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Territoriality and the rise of despotic social organization on western Santa Rosa Island, California

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A B S T R A C T

Changes in social organization accelerated on California's northern Channel Islands beginning around 1300 cal BP. These changes were associated with shifts in settlement and subsistence patterns related in part to drought conditions during the Medieval Climatic Anomaly (MCA; 1150-600 cal BP). By the end of the MCA, settlement patterns demonstrate evidence for territoriality and can be described by the ideal despotic distribution. The occupants of the most productive habitats prevented new settlers from moving in and accessing the available resources. We use faunal data from five sites on western Santa Rosa Island (CA-SRI-15, -31, −97, −313, and −333) to trace changes in settlement and population aggregation through this period. Fishing, which can support higher population densities than harvesting shellfish, increased overall from the Middle (2550-800 cal BP) to Late Period (650-168 cal BP), but there were fewer settlement sites on western Santa Rosa Island. In the centuries before the Middle to Late Period Transition (MLT; 800-650 cal BP), people occupied sites geographically dispersed along the west coast of the island. After the MLT, fishing was restricted to fewer large coastal villages. We argue that environmental stress and an increase in warfare on the northern Channel Islands drove the growth of more permanent consolidated villages, the development of territoriality, and settlement patterns consistent with greater resource defense and therefore a more despotic distribution.

1. Introduction

The development of sociopolitical complexity among human populations is accompanied by changes in population distribution, subsistence, and technology that are visible archaeologically (e.g., Rathje, 1971; Flannery, 1972; Earle, 1977, 1991a, 1991b; Sanders and Webster, 1978; Steponaitis, 1981, 1986; Netting, 1990; Arnold, 1992a, 2001a; Clark and Blake, 1994; Kennett, 2005). Indicators of societal complexity include degree of political centralization, political hierarchy and hereditary elites, craft specialization, centralized control of subsistence production and land ownership, production and redistribution by central authorities of food surplus, and increased social differentiation by sumptuary goods (e.g., Naroll, 1956; Carneiro, 1967, 1970, 1998; Sahlins, 1968; Rathje, 1971; Flannery, 1972; Earle, 1977, 1991a, 1991b; Sanders and Webster, 1978; Steponaitis, 1981, 1986; Drennan, 1987; Netting, 1990; Clark and Blake, 1994; Rosenswig, 2000; Kennett et al., 2009, 2017). The emergence of societies with institutionalized social hierarchies (i.e., chiefdoms) has played a central role in the anthropological study of the growth of complexity (e.g., Service, 1962; Sahlins, 1968; Rathje, 1971; Flannery, 1972; Earle, 1977, 1991a, 1991b; Peebles and Kus, 1977; Sanders and Webster, 1978; Steponaitis, 1981, 1986; Feinman and Neitzel, 1984; Arnold, 1992a; 2001a, b; Spencer, 1993; Wright, 1994; Rosenswig, 2000; Kennett et al., 2017). Among the important factors often associated with complexity are the increase in territoriality and social organization consistent with despotism, which can influence the geographic distribution of settlement sites. The definition of despotism that we are using here is narrow and consistent with that used in evolutionary biology: a subset of the population sequesters, controls, or defends a disproportionately large share of valued resources (Summers, 2005; Prufer et al., 2017).

In this study, we focus on the coastal Chumash of southern California, USA, a maritime society with economic and

