DIVERSITY SPECIALISTS:
COASTAL RESOURCE MANAGEMENT AND HISTORICAL CONTINGENCY IN THE OSMORE DESERT OF SOUTHERN PERU

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Prehispanic socioeconomic organization along the Andean coast is often understood with the "horizontality" model. In this scenario, coastal communities engaged in specialized economic activities and exchanged for products of other specialized communities. Throughout the lower reaches of the Osmore drainage on the south coast of Peru, settlement distribution and both residential and mortuary assemblages of Late Intermediate period Chiribaya partially reflect this pattern. However, investigations at the site of Wawakiki do not support a strict pattern of specialization, demonstrating that some communities along the intervalley coast emphasized a diversified production strategy. This practice appears late in the Chiribaya cultural sequence established for the Ilo valley, and it appears to have constituted part of a socioeconomic response to increasing hardships between about A.D. 1200–1400. Late Chiribaya populations responded to the combined effects of demographic growth and diminishing agricultural potential by (1) expanding into the relatively unpopulated intervalley coast, and (2) placing greater emphasis on diversified community level production along the coast. These results indicate that the variation observed in socio-economic organization should be interpreted within a more historically contingent and dynamic framework than that offered by a general model alone.

La organización socio-económica de la época prehispánica en la costa andina generalmente se entiende dentro del modelo horizontality. Según este argumento, las comunidades costeras participaron en actividades económicas especializadas e intercambiaron productos con otras también especializadas. Este patrón se evidencia en la distribución de las comunidades del cuenca costero del Osmore, sur del Perú, al igual que en los contextos domésticos y mortuorios de Chiribaya del período Intermedio Tardío. Sin embargo, investigaciones en el sitio Wawakiki demuestran que algunas comunidades en la costa entre los valles Ilo y Tambo practicaron una estrategia de producción diversificada. Esta aparece muy tarde en la secuencia cultural de Chiribaya del valle de Ilo, y habría constituido parte de una reacción socio-económica a las mayores dificultades experimentadas hacia 1200–1400 d.C. por las poblaciones del valle principal. Las poblaciones respondieron a los efectos combinados de crecimiento demográfico y la disminución del potencial agrícola (1) esparciéndose a los intervalles poco poblados, y (2) diversificando la producción al nivel de las comunidades costeras. Estos resultados indican que la variación en la organización económica se debe entender dentro de un contexto más dinámico e históricamente contingente del que ofrece el modelo de horizontalidad.

Ethnographic and archaeological accounts of prehispanic Andean communities offer a wealth of information concerning political and economic organization at the time of European arrival in the Americas. In coastal Peru, these accounts often indicate politically autonomous communities that engaged in specialized economic activities related primarily to fishing and agriculture (Rostworowski 1977, 1989). However, the degree to which ethnographic models can be applied to various local or regional levels of organization, or to historical periods prior to European contact remains to be demonstrated. While cultural values regarding economic specialization and exchange may have been strong among many Andean coastal communities (e.g., Lozada and Buikstra 2002, 2005; Rostworowski 1977, 1989; Sandweiss 1992), considerable variation existed across space and time in the implementation of those practices. Economic strategies are dynamic, especially at the household and community level, and necessarily must incorporate some flexibility to ensure sustainable production. Moreover, coastal Andean valleys embody much greater resource variability and...
distribution than once believed, creating an ecological mosaic within which coastal communities interacted (Shimada 1982). Ethnohistoric models applied broadly across a region may identify general principles of economic mindsets, but they often cannot identify or predict the diversity of human ingenuity and innovation that arises at the household or community level.

In the Osmore region of southern Peru, particularly along the Ilo River (the lower valley portion of the drainage), archaeological remains of Chiribaya communities during the late prehispanic period (A.D. 900–1400)\(^1\) exhibit some elements of ethnohistoric models applied to the Andean coast (Jespersen 1990; Knudson et al. 2007; Lozada and Buikstra 2002, 2005; Rice 1993; Tomczak 2003). People may have taken advantage of widely spaced resources by placing greater emphasis on specialized economic activities like agriculture or fishing, though likely not to the exclusion of all others. However, while some communities in the main valley sectors of the Osmore drainage may have participated in a specialized production economy, the entire region was by no means homogenous with respect to either the spatial distribution of key coastal resources, or community-level production strategies. Findings from recent excavations at the inter-valley coastal spring site of Wawakiki do not support a strict ethic of specialized production, suggesting rather that some small coastal communities intensively exploited multiple resources. This diversified strategy appears to have become most pronounced during the late Chiribaya period (ca. A.D. 1200–1400), and perhaps for several decades into the fifteenth century before the site experienced a century or so of abandonment prior to Spanish arrival. The results presented here suggest that economic organization and production strategies were complex and wide-ranging along the far southern coast of Peru, and that the variation in the archaeological record should be interpreted within a more historically contingent and dynamic framework than can often be offered by a general model alone.

**Economic Organization and the Andean Coast**

Two models of prehispanic economic organization have predominately been applied to the Andes culture region of South America, both of which largely reflect the distribution of natural resources and resource potential. The **verticality** model has primarily been applied to highland plateaus and intermontane valleys, suggesting that ancient Andeans exploited vertically stacked resource zones along the eastern and western slopes of the Andes (Murra 1972, 1985a, 1985b). Rather than accepting it a priori as a sweeping model of organization throughout the highlands, investigations in recent decades into the nature of the verticality model have ultimately cast light on the variation that existed in highland economic organization (e.g., Masuda et al. 1985; Stanish 1989a, 1989b, 1992; Van Buren 1996). These studies recommend defining the conditions under which the model successfully describes or explains human behavioral patterns of production and exchange among Andean highland communities, while also urging investigators to pursue alternative explanations for patterns that diverge from it.

