature adults, which may allow them to avoid and thus survive El Niño conditions. Mature adults, on the other hand, are known to forgo breeding or abandon nests to survive to breed another year (Schreiber & Burger, 2001; Schreiber, 2002).

Additionally, picky or specialized eaters also tend to be more vulnerable to ENSO (e.g., Furness and Camphuysen, 1997; Shealer, 2002; Vianna et al., 2014). This is particularly true for “guano birds” (i.e., guanay cormorant, Peruvian booby, Peruvian pelican, and Humboldt penguin) due to their preference for and heavy reliance on small pelagic fish such as anchovies and sardines. As a result of their diet, their nutrient dense feces (guano) has been valued by humans for agricultural purposes for millennia, making them and their prey a popular subject of interest in ecological monitoring and research (e.g., Bakun and Weeks, 2008; Furness and Camphuysen, 1997; Garate, 2013; Montevecchi, 1993; Schreiber, 2002). Indeed, many studies agree that a decline in anchovy stock frequently leads to declines in guano bird populations (Coker, 1919; Duffy, 1984; Garate, 2013; Spear and Ainley, 2008; Tovar, 1980). This is demonstrated by Duffy (1984), who found that El Niño events can cause population decreases of

around 17% and desertion of nesting areas around 35%, with severe events having a mean decrease in population of 47% and total nesting failure.

Some of the after-effects of El Niño may also have differential impacts on seabird species. For example, post-El Niño flourishing of vegetation in some nesting habitats can act as a barrier to some species while benefiting others by providing better nest coverage or additional subsistence resources (e.g., insects, vegetation, seeds) (Cardenas and Hurtado, 2019; Cruz, Burger, and Borgesa, 2007; Schreiber, 2002). Moreover, whilst marine avifauna suffer through the period before fish stocks return, wetland birds enjoy a boom of newly replenished resources (Schreiber, 2002).

As discussed previously, many of the impacts of El Niño affect different birds in unusual ways and at different times, and the same goes for responses. For instance, during strong events Masked Boobies desert Christmas Island (their primary nesting habitat) at the beginning of the event, signaling a change in conditions to monitors (Schreiber, 2002). Additionally, Great Frigate Birds and pelicans will nest but may lose their chicks to starvation, whereas cormorants will forgo nesting during inclement conditions (Schreiber, 2002). Despite these efforts, mass mortalities of seabirds can and have occurred in relation to El Niño and many of the species examined here have experienced a mass mortality event at some point in the past (see Table 5 and Figure 6).

3.6 Avifauna as Sentinel Organisms

According to Furness and Camphuysen (1997: 727) a useful bio-monitor must respond in a sensitive way to the conditions for which it serves as a proxy. This means that their responses should display a high “signal to noise” ratio, be predictable, and have a causal mechanism that is

understood and that invokes unique responses. For avifauna on the coast of Peru during El Niño, these criteria are still met despite the high variability of impacts and responses among species.

Birds are generally highly visible and thus observable and reliably found; their relatively long lifespan makes them observable over long and short time scales; they are highly sensitive to changes in their subsistence base; and unexpected changes in their population numbers and breeding success serve as signals for unknown problems. As top predators, they also possess the potential to offer insights into the health of lower trophic levels and serve as bio-monitors for ecosystem scale changes as well as quantitative indicators of ecosystem components such as fish stocks (e.g., Bakun and Weeks, 2008; Garate, 2013; Montevecchi, 1993).

Species	Year(s)	Location die offs recorded	Citation
Peruvian Booby	1917*, 1997	Marcona	Ayala et al, 2013; Lavalle 1917; Apaza & Figari 1999
Guanay Cormorant	1917*, 1963, 1997	Callao; Marcona	Ayala et al, 2013; Lavalle 1917; Apaza & Figari 1999; Jordan 1964
Peruvian Pelican	1917*, 1963, 1997	Callao; Marcona	Ayala et al, 2013; Lavalle 1917; Apaza & Figari 1999; Jordan 1964
Red Legged Cormorant	1963	Callao	Jordan 1964
Gray Gull	1963	Callao	Ayala et al, 2013; Jordan 1964; Apaza & Figari, 1999
Inca Tern	1989*, 1997	Marcona	Ayala et al, 2013; Apaza & Figari, 1999; Fuentes & Antonietti, 1989
Peruvian Diving Petrel	1989*	n.a.	Ayala et al, 2013; Fuentes & Antonietti, 1989
Pink-footed Petrel	1989*	n.a.	Ayala et al, 2013; Fuentes & Antonietti, 1989
Sooty Shearwater	2007*, 2010	Puerto Morin	Ayala et al, 2013; IMARPE, 2007
Humboldt Penguin	1997, 2011*	Marcona	Ayala et al, 2013; IMARPE, 2011; Apaza & Figari, 1999

Table 5. Species that have experienced massive die offs in relation to El Niño in Peru.

*No location given



Figure 6. Species that have experienced massive die offs in relation to El Niño in Peru.

El Niño is one such causal mechanism by which to evaluate the aptitude of avifauna as sentinel organisms. Its cyclicity and restorative after-effects have influenced the development of coping responses among avifauna, seabirds (Schreiber, 2002). Many of these are observable by humans and might serve as some of the first indications of impending change. Coping responses exhibited by seabirds during El Niño include abrupt dispersals in search of food and/or migration, delayed onset of breeding or forgoing breeding altogether, and modifications of prey choice (Ñiquen and Bouchon, 2004; Passuni et al., 2016; Schreiber & Burger, 2001; Schreiber, 2002).

The speed of a response is especially important for determining its viability as a potential indicator. For instance, changes in the environment on a scale of weeks to months may be reflected in reproductive performance. Too long of a lag (e.g., years vs. months) between a causal mechanism and its response reduces interpretability. Thus, ideal responses are those that are prompt and highly sensitive. Examples include breeding success, diet composition, and activity budgets of breeding adults (e.g., increased time foraging), all of which are associated with food supply (Schreiber, 2002).

Considering humans and seabirds frequently share subsistence resources (e.g., fish, shellfish), it is possible that early coastal occupants looked to them as a measure of fishing conditions. For instance, a congregation of various seabirds in an area usually indicates good fishing conditions (Huamanchumo, 2021; Prieto, 2015). Alternatively, scattered individuals outside their usual feeding range might indicate poor conditions due to deeper schooling or a lack of fish. The consensus among these studies maintains that long term monitoring of individuals is necessary to better understand and determine the effects of abrupt climate change on seabirds and the evolutionary implications of short-term changes (Montevecchi, 1993;

Schreiber and Burger, 2001; Schreiber, 2002). Early coastal populations would have been some of the first to witness avifaunal signals in response to El Niño. As such, looking to traditional ecological knowledge may inform our understanding of modern avifaunal coping mechanisms in response to abrupt changes in local ecological conditions, as well as their viability as proxy indicators. Though not necessarily as straightforward as modern conservation monitoring, archaeological and ethnobiological evidence of human-Aves ecodynamics could shed light on underlying symbiotic relationships. In the next chapter, I examine the connection between coastal Peruvians and the avifauna they share space with through the lens of human ecodynamics, with examples from mythology, art, subsistence, and policy.

CHAPTER 4

HUMAN-AVES ECODYNAMICS

“Obviously, northern hunting peoples have always been acute observers of the natural world; they could hardly have survived otherwise.”

Fiedel, 2007

As actors within and upon ecological systems and components (e.g., flora, fauna, water), humans are as much a part of nature as any other organism. We interact and form relationships with our surroundings in both conscious and unconscious ways, tuning in to cues from our environment or other actors within, and reacting to what we perceive (e.g., temperature, sounds, actions). Our ecological knowledge emerges from these interactions and relationships and has been integral to our ability to adapt and thrive throughout human evolution (Mithen, 1999; Holt, 1996). Through time, our positionality within ecological systems and the non-human world has also evolved, further shaping our adaptability (e.g., Mithen, 1999).

Here, I examine human-Aves relationships specific to early coastal Peruvians through the lens of human-ecodynamics, historical ecology, and ethnobiology, which reject the idea that humans are external to natural systems. Rather, these approaches appropriately view humans as integral to nature and examine the complex, dynamic relationships that exist between us and the non-human world holistically (e.g., Armstrong et al., 2017; Fitzhugh et al, 2019; Rick and Sandweiss, 2020; Sandweiss et al, 2020; Szabo, 2015). In this chapter I provide evidence of these relationships through time and space, pulling from myth, ritual, art, and policy. In chapter 5, I discuss subsistence. I also consider how these relationships might manifest during El Niño events, and whether avifaunal signals could have been one of the many tools coastal societies used to prepare for and cope with these otherwise mercurial events.

4.1 Foundations: Human Ecodynamics, Historical Ecology & Ethnobiology

Climate change is not new to the human experience. Throughout our time on this planet, humans have learned to adapt to and thrive in every kind of climate and ecosystem imaginable (with some obvious exceptions). It is this rich history of resilience that experts from various disciplines have begun consulting to address burning issues relevant to global warming and climate change today. Interdisciplinary studies are becoming increasingly important to this effort, and archaeology is well positioned to inform this growing body of knowledge (e.g., Brewer and Riede, 2018; Crumley, 2021; Rick and Sandweiss, 2020; Sandweiss et al., 2020). Archaeological deposits offer evidence not only of human activities but, both directly and through extrapolation, the ecosystems in which they live and operate. Further, they can be tied directly to changes in human variables without the use of age models and correlations over distance (Fitzhugh et al., 2019; Sandweiss and Kelley, 2012; Sandweiss et al., 2020).

Archaeological data also provide evidence of how communities, with presumably effective ecological knowledge and sustainable practices, managed to mitigate human over-exploitation of resources despite altering their local environment (Fitzhugh et al., 2019: 1088). Finally, as Sandweiss and colleagues assert (2020), in regions that lack robust local environmental proxies (e.g., corals, ice cores, lake cores, etc.), archaeological evidence offers opportunities for alternative proxies (e.g., faunal remains, charcoal, botanical remains).

Increasingly, these data are being utilized to address modern conservation issues and climate change. However, they mean little without robust frameworks within which to contextualize them. The conceptual frameworks of human eco-dynamics, historical ecology, and ethnobiology offer transdisciplinary (e.g., archaeology, biology, ecology, ethnology) lenses by

which to understand these connections both historically and in the present (Fitzhugh et al., 2019; Rick and Sandweiss, 2020; Sandweiss et al., 2020).

A predecessor to human ecodynamics, historical ecology examines environmental change in conjunction with human activity to develop an “open ended” narrative of ecology that recognizes humans as an aspect of the evolution of ecosystems (Armstrong et al., 2017; Crumley, 2021; Szabo, 2017). Further, this framework defines “history” in a manner that includes both that which is recorded (written) and that which is not, allowing for expanded understandings of the history of Earth systems and the social and physical histories of the human and non-human world (Armstrong et al, 2017; Crumley, 2021). Archaeological research has contributed to this framework since 1955 (e.g., William Hoskins’s *The Making of the English Landscape*), and focused on landscape histories as shaped by humans. By the 1990’s, this connection was fully established (Szabo, 2017). The primary goal of this approach is to use the past to inform the present and future when it comes to environmental change, sustainability, and conservation (Armstrong et al., 2017; Crumley, 2021).

Similarly, human ecodynamics, as described by Fitzhugh and colleagues (2019: 1077), is the “...interdisciplinary study of the human condition as it affects and is affected by the non-human world”. Humans are thus considered active agents within ecosystems, shaping and being shaped by them. A central focus in human ecodynamics research is understanding how humans endure and persist under extreme or geographically challenging conditions (e.g., deserts, polar landscapes) and disastrous events (e.g., El Niño, hurricanes, tsunamis) (Cooper and Sheets, 2012; Harrison and Maher, 2014). To achieve this, human ecodynamics is informed by human behavioral ecology, niche construction, cultural niche construction, and resilience theory (for a summary of these frameworks, see Fitzhugh et al., 2019). Akin to historical ecology,

archaeological research has contributed to this framework since at least the early 2000s and has ramped up in the last decade (e.g., Campbell, 2000; Kirch, 2005 & 2007; Nagaoka, 2019; Redman, 2005; Van der Leeuw and Redman, 2002).

Finally, ethnobiology examines the intersections of environmental archaeology, human ecology, geography, paleoecology, and more to arrive at a holistic understanding of past human-environment interactions (Albuquerque and Alves, 2016; Nagaoka and Wolverton, 2016). Unbounded by temporal and geographic scales, ethnobiology similarly collapses distinctions between the human and non-human world by instead examining biological and cultural diversity ranging from individuals to communities and from organisms to landscapes (Nagaoka and Wolverton, 2016). Archaeological studies of subsistence (e.g., zooarchaeology, paleoethnobotany) have informed this framework and continue to do so today (e.g., Campbell, 2000; deFrance, 2005; deFrance et al., 2001; Harrison and Maher, 2014; Jerardino et al., 1992; Sandweiss et al., 2012).

Also critical to informing the above frameworks, and the growing body of global ecological knowledge in general, traditional and local knowledge (TLK) offers place-based insights into socio-ecological systems (SESs), providing intimate individual and collective ecological expertise (Aswani, Lemahieu, and Sauer, 2018; Beaudreau and Levin, 2014; Belisle et al., 2018; Fitzhugh et al., 2019; Rick and Sandweiss, 2020; Sandweiss et al., 2020). The concept of TLK is informed by the basic reality that spending significant time in, interacting with, and basing one's livelihood on regular interactions with the local ecology allows individuals (and communities) to gain deep practical understandings of the SESs in which they are embedded. This wisdom is commonly shared generationally and accumulates over varying timescales

(Fitzhugh et al., 2019: 1087). It can encompass everything from resource locations and seasonality to medicinal plants, local predators and prey, and more.

Equally important to impart are place-based survival strategies aimed at mediating environmental challenges such as the impacts of natural disasters or resource depletion. Many of these impacts can be mediated by any number of social variables such as subsistence strategy, mobility, familiarity with the landscape, familiarity with local climate and seasonal changes, and/or other previous experience (Fitzhugh et al., 2019; Grattan and Torrence, 2007; Reycraft and Bawden, 2000; Oliver-Smith, 1996).

Following this line of thinking, it is reasonable then to believe that as active agents in their environment and as subsistence-oriented communities, early coastal Peruvians would have learned locally relevant ecological knowledge in their daily activities and interactions with others in their families and/or communities. Indeed, it is possible that the earliest settlers to the Peruvian coast would have arrived with ecological knowledge tied to coastal systems, affording them the ability to thrive despite their newness to the area (Keefer et al., 1998; Sandweiss et al., 1998).

In the next section, I examine what I refer to as “human-Aves ecodynamics”, which in a similar vein as its source frameworks, examines the dynamic and varied relationships humans have with avifauna, how these relationships fit in to resilience and sustainability research, and applications as potential proxies for environmental change and natural disasters both in the past and present.

4.2 Application: Human-Aves Ecodynamics

Archaeological studies have long examined the relationship between humans and non-humans from a utilitarian perspective (e.g., subsistence, labor, resources) (Hill, 2013; Reitz and

Wing, 1999). However, human engagement with the non-human world has and always will be much more nuanced and there is growing acceptance of the sentience and agency of animals within these traditionally human-centered narratives of the past (e.g., Hill, 2013). Interactions and relationships with the non-human world are therefore considered as integral to the makeup of societies.

Early in our evolution, the small body size and limited intellectual capacity of our earliest ancestors restricted interactions with the non-human world. Indeed, there is little evidence to suggest hominids hunted, but that doesn't negate other engagement with animals (Mithen, 1999). Cueing into sentinel organisms is one of many ways in which humans have taken a proactive step towards survival. For instance, some birds and primates use vocalizations to alert the approach of danger (Lilly et al., 2019; Suzuki, 2016). Heeding those cues could literally have meant life or death, hence those who learned to do so might have reduced their vulnerability to predation.

Alternatively, paying attention to signals from predators, such as vultures circling over a carcass as an indication of forageable meat, might also have benefited our ancestors, contributing to further evolutionary leaps in our species (e.g., Mithen, 1999: 196; see also Morelli et al., 2015). Later, when hunting did become more important, our understanding of the non-human world expanded, becoming more symbolic and being incorporated into cultural cosmologies, myths, rituals, and artistic expression (Holt, 1996; Ingold, 2000; Mithen, 1999).

Already acting as sentinels to other birds and non-human organisms within their habitats (e.g., Lilly et al., 2019; Suzuki, 2016), birds also serve as sentinels for various human interests (e.g., ecosystem health, resource availability, health hazards, etc.) (e.g., Keck, 2015; Van der Schalie et al., 1999; Wormworth and Sekercioglu, 2011). In the past, as today, birds would have

shared habitats and in some cases resources with humans. Indeed, our relationship with birds is among one of the oldest with the non-human world (e.g., Demarchi et al., 2019; Funk, 2018; Morelli et al., 2015), albeit not necessarily as companionable as our relationship with dogs.

Morelli and colleagues (2015) hypothesized that our earliest relationships with birds would have occurred early on, around 3 million years ago, the logic being that early hominins would have used predatory birds such as vultures as location beacons for forageable meat. Through time this relationship would bleed into the realm of the symbolic, with vultures and other raptors being featured in art, myth, and ritual activities. Later, some human societies would develop quasi-symbiotic relationships with vultures, leaving food waste out for them (and other scavengers) to clean up, thus maintaining community hygiene by mitigating against the spread of disease (Morelli et al., 2015: 457).

Fiedel (2007) goes so far as to suggest that the pursuit of migrating waterfowl was the impetus behind ancestral Paleoindians crossing the ice-free corridor to North America. This would have been a boon to newcomers traveling in unfamiliar landscapes, as waterfowl serve as apt beacons for habitable conditions with access to water. Some of the earliest waterfowl hunting in the region dates to around 11,500 cal BP based on faunal evidence from central Alaska. Fiedel also notes evidence from Swan Point, Dry Creek (10,600-9300 cal BP), and Charlie Lake Cave (10,500 cal BP). He suggests that Beringians might have noticed the comings and goings of migratory waterfowl at the change of seasons, prompting them to search for the habitats to which the birds were retreating. Likewise, the Kutchin of central Alaska interpret the arrival of waterfowl as an indication of warmer spring-time weather (Fiedel, 2007: 6). Similar relationships and associations continue today in many cultures, with conservation efforts being made to

protect raptor species (e.g., Fish and Game Code, Sections 3503, 3503.5, 3505 and 3513, and California Code of Regulation, Title 14, Sections 251.1, 652 and 783-786.6).

These examples represent but two previously examined aspects of the history of human-Aves connections. Modern day research focuses on measuring the aptitude of avian populations to serve as sentinels for environmental health from resource availability to pollution and disease. For example, canaries were used as an indicator of carbon monoxide concentrations in coal mining endeavors at least since the 1870s (Van der Schalie et al., 1999). Similarly, during the 1950s, massive bird die-offs were used as indicators for the presence of DDT in the United States. This was brought to national attention with the publication of Rachel Carson's seminal book, *Silent Spring* (Carson, 1963; Van der Schalie et al., 1999). Presently, people still monitor birds for heavy metal and pesticide contamination (Egwumah et al., 2017).

Previous research has also demonstrated that seabirds are apt sentinels for marine productivity at lower trophic levels, SST anomalies, and overall marine health (e.g., pollutants, disturbances) (Amat and Green, 2010; Durant et al., 2009; Furness and Camphuysen, 1997; Hyrenbach and Veit, 2003). This is due to many factors including their position as top predators in most marine food webs, the diversity of prey they forage, their general visibility, and their generally rapid response to changes in their habitat (Durant et al., 2009). On the coast of Peru, for example, many fisheries studies link guano bird health and activities (e.g., foraging, breeding, chick rearing) to anchovy populations (e.g., Fuentes, 1989; Passuni et al., 2018; Tovar and Cabrera, 1985; Weichler et al., 2004). No matter the application, however, caution should always be taken when interpreting avifaunal data (for thorough examination of relevant issues, see Durant et al., 2009).

4.3 Evidence from Coastal Peru

As demonstrated, there are many contexts both in the past and present in which birds and humans have interacted symbiotically and symbolically. Given the long and diverse history of human-Aves relationships, it is not a stretch to assume that early coastal Peruvians, as active agents in their environment and as subsistence-oriented communities, would have paid attention to the non-human world around them. For instance, relationships between fishers/fishing communities and birds developed as a result of a fishers' regular interactions with the sea (Huamanchumo, 2020; Prieto, 2015). Farmers would have also developed relationships to birds as pollinators and pest removers, but also as pests themselves. Other birds, such as raptors (e.g., owls, vultures, condors, falcons) and hummingbirds served symbolic purposes, appearing in early Andean myths, rituals, arts, and crafts (Huamanchumo, 2020). Here I explore this connection, bringing together evidence from archaeology, history, and ethnography.

4.3.1 Cosmology, Myth, & Ritual

Many, if not most, cultural cosmologies and myths are based in the non-human world, which can include anything from the natural to the supernatural. Totemism (i.e., mystical kinship with the spirit of an animal or plant) and animism (i.e. attribution of a living spirit to inanimate objects and natural phenomena) are common in early Andean oral traditions and creative expression (Alberti and Bray, 2009; Insoll, 2011). The most referenced totems in coastal Peru include condors, falcons, snakes, pumas, and killer whales (Eda, Yamasaki and Sakai, 2019; Grundy, 2002; Huamanchumo, 2020; Proulx, 1990; Whittaker, 2017; Yakovlev, 1932). These intersect with ritual practices, wherein elements or organisms of the natural world are involved as part of a ritual or medicine, are imbued with power, or are sacrificed. Ethnohistoric research suggests that indigenous Andeans view both people and things as animated by *camaquen*

(“common vital force”) (Alberti and Bray, 2009; Bray, 2009). This animism is observed in Andean oral traditions and practices (e.g., creation and worship of idols, offerings to sacred objects; Insoll, 2011) and imbues the mundane with person-like importance and/or power (Alberti and Bray, 2009; Bray, 2009).

Also important to understanding early Andean cosmologies and myths is the concept of *huaca* which generally refers to a sacred deity, object, idol, or place that is worshipped based on its intrinsic value and is considered living. Stories of huacas are a major feature of the *Huarochoiri Manuscript* (Salomon and Urioste, 1991), a transcribed 16th century text describing some of the earliest Andean cosmologies and myths. Of the many huacas described in this tome, Cuni Raya Vira Cocha and Paria Caca are the best understood, with much of their activities having great effect on the animals, people, and places with which they interact with or that interact with them (Salomon and Urioste, 1991).

In some tales, Cuni Raya Vira Cocha takes the form of a bird to assert his will or meet a goal. In one famous legend, he does so to secretly impregnate the beautiful virgin huaca, Caui Llaca. Upon learning of the father of her child, Caui Llaca flees to the sea and once there turns to stone. In her pursuit, Cuni Raya Vira Cocha runs into a series of birds (as well as other animals), the first being a condor. Hearing good news about her location from the condor, he blesses it with a long life and plenty to eat, adding that any who kill the condor will also die themselves (Salomon and Urioste, 1991: 48). Later, he meets with a falcon and, again upon hearing good news, blesses the falcon stating that it will eat well upon hummingbirds and all other birds and that when killed it will be provided with a sacrificial llama by its guilty murderer. He also grants that the falcon shall be revered at festivities and that people will adorn themselves with its image and dance beneath its splendor (Salomon and Urioste, 1991: 49). Last, Cuni Raya Vira Cocha

encounters a group of parakeets and, when met with bad news, curses them to shriek incessantly, loathed by humans and expelled from agricultural plots for all eternity (Salomon and Urioste, 1991: 49).

Stories of Paria Caca are similarly laden with avifaunal themes, especially in his origin. Legend states that Paria Caca was born in the form of five eggs at the top of Condor Coto Mountain (Salomon and Urioste, 1991: 54). The only witness to this was a poor and lonely man, described as his son, Huatya Curi. Paria Caca helped his son win a series of contests (whilst still in the form of five eggs), many of which involved trickery and the assistance of birds and other animals. Once his son's success was secured, Paria Caca sprang forth from the eggs, taking the form of five falcons and then further transforming into five humans. After hearing about the various sins of his son's competitors, Paria Caca brought torrential rains and washed them out to sea (Salomon, 1991: 59).

In the oral traditions of Huanchaco, early accounts of the activities of the gods and deities also feature bird transformations. In one account, a comet (described as the cousin of the Sun) becomes so infatuated with a famed beauty that he pursues her obsessively despite her rejection of him and love for another. At one point in his pursuit, he transforms into a duck in order to get closer to her, but her dog sees past this disguise and attacks, temporarily scaring him away. This interaction between her dog and the fake duck also serves as an explanation for why dogs in Huanchaco hunt ducks to this day (Huamanchumo, 2020). Another story tells of a locally beloved priest with the ability to turn into a lechuza (Burrowing Owl) who falls in love with a beautiful woman, but in her refusal of another (a warrior) she is murdered. Learning of this the lechuza-priest becomes enraged and seeks revenge, battling it out with the warrior and avenging his love.

From then on, the priest maintains the form of the lechuza and sings an ominous song, signaling impending doom to the listener. Alternatively, when someone witnesses the lechuza in serene flight it is considered a good omen of future prosperity. Hence, the people of Huanchaco bear animosity towards lechuzas and shoo them away, throwing rocks and yelling (Huamanchumo, 2020: 135-136).

The legend of the Bird Bride, also a classic Peruvian cosmology, describes the peopling of Peru after a great deluge (Spence, 1913: 130). The story takes place in the province of Canaribamba, Quito, and tells of two brothers who survived a great deluge by seeking safety on the high mountain of Huacaquan. Once the flooding was over, they were left to seek sustenance and more permanent shelter. They built a small house and made do with herbs and roots until one day they returned home to find a meal and chicha waiting prepared for them. Continuing for 10 days without any sign of who was preparing the meals for them, the older of the two brothers finally decided to hide in wait to catch a glimpse of their benefactor. Shortly after he saw two “guacamayo birds” (parrots) arrive and transform into Canaris, both of which were in reality two beautiful women. When the bird-like women became aware of his spying, they were angered and flew away, keeping away for another 10 days. Upon the return of the Canaris, the younger of the two brothers conspired to prevent them from escaping, but only captured one of the two women. She lived with the brothers for a long time, bearing six children from whom all Canaris proceed. The legend goes on to explain the reverence the Canaris have for guacamayo birds and the use of their feathers for festivities (Spence, 1913: 130).

In some cases, bird transformation was a form of punishment as seen in the tale of “El Cocho” (the Pelican), also from Huanchaco legend. El Cocho was a handsome, skilled, and generous fisher, who attracted many eligible bachelorettes. One such interested party was a witch

who, after being politely rejected by El Cocho, sought to follow him in the hopes of figuring out his disinterest in her and the other women. Following him to the seashore, she witnessed him use a snail shell to call upon a beautiful woman, his lover, who lived in the sea. The witch, envious of this woman and vengeful towards El Cocho, cursed him and transformed him into a pelican. His lover fought off the witch and tried relentlessly to return her lover to his human form but was unable to do so. Now, and forever, he flies low to the waves fishing just as before, bringing his catch back to his children in the pouch on his beak. Remembering that El Cocho was once a human, the people of Huanchaco do not eat pelicans and instead look to them as indicators of good fishing (Huamanchumo, 2020:125-126).

Rather than transforming into birds, some legends and cosmologies feature important figures with avian-like characteristics as seen in that of Ñaimlap (various spellings), founder and first lord of Lambayeque, on the northern coast of Peru. The legend goes that Ñaimlap, with his wife Ceterñi, concubines, and royal court including Pita Zoi (royal conch trumpeter), Ñina Cala (master of the throne and litter), Occhoçalo and Ñinagintue (masters of food and drink, respectively), Fonca Sigde (strewer of shell powder [wherever Ñaimlap walked]), Xum Muchec (the royal face-painter), Ollopcopoc (master of the baths), and Llap Chiluli (crafter of feather-adorned clothes), shipwreck at the mouth of the Lambayeque River after retreating from an ongoing war between a group of unknown island polities (Urban and Eloranta, 2017:155). Also in tow was a revered idol of Ñaimlap made of green stone and called “Yampellec” (translated to “figure and statue of Ñaimlap.”), which would later become an important catalyst for the end of Ñaimlap’s dynasty.

Shortly after their arrival, the royal estate established themselves in the area and over time Ñaimlap expanded his lineage, populating the region and securing his dynasty (Herencia,

2019; Urban and Eloranta, 2017). Much later, on his deathbed, Ñaimlap spreads a rumor that his absence is the result of him growing wings and flying away (Herencia, 2019; Urban and Eloranta, 2017). His departure spurs disquiet among his subjects and some accounts mention an abandonment of the area in response to such loss (Herencia, 2019). Meanwhile his son, Cium, succeeds the throne and fathers 12 sons who, along with their followers, are further attributed with populating the lands of Lambayeque. Their dynasty ends with Fempellec's (the last patrilineal descendant) fateful attempt at relocating the Yampallec idol, thus inciting his ancestor's rage. This manifests in El Niño-like conditions resulting in torrential rains, crop failure, and famine (de la Carrera [1644] in Salas García, 2002; Urban and Eloranta, 2017).

Sprouting wings and flying away are not the only avian traits exhibited by Ñaimlap. His name is frequently associated with the Mochica words for bird (“ñaiñ”) and water (“là”), respectively. This association is bolstered by his waterborne arrival and winged departure from the mortal plane, however there is some disagreement among linguists and historians about this translation (see Cerrón-Palomino, 1995: 44). Instead, they support the etymology of Ñaimlap's name as derived from the Mochica word for osprey, “ñampal”. Perhaps coincidentally, coastal peoples are believed to associate osprey with successful fishing (Urban and Eloranta, 2017; Watanabe, 1995).

Ñaimlap's association with osprey, albeit not without controversy, stems from aspects of the legend in conjunction with observable osprey behavior. First, his arrival from faraway lands is likened to the seasonal arrival of osprey during the austral summer and is a welcome sign of impending fertility and the crop-planting season (Urban and Eloranta, 2017). Second, Ñaimlap's strong connection with the sea as evinced by his island origins, arrival by boat, and subsistence on marine resources, is reflected in the osprey's fish-based diet which similarly binds them to

marine habitats. Lastly, that Ñaimlap brought along a specialized feather worker connotes the importance of birds to his sense of self identity (Urban and Eloranta, 2017).

Some of the names of other members of the royal lineage and court also have avifaunal associations. For instance, the name Escuñain, given to a grandson of Ñaimlap, is associated with the terms used to describe unborn (“eizcu”) bird (“ñaiñ”) that are still maturing. Further, the name Llap Chiluli (the royal feather mantle maker) corresponds to the Mochica words for hawk and dove (de la Carrera [1644] in Salas García, 2002; Urban and Eloranta, 2017). Additionally, Llamcoll (eighth in the succession of rulers) and Fempellec (last of the succession of rulers), are associated with the Mochica words for turkey vulture and penguin, respectively. This last is also associated with a kind of prophetic bird (Urban and Eloranta, 2017).

Despite these seemingly direct connections between Mochica bird terms and actors within the Ñaimlap legend, however, Urban and Eloranta (2017) are careful to note that they are tenuous at best and could be coincidental. Regardless, the importance of birds to Lambayecanos continues to hold true today. Carlos Elera describes the connectedness Lambayecanos still feel with birds, using them and aspects of them (e.g., feathers, flight) as a means of conceptualizing the world around them. For instance, he notes that Peruvian hairless dogs are frequently referred to as being “sin plumas”, or “without feathers” (personal communication, July, 2022).

Legends are also used to explain the reasoning behind certain animal behaviors, social morals, and human practices. One such tale from Huanchaco describes the sociality of coots. In it, a beautiful woman has the personal flaw of being chatty, so chatty that she is rejected by everyone for not being able to control her tongue. One day, she is met by a devil disguised in the form of a handsome rider. Taken with her, he invites her to join him. Along the way however, her incessant talking irritates him and he pleads with her to stop. Failing to do so, he transforms

her into a coot and, terrified at what he's done to her, she flees taking shelter in a stand of totora reeds. From this came the understanding of coots' tendency towards highly social behaviors (e.g., singing, making noise) when it meets other birds, as it used to do when it was still a chatty girl (Huamanchumo, 2020:142).

Birds also factor into ritual practices, especially sacrifice and medicine. At Lake Titicaca, for example, sacrificing to the sun was common (Spence, 1926). Here, visitors would pass through three sculpted doors before reaching the sacred rock. Two of these doors, "Quenti-puncu" and "Pillco-puncu", would be decorated with feathers from various species of birds commonly sacrificed to the sun (Spence, 1926). Other times, bird sacrifices accompanied human burials, such as those seen at Beringa. Here, Gladwell (2004) identifies 3 bird sacrifices: two mummified parrots, and one partially burned passerine bird in a bundle. Parrots were a highly valued trade item, especially among the elite, and their mummification and inclusion in a burial conveys their importance even in death (Gladwell, 2004).

Additionally, Andean peoples sometimes used birds in medicinal practices. For example, when breastfeeding mothers experience low lactation, the Andean Flicker (*Colaptes rupicola*) is given to them as a galactagogue (substances that increase milk production) to great effect (Monteban, 2017). Among traditional fishing communities in Huanchaco, certain seabirds hold symbolic power and are revered for their fishing and swimming abilities. This plays out in traditions such as rubbing the legs of a newborn with the whites of seabird eggs to make them stronger, as practiced in the Moche Valley (Prieto, 2015: 777). In a similar tradition, Humboldt Penguin flippers are saved for the purposes of tapping the legs of children to make them stronger and improve their swimming abilities.

Other ritual activities, such as dance and prayer, warrant taking up the likeness of birds (and other animals/fish). During times of drought in Huanchaco, for example, dances are performed in various animal costumes (Huamanchumo, 2020: 85). Dressing up as guano birds and fish may serve as sympathetic magic, recalling and re-enacting times of high marine productivity. In another ritual from Huanchaco, young bachelors and bachelorettes get together with friends to reenact the mating dance of the “tijereta” (Swallow-tailed Kite; *Elanoides forficatus*). The dance involves the bachelorette tossing a garment in the middle of a small group of suitors (with red painted chests, imitating male tijeretas) who then fight over the token to win her favor and be granted permission to marry her. Historically, this was performed by a couple whose families disagreed with their union, as a means of upholding alternative traditions, the ruse being that the other suitors intentionally lose. As a bonus, tijeretas are locally welcomed as an indication of fishing so in emulating its mating ritual the couple is thought to be blessed with fertility and abundance (Huamanchumo, 2020:129-132).

4.3.2 Creative Expression

The presence of birds in Peruvian creative expression (e.g., pottery, textiles, rock art) is just as prevalent as in their oral traditions and rituals. As keen observers of the world around them, early Peruvian groups frequently included birds as part of decorative motifs (see Figures 7, 8, 15), as anthropomorphized characters, and as deities (e.g., Proulx, 1990; Wolfe, 1981). Eventually, birds became precious resources in early Peruvian societies, valued for more than their guano, meat, or eggs. The use of their feathers in textiles became an important signifier of power, rank, and/or mysticism (Bernier, 2019).