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sociopolitical structures that were complex for hunter-gatherers broadly and California in particular (e.g., Arnold, 1992a, 2001a, b; Johnson, 1982, 1988, 1993; Kennett, 2005; Kennett et al., 2009; Winterhalder et al., 2010). Institutionalized social hierarchies emerged on the northern Channel Islands (NCI) (Fig. 1) and adjacent Santa Barbara coast beginning around 1300 cal BP (Kennett, 2005). This was coincident with a major reorganization of populations associated with an increase in territoriality on the western end of Santa Rosa Island. Before the shift, smaller permanent settlements were distributed across the landscape in resource rich areas at the mouths of major drainages. Here, we use the same definition for permanent settlements as Winterhalder et al. (2010) and Jazwa et al. (2016). Afterward, people lived in higher densities at a small number of primary villages with buffer zones between them largely devoid of permanent settlement sites, including locations where villages were located previously. While these consolidated sites were still at the mouths of major drainages, we show here that their locations are not predicted simply by the available resources in the habitats. Higher population densities that were a product of this settlement also offered protection during a period of elevated warfare (see Lambert, 1994; Kennett, 2005; Kennett et al., 2013). All villages with known locations are positioned adjacent to extensive sandy beaches, which allowed the inhabitants to land canoes and collect purple olive snail (*Callianax biplicata*; formerly *Olivella*) shells as a raw material for shell bead manufacture (Arnold, 1992a, 2001a). The increase in fishing among the coastal Chumash allowed for increased population density at these consolidated settlement sites. The elevated importance of fish as a subsistence resource in the archaeological record provides a useful proxy for settlement and subsistence changes indicative of the transition from an ideal free distribution (IFD) to an ideal despotic distribution (IDD).

2. Culture history of the Northern Channel Islands Chumash

The Chumash inhabitants of southern California and the four NCI off the coast of Santa Barbara had a relatively complex sociopolitical structure despite their reliance on hunting, fishing, and gathering marine resources rather than agriculture as a primary mode of subsistence (e.g., Arnold, 1992a, 2001a, 2001b; Johnson, 1982, 1988, 1993; Kennett, 2005; Winterhalder et al., 2010). Upwelling and marine productivity were sufficiently high that people could intensify food production enough to support craft specialists and chiefs (e.g., Raab, 1992; Glassow, 1993b; Caviedes, 2001;