Conversely, the **horizontality** model has largely been used to characterize the socioeconomic relationships among coastal Andean communities, where a division of labor arose predominately between **pescadores** and **labradores**—or fisherfolk and agriculturalists—but also included **mercaderes**, artisans, and other specialists (Rostworowski 1977, 1989). The model further recognizes that some coastal communities operated autonomously, each with its own internal social hierarchy, and each subordinate to a single supreme political leader, or **señor**, giving rise to the term **señorío** (Rostworowski 1977, 1989, 1999). While specialized production necessarily constituted an economic division among ancient Andean coastal communities, ceremonial centers continued to integrate **pescadores** and **labradores** for communal celebration of ritual events (Rostworowski 1977, 1981, 1993).

An economy organized around communities of specialized production necessitates a structured exchange system, and archival documents have suggested a complementary and reciprocal relationship between fishing communities and agriculturalists along much of the Andean coast (Rostworowski 1981:116–120). Furthermore, this exchange system integrated specialist communities on several distinct levels. First, it occurred locally and within a single village or **señorío**; each labor group focused on a particular product, and it was necessary for them to exchange with one another to obtain other
necessities. Second, it occurred regionally, beyond the local señorío. Pescadores dried excess fish to transport to distant places for exchange, typically to the inland valleys and neighboring highlands. Finally, a third level of exchange related to sacred objects, textiles, metal objects, or other extravagant items (Rostworowski 1981:90–91).

The horizontality model largely rests on the availability and distribution of renewable resources in the marine, littoral, agricultural, and inland lomas and forested sectors, with the ocean constituting a major resource base (Rostworowski 1977, 1981, 1989). Even after agriculture became viable and intensive in the coastal valleys, there remained large groups of specialized fisherfolk along the shoreline, politically autonomous and each with its own señor (Rostworowski 1993:225). Groups of inland farmers also maintained relative autonomy, specializing in agriculture in the lower and coastal valleys, and communities probably retained use rights to islands, beaches, lagoons, fertile farmland, and other areas of renewable resources through their proximity to such locations (Rostworowski 1998:98). This marked division of labor is perhaps illustrated best in the sixteenth century Chincha Valley where ethnohistoric documents record a population of 30,000 tributaries divided into 10,000 pescadores, 12,000 labradores, and 6,000 mercaderes (Rostworowski 1999:289–290). Archaeological testing of the Chincha Valley ethnohistoric information has provided greater detail regarding the organization of specialization, at least as it relates to fishing communities. For instance, it appears that strict specialization applies best to non-elite members of specialized groups, while elite members or specialist lords could oversee attached craft specialists in addition to fishing activities (Sandweiss 1992).

Ethnohistoric records also point to a series of specialized fishing communities along the far south coast of Peru and northern Chile that would resonate well with the overall model of horizontality. Referring directly to the Osmore and neighboring coastlines, archival documents note that “settlements of fisherfolk in Moquegua [Osmore/Ilo], Tacna, Arica, and southward to Atacama were established along the littoral zone and around the mouths of the coastal river valleys, forming particular villages under the authority of their own chiefly figurehead” (Rostworowski 1993:225; my translation). This points to the existence of at least some fishing communities operating in a politically autonomous fashion from agriculturalists in the Osmore region, and these specialized communities constituted a chief component of the coastal economy.

In general, the horizontality model provides an innovative scheme to understand late prehispanic and early Spanish colonial economies and sociopolitical organization along the coast, which has often stood in contrast to the highland verticality model (for a more unifying approach to Andean economies, see Stanish 1992). However, the degree to which archaeologists can apply specific principles of the horizontality model to Andean organization of production before European arrival remains unclear and subject to empirical testing. While there is some archaeological support for the horizontality model along the Ilo River during the late prehispanic era (ca. A.D. 900 to 1400 [e.g., Jessup 1990; Lozada and Buikstra 2002, 2005]), the area as a whole was neither static nor homogenous in terms of the organization of production at the community level. The distribution of key resources along the coastline can be complex with considerable spatial overlap, especially among intervalley sectors, and coastal communities responded in various ways to historically contingent conditions in order to reduce risk and ensure biological and social reproduction. In the Osmore region, the historical intersection of growing populations and several centuries of decreased highland precipitation would have generated stress among lower valley farming communities along the Ilo River. Ultimately, this appears to have catalyzed several organizational responses, including expansion into less populated intervalley regions and a greater emphasis on diversified production by those intervalley coastal communities. Each strategy would have effectively relieved pressure on main valley resources in the face of growing hardships.

Resource Variability, Horizontality, and the Coastal Osmore Region of Southern Peru

Resource Variability and the Osmore Drainage

The Osmore drainage is one of the southernmost valleys of Peru (Figure 1). The hyper-arid climate has been relatively stable for several thousand years
Osmore, this Chiribaya; the Chiribaya, some 38,000 km², non-existent for years at a time. Consequently, agricultural production along the Ilo River (as the Osmore is termed in the lower valley) relies heavily upon runoff from snow melt and seasonal highland rainfall (Rice 1989). The coastal plain north of the river mouth is bordered to the east by a series of inland hills that reach a maximum elevation of about 1200 m.a.s.l (Bellido and Guevara 1963). This cordillera runs north-northwest, narrowing the coastal plain until it ultimately fades out about 25 km north of the Ilo River (Figure 1).

