INTRODUCTION

Empires are massive, complex, political entities that present formidable challenges to traditional scales of archaeological analysis. Since empires extend across political boundaries, exchange systems, and environmental zones, the organization of populations before they fall under imperial control will undoubtedly vary from place to place. Relying on different strategies to take advantage of these local conditions, an empire will tend to form a “mosaic of control” (Schreiber 1992:69). In this mosaic, imperial actions taken in one region may often differ radically from those taken in an another. These actions, however, are usually part of a “grand strategy” of wealth extraction (after Luttwark 1976). The traditional field archaeology methods of settlement survey and site excavation are alone insufficient for understanding this grand strategy—a site or region cannot serve as an imperial microcosm. Politywide analysis that systematically synthesizes the results of these smaller scale analyses is also necessary. This article seeks to demonstrate the value of such an analysis.

In this article, we present a model for the political economy of the Wari Empire (AD 600–1000) of Peru. This model divides the empire into core and periphery zones. In the core, Wari political economy was organized to extract surplus agricultural production to feed the capital. In the periphery, the Wari strove to extract prestige goods. We suggest that there is a strong relationship between where the empire chose to locate its centers in the periphery and the political complexity of the local population in which the center was placed. We argue that in areas of low political organization sites should be located near the geographic center of a population. These sites will tend to function as local administrative centers geared toward the organization and exploitation of the area’s wealth potential. In areas with more complex political organization sites should be located on the margins of a population. These sites should have functioned as gateway centers controlling, or at least profiting from, interregional exchange. Our model was systematically tested through the use of Geographic Information Systems (GIS). The results suggest that much of the variability found in Wari site placement in the periphery can be explained by differences in local sociopolitical complexity.
way centers controlling, or at least profiting from, interregional exchange. These types of sites would tend to be located in areas with more complex political organization.

Archaeological data on the Wari Empire remain sparse. A small fraction of the capital city has been studied and the size and the structure of the site are still not well understood. Only a handful of extensive studies of provincial Wari sites are available. Our understanding of ancient travel corridors and the location of many important raw materials remains poor or, occasionally, nonexistent. We feel, however, that sufficient data exist to begin to understand the dynamics of Wari political economy. As the old saying goes, it is better to light a candle than to curse the darkness. A bit of light can be shed on the empire by offering tentative economic models and devising empirical means of testing them on a politywide level. In so doing, we hope, Wari studies can provide insight into the political economy of other ancient empires.

A MODEL OF WARI POLITICAL ECONOMY

An empire can be defined as an expansionist state that assumes effective control over other polities of varying scope and complexity (D’Altroy 1992:9). The political economy of an empire is shaped by how it produces, distributes, and exchanges wealth (Stanish 1992:11). Although empires vary tremendously in the ways that they extract wealth (Claessen and Skalnik 1978; Sinopoli 1994a:165–166), the imperial strategies employed are usually used to meet two essential needs. The first is the subsistence demands of the urbanized center of the empire (Johnson and Earle 1987:247). In most cases, a capital develops to such a degree that it is unable to easily provide for the subsistence needs of the residents without help from outside producers (e.g., Schwartz and Falconer 1994:3). Since some agricultural products spoil quickly and most are bulky to transport, the area around a capital often serves as the primary breadbasket. This is clearly seen in the agricultural core of such empires as the Aztec (Hassig 1985:133) and Vijayanagara (Sinopoli 1994b:226).

We suggest that the Wari Empire also contained an agricultural core that fed the capital’s burgeoning, increasingly specialized population. By the middle of the Middle Horizon, the population of the capital city had risen to at least 10,000 people (population estimates for the city vary between 10,000 and 70,000; see Isbell 1997a:186). Areas of craft specialization (Gonzalez Carre 1981:94; Spickard 1983:153–154; von Hagen and Morris 1998:130) and elite residences (Isbell 1997a:206) in the city suggest that at least some of the residents were not full-time farmers. The capital lies in a valley whose agricultural productivity, already massively terraced and irrigated by the smaller population of the previous period (Lumbreras 1974b; Isbell 1988:74–75), may not have been able to sustain a large urban center (Lumbreras 1974a:163, Gonzalez Carre 1981:88). It seems likely that agricultural products must have been brought from outside the valley. Research in areas surrounding the valley supports this idea by demonstrating a Wari focus on the intensification of agricultural exploitation in these localities (Raymond and Isbell 1969; Isbell 1977; Vivanco and Valdez 1990; Raymond 1992; Browman 1999). We believe that this region, the area of Ayacuchoan influence before imperial expansion (Lumbreras 1981:23), provided the surplus needed to maintain the city.

The second basic need of an empire is the support and legitimization of the imperial hierarchy (Brumfiel and Earle 1987:3; Earle and D’Altroy 1989:187; Brumfiel 1994:1). This need can be met by a number of means, several of which are often found operating within the same society (Blanton 1998:141–148). One of the most prevalent ways is through the extraction of prestige items or the conversion of staple goods into wealth. Since surplus production in the core
of the empire is often primarily geared toward sustaining the urban center, these goods must be largely collected in the periphery. As a heuristic, imperial extraction strategies can be divided into wealth and staple finance systems (D’Altroy and Earle 1985). Staple finance involves “obligatory payments in kind to the state of subsistence goods such as grains, livestock, or clothing” (D’Altroy and Earle 1985:188). In a staple finance system, the bulk and potential spoilage of staple goods (D’Altroy and Earle 1985:188) necessitates a substantial investment in storage facilities in peripheral extraction centers (e.g., LeVine 1992). Despite earlier convictions (Rowe 1963:14), scholars have yet to find compelling evidence for the use of massive storage facilities in the Wari Empire. Although it is possible that Wari storage systems have yet to be identified, present evidence suggests that the empire did not use a staple finance system.