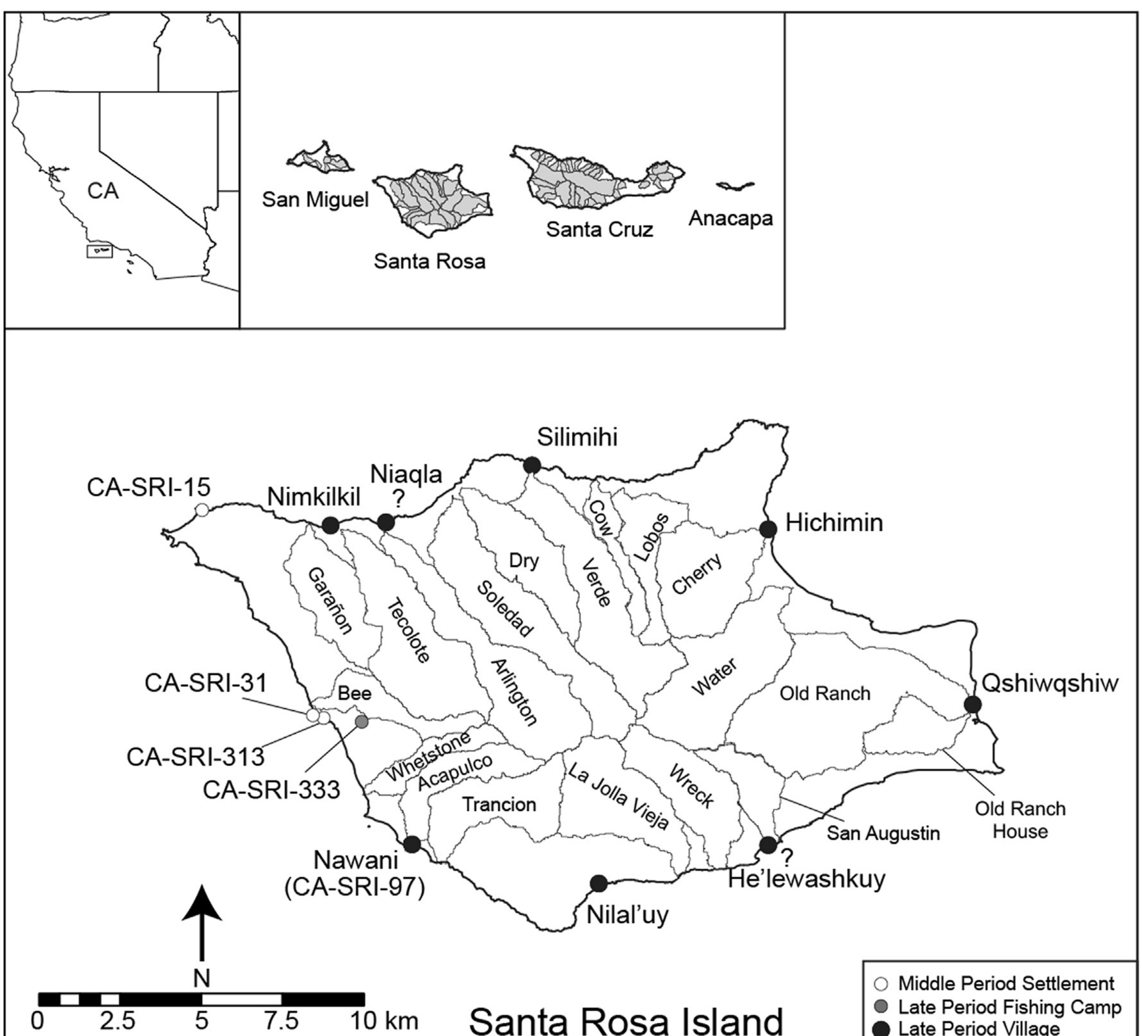

Fig. 1. Santa Rosa Island. Shown are the named drainages, most likely locations of the eight historically documented villages, and sites with faunal records investigated as a part of this study.

Johnson, 2001; Kennett, 2005; Rick et al., 2005; Erlandson et al., 2007, 2008, 2011). The NCI is one of several cross-cultural examples of coastal regions where chiefdoms developed, including the Andes (e.g., Quilter and Stocker, 1983), the northwest coast of North America (e.g., Ames, 1994; Fitzhugh, 2003; Cannon and Yang, 2006; Fitzhugh and Kennett, 2010), Africa (e.g., Breen and Lane, 2003), the southeastern United States (e.g., Marquardt and Payne, 1992), and Polynesia (e.g., Kirch, 1984, 2000; Kennett and Winterhalder, 2008). The richness of the marine resources on the NCI attracted people early in the colonization of the Americas (Erlandson et al., 2007, 2008, 2011; Johnson et al., 2002; Kennett, 2005; Kennett et al., 2008). At the time of European contact in 1542, the Santa Barbara Channel region was more densely populated than other areas in California and most areas with hunter-gatherer populations throughout the world. Some mainland villages contained over 1000 people (Moratto, 1984; Johnson, 1988; Kelly, 1995; Gamble, 2008; Winterhalder et al., 2010). The residents of the NCI lived in large coastal villages under the control of chiefs. They participated in an extensive trade network that included nonfood items like shell beads and steatite artifacts (King, 1976, 1990; Johnson, 1982, 1993; Arnold, 1992a, 2001a; Williams and Rosenthal, 1993; Raab et al., 2002, 2009; Kennett, 2005).

The four NCI (Anacapa, Santa Cruz, Santa Rosa, and San Miguel) are located off the coast of Santa Barbara, California (Fig. 1). The Chumash and their ancestors occupied these islands from the terminal Pleistocene through the Spanish colonial period in the early 1800s. The subsistence economy of the Island Chumash was heavily reliant on shellfish and other marine foods, although recent investigations have revealed a significant role for plant resources in island diets (e.g., Timbrook, 2007; Perry and Hoppa, 2012; Gill, 2013, 2014; Gill and Erlandson, 2014; Jazwa and Perry, 2013). Because of the importance of marine resources, cultural changes are particularly evident in the faunal record for the NCI, especially in the distribution of shell midden sites and the relative densities of the species they contain.