Agricultural potential along the Ilo River was quite modest during the period under investigation. The river flows through a steep sided canyon rarely reaching 450 m in width (and often much narrower near the coast), thereby generally restricting agricultural production to about 400 ha along the immediate floodplain (ONERN 1976). During the Chiribaya period (A.D. 900–1400), major canals were constructed to irrigate alluvial terraces along the valley floor and a limited area surrounding the river’s mouth (Owen 1993, 1994). Most noteworthy of all lower valley Chiribaya hydraulic endeavors was a roughly 7 km canal that transported water above several discontinuous alluvial terraces, sometimes traversing near-vertical bedrock faces (Reycraft 2000; Satterlee et al. 2000). Current evidence suggests this canal was in use by the middle of the eleventh century (Owen 1993:526–533; Satterlee et al. 2000:101), and it was ultimately destroyed by massive floods, sheet wash, and debris flows associated with a mid-fourteenth century El Niño event (Reycraft 2000; Satterlee 1993). Lower valley irrigation systems may have already been experiencing a period of stress, however, suggested by considerable variation in highland precipitation over the past millennium, including several centuries of below average highland precipitation between A.D. 1040 and 1490 documented in the Quelccaya ice cap of southern Peru (Thompson et al. 1985:973; Thompson et al. 1994:85). Sediment cores from Lake Titicaca in the Bolivian altiplano...
generally corroborate the ice core precipitation data (Abbott et al. 1997; Baker et al. 2001; Binford et al. 1997; Moseley 1997). During the late Chiribaya period (~ A.D. 1200–1400), Satterlee et al. (2000:96–97) estimate a 20–30 percent decline in runoff from the headwaters of the Osmore drainage, a decline that would have been exacerbated in the lower valley as transport distances increased.

Along the intervalley coast north of the Ilo River, a series of fresh water springs emerge from the desert between 100 and 150 m.a.s.l. (Bawden 1989a, 1989b; Clement and Moseley 1991). Because of the narrowing coastal plain, springs surface much nearer the coastline in the north than in the south. As the only freshwater sources outside the river valley, they became focal points for localized agricultural production among small communities. While the largest did not exceed 30 ha of cultivated area during the prehispanic era (Satterlee 1993), combined, these intervalley sites could have potentially sustained considerable amounts of cultivated terrain, at least relative to that supported along the Ilo River. For example, the four spring sites of Wawakiki, Pocoma, Miraflorres, and Carrizal supported a combined total of about 85 ha during the late prehispanic era, not including production from other nearby springs like Alastaya and Yara (Satterlee 1993; Zaro 2005a; Zaro and Umire Alvarez 2005). Moreover, several springs north of Wawakiki (e.g., Punta Callango) also exhibit extensive late prehispanic agricultural remains.

While agricultural potential varies throughout the region, marine resources abound along the coast (Alamo and Valdivieso 1987). Near-shore currents of coastal Peru bring cold water and nutrients to the surface, promoting an abundance of phytoplankton and other marine plants, which in turn support a large concentration of marine biomass, ranging from dense schools of anchovies, to larger cold-water marine species. Furthermore, shoreline rocky outcrops and sandy beaches support abundant littoral resources, including shellfish and marine birds (Moseley 1975), and these were readily accessible to Chiribaya populations living in the coastal portions of the drainage.

The lomas constitute a third principal resource zone, typically growing above the spring systems (ca. 200–1000 m.a.s.l.) and flourishing during the austral winter season as dense fog rolls off the ocean to provide considerable moisture to the dry terrain (Dillon 2006; Moseley 1975:8). The lomas support a variety of plants, shrubs, and grasses that have often provided grazing territories and habitats for wild animals like guanaco, deer, and fox. Ethno-historic sources note that the lomas around Ilo were at one time some of the most abundant of coastal Peru, and locals traditionally utilized them for herding llama and alpaca (Rostworowski 1981). Occasional rains delivered by El Niño events also foster notable surges of herbaceous vegetation growth, encouraging use of the zone by nearby herders (Arakaki Makishi 1999:17). Today, much of the intervalley coastal landscape remains highly desiccated, yet both historical and archaeological information suggests that abundance and biodiversity in these areas were much greater in antiquity (e.g., Frezier 1982[1713]; Rostworowski 1981; Umire Alvarez 1994, 1996; Vásquez de Espinosa 1987[1618]; Zaro 2005b).

Chiribaya Culture and Economic Specialization

The late prehispanic period in the lower Osmore drainage was largely associated with the Chiribaya culture (A.D. 900–1400). Chiribaya remains have been reported as far north as the Tambo drainage and as far south as northern Chile (Jessup 1990), and in very limited quantities in both domestic and funerary contexts as far inland as the upper Osmore sierra around 3,000 m.a.s.l. (Stanish 1992:119). Chiribaya remains have also been identified in the middle Moquegua valley at the site of La Victoria (Feldman 1984), two small sites near El Ramadón (García 1988), and at the largest middle valley Chiribaya site of Yaral (Rice 1993). By far, however, the majority of known Chiribaya settlement lies along the banks of the Ilo River, stretching from the river mouth to some 25 km inland (Buikstra et al. 2005; Ghersi 1956; Jessup 1990; Lozada 1998; Owen 1993, 1994, 2005; Umire and Miranda 2001), and along the coastal plain north of Ilo (Bawden 1989a, 1989b; Umire Alvarez 1994, 1996; Umire and Miranda 2001; Zaro and Umire Alvarez 2005 [see Figure 1]). Systematic survey conducted in the early 1990s along the Ilo River identified sizeable Chiribaya habitation areas, and the substantial increase in total area of habitation sites from early to late Chiribaya periods suggests lower valley population growth, followed by a significant decline into the subsequent Estuquiña period.
(Owen 1993, 1994). Owen (1993:526) further stresses that while “margins of error are large here, the net result suggests that the Chiribaya population probably increased over time, and possibly increased substantially.”

Using biological and cultural data, Lozada and Buikstra (2002, 2005) argue that the Chiribaya constituted a señorío in the lower Osmore drainage. They draw three primary conclusions: (1) the Chiribaya originated on the coast and therefore developed genetically independently from highland populations (for related studies, see Sutter 2000, 2005); (2) they were composed of economically specialized communities (predominately pescadores and labradores); and (3) Chiribaya communities were internally stratified socially, each holding its own elite but united under a single supreme authority at Chiribaya Alta. Materials for their study stem from sites located throughout the lower and immediately adjacent coastal portions of the valley, and specifically from regions of varied economic potential. These include Yaral in the middle valley, Chiribaya Alta located high on the Pampa Inalámbrica overlooking the lower valley but near lomas resources, El Algodonal adjacent to the Ilo River floodplain, and San Gerónimo situated on a low river terrace only a few hundred meters from the coast (see Figure 1).