In illustrations and ceramics, birds are often depicted naturalistically as part of the subject environment and are shown performing several naturalistic behaviors such as pecking at

agricultural crops, surrounding fishing activities, or interacting with other depicted fauna (see Figures 8 and 18). Even when depicted naturally, birds appear to be presented with more complex symbolism than other animals (Johns, 2017: p. 32). Sometimes anthropomorphized birds were also depicted in battle, headhunting, and ritual activities, as seen in Moche and Nazca visual cultures (Bernier, 2019; Whittaker, 2017). In Chimú culture, birds were frequently associated with prestige and wealth. Hence their feathers, which in many cases had to be imported, were included in ritual and prestige garments (Bernier, 2019; Rowe, 1984).



Figure 7. Chavín. 10th-5th century BCE. Pectoral featuring stylized bird heads, gold, Dimensions: H. 9 × W. 9 1/4 × D. 1/8 in. (22.9 × 23.5 × 0.3 cm). Metropolitan Museum of Art, from the Jan Mitchell and Sons Collection, Gift of Jan Mitchell, 1999.



Figure 8. Nazca. 1st- 6th century. Double-Spout, Bridge-Handle vessel depicting feeding hummingbirds. Ceramic, pigments, Dimensions: H. 6 × Diam. 5 in. (15.2 × 12.7 cm). Metropolitan Museum of Art, from the Michael C. Rockefeller Memorial Collection, Gift of Emilio Sanchez, 1962.



Figure 9. Moche. AD 4-700. Pair of Ear Ornaments with Winged Runners, Gold, turquoise, sodalite, shell. Dimensions: Diam. 3 3/16 in. (8 cm), Metropolitan Museum of Art, from the Gift and Bequest of Alice K. Bache, 1966, 1977.

As in oral traditions, sometimes anthropomorphic beings or deities are represented with avian features (e.g., wings, feathers, beaks, patterned markings, etc.) and in some instances, birds serve as totems or mascots representing a cultural group (see Figure 9). In reviewing several early Peruvian arts and crafts from various time periods and culture groups (e.g., Paracas, Moche, Nazca), I identified raptorial birds (e.g., hawks, falcons, condors, vultures, owls), parrots, a variety of seabirds (mostly guano-producing), and hummingbirds as the most represented and distinguishable avian motifs (see Appendix B). These tend to be interpreted as representing emotional, intellectual, or physical qualities such as ferocity, swiftness, cleverness, or strength, based on the bird's ecological position and behavior in the real world (e.g., Grundy, 2002; Whittaker, 2017). Additionally, many status items (e.g., decorated ear spools, chest plates, atlatls) feature avian motifs, whereas others (e.g., feather textiles, mantles, adornments) include avian elements (e.g., feathers, bones). Here, I focus on Paracas, Nazca, and Moche visual

cultures as they contain some of the most identifiable avifaunal iconography, however these represent a small subset of a rich history of creative expression from Peru.

From the earliest most naturalistic representations of the world around them to the more symbolic, many cultural groups express conceptual transitions through time in their stylistic decisions and subject matter. For example, the Monumental Phase (ca. 75 BCE to 175 AD) of Nazca iconography consists primarily of naturalistic motifs featuring birds and other environmental elements that are so detailed that individual species can be identified (Proulx, 1990). This is also true for the famous Nazca geoglyphs (see Figures 10 and 11). Of the more than 2000 geoglyphs at the Nazca and Palpa pampas, Lumbreras (2000) distinguished 20 birds. Of these he was able to identify nine to family, making it the most frequently depicted of the naturalistic (read: plant and animal) designs. Continuing this effort, Eda, Yamasaki, and Sakai (2019: 6) identified sixteen of the original twenty avian motifs to species, including pelicans, guano birds, flamingos, hermits, and an immature parrot. Based on the presence of the hermit and parrot, they suggest that exotic species were of particular interest, emphasizing their value.



Figure 10. Nazca. Hummingbird geoglyph courtesy of Diego Delso, CC BY-SA 4.0, via Wikimedia Commons



Figure 11. Nazca. Pelican geoglyph courtesy of Diego Delso, CC BY-SA 4.0, via Wikimedia Commons

Also of note is the connection between seabird geoglyphs and rain. The authors refer to a lesson from Nazcan TLK which observes that when seabirds arrive in the region around November-December, rain can be expected in the highlands by January-February. If the seabirds don't arrive, drought conditions are feared (Eda, Yamasaki and Sakai, 2019: 6). Could these geoglyphs represent sympathetic magic aimed at encouraging rain, enticing the birds to visit (similar to using decoys), or warding off drought? At the very least they represent past ecological observations in the region, a theme that is present throughout all phases of Nazca visual culture.

Later, during the Proliferous phase (ca. 425-550 AD), Nazca iconography as expressed on textiles and ceramics put form to legend by depicting mythological and religious beings, as well as scenes from legend (Proulx, 1990). The Horrible Bird is one such mythological avian theme frequently used as decoration on pottery and textiles (Proulx, 1990; Wolfe, 1981). Its origins can be traced to late Paracas iconography, and it has undergone a series of design changes through time. The earliest renditions of the Horrible Bird are thought to have derived from naturalistic representations of a carrion-eating condor-like bird. Later in its development it would take on a more anthropomorphic appearance (Proulx, 1990; Wolfe, 1981). Typically, it is depicted as a raptorial bird, perhaps a combination of a condor and a hawk, representing some of the most powerful forces in the sky. It is almost always depicted with or eating trophy heads or other human body parts, hence its association with punishment and death. After about 550 A.D., around the Late Nazca period, it ceases to be depicted (Proulx, 1990).



Figure 12. Nazca. Double-Spout, Bridge-Handle Vessel, 325-440. Ceramic, pigments, 9 1/4 x 7 x 6 1/4 in. (23.5 x 17.8 x 15.9 cm). Brooklyn Museum, Henry L. Batterman Fund, 41.423. Creative Commons-BY (Photo: Brooklyn Museum, 41.423_side3_PS6.jpg)

The Harpy is yet another bird-like creature found in Nazca myth, also depicted iconographically on ceramics and textiles (Proulx, 1990; also see Figures 12 and 13). It was named after the Greek tradition, for lack of a Nazcan name, and is characterized by a human head with an avian body. The head typically has markings consistent with those seen on hawks, and it, too, is frequently associated or depicted with trophy heads. The use of the Harpy as a decorative motif begins around the Early Nazca period and disappears from Nazca iconographic traditions by the Late Nazca period (Proulx, 1990). Additionally, the harpy features in Chavín culture and is present in painted textiles from the Paracas region, encountered about ~500 km from Chavín de Huantar (Stone, 1983: 51-71). Typically but not exclusively associated with burials, these textiles are made of sewn together strips of cotton cloth and painted either directly or via tie-dye-like methods. Naturalistic birds and other animals also appear as decorative motifs in these textiles.

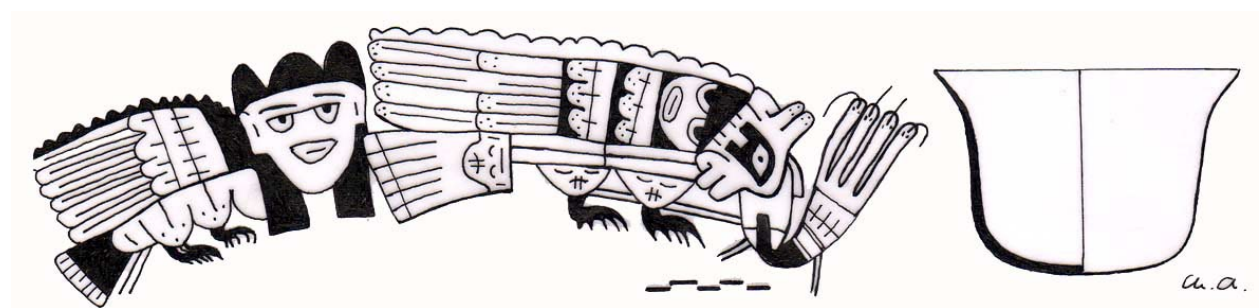


Figure 13. Nazca. Early Intermediate Period, Phase. Rollout reproduction of small vessel depicting Harpy and Horrible Bird. Harpy is depicted with a human head and avian body. Horrible Bird is depicted with a carrying cord (?) or cap (?) in its beak. Rollout and interpretation © 2003 Christiane Clados.

A predecessor to the Nazca, visual culture from the Paracas tradition also favors avian motifs, suggesting that birds and bird-like qualities were held in high regard (Brown, 2016; Dyer, 1996). Brown (2016) posits that the focus on birds in Paracas indicates a separation from the

dominant Chavín culture that predominantly depicted birds as part of a triad involving the snake and jaguar. In Chavín cosmology birds represent the lord of the sky, snakes represent the realm of the dead, and jaguars represent the realm of earth (Brown, 2016: 4). Based on some of the material culture associated with Paracas (e.g., textiles, feather works, and ceramics) there is reason to believe that ritual performances involving individuals in the guise of avifauna also took place.

Birds also feature prominently in association with the Oculate Being, a very important figure in Paracas cosmology (Dyer, 1996). The Oculate Being is identified by its resemblance to the iconic smiley face of popular culture and numerous snake-like appendages (Figure 14). Eventually, the Double-Headed Bird motif would join the Oculate Being as a decorative pattern. Later it would be featured in Paracas textiles and ceramics on its own, though still considered as a symbol of the Oculate Being (Dyer, 1996:7).

The Moche also frequently include avian iconography in their decorative motifs, drawing strong associations between certain avifauna (hawks, owls, condors, and hummingbirds) and depictions or weapons of war. Whittaker (2017) examines this relationship by analyzing the avian-themed decorations found on atlatls from three culture groups from different parts of the Americas. In reviewing Moche atlatls from El Brujo, Whittaker notes that these birds were chosen due to their swiftness, aggression, stealth, and deadliness (2017: 7-8). He also briefly mentions one instance of a duck decorating the handle of an atlatl from Cao, dismissing its presence as inscrutable in relation to war.



Figure 14. Oculate Being Mask, 300 BCE-AD 1 (Thermoluminescence date, 835 BCE-AD 185). Peru, South Coast, Paracas (Cavernas) style (700 BCE-AD1), 300 B.C. to A.D. 1. Ceramic, resin-based paint; overall: 23.6 x 22.5 x 13.2 cm (9 5/16 x 8 7/8 x 5 3/16 in.). The Cleveland Museum of Art, Purchase from the J. H. Wade Fund 2003.39.



Figure 15. Taylor, John Bigelow (photographer), “Camelid-fiber mantle with double-headed bird border, Paracas style, Peru,” from AMNH Research Library, Digital Special Collections.

I disagree with this last point based on Gamboa’s (2017) analysis of the importance of the Muscovy duck to the Moche. Muscovy ducks were among the first domesticated birds in Peru and were valued for their meat and eggs, and as pets. They were represented in every phase of Moche pottery and are frequently depicted as warriors likely due to their aggressive nature (Gamboa, 2017: 113; Gamboa, 2019). As seen in Figure 17 below, depicting a replicated image from a Moche vessel (Larco Phase V), the two ducks are in an active posture, gripping weapon bundles (that include atlatls) in their left hands, and are patterned in geometric shapes including wave-like shapes along their crests and 6 headed snake tails (McClelland, 1984 [29 CE]).

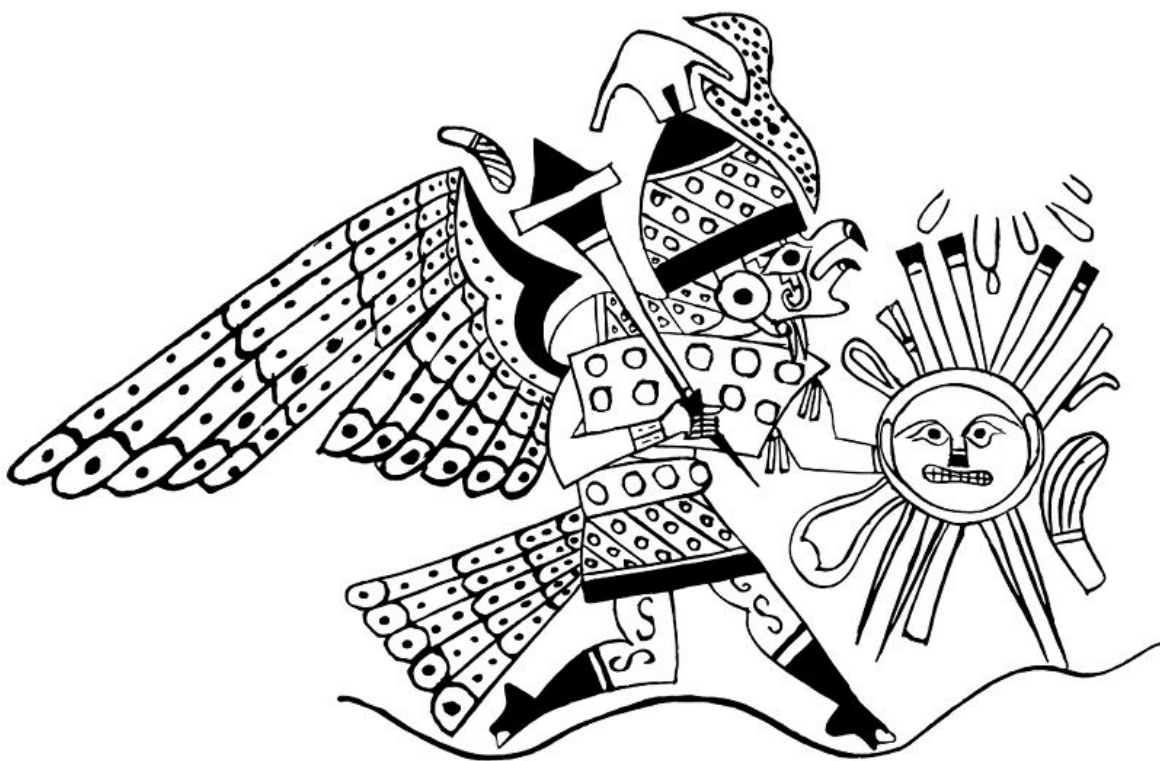


Figure 16. McClelland. (2003). Anthropomorphic owl warrior carrying weapons bundle, from the Christopher B. Donnan and Donna McClelland Moche Archive, Image Collections and Fieldwork Archives, Dumbarton Oaks.



Figure 17. McClelland. (29 CE). Anthropomorphic duck warriors, from the Christopher B. Donnan and Donna McClelland Moche Archive, Image Collections and Fieldwork Archives, Dumbarton Oaks.



Figure 18. McClelland. (23C.E.). Cranes with prey in their beaks, from the Christopher B. Donnan and Donna McClelland Moche Archive, Image Collections and Fieldwork Archives, Dumbarton Oaks.

Finally, no discussion of Peruvian art history, especially one as avian centric as this, is complete without at least brief mention of the amazing feather works produced in this region (see Figures 23-25). Feathered textiles were highly valuable items and are frequently found in association with burials of important social figures (O'Neill, 1984; Pasztory, 2008; Rowe, 1984). The brilliantly colored feathers typically came from exotic species including parrots, paradise tanagers, hummingbirds, and flamingos that would have needed to be imported, but domesticates such as the Muscovy duck were also procured (O'Neill, 1984; Pasztory, 2008; Rowe, 1984). According to Benson (1997: 73; see also: Johns, 2017 p. 32), feather colors are attributed with symbolic meaning, with red meaning power, blood, or sacrifice; yellow signifying the sun, energy, and fertility; green for vegetation; blue for the sky and water; and black, which could signify high status/power as well as or more negative aspects.

The Wari and Chimú cultures produced some of the most vibrant and detailed pieces known to the modern world, many of which are associated with ritual contexts and/or heightened social class (O'Neill, 1984; Pasztory, 2008; Rowe, 1984; see Figures 19-21). Many of these

textiles are meant to be worn, the wearer actively embodying an avian being. This act of transformation further emphasizing the importance of birds to these cultures.



Figure 19. Wari hanging, cotton camelid fiber and feathers, seventh–eighth century, ht. 66.04 cm, width. 219.71 cm. New York, the Metropolitan Museum of Art, the Michael C. Rockefeller Memorial Collection, Bequest of Nelson A. Rockefeller, 1979, 206.468 (© The Metropolitan Museum of Art).



Figure 20. Chimú. Headdress, 1100-1470 C.E. Cotton, hide, feathers, wood or reed, 5 1/8 x 8 1/4 x 8 1/4 in. (13 x 21 x 21 cm). Brooklyn Museum, Ella C. Woodward Memorial Fund, 61.11a-b. Creative Commons-BY (Photo: Brooklyn Museum, 61.11_PS2.jpg)



Figure 21. Chimú Tunic, cotton and feathers, 15th–early 17th century, Dimensions: H. 27 1/2 × W. 27 in. (69.9 × 68.6 cm). New York, the Metropolitan Museum of Art, Harris Brisbane Dick Fund, 1963 (© The Metropolitan Museum of Art).

This is merely the tip of the iceberg when it comes to avian representation in Peruvian visual traditions, but to go any further far exceeds the scope of this thesis. Keen observation of bird types and behaviors clearly informed the artists that reproduced their likeness, bolstering their, and perhaps others' understanding of birds in general. Feather works allowed individuals to physically embody or include avian elements in rituals, burials, and dance. Thus, through creative expression, animals and plants move beyond the realm of subsistence and into

ideological conceptualizations of the non-human world, further strengthening our connection (Alaica, 2018).

4.3.3 Policy (a rare case)

Given the cultural ties to birds, it follows that early Peruvians had a profound respect and appreciation for them. Legends would have provided an education in their ontology, function, and ecological importance, perhaps shaping human interactions with various bird species. This respect, in conjunction with ongoing development of cultural complexity, may have even encouraged the development of resource protections such as those in place during Inca rule.

The Inca Empire is among the most famous and widely studied civilizations in the world. Their rule spanned nearly 4000 km from north to south, including the Pacific coast as well as the Andes mountain range and eastern slopes, making them the largest ancient civilization in South America. The Inca Empire's success relied heavily upon a well-established workforce focused on agricultural production (Rodrigues and Micael, 2021). Food security at this time, as ever, would have been extremely important to maintaining and supporting the prosperity of the empire. Guano use for the purposes of fertilizer is thought to have been fundamental in sustaining agricultural development. Accordingly, guano birds were held in high regard and were highly valued. So much so that the Inca were among the first civilizations to establish a management plan with accompanying conservation law to protect guano birds and by extension guano resources (Rodrigues and Micael, 2021). Much of what is known about Inca policy is derived from ethnohistoric resources, which makes determining the date of implementation for this conservation effort difficult. What is known is that regulations were established for each region of their realm to abide with strict rules against disturbing guano birds during the breeding season, hunting them or taking their eggs. The penalty for breaking these rules was death. This

law was so effective, it is attributed with protecting guano birds to the degree that they exist in such large healthy numbers now (Rodrigues and Micael, 2021).

4.4 A Sentinel for El Niño?

Learning from and emulating the non-human world is embedded in Peruvian culture. Clearly, birds drew the attention of early Peruvians with their omnipresence, behavior, and aesthetics, featuring in various aspects of their cosmologies, cultural practices, arts and crafts. Ecological cues from birds that are related to important resources (e.g., fish, guano, water, and forageable meat), then, would have informed coastal Peruvians on the state of their environment. Pairing this with other knowledge, such as the visibility of the Pleiades (e.g., Orlove, Chiang, and Cane, 2000), or what can be gleaned from legends of humans surviving floods, for example, may have provided coastal Peruvians with part of the skill set they needed to cope with El Niño events.

As it stands, symbiotic/mutualistic relationships between fishers and marine birds are a given. As part of their tackle box of maritime skills, early fishers would have looked out across the sea for “Pajaradas”, large congregations of birds, indicating a shoal and taking them as a signal to go fishing (Huamanchumo, 2020: 216; Prieto, 2015:776). Similarly, they might have looked for the presence of specific birds (e.g., pelican, swallow-tail kite) as an indication of good fishing. Given enough time, fishers learned to associate specific birds with the prey they eat (e.g., Inca Tern and flounder), as seen in modern fishing communities on the north coast of Peru (Prieto, 2015:776-777). Conversely, a lack of birds might have indicated low stocks, perhaps causing the fisher to look for other indications of concern or to confer with other fishers in their community.

So, what might coastal occupants or fishers have observed from seabirds? Thinking back to the previous chapter, we know seabirds offer many indications of changes in their environment and prey resources. These include, but are not limited to, longer foraging times, migration out of the area of impact, nest abandon, and massive die-offs. On land, a sudden reduction in avifaunal populations might have served as the first indication. During the event, massive die-offs would have been apparent on shore and on nearby land. At sea, responses to El Niño might have looked like sparse scatters of birds indicating low fish stock in conjunction with low catch yields (of fish). Gatherers might have noticed fewer birds within known colonies and/or abandoned chicks or eggs. Reasonably, this could have been a boon, as it likely would have been difficult to procure eggs or juvenile birds with their parents around.

Beyond indications for food resources, observations of seabirds might have put coastal occupants on alert about the availability of other resources, such as guano. As seen in Tables – but need to correct the numbers for Table 5 and Figure 6, some of the most affected species during El Niño are the guano birds. Impacts to their population would have affected guano accumulation and, since guano is a vital resource, it is possible that special attention would be given to any environmental disturbance that might affect it. While the lag between El Niño impacts might preclude a noticeable effect, it is not unreasonable to assume that people closely monitored guano birds (e.g., Rodrigues and Micael, 2021) and noted any behavioral changes.



Figure 22 Top: Mass mortality of Guanay Cormorant on the shore of Jaguay (08/21/1963).
Bottom: Pelicans, dead and emaciated on the northern shores (07/24/1963). Images adapted from
Jordan 1964, Lamina 2 pg. 38.

Something else to consider is that biological signals may have varied depending on one's location on the coast. For instance, the southern coast may not experience very many changes in response to El Niño since these events tend to impact the north and central coasts the hardest. However, that is not to say this region does not experience any changes. For example, while there might be few birds in the north, many more than what is considered normal might be present on the central and southern coasts as fish and birds migrate away from the encroaching warm waters.

Also of note are the parallels between seabird and human coping strategies in response to El Niño. For example, both humans and birds begin diversifying their resource base in response to shifting resource availability. Later, as resources change and flooding on land becomes dangerous, both humans and seabirds abandon home (nests) and seek shelter or migrate away from the area of greatest impact. For humans, this is typically higher ground, but for seabirds this could mean much longer distances.

Whether these specific parallels are innate in all organisms as a method of survival or are the result of millennia of learning through cohabitation, or even some combination of influences, remains to be determined. What cannot be discounted is that coastal occupants, in their regular interactions with the marine environment and organisms within, would have noticed changes in them. Those observational skills would have been beneficial, if not altogether necessary to their resilience.

CHAPTER 5

META-DATA ANALYSIS: AVIFAUNAL CONSUMPTION THROUGH TIME IN COASTAL PERU

In addition to their role in cultural beliefs, practices and art, birds were also included in coastal Peruvian diets. Seabirds often made their way to the dinner table as a result of net fishing bycatch, however, intentional capture was also practiced (Prieto, 2015; Pozorski, 1976; de France, 2005; León, 2016). Much of the research on seabird capture suggests that nets, projectiles, and clubbing were the most employed methods (Prieto, 2015). Seabirds' high numbers and tendency towards congregating around fishing areas and in large colonies makes some hunting methods (e.g., clubbing, netting) relatively easy. Further, after becoming accustomed to the presence of humans, many birds show little fear, making up close methods relatively easy to employ (Prieto, 2015).

In the more recent past, Murphy (1919; in Prieto, 2015) observed that local fishers from the Chincha Islands used poles (usually bamboo or sugarcane) with fishhooks on the end as a means of capturing seabirds. Other methods included clubbing birds while they rest or using a sling to hit them with projectiles (e.g., rocks, modified pebbles). Clearly these methods have been maintained over time as they continue today (Prieto, 2015).

Along with guinea pig and llama, bird domestication was also practiced in Peru, with Muscovy duck being the most prevalent domestic bird prior to the arrival of the Spaniards. The Moche and others on the north coast of Peru were able to domesticate Muscovy by the first millennium AD, as seen represented in art and ritual (Gamboa, 2017; 2019). By the time of the Chimú (AD 1000-1470) and the Inca (AD 1470-1532), Muscovy domestication and husbandry was commonplace (Gamboa, 2019). Muscovy were bred for a variety of reasons, including their meat, their “services” as a pest remover, and for their feathers. Caring for Muscovy was fairly

low-effort in the past, with kitchen scraps being their primary source of food and minimal pinning required (Gamboa, 2019). Some ethnographic evidence suggests that Sooty Shearwaters, pelicans, and other seabirds were also domesticated to some degree, but the motives for doing so weren't always necessarily for subsistence (Huamanchumo, 2021; Prieto, 2015).

Early sites, such as Quebrada Tacahuay (12,850-12,130 cal yr BP) and Ring Site (~11,677- cal BP- ~5660 cal BP) contain some of the oldest evidence of seabird consumption in Peru, making it a long-held practice. León (2016: 332-348) identified at least 34 different species of bird consumed throughout the history of Peru. For some cultures, such as the Mochica and Chimú, birds were a regular part of the diet (Lockhard, 2005). In modern cases, however, seabird meat is saved for special occasions (Prieto, 2015: 775). Perhaps this was the case at least some of the time historically, considering the modest amount of bird remains (when compared to fish and shellfish) typically found at coastal archaeological sites. Issues of preservation are also in play, though the arid climate of Peru's coast typically does more good than harm.

Here, I employ a meta-data analysis of a sample (N=26) of coastal faunal assemblages to examine trends in avifaunal consumption through time, from the initial occupations of the coast to the end of the Inca Empire. In doing so I aim to determine the environmental conditions that would have supported the species found and consider how the impacts of El Niño might be reflected (e.g., presence of indicative species, abnormal quantities, health of individuals etc.). Are there any trends that might serve as a viable proxy for such events?

Making inferences about environmental conditions/change based on faunal data is challenging since the data reflect both human and non-human factors (Grayson, 1984). Faunal assemblages also provide useful information about meat consumption, species exploitation, species mobility and more. At the very least, the addition of these data contributes to the

overarching theme of human-Aves-ecodynamics, providing physical evidence of human-avian interaction.

BCE/AD	Period	BP
1450-1540 CE	Late Horizon	500-410
1000-1450 CE	Late Intermediate Period	950-500
650-1000 CE	Middle Horizon	1300-950
200-650 CE	Early Intermediate Period	2150-1300
1700 BCE-200 CE	Early Horizon	2850-2150
3850-1700 BCE	Initial Period	3650-2850
4800-3850 BCE	Late Preceramic	5800-3650
8000-4500 BCE	Middle Preceramic	9950-6450
14000? -8000 BCE	Early Preceramic	15950? -9950

Table 6. Estimated chronology of Peruvian Coast, loosely adapted from Quilter, 2014 (Figure 2.4; p. 36).



Figure 23. Early Preceramic sites included in this analysis.

5.1 Early Preceramic (Figure 23)

5.1.1 Quebrada Tacahuay

Considered one of the oldest manifestations of maritime adaptations in the Western Hemisphere, Quebrada Tacahuay was intermittently occupied during the Early Preceramic Period in the Terminal Pleistocene (12,850-12,130 cal yr BP) and Early Holocene (11,740-11,380 cal yr BP), and again at 11,020 cal yr BP (deFrance et al., 2001, 2005; Keefer et al., 1998; Reitz et. al., 2015). At the time of its occupation Quebrada Tacahuay rested upon an alluvial terrace between 0.7-0.9 km inland from the shoreline about 107-126 masl and was fronted by a sandy beach within proximity of vital resources including potable water, roosts, and rookeries (deFrance et al., 2001; Reitz et al., 2015).

Excavations at this site reveal a history of coastal foraging and specialized extraction of marine resources, particularly of marine avifauna. Avifaunal remains at Quebrada Tacahuay comprise the bulk of the faunal assemblage and suggest that avifaunal processing (preparing, butchering, and cooking) was the primary activity going on at this site (deFrance et al., 2001; 2005). Other faunal components include fish, mollusks, and marine mammals. The absence of midden and other residential features indicate that Quebrada Tacahuay was an ephemeral campsite (deFrance et al., 2001; 2005). It is therefore generally accepted that the area was used episodically by people who resided elsewhere throughout the year. After its initial occupation, the site was abandoned and later sealed by a series of debris flows associated with El Niño phenomena.

Materials recovered from a hearth feature at the site, dated to ca. 10,500- 10,800 cal BP, contained the remains of cormorants, boobies, anchovies, and seals, all of which migrate south in large numbers during El Niño events (Fiedel, 2007; Keefer et al. 1998; deFrance et al., 2001).

Possible evidence of net use at the site indicates a probable method of capture for both the birds and anchovy (deFrance et al., 2001). Of the total minimum number of individuals (MNI) comprising the Quebrada Tacahuay faunal assemblage, 68.8 percent were Aves. Cormorant and booby (*Phalacrocorax* sp. and *Sula* sp.) are the most prevalent within this aggregate, followed by pelican (*Pelecanus* sp.). Similarly abundant, anchovy (*Engraulis* sp.) accounted for 89 percent of the fish assemblage (deFrance et al., 2005; Reitz et al., 2015).

El Niño disrupts the marine food web, the consequences of which extend to marine avifauna. As a result, it was previously hypothesized that the immense number of bird remains at Quebrada Tacahuay could have resulted from an intense El Niño that weakened their populations, making them easily exploitable by early coastal inhabitants. Further analysis of the faunal assemblage, however, revealed that the marine avifauna of Quebrada Tacahuay were healthy adult individuals that were poached for consumption, exhibiting cut marks on forelimb and axial elements typical of the removal of breast meat (deFrance, 2005).

Given the lack of fear exhibited by some avifauna towards humans and the large numbers in which they congregate, it is possible they could have been approached and captured with relative ease. Even so, from what we know about avifaunal responses to El Niño, it is also possible the health of the specimens at their time of death could be attributed to the tendency towards abrupt migration exhibited by experienced adults during El Niño events, increasing available numbers and potentially the ease of capture.

5.1.2 Quebrada de los Burros

Occupied during the Early Preceramic Period and into the Late Preceramic Period (between 9,800- 3,200 cal BP), Quebrada de los Burros is situated 200 masl, 1.5 km from the shoreline, and 20 km south of Quebrada Tacahuay at the bottom of a quebrada. In contrast to the

aridity of the region, which only experiences precipitation during strong El Niño events, the quebrada maintains its moisture throughout most of the year (Béarez, 2000). Occupation events at the site are interrupted by debris flows associated with El Niño activity. One such flow might have even been contemporaneous with an event linked to the abandonment of Tacahuay (Reitz et al., 2015). Even so, coastal upwelling during the occupation of Quebrada de los Burros was strong, as indicated by sediment records (Fontugne et al., 1999).

Faunal analysis at Quebrada de los Burros resulted in the identification of numerous fish, avifauna, and mollusk remains in addition to terrestrial and sea mammals (Béarez, 2000; Rodríguez-Loredo, 2012). Most of the fish specimens are cool-water species, and much of the avifauna are marine. Cormorants and penguin were the most prevalent avifauna and drums, jacks and herring were the most prevalent fish. Surprisingly, anchovy amounted to less than 1 percent of the assemblage. The terrestrial assemblage analyzed by Rodríguez-Loredo (2012) suggests higher diversity during the Early Holocene. This may be due to fragmentation, differential preservation, or even due to the difference in the number of occupation levels during the Early Preceramic Period (Early Holocene, which was represented by 4 levels, double that of the Middle Preceramic/Mid-Holocene).

5.1.3 Quebrada Jaguay

Located on the northern bank of a quebrada channel 40 masl, Quebrada Jaguay is approximately 2 km from the modern shoreline and 20 km northwest of the modern city of Camaná. Rising sea level between 20,000 and 6,000 years ago inundated coastal plains, resulting in the inability to determine how the earliest peoples in this region adapted to living along the shore (Sandweiss et al., 1998). At around 13,000 cal BP, Quebrada Jaguay would have been around 7-8 km from the coast. The modern environment in this region is typical of the South

American coastal desert with very little precipitation, except during El Niño years, and seasonal stream flows during the austral summer (Sandweiss et al., 1998).

The occupation of QJ 280, one of few unsubmerged sites known from this era, spanned the Terminal Pleistocene and the Early Holocene between ca.13,145-11,188 cal yr BP and 11,706-10,248 cal yr BP (Sandweiss et al., 1998; McInnis, 1999; Reitz et al., 2016). Excavations led by Dan Sandweiss and his team in 1996 uncovered the remains of ten species of fish, mammals, birds, and crustaceans, with four species of mollusks along with other faunal classes. The vertebrate assemblage is dominated by fish (primarily Sciaenidae) which encompass 91.6 percent of the sample (NISP: 7,297). Only 0.2 percent of this assemblage is represented by Aves with a total NISP of 15. Surveys and test pitting of 55 smaller sites (dating from the Early Holocene to the early Late Holocene) in the area surrounding QJ 280 revealed midden deposits including mollusks, bifacially worked lithics, groundstone, and faunal remains (McInnis, 1999). Some sites in this survey included avifaunal remains, though they were often too fragmentary to identify. Avifaunal remains at site QJ 16 (NISP: 9) were relatively abundant compared to the other sites, though poor preservation resulted in the analyst not being able to identify them to species.

Analysis of the faunal assemblage indicates that the inhabitants of QJ 280 and the surrounding sites relied heavily on marine resources. Present-day ecological information indicates that the resources represented in this region are found in a variety of marine habitats ranging from near shore to intertidal zones, which further suggests that marine conditions in this region were likely similar to modern times (Sandweiss et al., 1998; McInnis, 1999).

5.1.4 Ring Site

One of the earliest sites in this analysis, the Ring Site was occupied from the Terminal Pleistocene/Early Holocene boundary through the Middle Holocene. Dates of occupation range from ca. 11,677-11,257 cal BP to 5886-5660 cal BP (Sandweiss et al., 1989; Reitz et al., 2015). By 7000 BP (5050 BCE) this site was occupied year-round (Sandweiss et al., 1989). Ring Site lies on a marine terrace 0.75 m inland from the modern coastline. When sea level was lower, at the end of the Pleistocene, the site might have been within ca. 5 km off the coast. By the time this site was abandoned, sea level rise brought the sandy shoreline within ca. 1km of the site (Sandweiss et al., 1989; Reitz et al., 2017). Punta Coles, a rocky peninsula home to bird and marine mammal rookeries, is within ca. 10 km of the site today (Reitz et al., 2017).

Ring Site is so named due to the deeply stratified shell midden that formed a ring approximately 26 m in diameter and between 2.5-8 m high prior to anthropogenic destruction from mining for shells used in copper smelting. Excavations at Ring Site took place in areas of flatter “pre-ring” deposits beneath the destroyed ring, as well as a small portion of the ring base (pers. comm., Sandweiss, 2019). The faunal assemblage at this site is dominated by fish (specifically, Sciaenidae s.) and a wide variety of birds were similarly recovered, though by the end of the occupation they became less abundant. All avifauna specimens, except for the chachalacas, are associated with the Peru Current. The presence of avifauna at this site suggests that nesting sites and other similar food sources were available nearby (Reitz et al., 2017). Today, bird rookeries and a marine reserve at Punta Coles are within access of the site, which suggests that a similar arrangement existed in the Early Holocene.