Although there is some early evidence for social inequality on the NCI during the middle Holocene (7550-3600 cal BP; King, 1990; Glassow, 2004), it was during the late Holocene (3600-168 cal BP) that related environmental, technological, economic, and sociopolitical changes led to rapid increases in societal complexity (Kennett, 2005; Rick et al., 2005; Glassow et al., 2010). At the time of contact, the Chumash had a complex economy that was heavily maritime based, relying primarily on the exploitation of coastal resources (e.g., Erlandson, 1988, 1994, 2001; Erlandson et al., 2008; Glassow, 1993b, 1997, 2005; Glassow et al., 2007, 2010; Jazwa et al., 2012, 2013; Jazwa and Perry, 2013; Kennett, 1998, 2005; Raab et al., 2009; Rick et al., 2005; Walker and DeNiro, 1986), trade and the exploitation of offshore fish and sea mammal species using sophisticated plank canoes (*tomols*) with restricted ownership (Arnold, 1992a, 1995, 2001a; Gamble, 2002; Fagan, 2004), and the manufacture and exchange of shell beads made from *Callianax biplicata* shells (Arnold, 1987, 1990, 1992a, b, 2001a; Arnold and Munns, 1994; Munns and Arnold, 2002; Kennett, 2005; King, 1990; Rick, 2007). Both *tomols* and *C. biplicata* beads were manufactured by craft specialists (e.g., Arnold, 1992a, 2001a; Kennett, 2005; Perry and Jazwa, 2010).

Beginning around 1300 cal BP, population increase accelerated and the number of permanent settlements on the northern Channel Islands expanded (Arnold, 2001a; Kennett, 2005; Kennett and Conlee, 2002; Winterhalder et al., 2010). Institutionalized differences in social status appeared at the same time (Kennett et al., 2009). The Middle to Late Period Transition (MLT; 800-650 cal BP) has been associated with important changes that facilitated sociopolitical complexity (Arnold, 1991, 1992a, 1997, 2001b; Arnold and Tissot, 1993; Arnold et al., 1997; Jazwa et al., 2012; Kennett, 2005; Kennett and Conlee, 2002; Raab and Larson, 1997). During the Late Period (600-168 cal BP), the Chumash economy reached its greatest levels of complexity. Unlike earlier when islanders were distributed among a greater number of smaller permanent settlement sites, during the Late Period, they primarily lived in large consolidated coastal villages led by hereditary chiefs with extensive social and economic influence (e.g., Johnson, 1982, 1993; King, 1990; Arnold, 1992b, 2001a, 2001b; Kennett, 1998, 2005; Rick et al., 2005; Kennett et al., 2009; Glassow et al., 2010; Jazwa and Perry, 2013).

3. Territoriality and the IDD

Greater territoriality is related in part to increases in sociopolitical complexity. Two variables, population density and distribution of resources, have been examined cross-culturally to explain the development of societal complexity. There has been an extensive discussion about the relationship between population size/density and complexity (see Drennan, 1987; also Naroll, 1956; Naroll and Margolis, 1974; Carniero, 1967, 1970; Baker and Sanders, 1972; Feinman and Neitzel, 1984; Henrich et al., 2016; Mattison et al., 2016; Vaesen et al., 2016a, 2016b). In a general sense, there must be enough people to produce a surplus of resources allowing elites to attain status. With elevated production and population, the level of social complexity could vary widely. Human population size can be influenced by environmental productivity and the spatial distribution of resources. Larger populations need more subsistence resources. However, technological and cultural developments that increase the ability to access these resources (i.e., economies of scale) also have the potential to affect settlement patterns. In a cross-cultural survey of the appearance of persistent institutionalized inequality, Mattison et al. (2016) identify the defensibility of economic resources, ability for material wealth to be transferred to offspring, and population and resource pressure as three key determinants.