Other investigations have also found support for a tendency toward economic specialization among Chiribaya settlements. Tomczak (2003) finds evidence for specialized communities in stable isotope data from the middle and lower Osmore drainage, while others have noted the ecological zones in which Chiribaya settlements are found (Bawden 1989a; Jessup 1990). Jessup (1990) first suggested there was some degree of economic specialization among Chiribaya in the main river valley, though probably not to an absolute degree nor limited to food procurement. This assertion is based principally on the location of particular sites and their associated residential and mortuary artifacts. Specifically, Yaral and Chiribaya Baja are both located near the valley floor and associated with substantial canal and terrace systems. However, while it appears that these communities invested heavily in agricultural production, the degree to which they did so to the exclusion of other activities remains unclear. For instance, aside from evidence for agriculture, excavations at Chiribaya Baja also indicate a subsistence economy that included the drying and smoking of fish (Rice 1993:70). Furthermore, the remains of marine and riverine resources are found in varying abundances at lower valley sites (Owen 1993), though it is unclear to what degree these were procured by specific valley communities or obtained through exchange networks with nearby coastal villages. Elsewhere, greater tendency toward specialized production is evidenced at San Gerónimo, near the coast. Excavations there revealed stone-lined storage bins of dried fish, and middens dominated by both fish and shellfish. Fishing paraphernalia such as hooks, weights, and floats were common in burial assemblages as well. Finally, Chiribaya Alta is located high up on the valley rim overlooking the Ilo River but near lomas areas that may have been utilized for herding. Shimada and Shimada (1985) have made a compelling case for successful camelid herding along the north coast of Peru, addressing in part the adaptability of camelids to coastal climate and flora. At Chiribaya Alta, camelid remains were found in tombs of all time periods (Jessup 1990), and wool was the most common fiber in Chiribaya textiles, suggesting the important role of camelids in the region (Boytner 1998; Wallert and Boytner 1996). Aside from possibly housing the Chiribaya supreme authority, Chiribaya Alta may have controlled grazing territories for camelid herds raised in the lower valley (Jessup 1990; Lozada and Buikstra 2002). However, this may not have occurred to the exclusion of others, as camelid bones and feces are fairly common among lower valley Chiribaya sites, suggesting that access to the lomas may have been only minimally restricted (see Owen 1993:154, 180, 500).

The intervalley coast presents a different configuration than the main valley, though the principal resource bases remain the same. In the lower valley, the resource triad of agriculture-marine-lomas is widely spaced horizontally, which may have fostered tendencies toward specialization and exchange among local communities near these areas. Along the intervalley coast, these resources are generally found in much closer proximity, and in some cases they spatially overlap. Nonetheless, Umire and Miranda (2001:63) synthesize available data by assigning principal Chiribaya sites of the region to distinct economic categories that relate to either fishing or agriculture: (1) sites within 200 m
of the coastline and whose principal concern was marine exploitation; (2) small villages located in coastal quebradas that were associated with small-scale agricultural production; and (3) larger communities in the main river valley and whose economic investment was primarily focused on canal irrigation agriculture (Table 1). Some inter-valley coastal sites, however, are not so easily placed into distinct categories of economic specialization. In fact, remains of Chiribaya settlements like those situated at Wawakiki (quebradas Agua Buena and Seca) and Punta Callango reflect intensive exploitation of several primary resources and therefore do not support strictly defined economic categories of *pescadores* and *labradores* at the community level.

### Diversified Production at Wawakiki

Wawakiki occupies a steep and rocky coastal promontory 27 km north of the mouth of the Ilo River where three primary coastal resource zones—the *lomas*, fresh water springs, and littoral/marine zones—are highly compacted with little horizontal separation (Figure 1). This configuration continues from Wawakiki northward for at least 20 km, though a high sea cliff with intermittent and isolated sandy beaches exists along the coastline for much of the remaining distance to the Tambo Valley. Wawakiki is bordered by Quebrada Agua Buena to the north and Quebrada Seca to the south, both of which extend 2 to 3 km inland (Figure 2). The Quebrada Agua Buena channel empties directly into the sea, dropping some 40 m over an escarpment, while Quebrada Seca spills over a similar height onto a 200 m wide beach enclosed by rocky outcrops.

### Late Chiribaya Resource Procurement at Wawakiki

Excavations at Wawakiki in 2003 focused on the agricultural sectors and associated irrigation features, with some investigation into the Chiribaya habitation terraces visible on the surface (Figure 2). These habitation terraces cover only .48 ha, but profile data suggest a much more complicated evolution than can be discerned from surface remains (Zaro 2005a:192–193, see also 243–248, Figures A2–A7). Importantly, these are the only Chiribaya period domestic remains identified in either of the two quebradas, which supports the notion that a single community diversified its production strategy to include multiple resource bases.

A series of isolated profiles and excavations were dug across the site (Figure 3). Isolated profiles targeted natural rills that are scattered throughout the area. These were cleaned to sterile, and detailed profiles were drawn to document depositional patterns, field technologies, and the evolution of field systems. Excavation units, on the other hand, targeted areas with little erosional disturbance. All units were excavated to sterile by depositional stratigraphy or by 10 cm levels, and sediments were screened through .5 cm mesh. In total, 31 isolated profiles and 10 excavations were dug.