The site also contained an extensive molluscan assemblage of cold-water species. Most of the taxa present are adapted to cool-temperate or mixed-water conditions suggesting there was

not a significant change to local habitats and water regimes during the occupation of the site (Reitz et al., 2017). Organic materials from this and other contemporaneous sites indicate that cool-temperate marine conditions were prevalent between 13,000 and 7500 cal BP, similar to current conditions (Sandweiss, 2003; Reitz et al., 2017).

5.1.5 Sitio Siches

Sitio Siches is located on the coast at 4° 24.77' S. It is a stratified site with an occupational sequence spanning the Early to Mid-Holocene (Reitz et al., 2019). It is temporally divided into three cultural phases: Amotape (~10,700–10,100 cal BP), Siches (~7,900–6,800 cal BP), and Honda (~5,800–5,200 cal BP). The Sitio Siches faunal assemblage comprises an estimated 2,759 MNI of primarily marine vertebrates (Reitz et al., 2019). Taken together the faunal data from the Amotape phase suggests warm marine waters, the assemblage associated with Siches suggests even warmer waters, and the data from Honda show a transition to modern conditions (Reitz et al., 2019).

The Amotape faunal assemblage is dominated by fish, with drums contributing 62 percent of the MNI. Avifauna were not identified to species and amounted to a meager number of individual specimens (NISP) of 4. Assemblages from the Siches phase were divided into 3 analytical units, all three were dominated by fish (primarily sea trout, 43 percent MNI). Avifauna during this phase amounted to 3 individuals, cormorant being the only identified species (Reitz et al., 2019).

Finally, the Honda phase assemblage was divided into lower and upper analytical units. Both were similar to the previous phases in fish dominance (96–7 percent MNI) and avifauna were represented by 13 individuals. Many of the taxa represented in the site are adapted to warm waters. Terrestrial fauna were rarely exploited but were most abundant during the Amotape

phase, which may indicate more humid conditions on the coast during this time. Marine mammals and birds were most common in the Honda phase. Reitz et al., (2019) suggest that the differences in each phase reflect cultural responses to environmental changes during the mid-Holocene.



Figure 24. Middle and Late Preceramic sites included in this analysis.

5.2 Middle Preceramic to Late Preceramic (Figure 24)

5.2.1 Ostra Base Camp

Located on the north central coast of Peru and occupied during the Middle Preceramic Period (6,250-5,450 cal BP; 4300-3500 BCE), Ostra Base Camp exhibits evidence supporting a change in environment during the Preceramic periods. Previous geological studies indicate that there was once a warm-tropical bay where today there is a coastal strand exposed to cooler waters (Sandweiss, 1986; Sandweiss et al., 1996, 1998). Further analysis of the faunal assemblage from Ostra Base Camp supports this interpretation and suggests that the change in water conditions was not a localized event.

Marine resources dominate the Ostra Base Camp faunal assemblage with bony fish comprising 89 percent of the MNI. Tropical and estuarine fishes are represented by 53 percent of this assemblage. Temperate fishes common to the Peru Current make up an additional 30 percent of MNI (Reitz and Sandweiss, 2001). Other elements include turtles, birds, and mammals. The presence of turtles suggests that this site was occupied during the austral winter as well as the summer, which is when they are observed to occur on the coast today. Avifaunal data from this site are represented by pelican (MNI: 1), cormorant (MNI: 7), and gull (MNI: 2) (Reitz and Sandweiss, 2000). By 5,800 cal BP, after the site was abandoned, fauna typically adapted to warm-tropical climates largely disappeared, a ridge plain began forming to the west of the beach, and the climatological conditions (including ENSO) with which we are familiar today were developing (Sandweiss, 1986; Sandweiss et al., 1996; Reitz and Sandweiss, 2000).

5.2.2 Paloma

Located in the Chilca Valley, about 65 km south of Lima and 3-5 km from the ocean, lies the Archaic village of Paloma (Reitz, 1988; Reitz and Sandweiss, 2001). It was occupied during

the Middle Preceramic Period between 8,600-5,400 cal yr BP. In the Chilca River floodplain, deer and birds are observed to frequent the area when the summer brings increased precipitation and waterflow (Reitz, 1988).

Faunal analysis conducted by Elizabeth Reitz (1988) indicates that the biomass represented by the faunal assemblage is 90 percent marine, with anchovies accounting for 60 percent of the vertebrate total. Reitz suggests that the fish species represented are indicative of an inshore fishing strategy using nets to catch small schooling fish (herring and anchovy) on sandy beaches. Avifauna made up 0.5 percent of the MNI at the site and included Penguin (*Spheniscus humboldti*), Pelican (*Pelecanus thagus*), Booby (*Sula variegata*), and Guanay Cormorant (*Phalacrocorax bougainvillii*) (Reitz, 1988). The amounts for these were not provided in the source material. According to Reitz, the species present in the Paloma assemblage indicate that local environmental conditions have not changed much since Paloma's occupation.

5.2.3 El Paraíso

The monumental site of El Paraíso was occupied between 4,500 and 2,800 cal BP (2550-850 BCE) and comprises 8-9 stone buildings varying in size from 3-4 rooms to massive room complexes 300 m long by 100 m wide (Quilter et al., 1991). El Paraíso is situated north of Lima near the opening of the Chillón Valley and extends over 50 hectares in area. Paleobotanical evidence of a lomas bloom indicates the presence of El Niño conditions between 3,725 and 3,577 cal BP (1775-1627 BCE)(Caramanica et al., 2018). Contrary to these findings, the faunal assemblage of El Paraíso is dominated by anchovy which, along with other fish taxa and mollusks, suggest normal Peru Current conditions (Sandweiss, 1996).

Surprisingly, despite the high number of anchovies recovered at the site, no marine avifauna were represented in this assemblage. Avifaunal remains instead include duck, dove,

mockingbird, and owl, species otherwise unrepresented at other sites within this analysis. This was also noted by Prieto (2015: 787) as a curiosity since many, if not most, sites in his (and my) analysis also exhibited a preference towards seabirds. Duck remains at the site suggest the possible existence of wetlands nearby that would have similarly been supported by the precipitation brought on by El Niño. However, additional evidence of wetland species at the site would better support such a hypothesis. Alternatively, the presence of ducks could indicate early domestication activities.

5.2.4 Padre Aban

Located in the Moche Valley, Padre Aban is situated west of Trujillo and above eastern Huanchaquito (Pozorski, 1976: 17). The site covers around 100 sq meters and emanates from the bank of a small quebrada. Based on its size, lack of architecture, and midden contents, Pozorski (1976: 19; 1979: 165) suggests it was a seasonal habitation site with evidence suggesting a transition towards sedentism. The site contains midden deposits with evidence of fishing activities (e.g., netting, cotton cordage) and a generally marine based faunal assemblage. Industrial cultigens such as cotton and gourd were used in fishing and emphasize the importance of marine resources.

Avifaunal remains at this site comprised mostly shore birds, but only pelicans were identified to species due to lack of a robust type collection (at the time). Pozorski and Pozorski (2018: 314) calculated that bird meat constituted about 20 percent (487.5 g) of the total meat in the Padre Aban diet. Other marine components included sharks, rays, guitarfish, mullet and croakers, as well as a variety of mollusks (Pozorski, 1976).

5.2.5 Alto Salaverry

Alto Salaverry is also located in the Moche Valley, south-southeast of Trujillo. It is situated some 1.65 km from the ocean and spans approximately 180 m north-south by 120 m east-west (Pozorski, 1976: 20). During its occupation, it would have been somewhere around 400 m away from the ocean, however tectonic activity in the region during the Early Intermediate Period shifted the local landscape (Pozorski, 1979: 165).

The site consists of various domestic and non-domestic structures made of adobe, cobbles and boulders, as well as midden deposits (Pozorski, 1976; 1979). The midden components of the site include evidence of twined textiles, a large variety of plant cultigens, and marine resources (e.g., fish, avifauna and shellfish). The presence of cotton and gourds at the site emphasize the importance of fishing activities.

Avifaunal remains here were less substantial than at other sites, amounting to less than 1 percent (12.5 g) of the total meat consumed. Pozorski (1976: 81) posits that this the result of dietary preference or differential access, citing a site from a later time period near Padre Aban that contained a lot of bird bone. Rather, the faunal assemblage at Alto Salaverry predominantly consisted of fish including drum, sharks, rays, and mullet (Pozorski, 1976).

5.2.6 Los Gavilanes

Located on the right bank of the coastal Huarmey Valley, Los Gavilanes is comprised of 47 storage bins used to contain maize. Food remains at the site include a variety of cultivars (e.g., maize, chilies, avocados), fish (e.g., drums, palm ruff), crab, sea lions, and seabirds.

Between 4000-3000 BCE (5,950-4,950 cal BP) sea lion and horse mackerel were predominate protein sources. Later circa 3000-1400 BCE (4,950-3,350 cal BP) the preferred protein sources changed to include sharks, birds, and anchovies (Bonavia, 1982; Leon, 2014).

Avifaunal remains at the site include guano birds (e.g., penguins, pelicans, cormorants, and boobies), gulls, rails, sandpipers, and petrels (Bonavia, 1982). Bonavia attributes changes in dietary preferences during the occupation of Los Gavilanes to the gradual settling of the Peru Current to cooler temperatures, similar to modern conditions. By this point in time, El Niño events would have been occurring at low frequencies (Sandweiss, 2004).



Figure 25. Initial period sites included in this analysis.

5.3 Initial Period (Figure 25)

5.3.1 Huaca Prieta

First excavated in 1946 by Junius Bird, Huaca Prieta is situated in the Chicama valley and contains Early ceramic components, with a greater predominance of Late Preceramic and Initial Period components (Bird et al. 1985; Dillehay, 2017). Since at least 2006, excavations have continued under the supervision of Tom Dillehay (McTavish, 2013). Occupation of the site was not solely domestic, with some contexts suggesting ritual and feasting activities (Dillehay, 2017; 197). Maritime subsistence strategies are apparent in the archaeological assemblages from this site and its intentional location near multiple resource zones (e.g., freshwater, coast, wetlands) ensured long term access to these resources (Bird et al., 1985; Dillehay, 2017; McTavish, 2013). Industrial crops including gourds and cotton were present and used in the production of textiles, fishing gear, and storage. Marine themed motifs decorated textiles encountered here (McTavish, 2013: 22).

Subsistence materials at the site included both plant cultigens, including squash, avocado, and chilies, as well as marine resources, including fish, shellfish, sea mammals, and guano birds (Dillehay, 2017; McTavish, 2013). These resources have also been found in ritual contexts (Dillehay, 2017: 197). Wetland resources were the most abundant with most fish being sourced to nearby lagoons and birds being sourced from colonies along the littoral as well as the lagoons (Dillehay, 2017: 364). Birds appear to have been consistently abundant and were likely easily captured using nets or clubs.

Avifaunal remains at this site include both marine and wetland birds but were predominantly marine. Guano birds were the most encountered species, likely because they could be found nearby in sizable colonies and could be taken easily. Phase 3 (6,538-5,308 cal

BP; 4408-2157 BCE) exhibited the highest number (n=156) of Guanay Cormorant compared to earlier and later phases. Gulls were also at their highest during Phase 3 with a total of n=185 (Dillehay, 2017: 359). While Peruvian Pelican were not present in the late Pleistocene, they were by the early Holocene with the highest number (n=45) encountered during Phase 4 (5,308-4,107 cal BP; 3358-2157 BCE).

Phase 3 at Huaca Prieta is coincident with El Niño's return from hiatus ca. 5,800 cal BP (see Figure 2, Appendix A). The consistent presence and abundance of marine resources at the site, however, suggests relatively stable access to these resources despite El Niño disturbances. This makes drawing a connection between avifaunal abundance and El Niño difficult. Whereas the higher presence of guano birds during and post-Phase 3 *could* be associated with the return of El Niño events, perhaps because of event-related windfalls, or alternatively, post- El Niño flourishing of marine PP (e.g., return of fish stocks), it is probable that marine resources during this time are abundant due to stabilized environmental conditions (e.g., cool SSTs, low frequency ENSO; see Figure 2). Further study is needed to draw stronger conclusions; however, it is enough for now that there could be a positive (e.g., increased presence of guano birds) association between avifaunal consumption and the return of El Niño at this site.

5.3.2 Pampa de las Llamas-Moxeke

Situated in the Casma Valley, Pampa de las Llamas-Moxeke lies between the Casma River to the south and the Sechín River to the North (Pozorski and Pozorski, 1986). In this drainage, the site covers an area of 220 ha and dates to between 1800 and 900 BCE (3,750-2,850 cal BP). The site comprises two large opposing mounds (Moxeke and Huaca A) with several plazas in between. Their construction has been attributed to corporate labor, with their large size suggesting an association with centralized authority (Pozorski and Pozorski, 1986: 383). Further

interpretation of the mounds suggests that Moxeke served as a seat of ideological power/religion while Huaca A served more utilitarian and communal purposes facilitating the storage and distribution of commodities.

During the 1980 field season, recovery of floral and faunal material was the prime operation carried out. Pozorski and Pozorski (1986) report a strong marine focus with abundant shellfish and fish. There was no specific mention of birds, though further probing is needed to obtain the necessary data. Evidence of the first land mammal use in the form of a small mammal bone as well as white-tailed deer bones was also present. Plant remains included cotton (seeds and fibers), gourds (seeds and rinds), lucuma and peanuts. Other fruits and tubers were also present but occurred much less frequently.

5.3.3 Gramalote

Located on the northern coast of Peru about 1 km south of Huanchaco, a traditional fishing village in the Moche Valley, Gramalote sits atop a 13 m high marine terrace and covers an area between 2.6 - 3.5 hectares (McTavish, 2013; Pozorski, 1976; Prieto, 2014). It was occupied between 1500-1200 BCE (3,450-3,150 cal BP) (Prieto, 2015). The site is a domestic settlement with various occupational phases split between two sectors. There is no monumental architecture associated with this site. Its name is associated with a type of native grass (salad-grass) abundant in the area that traditionally serves as an indication of a high water table. Its location allows access to a variety of environments such as lomas, dry forests, marshlands, and rocky/sandy beaches.

The avifaunal component of the assemblage from Prieto's excavations amounted to an NISP of 8,860; that contributed an estimated 9% of the meat weight consumed at the site (Prieto, 2015). As such, Prieto rates birds among the top 3 sources of protein at the site (especially

Guano birds). In contrast, Pozorski (1976) estimated around 6.3 %. (527.5 g) in her zooarchaeological analysis of this site. Pairing this with ethnographic evidence, Prieto suggests that birds were likely only eaten on special occasions or when captured because of fishing activities rather than as part of the regular diet. McTavish's (2013) analysis of Unit 18A resulted in the identification of an additional 14,542 vertebrate remains to class, with birds amounting to 3,035 of the NISP. There was a larger number of birds identified in McTavish's study compared to Pozorski (1976), however Pozorski's bird IDs were at a disadvantage due to the lack of a comparative collection at the time of her analysis.

Pozorski attributes much of the seabird remains found at Gramalote to be the result of accidental bycatch during gillnet fishing (Pozorski, 1976; Prieto, 2015). However, Prieto (2015: 821) posits that the amount and variety of avifaunal remains at Gramalote indicate more intentional capture using selective criteria. For instance, he notes that a small percentage of the species captured (e.g., terns, petrels, hawks, and condors) would not have been captured so easily in the context of gillnet fishing.

Alternatively, depending on what was going on environmentally at the time (e.g., El Niño conditions), some of these more difficult species could have been in a state of health that made them more docile and thus easier to procure. Prieto (2015: 822) also notes the presence of very young individuals amidst the assemblage, which could indicate intentional capture from breeding colonies. The immaturity of the birds could also indicate inexperience near human fishing activities resulting in being unintentionally captured. A potential connection to El Niño could exist here as well, wherein the immature birds are present in the Gramalote assemblage because of the ease of capture associated with juveniles being in a weakened state, under-experienced

around humans, or abandoned by their parents. More research is needed to move this last possibility beyond the realm of conjecture, however.



Figure 26. Early Horizon sites included in this analysis.

5.4 Early Horizon (Figure 26)

5.4.1 Caylán

The urban center of Caylán (800 – 1 cal. BCE; 2,750-1,951 cal BP) was the largest in the Nepeña Valley during the Early Horizon (Warner, 2014). Situated approximately 15 km from the Pacific Ocean on a pampa 105-150 masl between the twin peaks of Cerro Caylán. The site comprises 50 ha at its “monumental core” but extends approximately 200 ha. The core is comprised of over 40 house compounds grouped into four main quarters. Stone structures scatter the north end of the site and likely served as low status residential groups (Warner 2014: 39).

Despite the relatively long occupation of the site, animal remains amounted to a small quantity (~1.32 kg) of the overall materials recovered by Warner at Caylán. Warner notes that animal remains are scattered about the outside of the city in open-air middens. The remains likely represent butchering activities or trash pits, with some evidence of textile production (e.g., hair, hides). Warner (2014: 52) notes that the most odorous remains would also have been discarded further from residential areas. The low amount of remains could also be the result of the testing strategy employed by Warner, wherein 16 test pits, 6 units, and 1 looter’s pit were excavated.

Avian remains at the site were minimal, but most abundant in TP1 and TP4. Birds were present at all of the testing locations and were often encountered in association with fish remains. Whether or not the bird remains were identified to species is unclear, as these data are not published. Permission from the author will be necessary to obtain the missing data. At the very least, the evidence presented here confirms the continued presence of birds in midden context/coastal diets. Moreover, the consistent presence of food items suggests relatively stable

conditions, despite sporadic El Niño events, during its occupation (Sandweiss and Maasch, 2020).

5.4.2 Samanco

Samanco, near the shore in the Nepeña Valley, dates to the middle of the first millennium BCE, encompassing both the Initial Period and the Early Horizon (Helmer, 2015). This period coincides with the onset of intensified agriculture and the introduction of animal domestication on the coast. The site covers 20 ha at its monumental core, with an additional 2-3 ha of residential areas. It was located 2 km from the Pacific coast along the northern border of the Nepeña River Valley. During its occupation Samanco flourished as a result of its access to rich marine resources and agricultural products. Animal husbandry activities also supported the economy of the town.

Today, as in the past, Samanco is a fishing community. Stable access to marine resources, supplemented by agriculture and animal husbandry was key in ancient Samanco. Animal remains at the site include birds, dogs, camelids, guinea pigs, sea lion, deer, and marine otter. Rodents (NISP: 1178) and reptiles (NISP: 29) are also present on site, but they could be intrusive and not necessarily associated with any archaeological contexts. The avifaunal assemblage at Samanco makes up the largest percentage (55.69%) of the total faunal assemblage, with an NISP of 670 (not including an additional 148 unidentified bird remains).

The bulk of the avifaunal assemblage is comprised of seabirds including guano birds, gulls, terns, and petrels. According to Helmer (2015:74) these can be accessed from a large estuary due west of the site. Among these, Guanay Cormorant was the most abundant species, amounting to 19% of the total avifaunal assemblage. The large number of Guanay Cormorants in the avifaunal assemblage could point to El Niño-related activity. This is bolstered by evidence

(intrusive presence of warm water marine species) of an El Niño event at nearby of Puemape during the same period (Helmer, 2015: 13). Interestingly, Helmer notes that despite the evidence of animal husbandry and other domesticates (dog, llama, guinea pig), Muscovy duck are absent from this site.

5.4.4 Huambacho

Huambacho was an elite center situated in the lower Nepeña Valley and dates to around 800-200 cal BCE (2,750-2,150 cal BP). It rests 8 km from the Pacific Ocean on the southern margin of the Nepeña river around 65 masl and is bordered by hills to the south and east. It is comprised of two discrete enclosed compounds with benched plazas, raised mounds and colonnaded patio rooms (Chicoine, 2011). Excavations at the site suggest that many of the architectural contexts examined were used to hold feasts.

The presence of maize in addition to camelids substantiates interregional trade interactions and marks a change in coastal economies. Chicoine attributes this change to the fall of the Initial Period centers. Vertebrate food remains at the site predominately consist of camelids, with fewer numbers of rodents, fishes, and birds. Mollusks and crustaceans made up the highest amount of food remains, totaling around 20,000 fragments and an MNI of 11,274. Bird remains constitute a mere 4.23% of the total vertebrate assemblage, with a total NISP of 55 (Chicoine, 2011). This low number has been attributed to bone size and fragility, which can restrict what is recovered archaeologically. Chicoine notes that the avifaunal assemblage includes both domestic and non-domestic species, however a species breakdown is not provided.

While there is very little evidence to suggest El Niño activity in the area, one striking feature of the Huambacho faunal assemblage is the high number of rodents present, which amount to a whopping 35.69% of the total vertebrate assemblage. The lack of clarity on whether

these rodents are guinea pigs allows for a potential connection to the oft-reported influx of rodents that plague the coast shortly after El Niño events (Alcocer [1580] in Huertas-Vallejos, 2001; Jaksic et al., 1997). More evidence is needed to support this connection, especially as guinea pig domestication and husbandry were common by this point and the consumption of guinea pig is frequently associated with special and ritual occasions (Leon, 2013: p. 75), which would make sense for this site.



Figure 27. Early Intermediate period sites included in this analysis.

5.5 Early Intermediate Period (Figure 27)

5.5.1 Huacas de Moche

The Huacas de Moche are situated approximately 5 km from the ocean, south east of Trujillo and were occupied during the Early Intermediate Period (between 200-600 CE; 2,150-2,550 cal BP) (Rosello et al, 2001). The site comprises two large adobe mounds (Huaca del Sol and Huaca de la Luna), a subterranean burial platform, and both high and low status residences (Pozorski, 1976: 24). Prior to this study, it was suggested that substantial tectonic uplift along with an overexploitation of marine resources led to a sharp decrease in the consumption of marine items by Moche times.

Faunal assemblages from this site contain significant evidence of domesticated llama husbandry and consumption, but marine resources are also present (Pozorski, 1976). Pozorski (1976) calculated that bird remains amounted to less than 1 percent (~35 g) of the total meat consumed here. Plant remains and cultigens are also present at the site.

In Rosello et al.'s (2001) subsequent zooarchaeological analysis of this site, the Peruvian *Donax* clam made up 81 percent and hake contributed 4 percent of the total MNI. Consumption of booby (MNI 4), gulls (MNI 5), and cormorant (MNI 5) is evident, though in lesser amounts than the primary species noted above. Based on the assessment of this assemblage, Rosello et al (2001) concluded that there was no evidence to support El Niño activity, rather the species in the assemblage indicate normal conditions.

5.5.2 Huaca Gallinazo

Comprised of clustered mounds about 4 km from the Pacific Ocean, Huaca Gallinazo was the capital of the Virú polity (Johns, 2017). It is the largest mound of the Huaca Gallinazo group and has architecture featuring decorative elements including friezes, painted walls, and niches.

Huaca Gallinazo was occupied between 100 BCE-700 CE, (2,050-2,650 cal BP) and was likely contemporary with Huaca Santa Clara (Johns, 2017).

The faunal assemblage at Huaca Gallinazo is comprised of a mix of both wild and domesticated mammals and birds, as well as a variety of fish and shellfish. Marine resources predominated in the faunal assemblage, likely due to the site's close proximity to the ocean (Johns, 2017; Venet-Rogers, 2013). The avifaunal assemblage comprises the usual fare such as guano birds, as well as some unusual species including Peruvian Meadowlarks (*Sturnella bellicosa*) and Great Horned Owls (*Bubo virginianus*) (Venet-Rogers, 2013). Johns (2017) suggests that songbirds, such as the Peruvian Meadowlark, might have been kept as novelties or pets. As for seabirds, guano producers (e.g., cormorant, boobies, penguin) were consumed at both Huaca Gallinazo and Huaca Santa Clara, with boobies being the most prevalent at both sites.

Despite the sizable number of seabirds represented in the Huaca Gallinazo assemblage, there is very little evidence to suggest ENSO activity played a part in the availability of the resources exploited. Rather, it is more likely that the number of birds encountered at Huaca Gallinazo is the result of its proximity to prime breeding and nesting areas. One El Niño connection that could conceivably be made relates to the high number of boobies and sardines, and the absence of anchovy. Sometimes warm SSTs, such as those associated with El Niño events, cause anchovy populations to decline, making way for sardines to take over in predominance (Alheit, 2009; Alheit and Niquen, 2004; Sandweiss et al., 2004). Since boobies consume a wider variety of pelagic resources than the other guano birds, the transition to sardines may be easier for this species, allowing them to thrive while others depart or perish.

More research is necessary to substantiate this idea, making Huaca Gallinazo a good candidate for continued study.

5.5.3 Huaca Santa Clara

Built on Cerro Cementerio, Huaca Santa Clara lies in the lower Virú-Valley and is comprised of seven sectors (3 administrative) with small rooms laid out in a honeycomb pattern and residential sectors on both mid-and low level terraces (Johns, 2017). Radiocarbon dating at the site places occupation between 200 BCE (2,150 cal BP) and 800 CE (2,750 cal BP). The site served as an administrative center and defensive barrier and was surrounded by irrigation canals.

Occupational phases at the site were relatively short. Because refuse was disposed of away from living areas, faunal assemblages are small. Therefore, Johns's (2017) investigations required grouping of faunal materials from each level within a sector. The faunal assemblage at Huaca Santa Clara was similar to that of Huaca Gallinazo in types of resources used, however Huaca Gallinazo contained higher amounts of marine resources. In contrast, Huaca Santa Clara contained more domesticated species (e.g., camelids, guinea pigs) in its assemblage.

Additionally, more terrestrial protein sources (e.g., white tail deer) were present in Huaca Santa Clara's assemblage.

The avifaunal assemblage at the site is similar to that of Huaca Gallinazo as well, however the latter contains more avifauna overall. Boobies were also the most prevalent species at Huaca Santa Clara with gulls being the next most abundant. Guanay Cormorant and Humboldt Penguin are also among the top four avifaunal species present at the site, but these are also lacking in quantity compared to Huaca Gallinazo. Again, this is to be expected due to the difference in proximity to the ocean. Since Huaca Santa Clara lies further inland, reliance on mammals was more important than marine resources. Additionally, the fish assemblage at Huaca

Santa Clara suggests different fishing strategies than that of Huaca Gallinazo, with fewer pelagic resources represented at the former (Johns, 2017: 75).

Like Huaca Gallinazo, there is not enough evidence to suggest ENSO activity played a role in the makeup of the faunal assemblage. However, perhaps due to the heavier reliance on terrestrial and domesticated resources at Huaca Santa Clara, occupants of this location might have had a buffer against El Niño impacts. Comparatively, occupants of Huaca Gallinazo might have fared worse due to their heavier reliance on marine resources, most of which are adversely impacted by El Niño events.



Figure 28. Middle Horizon sites included in this analysis.

5.6 Middle Horizon (Figure 28)

5.6.1 Galindo

Located about 20 km inland, east-northeast of Trujillo, the Middle Horizon site of Galindo (700-800 CE; 2,650-2,750 cal BP) covers approximately 6 km sq (Lockard, 2005, 2009; Pozorski, 1976, 1979). The site is among the largest extant sites in the Moche Valley and comprises six distinct areas delineated by walls and ditches. Excavations by Lockard took place in the early 2000's in at least two low status Moche residences as well as three Chimú residences and two moderate-status Moche residences. Additional excavations occurred within the plazas of Huaca de las Abejas (Lockard, 2009: p. 283). Excavations by Pozorski took place in shallow hearths found in domestic contexts. A total of seven of these deposits were sampled (Pozorski, 1976: 26). Preservation at the site is complicated as many of the hearths were not deposited deeply and were subject to moisture exposure.

Pozorski (1979: 177) reports a heavy reliance on camelids for protein, with all other protein sources considered “incidental” or supplemental. Pozorski's (1976) work also suggests that birds made up a very small amount of this supplemental protein, with pelican being the only identifiable species and the quantity of remains not given save an estimated less than 1% (Pozorski, 1976; 347). The faunal assemblage examined by Lockard (2005) contains more marine resources, but camelids remain the most prevalent protein source. The avifaunal assemblage examined by Lockard also seems more robust, however most bird species apart from Guanay cormorant (3.6%) amounted to less than 1% of the total NISP (Lockard, 2005: p. 152). Only 3 species of bird were identified and include Melodious Blackbird, gull, and Guanay Cormorant.

Nothing reported in these two studies suggests the presence of El Niño activity at the site. Given the heavy focus on domesticated food sources (both faunal and botanical), avian resources appear to be slowly falling out of some coastal Peruvian diets. Marine resources continue to be present but, at least at this site, in comparatively lesser quantities. This is likely a result of Galindo's inland location. The diversification of food resources likely provided food security whenever environmental conditions placed constraints on resources.

5.6.2 Hatun Cotuyoc

Hatun Cotuyoc is the residential sector of a Wari colony (Huaró) within the Cusco region occupied between 1,350-950 cal BP (3300-2900 BCE) (Turner et al., 2018). The Cusco region rests 3-4,000 masl and spans several ecozones. Pollen records indicate a continuous history of human activity in the area for at least 6,000 years. Additionally, paleoclimatic surveys of the area suggest climatic changes around 1,450 cal BP (3400 BCE) as well as 900 cal BP (2850 BCE) that may have led to cultural shifts (Turner et al., 2018: 138). During Hatun Cotuyoc's occupation, conditions were wetter, facilitating the cultivation of various resources. Here, isotopic analysis of human bone and enamel reveals the bulk of the protein resources consumed at the site were comprised of domesticates (faunal and botanical), with some fish (Turner et al., 2018).

Birds did not register in the results from this site, further exemplifying the focus on other sources of protein. Since subsistence was inferred from isotopic analyses, there is no faunal data available from this site, at least not anything currently published. I include this data to show the shifting of subsistence efforts away (though not completely) towards domesticated sources. Future work might seek to test for faunal data to compare isotopic results with zooarchaeological evidence.

5.6.3 Ak'awillay

The village site of Ak'awillay is also situated within the broader Cusco region and was occupied during a period dominated by Wari, and to a much lesser extent, Tiwanaku, influence (ca. 1,350-950 cal BP; 600-1000 BCE)(Turner et al., 2018). A contemporary of Hatun Cotuyoc, Ak'awillay was occupied under the same wet climate. Specific zooarchaeological data were not provided for this site, rather bioarcheological analysis reveals a strong reliance on camelid meat with tubers and beans making up the remainder of resources identified. Similar to Hatun Cotuyoc, further testing needs to be done to determine the presence of fauna at the site.



Figure 29. Late Intermediate period sites included in this analysis.

5.7 Late Intermediate (Figure 29)

5.7.1 Chan Chan

Covering an approximate 6 square-kilometers, the Chimú capital of Chan Chan (1000-1532 CE; 2,950-3,482 cal BP) is situated south-west of Trujillo. Architecture at the site was constructed using adobe, tapia (tamped rocks and soil), and cobbles. Many of the structures were associated with administrative activities, with housing structures situated between compounds and artisan sectors (Pozorski, 1979: 177). The faunal assemblage contains an abundance of mollusks and fish with minimal bird remains present (~30 g, 3% total meat consumed). Domesticates such as llama and guinea pig make up over half of the meat consumed at the site (Pozorski, 1976). Plant remains and cultigens are also present.

5.7.2 Caracoles

Comprising a small ovular refuse deposit overlooking the ocean near the border of the Moche-Chicama Valley, Caracoles is a Late Intermediate Chimú (with some Inca influence) site. Pozorski (1979: 178) suggests it was a temporary work camp used during the construction of a nearby cemetery and two roadside way stations. The faunal assemblage at Caracoles is composed of mollusks, fish, birds, and mammals. Plant remains and cultigens are also present at the site. Avifaunal remains comprised 8.9% of the total meat consumed in Pozorski's (1976) study, with pelican being the only species identified as well as the most prevalent avifaunal resource.

5.7.3 Cerró la Virgen

Cerró la Virgen is situated 5 km north of Chan Chan, to which it is connected via a road, and approximately 2 km from the ocean (Pozorski, 1979). Subsistence refuse at the site includes mollusks, fish, birds and mammals, plus a small amount of reptile remains. Plant remains and

cultigens are also present at the site. Bird remains make up less than 1 percent (3.8 g) of the total meat consumed.

5.7.4 Cerro Azul

Cerro Azul is a fishing community within the kingdom of Huarco, located in the lower Cañete Valley, 130 km south of Lima (Marcus, 1987). Situated in a saddle between Cerro del Fraile, Cerro Centinela, and Cerro Camacho, Cerro Azul comprises an 80,000 m² sprawl of buildings (Marcus 1987). In 1984, two residential compounds were excavated by Joyce Marcus and a team of archaeologists. Radiocarbon dates from this site provide an occupational date range of 1305-1623 CE (3,255-35.73 cap BP).

Middens at the site were analyzed, revealing a faunal assemblage consisting of predominantly marine resources such as fish, seabirds, and sea mammals (Marcus, 2016; 2020). The avifaunal assemblage reveals an extremely rich variety of both marine and inland plain species. Guanay Cormorant were the most prevalent species of bird found throughout Cerro Azul's occupation in both elite and non-elite residences. Guano birds in general were the most prevalent in the assemblage, with small amounts of dove, duck, gulls and rails. Marcus notes that these and other birds were likely hunted with slings and bolas. Additionally, scant domesticated chicken remains are associated with the 16th century Spanish occupation of the site (Marcus, 2016: p. 185).

After the El Niño of 1983, Marcus (2015) and her team noted a massive number of weakened and perished guano birds that were scattered about the beaches of Cerro Azul. Given the high number of guano birds present in the faunal assemblage, one might reasonably suspect the influence of El Niño. Marcus et al. (2020) examined fish remains collected from Cerro Azul to determine whether the assemblage represented normal (cool) or ENSO (warm) conditions.

Based on their findings, however, they determined there is little evidence for ENSO events apparent in the assemblages. Even so, one cannot deny the possibility that massive ENSO-related bird and fish die offs would have benefitted industrious coastal inhabitants. Something that might be interesting to explore is whether massive die off events happen multiple times in the same location. Referring Table 5 and Figure 6, one can see that there have yet to be any recurring die-offs in any one area.



Figure 30. Late Horizon sites included in this analysis.

5.8 Late Horizon (Figure 30)

5.8.1 Lo Demás

The site of Lo Demás lies in the Chincha Valley of Peru. Historic records and artifacts place the time of occupation during the Inca Period between 1480 and 1540 CE (3,430-3,490 cal BP). Archaeological investigations examining the economic organization of fishing in the coastal colony of the Inca took place in 1983-1984 (Sandweiss, 1992; Sandweiss and Wing, 1997). The faunal assemblage at this site was dominated by pelagic fish, particularly sardine and anchovy which made up 91.2 percent of MNI. The large quantities of these specimens suggest a shift from a cool anchovy regime to a warmer sardine regime at about 1500 CE (Sandweiss et al., 2004).

The most interesting faunal remains at Lo Demás were the mummified guinea pigs which were associated with ritual activity. In addition, two intact birds were discovered indicating additional ritual activity at the site (Sandweiss and Wing, 1997). Both birds were placed in unusual locations, one in a wall and one in a pit under a use-floor. Wild birds are commonly sacrificed in ritual according to ethnohistorical accounts, and it is probable that was the intention here.

Other avifaunal remains at the site (reported as NISP) were dominated by marine species including cormorant, pelican, and gulls (Sandweiss, 1992). However, additional data from my ongoing analysis of a previously unprocessed column sample excavated by Daniel Sandweiss during the 1983-84 field season has thus far yielded very few avifaunal bones (NISP = 4). Feathers are also present in the assemblage, which may prove useful should stable isotope analysis be undertaken in the future.