Wealth finance, on the other hand, involves “the manufacture and procurement of special products (valuables, primitive money, and currency)” (D’Altroy and Earle 1985:188). An empire will generally benefit by adopting a wealth finance system for supporting the imperial hierarchy. This switch typically allows for a reduction in transportation and storage costs since wealth goods are often less bulky and more durable than staple goods. (D’Altroy and Earle 1985:193–194). Exchange of metals, obsidian, decorated ceramics, textiles, turquoise, and specific marine shell (spondylus and strombus) increase during the Middle Horizon (Burger and Asaro 1977; Lechtman 1980; Shady Solís 1988). These items, found both in ritual context in Wari administrative centers (Cook 1985, Cook 1992:359; Williams et al. 2000:73) and at the site of Wari itself (Cabra Romero 1996:88–91, Pérez Calderón 1995: 85–86, González Carre et al. 1996: 100–102; Isbell 1985:70), were prestige items for at least 2 millennia in the Andes. The increased exchange of these goods, combined with an absence of evidence for state storage system of staple surplus, suggests that the Wari organized its peripheral political economy around the production and exchange of prestige objects.

The means by which the empire extracted goods from the core and periphery were undoubtedly variable. As Schreiber has noted (1992:267), the empire adapted its strategies to local conditions. A region’s distance from the core, political organization, wealth potential, and tolerance to outside rule largely determined the amount of investment that the empire would make in the area. In many regions, the empire chose to construct imperial sites.

Over 30 sites have been found that contain buildings that follow a rigid architectural canon (Schreiber 1978; Spickard 1983;
Aspects shared by these centers (see Fig. 1) include (a) a high, rectangular enclosure wall; (b) limited access—usually only one or two entrances were made into the site; (c) interior divided into rectangular cells that are composed of an open courtyard flanked by corridors on at least two sides; and (d) restricted access through the structure and between cells. The centers are imposing structures that may have been designed to appear invincible and bureaucratically efficient (Spickard 1983:141). The centers, however, were not military garrisons. They were neither built in defensive locations nor built or organized to defend any kind of attack. Instead, excavations at the centers indicate that the centers housed a group of elites whose tastes ran more for feasting and ritual than for battle (Schreiber 1992, McEwan 1998).

A HYPOTHESIS FOR THE WARI PERIPHERY

This article tests if the locations chosen for administrative centers fits with the expectations of our model. According to our model of Wari political economy, the imperial strategy in the periphery was to extract prestige goods. This strategy will cause administrative sites, if they are established at all, to be located in significantly different geographic locations in regard to the local populations that these sites are situated to control.

The degree of complexity will largely determine what strategy the empire must pursue when entering a valley. We argue that Wari sites built in valleys of low political complexity will be found near the geographic center of the valley’s population. In independent villages dominated by a kin-based mode of production, village leaders will tend to have difficulty coercing surplus production on a regular basis (Cobb 1996:254). Another level of political hierarchy would therefore be needed to extract wealth from the region (Schreiber 1992:24).

One of the strategies used to build a political organization is to construct a regional administrative center (Schreiber 1992:24). According to central-place theory, the position of service centers, even in nonmarket based societies, will tend to be located centrally to the people that use them (Smith 1976:7). Since an administrative center of a valley functions to exercise political and economic control over the people of the valley, the optimal location of this site is where the costs of maintaining control would be the lowest. The administrative site will therefore tend to be located near the center of the valley’s population.

Another imperial control strategy is to place sites on the margins of valley as gateway administration centers. Sites located at strategic locations on the edges of regions are ideally suited to the control of interregional exchange (Hirth 1978:37). An administrative center in this location would tend to focus more on controlling a valley’s external exchange than the political control of the valley itself. These “gateway” centers (after Hirth 1978) should be found in valleys of high political complexity. In more complex societies, elites often actively participate in the long distance exchange of prestige goods (Cobb 1996:258). These goods are often the major means by which elite power is maintained (Cobb 1996; Earle 1997:7; Baines and Yoffe 1998:253). In controlling the exchange routes of these goods, an empire can siphon off a portion of these resources to feed the appetite of the core. By adopting these strategies, Wari could cheaply and effectively control the areas of high political complexity under its influence. Administrative centers in areas of high political complexity therefore will tend to be found near the margins of valley as gateway centers controlling long-distance exchange.

In archaeology, we rarely have the luxury of studying variables in the way that we would like. In this case, directly analyzing the relationship between site location and
local political organization proved to be impossible. We would ideally measure the distance of each Wari site from the center of a valley’s population. Unfortunately, we simply do not know where populations were during this period for most of the valleys in which Wari centers are found. Valleys in the Andes, however, are sharply bound oases of arable land and permanent settlement interspersed within high puna, mountains, and desert. Although these nonvalley areas, especially the high puna, were core components of the Andean economy, population size was very small in these regions and usually directly associated with valley settlements. The geographic boundaries of these valleys were therefore used as proxy measurements for the extent of local populations in our analysis.

In this article, we test the relationship between administrative site location and local political organization. In valleys of simple political complexity, Wari administrative sites should tend to be placed near the center of the valley. In valleys occupied by more complex polities, administrative sites should tend to be located toward the margins of the valley—further from the valley’s center. The remainder of this article demonstrates how this relationship was tested and what the results of this test were.