### Agricultural Production at Wawakiki

**Coastal Agriculture.** Excavations and isolated profiles at Wawakiki revealed an intensive, arid-
adaptive agricultural land-use strategy that consisted of steep irrigation canals and stone-faced terraces across 11 ha of coastal terrain (Zaro and Umire Alvarez 2005). Two primary canals extended from their inland springs in both quebradas Agua Buena and Seca to terraced fields along steep canyon walls and the coastal promontory (see Figure 3). Both the Agua Buena and Seca canals traversed the canyon walls at relatively steep gradients (four and three percent, respectively), extending onto the upper portion of the coastal promontory where they pass beneath Chiribaya habitation terraces and nearly overlap at similar contours. The use of multiple springs to irrigate much of a single unit of land, principally the coastal promontory, may have been a response by local farmers to partially overcome fluctuations in spring discharge and maintain some degree of stability in agricultural production (Zaro and Umire Alvarez 2005:732). Although road construction has buried inland portions of the primary canals in both quebradas, they can be securely traced for about 430 m in Agua Buena and 215 m in Seca, though their locations high up on the canyon walls suggest that they may have extended for distances of nearly 750 m before intersecting spring sources near the quebrada channels. Excavations on steep canyon walls in both quebradas and on the coastal promontory confirm that the area had been intensively modified with stone-faced agricultural terraces (Figure 4).

Canals and terraces are dated with a combination of techniques, including radiocarbon age ranges from a variety of contexts (Figure 5), and several relative chronological markers that include diagnostic ceramics, relative preservation of terraced fields, and the superposition of Huaynaputina volcanic tephra of A.D. 1600 (Thouret et al. 1999). Based on these markers, most canals and terraces appear to have been constructed during the late Chiribaya period (Figure 5). Profile data from excavations around the agricultural sector suggest that while it is possible that the system as a whole may have been constructed in sections, most individual terraces were built in a planned, systematic fashion, rather than incrementally over long periods of use and modification (for incremental construction, see Doolittle 1984 and Smith and Price 1994). This spring-fed irrigation system also appears to have been most extensive during the late Chiribaya
Figure 3. Historic aerial photograph of the Wawakiki promontory showing the locations of principal excavations (-E) and profiles (-P) that yielded evidence for late Chiribaya occupation and exploitation. White lines designate the remains of primary canals extending onto the coastal promontory from quebradas Agua Buena and Seca. Spanish colonial property wall is visible to the south of excavation WK3C-e, extending toward the southwest from the colonial period road (C.R.). Chiribaya habitation terraces can be seen best near profiles WK4A-p and WK4B-p as light-colored linear features east of the colonial road (photograph taken by the Servicio Aerofotográfico Nacional del Perú, 1951).
1 Thin alluvial deposits consisting of laminated silt and sand with scattered medium to coarse gravels
2 Upper strata of terrace fill; fine silt and sand with scattered medium gravels, fairly homogeneous along with strata 3; small scatters of rootlets throughout much of this strata; it exhibits light to medium compaction
3 Lower strata of terrace fill; silty sand, scattered gravels, underlying strata 2 for the entire length of the profile; primary difference between 2 and 3 is level of compaction, with 3 being much more compacted

Figure 4. Buried prehispanic agricultural terraces identified in isolated profile WK5E-p are regularly spaced at about 1 to 1.5 m intervals. This sector of the coastal promontory does not appear to have been cultivated beyond the prehispanic era. Spanish colonial period property wall is visible in the background near the horizon (view to the north).
Chiribaya at Wawakiki, Probability Distributions

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<td>domestic refuse</td>
<td>1000 1200 1400 1600 1800</td>
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Figure 5. Radiocarbon age ranges (2-sigma probability distributions) discussed in the text. Dates were calibrated using CALIB REV5.01 Radiocarbon Calibration Program (Stuiver and Reimer 1993) made available by the University of Washington, based on southern hemispheric data sets described by McCormac et al. (2002). Uncalibrated radiocarbon years B.P. for Carrizal Bajo are originally published in Owen (2005:60), while Wawakiki samples WK5E6-E and WK3B8-E are originally reported in Zaro (2005a:241). All other uncalibrated radiocarbon ages are published in Zaro and Umire Alvarez (2005:725).

period, and terrace construction at the most distal end of the irrigation canals continued into the fourteenth century (Figure 5, see agricultural terrace; Zaro and Umire Alvarez 2005:727). With considerable initial investments, a small Chiribaya community transformed the arid coastal promontory at Wawakiki into a productive agricultural landscape, where steep irrigation canals and stone-faced terraces increased water use efficiency while limiting soil erosion on steep, sparsely vegetated hill slopes.

**Inland Agriculture.** Survey of the inland quebradas documented at least two areas of probable Chiribaya agricultural land use (see Figure 2). The first lies near the very wind-deflated summit between quebradas Agua Buena and Seca at an elevation of 320 m.a.s.l. It consists of a series of small, low-lying stone alignments extending from an intermittent stream/erosional channel that may have formed from spring runoff and/or periodic El Niño rains. The second site lies in the upper section of Quebrada Seca at an elevation of 378 m.a.s.l., in a heavily eroded area along the south canyon wall. While no diagnostic artifacts were found at either location, the presence of stone-faced terraces with associated footer walls suggests contemporaneity with those described for the coastal sectors at Wawakiki (see Zaro 2005a; Zaro and Umire Alvarez 2005:728). This double-wall construction appears to be unusual in the area, as it has not been reported elsewhere along the intervalley coastline.
between Tambo and Ilo\textsuperscript{2}. Furthermore, reliance on low-lying, stone-faced terraces contrasts sharply with early Spanish colonial agricultural technologies in the area, lending further support for their prehispanic construction (Clement and Moseley 1991; Zaro 2005a). While excessive wind may have posed problems to crops cultivated near the summit, Chiribaya farmers may have been intermittently cultivating these inland areas, at least when hydrological conditions permitted, and possibly on a seasonal or interannual schedule. Evidence of terraces, canals, and other agricultural features have been described for lomas sectors elsewhere along the Peruvian coast, where dense seasonal fog may have augmented their agricultural potential (Denevan 2001:168).