As populations grow in a region, people can distribute themselves on the landscape in two ways. Existing village populations can grow or populations can fission into a larger number of settlements. Both can also occur simultaneously. The IFD (e.g., Åström, 1994; Fretwell and Lucas, 1969; Fretwell, 1972; Sutherland, 1983, 1996; Treganza, 1995) is a behavioral ecology model that was developed to predict the effects of habitat structure and population density on population distribution. Adapted for anthropological uses, the IFD allows us to examine the impact of changing population density on settlement patterns (e.g., Kennett, 2005; Kennett et al., 2006, 2009; Kennett and Winterhalder, 2008; McClure et al., 2009; Winterhalder et al., 2010; Culleton, 2012; Jazwa et al., 2013, 2016; Codding and Jones, 2013; Giovas and Fitzpatrick, 2014; Moritz et al., 2014; Jazwa, 2015; Jazwa and Jazwa, 2017; Prufer et al., 2017; Tremayne and Winterhalder, 2017). Different habitats are assigned a suitability curve that is dependent on population density and related to the distribution of environmental resources, including subsistence foods, water, trade goods, and salubrious living sites. Suitability is determined by the way that the population uses culture and technology to access and use the resources. It can change over time for a variety of reasons.

The most common formulation of the IFD relies on negative density dependence (see Winterhalder et al., 2010). Suitability decreases as population density increases because of interference competition, resource depletion or depression, and other factors. In a variant formulation, the Allee effect allows for positive density dependence at low population densities. Suitability may increase with population density up to a point because of economies of scale. Further, density *independent* effects can result in a shift up or down, or a change in the shape, of suitability curves (Jazwa et al., 2013). Density independent effects could include climate change, sea level rise, geomorphological processes, and other factors not directly influenced by a human presence in the habitat. Other possibilities include technological innovation, infectious disease, development of new trade routes, and religious change. For instance, after plank canoes were developed and the role of shell beads in the economy increased on the NCI, the presence of sandy beaches likely became more important for establishing settlement locations (Jazwa et al., 2013).

The IFD predicts that when people colonize a region they will first settle those habitats with the highest *basic suitability* (for a given set of environmental, technological, and social conditions, the suitability experienced by the first individual or small group to settle a habitat). As population density in a habitat increases, suitability decreases, excepting Allee effects. Tremayne and Winterhalder (2017) and Prufer et al. (2017) define *effective suitability* as suitability for a given set of environmental conditions at nonzero population (i.e., non-basic suitability). For simplicity, here we only discuss suitability, with basic suitability the special case of zero population density. This is the value considered by the colonists deciding which new habitat to occupy. Eventually, suitability at the highest-ranked habitats will decrease to the point that people will choose to move to the next ranked habitat – that with the next highest basic suitability (Sutherland, 1983, 1996; Greene and Stamps, 2001).

Suitability curves for each habitat either shift or change in shape as the natural or technological environment undergoes density independent changes. For example, the establishment of maritime trade networks could substantially increase the suitability of a location with a protected harbor, transforming a coastal habitat with minimal subsistence resources into a conduit for economically valuable trade items. The technological development of boats would have the same effect. IFD models allow us to predict how these changes would influence the degree to which population is nucleated or dispersed. Furthermore, the increase in importance of specific, geographically discrete resources could lead to competition between groups for those resources, and thus to their control and defense.

An important variant of the IFD is the IDD, in which some inhabitants of a habitat are able to defend a disproportionate share of resources (i.e., despotism). This forces outmigration of residents experiencing disproportionately diminished habitat suitability. It can also impede in-migration and prompts an expansion of the population to lower ranked habitats earlier than would be predicted by the IFD (Summers, 2005; Kennett and Winterhalder, 2008; Kennett et al., 2009, 2013; Culleton, 2012; Bell and Winterhalder, 2014; Jazwa, 2015; Jazwa et al., 2016; Harvey, this issue). It is common for the IFD to be taken as a null hypothesis in population ecology models against which the effects of unequal access to resources and competition can be measured (Kennett and Winterhalder, 2008; Sutherland, 1996; Culleton, 2012; Jazwa and Jazwa, 2017).