DATA: VALLEY POLITICAL ORGANIZATION AND ADMINISTRATIVE CENTERS

At least, 20 Wari peripheral administrative centers are found in 11 valleys across much of modern-day Peru² (Fig. 2). To provide an adequate sample to test our site location model, all centers, even those that are disputed, are included in this analysis. Those centers, however, conclusively shown to be non-Wari design, such as Pampa de las Llamas (Pozorski and Pozorski 1987:32), El Purgatorio (Pozorski and Pozorski 1987:38; T. Pozoski personal communication and 1999), and Chimu Capac (Valkenier 1995:279), were not included. Further, numerous sites attributed to the empire, such as San Nicolás in the valley of Supe (Lumbreras 1974b:155), Yanahuanca in the Pasco valley (Isbell 1988:186), and Wisajirca (MacNeish, Patterson, and Browman 1975:60) in Huanaco, could not be included in this analysis because insufficient data exist to consider the nature of these sites.

Data on pre-Wari political organization were also compiled for each of the valleys in which administrative centers have been found. Archaeological literature pertaining to each valley was examined for this preceding period, the Early Intermediate Period (AD 0–700), and the valley’s political organization was ranked as either simple or complex. For our purposes, if a valley’s inhabitants were organized in a political hierarchy above the village level, the valley was labeled complex. If the inhabitants lived as in independent villages and/or as scattered agropastoralists, the valley was labeled as simple. The list below provides a valley-by-valley account of the data used to assess valley political organization and identify Wari administrative centers. The data, in part, are summarized in Table 1.

Cajamarca–Huacahuas Valley

Early Intermediate Organization. During the Early Intermediate period, this large valley was divided into two polities that were probably organized as paramount chiefdoms with wide-ranging trade relations (Ravines 1985:15). The first polity in the north was centered on the site of Coyor (Julien 1988:240). The second polity, in the south, was centered on the site of Marcahuamachuco (Thatcher 1975; Topic and Topic 1984, 1987).

Huacaloma de Sulluscocha (Julien 1988:265). A 2.45-hectare site, Huacaloma consists of a 50 × 25 m rectangular enclosure surrounded by local architecture. In his settlement survey, Julien associates the structure
with Wari by its architecture. The surrounding settlement may postdate the enclosure.

*El Palacio* (*Julien 1988:262*). A 0.3-hectare site, El Palacio consists of a large rectangular compound measuring $70 \times 50$ m. The structure, based on its architectural elements, is Wari.

*Ichabamba* (*Williams and Pineda 1985:59*). A 0.9-hectare site, Ichabamba is a $120 \times 70$ m rectangular enclosure that is identified as Wari by its architecture. The identification of the site is based solely on air photos.

*Santa Delia* (*Julien 1988:270*). The largest site found in Julien’s survey, Santa Delia covers some 75 hectares. Within the site, several medium- to large-sized rectangular enclosures are found that, based on their architectural elements, are Wari. Julien does not specify the number or exact size of these enclosures.
Viracochapampa (McCown 1945; Topic and Topic 1987; Topic 1991). A massive rectangular enclosure, Viracochapampa covers an area of 32 hectares. The site, however, may never have been completed or occupied. Ceramic sherds associated with temporary labor camps date the construction of Viracochapampa to Middle Horizon 2A.

Pampa de Yamobamba (Williams and Pineda 1985:59; Julien 1988:292). A 1.3-hectare site, Yamobamba is a rectangular compound measuring $130 \times 210$ m. The site’s architecture is Wari.

Callejon de Huaylas Valley

Early Intermediate Organization. In the 1960s, Gary Vescelius conducted an extensive project of survey and excavation in the region. The notes for the project are famously lost and only brief summaries regarding this work exist (Lanning 1965:140; Buse 1965:317–333). These summaries suggest that stratified societies populated the region and the presence of monumental tombs (Isbell 1997b:195–205), both rich and poor burials (Larco Hoyle 1966:106; Grieder 1978:45) and large sites with monumental architecture (Greider 1978; Bennet 1944) support these claims. Current research in the region (George Lau, personal communication and 2000) demonstrates that chiefdom level societies existed in at least some areas of the valley.

Huncopampa (Isbell 1989, 1991a). A densely occupied 3-hectare site is made up primarily of individual patio groups (at least 18) and two D-shaped enclosures. The site is clearly Wari but its architecture is more reminiscent of that seen in the Capital City than the rectangular enclosures typical of domestic architecture. Pottery from the site appears to date to Middle Horizon 2A.