5.8.2 Carrizales

The site of Carrizales is comprised of several domestic occupations and associated cemeteries situated at the mouth of the Rio Carrizal. The seasonal waters of the Rio Carrizal are brackish and access to fresh water is 5 km to the north near the Rio Zaña (Kennedy and Van Valkenburgh, 2016). Site occupation begins as early as the Early Intermediate Period from 200-750 CE (2,150-2,700 cal BP) and continues through the early part of the colonial era. Despite being the largest settlement in the lower Zaña Valley, Carrizales lacks monumental architecture and is instead associated with maritime domestic contexts and burials (Kennedy and Van Valkenburgh, 2016).

The faunal assemblage from Carrizales is derived from two sectors, one from a planned colonial town established by the Spaniards between 1566-1572 CE that was abandoned around three decades later (Conjunto 123), and another from an earlier prehispanic fishing village (Conjunto 125) that dates to around 1150-1350 CE (3,100-3,300 cal BP) (Kennedy and Van Valkenburgh, 2016: 75). Evidence from these assemblages suggests that a fundamental reorganization of subsistence practices occurred after the arrival of the Spaniards. Both assemblages contained mammals, fish, and birds and included wild and domesticated taxa. Prior to the arrival of the Spaniards the domestic economy of Carrizales was largely based on marine resources with supplemental resources obtained through the hunting of wild animals (e.g., deer, cormorant, booby)(Kennedy and Van Valkenburgh, 2016: 94). After the arrival of the Spaniards and the forced displacement of Indigenous Peruvians, the subsistence economy at the site expanded to include a variety of Eurasian domesticates (e.g., chickens, geese, horses), with a refocusing of resource procurement from fishing activities to predominantly hunting activities.

As one might expect, avifauna varied between the two loci, with a heavier reliance on domesticated birds including chickens, ducks and geese associated with the colonial occupational context. Both sites exhibit scant quantities of identified seabirds with NISP = 28 during the prehispanic occupation and NISP = 24 during the colonial period. Many birds were not identified to species, amounting to an NISP of 239 in the prehispanic assemblage and an NISP of 630 in the colonial assemblage. Overall, birds comprised 1% of the total prehispanic faunal assemblage and 13% of the total colonial period faunal assemblage.

There is no evidence in the faunal assemblage of Carrizales that suggests El Niño activity. However, a mere 6 years after the latest date given for Conjunto 123 (ca. 1572 CE), the Spanish experienced their first large magnitude El Niño event in 1578 CE (Alcocer [1580] in Huertas-Vallejos, 2001). The aftermath of this devastating event was later recorded in 1580 CE by Francisco de Alcocer, a royal scribe, as he traveled along the coast of Peru to investigate the event at the request of the Spanish Crown (Huertas-Vallejos, 2001).

The result of these investigations is a transcription of the hearings conducted at various locations on the coast of Peru. Indigenous coping strategies can be gleaned from the testimonies, albeit constrained by Spanish rule and the encomendero system which placed Spanish lords in charge of displaced populations of Indigenous Peruvians residing in forced resettlements. Additionally, the Spaniards appropriated a form of the tribute system that was in place during Inca rule, forcing the indigenous population to provide goods, labor, and other services. Traditionally, this would have been done with the expectation that Inca rulers reciprocated and offered protection to those participating in tribute activities, however the Spaniards took a more exploitative approach (Copson and Sandweiss, 1991).

As seen in the testimonies, many of the coping strategies employed by the Indigenous population at this time involved migrating away from inundated areas, replanting destroyed crops, and selling remaining goods (e.g., livestock, crops, textiles) and services (e.g., labor) at a much lower price point than under normal conditions (Copson and Sandweiss, 1991; Alcocer [1580] in Huertas-Vallejos, 2001).

Though there is little to no mention of marine avifauna reacting to these events, terrestrial avifauna (species not provided) and other pests (e.g., rats, locusts) came in droves, plaguing fields and eating whatever crops were available in the aftermath of the event. This presented yet another hurdle for Indigenous populations, setting back any progress their agricultural endeavors would have yielded. Continued examination of Alcocer's work is ongoing with future potential lying in the testing of sites (huacas) identified in the text.

5.9 Bird's Eye View: Avifaunal Consumption Through Time

While archaeological sites do not provide exact representations of environmental conditions, they do reflect decisions made by their human occupants. Since patterns of animal use can be indicative of the environment in which they occur, changes to subsistence strategies can sometimes be attributed to changes in the local environment (Reitz and Wing, 1999). Furthermore, if a specimen is found outside of its usual habitat range and other mechanisms of transport are not associated with its presence in an assemblage, it could be that environmental conditions instigated a migration.

Throughout coastal Peruvian history birds have consistently been a part of the diet, albeit in different quantities at different times and places. The Preceramic Period coincides with a series of environmental shifts as coastal climates cooled to modern conditions. Coastal occupants at this time exhibited a strong marine bias, foraging in near-shore environments at first and

eventually venturing further to sea. Based on this exploratory analysis, Preceramic sites (encompassing all stages: early, middle, and late) seem to reflect the highest consumption of birds of any other period. This is no surprise as whole colonies birds would have been amply available along with foragable mollusks and nearshore fish. Using even the most rudimentary of clubs or slings would have likely yielded successful results, especially as many seabirds do not exhibit the same intimidation as other birds in the presence of humans.

By the Initial Period, environmental conditions had stabilized to modern conditions and coastal occupants exhibited a mastery of their local ecology, diversifying their diets and introducing industrial cultivars such as cotton and gourd. These advances contributed to intensified exploitation of marine resources. Avifauna continue to be consumed in seemingly large quantities. This could reflect the advancement in tools such as nets and floats, as well as advancement in fishing vessels (e.g., reed boats) which allowed for excursions into deeper waters. Additionally, it is likely that the quantity of birds eaten may also reflect the growing human population consuming them.

Birds seem to make up less of the diets of coastal Peruvian societies as time progresses (see Figure 36 below). Their importance as guano producers and environmental indicators, on the other hand, likely remained consistent. It would follow that with the rise in agriculture comes more of an awareness of climate and climate disturbances. Perhaps early coastal Peruvian societies formed their own almanac-like understanding of local environments and climates, including observations of the non-human world as part of their tool kit for success.

Diversifying their diet through plant and animal domestication no doubt improved chances of survival during instances of environmental uncertainty. The shift in a heavy reliance on marine resources to a heavier reliance on domesticates indicates that as civilizations grew,

proactive steps towards reducing food insecurity became even more crucial. Where El Niño events may wipe out marine resources and or wash away agricultural fields, having stores of each of a variety of resources certainly would not have hurt one's resilience to these events.

Moreover, avifaunal consumption during the Late Intermediate and Late Horizon might have been higher if not, at least in part, due to the strict regulations placed on guano and guano bird extraction by the Inca. As mentioned in Chapter 4 (section 4.3.3), at the risk of penalty of death, it would not have been wise for anyone to participate in any unsanctioned capture of guano birds or guano harvesting (Rodrigues and Micael, 2021). Given that the Inca were highlanders with limited experience of coastal conditions and ecology, their strategies to maintain the populations of guano birds were likely learned from coastal people incorporated into the Empire. If this is so, then restrictions on guano bird hunting very likely are much older than the time of the Inca.

Despite the limitations associated with the data presented (see Chapter 1, section 1.2), birds were inextricable from the lives (and diets) of coastal Peruvians. In the following chapter, I conclude this thesis with a brief discussion on potential future work.

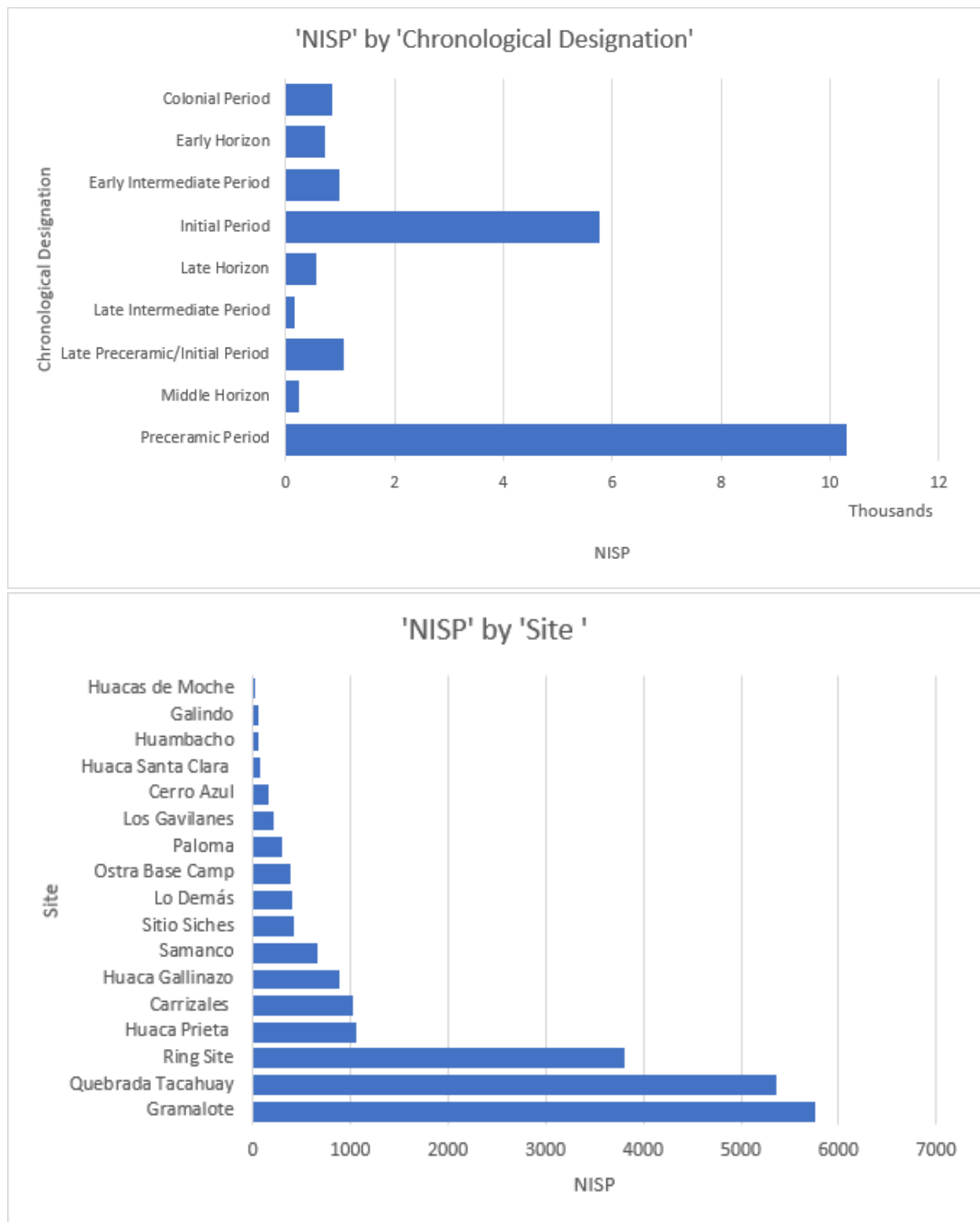


Figure 31. Collective results of the meta-data analysis showing the relative quantities of published avifaunal data by chronological period (top) and site (bottom).

CHAPTER 6

CONCLUDING REMARKS AND FUTURE RESEARCH

The hypotheses and connections presented here serve as a jumping off point for further research investigating past human-Aves-ecodynamics and archaeo-ornithological remains as environmental proxies. They also allow for the synthesis and improved understanding of avifaunal consumption in early Peruvian communities, which until this point has not been examined in much detail or over long time scales. Further research potential lies in determining the effects other El Niño flavors on subsistence practices.

Birds express a variety of responses to short term perturbations in their ecosystems, and El Niño is no exception. Considering the known effects each flavor has on precipitation and water resources what might we expect to see in avifaunal populations? During eastern Pacific and coastal El Niño events, increased SSTs and accompanying rains pose dangers for some species, particularly guano birds, which rely on healthy anchovy stock. Others, such as wetland species reap the benefits of flourishing vegetation and insects.

Around the onset of these events, coastal occupants might have noticed dwindling seabird populations, nest abandonment, or even die-offs, perhaps signaling impending changes. Archaeologically these events may manifest in the avifaunal assemblage as a high presence of juvenile or weakened adult remains, a high presence of nestlings or eggs, or a shift from a seabird-dominated assemblages to wetland bird-dominated assemblages as their populations prosper.

This, in conjunction with other archaeological/geological evidence (e.g., debris flows, shifting fish regimes, molluscan die-offs) can contribute to a more holistic understanding of

environmental contexts. For coastal events, evidence may be similar to Eastern Pacific events, albeit restricted to northern sites.

Conversely, during a central Pacific El Niño one might expect stable marine resources and increased aridity/drought-like conditions on land. The restriction of water flow as a result of these events could have cascading effects within wetlands systems, perhaps impacting wetland birds in a similar manner to marine birds during central Pacific events. Since there is still very little known about how these events impact organisms on land, making inferences about how they might manifest in a faunal assemblage is difficult. A safe assumption might be that the cool conditions of the Peru Current, unaltered by date-line warming, continues to support healthy marine resources remains while wetland resources struggle because of the weakened precipitation over the highlands and attenuated water flow/runoff to the coast.

Finally, since La Niña events are essentially amplified “normal” conditions, it is difficult to distinguish them from non-ENSO related climates. Faunal assemblages associated with La Niña likely contain cool-water adapted species of fish and mollusks with wetland avian species present in quantities “normal” for the site in question. The limited information surrounding La Niña conditions on land restricts our ability to apply known impacts to archaeological contexts, making this an important topic for further investigation.

Zooarchaeological and paleontological remains from recent and legacy collections can serve as novel resources for understanding environmental conditions. It is common to use data collected from fish otoliths or the sclerochronology of mollusk shells to infer environmental conditions. Avian remains or, more precisely, avian feathers are not commonly used in this sort of research. However recent advances in stable isotope analysis (SIA) have made it possible to

extract data from such sources, which can be used to infer not only environmental conditions, but also migrations and diet (Wiley et al, 2017).

Thanks to the excellent preservation of the arid Peruvian coast, feathers (and in some cases whole birds) have previously been recovered and, depending on one's ability to procure them for analysis, the potential for further understanding environmental conditions and migration patterns of avifauna is promising. For instance, performing SIA on some of the intact avifaunal remains recovered at Lo Demás, Quebrada Tacahuay, or Carrizales may yield interesting results.

Going beyond subsistence-based relationships with the non-human world provides a more complete/nuanced understanding of past human cultures. Visual and oral traditions offer windows into how people understand the world around them. These sources may also provide insight into or even describe or imitate the environmental conditions they were created/performed under. Naturalistic representations of plants and animals make it possible to piece together the environmental contexts in which the representations were produced. An initial exploration of this in relation to El Niño is currently underway by Dan Sandweiss (forthcoming; personal communication, n.d.) investigating Moche pottery for elements that could signal El Niño conditions.

In this thesis, visual and oral traditions served as a means of drawing connections between early coastal societies and the local avifauna. In future work, I aim to take this initial foray a step further by examining the types of avifauna represented and the contexts in which they are depicted in order to trace the evolution of human-Aves ecodynamics in coastal Peru. How do depictions of birds change over time? What might contribute to such change? What can the species depicted tell us about environmental conditions? Social relations? Cultural ideologies?

Another avenue of exploration that will undoubtedly provide a deeper understanding of environmental resilience and perhaps even methods for conservation and disaster mitigation, as related to ENSO, can be found in the realm of Traditional Ecological Knowledge (TEK) or Traditional Local Knowledge (TLK). As discussed previously, TEK/TLK offers place-based experiential data on ecological conditions from individuals who live within the region in question.

An original element of this thesis would have been an ethnographic study of artisanal fishermen in Peru to better understand how modern El Niño events affect their community, what mitigations they have in place in response to these events, and whether seabirds offer any signal of impending environmental change. Unfortunately, this was impeded by the COVID-19 pandemic. Nevertheless, as health conditions continue to improve, I seek to follow through with this original ethnographic work in the future. Additionally, in conjunction with historical resources, ethnographic research has the potential to provide a more detailed history of coping strategies in response to El Niño and how strategies might have changed through time as a result of colonization and more recently as a result of capitalism and global climate change.

While the ecological data inferred by examination of archaeo-ornithological materials can help paint a more wholistic picture of marine activities and conditions on the coast of Peru, there is still much to learn when it comes to human-Aves ecodynamics in this region. Continued exploration of these relationships should be expanded to include avifaunal data from other documented coastal sites not included in the meta-data analysis. Comparing human-Aves ecodynamics on the coast with the highlands might also provide interesting insights. What kinds of signals might birds from higher altitude habitats give in response to environmental changes? Can inferences be made based on what is known about the effects of El Niño on highland

environments? What species can survive the attenuated water flow due to reduced precipitation caused by El Niño? How do social changes (e.g., imperial expansion, public policy) affect avifaunal consumption?

While it seems probable that birds would have served as reliable environmental sentinels, more evidence is necessary to substantiate this claim. Using archaeo-ornithological remains as proxies for ecological conditions, or even El Niño events, is complicated by various factors (e.g., human agency, taphonomic processes, collection methods, etc.). Regardless, as part of the ecological snapshot of a site, avifauna have much to offer as sensitive actors within ecological systems and merit more attention than has been given in the past.

BIBLIOGRAPHY

Alaica, A. K. (2018). Partial and complete deposits and depictions: Social zooarchaeology, iconography and the role of animals in Late Moche Peru. *Journal of Archaeological Science: Reports*, 20, 864-872.

Alberti, B. and Bray, T. L. 2009. 'Animating Archaeology: Of subjects, objects and alternative ontologies'. Introduction, special section, *Cambridge Archaeological Journal* 19(3): 337–43.

Albuquerque, U. P., & Alves, A. G. C. (2016). What is ethnobiology?. In *Introduction to ethnobiology* (pp. 3-7). Springer, Cham.

Aguilar, R., Simeone, A., Rottmann, J., Perucci, M. and Luna-Jorquera, G. (2016). Unusual coastal breeding in the desert-nesting Gray Gull (*Leucophaeus modestus*) in northern Chile. *Waterbirds*. 39(1): 69–73.

Ainley, D. G. (1990). *Seabirds of the Farallon Islands: ecology, dynamics, and structure of an upwelling-system community*. Stanford University Press.

Alheit, J., & Niquen, M. (2004). Regime shifts in the Humboldt Current ecosystem. *Progress in Oceanography*, 60(2-4), 201-222.

Alheit, J. (2009) *Consequences of Regime Shifts for Marine Food Webs*. *International Journal of Earth Sciences* 98: 261–268.

Amat, J. A., & Green, A. J. (2010). Waterbirds as bioindicators of environmental conditions. In *Conservation monitoring in freshwater habitats* (pp. 45-52). Springer, Dordrecht.

Ancona, S., Calixto-Albarrán, I., & Drummond, H. (2012). Effect of El Niño on the diet of a specialist seabird, *Sula nebouxii*, in the warm eastern tropical Pacific. *Marine Ecology Progress Series*, 462, 261-271.

Andrus, C. Fred T., Douglas E. Crowe, Daniel H. Sandweiss, Elizabeth J. Reitz, and Christopher S. Romanek. (2002). "Otolith $\delta^{18}\text{O}$ Record of Mid-Holocene Sea Surface Temperatures in Peru." *Science* 295 (5559): 1508–11.

Angulo Pratolongo, F. (2009). Peru [Print]. In C. Devenish, D. F. Díaz Fernández, R. P. Clay, I. Davidson, & I. Yépez Zabala (Eds.), *Important Bird Areas Americas - Priority sites for biodiversity conservation* (Vol. 16, pp. 307–316). BirdLife International.

Aponte, H., Gonzales, S., & Gomez, A. (2020). Impulsores de cambio en los humedales de América Latina: el caso de los humedales costeros de Lima. *South Sustainability*, 1(2), e023-e023.

Armstrong, C. G., Shoemaker, A. C., McKechnie, I., Ekblom, A., Szabó, P., Lane, P. J., ... & Crumley, C. L. (2017). Anthropological contributions to historical ecology: 50 questions, infinite prospects. *PloS one*, 12(2), e0171883.

Arntz, W. (1986). "The Two Faces of El Niño 1982–1983." *Meeresforschung* 31: 1–46.

Arntz, W. E., & Tarazona, J. (1990). Effects of El Niño 1982-83 on benthos, fish and fisheries off the South American Pacific coast. Elsevier oceanography series, 52, 323-360.

Ashok, Karumuri, Swadhin K. Behera, Suryachandra A. Rao, Hengyi Weng, and Toshio Yamagata. (2007). "El Niño Modoki and Its Possible Teleconnection." *Journal of Geophysical Research: Oceans* 112 (C11). <https://doi.org/10.1029/2006JC003798>.

Aswani, S., Lemahieu, A., & Sauer, W. H. (2018) *Global trends of local ecological knowledge and future implications*. PLoS One, 13 (4).

Bakun, A., & Weeks, S. J. (2008, October). The marine ecosystem off Peru: What are the secrets of its fishery productivity and what might its future hold? *Progress in Oceanography*, 79(2–4), 290–299. <https://doi.org/10.1016/j.pocean.2008.10.027>

Baptista, L. F., P. W. Trail, H. M. Horblit, P. F. D. Boesman, and E. F. J. Garcia (2020). West Peruvian Dove (*Zenaida meloda*), version 1.0. In *Birds of the World* (J. del Hoyo, A. Elliott, J. Sargatal, D. A. Christie, and E. de Juana, Editors). Cornell Lab of Ornithology, Ithaca, NY, USA.

Baptista, L. F., P. W. Trail, H. M. Horblit, P. F. D. Boesman, and E. F. J. Garcia (2020). Eared Dove (*Zenaida auriculata*), version 1.0. In *Birds of the World* (J. del Hoyo, A. Elliott, J. Sargatal, D. A. Christie, and E. de Juana, Editors). Cornell Lab of Ornithology, Ithaca, NY, USA.

Baptista, L. F., P. W. Trail, H. M. Horblit, P. F. D. Boesman, E. de Juana, and E. F. J. Garcia (2020). Croaking Ground Dove (*Columbina cruziana*), version 1.0. In *Birds of the World* (J. del Hoyo, A. Elliott, J. Sargatal, D. A. Christie, and E. de Juana, Editors). Cornell Lab of Ornithology, Ithaca, NY, USA.

Baran, M. A. and M. G. Harvey (2021). Guanay Cormorant (*Leucocarbo bougainvillii*), version 1.1. In *Birds of the World* (T. S. Schulenberg, Editor). Cornell Lab of Ornithology, Ithaca, NY, USA.

Barber, R. T., and F. P. Chavez (1983) *Biological Consequences of El Niño*. *Science* 222:1203–1210.

Bawden, G., & Reycraft, R. M. (Eds.). (2000). Environmental disaster and the archaeology of human response (No. 7). Maxwell Museum of Anthropology.

- Béarez, P. (2000). Archaic fishing at Quebrada de los Burros, southern coast of Peru. Reconstruction of fish size by using otoliths. *Archaeofauna*, 9, 29-34.
- Beaudreau, A. H., & Levin, P. S. (2014) *Advancing the use of local ecological knowledge for assessing data-poor species in coastal ecosystems*. *Ecological Applications*, 24(2), 244-256.
- Begazo, A. (Ed.) (2022). Peru Aves. CORBIDI, Lima, Peru. [Online]. Available at <https://www.peruaves.org/bird-habitats> (Accessed: 2022)
- Bélisle, A. C., Asselin, H., LeBlanc, P., & Gauthier, S. (2018) *Local knowledge in ecological modeling*. *Ecology and Society*, 23(2).
- Bernier, H. (2019). Dualism in Andean Art. Heilbrunn Timeline of Art History.
- Bierregaard, R. O., J. S. Marks, and G. M. Kirwan (2020). Variable Hawk (*Geranoaetus polyosoma*), version 1.0. In *Birds of the World* (J. del Hoyo, A. Elliott, J. Sargatal, D. A. Christie, and E. de Juana, Editors). Cornell Lab of Ornithology, Ithaca, NY, USA.
- Bird, Junius, John Hyslop, and Milica D. Skinner, 1985, The Preceramic Excavations at Huaca Prieta Chi- cama Valley, Peru. *Anthropological Papers of the American Museum of Natural History*, vol. 62, part 1.
- BirdLife International (2022) Country profile: Peru. Available from <http://www.birdlife.org/datazone/country/peru> . Checked: 2022-09-22
- Bonavia, D. (1982). Los Gavilanes: mar, desierto y oasis en la historia del hombre: precerámico peruano. Corporación Financiera de Desarrollo, Oficina de Asuntos Culturales.
- Bray, Tamara L. (2009). An Archaeological Perspective on the Andean Concept of Camaquen: hinking hrough Late Pre-Columbian Orendas and Huacas. *Cambridge Archaeological Journal*, 19, pp 357-366. doi:10.1017/S0959774309000547. Available at: <http://digitalcommons.wayne.edu/anthrofrp/1>
- Brewer, J., & Riede, F. (2018). Cultural heritage and climate adaptation: a cultural evolutionary perspective for the Anthropocene. *World Archaeology*, 50(4), 554-569. doi:10.1080/00438243.2018.152724
- Britannica, T. Editors of Encyclopedia (2012, September 7). Southern Oscillation. Encyclopedia Britannica. <https://www.britannica.com/science/Southern-Oscillation>
- Brooke, M. D. L. (2002). Seabird systematics and distribution: a review of current knowledge. *Biology of marine birds*. CRC Press, Boca Raton, Florida, 57-85.
- Brown, M. (2016). *The Emergence of the Bird in Andean Paracas Art: c. 900 BCE-200 CE*. City University of New York.

Buckley, N. J., B. M. Kluever, R. Driver, and S. A. Rush (2022). Black Vulture (*Coragyps atratus*), version 2.0. In *Birds of the World* (P. G. Rodewald and B. K. Keeney, Editors). Cornell Lab of Ornithology, Ithaca, NY, USA.

Burger, Richard L., (2003). “El Niño, Early Peruvian Civilization, and Human Agency: Some Thoughts from the Lurin Valley.” In *El Niño in Peru: Biology and Culture over 10,000 years*, edited by Jonathan Haas and Michael O. Dillion. Fieldiana Publication 1524: 90–107. Field Museum of Natural History, Chicago, IL.

Burger, J., M. Gochfeld, G. M. Kirwan, and E. F. J. Garcia (2020). Belcher's Gull (*Larus belcheri*), version 1.0. In *Birds of the World* (J. del Hoyo, A. Elliott, J. Sargatal, D. A. Christie, and E. de Juana, Editors). Cornell Lab of Ornithology, Ithaca, NY, USA.

Burger, J., M. Gochfeld, E. F. J. Garcia, and P. F. D. Boesman (2020). Gray Gull (*Leucophaeus modestus*), version 1.0. In *Birds of the World* (J. del Hoyo, A. Elliott, J. Sargatal, D. A. Christie, and E. de Juana, Editors). Cornell Lab of Ornithology, Ithaca, NY, USA.

Burger, J. and M. Gochfeld (2020). Franklin's Gull (*Leucophaeus pipixcan*), version 1.0. In *Birds of the World* (A. F. Poole, Editor). Cornell Lab of Ornithology, Ithaca, NY, USA.

Cabello Valboa, Miguel. (1586) 2011. *Miscelánea Antártica* [Antarctic Miscellanea]. Ed. Isaías Lerner. Seville: Fundación José Manuel Lara.

Campbell, K. D. (2000). Fauna, subsistence patterns, and complex society at the El Brujo site complex, Peru. Masters thesis, Department of Anthropology, Northern Arizona University, Flagstaff.

Cárdenas, W. N., & Hurtado, Y. L. B. (2019). Variation of abundance and diversity of birds in Lucre-Huacarpay wetland, Quispicanchi/Cusco/Peru, during the period of "El Niño" 2015-2016. *Ecología Aplicada*, 18(2), 111-124.

Caramanica, Ari, and Michele L. Koons. (2016). “Living on the Edge: Pre-Columbian Habitation of the Desert Periphery of the Chicama Valley, Perú.” In *The Archaeology of Human-Environment Interactions: Strategies for Investigating Anthropogenic Landscapes, Dynamic Environments, and Climate Change in the Human Past*, edited by Daniel A. Contreras, 141–64. New York: Routledge.

Caramanica, Ari, Jeffrey Quilter, Luis Huaman, Fiorella Villanueva, and Claudia R. Morales. (2018). “Micro-Remains, ENSO, and Environmental Reconstruction of El Paraíso, Peru, a Late Preceramic Site.” *Journal of Archaeological Science: Reports* 17 (February): 667–77. <https://doi.org/10.1016/j.jasrep.2017.11.026>.

Caramanica, A., Huaman Mesia, L., Morales, C. R., Huckleberry, G., Castillo B, L. J., & Quilter, J. (2020). El Niño resilience farming on the north coast of Peru. *Proceedings of the National Academy of Sciences*, 117(39), 24127-24137.

Carboneras, C., F. Jutglar, G. M. Kirwan, and L. Kahle (2020). Peruvian Diving-Petrel (*Pelecanoides garnotii*), version 1.1. In *Birds of the World* (S. M. Billerman, T. S. Schulenberg, and B. K. Keeney, Editors). Cornell Lab of Ornithology, Ithaca, NY, USA.

Carboneras, C., D. A. Christie, and F. Jutglar (2020). Peruvian Booby (*Sula variegata*), version 1.0. In *Birds of the World* (J. del Hoyo, A. Elliott, J. Sargatal, D. A. Christie, and E. de Juana, Editors). Cornell Lab of Ornithology, Ithaca, NY, USA.

Carboneras, C., F. Jutglar, and G. M. Kirwan (2020). Sooty Shearwater (*Ardenna grisea*), version 1.0. In *Birds of the World* (J. del Hoyo, A. Elliott, J. Sargatal, D. A. Christie, and E. de Juana, Editors). Cornell Lab of Ornithology, Ithaca, NY, USA.

Cardenas, M., Vivar, J., Olivera, G., Huapaya, B. (1993). *Materiales arqueologicos del Macizo de Illescas, Sechura-Piura*. PUCP, Lima.

Carré, M., Sachs, J. P., Purca, S., Schauer, A. J., Braconnot, P., Falcón, R. A., ... & Lavallée, D. (2014). Holocene history of ENSO variance and asymmetry in the eastern tropical Pacific. *Science*, 345(6200), 1045-1048.

Carrillo CN (1893) *Hidrografía oceánica*. Bol Soc Geogr Lima, pp 72–11

Carson, R. (1962). *Silent Spring*. Houghton Mifflin Company.

Chauchat, C., Wing, E.S., Lacombe, J.P., Demars, P.Y., Uceda, S., Deza, C., (1992). Préhistoire de la côte nord du Pérou: Le Paijanien de Cupisnique. *Cahiers du Quaternaire* 18, CNRS-Editions, Centre Régional de Publication de Bordeaux, Bordeaux.

Chavez F., Ryan J., Lluch-Cota S., Niquen M. (2003) *From Anchovies To Sardines And Back: Multidecadal Change In The Pacific Ocean*, *Science*, vol. 299 (pg. 217-221)

Chicoine, D. (2011). Feasting landscapes and political economy at the Early Horizon center of Huambacho, Nepeña Valley, Peru. *Journal of Anthropological Archaeology*, 30(3), 432-453.

Coker, R. E. (1919). *Habits and economic relations of the guano birds of Peru*.

Collins, M., An, S. I., Cai, W., Ganachaud, A., Guilyardi, E., Jin, F. F., & Wittenberg, A. (2010). The impact of global warming on the tropical Pacific Ocean and El Niño. *Nature Geoscience*, 3(6), 391-397.

Cooper, J., & Sheets, P. (Eds.). (2012). *Surviving sudden environmental change: answers from archaeology*. University Press of Colorado.

Cruz, Z., Angulo, F., Burger, H., & Borgesa, R. (2007). Evaluación de aves en la laguna El Paraíso, Lima, Perú. *Revista Peruana de Biología*, 14(1), 139-144.

DeFrance , S.D., Keefer, D.K., Richardson, J.B., III, Umire Alvarez, A., (2001). Late Paleo-Indian coastal foragers: Specialized extractive behavior at Quebrada Tacahuay, Peru. *Lat. Am. Antiq.* 12, 413-426.

DeFrance , S. D. (2005) *Late Pleistocene Marine Birds from Southern Peru: Distinguishing Human Capture from El Niño-Induced Windfall*. *Journal of Archaeological Science*, 32(8), 1131–1146. doi: 10.1016/j.jas.2005.03.001.

Del Hoyo, J., N. Collar, E. F. J. Garcia, and G. M. Kirwan (2020). Peruvian Pelican (*Pelecanus thagus*), version 1.0. In *Birds of the World* (J. del Hoyo, A. Elliott, J. Sargatal, D. A. Christie, and E. de Juana, Editors). Cornell Lab of Ornithology, Ithaca, NY, USA

Demarchi, B., Presslee, S., Gutierrez-Zugasti, I., Gonzalez-Morales, M., Marin-Arroyo, A. B., Straus, L. G., & Fischer, R. (2019). Birds of prey and humans in prehistoric Europe: A view from El Mirón Cave, Cantabria (Spain). *Journal of Archaeological Science: Reports*, 24, 244-252.

Deser, C., Wallace JM (1987) El Niño events and their relation to the Southern Oscillation: 1925–1986. *J Geophys Res* 92:14189–14196

Devenish, C., Díaz Fernández, D. F., Clay, R. P., Davidson, I., Yépez Zabala, I., Wege, D. C., & Anadón-Irizarry, V. (Eds.). (2009). *Important Bird Areas Americas: Priority Sites for Biodiversity Conservation* (Vol. 16) [Print]. BirdLife International.

Dewitte B, Takahashi K (2016) Diversity of moderate El Niño events evolution: role of air–sea interactions in the eastern tropical Pacific. *Clim Dyn*.

Dillehay, T. D. (Ed.). (2017). *Where the land meets the sea: fourteen millennia of human history at Huaca Prieta, Peru*. University of Texas Press.

Dillehay, Tom D., Steve Goodbred, Mario Pino, Víctor F. Vásquez Sánchez, Teresa Rosales Tham, James Adovasio, Michael B. Collins et al. (2017). "Simple technologies and diverse food strategies of the Late Pleistocene and Early Holocene at Huaca Prieta, Coastal Peru." *Science Advances* 3, no. 5: e1602778.

Duffy, D. C., & Hays, C. (1984). *The Conservation Status Of Peruvian Seabirds*.

Durant, J. M., Hjermmann, D. Ø., Frederiksen, M., Charrassin, J. B., Le Maho, Y., Sabarros, P. S., ... & Stenseth, N. C. (2009). Pros and cons of using seabirds as ecological indicators. *Climate research*, 39(2), 115-129.

Dyer, M. A. (1996). *Threads of time: technique, structure and iconography in an embroidered mantle from Paracas*.

Eda, M., Yamasaki, T., & Sakai, M. (2019). Identifying the bird figures of the Nasca pampas: An ornithological perspective. *Journal of Archaeological Science: Reports*, 26, 101875.