An expectation is that more sociopolitically complex populations tend to be more consistent with the IDD. Kennett and Winterhalder (2008) provide an example of the effects of despotism on the colonization of Polynesia, which had well established chiefdoms (Kirch, 1984; Kirch and Kahn, 2007). Social factors, including the threat of violence to immigrants in habitats that might otherwise be attractive for resettlement, forced potential migrants to remain in their homes and avoid otherwise attractive locales. However, it is not always the case that high population density and social complexity led to despotic social organization. Jazwa and Jazwa (2017) describe the case of Bronze Age Messenia in Greece, in which settlement within a complex agricultural society is consistent with the IFD and not the IDD.

A topic that has received increasing attention is the transition from the IFD to the IDD (Summers, 2005; Kennett et al., 2009; Fitzhugh and Kennett, 2010; Bell and Winterhalder, 2014; Prufer et al., 2017). It is part of a broader discussion on the appearance of persistent institutionalized inequality (e.g., Mattison et al., 2016). As an example of the process, Fitzhugh (2003) has created a model for the emergence of complexity with a specific focus on the Kodiak Archipelago in the Gulf of Alaska. The early stages are strongly tied to population growth and expansion. Initially, people slowly expanded throughout the archipelago. As long as the population was able to maintain unfettered access to local resources, its distribution could be represented using the IFD (Fitzhugh and Kennett, 2010). However, this changed once the archipelago filled and population became circumscribed (Fitzhugh, 2003). The increase in population density was associated with depression of high-ranked resources, increasing diet breadth and the inclusion of lower-ranked resources, and increasing hardship for everyone. Under IFD conditions, life was getting harder for everyone in the population equally. In the IDD, hardship was distributed differently between different groups of people.

Fitzhugh's (2003) model predicts technological and labor intensification to adapt to resource depression, either to increase the yield of high-ranked resources or intensify the production of previously low-ranked resources. Fitzhugh and Kennett (2010) further suggest that these technological changes may result in asymmetries in the production of controlled resource through differential access to them. In turn, this could have provided opportunities for control through territoriality and social differentiation of resource access. These technologies make it easier to exclude competitors from resource-extraction locations.

In the IDD, the existing occupants of a habitat prevent others from moving in even if the IFD predicts that they should. This allows dominant individuals to maintain high habitat suitability and prevent exploitation by subordinates and thus further resource stress or degradation. This is done through economic and socio-political control along with enforcing greater territoriality (Summers, 2005; Kennett et al., 2006, 2009; Culleton, 2012; Bell and Winterhalder, 2014; Codding et al., this issue). Fitzhugh's example suggests that fundamental to understanding the transition from the IFD to IDD are data on site distribution and chronology, complexity, territoriality, and various other processes of social change. The ways that archaeological assemblages from individual sites can be used to track this process have not been adequately explored with real data. One way to look at the appearance of territoriality in the archaeological record is through changing diet (Whitaker et al., this issue). An important step in this process is to operationalize the relationship between shifts in the faunal record, changes in targeted species and diet breadth, and predictions about control over decreases in habitat suitability. Furthermore, the increase in overall meat weight of faunal constituents in general and fish in particular indicate higher population density at village sites, an important variable in increasing complexity and changes in suitability within the IFD/IDD.

4. Resource stress and the IDD on the NCI

We focus on changing settlement distributions on the islands during the late Holocene and potential relationships between the consolidation of coastal villages and socio-political developments. Throughout the early occupation of the NCI, the general pattern is an expansion to larger numbers of settlement locations in progressively lower suitability habitats, consistent with the predictions of the IFD (Kennett et al., 2009; Winterhalder et al., 2010; Jazwa et al., 2013, 2016; Jazwa, 2015). Here, we document a reversal of this trend later in prehistory, dating roughly from the MLT through historic contact.