<table>
<thead>
<tr>
<th>Site Name</th>
<th>Valley Name</th>
<th>Valley Organization</th>
<th>Wari Site Placement</th>
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<tbody>
<tr>
<td>Acachiwa</td>
<td>Colca</td>
<td>Simple</td>
<td>Valley center</td>
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<tr>
<td>Cerro Baul</td>
<td>Upper Moquequa</td>
<td>Simple</td>
<td>Valley center</td>
</tr>
<tr>
<td>Cerro Mejia</td>
<td>Upper Moquequa</td>
<td>Simple</td>
<td>Valley center</td>
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<tr>
<td>Collota</td>
<td>Cotahuasi</td>
<td>Simple</td>
<td>Valley center</td>
</tr>
<tr>
<td>El Palacio</td>
<td>Cajamarca-Huamachucho</td>
<td>Complex</td>
<td>Valley edge</td>
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<tr>
<td>Honcopampa</td>
<td>Callejon de Huallayas</td>
<td>Complex</td>
<td>Valley edge</td>
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<tr>
<td>Huacaloma</td>
<td>Cajamarca-Huamachucho</td>
<td>Complex</td>
<td>Valley edge</td>
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<tr>
<td>Huarco</td>
<td>Cuzco</td>
<td>Simple</td>
<td>Valley center</td>
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<tr>
<td>Ichabamba</td>
<td>Cajamarca-Huamachucho</td>
<td>Complex</td>
<td>Valley edge</td>
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<td>Jincamocco</td>
<td>Carhuaraizo</td>
<td>Simple</td>
<td>Valley center</td>
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<td>Numero 8</td>
<td>Chuquibamba</td>
<td>Simple</td>
<td>Valley center</td>
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<tr>
<td>Pariamarka</td>
<td>Callejon de Huallayas</td>
<td>Complex</td>
<td>Valley edge</td>
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<tr>
<td>Pataraya</td>
<td>Nasca</td>
<td>Complex</td>
<td>Valley edge</td>
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<tr>
<td>Pikillacta</td>
<td>Cuzco</td>
<td>Simple</td>
<td>Valley center</td>
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<tr>
<td>Santa Delia</td>
<td>Cajamarca-Huamachucho</td>
<td>Complex</td>
<td>Valley edge</td>
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<tr>
<td>Sonay</td>
<td>Camana</td>
<td>Simple</td>
<td>Valley center</td>
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<tr>
<td>Tocroc</td>
<td>Callejon de Huallayas</td>
<td>Complex</td>
<td>Valley edge</td>
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<tr>
<td>Viracochapampa</td>
<td>Cajamarca-Huamachucho</td>
<td>Complex</td>
<td>Valley edge</td>
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<tr>
<td>Yamomamba</td>
<td>Cajamarca-Huamachucho</td>
<td>Complex</td>
<td>Valley edge</td>
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<tr>
<td>Socos</td>
<td>Chillon</td>
<td>Complex</td>
<td>Valley edge</td>
</tr>
</tbody>
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TABLE 1
Pre-Wari Valley Political Organization and Our Predictions for Wari Site Placement

This 0.96-hectare site is made up of a $120 \times 80$ m rectangular enclosure. The architecture has been identified as Wari by air photographs.
Tocroc (Williams and Pineda 1985:60). This 0.96-hectare site is made up of a 120 × 80 m rectangular enclosure. The architecture has been identified as Wari by air photographs.

Carhuarazo Valley

*Early Intermediate Organization.* Before the Middle Horizon, settlers in the valley lived in 7 small villages and 17 seasonally occupied hamlets (Schreiber 1987:95). With Wari, the valley became centrally organized and agriculture was intensified (Schreiber 1987, 1992:143–144). The valley was not politically centralized and no status differentiation within or between villages appears to have existed (Schreiber 1992:144).

Jincamocco. A 15-hectare rectangular enclosure, this site dates from the MH1B to 2A (Schreiber 1992). The valley also contains three smaller sites from the Middle Horizon that probably assisted imperial actions.

Cuzco Valley

*Early Intermediate Organization.* Survey in the valley dates all major sites to the Middle Horizon or later (McEwan 1987). The tremendous rate of natural erosion in the valley may have buried some early sites (McEwan 1987:7), and Early Intermediate Period ceramics have been found in the soundings and surface collections (McEwan 1984:12). No evidence for complex social organization has yet been found for the region.

Huarco (Glowacki and Zapata 1998). In 1995, Julinho Zapata found what appears to be a massive Wari complex scattered over approximately 150 hectares. Evidence from preliminary excavations suggest that a few of the buildings contain aspects of administrative architecture. Ceramics date from Middle Horizon 1B to 2A.

Pikillacta (McEwan 1987, 1989, 1991, 1996, 1998). A massive 47-hectare rectangular enclosure measuring 630 × 745 m, Pikillacta was never completed. Unlike Viracocha-pampa, a portion of the site was occupied. Ceramics found at the site date from the Middle Horizon 1B to 2A (Glowacki 1996:479).

Chillon Valley

*Early Intermediate Organization.* During much of the Early Intermediate Period, the valley was made up of politically independent villages that participated in interregional trade (Gonzales Carbajal 1998:56). By the end of the period, however, the Chillon valley became part of the Lima polity (Shady Solís 1982:18). Differences in settlement size and monumental architecture suggest that the political complexity of this polity was at least two-tiered (Arguto Calvo 1984:84; Shady Solís 1989:6; Bruhns 1994:199).

Socos (Isla and Guerrero 1987). The site contains a number of different structures over an area of at least 13 hectares. The largest building appears to be a rectangular enclosure measuring 180 × 86 m. Other buildings also exhibit Wari-derived architectural traits. The enclosure dates to Middle Horizon 2B. It is possible that the bulk of the site postdates the enclosure.

Nasca Valley

*Early Intermediate Organization.* Survey work in the Nasca valley suggests that the valley was organized into a series of small polities by the end of the Early Intermediate Period (Schreiber 1999:168). Although not a centralized state, political organization in Nasca was clearly above the village level (Schreiber 1999).

Pataraya (Schreiber 1999:169). A 0.2-hectare site, Pataraya is a rectangular enclosure measuring 40 × 50 m. Ceramics associated with the site date to Middle Horizon 2. A small area of domestic architecture lies immediately adjacent to the enclosure and may be part of the site.
Camana Valley

Early Intermediate Organization. Although the area has not been intensively surveyed, archaeological work in the valley suggests that it was occupied by the Early Intermediate Period (Manrique and Cornejo 1990). As far as current research indicates, however, there is nothing to suggest anything but village-level political organization in the region during this period (Malpass personal communication, 1999).

Sonay (Malpass et al. 1997). This 0.45-hectare site is made up of a rectangular enclosure measuring 90 × 50 m. Excavations at the site uncovered Wari derived sherds that have not yet been fully analyzed.