Egwumah, F. A., Egwumah, P. O., & Edet, D. I. (2017). Paramount roles of wild birds as bioindicators of contamination. *Int J Avian & Wildlife Biol*, 2(6), 00041.

Fiedel, S. J. (2007). Quacks in the ice: Waterfowl, Paleoindians, and the discovery of America. *Foragers of the Terminal Pleistocene in North America*, 1-14.

Fitzhugh, Ben, Virginia L. Butler, Kristine M. Bovy, and Michael A. Etnier. (2019). "Human ecodynamics: A Perspective for the Study of Long-Term Change in Socioecological Systems." *Journal of Archaeological Science: Reports* 23: 1077–94.

Fontugne, M., Usselman, P., Lavallée, D., Julien, M., & Hatté, C. (1999). El Niño variability in the coastal desert of southern Peru during the mid-Holocene. *Quaternary research*, 52(2), 171-179.

Fraga, R. (2020). Melodious Blackbird (*Dives dives*), version 1.0. In *Birds of the World* (J. del Hoyo, A. Elliott, J. Sargatal, D. A. Christie, and E. de Juana, Editors). Cornell Lab of Ornithology, Ithaca, NY, USA

Freedberg, W. (2018). How Do Pelagic Birds Find Fresh Water At Sea? Distraction Displays Bird Conservation at Mass Audubon. Retrieved June 25, 2022, from <https://blogs.massaudubon.org/distractiondisplays/how-do-pelagic-birds-find-fresh-water-at-sea/>

French, A. and Mechler, R. (2017). Managing El Niño Risks Under Uncertainty in Peru: Learning from the past for a more disaster-resilient future. Laxenburg, Austria: International Institute for Applied Systems Analysis.

Frere, E. and A. Millones (2021). Red-legged Cormorant (*Poikilocarbo gaimardi*), version 1.1. In *Birds of the World* (T. S. Schulenberg, Editor). Cornell Lab of Ornithology, Ithaca, NY, USA.

Freund, M. B., Henley, B. J., Karoly, D. J., McGregor, H. V., Abram, N. J., & Dommenges, D. (2019). Higher frequency of Central Pacific El Niño events in recent decades relative to past centuries. *Nature Geoscience*, 12(6), 450-455.

Fuentes, H. and E. Antonietti (1989). Efectos del fenómeno El Niño en las aves marinas del litoral peruano. *Boletín Estudio Regional del Fenómeno El Niño Pacífico Sur Este (ERFEN)* 29: 19-26.

Funk, C. (2018). Ethno-ornithology in the Rat Islands: Prehistoric Aleut relationships with birds in the western Aleutians, Alaska. *Journal of Anthropological Archaeology*, 51, 144-158.

Furness, R. W., & Camphuysen, K. (1997). Seabirds as monitors of the marine environment. *Journal of marine Science*, 54(4), 726-737.

Gamboa, J. (2017). El pato, la chicha, y la fiesta: representaciones visuales y simbolismo de los ánades domésticos y silvestres entre los Moche. *Ñawpa Pacha*, 37(2), 111-131.

- Gamboa, J. (2019). The modern ontological natures of the *Cairina moschata* (Linnaeus, 1758) duck. Cases from Perú, the northern hemisphere, and digital communities. *Anthropozoologica*, 54(1), 123-139.
- Garate, P. (2013). A mass mortality event of sooty shearwaters (*Puffinus griseus*) on the central coast of Peru. *Notornis*, 60, 258-261.
- Gladwell, R. (2004). Animals among the dead: a Middle Horizon and late intermediate period archaeological site in southwestern Peru. Senior Honor's Thesis, University of New Mexico, Albuquerque.
- Glantz, M. (2002). La Niña and its impacts: facts and speculation. United Nations University (UNU).
- Gochfeld, M. and J. Burger (2020). Inca Tern (*Larosterna inca*), version 1.0. In *Birds of the World* (J. del Hoyo, A. Elliott, J. Sargatal, D. A. Christie, and E. de Juana, Editors). Cornell Lab of Ornithology, Ithaca, NY, USA.
- Gohary RE. (2015). Agriculture, Industry, and Wastewater in the Nile Delta. *International Journal of Scientific Research in Agricultural Sciences*.; 2:159–172.
- Goldstein, D. L. (2001). Water and salt balance in seabirds. In *Biology of marine birds* (pp. 485-502). CRC Press.
- Goodbred Jr, Steven L., Tom D. Dillehay, César Galvéz Mora, and André O. Sawakuchi. "Transformation of Maritime Desert to an Agricultural Center: Holocene Environmental Change and Landscape Engineering in Chicama River valley, northern Peru coast." *Quaternary Science Reviews* 227 (2020): 106046. <https://doi.org/10.1016/j.quascirev.2019.106046>.
- Grattan, J., & Torrence, R. (2007). Beyond gloom and doom: The long-term consequences of volcanic disasters. *Living under the shadow: Cultural impacts of volcanic eruptions*, 1-18.
- Grayson, D. K. (1984). *Quantitative Zooarchaeology: Topics in the Analysis of Archaeological Faunas*. Academic Press, Inc., New York.
- Grundy, P. L. (2002). *Hummingbird-warriors: Status and transformation in Mochica art*. Virginia Commonwealth University.
- Harrison, R. & Maher, R. A. (2014). *Humans—A Force of Nature. Human Ecodynamics in the North Atlantic: A Collaborative Model of Humans and Nature through Space and Time*, 1.
- Helmer, Matthew & David Chicoine (2015) Seaside life in Early Horizon Peru: Preliminary insights from Samanco, Nepeña Valley, *Journal of Field Archaeology*, 40:6, 626-643, DOI: 10.1080/00934690.2015.1101943

Herencia, R. S. (2019). ¿Naymlap o Ñam-la, padre de compañías o ave de aguas? Oralidad, leyenda e historia en la Miscelánea Antártica de Miguel Cabello Valboa. *Grau Zero—Revista de Crítica Cultural*, 7(2), 89-104.

Hill, E. (2013). Archaeology and animal persons: toward a prehistory of human-animal relations. *Environment and Society*, 4(1), 117-136.

Holt, J. Z. (1996). Beyond optimization: alternative ways of examining animal exploitation. *World archaeology*, 28(1), 89-109.

Hoskins, W. G. (1970). *Making of the English landscape*. Hodder and Stoughton.

Houston, D., G. M. Kirwan, D. A. Christie, and C. J. Sharpe (2020). Andean Condor (*Vultur gryphus*), version 1.0. In *Birds of the World* (J. del Hoyo, A. Elliott, J. Sargatal, D. A. Christie, and E. de Juana, Editors). Cornell Lab of Ornithology, Ithaca, NY, USA.

Huamanchumo, Percy Valladares, (2020). *Historias del abuelo*. Institute of Andean Research 10 Sachem St. New Haven, Connecticut, 06511 Estados Unidos
<http://instituteofandeanresearch.org/about/>

Hyrenbach, K. D., & Veit, R. R. (2003). Ocean warming and seabird communities of the southern California Current System (1987–98): response at multiple temporal scales. *Deep Sea Research Part II: Topical Studies in Oceanography*, 50(14-16), 2537-2565.

IMARPE. (2007). Mortandad de aves marinas frente al litoral Norte del Perú (Piura y Tumbes) En Seguimientos de las pesquerías y evaluación de los recursos pesqueros.
http://www.imarpe.gob.pe/imarpe/archivos/informes/imarpe_eval_po_iii_tri07.pdf.

IMARPE (2011). Mortandad de aves. En Resultados principales del POI – PTI - I Semestre 2011.
http://www.imarpe.gob.pe/imarpe/archivos/informes/imarpe_eval_ejec_poi_pti_sem_i_2011.pdf.

Ingold, T. (2021). Hunting and gathering as ways of perceiving the environment. In *Redefining nature* (pp. 117-155). Routledge.

Insoll, T. (2011). Animism and totemism. *The Oxford Handbook of the Archaeology of Ritual and Religion*, 1004-1016.

Jackson, Barbara, and Terry Stocker. (1982). "Peru's preceramic menu." *Field Museum of Natural History Bulletin* 53 (7): 12–23.

Jaksic, F. M. (2001). Ecological effects of El Niño in terrestrial ecosystems of western South America. *Ecography*, 24(3), 241-250.

Jaksic, F. M. (2004). El Niño effects on avian ecology: lessons learned from the southeastern Pacific. *Ornitología Neotropical*, 15(Suppl.), 61-72.

Jaksic, F. M., Silva, S. I., Meserve, P. L., & Gutierrez, J. R. (1997). A long-term study of vertebrate predator responses to an El Niño (ENSO) disturbance in western South America. *Oikos*, 341-354.

Jerardino, A., Castilla, J. C., Ramírez, J. M., & Hermosilla, N. (1992). Early coastal subsistence patterns in central Chile: a systematic study of the marine-invertebrate fauna from the site of Curaumilla-1. *Latin American Antiquity*, 3(1), 43-62.

Johns, Arwen M., "The Richness of Food: A Zooarchaeological Analysis of Huaca Santa Clara and Huaca Huaca Gallinazo, North Coast of Peru" (2017). Electronic Thesis and Dissertation Repository. 4899. <https://ir.lib.uwo.ca/etd/4899>

Jordán, R. (1964) Las emigraciones y mortandad de las aves en el invierno y otoño de 1963. *Informe Instituto de Investigación de los Recursos Marinos* 27: 1-31.

Keck, F. (2015). Sentinels for the environment. *Birdwatchers in Taiwan and Hong Kong. China Perspectives*, 2015(2015/2), 43-52.

Keefer, D.K., deFrance, S.D., Moseley, M.E., Richardson, J.B., III, Satterlee, D.R., Day-Lewis, A., (1998). Early maritime economy and El Niño events at Quebrada Tacahuay, Peru. *Science* 281, 1833-1835.

Kennedy, S. A., & VanValkenburgh, P. (2016). Zooarchaeology and changing food practices at Carrizales, Peru following the Spanish invasion. *International Journal of Historical Archaeology*, 20(1), 73-104.

Kirch, P. V. (2005). Archaeology and global change: the Holocene record. *Annu. Rev. Environ. Resour.*, 30, 409-440.

Kirch, P. V. (2007). Hawaii as a model system for human ecodynamics. *American anthropologist*, 109(1), 8-26.

Kirk, D. A. and M. J. Mossman (2020). Turkey Vulture (*Cathartes aura*), version 1.0. In *Birds of the World* (A. F. Poole and F. B. Gill, Editors). Cornell Lab of Ornithology, Ithaca, NY, USA.

Lavado-Casimiro, W. S., Felipe, O., Silvestre, E., & Bourrel, L. (2013). ENSO impact on hydrology in Peru. *Advances in Geosciences*, 33, 33-39.

Lavallée y García, J.A, de. 1917. Informe preliminar sobre la causa de la mortalidad anormal de las aves ocurrida en el mes de Marzo del presente año. *Memoria de la Compañía Administradora del Guano* 8: 61- 88

Lavallée, D., Béarez, P., Chevalier, A., Julien, M., Usselman, P., Fontugne, M., (1999). Paleoambiente y ocupación prehistórica del litoral extremo-sur del Perú. *Bol. Arqueol. PUCP* 3, 393-416

León Canales Elmo. (2013). 14 000 Años de alimentación en el Perú (Primera edición). USMP Universidad de San Martín de Porres Fondo Editorial.

Lerner, Isaías. (2011). “Introducción” [Introduction]. In Miguel Cabello de Valboa: *Miscelánea Antártica* ed. Isaías Lerner, viii–xxxvii. Seville: Fundación José Manuel Lara.

Lilly, M. V., Lucore, E. C., & Tarvin, K. A. (2019). Eavesdropping grey squirrels infer safety from bird chatter. *PLoS One*, 14(9), e0221279.

Llimona, F., J. del Hoyo, F. Jutglar, and G. M. Kirwan (2020). Great Grebe (*Podiceps major*), version 1.0. In *Birds of the World* (J. del Hoyo, A. Elliott, J. Sargatal, D. A. Christie, and E. de Juana, Editors). Cornell Lab of Ornithology, Ithaca, NY, USA.

Liu, Y., Cobb, K. M., Song, H., Li, Q., Li, C. Y., Nakatsuka, T., & Linderholm, H. W. (2017). Recent enhancement of central Pacific El Niño variability relative to last eight centuries. *Nature communications*, 8(1), 1-8.

Lockard, G. D. (2005). Political power and economy at the archaeological site of Galindo, Moche Valley, Peru. The University of New Mexico.

Lockard, G. D. (2009). The occupational history of Galindo, Moche Valley, Peru. *Latin American Antiquity*, 20(2), 279-302.

Lockart, Gregory, (2009) The occupational history of Galindo, Moche Valley, Peru. *Latin American Antiquity* 20(4): 279–302.

López de la Lama, R., de la Puente, S., Sueiro, J. C., & Chan, K. M. (2021). Reconnecting with the past and anticipating the future: A review of fisheries-derived cultural ecosystem services in pre-Hispanic Peru. *People and Nature*, 3(1), 129-147.

Lu, Z., Liu, Z., Zhu, J., & Cobb, K. M. (2018). A review of paleo El Niño-southern oscillation. *Atmosphere*, 9(4), 130.

Lumbreras, L.G., (2000). Contexto arqueológico de las líneas y geoglifos de Nasca. UNESCO-INC.

Makowski, Krzysztof. (2001). “Las divinidades en la iconografía mochica” [The deities in Mochica iconography]. In *Los dioses del antiguo Perú* [The gods of ancient Peru], 137–175. Lima: Banco del Crédito del Perú.

Manrique Paredes, R. S. (2011). El Niño southern oscillation and its effect on fog oases along the Peruvian and Chilean coastal deserts.

Marcus, J., Flannery, K. V., Sommer, J., Reynolds, R. G., & Thompson, V. D. (2020). Maritime Adaptations at Cerro Azul, Peru: A Comparison of Late Intermediate and Twentieth-Century Fishing. In G. Prieto & D. H. Sandweiss (Eds.), *Maritime Communities of the Ancient Andes* (1st ed., pp. 351–365). University Press of Florida. <https://doi.org/10.2307/j.ctvwvr380.19>

Marti, C. D., A. F. Poole, L. R. Bevier, M.D. Bruce, D. A. Christie, G. M. Kirwan, and J. S. Marks (2020). Barn Owl (*Tyto alba*), version 1.0. In *Birds of the World* (S. M. Billerman, Editor). Cornell Lab of Ornithology, Ithaca, NY, USA.

Martínez, I., D. A. Christie, F. Jutglar, E. F. J. Garcia, and G. M. Kirwan (2020). Humboldt Penguin (*Spheniscus humboldti*), version 1.0. In *Birds of the World* (J. del Hoyo, A. Elliott, J. Sargatal, D. A. Christie, and E. de Juana, Editors). Cornell Lab of Ornithology, Ithaca, NY, USA.

Mauricio, Ana. (2018). “Reassessing the impact of El Niño at the end of the early intermediate period from the perspective from the Lima culture.” *Ñawpa Pacha* 38: 203–31.

McInnis, Heather (1999). *Subsistence and Maritime Adaptations at Quebrada Jaguay, Camaná, Peru: A Faunal Analysis*. Unpublished M.S. Thesis. Institute for Quaternary Studies, University of Maine.

McTavish, R. C. (2013). *Faunal subsistence strategies among initial period coastal fishers at the Gramalote site in the Moche Valley of Peru* (Doctoral dissertation, The University of Wisconsin-Milwaukee).

Mithen, Steven (1999) The Hunter—Gatherer Prehistory Of Human—Animal Interactions, *Anthrozoös*, 12:4, 195-204, DOI: 10.2752/089279399787000147

Moore, Jerry. (1991). “Cultural Responses to Environmental Catastrophes: Post-El Niño Subsistence on the Prehistoric North Coast of Peru.” *Latin American Antiquity* 2(1): 27–47.

Monteban, M. (2017). Maternal knowledge and use of galactagogues in Andean communities of Cusco, Peru. *Ethnobiology letters*, 8(1), 81-89.

Montevecchi, W. A. (1993). Birds as indicators of change in marine prey stocks. *Birds as monitors of environmental change*, 217-266.

Morelli, F., Kubicka, A. M., Tryjanowski, P., & Nelson, E. (2015). The vulture in the sky and the hominin on the land: three million years of human–vulture interaction. *Anthrozoös*, 28(3), 449-468.

Moseley, Michael E. (1975). *The Maritime Foundations of Andean Civilization*. Menlo Park, CA: Cummings.

- Moseley, M. E. (1992). Maritime foundations and multilinear evolution: Retrospect and prospect. *Andean Past*, 3(1), 5
- Moseley, Michael E. (1999). Convergent catastrophe: Past patterns and future implications of collateral natural disasters in the Andes. In *The Angry Earth. Disaster in Anthropological Perspective*, edited by Anthony Oliver-Smith and Susanna M. Hoffman, pp. 59–71. Routledge, New York/London.
- Murphy, R. C. (1936). Oceanic birds of South America: a study of species of the related coasts and seas, including the American quadrant of Antarctica, based upon the Brewster-Sanford collection in the American Museum of Natural History(Vol. 2). MacMillan Company.
- Nagaoka, L. (2019). Human behavioral ecology and zooarchaeology. In *Handbook of evolutionary research in archaeology* (pp. 231-253). Springer, Cham.
- Nebel, S. and J. M. Cooper (2020). Least Sandpiper (*Calidris minutilla*), version 1.0. In *Birds of the World* (A. F. Poole, Editor). Cornell Lab of Ornithology, Ithaca, NY, USA.
- Nesbitt, J. (2020). Ancient agriculture and climate change on the north coast of Peru. *Proceedings of the National Academy of Sciences*, 117(40), 24617-24619.
- Ñiquen, M., and Bouchon, M. (2004). Impact of El Niño Events on Pelagic Fisheries in Peruvian Waters. *Deep Sea Research Part II: Topical Studies in Oceanography*, 51(6-9), 563–574. doi: 10.1016/j.dsr2.2004.03.001
- Oliver-Smith, A. (1996). Anthropological research on hazards and disasters. *Annual review of anthropology*, 303-328.
- O'Neill, J. P. (1984). Introduction: feather identification. *Costumes and Featherwork of the Lords of Chimor. Textiles from Peru's North Coast*, 145-150.
- Orlove, Benjamin S., John C. H. Chiang, and Mark A. Cane. (2000). "Forecasting Andean Rainfall and Crop Yield from the Influence of El Niño on Pleiades Visibility." *Nature* 403 (6765): 68–71.
- Ortloff, Charles, and Michael E Moseley. (2009). "Climate, Agricultural Strategies, and Sustainability in the Precolumbian Andes." *Andean Past* 9 (15): 277–304.
- Palacios-Abrantes, J., Frölicher, T. L., Reygondeau, G., Sumaila, U. R., Tagliabue, A., Wabnitz, C. C., & Cheung, W. W. (2022). Timing and magnitude of climate-driven range shifts in transboundary fish stocks challenge their management. *Global change biology*, 28(7), 2312-2326.
- Parker, T. A., Parker, S. A., & Plenge, M. A. (1982, March 31). *An Annotated Checklist of Peruvian Birds* (1st ed.). Buteo Books.

- Passuni, G., Barbraud, C., Chaigneau, A., Demarcq, H., Ledesma, J., Bertrand, A., ... & Bertrand, S. (2016). Seasonality in marine ecosystems: Peruvian seabirds, anchovy, and oceanographic conditions. *Ecology*, 97(1), 182-193.
- Paszatory, E. (2008). Rare ancient featherwork from Peru. *American Journal of Archaeology Online Museum Review*, 112.
- Perú. Consejo Nacional del Medio Ambiente - CONAM. Comisión Nacional de Diversidad Biológica. <https://repositoriodigital.minam.gob.pe/handle/123456789/169>
- Philander, S. G. H. (2004). On El Nino & the uncertain science of global warming. *Daedalus*, 133(2), 105-108.
- Poulin, R. G., L. D. Todd, E. A. Haug, B. A. Millsap, and M. S. Martell (2020). Burrowing Owl (*Athene cunicularia*), version 1.0. In *Birds of the World* (A. F. Poole, Editor). Cornell Lab of Ornithology, Ithaca, NY, USA
- Pozorski, S. G. (1976). Prehistoric subsistence patterns and site economics in the Moche Valley, Peru. The University of Texas at Austin.
- Pozorski, S.G., (1979). Prehistoric diet and subsistence in the MocheValley, Peru. *WorldArchaeol.* 11,163-184.
- Pozorski, S., & Pozorski, T. (1986). Recent excavations at Pampa de las Llamas-Moxeque, a complex Initial Period site in Peru. *Journal of Field Archaeology*, 13(4), 381-401.
- Pozorski S., Pozorski, T., (1987). *Early Settlement and Subsistence in the Casma Valley, Peru*. University of Iowa Press, Iowa City.
- Pozorski, T., Pozorski, S., (1990). Huaynuna: A late Cotton Pre-ceramic Site on the north coast of Peru. *J. Field Archaeology*. 17, 17-26.
- Pozorski, T., & Pozorski, S. (2018). Early complex society on the north and central peruvian coast: new archaeological discoveries and new insights. *Journal of Archaeological Research*, 26(4), 353-386.
- Prieto, Gabriel. (2015). "Gramalote: Domestic Life, Economy and Ritual Practices of a Prehispanic Maritime Community." Ph.D. dissertation, Yale University, New Haven, CT.
- Prieto, G., Verano, J. W., Goepfert, N., Kennett, D., Quilter, J., LeBlanc, S., & Tschinkel, K. (2019). A mass sacrifice of children and camelids at the Huanchaquito-Las Llamas site, Moche Valley, Peru. *PLoS One*, 14(3), e0211691.
- Prieto, G., Sandweiss, D. H., & Thompson, V. D. (Eds.). (2020). *Maritime communities of the Ancient Andes* (p. 218). Gainesville, FL: University Press of Florida.

- Proulx, D. A. (1990). Nasca Iconography. *Inca-Peru*, 3000, 384-399.
- Quilter, J., & Stocker, T. (1983). Subsistence economies and the origins of Andean complex societies. *American Anthropologist*, 85(3), 545-562.
- Quilter, J., Ojeda E, B., Pearsall, D. M., Sandweiss, D. H., Jones, J. G., & Wing, E. S. (1991). Subsistence economy of El Paraíso, an early Peruvian site. *Science*, 251(4991), 277-283.
- Quilter, J. (1992). To fish in the afternoon: Beyond subsistence economies in the study of early Andean civilization. *Andean Past*, 3(1), 10.
- Quilter, J. (2014). *The ancient central Andes*. Routledge
- Quinn, W. H. (1992). *The historical record of El Niño events*. *Climate since AD 1500*, 623-648
- Quiñonez, A. S., & Hernandez, F. (2017). Uso de hábitat y estado de conservación de las aves en el humedal El Paraíso, Lima, Perú. *Revista peruana de biología*, 24(2), 175-186.
- Redman, C. L. (2005). Resilience theory in archaeology. *American Anthropologist*, 107(1), 70–77
- Rein, Bert, Andreas Lückge, Lutz Reinhardt, Frank Sirocko, Anja Wolf, and Wolf-Christian Dullo. (2005). "El Niño Variability off Peru During the Last 20,000 years." *Paleoceanography* 20 (4).
- Reitz, E.J., (1988). Faunal remains from Paloma, an Archaic site in Peru. *Am. Anthropology*. 90, 310-322.
- Reitz, Elizabeth J., and Daniel H. Sandweiss. (2001). "Environmental Change at Ostra Base Camp , A Peruvian Preceramic Site." *Journal of Archaeological Science* 28 (10): 1085–1100.
- Reitz, E. J. & Wing, E. S. (1999). *Zooarchaeology*. Cambridge University Press.
- Reitz, E. J., deFrance , S. D., Sandweiss, D. H., & McInnis, H. E. (2015). Flexibility in southern Peru coastal economies: A vertebrate perspective on the Terminal Pleistocene/Holocene transition. *The Journal of Island and Coastal Archaeology*, 10(2), 155-183.
- Reitz, E. J., McInnis, H. E., Sandweiss, D. H., & deFrance , S. D. (2017). Variations in human adaptations during the Terminal Pleistocene and Early Holocene at Quebrada Jaguay (QJ-280) and the Ring Site, southern Peru. *The Journal of Island and Coastal Archaeology*, 12(2), 224-254.
- Reitz, Elizabeth J., Daniel H. Sandweiss, and Nicole R. Cannarozzi. (2019). "Fishing on the Frontier: Vertebrate Remains from Amotape, Siches, and Honda Phase Occupations at Sitio Siches (Pv 7-19), Perú." *Bulletin of the Florida Museum of Natural History* 56 (4): 109–81.

Rodríguez-Loredo, C. (2012). La explotación de la fauna terrestre. Pehistoria de la costa extremo-sur del Perú. Los pescadores arcaicos de la Quebrada de los Burros (10000-7000 a. P.), 141-174.

Rodrigues, P., & Micael, J. (2021). The importance of guano birds to the Inca Empire and the first conservation measures implemented by humans.

Rodríguez-Morata, C., Díaz, H. F., Ballesteros-Canovas, J. A., Rohrer, M., & Stoffel, M. (2019). The anomalous 2017 coastal El Niño event in Peru. *Climate Dynamics*, 52(9), 5605-5622.

Rollins, Harold, James Richardson III, and Daniel Sandweiss. 1986. "The Birth of El Niño: Geoarchaeological Evidence and Implications." *Geoarchaeology* 1 (1): 3–15.

Roscoe, Paul. 2008. "Catastrophe and the Emergence of Political Complexity: A Social Anthropological Model." In *El Niño, Catastrophism, and Culture Change in Ancient America*. Dumbarton Oaks Research Library and Collection, edited by Daniel H. Sandweiss and Jeffrey Quilter, 77–100. Washington D.C.: Harvard University Press.

Rossi, S., & Soares, M. D. O. (2018). Effects of El Niño on the coastal ecosystems and their related services. *Mercator (Fortaleza)*, 16.

Rowe, A. P. (1984). The Junius B. Bird Conference On Andean Textiles. Ann Pollard Rowe.

Richardson III, J.B., (1978). EarlyMan on the Peruvian north coast, early maritime exploitation and Pleistocene and Holocene environment. In: Bryan, A.L. (Ed.), *Early Man in America from a Circum-Pacific Perspective*. Department of Anthropology, University of Alberta, Occasional Papers 1, pp. 274-289.

Rick, T. C., & Sandweiss, D. H. (2020). Archaeology, climate, and global change in the Age of Humans. *Proceedings of the National Academy of Sciences*, 117(15), 8250-8253.

Salas García, José Antonio. 2002. *Diccionario mochica – castellano [Mochica – Spanish dictionary]*. Lima: Universidad de San Martín de Porres, Escuela Profesional de Turismo y Hotelería.

Salomon, F. (1991). Introductory essay: the Huarochiri manuscript. *The Huarochirí Manuscript: a testament of ancient and Colonial Andean religion*, 1-38.

Sandweiss, A. (2019). "El Niño Modoki: A Diagnostic Study for Peru and Beyond." In *Climate Change and the Future of Water*, 133–58. Abu Dhabi: Emirates Center for Strategic Studies and Research.

Sandweiss, D. H. (1986). The beach ridges at Santa, Peru: El Niño, uplift, and prehistory. *Geoarchaeology*, 1(1), 17-28.

Sandweiss, D. H. (1989). *The fishermen of Chincha, Peru: An archaeological investigation of late prehispanic coastal specialization*. (Volumes I and II). Cornell University.

Sandweiss, D. H. (1992). The archaeology of Chincha fishermen: specialization and status in Inka Peru (No. 29). Carnegie Museum of Natural History.

Sandweiss, D.H., Richardson III, J.B., Reitz, E.J., Rollins, H.B., Maasch, K.A., (1996). Geoarchaeological evidence from Peru for a 5000 years B.P. onset of El Niño. *Science*. 273, 1531-1533.

Sandweiss, D. H., & Wing, E. S. (1997). Ritual rodents: the guinea pigs of Chincha, Peru. *Journal of Field Archaeology*, 24(1), 47-58.

Sandweiss, D. H., McInnis, H., Burger, R. L., Cano, A., Ojeda, B., Paredes, R., ... & Glascock, M. D. (1998). Quebrada Jaguay: early south American maritime adaptations. *Science*, 281(5384), 1830-1832.

Sandweiss, D. H., Maasch, K. A., Chai, F., Andrus, C. T., & Reitz, E. J. (2004) *Geoarchaeological Evidence for Multidecadal Natural Climatic Variability and Ancient Peruvian Fisheries*. *Quaternary Research*, 61(3), 330–334. doi: 10.1016/j.yqres.2004.02.008

Sandweiss, Daniel H., Kirk A. Maasch, C. Fred T. Andrus, Elizabeth J. Reitz, James B. Richardson, Melanie Riedinger-Whitmore, and Harold B. Rollins. (2007). “Chapter 2 - Mid-Holocene Climate and Culture Change in Coastal Peru.” In *Climate Change and Cultural Dynamics*, edited by David G. Anderson, Kirk A. Maasch, and Daniel H. Sandweiss, 25–50. San Diego: Academic Press.

Sandweiss, D.H., Richardson, J.B. (2008). Central Andean Environments. In: Silverman, H., Isbell, W.H. (eds) *The Handbook of South American Archaeology*. Springer, New York, NY. https://doi.org/10.1007/978-0-387-74907-5_6

Sandweiss, Daniel H., and Alice R. Kelley. (2012). "Archaeological Contributions to Climate Change Research: The Archaeological Record as a Paleoclimatic and Paleoenviromental archive." *Annual Review of Anthropology* 41: 371–91.

Sandweiss, D.H., and J. Quilter. (2012). “Collation, Correlation, and Causation in the Prehistory of Coastal Peru.” In *Surviving Sudden Environmental Change: Answers from Archaeology*, edited by P. Sheets and J. Cooper, 117–41. Boulder: University of Colorado Press.

Sandweiss, Daniel H., C. Fred T. Andrus, Alice R. Kelley, Kirk A. Maasch, Elizabeth J. Reitz, and Paul B. Roscoe. (2020). "Archaeological Climate Proxies and the Complexities of Reconstructing Holocene El Niño in Coastal Peru." *Proceedings of the National Academy of Sciences* 117 (15): 8271–79.

Sandweiss, Daniel H., and Kirk A. Maasch. (2020). “El Niño as Catastrophe on the Peruvian Coast.” In *Going Forward by Looking Back*, edited by Felix Riede and Payson Sheets. Berghahn Books, Oxford & New York

- Satterlee, Dennis R, Michael E Moseley, David K Keefer, and Jorge E. Tapia A. (2000). “The Miraflores El Niño Disaster: Convergent Catastrophes and Prehistoric Agrarian Change in Southern Peru.” *Andean Past* 6: 95–116.
- Sault, N. (2020). Bird Stories from Latin America. *Ethnobiology Letters*, 11(2), 58-68.
- Schreiber, E. A., & Burger, J. (2001, August 16). *Biology of Marine Birds* (CRC Marine Biology Series) (1st ed.). CRC Press.
- Schreiber, E. A. (2002). Climate and weather effects on seabirds. *Biology of marine birds*, 179-216.
- Schreiber, R. W., & Schreiber, E. A. (1982). Essential habitat of the Brown Pelican in Florida. *Florida Field Naturalist*, 10(1), 9-17.
- Schreiber, R. W. (1989). Insights into Seabird Ecology from a Global. *National Geographic Research*, 5(1), 64-81.
- Schulenberg, T. S., & Parker III, T. A. (1981). Status and distribution of some northwest Peruvian birds. *The Condor*, 83(3), 209-216.
- Schulenberg, T. S., Stotz, D. F., Lane, D. F., O'Neill, J. P., & Parker, T. A. (2010). *Birds of peru*. In *Birds of Peru*. Princeton University Press.
- Schulenberg, T. S. and H. Batcheller (2020). Peruvian Pygmy-Owl (*Glaucidium peruanum*), version 1.0. In *Birds of the World* (T. S. Schulenberg, Editor). Cornell Lab of Ornithology, Ithaca, NY, USA.
- Shady Solís, Ruth, Jonathan Haas, and Winifred Creamer. (2001). “Dating Caral, a Preceramic Site in the Supe Valley on the Central Coast of Peru.” *Science*. 292 (5517): 723–26.
- Shealer, D. A. (2002). Foraging behavior and food of seabirds. *Biology of marine birds*, 14, 137-177.
- Shields, M. (2020). Brown Pelican (*Pelecanus occidentalis*), version 1.0. In *Birds of the World* (A. F. Poole, Editor). Cornell Lab of Ornithology, Ithaca, NY, USA.
- Simeone, A., Araya, B., Bernal, M., Diebold, E. N., Grzybowski, K., Michaels, M., ... & Willis, M. J. (2002). Oceanographic and climatic factors influencing breeding and colony attendance patterns of Humboldt penguins *Spheniscus humboldti* in central Chile. *Marine Ecology Progress Series*, 227, 43-50.
- Suzuki, T. N. (2016). Semantic communication in birds: evidence from field research over the past two decades. *Ecological Research*, 31(3), 307-319.
- Szabó, P. (2015). Historical ecology: past, present and future. *Biological Reviews*, 90(4), 997-1014.

Spear, L. B., & Ainley, D. G. (2008). The seabird community of the Peru Current, 1980-1995, with comparisons to other eastern boundary currents. *Marine Ornithology*, 36, 125-144.

Spence, L. (1913). *Mythologies of Mexico and Peru*. Harrap.

Spence, L. (1926). *The Gods of Peru*. The Open Court, 1926(7), 2.

St. Amand, Frankie, S. Terry Childs, Elizabeth J. Reitz, Sky Heller, Bonnie Newsom, Torben C. Rick, Daniel H. Sandweiss, and Ryan Wheeler. (2020). “Leveraging Legacy Archaeological Collections as Proxies for Climate and Environmental Research.” *Proceedings of the National Academy of Sciences* 117 (15): 8287–94. <https://doi.org/10.1073/pnas.1914154117>.

Stewart, R. E. (2016). *Wetlands as Bird Habitat*. National Water Summary on Wetland Resources. Retrieved July 24, 2022, from <https://water.usgs.gov/nwsun/WSP2425/birdhabitat.html>

Stone, R. R. (1983). of Chavín-style painted textiles. In *Investigations of the Andean Past: Papers from the First Annual Northeast Conference on Andean Archaeology and Ethnohistory*. Latin American Studies Program, Cornell University.

Stotz, D. F., Fitzpatrick, J. W., Iii, T. P. A., & Moskovits, D. K. (1996, June 1). *Neotropical Birds: Ecology and Conservation* (New edition). University of Chicago Press.

Sulca, Juan, Ken Takahashi, Jhan-Carlo Espinoza, Mathias Vuille, and Waldo Lavado-Casimiro. 2018. “Impacts of Different ENSO Flavors and Tropical Pacific Convection Variability (ITCZ, SPCZ) on Austral Summer Rainfall in South America, with a Focus on Peru.” *International Journal of Climatology* 38 (1): 420–35. <https://doi.org/10.1002/joc.5185>.

Takahashi K, Montecinos A, Goubanova K, Dewitte B (2011). ENSO regimes: reinterpreting the canonical and Modoki El Niño. *Geo- phys Res Lett* 38:L10704. doi:10.1029/2011GL047364
Taylor, B. (2020). Plumbeous Rail (*Pardirallus sanguinolentus*), version 1.0. In *Birds of the World* (J. del Hoyo, A. Elliott, J. Sargatal, D. A. Christie, and E. de Juana, Editors). Cornell Lab of Ornithology, Ithaca, NY, USA.