We focus on Santa Rosa Island, the second largest of the NCI and the location of many of the habitats ranked highest in an earlier IFD assessment of basic habitat suitability (see Winterhalder et al., 2010). The northwest coast of the island is ranked highest because it has large drainages with high water flow and resource-rich kelp forests and rocky intertidal shorelines. The northwest coast of the island was the first location in which permanent settlement expanded beyond dispersed individual sites at the beginning of the middle Holocene and it has a record of relatively continuous habitation thereafter (Kennett et al., 2009; Winterhalder et al., 2010; Jazwa et al., 2013, 2016). As NCI populations grew, clear evidence for permanent occupation progressively expanded into lower-ranked habitats on the eastern end of the island (middle Holocene), the south coast (middle Holocene), the northeast coast (middle Holocene), and finally the west coast (late Holocene; Jazwa, 2015; Jazwa et al., 2016).

Archaeological survey on Santa Rosa Island has identified large permanent settlements at the mouths of all nineteen of the major drainages (Phil Orr, unpublished site records; Don Morris, unpublished site records). Settlements from at least seventeen of these locations have components that date to the late Holocene prior to the MLT (Kennett, 1998, 2005; Jazwa et al., 2016). The two drainages that lack clear late Holocene components contain large midden sites that have not yet been dated and may conform to this pattern. At the time of historic contact, there are records of only eight or nine historic villages on Santa Rosa Island distributed more or less evenly around the coast (Johnson, 1982, 1993, 1999, 2001; Kennett, 1998, 2005; Glassow et al., 2010). Baptismal records from Spanish missions provide an approximation for village sizes at the time that the last people were removed, after more than two centuries of island depopulation from disease, violence, and out-migration (Strudwick, 2013). The largest village on Santa Rosa Island, *Qshiwqshiw*, was located on the east coast of the island and had 101 recorded baptisms. The village of origin for 138 islanders was not recorded, but Johnson (1993) believes most of them were from Santa Rosa Island. The largest historically documented population center on all the islands was *Swaxil* on the east end of Santa Cruz Island, with 203 recorded baptisms (Johnson, 1993). Both large villages are at locations on the islands that would have been among the most convenient departure points for the mainland. It is likely that population sizes at these villages would have been much higher prior to European contact because of decreases from introduced disease, conflict with Alaskan otter hunters, and other factors (Strudwick, 2013).

The number of village sites on the NCI decreased in the centuries before and during the MLT. The increase in site size after this time (Kennett, 1998, 2005) suggests that people consolidated in a smaller number of larger communities (Fig. 2). Island residents altered how they valued the resources available at different locations, changing the relative suitability of settlement locations and associated habitats. For instance, we have previously argued (Jazwa et al., 2013) that the development of *tomols* and expansion of the *C. biplicata* shell bead industry during the late Holocene may have increased the importance of sandy beach shoreline. Beaches provided good canoe pull-out locations and habitat for *C. biplicata* snails. Each of the Late Period villages was adjacent to abundant sandy beach habitat (Kennett et al., 2009; Winterhalder et al., 2010; Jazwa et al., 2016).