Cotahuasi Valley

Early Intermediate Organization. According to survey work on the valley, the valley was organized into a number of small villages by the beginning of the Middle Horizon (Chávez Chávez and Salas Hinijoza 1990:18, Trawick 1994:71, and Jennings in preparation). No site size hierarchy is apparent in the valley and no evidence for social stratification is known.

Collota (Chávez Chávez 1982:86–89; Trawick 1994:72). The site is made up of two rectangular enclosures covering approximately 0.75 hectares. The first enclosure measuring 90 × 50 m and the second 30 × 20 m. An associated Wari site contains ceramics from MH 2 and 2A (Jennings, in preparation.).

Colca Valley

Early Intermediate Organization. The archaeological work done in the valley suggests that the Early Intermediate occupation in the valley was most likely confined to pastoralists and small, independent villages (de la Vera Cruz 1987:115, de la Vera Cruz 1988:121–122, Brooks 1998:299).

Acachiwa (de la Vera Cruz 1987:97–98). This 35-hectare site is made up of a rectangular enclosure measuring 500 × 700 m. Although the internal subdivisions are poorly preserved, the ceramics are derived Middle Horizon 2. Some scholars (Schreiber 1992:104), however, dispute the authenticity of the site.

Chuquibamba Valley

Early Intermediate Organization. Survey in the valley suggests low population densities before the Middle Horizon (Sciscento 1989, Cardones Rosas 1993). No site size hierarchy is apparent in the sites that may date to directly before the introduction of Wari occupation in the valley (Sciscento 1989:275) and no indication for social stratification has yet been found. The existing evidence suggests that political organization in the valley before the Middle Horizon was simple.

Numero 8: (Sciscento 1989). This 6.5-hectare site is one of the largest in the valley and dates from the Middle Horizon through the Inka period (Sciscento 1989:206). Among the site’s local architecture, a 40 × 50 rectangular enclosure stands out. Although the investigator felt it premature to classify this enclosure as a Wari center (Sciscento 1989:266), architectural details of the structure are sufficient enough to include the site in our analysis.

Upper Moquequa Valley

Early Intermediate Organization. Research in the valley indicates that population densities were low until the advent of the Middle Horizon (Rice and Wantanabe 1990:26). During this period, a colony of the Tiwanaku State moved in the area to centralize the middle portion of the valley and systematize agriculture (Goldstein 1990:36). The Wari Empire also established a site in the upper portion of the valley and sub-
The data on administrative centers and valley political complexity was integrated into an ArcView 3.0a GIS database. The following steps were taken to construct the database used to test our ideas about Wari site placement. First, an elevation model was obtained and cropped to the study area. Second, site locations were obtained and represented in the computer database as a set of points. Third, valleys were defined and modeled as polygons. Fourth, a method of determining valley center was chosen and applied to each valley. Last, varying measurements of distance from center to site were determined and compared. Each of these steps is covered in turn.

**Map Database**

An empire, like Wari, covers an enormous spatial extent. A model of the earth, covering the entire extent of the polity in a common resolution and projection, was needed for this analysis. Fine-resolution topographic maps covering this expansive region have not yet been digitized and organized into a single coregistered database. Coarse resolution digital elevation data, however, do exist for the entire Earth and are available for free over the World Wide Web [from Earth Resources Observation System Data Center (EDC) Distributed Active Archive Center (DAAC) (http://edcwww.cr.usgs.gov/landdaac/glcc/glcc.html)]. These 1-km, or 30 arc sec, data are part of the GTOPO30 global digital elevation model. Using a cropped portion of the GTOPO30 data set fulfills the basic need of having a consistent Earth model into which sites can be placed for executing spatial analysis. The GTOPO30 data have been widely used for a variety of modeling purposes including hydrologic analysis and drainage basin delineation (http://edcsnw3.cr.usgs.gov/topo/hydro/apps.html). While the data are not at an optimal resolution (Kvamme 1990:112), they do provide the basis for proceeding with a polity-
wide analysis of Wari administrative center site selection until finer resolution data can be constructed.

Wari Site Location

Accurate site location information was crucial for this analysis. In most cases, site coordinates were obtained directly from researchers who visited or worked at these sites. When this was not possible, coordinates have been taken from published maps onto which site locations have been plotted. Once values for site locations were obtained these were entered into the GIS and represented as a layer, or theme, of points. Additional attributes about each site (size, type, previous occupation, and information references) were added to the theme’s attribute table prior to analysis. Wari peripheral administrative centers that are included in the analysis are reported in Table 1.

Defining Valleys

Examining possible variation in how Wari invested in the construction and maintenance of control in different valley systems forms a core question of this research. In order to pursue the problem, it was necessary to define the spatial extent of each valley system in which we examine Wari administrative site selection. A variety of objective methods for defining valley limits were considered. However, objective valley definition was quite difficult given the broad spatial setting and the features we wished to model. Valley extents were determined by examining the physical structure of each valley represented in the Earth model. An isopleth map of elevation was constructed such that isobars representing contour lines were drawn for the entire region (Johnston 1998:80; DeMers 1997:258). Contour lines, or isobars, were then displayed on top of the Digital Elevation Model. Inspection of the contour lines provided a good way of representing where valley edges met with flatter intervalley puna highlands.

On an isopleth map, the flatter highlands are represented by isobars that are further apart due to the fact that there is less change across distance (DeMers 1997:260). Likewise isopleth mapping of steep valley edges produces closely spaced isobars due to greater slope. Knowing these facts of isopleth mapping, it was possible to identify individual contours where the slope within a polygon was high while the slope outside of the polygon was much lower. For each of the valleys, higher resolution topographic and land cover maps were examined. On the coast these higher resolution maps were particularly important sources of information on valley extents, since valleys tend not to produce the deep drainage channels seen in the highlands. The extent of arable land as represented on these maps became an important source of information for defining coastal valley limits.