Takahashi, K., & Martínez, A. G. (2019). The very strong coastal El Niño in 1925 in the far-eastern Pacific. *Climate Dynamics*, 52(12), 7389-7415.

Taylor, B., D. A. Christie, and G. M. Kirwan (2020). Eurasian Moorhen (*Gallinula chloropus*), version 1.0. In *Birds of the World* (J. del Hoyo, A. Elliott, J. Sargatal, D. A. Christie, and E. de Juana, Editors). Cornell Lab of Ornithology, Ithaca, NY, USA.

Taylor, B. (2020). Slate-colored Coot (*Fulica ardesiaca*), version 1.0. In *Birds of the World* (J. del Hoyo, A. Elliott, J. Sargatal, D. A. Christie, and E. de Juana, Editors). Cornell Lab of Ornithology, Ithaca, NY, USA.

- Taylor M. H., Tam J., Blaskovic V., Espinoza P., Ballón R. M., Wosnitza-Mendo C., Argüelles J. (2008) Trophic modeling of the northern Humboldt Current ecosystem. 2. Elucidating ecosystem dynamics from 1995–2004 with a focus on the impact of ENSO, *Progress in Oceanography*, vol. 79 (pg. 336-351).
- Tedeschi, R. G., Grimm, A. M., & Cavalcanti, I. F. (2016). Influence of Central and East ENSO on precipitation and its extreme events in South America during austral autumn and winter. *International Journal of Climatology*, 36(15), 4797-4814.
- Telfair II, R. C. and M. L. Morrison (2022). Neotropic Cormorant (*Nannopterum brasilianum*), version 2.2. In *Birds of the World* (P. G. Rodewald and B. K. Keeney, Editors). Cornell Lab of Ornithology, Ithaca, NY, USA.
- Timmermann, A., Oberhuber, J., Bacher, A., Esch, M., Latif, M., & Roeckner, E. (1999). Increased El Niño frequency in a climate model forced by future greenhouse warming. *Nature*, 398(6729), 694-697.
- Timmermann, A., An, S. I., Kug, J. S., Jin, F. F., Cai, W., Capotondi, A., & Zhang, X. (2018). El Niño–southern oscillation complexity. *Nature*, 559(7715), 535-545.
- Tovar, H. (1980). Observaciones de Aves Marinas en la zona Sur del Peru en Diciembre de 1978. IMARPE Informe No. 68
- Tovar, H., Guillén, V., & Cabrera, D. (1987). Reproduction and population levels of Peruvian guano birds, 1980 to 1986. *Journal of Geophysical Research: Oceans*, 92(C13), 14445-14448.
- Trenberth, K. E. (1997). The definition of el nino. *Bulletin of the American Meteorological Society*, 78(12), 2771-2778.
- Turner, B. L., Bélisle, V., Davis, A. R., Skidmore, M., Juengst, S. L., Schaefer, B. J., ... & Bauer, B. S. (2018). Diet and foodways across five millennia in the Cusco region of Peru. *Journal of Archaeological Science*, 98, 137-148.
- Urban, M., & Eloranta, R. (2017). Ñaimlap, the Birds, and the Sea: Viewing an Ancient Peruvian Legend through the Lens of Onomastics. *Names*, 65(3), 154-166.
- USAID. 2011. Peru Climate Change Vulnerability and Adaptation Desktop Study.
- Huertas-Vallejos, L. H. (2001). Diluvios andinos: a través de las fuentes documentales. Fondo Editorial PUCP.
- Van der Schalie, W. H., Gardner Jr, H. S., Bantle, J. A., De Rosa, C. T., Finch, R. A., Reif, J. S., ... & Stokes, W. S. (1999). Animals as sentinels of human health hazards of environmental chemicals. *Environmental health perspectives*, 107(4), 309-315.

Van Buren, Mary.(2001). "The Archaeology of El Niño Events and Other 'Natural' Disasters." *Journal of Archaeological Method and Theory* 8 (2): 129–49.
<https://doi.org/10.1023/A:1011397001694>.

Van der Leeuw, S., & Redman, C. L. (2002). Placing archaeology at the center of socio-natural studies. *American antiquity*, 67(4), 597-605.

Venet-Rogers, Claire, "A Study of Faunal Consumption at the Huaca Gallinazo Group Site, Northern Coast of Peru" (2013). Electronic Thesis and Dissertation Repository. 1749.
<https://ir.lib.uwo.ca/etd/1749>

Vianna, J. A., Cortes, M., Ramos, B., Sallaberry-Pincheira, N., González-Acuña, D., Dantas, G. P., ... & Luna-Jorquera, G. (2014). Changes in abundance and distribution of Humboldt penguin *Spheniscus Humboldti*. *Marine Ornithology*, 42, 153-159.

Visser, G. H. (2001). Chick growth and development in seabirds. *Biology of marine birds*. Edited by EA Schreiber and J. Burger. CRC Press, Boca Raton, Fla, 439-465.

Wallace JM, Rasmusson EM, Mitchell TP, Kousky VE, Sarachik ES, von Storch H (1998) On the structure and evolution of ENSO- related climate variability in the tropical Pacific: lessons from TOGA. *J Geophys Res* 103(C7):14241–14259

Wantanabe, Luis K. 1995. *Culturas preincas del Perú [Pre-Inka cultures of Peru]*. Lima: COFIDE.

Warner, J. P. (2014). Production, Discard, and Urban Life at the Early Horizon Center of Caylán, Coastal Peru.

Weng, H., Ashok, K., Behera, S. K., Rao, S. A., & Yamagata, T. (2007). Impacts of recent El Niño Modoki on dry/wet conditions in the Pacific rim during boreal summer. *Climate dynamics*, 29(2), 113-129.

Wege, D. C., Anadón-Irizarry, V., Mugica, S. A., BirdLife International, & Balman, M. (2009). *Important Bird Areas Americas: Priority Sites for Biodiversity Conservation*. Birdlife International.

Weichler, T., S. Garthe, G. Luna-Jorquera, J. and Moraga (2004) Seabird distribution on the Humboldt Current in northern Chile in relation to hydrography, productivity, and fisheries. *ICES Journal of Marine Science* 61: 148–154.

Whelan, C. J., Wenny, D. G., & Marquis, R. J. (2008). Ecosystem services provided by birds. *Annals of the New York academy of sciences*, 1134(1), 25-60.

Whittaker, J. (2017). *Deadly Flight: Birds and Atlatls*. The Missouri Archaeologist Volume.

Wiley, A. E., James, H. F., & Ostrom, P. H. (2017) Emerging Techniques for Isotope Studies of Avian Ecology 1. In the *Extended Specimen* (pp. 89-110). CRC Press.

Winkler, D. W., S. M. Billerman, and I.J. Lovette (2020). Ducks, Geese, and Waterfowl (Anatidae), version 1.0. In *Birds of the World* (S. M. Billerman, B. K. Keeney, P. G. Rodewald, and T. S. Schulenberg, Editors). Cornell Lab of Ornithology, Ithaca, NY, USA.

Winkler, D. W., S. M. Billerman, and I.J. Lovette (2020). Rails, Gallinules, and Coots (Rallidae), version 1.0. In *Birds of the World* (S. M. Billerman, B. K. Keeney, P. G. Rodewald, and T. S. Schulenberg, Editors). Cornell Lab of Ornithology, Ithaca, NY, USA.

Winkler, D. W., S. M. Billerman, and I.J. Lovette (2020). Sandpipers and Allies (Scolopacidae), version 1.0. In *Birds of the World* (S. M. Billerman, B. K. Keeney, P. G. Rodewald, and T. S. Schulenberg, Editors). Cornell Lab of Ornithology, Ithaca, NY, USA.

Winkler, D. W., S. M. Billerman, and I.J. Lovette (2020). Pigeons and Doves (Columbidae), version 1.0. In *Birds of the World* (S. M. Billerman, B. K. Keeney, P. G. Rodewald, and T. S. Schulenberg, Editors). Cornell Lab of Ornithology, Ithaca, NY, USA.

Winkler, D. W., S. M. Billerman, and I.J. Lovette (2020). Crows, Jays, and Magpies (Corvidae), version 1.0. In *Birds of the World* (S. M. Billerman, B. K. Keeney, P. G. Rodewald, and T. S. Schulenberg, Editors). Cornell Lab of Ornithology, Ithaca, NY, USA.

Winkler, D. W., S. M. Billerman, and I.J. Lovette (2020). Guans, Chachalacas, and Curassows (Cracidae), version 1.0. In *Birds of the World* (S. M. Billerman, B. K. Keeney, P. G. Rodewald, and T. S. Schulenberg, Editors). Cornell Lab of Ornithology, Ithaca, NY, USA.

Winkler, D. W., S. M. Billerman, and I.J. Lovette (2020). Finches, Euphonias, and Allies (Fringillidae), version 1.0. In *Birds of the World* (S. M. Billerman, B. K. Keeney, P. G. Rodewald, and T. S. Schulenberg, Editors). Cornell Lab of Ornithology, Ithaca, NY, USA.

Winkler, D. W., S. M. Billerman, and I.J. Lovette (2020). Mockingbirds and Thrashers (Mimidae), version 1.0. In *Birds of the World* (S. M. Billerman, B. K. Keeney, P. G. Rodewald, and T. S. Schulenberg, Editors). Cornell Lab of Ornithology, Ithaca, NY, USA.

Winkler, D. W., S. M. Billerman, and I.J. Lovette (2020). New World Sparrows (Passerellidae), version 1.0. In *Birds of the World* (S. M. Billerman, B. K. Keeney, P. G. Rodewald, and T. S. Schulenberg, Editors). Cornell Lab of Ornithology, Ithaca, NY, USA.

Winkler, D. W., S. M. Billerman, and I.J. Lovette (2020). New World and African Parrots (Psittacidae), version 1.0. In *Birds of the World* (S. M. Billerman, B. K. Keeney, P. G. Rodewald, and T. S. Schulenberg, Editors). Cornell Lab of Ornithology, Ithaca, NY, USA.

Winkler, D. W., S. M. Billerman, and I. J. Lovette (2020). Owls (Strigidae), version 1.0. In *Birds of the World* (S. M. Billerman, B. K. Keeney, P. G. Rodewald, and T. S. Schulenberg, Editors). Cornell Lab of Ornithology, Ithaca, NY, USA.

Winkler, D. W., S. M. Billerman, and I.J. Lovette (2020). Tinamous (Tinamidae), version 1.0. In *Birds of the World* (S. M. Billerman, B. K. Keeney, P. G. Rodewald, and T. S. Schulenberg, Editors). Cornell Lab of Ornithology, Ithaca, NY, USA.

Wolfe, E. F. (1981). The Spotted Cat and the Horrible Bird; Stylistic Change in Nasca 1–5 Ceramic Decoration. *Ñawpa Pacha*, 19(1), 1-62.

World Bank Group. (2013, August 12). Peru: a Mega-Diverse Country Investing in National Protected Areas. World Bank. <https://www.worldbank.org/en/news/feature/2013/06/06/peru-pais-megadiverso-que-invierte-en-areas-naturales-protegidas-gpan-pronap>

Wormworth, J., & Sekercioglu, C. H. (2011). *Winged sentinels: birds and climate change*. Cambridge University Press.

Yakovleff, Eugenio. (1932). Las Falconidas en el arte y en las creencias de los antiguos Peruanos [The Falconidae in the art and the beliefs of the ancient Peruvians]. *Revista del Museo Nacional* 1, no. 1: 33–111

APPENDIX A

Tabulated results of the published meta-data from 17 out of the 26 sites examined in this thesis.

Site	Dates	Chronological Designation	Common Name	Taxon	NISP	References
Carrizales	1566-1572	Colonial Period	Chicken order	<i>Galliformes</i>	29	Kennedy and VanValkenburgh, 2016
Carrizales	1566-1572	Colonial Period	Domestic chicken	<i>Gallus gallus</i>	72	Kennedy and VanValkenburgh, 2016
Carrizales	1566-1572	Colonial Period	Duck, goose order	<i>Anseriformes</i>	4	Kennedy and VanValkenburgh, 2016
Carrizales	1566-1572	Colonial Period	Domestic goose	<i>Anser anser</i>	3	Kennedy and VanValkenburgh, 2016
Carrizales	1566-1572	Colonial Period	Muscovy duck	<i>Cairina moschata</i>	2	Kennedy and VanValkenburgh, 2016
Carrizales	1566-1572	Colonial Period	Humboldt penguin	<i>Spheniscus humboldti</i>	1	Kennedy and VanValkenburgh, 2016
Carrizales	1566-1572	Colonial Period	Ibis	<i>Ciconiiformes</i>	1	Kennedy and VanValkenburgh, 2016
Carrizales	1566-1572	Colonial Period	Pelicans	<i>Pelecaniformes</i>	1	Kennedy and VanValkenburgh, 2016
Carrizales	1566-1572	Colonial Period	Cormorant unsp.	<i>Phalacrocorax sp.</i>	15	Kennedy and VanValkenburgh, 2016
Carrizales	1566-1572	Colonial Period	Booby unsp.	<i>Sula sp.</i>	6	Kennedy and VanValkenburgh, 2016
Carrizales	1566-1572	Colonial Period	Pigeons and doves	<i>Columbidae</i>	95	Kennedy and VanValkenburgh, 2016
Carrizales	1566-1572	Colonial Period	Songbirds	<i>Passeriformes</i>	1	Kennedy and VanValkenburgh, 2016
Carrizales	1566-1572	Colonial Period	Small aves uid	Unidentified	12	Kennedy and VanValkenburgh, 2016
Carrizales	1566-1572	Colonial Period	Aves uid	Unidentified	512	Kennedy and VanValkenburgh, 2016
Carrizales	1566-1572	Colonial Period	Large aves uid	Unidentified	105	Kennedy and VanValkenburgh, 2016
Carrizales	1150-1350 CE	Late Horizon	Shearwater unsp.	<i>Procellariiformes</i>	1	Kennedy and VanValkenburgh, 2016
Carrizales	1150-1350 CE	Late Horizon	Cormorant unsp.	<i>Phalacrocorax sp.</i>	26	Kennedy and VanValkenburgh, 2016
Carrizales	1150-1350 CE	Late Horizon	Booby unsp.	<i>Sula sp.</i>	1	Kennedy and VanValkenburgh, 2016
Carrizales	1150-1350 CE	Late Horizon	Songbirds	<i>Passeriformes</i>	3	Kennedy and VanValkenburgh, 2016
Carrizales	1150-1350 CE	Late Horizon	Small aves uid	Unidentified	17	Kennedy and VanValkenburgh, 2016
Carrizales	1150-1350 CE	Late Horizon	Aves uid	Unidentified	80	Kennedy and VanValkenburgh, 2016
Carrizales	1150-1350 CE	Late Horizon	Large aves uid	Unidentified	44	Kennedy and VanValkenburgh, 2016
Lo Demás	1480-1532	Late Horizon	Gulls	<i>Laridae</i>	15	Sandweiss, 1989
Lo Demás	1480-1532	Late Horizon	Gulls	<i>Laridae</i>	32	Sandweiss, 1989
Lo Demás	1480-1532	Late Horizon	Band-tailed gull	<i>Larus Belcheri</i>	3	Sandweiss, 1989
Lo Demás	1480-1532	Late Horizon	Gull unsp.	<i>Larus sp.</i>	2	Sandweiss, 1989
Lo Demás	1480-1532	Late Horizon	Cormorants	<i>Phalacrocoracidae</i>	6	Sandweiss, 1989
Lo Demás	1480-1532	Late Horizon	Cormorant unsp.	<i>Phalacrocorax sp.</i>	55	Sandweiss, 1989
Lo Demás	1480-1532	Late Horizon	Cormorant unsp.	<i>Phalacrocorax sp.</i>	79	Sandweiss, 1989
Lo Demás	1480-1532	Late Horizon	Pelican unsp.	<i>Pelicanus sp.</i>	7	Sandweiss, 1989
Lo Demás	1480-1532	Late Horizon	Pelican unsp.	<i>Pelicanus sp.</i>	25	Sandweiss, 1989
Lo Demás	1480-1532	Late Horizon	Peruvian booby	<i>Sula variegata</i>	14	Sandweiss, 1989
Lo Demás	1480-1532	Late Horizon	Peruvian booby	<i>Sula variegata</i>	5	Sandweiss, 1989
Lo Demás	1480-1532	Late Horizon	Booby unsp.	<i>Sula sp.</i>	4	Sandweiss, 1989
Lo Demás	1480-1532	Late Horizon	Booby unsp.	<i>Sula sp.</i>	14	Sandweiss, 1989
Lo Demás	1480-1532	Late Horizon	Dove unsp.	<i>Zenaida sp.</i>	14	Sandweiss, 1989
Lo Demás	1480-1532	Late Horizon	Dove unsp.	<i>Zenaida sp.</i>	1	Sandweiss, 1989
Lo Demás	1480-1532	Late Horizon	Unid. Seabird	Unidentified	43	Sandweiss, 1989
Lo Demás	1480-1532	Late Horizon	Sm. Unid. Seabird	Unidentified	8	Sandweiss, 1989
Lo Demás	1480-1532	Late Horizon	Sm. Unid. Seabird	Unidentified	8	Sandweiss, 1989
Lo Demás	1480-1532	Late Horizon	Md. Unid. Seabird	Unidentified	7	Sandweiss, 1989
Lo Demás	1480-1532	Late Horizon	Md. Unid. Seabird	Unidentified	44	Sandweiss, 1989
Lo Demás	1480-1532	Late Horizon	Lg. Unid. Seabird	Unidentified	1	Sandweiss, 1989
Lo Demás	1480-1532	Late Horizon	Aves uid	Unidentified	1	Sandweiss, 1989
Lo Demás	1480-1532	Late Horizon	Small aves uid	Unidentified	4	Sandweiss, 1989
Lo Demás	1480-1532	Late Horizon	Medium aves uid	Unidentified	4	Sandweiss, 1989
Lo Demás	1480-1532	Late Horizon	Large aves uid	Unidentified	1	Sandweiss, 1989
Cerro Azul	1000-1470 AD	Late Intermediate Period	Humboldt penguin	<i>Spheniscus humboldti</i>	1	Marcus, 2015
Cerro Azul	1000-1470 AD	Late Intermediate Period	Guanay cormorant	<i>Phalacrocorax bougainvillei</i>	20	Marcus, 2015
Cerro Azul	1000-1470 AD	Late Intermediate Period	Red-legged cormorant	<i>Phalacrocorax gaimar</i>	2	Marcus, 2015
Cerro Azul	1000-1470 AD	Late Intermediate Period	Cormorant unsp.	<i>Phalacrocorax sp.</i>	46	Marcus, 2015
Cerro Azul	1000-1470 AD	Late Intermediate Period	Peruvian pelican	<i>Pelicanus thagus</i>	1	Marcus, 2015

Site	Dates	Chronological Designation	Common Name	Taxon	NISP	References
Cerro Azul	1000-1470 AD	Late Intermediate Period	Common moorhen	<i>Gallinula chloropus</i>	1	Marcus, 2015
Cerro Azul	1000-1470 AD	Late Intermediate Period	Andean coot	<i>Fulica ardesiaca</i>	2	Marcus, 2015
Cerro Azul	1000-1470 AD	Late Intermediate Period	Sandpiper unsp.	<i>Scolopacidae unsp.</i>	3	Marcus, 2015
Cerro Azul	1000-1470 AD	Late Intermediate Period	Sandpiper unsp.	<i>Scolopacidae</i>	4	Marcus, 2015
Cerro Azul	1000-1470 AD	Late Intermediate Period	Gull or tern		1	Marcus, 2015
Cerro Azul	1000-1470 AD	Late Intermediate Period	Inca tern	<i>Larosterna inca</i>	2	Marcus, 2015
			cf. Band-tailed gull			
Cerro Azul	1000-1470 AD	Late Intermediate Period	cf. gull	<i>cf. Larus Belcheri</i>	1	Marcus, 2015
Cerro Azul	1000-1470 AD	Late Intermediate Period	Dove or pigeon		2	Marcus, 2015
Cerro Azul	1000-1470 AD	Late Intermediate Period	Pigeon unsp.	<i>Patagioenas sp.</i>	1	Marcus, 2015
			cf. West Peruvian dove			
Cerro Azul	1000-1470 AD	Late Intermediate Period	dove	<i>Zenaida meloda</i>	1	Marcus, 2015
Cerro Azul	1000-1470 AD	Late Intermediate Period	cf. Eared dove	<i>Zenaida auriculata</i>	1	Marcus, 2015
Cerro Azul	1000-1470 AD	Late Intermediate Period	Guanay cormorant	<i>Phalacrocorax bougai</i>	7	Marcus, 2015
			Red-legged cormorant			
Cerro Azul	1000-1470 AD	Late Intermediate Period	cormorant	<i>Phalacrocorax gaimar</i>	1	Marcus, 2015
Cerro Azul	1000-1470 AD	Late Intermediate Period	Cormorant unsp.	<i>Phalacrocorax sp.</i>	9	Marcus, 2015
Cerro Azul	1000-1470 AD	Late Intermediate Period	Peruvian pelican	<i>Pelicanus thagus</i>	1	Marcus, 2015
Cerro Azul	1000-1470 AD	Late Intermediate Period	Rails	<i>Rallidae</i>	2	Marcus, 2015
Cerro Azul	1000-1470 AD	Late Intermediate Period	Sandpiper unsp.	<i>Scolopacidae unsp.</i>	1	Marcus, 2015
Cerro Azul	1000-1470 AD	Late Intermediate Period	Pigeon unsp.	<i>Patagioenas sp.</i>	1	Marcus, 2015
Cerro Azul	1000-1470 AD	Late Intermediate Period	Guanay cormorant	<i>Phalacrocorax bougai</i>	3	Marcus, 2015
Cerro Azul	1000-1470 AD	Late Intermediate Period	Pelican unsp.	<i>Pelicanus sp.</i>	1	Marcus, 2015
Cerro Azul	1000-1470 AD	Late Intermediate Period	Common moorhen	<i>Gallinula chloropus</i>	1	Marcus, 2015
Cerro Azul	1000-1470 AD	Late Intermediate Period	Peruvian booby	<i>Sula variegata</i>	3	Marcus, 2015
Cerro Azul	1000-1470 AD	Late Intermediate Period	Ducks	<i>Anatidae</i>	1	Marcus, 2015
Cerro Azul	1000-1470 AD	Late Intermediate Period	Plumbeous rail	<i>Rallus sanguinolentus</i>	1	Marcus, 2015
Cerro Azul	1000-1470 AD	Late Intermediate Period	Gull or tern		1	Marcus, 2015
Cerro Azul	1000-1470 AD	Late Intermediate Period	Pelican unsp.	<i>Pelicanus sp.</i>	1	Marcus, 2015
Cerro Azul	1000-1470 AD	Late Intermediate Period	Guanay cormorant	<i>Phalacrocorax bougai</i>	1	Marcus, 2015
Cerro Azul	1000-1470 AD	Late Intermediate Period	Guanay cormorant	<i>Phalacrocorax bougai</i>	1	Marcus, 2015
Cerro Azul	1000-1470 AD	Late Intermediate Period	Guanay cormorant	<i>Phalacrocorax bougai</i>	1	Marcus, 2015
Cerro Azul	1000-1470 AD	Late Intermediate Period	Cormorant unsp.	<i>Phalacrocorax sp.</i>	1	Marcus, 2015
Cerro Azul	1000-1470 AD	Late Intermediate Period	Ducks	<i>Anatidae</i>	1	Marcus, 2015
Cerro Azul	1000-1470 AD	Late Intermediate Period	Guanay cormorant	<i>Phalacrocorax bougai</i>	5	Marcus, 2015
Cerro Azul	1000-1470 AD	Late Intermediate Period	Red-legged	<i>Phalacrocorax gaimar</i>	1	Marcus, 2015
Cerro Azul	1000-1470 AD	Late Intermediate Period	Cormorant unsp.	<i>Phalacrocorax sp.</i>	1	Marcus, 2015
Cerro Azul	1000-1470 AD	Late Intermediate Period	cf. Peruvian booby	<i>cf. Sula variegata</i>	1	Marcus, 2015
			cf. Lesser yellowlegs			
Cerro Azul	1000-1470 AD	Late Intermediate Period	yellowlegs	<i>cf. Tringa flavipes</i>	1	Marcus, 2015
Cerro Azul	1000-1470 AD	Late Intermediate Period	cf. Inca tern	<i>cf. Larosterna inca</i>	1	Marcus, 2015
Cerro Azul	1000-1470 AD	Late Intermediate Period	Parrot unsp.	<i>Psittacoidea sp.</i>	1	Marcus, 2015
Cerro Azul	1000-1470 AD	Late Intermediate Period	Peruvian pelican	<i>Pelicanus thagus</i>	1	Marcus, 2015
Cerro Azul	1000-1470 AD	Late Intermediate Period	cf. Andean coot	<i>cf. Fulica ardesiaca</i>	1	Marcus, 2015
Cerro Azul	1000-1470 AD	Late Intermediate Period	Guanay cormorant	<i>Phalacrocorax bougai</i>	1	Marcus, 2015
Cerro Azul	1000-1470 AD	Late Intermediate Period	Duck unsp.	<i>Anatidae sp.</i>	1	Marcus, 2015
Cerro Azul	1000-1470 AD	Late Intermediate Period	cf. Andean coot	<i>cf. Fulica ardesiaca</i>	1	Marcus, 2015
Cerro Azul	1000-1470 AD	Late Intermediate Period	Sandpiper unsp.	<i>Scolopacidae unsp.</i>	1	Marcus, 2015
Cerro Azul	1000-1470 AD	Late Intermediate Period	Inca tern	<i>Larosterna inca</i>	1	Marcus, 2015
Cerro Azul	1000-1470 AD	Late Intermediate Period	Grey gull	<i>Leucophaeus modestus</i>	1	Marcus, 2015
Cerro Azul	1000-1470 AD	Late Intermediate Period	Band-tailed gull	<i>Larus Belcheri</i>	1	Marcus, 2015
Cerro Azul	1000-1470 AD	Late Intermediate Period	Peruvian booby	<i>Sula variegata</i>	2	Marcus, 2015

Site	Dates	Chronological Designation	Common Name	Taxon	NISP	References
Cerro Azul	1000-1470 AD	Late Intermediate Period	Peruvian booby	<i>Sula variegata</i>	2	Marcus, 2015
Cerro Azul	1000-1470 AD	Late Intermediate Period	Guanay cormorant	<i>Phalacrocorax bougaini</i>	3	Marcus, 2015
Cerro Azul	1000-1470 AD	Late Intermediate Period	Cormorant unsp.	<i>Phalacrocorax sp.</i>	3	Marcus, 2015
Cerro Azul	1000-1470 AD	Late Intermediate Period	Peruvian booby	<i>Sula variegata</i>	3	Marcus, 2015
Cerro Azul	1000-1470 AD	Late Intermediate Period	Pelican unsp.	<i>Pelicanus sp.</i>	2	Marcus, 2015
Cerro Azul	1000-1470 AD	Late Intermediate Period	Grey gull	<i>Leucophaeus modestus</i>	1	Marcus, 2015
Cerro Azul	1000-1470 AD	Late Intermediate Period	Guanay cormorant	<i>Phalacrocorax bougaini</i>	1	Marcus, 2015
Cerro Azul	1000-1470 AD	Late Intermediate Period	Cormorant unsp.	<i>Phalacrocorax sp.</i>	2	Marcus, 2015
Cerro Azul	1000-1470 AD	Late Intermediate Period	Inca tern	<i>Larosterna inca</i>	2	Marcus, 2015
Los Gavilanes	~3400-4650 BF	Middle Horizon	Penguin unsp.	<i>Spheniscus sp.</i>	3	Bonavia, 1982
Los Gavilanes	~3400-4650 BF	Middle Horizon	Petrels	<i>Procellariidae</i>	5	Bonavia, 1982
Los Gavilanes	~3400-4650 BF	Middle Horizon	Pelicans	<i>Pelecaniformes</i>	1	Bonavia, 1982
Los Gavilanes	~3400-4650 BF	Middle Horizon	Pelican unsp.	<i>Pelicanus sp.</i>	11	Bonavia, 1982
Los Gavilanes	~3400-4650 BF	Middle Horizon	Cormorant unsp.	<i>Phalacrocorax sp.</i>	141	Bonavia, 1982
Los Gavilanes	~3400-4650 BF	Middle Horizon	Booby unsp.	<i>Sula sp.</i>	24	Bonavia, 1982
Los Gavilanes	~3400-4650 BF	Middle Horizon	Rails	<i>Rallidae</i>	1	Bonavia, 1982
Los Gavilanes	~3400-4650 BF	Middle Horizon	Sandpiper unsp.	<i>Scolopacidae</i>	3	Bonavia, 1982
Los Gavilanes	~3400-4650 BF	Middle Horizon	Gull unsp.	<i>Larus sp.</i>	16	Bonavia, 1982
Galindo	700-800 AD	Middle Horizon	Melodious blackbird	<i>Dives Dives</i>	4	Lockard, 2005, Table 7
Galindo	700-800 AD	Middle Horizon	Gulls unsp.	<i>Larus sp.</i>	4	Lockard, 2005, Table 7
Galindo	700-800 AD	Middle Horizon	Guanay cormorant	<i>Phalacrocorax bougaini</i>	32	Lockard, 2005, Table 7
Galindo	700-800 AD	Middle Horizon	Unid. Bird	Unidentified	11	Lockard, 2005, Table 7
Huacas de Moche	470-600 AD	Early Intermediate Period	Guanay cormorant	<i>Phalacrocorax bougaini</i>	10	Roselló et al, 2001; p. 78
Huacas de Moche	470-600 AD	Early Intermediate Period	Cormorant unsp.	<i>Phalacrocorax sp.</i>	1	Roselló et al, 2001; p. 78
Huacas de Moche	470-600 AD	Early Intermediate Period	Peruvian booby	<i>Sula variegata</i>	3	Roselló et al, 2001; p. 78
Huacas de Moche	470-600 AD	Early Intermediate Period	cf. Peruvian booby	<i>Sula cf. variegata</i>	2	Roselló et al, 2001; p. 78
Huacas de Moche	470-600 AD	Early Intermediate Period	Gull unsp.	<i>Larus sp.</i>	5	Roselló et al, 2001; p. 78
Huacas de Moche	470-600 AD	Early Intermediate Period	Heron unsp.	<i>cf. Butorides atratus</i>	1	Roselló et al, 2001; p. 78
Huaca Santa Clara	200 BCE-800 CE	Early Intermediate Period	Unid. Bird	Unidentified	22	Johns, 2017; Table 7 p. 56-58
Huaca Santa Clara	200 BCE-800 CE	Early Intermediate Period	Great horned owl	<i>Bubo virginianus</i>	1	Johns, 2017; Table 7 p. 56-58
Huaca Santa Clara	200 BCE-800 CE	Early Intermediate Period	Plover unsp.	<i>Charadrius sp.</i>	2	Johns, 2017; Table 7 p. 56-58
Huaca Santa Clara	200 BCE-800 CE	Early Intermediate Period	Gull unsp.	<i>Larus sp.</i>	3	Johns, 2017; Table 7 p. 56-58
Huaca Santa Clara	200 BCE-800 CE	Early Intermediate Period	Pelican unsp.	<i>Pelicanus sp.</i>	1	Johns, 2017; Table 7 p. 56-58
Huaca Santa Clara	200 BCE-800 CE	Early Intermediate Period	Guanay cormorant	<i>Phalacrocorax bougaini</i>	2	Johns, 2017; Table 7 p. 56-58
Huaca Santa Clara	200 BCE-800 CE	Early Intermediate Period	Humboldt penguin	<i>Spheniscus humboldti</i>	1	Johns, 2017; Table 7 p. 56-58
Huaca Santa Clara	200 BCE-800 CE	Early Intermediate Period	Booby unsp.	<i>Sula sp.</i>	12	Johns, 2017; Table 7 p. 56-58
Huaca Santa Clara	200 BCE-800 CE	Early Intermediate Period	Peruvian booby	<i>Sula variegata</i>	1	Johns, 2017; Table 7 p. 56-58
Huaca Santa Clara	200 BCE-800 CE	Early Intermediate Period	White winged dove	<i>Zenaida asiatica meloc</i>	1	Johns, 2017; Table 7 p. 56-58
Huaca Santa Clara	200 BCE-800 CE	Early Intermediate Period	Unid. Bird	Unidentified	7	Johns, 2017; Table 7 p. 56-58
Huaca Santa Clara	200 BCE-800 CE	Early Intermediate Period	Great horned owl	<i>Bubo virginianus</i>	1	Johns, 2017; Table 7 p. 56-58
Huaca Santa Clara	200 BCE-800 CE	Early Intermediate Period	Albatross unsp.	<i>Diomedea sp.</i>	1	Johns, 2017; Table 7 p. 56-58
Huaca Santa Clara	200 BCE-800 CE	Early Intermediate Period	Gull unsp.	<i>Larus sp.</i>	1	Johns, 2017; Table 7 p. 56-58
Huaca Santa Clara	200 BCE-800 CE	Early Intermediate Period	Pelican unsp.	<i>Pelicanus sp.</i>	1	Johns, 2017; Table 7 p. 56-58
Huaca Santa Clara	200 BCE-800 CE	Early Intermediate Period	Cormorants	<i>Phalacrocoracidae</i>	1	Johns, 2017; Table 7 p. 56-58
Huaca Santa Clara	200 BCE-800 CE	Early Intermediate Period	Guanay cormorant	<i>Phalacrocorax bougaini</i>	1	Johns, 2017; Table 7 p. 56-58
Huaca Santa Clara	200 BCE-800 CE	Early Intermediate Period	Grebe unsp.	<i>Podiceps sp.</i>	1	Johns, 2017; Table 7 p. 56-58
Huaca Santa Clara	200 BCE-800 CE	Early Intermediate Period	Peruvian meadowlark	<i>Sturnella bellicosa</i>	2	Johns, 2017; Table 7 p. 56-58
Huaca Santa Clara	200 BCE-800 CE	Early Intermediate Period	Booby unsp.	<i>Sula sp.</i>	7	Johns, 2017; Table 7 p. 56-58
Huaca Santa Clara	200 BCE-800 CE	Early Intermediate Period	Peruvian booby	<i>Sula variegata</i>	1	Johns, 2017; Table 7 p. 56-58
Huaca Santa Clara	200 BCE-800 CE	Early Intermediate Period	Boobys	<i>Sulidae</i>	1	Johns, 2017; Table 7 p. 56-58
Huaca Gallinazo	100 BCE-700 CE	Early Intermediate Period	Unid. Bird	Unidentified	196	Johns, 2017; Table 8 p. 58-60; Venet-Rog