**Pollen and Species Diversity at Wawakiki.** A total of 20 soil samples associated with late Chiribaya, Spanish colonial, and postcolonial contexts were collected from both excavations and isolated profiles and subsequently sent to the Paleoresearch Institute in Golden, CO, for pollen analysis. Pollen preservation in these samples varied from good to poor, and nine of the samples came from field and terrace contexts securely dated to the Chiribaya period.\textsuperscript{3} The following information is based on the pollen report produced by Paleoresearch Institute (Cummings 2004).

All Chiribaya samples exhibit a relatively large quantity of charcoal when compared to later samples, suggesting late prehispanic farmers regularly burned their fields, or that burning was relatively more widespread. Chiribaya samples also display fluctuating amounts of high-spine Asteraceae and Chen-\-am pollen, representing the presence of weedy members of the sunflower and goosefoot families, both of which possibly grew along the margins of canals. Six of the nine samples also exhibit small quantities of mesquite pollen (*Prosopis* sp.), indicating its presence nearby.

The plants likely to have been growing in the agricultural fields or perhaps nearby in the quebrada channels—either cultivated or possibly tolerated—include *Zea mays*, Solanaceae and *Solanum* sp., *Datura* sp., and *Indigofera* sp. *Zea mays* was identified in all samples, suggesting that maize was an important subsistence crop during the Chiribaya occupation of the site and may well have been the dominant crop present. In addition, *Zea mays* starch was recovered from Chiribaya associated strata in profile WK3C-p, which suggests deterioration of maize kernels in the ground. Solanaceae and *Solanum* encompass a variety of cultivated plants including tomato and potato, though unfortunately genus could not be identified for any of the Solanaceae pollen recovered. *Datura* was identified in a sample from profile WK5E-p, possibly indicating this hallucinogenic plant was either growing nearby or even tolerated in the fields, and it has a number of uses. Prehispanic Andeans smoked parts of the roots of one species as a remedy for asthma (*Datura stramonium*), and its seeds were extracted for their narcotic properties (Yacovleff and Herrera 1935:66). *Indigofera* is especially noteworthy because a blue dye is produced from one species (Keary and Peabees 1960:428). In their studies of Tumilaca and Chiribaya textiles, Wallert and Boytner (1996:858) determined indigo to be the source of blue dye used in Chiribaya textiles sampled from the Ilo valley. This plant can be found in the geographical area of the Osmore, and it may have been encouraged to grow in fields at Wawakiki, near the edges of fields for easy exploitation, or perhaps nearby in the inland lomas.

Pollen remains from this limited number of samples suggest an agricultural base dominated by maize, but a variety of weedy and herbaceous plants in and around the site almost certainly contributed to the local economy as well. Together, the intensive canal and hillside terrace technology coupled with a range of subsistence and other economic plants at their disposal suggests that Chiribaya invested considerably in both domesticated and nondomesticated plants in and around their local environment.

**Marine Exploitation**

Marine and littoral resources are plentiful around Wawakiki. Much of the immediate surrounding shoreline is very steep and rocky, providing many procurement locations for marine products. Almost daily from February through August of 2003, our field crew observed local fisherfolk casting lines from the rocky shore or exploiting near-shore rocky outcrops from small boats for both fish and shellfish. In addition, the enclosed sandy beach at the mouth of Quebrada Seca provides an excellent landing for watercraft. Today, local fisherfolk continue to practice a traditional fishing technique termed *chinchorro*, where they utilize the Wawakiki
Figure 6a, b. Seen here at Wawakiki Beach (a), these local fisher-folk continue to practice a strategy termed chinchorro, where traditional watercraft are used (termed balsa). Small models of wooden boats virtually identical to those currently in use along the Osmore coast (b) have also been found in many Chiribaya burials, especially along the coast at San Gerónimo (Jessup 1990).
beachfront to land two watercraft at opposite ends of the beach, each dragging an end of a single long net. Once ashore, a small group hauls in the net, trapping a variety of fish, crabs, and other marine delights. Locals continue to use traditional watercraft called balsas, or on occasion, small outboard motor boats (Figure 6a, 6b).

By far, marine shell fragments constitute the most common ecofacts observed in isolated profiles or recovered from excavations (n = 60,241; weight = 63.2 kg). While considerable amounts were recovered from both slope wash and agricultural terrace fill contexts, substantial quantities (n = 12,244; weight = 17.3 kg) came from excavation WK3C-e, a 1 x 2 m unit located just below the colonial road and associated with Chiribaya habitation terraces (see Figure 3). Excavations revealed dense domestic refuse and cobbles fill in the context of a buried domestic terrace wall. Deposits overlying the wall date to the early Spanish colonial era, but ceramics encountered in lower levels exhibit bowl forms with interior decoration, and rims painted with black lines and white dots. Elsewhere in the lower valley, bowls decorated in this style have been dated to the late Chiribaya phase (Jessup 1990; Lozada and Buikstra 2002; Owen 1993). Moreover, three charcoal samples from these deposits, including a carbon lens immediately beneath dense marine refuse and just above culturally sterile colluvium, yielded calibrated age ranges consistent with late Chiribaya occupation, and possibly extending into the fifteenth century (Figure 5, see marine refuse). Combined, the radiocarbon assays and ceramic decoration securely place this deposit in the late Chiribaya period (ca. A.D. 1200–1400), and possibly extending slightly beyond the conventional dates accepted for Chiribaya.

Marine shell was very dense in these refuse layers. In four excavation levels, 8,220 marine shell fragments weighing 12.8 kg were recovered from a calculated volume of just .36 m³ of silt, sand, cobbles, and refuse. The quantities recovered from this unit are also comparable to the amount and density of shell fragments collected in several other excavation units or observed in isolated profiles, especially those associated with the Chiribaya phase habitation terraces, where all associated radiocarbon age ranges support a late Chiribaya phase occupation (Figure 5, see habitation terrace). Several species were commonly represented in these strata, including conch (Concholepas concchlepas), mussels (Choromytilus chorus), keyhole limpets (Fissurella sp.), surf clams (Donax sp.), and chitons (Chitonidae sp.). All are known to inhabit shallow rocky shorelines, with the exception of surf clams, which tend to inhabit shallow sandy shorelines (Alamo and Valdivieso 1987). In addition, fragments of crabs and sea urchin were common, as were unidentified fish remains. Finally, fishing implements such as weights and copper hooks were observed on the surface throughout the various agricultural sectors of the site, no doubt churned up and redeposited by 350 years of Spanish colonial and postcolonial cultivation. Overall, there is strong evidence to suggest that the small Chiribaya community occupying Wawakiki actively exploited both the sandy beachfront and nearby rocky outcrops for seafood.