Transitional isolines and additional information about valley structure were used for defining valley system boundaries on a valley by valley basis (Fig. 3). This subjective method of feature definition has precedents in geography (Clarke personal communication and 1999). In order to proceed with analysis it was necessary to make a decision, and occasionally those decisions must be arbitrary. We hope to have made our valley definition decision rules explicit, and we encourage researchers to comment on how valley extents were defined. If it is possible to improve the model by modifying the shape and extent of a particular valley we are interested in incorporating those changes.

Defining Valley Center

Once valley systems were defined and modeled as polygon’s, it was necessary to develop a spatial point of reference that
could be used to test theoretical predictions about where Wari sites are located with respect to the center of each of those systems. Defining the center of a polygon is a complex geographic problem, and there are a variety of solutions to the question of “where is the center of this polygon.” For this analysis, we computed a polygons centroid using the trapezoid rule with a weighted mean center (DeMers 1997:195; Clarke 1995). Using this method it is possible to have a centroid that is outside of its respective polygon. Since we wanted to model centrality within valley systems, centroids were forced to occur within polygons.

**Distance from Center**

Since our theoretical expectations relate to the distance Wari sites are predicted to fall from a valley’s center, we computed two kinds of “distance from” layers that cover the study area using the GTOPO30 elevation data. First, we computed a raster
theme such that each cell contains a value representing the isotropic Euclidean distance from each valley’s centroid in units of meters. Second, applying Tobler’s hiking function (Tobler 1993; Kantner 1997) we computed a cost surface that represents space nonisotropically in terms of walking time.

Aldenderfer (1998:12) has tested Tobler’s hiking function by comparing computer generated travel times to actual walking trips in the Andean high-sierra and puna rim region of the Río Osmore drainage. Aldenderfer’s test walkers included both indigenous Aymara speakers and North American researchers. Ten trips were timed and compared to the same trips modeled on the computer using Tobler’s (1993) hiking function. Walking trips ranged in distance from about a half a kilometer to 16 km. Results of Aldenderfer’s tests showed that the model slightly underestimates travel times, but that “it appears to be a reasonably good estimator of travel times in mountainous terrain” (Aldenderfer 1998:15).

For execution in the Arc/Info GIS package, Tobler’s transformation can be expressed using the following formula provided by Kantner (1997):

\[
T = D / (6 \exp(-3.5 \times abs(S + .6))),
\]

where \( T \) = traveltime across a given dem cell, \( D \) = euclidean distance across a given dem cell, and \( S \) = slope of a given cell.

This nonisotropic friction surface was applied in computing a cost distance grid theme using each valley’s centroid as the source cells. This resulted in a grid such that cell values represented distances from valley centers in units of hours walking.

ANALYTICAL METHODS

After constructing the database, we needed to develop a statistic that would allow us to test our expectations about the relationships between early Intermediate Period political complexity and the placement of Wari administrative centers during the Middle Horizon. Recall that when Wari expanded into politically complex valleys, we expect sites to be located in places that facilitate the movement of goods back to the core since the empire is co-opting existing prestige good exchange networks. When this is the case, on average we expect sites to be located further away from the valley’s center. Likewise, we expect Wari would have had to develop an administrative infrastructure in those valleys where the preexisting political complexity was low. In these cases, we expect Wari sites to be closer to the center of the valley since there is a need to establish political and economic control over unorganized settlements within the valley.

The metric we developed treats each administrative center as an independent case and relies on differences between observed and expected values in Euclidean distances from the centroid. For each valley, we randomly generated a 20% sample of points (\( R \)) such that no two points could be closer than a kilometer. We forced points to be further than 1 km apart so that no grid cell within the valley will be sampled more than once. These randomly generated points represent expected site locations if no factors were influencing Wari site selection.

The random points layer for each valley was used to query the Euclidean distance grid theme. The mean values returned from each (\( R \)) set of points was calculated independently on a valley-by-valley basis. This produced an isotropic, Euclidean, average expected distance from the center for each valley (\( \mu_R \)). The points representing Wari sites were also used to query the Euclidean grid theme returning an isotropic measure of observed distance from the centroid for each site (\( W \)). Each Wari site is treated as an independent case regardless of whether or not it was the only site in the valley. Once isotropic observed and expected values were computed we subtracted observed Wari distances from cen-
ter from the expected distance from center \((\mu_R - W)\), producing a residual. This residual, in units of meters, describes how average expected distances from the centroid differ from an observed distance from the centroid within each valley. Positive residuals indicate sites that are closer to the center than expected, while negative residuals represent sites that are further from the center than the mean of our 20% random sample. In order to place all of the sites, dispersed between 12 different valleys of varying size, on a comparable axis we divided the residual \((\mu_R - W)\) by the square root of valley area \((A)\), which was measured in units of square meters. Division by the square root of a valley’s area cancels out any units leaving a unitless numerical descriptor (Fig. 4).

Two key data constraints needed to be taken into account when developing this spatial metric. First, valley definition was judgmental and subject to revision. However, the metric should be relatively resistant to most changes in valley shape. It is clear that if corrections need to be made to a valley’s boundaries then location of the polygon’s centroid will move. This is potentially significant since the centroid which is a higher order feature forms a reference point for analysis. However, changing the shape of a valley system will also modify where the randomly selected points can be placed. The distance of every point to the center will change, but where a particular Wari site falls with respect to the full range of possibilities should remain resistant to all except the most drastic changes in valley shape. Second, valley area is not constant some valleys are very large and others are quite small. Any distance metric used to compare valleys of differing sizes must account for the fact that there is great variability in the spatial extent of the valleys. While large valleys will have a much greater average distance from the center, dividing by valley area standardizes the metric controlling for this source of variability.