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Huaca Gallinazo	100 BCE-700 CE	Early Intermediate Period	Duck unsp.	<i>Anas sp.</i>	7	Johns, 2017; Table 8 p. 58-60; Venet-Rogers, 2014
Huaca Gallinazo	100 BCE-700 CE	Early Intermediate Period	Ducks	<i>Anatidae</i>	1	Johns, 2017; Table 8 p. 58-60; Venet-Rogers, 2015
Huaca Gallinazo	100 BCE-700 CE	Early Intermediate Period	Shorebirds	<i>Charadriiformes</i>	1	Johns, 2017; Table 8 p. 58-60; Venet-Rogers, 2016
Huaca Gallinazo	100 BCE-700 CE	Early Intermediate Period	Common moorhen	<i>Gallinula chloropus</i>	1	Johns, 2017; Table 8 p. 58-60; Venet-Rogers, 2017
Huaca Gallinazo	100 BCE-700 CE	Early Intermediate Period	Domestic chicken	<i>Gallus gallus</i>	4	Johns, 2017; Table 8 p. 58-60; Venet-Rogers, 2018
Huaca Gallinazo	100 BCE-700 CE	Early Intermediate Period	New World blackbirds	<i>Icteridae</i>	3	Johns, 2017; Table 8 p. 58-60; Venet-Rogers, 2019
Huaca Gallinazo	100 BCE-700 CE	Early Intermediate Period	Gulls	<i>Laridae</i>	2	Johns, 2017; Table 8 p. 58-60; Venet-Rogers, 2020
Huaca Gallinazo	100 BCE-700 CE	Early Intermediate Period	Gull unsp.	<i>Larus sp.</i>	19	Johns, 2017; Table 8 p. 58-60; Venet-Rogers, 2021
Huaca Gallinazo	100 BCE-700 CE	Early Intermediate Period	Songbirds	<i>Passeriformes</i>	3	Johns, 2017; Table 8 p. 58-60; Venet-Rogers, 2022
Huaca Gallinazo	100 BCE-700 CE	Early Intermediate Period	Peruvian pelican	<i>Pelicanus thagus</i>	1	Johns, 2017; Table 8 p. 58-60; Venet-Rogers, 2023
Huaca Gallinazo	100 BCE-700 CE	Early Intermediate Period	Guanay cormorant	<i>Phalacrocorax bougainvillei</i>	90	Johns, 2017; Table 8 p. 58-60; Venet-Rogers, 2024
Huaca Gallinazo	100 BCE-700 CE	Early Intermediate Period	Petrels	<i>Procellariidae</i>	1	Johns, 2017; Table 8 p. 58-60; Venet-Rogers, 2025
Huaca Gallinazo	100 BCE-700 CE	Early Intermediate Period	Plumbeous rail	<i>Rallus sanguinolentus</i>	2	Johns, 2017; Table 8 p. 58-60; Venet-Rogers, 2026
Huaca Gallinazo	100 BCE-700 CE	Early Intermediate Period	Humboldt penguin	<i>Spheniscus humboldti</i>	25	Johns, 2017; Table 8 p. 58-60; Venet-Rogers, 2027
Huaca Gallinazo	100 BCE-700 CE	Early Intermediate Period	Peruvian meadowlark	<i>Sturnella bellicosa</i>	3	Johns, 2017; Table 8 p. 58-60; Venet-Rogers, 2028
Huaca Gallinazo	100 BCE-700 CE	Early Intermediate Period	Booby unsp.	<i>Sula sp.</i>	142	Johns, 2017; Table 8 p. 58-60; Venet-Rogers, 2029
Huaca Gallinazo	100 BCE-700 CE	Early Intermediate Period	White winged dove	<i>Zenaida asiatica meloc</i>	3	Johns, 2017; Table 8 p. 58-60; Venet-Rogers, 2030
Huaca Gallinazo	100 BCE-700 CE	Early Intermediate Period	Dove unsp.	<i>Zenaidura sp.</i>	3	Johns, 2017; Table 8 p. 58-60; Venet-Rogers, 2031
Huaca Gallinazo	100 BCE-700 CE	Early Intermediate Period	Unid. Bird	Unidentified	151	Johns, 2017; Table 8 p. 58-60; Venet-Rogers, 2032
Huaca Gallinazo	100 BCE-700 CE	Early Intermediate Period	Sandpiper unsp.	<i>Calidris sp.</i>	1	Johns, 2017; Table 8 p. 58-60; Venet-Rogers, 2033
Huaca Gallinazo	100 BCE-700 CE	Early Intermediate Period	New World dove	<i>Columbina sp.</i>	1	Johns, 2017; Table 8 p. 58-60; Venet-Rogers, 2034
Huaca Gallinazo	100 BCE-700 CE	Early Intermediate Period	American Kestrel	<i>Falco sparverius peru</i>	5	Johns, 2017; Table 8 p. 58-60; Venet-Rogers, 2035
Huaca Gallinazo	100 BCE-700 CE	Early Intermediate Period	(Peru) Gulls	<i>Laridae</i>	5	Johns, 2017; Table 8 p. 58-60; Venet-Rogers, 2036
Huaca Gallinazo	100 BCE-700 CE	Early Intermediate Period	Gull unsp.	<i>Larus sp.</i>	11	Johns, 2017; Table 8 p. 58-60; Venet-Rogers, 2037
Huaca Gallinazo	100 BCE-700 CE	Early Intermediate Period	Peruvian pelican	<i>Pelicanus thagus</i>	2	Johns, 2017; Table 8 p. 58-60; Venet-Rogers, 2038
Huaca Gallinazo	100 BCE-700 CE	Early Intermediate Period	Cormorants	<i>Phalacrocoracidae</i>	1	Johns, 2017; Table 8 p. 58-60; Venet-Rogers, 2039
Huaca Gallinazo	100 BCE-700 CE	Early Intermediate Period	Guanay cormorant	<i>Phalacrocorax bougainvillei</i>	45	Johns, 2017; Table 8 p. 58-60; Venet-Rogers, 2040
Huaca Gallinazo	100 BCE-700 CE	Early Intermediate Period	Rails	<i>Rallidae</i>	4	Johns, 2017; Table 8 p. 58-60; Venet-Rogers, 2041
Huaca Gallinazo	100 BCE-700 CE	Early Intermediate Period	Humboldt penguin	<i>Spheniscus humboldti</i>	12	Johns, 2017; Table 8 p. 58-60; Venet-Rogers, 2042
Huaca Gallinazo	100 BCE-700 CE	Early Intermediate Period	Booby unsp.	<i>Sula sp.</i>	141	Johns, 2017; Table 8 p. 58-60; Venet-Rogers, 2043
Huaca Gallinazo	100 BCE-700 CE	Early Intermediate Period	Peruvian booby	<i>Sula variegata</i>	3	Johns, 2017; Table 8 p. 58-60; Venet-Rogers, 2044
Huaca Gallinazo	100 BCE-700 CE	Early Intermediate Period	Eared dove	<i>Zenaida auriculata</i>	1	Johns, 2017; Table 8 p. 58-60; Venet-Rogers, 2045
Samanco	500-1 BC	Early Horizon	Guanay cormorant	<i>Phalacrocorax bougainvillei</i>	146	Helmer, 2015
Samanco	500-1 BC	Early Horizon	Croaking ground dove	<i>Columbina cruziana</i>	86	Helmer, 2015
Samanco	500-1 BC	Early Horizon	Peruvian diving petrel	<i>Pelecanoides garnotii</i>	69	Helmer, 2015
Samanco	500-1 BC	Early Horizon	Cormorant unsp.	<i>Phalacrocorax sp.</i>	52	Helmer, 2015
Samanco	500-1 BC	Early Horizon	Franklin's gull	<i>Larus pipixcan</i>	26	Helmer, 2015
Samanco	500-1 BC	Early Horizon	Songbirds	<i>Passeriformes</i>	70	Helmer, 2015
Samanco	500-1 BC	Early Horizon	Band-tailed gull	<i>Larus belcheri</i>	74	Helmer, 2015
Samanco	500-1 BC	Early Horizon	Peruvian pelican	<i>Pelicanus thagus</i>	40	Helmer, 2015
Samanco	500-1 BC	Early Horizon	Peruvian booby	<i>Sula variegata</i>	10	Helmer, 2015
Samanco	500-1 BC	Early Horizon	Neotropic cormorant	<i>Phalacrocorax brasilic</i>	18	Helmer, 2015
Samanco	500-1 BC	Early Horizon	Inca tern	<i>Larosterna inca</i>	12	Helmer, 2015
Samanco	500-1 BC	Early Horizon	Shorebirds	<i>Charadriiformes</i>	5	Helmer, 2015
Samanco	500-1 BC	Early Horizon	Pelicans	<i>Pelecaniformes</i>	4	Helmer, 2015
Samanco	500-1 BC	Early Horizon	Andean condor	<i>Vultur gryphus</i>	4	Helmer, 2015
Samanco	500-1 BC	Early Horizon	Rails	<i>Rallidae</i>	6	Helmer, 2015
Samanco	500-1 BC	Early Horizon	Turkey vulture	<i>Cathartes aura</i>	35	Helmer, 2015

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Samanco	500-1 BC	Early Horizon	Humboldt penguin	<i>Spheniscus humboldti</i>	2 Helmer, 2015
Samanco	500-1 BC	Early Horizon	Petrel unsp.	<i>Procellaria sp.</i>	5 Helmer, 2015
Samanco	500-1 BC	Early Horizon	Sandpiper unsp.	<i>Scolopacidae</i>	2 Helmer, 2015
Samanco	500-1 BC	Early Horizon	Variable hawk	<i>Buteo polyosoma</i>	1 Helmer, 2015
Samanco	500-1 BC	Early Horizon	Sooty shearwater	<i>Puffinus griseus</i>	1 Helmer, 2015
Samanco	500-1 BC	Early Horizon	Barn owl	<i>Tyto alba</i>	1 Helmer, 2015
Samanco	500-1 BC	Early Horizon	Owls	<i>Strigiformes</i>	1 Helmer, 2015
Huambacho	800-200 cal BC	Early Horizon	Unid. Bird	Unidentified	55 Chicoine, 2011, Table 3
Gramalote	1500-1400 cal	Initial Period	Guanay cormorant	<i>Phalacrocorax bougai</i>	453 Prieto, 2015; p.791
Gramalote	1500-1400 cal	Initial Period	Cushuri cormorant	<i>Phalacrocorax olivace</i>	8 Prieto, 2015; p.791
Gramalote	1500-1400 cal	Initial Period	Red-legged cormorant	<i>Phalacrocorax gaimar</i>	5 Prieto, 2015; p.791
Gramalote	1500-1400 cal	Initial Period	Cormorant unsp.	<i>Phalacrocorax sp.</i>	343 Prieto, 2015; p.791
Gramalote	1500-1400 cal	Initial Period	Peruvian booby	<i>Sula variegata</i>	131 Prieto, 2015; p.791
Gramalote	1500-1400 cal	Initial Period	Blue footed booby	<i>Sula neboxii</i>	1 Prieto, 2015; p.791
Gramalote	1500-1400 cal	Initial Period	Booby unsp.	<i>Sula sp.</i>	91 Prieto, 2015; p.791
Gramalote	1500-1400 cal	Initial Period	Peruvian pelican	<i>Pelicanus thagus</i>	168 Prieto, 2015; p.791
Gramalote	1500-1400 cal	Initial Period	Franklin's gull	<i>Larus pipixcan</i>	6 Prieto, 2015; p.791
Gramalote	1500-1400 cal	Initial Period	Dominican gull	<i>Larus dominicanus</i>	1 Prieto, 2015; p.791
Gramalote	1500-1400 cal	Initial Period	Gull unsp.	<i>Larus sp.</i>	75 Prieto, 2015; p.791
Gramalote	1500-1400 cal	Initial Period	Sooty shearwater	<i>Puffinus griseus</i>	12 Prieto, 2015; p.791
Gramalote	1500-1400 cal	Initial Period	Shearwater unsp.	<i>Puffinus sp.</i>	3 Prieto, 2015; p.791
Gramalote	1500-1400 cal	Initial Period	Humboldt penguin	<i>Spheniscus humboldti</i>	74 Prieto, 2015; p.791
Gramalote	1500-1400 cal	Initial Period	Peruvian diving petrel	<i>Pelecanoides garnotii</i>	39 Prieto, 2015; p.791
Gramalote	1500-1400 cal	Initial Period	Royal Tern	<i>Thalasseus maximus</i>	2 Prieto, 2015; p.791
Gramalote	1500-1400 cal	Initial Period	Inca tern	<i>Larosterna inca</i>	2 Prieto, 2015; p.791
Gramalote	1500-1400 cal	Initial Period	Sandpiper unsp.	<i>Scolopacidae</i>	15 Prieto, 2015; p.791
Gramalote	1500-1400 cal	Initial Period	Albatross unsp.	<i>Diomedea sp.</i>	2 Prieto, 2015; p.791
Gramalote	1500-1400 cal	Initial Period	Tern unsp.	<i>Sternidae</i>	5 Prieto, 2015; p.791
Gramalote	1500-1400 cal	Initial Period	Shearwater unsp.	<i>Puffinus sp.</i>	3 Prieto, 2015; p.791
Gramalote	1500-1400 cal	Initial Period	Unid. Bird	Unidentified	2 Prieto, 2015; p.791
Gramalote	1400-1300 cal	Initial Period	Guanay cormorant	<i>Phalacrocorax bougai</i>	1077 Prieto, 2015; p.791
Gramalote	1400-1300 cal	Initial Period	Cushuri cormorant	<i>Phalacrocorax olivace</i>	18 Prieto, 2015; p.791
Gramalote	1400-1300 cal	Initial Period	Red-legged cormorant	<i>Phalacrocorax gaimar</i>	25 Prieto, 2015; p.791
Gramalote	1400-1300 cal	Initial Period	Cormorant unsp.	<i>Phalacrocorax sp.</i>	427 Prieto, 2015; p.791
Gramalote	1400-1300 cal	Initial Period	Peruvian booby	<i>Sula variegata</i>	213 Prieto, 2015; p.791
Gramalote	1400-1300 cal	Initial Period	Blue footed booby	<i>Sula neboxii</i>	3 Prieto, 2015; p.791
Gramalote	1400-1300 cal	Initial Period	Booby unsp.	<i>Sula sp.</i>	122 Prieto, 2015; p.791
Gramalote	1400-1300 cal	Initial Period	Peruvian pelican	<i>Pelicanus thagus</i>	319 Prieto, 2015; p.791
Gramalote	1400-1300 cal	Initial Period	Brown pelican	<i>Pelecanus occidentalis</i>	1 Prieto, 2015; p.791
Gramalote	1400-1300 cal	Initial Period	Franklin's gull	<i>Larus pipixcan</i>	55 Prieto, 2015; p.791
Gramalote	1400-1300 cal	Initial Period	Dominican gull	<i>Larus dominicanus</i>	3 Prieto, 2015; p.791
Gramalote	1400-1300 cal	Initial Period	Laughing gull	<i>Larus atricilla</i>	1 Prieto, 2015; p.791
Gramalote	1400-1300 cal	Initial Period	Gull unsp.	<i>Larus sp.</i>	135 Prieto, 2015; p.791
Gramalote	1400-1300 cal	Initial Period	Sooty shearwater	<i>Puffinus griseus</i>	50 Prieto, 2015; p.791
Gramalote	1400-1300 cal	Initial Period	Shearwater unsp.	<i>Puffinus sp.</i>	11 Prieto, 2015; p.791
Gramalote	1400-1300 cal	Initial Period	Humboldt penguin	<i>Spheniscus humboldti</i>	110 Prieto, 2015; p.791
Gramalote	1400-1300 cal	Initial Period	Peruvian diving petrel	<i>Pelecanoides garnotii</i>	49 Prieto, 2015; p.791
Gramalote	1400-1300 cal	Initial Period	Inca tern	<i>Larosterna inca</i>	1 Prieto, 2015; p.791
Gramalote	1400-1300 cal	Initial Period	Andean condor	<i>Vultur gryphus</i>	3 Prieto, 2015; p.791

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Gramalote	1400-1300 cal	Initial Period	Sandpiper unsp.	<i>Scolopacidae</i>	14	Prieto, 2015; p.791
Gramalote	1400-1300 cal	Initial Period	Albatross unsp.	<i>Diomedea sp.</i>	1	Prieto, 2015; p.791
Gramalote	1400-1300 cal	Initial Period	Hawk unsp.	<i>Accipitridae</i>	1	Prieto, 2015; p.791
Gramalote	1400-1300 cal	Initial Period	Eagle unsp.	<i>Falconidae</i>	1	Prieto, 2015; p.791
Gramalote	1400-1300 cal	Initial Period	Shearwater unsp.	<i>Puffinus sp.</i>	6	Prieto, 2015; p.791
Gramalote	1300-1200 cal	Initial Period	Guanay cormorant	<i>Phalacrocorax bougai</i>	560	Prieto, 2015; p.791
Gramalote	1300-1200 cal	Initial Period	Cushuri cormorant	<i>Phalacrocorax olivaceus</i>	15	Prieto, 2015; p.791
Gramalote	1300-1200 cal	Initial Period	Red-legged cormorant	<i>Phalacrocorax gaimar</i>	7	Prieto, 2015; p.791
Gramalote	1300-1200 cal	Initial Period	Cormorant unsp.	<i>Phalacrocorax sp.</i>	395	Prieto, 2015; p.791
Gramalote	1300-1200 cal	Initial Period	Peruvian booby	<i>Sula variegata</i>	116	Prieto, 2015; p.791
Gramalote	1300-1200 cal	Initial Period	Booby unsp.	<i>Sula sp.</i>	103	Prieto, 2015; p.791
Gramalote	1300-1200 cal	Initial Period	Peruvian pelican	<i>Pelecanus thagus</i>	129	Prieto, 2015; p.791
Gramalote	1300-1200 cal	Initial Period	Brown pelican	<i>Pelecanus occidentalis</i>	1	Prieto, 2015; p.791
Gramalote	1300-1200 cal	Initial Period	Franklin's gull	<i>Larus pipixcan</i>	88	Prieto, 2015; p.791
Gramalote	1300-1200 cal	Initial Period	Dominican gull	<i>Larus dominicanus</i>	1	Prieto, 2015; p.791
Gramalote	1300-1200 cal	Initial Period	Laughing gull	<i>Larus atricilla</i>	7	Prieto, 2015; p.791
Gramalote	1300-1200 cal	Initial Period	Gull unsp.	<i>Larus sp.</i>	56	Prieto, 2015; p.791
Gramalote	1300-1200 cal	Initial Period	Sooty shearwater	<i>Puffinus griseus</i>	31	Prieto, 2015; p.791
Gramalote	1300-1200 cal	Initial Period	Shearwater unsp.	<i>Puffinus sp.</i>	4	Prieto, 2015; p.791
Gramalote	1300-1200 cal	Initial Period	Humboldt penguin	<i>Spheniscus humboldti</i>	81	Prieto, 2015; p.791
Gramalote	1300-1200 cal	Initial Period	Peruvian diving petrel	<i>Pelecanoides garnotii</i>	53	Prieto, 2015; p.791
Gramalote	1300-1200 cal	Initial Period	Royal Tern	<i>Thalasseus maximus</i>	2	Prieto, 2015; p.791
Gramalote	1300-1200 cal	Initial Period	Gaviotin	<i>Sternidae</i>	1	Prieto, 2015; p.791
Gramalote	1300-1200 cal	Initial Period	Inca tern	<i>Larosterna inca</i>	7	Prieto, 2015; p.791
Gramalote	1300-1200 cal	Initial Period	Sandpiper unsp.	<i>Scolopacidae</i>	8	Prieto, 2015; p.791
Gramalote	1300-1200 cal	Initial Period	Albatross unsp.	<i>Diomedea sp.</i>	1	Prieto, 2015; p.791
Gramalote	1300-1200 cal	Initial Period	Shearwater unsp.	<i>Puffinus sp.</i>	2	Prieto, 2015; p.791
Huaca Prieta	14,500-11,400	Late Preceramic/Initial	Gull unsp.	<i>Larus sp.</i>	1	Dillehay, 2017, Table 9.2 p. 217-218
Huaca Prieta	14,500-11,400	Late Preceramic/Initial	Guanay cormorant	<i>Phalacrocorax bougai</i>	3	Dillehay, 2017, Table 9.2 p. 217-218
Huaca Prieta	14,500-11,400	Late Preceramic/Initial	Scrub blackbird	<i>Dives warczewiczi</i>	1	Dillehay, 2017, Table 9.2 p. 217-218
Huaca Prieta	14,500-11,400	Late Preceramic/Initial	Gull unsp.	<i>Larus sp.</i>	2	Dillehay, 2017, Table 9.2 p. 217-218
Huaca Prieta	14,500-11,400	Late Preceramic/Initial	Guanay cormorant	<i>Phalacrocorax bougai</i>	1	Dillehay, 2017, Table 9.2 p. 217-218
Huaca Prieta	11,400-7,571 B	Late Preceramic/Initial	Guanay cormorant	<i>Phalacrocorax bougai</i>	3	Dillehay, 2017, Table 9.3 p. 231-233
Huaca Prieta	11,400-7,571 B	Late Preceramic/Initial	Guanay cormorant	<i>Phalacrocorax bougai</i>	2	Dillehay, 2017, Table 9.3 p. 231-233
Huaca Prieta	7,571-6538 BP	Late Preceramic/Initial	Albatross unsp.	<i>Diomedea sp.</i>	1	Dillehay, 2017, Table 9.4 p. 246
Huaca Prieta	7,571-6538 BP	Late Preceramic/Initial	Albatross unsp.	<i>Diomedea sp.</i>	3	Dillehay, 2017, Table 9.4 p. 246
Huaca Prieta	7,571-6538 BP	Late Preceramic/Initial	Gull unsp.	<i>Larus sp.</i>	1	Dillehay, 2017, Table 9.4 p. 246
Huaca Prieta	7,571-6538 BP	Late Preceramic/Initial	Gull unsp.	<i>Larus sp.</i>	2	Dillehay, 2017, Table 9.4 p. 246
Huaca Prieta	7,571-6538 BP	Late Preceramic/Initial	Gull unsp.	<i>Larus sp.</i>	9	Dillehay, 2017, Table 9.4 p. 246
Huaca Prieta	7,571-6538 BP	Late Preceramic/Initial	Gull unsp.	<i>Larus sp.</i>	2	Dillehay, 2017, Table 9.4 p. 246
Huaca Prieta	7,571-6538 BP	Late Preceramic/Initial	Terns unsp.	<i>Larosterna sp.</i>	21	Dillehay, 2017, Table 9.4 p. 246
Huaca Prieta	7,571-6538 BP	Late Preceramic/Initial	Peruvian pelican	<i>Pelecanus thagus</i>	15	Dillehay, 2017, Table 9.4 p. 246
Huaca Prieta	7,571-6538 BP	Late Preceramic/Initial	Peruvian pelican	<i>Pelecanus thagus</i>	6	Dillehay, 2017, Table 9.4 p. 246
Huaca Prieta	7,571-6538 BP	Late Preceramic/Initial	Guanay cormorant	<i>Phalacrocorax bougai</i>	12	Dillehay, 2017, Table 9.4 p. 246
Huaca Prieta	7,571-6538 BP	Late Preceramic/Initial	Guanay cormorant	<i>Phalacrocorax bougai</i>	36	Dillehay, 2017, Table 9.4 p. 246
Huaca Prieta	7,571-6538 BP	Late Preceramic/Initial	Peruvian booby	<i>Sula variegata</i>	5	Dillehay, 2017, Table 9.4 p. 246
Huaca Prieta	7,571-6538 BP	Late Preceramic/Initial	Booby unsp.	<i>Sula sp.</i>	5	Dillehay, 2017, Table 9.4 p. 246
Huaca Prieta	7,571-6538 BP	Late Preceramic/Initial	Unid. Bird	Unidentified	14	Dillehay, 2017, Table 9.4 p. 246
Huaca Prieta	7,571-6538 BP	Late Preceramic/Initial	Unid. Bird	Unidentified	49	Dillehay, 2017, Table 9.4 p. 246
Huaca Prieta	6,538-5,308 B	Late Preceramic/Initial	Humboldt penguin	<i>Spheniscus humboldti</i>	3	Dillehay, 2017, Table 9.6 p. 267

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Huaca Prieta	6,538-5,308 BFLate	Preceramic/Initial	Shorebirds	<i>Charadrius sp.</i>	51	Dillehay, 2017, Table 9.6 p. 267
Huaca Prieta	6,538-5,308 BFLate	Preceramic/Initial	Gulls unsp.	<i>Larus sp.</i>	30	Dillehay, 2017, Table 9.6 p. 267
Huaca Prieta	6,538-5,308 BFLate	Preceramic/Initial	Terns unsp.	<i>Larosterna sp.</i>	8	Dillehay, 2017, Table 9.6 p. 267
Huaca Prieta	6,538-5,308 BFLate	Preceramic/Initial	Peruvian pelican	<i>Pelecanus thagus</i>	4	Dillehay, 2017, Table 9.6 p. 267
Huaca Prieta	6,538-5,308 BFLate	Preceramic/Initial	Peruvian pelican	<i>Pelecanus thagus</i>	1	Dillehay, 2017, Table 9.6 p. 267
Huaca Prieta	6,538-5,308 BFLate	Preceramic/Initial	Peruvian pelican	<i>Pelecanus thagus</i>	12	Dillehay, 2017, Table 9.6 p. 267
Huaca Prieta	6,538-5,308 BFLate	Preceramic/Initial	Guanay cormorant	<i>Phalacrocorax bougai</i>	1	Dillehay, 2017, Table 9.6 p. 267
Huaca Prieta	6,538-5,308 BFLate	Preceramic/Initial	Guanay cormorant	<i>Phalacrocorax bougai</i>	155	Dillehay, 2017, Table 9.6 p. 267
Huaca Prieta	6,538-5,308 BFLate	Preceramic/Initial	Peruvian booby	<i>Sula variegata</i>	14	Dillehay, 2017, Table 9.6 p. 267
Huaca Prieta	6,538-5,308 BFLate	Preceramic/Initial	Booby unsp.	<i>Sula sp.</i>	3	Dillehay, 2017, Table 9.6 p. 267
Huaca Prieta	6,538-5,308 BFLate	Preceramic/Initial	Unid. Bird	Unidentified	2	Dillehay, 2017, Table 9.6 p. 267
Huaca Prieta	6,538-5,308 BFLate	Preceramic/Initial	Unid. Bird	Unidentified	3	Dillehay, 2017, Table 9.6 p. 267
Huaca Prieta	6,538-5,308 BFLate	Preceramic/Initial	Unid. Bird	Unidentified	166	Dillehay, 2017, Table 9.6 p. 267
Huaca Prieta	5,308-4,107 BFLate	Preceramic/Initial	Humboldt penguin	<i>Spheniscus humboldti</i>	8	Dillehay, 2017, Table 9.8 p. 284-287
Huaca Prieta	5,308-4,107 BFLate	Preceramic/Initial	Terns unsp.	<i>Larus sp.</i>	2	Dillehay, 2017, Table 9.8 p. 284-287
Huaca Prieta	5,308-4,107 BFLate	Preceramic/Initial	Terns unsp.	<i>Laridae</i>	3	Dillehay, 2017, Table 9.8 p. 284-287
Huaca Prieta	5,308-4,107 BFLate	Preceramic/Initial	Peruvian Pelican	<i>Pelecanus thagus</i>	1	Dillehay, 2017, Table 9.8 p. 284-287
Huaca Prieta	5,308-4,107 BFLate	Preceramic/Initial	Guanay Cormorant	<i>Phalacrocorax bougai</i>	1	Dillehay, 2017, Table 9.8 p. 284-287
Huaca Prieta	5,308-4,107 BFLate	Preceramic/Initial	Guanay Cormorant	<i>Phalacrocorax bougai</i>	2	Dillehay, 2017, Table 9.8 p. 284-287
Huaca Prieta	5,308-4,107 BFLate	Preceramic/Initial	Guanay Cormorant	<i>Phalacrocorax bougai</i>	5	Dillehay, 2017, Table 9.8 p. 284-287
Huaca Prieta	5,308-4,107 BFLate	Preceramic/Initial	Peruvian booby	<i>Sula variegata</i>	4	Dillehay, 2017, Table 9.8 p. 284-287
Huaca Prieta	5,308-4,107 BFLate	Preceramic/Initial	Unid. Bird	Unidentified	7	Dillehay, 2017, Table 9.8 p. 284-287
Huaca Prieta	5,308-4,107 BFLate	Preceramic/Initial	Unid. Bird	Unidentified	2	Dillehay, 2017, Table 9.8 p. 284-287
Huaca Prieta	5,308-4,107 BFLate	Preceramic/Initial	Unid. Bird	Unidentified	6	Dillehay, 2017, Table 9.8 p. 284-287
Huaca Prieta	4,107-3,455 BFLate	Preceramic/Initial	Oyster catcher	<i>Haematopus sp.</i>	1	Dillehay, 2017, Table 9.10 p. 308-316
Huaca Prieta	4,107-3,455 BFLate	Preceramic/Initial	Gulls unsp.	<i>Larus sp.</i>	12	Dillehay, 2017, Table 9.10 p. 308-316
Huaca Prieta	4,107-3,455 BFLate	Preceramic/Initial	Guanay Cormorant	<i>Phalacrocorax bougai</i>	9	Dillehay, 2017, Table 9.10 p. 308-316
Huaca Prieta	4,107-3,455 BFLate	Preceramic/Initial	Booby unsp.	<i>Sula sp.</i>	2	Dillehay, 2017, Table 9.10 p. 308-316
Huaca Prieta	4,107-3,455 BFLate	Preceramic/Initial	Unid. Bird	Unidentified	10	Dillehay, 2017, Table 9.10 p. 308-316
Huaca Prieta	4,107-3,455 BFLate	Preceramic/Initial	Humboldt penguin	<i>Spheniscus humboldti</i>	13	Dillehay, 2017, Table 9.12
Huaca Prieta	4,107-3,455 BFLate	Preceramic/Initial	Shorebirds	<i>Charadrius sp.</i>	1	Dillehay, 2017, Table 9.12
Huaca Prieta	4,107-3,455 BFLate	Preceramic/Initial	Gulls unsp.	<i>Larus sp.</i>	6	Dillehay, 2017, Table 9.12
Huaca Prieta	4,107-3,455 BFLate	Preceramic/Initial	Gulls unsp.	<i>Larus sp.</i>	1	Dillehay, 2017, Table 9.12
Huaca Prieta	4,107-3,455 BFLate	Preceramic/Initial	Gulls unsp.	<i>Laridae</i>	4	Dillehay, 2017, Table 9.12
Huaca Prieta	4,107-3,455 BFLate	Preceramic/Initial	Peruvian Pelican	<i>Pelecanus thagus</i>	14	Dillehay, 2017, Table 9.12
Huaca Prieta	4,107-3,455 BFLate	Preceramic/Initial	Guanay cormorant	<i>Phalacrocorax bougai</i>	5	Dillehay, 2017, Table 9.12
Huaca Prieta	4,107-3,455 BFLate	Preceramic/Initial	Guanay cormorant	<i>Phalacrocorax bougai</i>	18	Dillehay, 2017, Table 9.12
Huaca Prieta	4,107-3,455 BFLate	Preceramic/Initial	Booby unsp.	<i>Sula sp.</i>	1	Dillehay, 2017, Table 9.12
Huaca Prieta	4,107-3,455 BFLate	Preceramic/Initial	Booby unsp.	<i>Sula sp.</i>	4	Dillehay, 2017, Table 9.12
Huaca Prieta	4,107-3,455 BFLate	Preceramic/Initial	Unid. Bird	Unidentified	28	Dillehay, 2017, Table 9.12
Huaca Prieta	4,107-3,455 BFLate	Preceramic/Initial	Gulls unsp.	<i>Laridae</i>	1	Dillehay, 2017, Table 9.13
Huaca Prieta	4,107-3,455 BFLate	Preceramic/Initial	Peruvian booby	<i>Sula variegata</i>	4	Dillehay, 2017, Table 9.13
Huaca Prieta	4,107-3,455 BFLate	Preceramic/Initial	Ducks unsp.	<i>Anas sp.</i>	1	Dillehay, 2017, Table 9.13
Huaca Prieta	4,107-3,455 BFLate	Preceramic/Initial	Unid. Bird	Unidentified	3	Dillehay, 2017, Table 9.13
Huaca Prieta	4,107-3,455 BFLate	Preceramic/Initial	Albatross unsp.	<i>Diomedea sp.</i>	10	Dillehay, 2017, Table 9.15
Huaca Prieta	4,107-3,455 BFLate	Preceramic/Initial	Oyster catcher	<i>Haematopus sp.</i>	1	Dillehay, 2017, Table 9.15
Huaca Prieta	4,107-3,455 BFLate	Preceramic/Initial	Gulls unsp.	<i>Larus sp.</i>	21	Dillehay, 2017, Table 9.15
Huaca Prieta	4,107-3,455 BFLate	Preceramic/Initial	Terns unsp.	<i>Larosterna sp.</i>	1	Dillehay, 2017, Table 9.15
Huaca Prieta	4,107-3,455 BFLate	Preceramic/Initial	Egrets unsp.	<i>Egretta sp.</i>	21	Dillehay, 2017, Table 9.15
Huaca Prieta	4,107-3,455 BFLate	Preceramic/Initial	Guanay cormorant	<i>Phalacrocorax bougai</i>	3	Dillehay, 2017, Table 9.15