Lomas Exploitation

Because of the steep rise of the coastal cordillera, lomas areas once flourished only a short hike inland from Wawakiki, offering access to wild shrubs, game, fuel, and possibly opportunities to raise small herds of camels. The lomas behind the site have all but disappeared today, but stumps of tara (Caesalpinea spinosa) trees remain scattered among the inland hills behind Wawakiki, and historic aerial photographs taken by Peru’s Servicio Aereofotográfico Nacional confirm that some remained standing in 1951. Tara scatters are also reported to have been quite extensive behind Alastay a several kilometers south of the site (Arakaki Makishi 1999:18). In addition, archival documents note that during the early seventeenth century, a hacienda situated along the coast between the Tambo and Ilo rivers included over 200 mules that were sent to graze among the Lomas de Saucos, only a few kilometers north of Wawakiki (Vásquez de Espinosa 1987:27–28 [1618]).

While data regarding lomas exploitation is limited, there are a few bits of information stemming from both excavations and isolated profiles that suggest at least some use of this area, though its intensity remains unclear. First, a small burned deposit underlying an agricultural terrace wall in isolated profile WK5B-p (Figure 5, see agricultural terrace) contained small cameld dung pellets, suggesting that camels had at least made their way to the site. Corrals noted behind Wawakiki in the
lomas zones of both quebradas appear to be historic, but their presence supports the notion that these areas were at one time productive enough to support grazing activities. Second, as mentioned above, there is good evidence that the Chiribaya utilized at least the summit area between the two quebradas and the upper sector of Quebrada Seca for agriculture. It seems reasonable that Chiribaya presence at elevations within the inland lomas for agriculture might have encouraged additional economic pursuits there as well. With such close proximity to the lomas and the wide array of herbaceous and woody plants available to them, local communities likely took advantage of this resource, especially given their intensive investment in other economic activities in their immediate environment. Finally, excavations in the main agricultural sector recovered five chert projectile points associated with slope wash or terrace fill. Similar forms have been found elsewhere along the coast and in association with late preceramic, early ceramic, and Late Intermediate period remains (Umire Alvarez 1994, 1996). Though their chronological placement remains difficult, their presence suggests that hunting may have been a supplemental activity around Wawakiki.

Discussion and Conclusions

Data recovered at Wawakiki do not support strict economic principles of specialization as defined by the horizontality model. The results presented here suggest that considerable variation in economic strategies can exist at the community level within a fairly restricted region. Economic organization among Chiribaya communities was neither static nor homogenous. Rather, some lower Ilo valley communities tended to specialize toward farming, while others primarily pursued fishing as an economic mainstay, though neither may have constituted specialization of production in an absolute sense (see Jessup 1990; Lozada and Buikstra 2002; Rostworowski 1993; Umire and Miranda 2001). Still, others along the intervalley coast appear to have satisfied economic needs by intensively pursuing multiple subsistence strategies in agriculture, fishing, and gathering of wild terrestrial resources, suggesting that not all communities can be easily placed into well-defined categories of specialists. While a strict model of horizontality does not apply to the intervalley coastal site of Wawakiki, this does not discredit the use of general models. Rather, they may be used heuristically to identify variation in the archaeological record, while still serving partially to explain more broadly observed patterns of human interaction and organization.

The archaeological variation observed in production strategies among lower and coastal Osmore communities can be explained by situating these patterns into a historically contingent and dynamic framework. Population levels in the lower Ilo River valley were increasing during the Andean Late Intermediate period, and possibly increasing substantially between the early and late Chiribaya phases. Concurrently, runoff from highland precipitation and snow melt remained below the 1,500 year average, the effects of which were likely exacerbated over time. On the other hand, the coastal springs are quite dynamic, where rates of discharge can vary independently of river flow and can often change dramatically after seismic activity. As such, they may have provided alternatives to a declining water source in the main valley, even in a context of minimal highland runoff (see Zaro and Umire Alvarez 2005:722). The historical intersection of population growth and reduced runoff would have made it more difficult for local farming communities in the lower valley to maintain sufficient production within an exchange-based economy.

Chiribaya appears to have responded to this challenge in two ways. First, some communities expanded into relatively unpopulated intervalley coastal sectors during the late Chiribaya period. While people appear to have settled around these intervalley spring systems early in the first millennium A.D. (see Bawden 1989a; Bolaños 1987; Buikstra 1995; Tello 1987; Umire Alvarez 1994, 1996), there is very little evidence to suggest this occupation lasted beyond the fourth or fifth century. Hence, it appears the coastal landscape between the Tambo and Ilo rivers was relatively unpopulated around the time of the development of Chiribaya culture along the Ilo River ca. A.D. 900 or slightly earlier. Several intervalley coastal springs have produced evidence of significant Chiribaya occupation, including Pocoma, Miraflores, and Carrizal (Clement and Moseley 1991; Reycraft 1998; Satterlee 1993), and there is even preliminary evidence at Punta Callango (Zaro and Umire Alvarez 2005), yet available information
strongly suggests that expansion into this inter-valley region by Chiribaya communities did not occur until the thirteenth century or so. Calibrated radiocarbon age ranges from agricultural, domestic, and marine shell midden contexts at Wawakiki strongly suggest a late Chiribaya occupation and exploitation of the site, while two additional radiocarbon age ranges from the nearby site of Carrizal provide additional support for late phase occupation (Figure 5, Carrizal Bajo). While limited in number, these latter two age ranges stem from burials T5 and T7 at Carrizal Bajo, both of which have been described as “Terminal Chiribaya” in terms of cultural remains (Owen 2005:52; Reycraft 1998), though the calibrated age ranges generated from wool textiles of these burials are fairly consistent with the A.D. 1200–1400 age range established at Wawakiki. Unfortunately, no other late prehispanic radiocarbon age ranges have been produced from this intervalley coastal region. Combined, however, the Wawakiki and Carrizal data point to a fairly late expansion into and occupation of the coastal springs within the general Chiribaya cultural sequence defined in the lower Ilo valley.