It is not logical to apply the distance metric to the nonisotropic cost surface produced using Tobler’s (1993) hiking function because it does not make sense to divide units of hours by square meters. Therefore we did not attempt to control for valley area with the nonisotropic measure of distance. Differences in walking times could be influenced by valley area, but expressing distances in units of hours walking should provide a useful basis for comparing sites’ distances from center in different valleys.

### RESULTS AND DISCUSSION

Results from all distance measures show a trend for Wari administrative sites in politically complex valleys to be further from the center than one would expect on average. Likewise, Wari administrative sites placed in politically simple valleys tend to be closer to the center than the mean of our 20% sample. A rank order plot of our distance metric, whose computation is described above, illustrates these trends (Fig. 6a). The cost distance from a Wari site to the geographic center of a valley further supports our predictions (Fig. 6b). Application of Tobler’s hiking algorithm shows that administrative sites in politically complex valleys are a greater walking time away from the center than all but one of the sites found

\[
D = \left( \frac{\mu_R - W}{\sqrt{A}} \right)
\]

**FIG. 4.** The distance statistic formula is shown on the left and a schematic example of a valley is shown on the right. In the diagram on the right the valley centroid is represented by a cross, randomly sampled points are shown as dots, and the location of a Wari site in this hypothetical case is shown as a triangle. \(D = \) distance from center statistic; \(R = \) distance from center for a 20% random sample based on area; \(W = \) distance of a Wari site; \(A = \) valley area.
in valleys exhibiting simple Early Intermediate Period political complexity.

Differences between Wari sites found in politically simple and complex valleys is significant in three measures of distance: (1) raw untransformed Euclidean distance is significant at \( t = 5.77, p > 0.0001 \), while (2) our distance \((D)\) metric is also significant \((t = -3.21, p > 0.0048\).), and (3) Tobler’s cost–distance function is significant at \( t = 5.35, p > 0.0001 \). All three measures indicate that there is a significant separability in the distance from center between politically complex and simple valleys.

These results are promising, but we would expect valley size to exert influence on measures of distance. In this population, four of five politically complex valleys have larger areas than simple ones (Fig. 5), and we would expect area to correlate with measures of distance. We attempted to deal with the problem of valley size in the development of our distance \((D)\) metric discussed above, and regression analysis shows that valley area is not the sole source of variability (Table 2). Holding area as the independent measure it accounts for about half of the variability of raw untransformed Euclidean distance from center \((R^2 = 0.52)\).

Our distance metric \((D)\) factors area out (Fig. 4), and as we would expect regression demonstrates that valley area accounts for a very small fraction of variability when using this distance statistic \((R^2 = 0.06)\). Area appears to account for a good portion of Tobler’s cost–distance formula \((R^2 = 0.59)\), but the measure has the significant advantage of being in easily interpretable units. Area and complexity are directionally correlated as are distance from center and complexity. Simple valleys are small and sites in complex valleys should be further from the center. Our distance \((D)\) metric, which standardizes valley area yet discriminates cases well, shows that the greater distances from center seen in large and complex valley systems have more to do with placement of administrative centers within the valley rather than by the effects of a valley’s size alone.

Four of the 20 sites do not follow trends that we would expect. Two sites in complex valleys are closer to the center than an isotropically measured 20% random sample, and two sites located in politically simple valley systems are further from the center than the 20% sample. Sonay, located in the coastal valley of Camana, and Jin-

FIG. 5. Rank order plot of valley area. The units for the y axis are square kilometers. Valleys with complex pre-Wari political organization are represented by horizontal lines while valleys with simple pre-Wari political organization are shown with diagonal hatching.
camocco, located in the highland valley of Carhuarazo, are both further from the center than the mean for a 20% random sample. However, both are about a days’ walk from the center. Pariamarca and Honcopampa are closer to the center than the mean for a 20% random sample for the Callejon de Huaylas, where they are located. However, they appear to have travel costs to the center that are similar to other Administrative sites located in complex valley systems. It is interesting to note that the relative positions of Honcopampa and Pariamarca do not necessarily run counter to the proposed model. Both sites are located along the boundary of the long narrow elliptically shaped Callejon de Huaylas valley. These sites are located in a position where travel time from the center, up the steep flanks of the valley, is high while Euclidean distance from center is low. It is significant to note that both Honcopampa and Pariamarca are located on the eastern flanks of the valley, closer to the Wari core. More extensive research in these two regions is needed to determine what other local conditions impacted site placement.

Despite the four exceptions described above, results strongly matched our predictions. The technique allowed us to test predictions in 12 local systems that vary greatly in size over a vast horizontal extent. Valley area ranges from less than 200 km² to over 2500 km², and the northern most valley is about 1380 km away from the southern most valley. Early Intermediate Political complexity tends to have occurred more often in larger valley systems. t-Tests showed significant differences in Wari Administrative site placement depending on whether they were located in valleys exhibiting simple or complex Early Intermediate Period social complexity. Area and complexity are correlated, and so it is difficult to tell from the distance measures alone whether Early Intermediate Period complexity or valley area is a better predictor for Wari Administrative site placement. Regression shows that our distance metric was not correlated with valley area. The combination of significant differences in Wari site placement between simple and complex valleys and the lack of correlation between valley area and our distance metric indicates that Early Intermediate Period political complexity is the likely source of variation in Wari site placement with respect to the centrality of site location in a valley system.

From a methodological and analytical perspective these GIS based techniques of spatial analysis have the advantage that they permit additional analysis of and comparisons between the survey results from numerous independent research efforts. This permits examination and modeling of systems that are much larger than any one person could collect the data to test. These same techniques should be applicable to other archaeological contexts.