Site	Dates	Chronological Designation	Common Name	Taxon	NISP	References
Huaca Prieta	4,107-3,455 BF	Late Preceramic/Initial	Guanay cormorant	<i>Phalacrocorax bougain</i>	95	Dillehay, 2017, Table 9.15
Huaca Prieta	4,107-3,455 BF	Late Preceramic/Initial	Peruvian booby	<i>Sula variegata</i>	22	Dillehay, 2017, Table 9.15
Huaca Prieta	4,107-3,455 BF	Late Preceramic/Initial	Unid. Bird	Unidentified	2	Dillehay, 2017, Table 9.15
Huaca Prieta	4,107-3,455 BF	Late Preceramic/Initial	Unid. Bird	Unidentified	57	Dillehay, 2017, Table 9.15
Quebrada Tacahuay	12,880-11,970	Preceramic Period	cf. Tinamou	<i>cf. Tinamidae</i>	4	deFrance, 2005
Quebrada Tacahuay	12,880-11,970	Preceramic Period	Pelican unsp.	<i>Pelicanus sp.</i>	117	deFrance, 2005
Quebrada Tacahuay	12,880-11,970	Preceramic Period	Cormorant unsp.	<i>Phalacrocorax sp.</i>	2252	deFrance, 2005
Quebrada Tacahuay	12,880-11,970	Preceramic Period	Guanay cormorant	<i>Phalacrocorax bougain</i>	930	deFrance, 2005
Quebrada Tacahuay	12,880-11,970	Preceramic Period	Neotropic cormorant	<i>Phalacrocorax brasilic</i>	8	deFrance, 2005
Quebrada Tacahuay	12,880-11,970	Preceramic Period	Booby unsp.	<i>Sula sp.</i>	1567	deFrance, 2005
Quebrada Tacahuay	12,880-11,970	Preceramic Period	Cormorant or booby		460	deFrance, 2005
Quebrada Tacahuay	12,880-11,970	Preceramic Period	Least sandpiper	<i>Calidris minutilla</i>	1	deFrance, 2005
Quebrada Tacahuay	12,880-11,970	Preceramic Period	Sandpiper unsp.	<i>Calidris sp.</i>	5	deFrance, 2005
Quebrada Tacahuay	12,880-11,970	Preceramic Period	Inca tern	<i>Larosterna inca</i>	10	deFrance, 2005
Quebrada Tacahuay	12,880-11,970	Preceramic Period	Finches	<i>Fringillidae</i>	2	deFrance, 2005
Quebrada Tacahuay	12,880-11,970	Preceramic Period	Songbirds	<i>Passeriformes</i>	5	deFrance, 2005
Quebrada Tacahuay	12,880-11,970	Preceramic Period	Songbird or finch		1	deFrance, 2005
Ostra Base Camp	6,250-5,450 BF	Preceramic Period	Pelican unsp.	<i>Pelicanus sp.</i>	3	Reitz and Sandweiss, 2001
Ostra Base Camp	6,250-5,450 BF	Preceramic Period	Cormorant unsp.	<i>Phalacrocorax sp.</i>	265	Reitz and Sandweiss, 2001
Ostra Base Camp	6,250-5,450 BF	Preceramic Period	Gulls	<i>Laridae</i>	11	Reitz and Sandweiss, 2001
Ostra Base Camp	6,250-5,450 BF	Preceramic Period	Unid. Bird	Unidentified	115	Reitz and Sandweiss, 2001
Ring Site	11,680- 5,660 I	Preceramic Period	Humboldt penguin	<i>Spheniscus humboldti</i>	23	Reitz et al, 2017
Ring Site	11,680- 5,660 I	Preceramic Period	Great grebe	<i>Podiceps major</i>	1	Reitz et al, 2017
Ring Site	11,680- 5,660 I	Preceramic Period	Shearwater unsp.	<i>Procellariidae</i>	2	Reitz et al, 2017
Ring Site	11,680- 5,660 I	Preceramic Period	Peruvian diving petrel	<i>Pelecanoides gamotii</i>	2	Reitz et al, 2017
Ring Site	11,680- 5,660 I	Preceramic Period	Pelican unsp.	<i>Pelicanus sp.</i>	10	Reitz et al, 2017
Ring Site	11,680- 5,660 I	Preceramic Period	Booby unsp.	<i>Sula sp.</i>	163	Reitz et al, 2017
Ring Site	11,680- 5,660 I	Preceramic Period	Cormorant unsp.	<i>Phalacrocorax sp.</i>	800	Reitz et al, 2017
Ring Site	11,680- 5,660 I	Preceramic Period	cf. Chachalaca	<i>cf. Cracidae</i>	1	Reitz et al, 2017
Ring Site	11,680- 5,660 I	Preceramic Period	Inca tern	<i>Larosterna inca</i>	1	Reitz et al, 2017
Sitio Siches	7,900- 6,800 B	Preceramic Period	Cormorant unsp.	<i>Phalacrocorax sp.</i>	1	Reitz et al, 2019
Sitio Siches	7,900- 6,800 B	Preceramic Period	Songbirds	<i>Passeriformes</i>	1	Reitz et al, 2019
Sitio Siches	7,900- 6,800 B	Preceramic Period	Crows	<i>Corvidae</i>	1	Reitz et al, 2019
Sitio Siches	7,900- 6,800 B	Preceramic Period	Songbirds	<i>Mimidae</i>	1	Reitz et al, 2019
Sitio Siches	5,800-5,200 BF	Preceramic Period	Unid. Bird	Unidentified	223	Reitz et al, 2019
Sitio Siches	5,800- 5,200 B	Preceramic Period	Inca tern	<i>Larosterna inca</i>	10	Reitz et al, 2019
Sitio Siches	5,800- 5,200 B	Preceramic Period	Sooty shearwater	<i>Puffinus griseus</i>	70	Reitz et al, 2019
Sitio Siches	5,800- 5,200 B	Preceramic Period	Booby unsp.	<i>Sula sp.</i>	6	Reitz et al, 2019
Sitio Siches	5,800- 5,200 B	Preceramic Period	Cormorant unsp.	<i>Phalacrocorax sp.</i>	2	Reitz et al, 2019
Sitio Siches	5,800- 5,200 B	Preceramic Period	Gulls	<i>Laridae</i>	2	Reitz et al, 2019
Sitio Siches	5,800- 5,200 B	Preceramic Period	Inca tern	<i>Larosterna inca</i>	1	Reitz et al, 2019
Sitio Siches	5,800- 5,200 B	Preceramic Period	Sooty shearwater	<i>Puffinus griseus</i>	5	Reitz et al, 2019
Sitio Siches	5,800- 5,200 B	Preceramic Period	Cormorant unsp.	<i>Phalacrocorax sp.</i>	1	Reitz et al, 2019
Sitio Siches	5,800- 5,200 B	Preceramic Period	Unid. Bird	Unidentified	96	Reitz et al, 2019
Ring Site	11,680- 5,660 I	Preceramic Period	Unid. Bird	Unidentified	15	Reitz (R0130) Avifauna Data Cards
Ring Site	11,680- 5,660 I	Preceramic Period	Cormorant unsp.	<i>Phalacrocorax sp.</i>	10	Reitz (R0130) Avifauna Data Cards
Ring Site	11,680- 5,660 I	Preceramic Period	Penguin unsp.	<i>Spheniscus sp.</i>	1	Reitz (R0130) Avifauna Data Cards
Ring Site	11,680- 5,660 I	Preceramic Period	Cormorant unsp.	<i>Phalacrocorax sp.</i>	6	Reitz (R0130) Avifauna Data Cards
Ring Site	11,680- 5,660 I	Preceramic Period	Booby unsp.	<i>Sula sp.</i>	1	Reitz (R0130) Avifauna Data Cards
Ring Site	11,680- 5,660 I	Preceramic Period	Humboldt penguin	<i>Spheniscus humboldti</i>	3	Reitz (R0130) Avifauna Data Cards
Ring Site	11,680- 5,660 I	Preceramic Period	Cormorant unsp.	<i>Phalacrocorax sp.</i>	14	Reitz (R0130) Avifauna Data Cards
Ring Site	11,680- 5,660 I	Preceramic Period	Unid. Bird	Unidentified	84	Reitz (R0130) Avifauna Data Cards
Ring Site	11,680- 5,660 I	Preceramic Period	Penguin unsp.	<i>Spheniscus sp.</i>	4	Reitz (R0130) Avifauna Data Cards
Ring Site	11,680- 5,660 I	Preceramic Period	Cormorant unsp.	<i>Phalacrocorax sp.</i>	23	Reitz (R0130) Avifauna Data Cards
Ring Site	11,680- 5,660 I	Preceramic Period	Booby unsp.	<i>Sula sp.</i>	3	Reitz (R0130) Avifauna Data Cards

Site	Dates	Chronological Designation	Common Name	Taxon	NISP	References
Ring Site	11,680- 5,660	IPreceramic Period	Unid. Bird	Unidentified	48	Reitz (R0130) Avifauna Data Cards
Ring Site	11,680- 5,660	IPreceramic Period	Penguin unsp.	<i>Spheniscus sp.</i>	1	Reitz (R0130) Avifauna Data Cards
Ring Site	11,680- 5,660	IPreceramic Period	Cormorant unsp.	<i>Phalacrocorax sp.</i>	13	Reitz (R0130) Avifauna Data Cards
Ring Site	11,680- 5,660	IPreceramic Period	Booby unsp.	<i>Sula sp.</i>	4	Reitz (R0130) Avifauna Data Cards
Ring Site	11,680- 5,660	IPreceramic Period	Unid. Bird	Unidentified	245	Reitz (R0130) Avifauna Data Cards
Ring Site	11,680- 5,660	IPreceramic Period	Penguin unsp.	<i>Spheniscus sp.</i>	6	Reitz (R0130) Avifauna Data Cards
Ring Site	11,680- 5,660	IPreceramic Period	Cormorant unsp.	<i>Phalacrocorax sp.</i>	86	Reitz (R0130) Avifauna Data Cards
Ring Site	11,680- 5,660	IPreceramic Period	Pelican unsp.	<i>Pelicanus sp.</i>	1	Reitz (R0130) Avifauna Data Cards
Ring Site	11,680- 5,660	IPreceramic Period	Booby unsp.	<i>Sula sp.</i>	17	Reitz (R0130) Avifauna Data Cards
Ring Site	11,680- 5,660	IPreceramic Period	Peruvian diving petrel	<i>Pelecanoides garnotti</i>	1	Reitz (R0130) Avifauna Data Cards
Ring Site	11,680- 5,660	IPreceramic Period	Unid. Bird	Unidentified	903	Reitz (R0130) Avifauna Data Cards
Ring Site	11,680- 5,660	IPreceramic Period	Inca tern	<i>Larosterna inca</i>	1	Reitz (R0130) Avifauna Data Cards
Ring Site	11,680- 5,660	IPreceramic Period	Penguin unsp.	<i>Spheniscus sp.</i>	4	Reitz (R0130) Avifauna Data Cards
Ring Site	11,680- 5,660	IPreceramic Period	Peruvian diving petrel	<i>Pelecanoides garnotti</i>	1	Reitz (R0130) Avifauna Data Cards
Ring Site	11,680- 5,660	IPreceramic Period	Cormorant unsp.	<i>Phalacrocorax sp.</i>	373	Reitz (R0130) Avifauna Data Cards
Ring Site	11,680- 5,660	IPreceramic Period	Booby unsp.	<i>Sula sp.</i>	91	Reitz (R0130) Avifauna Data Cards
Ring Site	11,680- 5,660	IPreceramic Period	Unid. Sm. Bird	Unidentified	3	Reitz (R0130) Avifauna Data Cards
Ring Site	11,680- 5,660	IPreceramic Period	Shearwater unsp.	<i>Procellariidae</i>	1	Reitz (R0130) Avifauna Data Cards
Ring Site	11,680- 5,660	IPreceramic Period	Pelican unsp.	<i>Pelicanus sp.</i>	7	Reitz (R0130) Avifauna Data Cards
Ring Site	11,680- 5,660	IPreceramic Period	Unid. Bird	Unidentified	303	Reitz (R0130) Avifauna Data Cards
Ring Site	11,680- 5,660	IPreceramic Period	Unid. Bird	Unidentified	1	Reitz (R0130) Avifauna Data Cards
Ring Site	11,680- 5,660	IPreceramic Period	Penguin unsp.	<i>Spheniscus sp.</i>	3	Reitz (R0130) Avifauna Data Cards
Ring Site	11,680- 5,660	IPreceramic Period	Cormorant unsp.	<i>Phalacrocorax sp.</i>	110	Reitz (R0130) Avifauna Data Cards
Ring Site	11,680- 5,660	IPreceramic Period	Pelican unsp.	<i>Pelicanus sp.</i>	2	Reitz (R0130) Avifauna Data Cards
Ring Site	11,680- 5,660	IPreceramic Period	Booby unsp.	<i>Sula sp.</i>	12	Reitz (R0130) Avifauna Data Cards
Ring Site	11,680- 5,660	IPreceramic Period	Shearwater unsp.	<i>Procellariidae</i>	1	Reitz (R0130) Avifauna Data Cards
Ring Site	11,680- 5,660	IPreceramic Period	Cormorant unsp.	<i>Phalacrocorax sp.</i>	68	Reitz (R0130) Avifauna Data Cards
Ring Site	11,680- 5,660	IPreceramic Period	Booby unsp.	<i>Sula sp.</i>	12	Reitz (R0130) Avifauna Data Cards
Ring Site	11,680- 5,660	IPreceramic Period	Cormorant unsp.	<i>Phalacrocorax sp.</i>	43	Reitz (R0130) Avifauna Data Cards
Ring Site	11,680- 5,660	IPreceramic Period	Booby unsp.	<i>Sula sp.</i>	6	Reitz (R0130) Avifauna Data Cards
Ring Site	11,680- 5,660	IPreceramic Period	Penguin unsp.	<i>Spheniscus sp.</i>	1	Reitz (R0130) Avifauna Data Cards
Ring Site	11,680- 5,660	IPreceramic Period	Unid. Bird	Unidentified	64	Reitz (R0130) Avifauna Data Cards
Ring Site	11,680- 5,660	IPreceramic Period	Cormorant unsp.	<i>Phalacrocorax sp.</i>	18	Reitz (R0130) Avifauna Data Cards
Ring Site	11,680- 5,660	IPreceramic Period	Unid. Bird	Unidentified	113	Reitz (R0130) Avifauna Data Cards
Ring Site	11,680- 5,660	IPreceramic Period	Cormorant unsp.	<i>Phalacrocorax sp.</i>	32	Reitz (R0130) Avifauna Data Cards
Ring Site	11,680- 5,660	IPreceramic Period	Booby unsp.	<i>Sula sp.</i>	17	Reitz (R0130) Avifauna Data Cards
Ring Site	11,680- 5,660	IPreceramic Period	Great grebe	<i>Podiceps major</i>	1	Reitz (R0130) Avifauna Data Cards
Ring Site	11,680- 5,660	IPreceramic Period	Unid. Bird	Unidentified	27	Reitz (R0130) Avifauna Data Cards
Ring Site	11,680- 5,660	IPreceramic Period	Cormorant unsp.	<i>Phalacrocorax sp.</i>	4	Reitz (R0130) Avifauna Data Cards
Paloma	7700-5000 BP	Preceramic Period	Unid. Bird	Unidentified	307	Reitz, 1988; Table 2 p. 315; Appendix p. 319

APPENDIX B

Tabulated results of the avifaunal art review.

Avifaunal Type	Habitat	Description	Materials	Date	Culture	References
N/A	N/A	Container in the form of two birds with shell, turquoise, and gold sheet inlays.	Sheet gold, shell, turquoise	0 BCE-650 CE	Moche	Quilter, 2005; p. 6
Owl	Terrestrial	Twin figures of owls made with copper and inlaid with shell, details of the owls faces are incised into the material.	Shell and copper	0 BCE-650 CE	Moche	Quilter, 2005; p. 13
Toucan	Terrestrial	Figure of a toucan-like bird detailed with geometric designs to represent feathers and other specific features (eyes, beak, legs).	Sheet gold with turquoise inlay	0 BCE-650 CE	Moche	Quilter, 2005; p.14
Diety	Mythical	Ear spool with an avian war deity depicted. The beak is rendered in gold. Is shown as an anthropomorph and holds a club and shield in its right hand, and a sling (with golden sling stone) in the left.	Mosaic of semi-precious stones, gold and shell inlays	0 BCE-650 CE	Moche	Quilter, 2005; p.15

Avifaunal Type	Habitat	Description	Materials	Date	Culture	References
Owl	Terrestrial	Metalwork figure of an owl in an attacking posture	Gold, inlays	0 BCE-650 CE	Moche	Quilter, 2005; pp. 80-81
Raptor	Terrestrial	Moche stirrup spout vessel in shape of head/face with dual headed Raptor? Birds molded on the head (headdress like)	Ceramic, paint/slip	0 BCE-650 CE	Moche	Quilter, 2005; p.86
Raptor?	N/A	Moche ear spool made of gold with image of a running warrior depicted in an inlaid mosaic of lapis lazuli and shell.	Gold, shell inlays, lapis lazuli inlays	0 BCE-650 CE	Moche	Quilter, 2005; p.87
Hawk?	N/A	Moche mirror decorated by cast copper birds (hawks?)	pyrite and copper	0 BCE-650 CE	Moche	Quilter, 2005; p. 89; Lapiner, 1976 p. 155

Avifaunal Type	Habitat	Description	Materials	Date	Culture	References
Hummingbird	Terrestrial	Painted double spouted vessel with multiple hummingbirds surrounding a flower.	Ceramic, paint/slip	0 BCE-700 CE	Nazca	Quilter, 2005; p. 74
Feather Garment	Tropical	Feather garment with Nazca style monkey or human figure	Tropical bird feathers, textile	0 BCE-700 CE	Nazca	Quilter, 2005; p. 70
Hummingbird	Terrestrial	Nazca land-art (lines) in form of hummingbird	geoglyph	0 BCE-700 CE	Nazca	Quilter, 2005; p. 75
Seabird	Marine	Early Nazca double spout vessel depicting a seabird catching a fish	Ceramic, white, brown, maroon, black, red and tan paint	100 BC- AD 200	Nazca	Lapiner, 1976; 216
Inca Tern	Marine	Early Nazca double spout vessel depicting an Inca Tern with a shell (plasdadora) in its beak	Ceramic, grey, tan, red, brown and white paint	100 BC- AD 200	Nazca	Lapiner, 1976; 216
Seabird	Marine	Early Nazca ceramic nesting seabird	Ceramic, red, white, black, and deep brown paint	100 BC- AD 200	Nazca	Lapiner, 1976; 220

Avifaunal Type	Habitat	Description	Materials	Date	Culture	References
Ibis?	Wetland	Painted wooden paddle/digging stick/steering board with ibis-like bird carved in a bent head position ornamenting the shaft and handle and geometric reproductions of a similar ibis-like shape along one side of the shaft of the object as well as on the flat edges of the head of the spade/paddle	wood and paint	1000-1450 CE	Ica or Chincha	Quilter, 2005; p. 135
Condor	N/A	Middle-Late Chavín stone beaker with low relief incised feline headed condors	Gray-tan soapstone (steatite?) with rose colored striations	1000-400 BC	Chavín	Lapiner, 1976; 64
Parrot	Tropical	Stirrup spout vessel in the form of seated parrot in Chongyape style	red-gray ceramic	1000-700 BC	Chavín	Lapiner, 1976; 48

Avifaunal Type	Habitat	Description	Materials	Date	Culture	References
N/A	Marine	Spondylus princeps shell polished and decorated with inlays of purple spondylus, darker spondylus princeps in the form of two marine birds eating (pecking at) fish, and turquoise	Shell with shell and turquoise inlays	1100-1450 CE	Chimú	Quilter, 2005; p. 150
N/A	N/A	Chimú tunic decorated with a repeated pattern of stylized birds (stork like in appearance)	Textile	1100-1450 CE	Chimú	Quilter, 2005; p. 162
Feather Garment	Varied	Ceremonial Chimú feathercloth headdress made from feathers of flamingo, macaw, Amazonian parrot, and razor-billed curassow	Feathercloth, exotic bird feathers	1100-1450 CE	Chimú	Quilter, 2005; p. 165
Multiple	N/A	Decorated Chimú palanquin with decorations including wave and bird (stork-like) motifs	Various	1100-1450 CE	Chimú	Quilter, 2005; pp. 166-7

Avifaunal Type	Habitat	Description	Materials	Date	Culture	References
Parrot	Tropical	Early Chavín stirrup spout vessel featuring an incised parrot head with feline mouth	Burnished and incised blackware	1400-1000 BC	Chavín	Lapiner, 1976; 58
N/A	Tropical	Silver Inca figurines clothed in small textiles and metal fasteners with feather headdresses	Silver, textile, tropical bird feathers	1450-1534 CE	Inca	Quilter, 2005; pp. 185
N/A	Tropical?	painted wooden kero from the Colonial Period depicting Inca with captive woman. A colorful bird flies from between them	wood and paint	1534+ CE	Colonial Period	Quilter, 2005; pp.206-7
N/A	Terrestrial	Early Nazca painted textile fragment depicting birds holding pachai pods and other plants	Multicolored painted cotton	200 BC-1 AD	Nazca	Lapiner, 1976; 201
Condor	Terrestrial	Early to Middle Mochica ornamental crescent plaque depicting two condors holding a trophy head.	Copper with green stone inlays	300 BC-AD 300	Mochica	Lapiner, 1976; 148
Owl	Terrestrial	Early to Middle Mochica owl with outspread wings and gilded copper dangles.	Copper	300 BC-AD 300	Mochica	Lapiner, 1976; 154

Avifaunal Type	Habitat	Description	Materials	Date	Culture	References
Owl	Terrestrial	Early to Middle Mochica owl ornament	Silvered or gilded copper with shell and pyrite inlays	300 BC-AD 300	Mochica	Lapiner, 1976; 154
Owl	Terrestrial	Early to Middle Mochica owl heads	Gilded copper with shell inlays and copper wire	300 BC-AD 300	Mochica	Lapiner, 1976; 154
Owl Diety	Mythical	Early to Middle Mochica ear ornaments depicting owl deities holding a trophy prisoner in one hand and a tumi knife in the other	Gold	300 BC-AD 300	Mochica	Lapiner, 1976; 159
Condor	Terrestrial	Early to Middle Mochica ear ornaments depicting condors	Silver condors attached to gold frontals with stone and shell inlays	300 BC-AD 300	Mochica	Lapiner, 1976; 159
Seabird	Marine	Early to Middle Mochica nose ornament attachment with repoussé sea birds	Gold, silvered background	300 BC-AD 300	Mochica	Lapiner, 1976; 161
Owl	Terrestrial	Early to Middle Mochica nose ornament in the shape of an owl with gold dangles	Gold	300 BC-AD 300	Mochica	Lapiner, 1976; 161
Condor	Terrestrial	Mochica knife finial in the form of a standing condor	Cast copper with turquoise and shell inlays	300 BC-AD 500	Mochica	Lapiner, 1976; 155

Avifaunal Type	Habitat	Description	Materials	Date	Culture	References
Parrot	Tropical	Mochica knife finial in the form of a seated parrot holding a man/prisoner	Cast copper with traces of shell inlays	300 BC-AD 500	Mochica	Lapiner, 1976; 155
Black bird?	N/A	Late Paracas ceramic hand and forearm with a number of black bird motifs along with cat motifs. Birds appear dead?	Ceramic, paint/slip	300-100 BC	Paracas	Lapiner, 1976; 85
N/A	N/A	Two painted bird motifs on a Late Paracas textile mask from a mummy bundle.	Painted textile	300-100 BC	Paracas	Lapiner, 1976; 86
N/A	N/A	Painted bird motifs, including a double headed bird figure on a textile mask from a mummy bundle.	Painted textile	300-100 BC	Paracas	Lapiner, 1976; 86
Multiple	Varied	Fringed shirt with seabird and hummingbird (?) motifs along borders.	Textile: cotton and wool	300-100 BC	Paracas	Lapiner, 1976; 92
Condor	Terrestrial	Late paracas mantle border with embroidered condor motifs within squares; multiple colors	Textile: cotton and wool	300-100 BC	Paracas	Lapiner, 1976; 100

Avifaunal Type	Habitat	Description	Materials	Date	Culture	References
Goat Sucker Birds	N/A	Detail from Late Paracas embroidered textile border depicting goatsucker birds	Textile: cotton and wool	300-100 BC	Paracas	Lapiner, 1976; 100
Condor	Terrestrial	Late Paracas embroidered mantle depicting numerous colorful condors	Textile: cotton and wool in dark blue, green, blue, yellow on red	300-100 BC	Paracas	Lapiner, 1976; 101
Feather Applique	Varied	Late Paracas feather applique doll ornament	Leather, feathers in yellow, blue, black, white, orange/red	300-100 BC	Paracas	Lapiner, 1976; 104
N/A	N/A	Late Paracas knitted textile with various stylized bird motifs	Textile: wool	300-100 BC	Paracas	Lapiner, 1976; 108
Chimera	Mythical	Early Nazca (proto Nazca) anthropomorphic aviary feline figure	Incised and slip decorated ceramic	300-100 BC	Nazca	Lapiner, 1976; 200
Falcon	Terrestrial	Early Nazca (proto Nazca) spouted vessel with strap handle in shape of falcon	Incised and resin painted ceramic	300-100 BC	Nazca	Lapiner, 1976; 201
Dove	Terrestrial	Early Nazca (proto Nazca) pair of baby doves	Incised and slip decorated ceramic, white, dark red, black and grey	300-100 BC	Nazca	Lapiner, 1976; 201
Owl	Terrestrial	Early Mochica stirrup spout vessel in the shape of owl	Ceramic, white and pale red orange slip decoration	400 BC - AD 1	Mochica	Lapiner, 1976; 129

Avifaunal Type	Habitat	Description	Materials	Date	Culture	References
Condor	Terrestrial	Early Mochica stirrup spout vessel in the shape of condor	Ceramic, red and white slip decoration	400-100 BC	Mochica	Lapiner, 1976; 128
Owl	Terrestrial	Early Mochica stirrup spout vessel in the shape of owl	Red ceramic, white slip decoration	400-100 BC	Mochica	Lapiner, 1976; 129
N/A	N/A	Tiwanaku vessel with bird's head and handle.	Ceramic, paint/slip	450-1000 CE	Tiwanaku	Quilter, 2005; p. 105
Falcon	Terrestrial	Middle Paracas spouted vessel with strap handle in the form of falcon	Ceramic, red, black, dark green and yellow resin paint	500-300 BC	Paracas	Lapiner, 1976; 94
N/A	Marine	Salinar spouted vessel with tubular handle in shape of seabird with fish in its mouth	burnished buff-red ceramic, traces of resist decoration	500-300 BC	Salinar	Lapiner, 1976; 117
Owl	Terrestrial	Salinar spouted vessel with tubular handle in shape of owl	Burnished red ceramic; cream slip decoration	500-300 BC	Mochica	Lapiner, 1976; 120
N/A	N/A	"Puma Festival Tunic" atypical of Wari style including imagery of animals (birds) and musicians	Textile	650-900 CE	Wari	Quilter, 2005; p.120

Avifaunal Type	Habitat	Description	Materials	Date	Culture	References
Raptor?	N/A	Wari tapestry shirt with large figures and various animal motifs. Repetitive image of a Raptor?ike bird throughout	Textile	650-900 CE	Wari	Quilter, 2005; p. 122
Raptor?	N/A	Decorated Wari kero with image of an elite male holding a stalk of corn and a camelid carrying numerous raptor-like bird heads	wood, paint/slip	650-900 CE	Wari	Quilter, 2005; p. 124
Feather Garnet	N/A	Feather mantle with two 8-pointed stars and a dual headed feline serpent, both details are in orange and black feathers on a field of white feathers.	Tropical bird feathers, textile	650-900 CE	Wari	Quilter, 2005; p. 126

Avifaunal Type	Habitat	Description	Materials	Date	Culture	References
Shaman	N/A	Embroidered mantle with "bird shaman" or spirit impersonator. It's claws and cape are outstretched and it appears to have "snuff mucus" emanating from its nose.	Textile	700-0 BCE	Paracas	Quilter, 2005; p.34-5
Feather Garment	N/A	South coast Paracas mantle with stylized dual headed birds and feline motifs	dyed and woven camelid fibers	700-0 BCE	Paracas	Quilter, 2005; p.60
Avian Attributes	N/A	Incised bone spatula with traces of red and blue pigment; feline and aviary attributes in the incised design	Bone and paint/pigment	700-400 BC	Chavín	Lapiner, 1976; 38
Owl	Terrestrial	Late Chavín stirrup spout vessel in the shape of an owl's head	red-brown and dark brown ceramic	700-400 BC	Chavín	Lapiner, 1976; 48
Owl	Terrestrial	Late Chavín bowl with incised owl face design	Gray-brown ceramic with red-orange paint	700-400 BC	Chavín	Lapiner, 1976; 48
Parrot	Tropical	Late Chavín stirrup spout vessel in the shape of a resting parrot	Incised, gray-black ceramic	700-400 BC	Chavín	Lapiner, 1976; 49
N/A	N/A	Late Chavín ceramic stamp with aviary glyph	Dark brown ceramic	700-400 BC	Chavín	Lapiner, 1976; 49

Avifaunal Type	Habitat	Description	Materials	Date	Culture	References
Parrot	Tropical	Late Chavín stirrup spout vessel in the shape of a resting parrot	Burnished and incised blackware	700-400 BC	Chavín	Lapiner, 1976; 49
Condor	Terrestrial	Late Chavín spouted vessel condor with feline glyph head	Gray-brown ceramic with white, yellow and orange paint	700-400 BC	Chavín	Lapiner, 1976; 50
N/A	N/A	Late Chavín spouted whistling vessel with strap handle, sausage form decorated with a small bird form	Gray-brown ceramic	700-400 BC	Chavín	Lapiner, 1976; 50
N/A	N/A	Late Chavín stirrup spout vessel in the shape of a two headed deer with incised glyph panel featuring feline, aviary and serpent motifs	Burnished ceramic with paint	700-400 BC	Chavín	Lapiner, 1976; 51
Parrot	Tropical	Late Chavín stirrup spout vessel with two parrots perched on a gourd	Gray-brown ceramic	700-400 BC	Chavín	Lapiner, 1976; 62
N/A	N/A	Late Chavín stone beaker with low relieve and incised plant forms and aviary motifs	Yellow-beige soft soapstone (steatite?)	700-400 BC	Chavín	Lapiner, 1976; 66

Avifaunal Type	Habitat	Description	Materials	Date	Culture	References
Condor	N/A	Late Chavín double stone beaker with low relief incised feline headed condors	Gray-tan soft soapstone (steatite?)	700-400 BC	Chavín	Lapiner, 1976; 66
Falcon	Terrestrial	Early Paracas spouted vessel with strap handle and Falcon?top a decorated house	Black ceramic, red, brown, yellow, and buff resin paint	700-500 BC	Paracas	Lapiner, 1976; 94
N/A	N/A	Lambayeque tumi blade in gold and precious stones in the form of a "Sicán Lord" with a single bird earring/decoration on his crown/headress	Gold, precious stones	800-1350 CE	Lambayeque	Quilter, 2005; p. 146
Multiple	Marine	Middle Mochica painted stirrup spout vessel with depiction of a diety holding a cormorant and other smaller birds surrounding	Ceramic, slip decoration	AD 1-300	Mochica	Lapiner, 1976; 133
N/A	N/A	Spouted vessel with hollow tubular handle, erotic couple within a temple chamber with human and bird guardians	White ceramic, traces of resist decoration	AD 1-300	Recuay	Lapiner, 1976; 177

Avifaunal Type	Habitat	Description	Materials	Date	Culture	References
Owl	Terrestrial	Warrior wearing gigantic owl headdress with young llama	Ceramic, black resist decoration on white with red paint	AD 1-300	Recuay	Lapiner, 1976; 178
Seabird	Marine	Middle Mochica master mold of a human head surmounted by a seabird	N/A	AD 1-600	Mochica	Lapiner, 1976; 144
Mythical	Mythical	Middle Nazca pair of cups depicting "trophy headed bird demons", possibly "the Horrible Bird"	Polychrome ceramic	AD 100-300	Nazca	Lapiner, 1976; 208
Diety	Mythical	Late Huari bird diety plaque	Beaten gold	AD 1100	Huari	Lapiner, 1976; 244
Diety	Mythical	Late Huari bird diety plaque	Beaten gold	AD 1100	Huari	Lapiner, 1976; 245
Falcon?	Terrestrial	Middle Mochica painted stirrup spout vessel with depiction of a seated dignitary with bean bag messengers, one of which wearing a Falcon?ooking mask/head	Ceramic, red-brown slip decoration	AD 200-500	Mochica	Lapiner, 1976; 134

Avifaunal Type	Habitat	Description	Materials	Date	Culture	References
Hawk	Terrestrial	Middle Mochica ear ornaments with winged hawk messengers carrying bean bags	Gold with shell and turquoise mosaic	AD 200-500	Mochica	Lapiner, 1976; 162
Gulls?	Marine	Middle Mochica painted stirrup spout vessel with depiction of a "ceremonial scene" in which a shamanic being is laying within a box that is being pecked at by what looks like gulls.	White slipped ceramic, red-brown paint	AD 300-500	Mochica	Lapiner, 1976; 129
Duck	Terrestrial	Middle Mochica hollow duck vessel	Hammered gold	AD 300-500	Mochica	Lapiner, 1976; 164
Hummingbird	Terrestrial	Middle Mochica painted stirrup spout vessel with depiction of running bean bag messengers in the guise of hummingbirds	White slipped ceramic, red-brown paint	AD 300-600	Mochica	Lapiner, 1976; 139

Avifaunal Type	Habitat	Description	Materials	Date	Culture	References
Cormorant	Marine	Middle Mochica painted stirrup spout vessel in the shape of a cormorant	White slipped ceramic, red-brown paint	AD 300-600	Mochica	Lapiner, 1976; 140
Hawk Diety	Mythical	Middle Mochica painted stirrup spout vessel depicting a procession headed by a hawk diety carried in a litter by other figures in bird masks (humming bird? Ibis?)	White slipped ceramic, red-brown paint	AD 300-600	Mochica	Lapiner, 1976; 140
Owl	Terrestrial	Middle Mochica stirrup spout vessel in the form of a dignitary (Ai-Apec) as a drummer surrounded by an owl, a sea lion like animal, and a small human figure	Red-brown ceramic, cream-white slip decoration	AD 300-600	Mochica	Lapiner, 1976; 147
Multiple	N/A	Late Nazca embroidered mantle depicting a series of mythological ceremonies involving women, felines, birds, monkeys and plant demons.	Cotton	AD 300-600	Nazca	Lapiner, 1976; 204

Avifaunal Type	Habitat	Description	Materials	Date	Culture	References
Parrot	Tropical	Middle Nazca jar depicting warriors holding a spear thrower, parrot perched on its finial, package of darts and a sling in the other hand.	Ceramic	AD 300-600	Nazca	Lapiner, 1976; 211
N/A	N/A	Late Nazca double spout vessel depicting two standing figures each holding two knives and surrounded by dead bird figures and cactus(?)	Ceramic, grey, red, brown, cream, black and white paint	AD 300-600	Nazca	Lapiner, 1976; 215

Avifaunal Type	Habitat	Description	Materials	Date	Culture	References
Raptor?	Terrestrial	Middle Mochica painted stirrup spout vessel with depiction of running warriors; details of an upside down raptor looking bird between them (perhaps dead?) and a smaller gull-like bird overhead.	White slipped ceramic, red-brown paint	AD 400-600	Mochica	Lapiner, 1976; 135
Feather Décor	Tropical?	Shaped tapestry bag, profile standing feline with blue feather tassels	Cotton and wool with feather tassels	AD 600-700	Nazca-Huari	Lapiner, 1976; 217
Dove?	Terrestrial	Early Huari Nieveria style double vessel in the form of two seated birds, one with something in its beak	Painted ceramic	AD 800-1000	Huari	Lapiner, 1976; 231
Parrot	Terrestrial	Early Huari spouted vessel with strap handle in the shape of a parrot	Burnished ceramic, ocher, dark brown, gray and cream paint	AD 800-1000	Huari	Lapiner, 1976; 247

Avifaunal Type	Habitat	Description	Materials	Date	Culture	References
Seabird?	Marine	Early Huari spouted vessel with strap handle in the shape of a bird (penguin?) with painted feline head decorations	Highly burnished ceramic	AD 800-1000	Huari	Lapiner, 1976; 247
Feather Garment	Tropical	Cube shaped hat made of multi colored tropical bird feathers, with fanged face motifs and geometric designs	Tropical bird feathers, textile			Quilter, 2005; p. 121

BIOGRAPHY OF THE AUTHOR

Heather Landazuri was born in Artesia, California on November 26th, 1991. She was raised in various coastal towns in southern and central California but of them all, Lompoc, CA has always been “home”. She graduated from Lompoc High School in 2009 and attended the University of California, Santa Barbara 3 years later, graduating in 2015 with a Bachelor’s degree in Cultural Anthropology. She ventured to Maine in the fall of 2019 and entered the Quaternary and Climate Studies program offered by the Climate Change Institute at The University of Maine. Whilst completing her degree, Heather joined PaleoWest LLC., an international cultural resources management firm, to begin her career as an Archaeologist. Heather is a candidate for the Master of Science degree in Quaternary and Climate Studies from the University of Maine in December 2022.