Second, while some Chiribaya communities along the Ilo River may have specialized their production to some degree, the intervalley coastal community at Wawakiki placed much greater emphasis on a diversified production strategy, investing heavily in both agriculture and marine resources, while perhaps also exploiting wild terrestrial species among the inland lomas. This would have generated much greater autonomy, and perhaps longer sustainability, among those intervalley communities that pursued such strategies, while also relieving stress on lower valley populations. Thus, decisions to both expand to previously unpopulated intervalley zones and to explicitly pursue a more diversified production strategy among the intervalley coastal springs would have reduced subsistence risks associated with diminishing conditions in the main river valley (e.g., low runoff coupled with a growing population).

A series of sea cliff communities for some distance to the north of Wawakiki likely placed greater emphasis on a diversified production economy, incorporating marine, agricultural, and lomas resources into local subsistence activities. The uninvestigated Chiribaya site at Punta Callango, for instance, exhibits similar features to Wawakiki. It is perched on a rocky sea cliff in high, vertical-relief terrain, and it displays surface evidence for a heavy investment in agricultural infrastructure coupled with intensive marine resource exploitation. Indeed, communities situated along this rugged intervalley coastal zone may have constituted a third division of society, where communities took liberty to invest heavily in multiple production activities.

While specialization may constitute the foundation of economic integration among many coastal Andean communities at the time of European arrival, it need not have occurred solely at the community level. Specialization often occurs on multiple levels that include household, allya, community, or even polity. For instance, production at Wawakiki may have been diversified at the community level, while particular households specialized in fishing, agriculture, or gathering of wild resources among the inland hills, though a more explicit investigation into the domestic sector at the site is required to test this hypothesis. Alternatively, production may have been organized around seasonal activities. In this scenario, agricultural fields and terraces may have been left fallow during months of limited spring discharge, when marine and wild terrestrial resources could have become the focus of community efforts. Elsewhere in the middle and lower Osmore, Knudson et al. (2007) find some support for seasonal consumption of marine products and C₃ plants like maize. They draw their conclusions from carbon and nitrogen isotope studies of archaeological samples of human hair, and clearly seasonality must remain an important consideration in future archaeological investigations of coastal resource management.

In reality, the economic practice described by the more traditionally accepted model of horizontal exchange and specialization on the coast was probably quite dynamic. Organization of production among, and within, particular communities likely vacillated between more extreme versions of specialization and more innovative techniques to economic sustainability that include, but are not limited to, more diversified strategies of production. Hence, Wawakiki represents a historically contingent response to both cultural and biological necessities and the opportunities afforded by the immediate environment during the Late Intermediate period of southern Peru.
Acknowledgments. This research was funded in part by the National Science Foundation (BCS-0222040), the Latin American and Iberian Institute of the University of New Mexico (UNM), Sigma Xi Scientific Research Society, the Office of Graduate Studies (UNM), the Student Resource Allocations Committee (UNM), the Accelerator Mass Spectrometry Laboratory of the University of Arizona, and Geochron Laboratories. Permits to conduct fieldwork in Peru were provided by the Instituto Nacional de Cultura del Perú. The Museo Contisuyo and Southern Peru Copper Corporation very generously provided logistical support throughout this project, without which much of this research would not have been possible. Adán Umire Álvarez co-directed Proyecto Wawakiki 2003 and I thank him for his collaboration and assistance in the field.

Ken Nystrom donated considerable time and energy to the project during its field phase, while Ana Miranda provided helpful advice and encouragement in the laboratory. I would also like to thank Garth Bawden, Jane Buikstra, and Cecilia Lewis for their comments on earlier drafts of this paper, and I am very grateful to David Keefer, María Cecilia Lozada, Michael Moseley, Bruce Owen, and one anonymous reviewer for their insightful comments and advice. Finally, Gabriel A. Torres helped with the Spanish abstract, while Mark Aldenderfer, José Luis Lanata, Brian McKee, and the rest of the LAQ editorial staff were instrumental in finalizing the manuscript. While all those noted have enriched this research with their constructive comments and criticisms, any shortcomings or misinterpretations are strictly my own.

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Notes

1. The Chiribaya cultural chronology continues to be modified, though it often extends from A.D. 900 to 1375 (Owen 1993; Reycraft 1998). In another case, the beginning of Chiribaya has been pushed as far back as A.D. 772 (Lozada and Buikstra 2005:208). Radiocarbon dates associated with Chiribaya remains at Wawakiki presented in this paper and elsewhere (i.e., Zaro and Umire Alvarez 2005) suggest Chiribaya may have persisted until A.D. 1400. For this paper, the period from A.D. 900–1400 will be used to define Chiribaya cultural chronology generally, with the late Chiribaya sequence along the coast defined as A.D. 1200–1400.

2. Bruce Owen has identified similar constructions associated with Chiribaya remains in the lower Ilo valley that may have served similar functions. While thus not unique to Wawakiki, their distribution might be a useful marker of Chiribaya agricultural activities.

3. The remaining 11 samples were extracted from contexts determined to be associated with Spanish colonial and postcolonial period land use. All samples were analyzed under the direction of Dr. Linda Scott Cummings.

Submitted March 1, 2006; Accepted April 17, 2006; Revised June 7, 2006. No conflicts declared by reviewers.