**CONCLUSIONS**

Imperial conquest and consolidation is a complex process that is strongly shaped by
FIG. 6. (a) Isotropic distance measure in a rank order plot where the $y$ axis is produced by applying the distance metric described in the analytical methods section. In this figure sites that are located in complex valleys have horizontal hatching while sites located in simple valleys have diagonal hatch marks. (b) Nonisotropic costdistances in a rank order plot. The $y$ axis is in units of hours walking time established using Tobler’s (1993) hiking function with the GTOPO30 data set. Sites located in complex valleys have horizontal hatching while sites located in simple valleys have diagonal hatch marks.
the local conditions that are encountered during expansion. Scholars studying particular sites and areas can only hope to elucidate the impact of these local conditions on their study area. The overall importance of these conditions in imperial strategies, however, must be left to conjecture. We suggest that politywide analysis can build on these local analyses to measure the impact varying local conditions throughout an empire.

In this case, we considered the effect of an area’s political organization on Wari’s imperial strategies. We suggest that the empire developed a wealth finance system anchored by a number of administrative centers. At the time of Wari expansion, a number of complex societies flourished in the northern Highlands and coastal Peru. The long distance exchange of prestige goods appears to have formed a fundamental aspect of the political economies of these polities (Shady Solís 1978:27, Topic and Topic 1983; Arguto Calvo 1984:84–87). Instead of destroying these exchange relationships, the empire co-opted them. Wari administrative centers were placed at the margins of these polities to control their exchange networks. The end result was an increase in both the scale of trade and regional economic prosperity that may have benefited local groups as well (Shady Solís 1982, 1988). Outside of these areas of high political complexity, the empire encountered areas settled by independent villagers and, more rarely, pastoralists. In these cases, Wari control focused on the development and then control of these areas and their local wealth potential (de la Vera Cruz 1996:150–151). Administrative centers for these areas tended to be located toward the center of the population in order to organize these populations cheaply and effectively.

Over the past 2 decades, research into ancient empires has underscored the incredible variety of imperial practices. Underneath and running though these practices, we sincerely hope, lie patterns. Tantalizing parallels to the processes described in this model may exist, for example, in Egyptian imperial practices in Nubia (Smith 1998:80–81); Assyrian strategies on their northern frontiers (Parker 1998:379–381); and the mixed economy of trade and tribute of the Turks, Tibetans, and Uighurs of Central Asia (Di Cosmo 1999:30–32). Without systematic spatial analysis at a politywide level, however, the applicability of this model to the understanding of other empires can only be tentative. We hope that this article has demonstrated the value of such a level of analysis in the study of ancient empires and other macroregional processes.

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NOTES

1 Evidence for storage capacity above the basic subsistence needs of a peripheral center was long thought to come from the enclosures of Viracochapampa and Pikillacta. In these centers, there are massive blocks of small rooms with raised doorways that have been interpreted as storage facilities (Menzel 1964). The principal investigators of these sites, however, now suggest that these facilities never operated as such in any significant way. Viracochapampa was abandoned before it was finished and put to use (Topic 1991:151), while only a portion of Pikillacta’s room blocks were in use during the site’s occupation (McEwan 1991, 1996). Even the rooms put into use at Pikillacta were used for a variety of functions and only occasionally, if at all, used for storage (McEwan 1996:183). While it is possible that storage facilities of the empire remain
unidentified in the record, we suggest that the massive storage and control of perishable, nonprecious goods may not have served an important aspect in the Wari political economy.

2 In this article, administrative centers are differentiated from offering deposits and temple centers. A common practice in Wari studies (Isbell and Schreiber 1977, Schreiber 1992, Cook 1985), this distinction is based on the different functions of the three site types. The offering deposits, consisting of intentionally smashed decorative wares, are thought to have had a ritual function. Temple centers, such as Pachacamac and Wari Willka, most likely functioned as pilgrimage centers and did not, strictly speaking, have an administrative use.

All sites included in the analysis are treated equally regardless of variations in site size. In 1978, William Isbell and Katharina Schreiber suggested that the Wari empire was arranged into a three level administrative hierarchy with the site Wari the first order site, Viracochapampa and Pikkillacta as second order centers, and the other enclosures as third order sites (379). Recent work however suggests that Viracochapampa was still under construction when it was abandoned and contains only limited occupation debris (Topic 1991:152). Pikkillacta was also under construction at the time of abandonment and only a small portion of the site was ever occupied (McEwan 1996:181). We believe that it is likely that these centers never rose to become true second-order sites in the Wari administrative hierarchy.

3 We struggled for several months in an attempt to find more objective means to determine valley boundaries. A more objective definition does not seem to be possible for several reasons. First, the vertical extent of vegetation zones is not consistent through out the study area. In general, the northern portion of the study area is wetter while the southern extent tents to be more arid. Furthermore, valleys included in analysis are found on the coast, the highlands, and the eastern flanks of the Andes. Each radically different environmental zones. Therefore, horizontal variation in the nature of vertical ecology would not permit uniform objective valley definition based on a consistent upper elevation threshold. Second, another common approach is to delineate drainage basins through down slope accumulation in order to define valleys (Johnston 1998:91). Drainage basin delineation has been explored to some extent with this earth model. However, given the entities we want to examine, downslope accumulation modeling is not appropriate. Application of the technique produces polygonal objects that define the limits of basin catchments rather than valley extents (Johnston 1998:95). For example, when the method was applied to our data set catchment basins often included large sections of puna highland. However, we wish to define valleys based on the limits of arable agricultural land and habitable space.

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