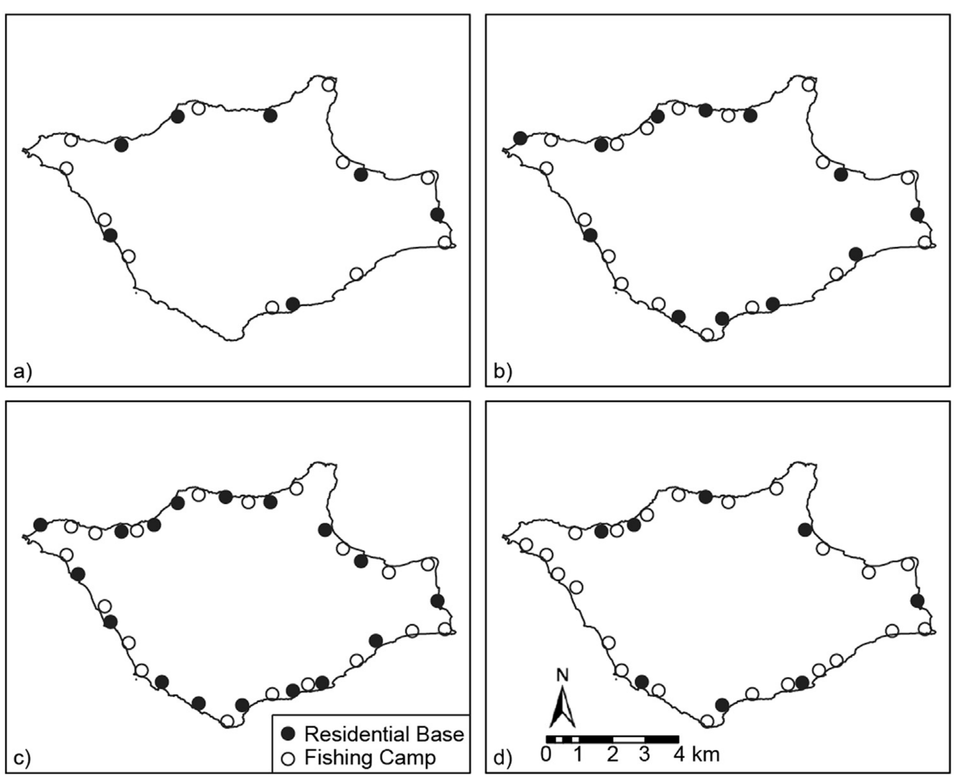

Fig. 2. Hypothetical late Holocene coastal settlement model for Santa Rosa Island. a) At the beginning of the late Holocene, settlement sites and fishing camps are sparsely distributed around the island; b) there is an increase over time in both site types with fish bone, including an increase in faunal density; c) the number of residential bases reaches a maximum at the end of the Middle Period prior to the MLT; d) during the Late Period, population condenses to a small number of large villages spaced around the island, but with continued use of some scattered smaller fishing camps. Dots do not necessarily represent actual archaeological site locations.

The cultural changes that occurred on the NCI before and during the MLT were partially related to environmental stress associated with drought (Arnold, 1991, 1992a, 1997, 2001b; Arnold and Tissot, 1993; Arnold et al., 1997; Colten, 2001; Jazwa et al., 2012; Jones et al., 1999; Jones and Schwitalla, 2008; Lambert and Walker, 1991; Lambert, 1993; Kennett, 2005; Kennett and Conlee, 2002; Pisias, 1978; Pletka, 2001; Raab and Larson, 1997; Stine, 1994; Yatsko, 2000). There are relatively few well-documented and precisely dated sites on the islands that have been associated with the MLT (Arnold, 1991, 1992a, 1992b; Raab and Larson, 1997; Yatsko, 2000; Munns and Arnold, 2002; Perry, 2003; Kennett, 2005; Rick et al., 2005; Rick, 2007; Glassow et al., 2010; Jazwa et al., 2012; Byrd and Whitaker, 2015). Arnold (1992a) notes a pattern of site abandonment during the MLT. This suggests that the population may have condensed to a smaller number of sites at this time. Poor environmental conditions could have also been one of the motivations for the disuse of many of the coastal residential bases that were occupied earlier in the Middle Period (2550-800 cal BP). Drainages most resilient to drought conditions (i.e., where the lowest percent of water flow was lost) were the target of more intensive settlement during dry periods like the middle Holocene (Jazwa et al., 2016). We similarly expect resilient habitats within territories that form during and shortly after the MLT to be the location of consolidated settlement.

The MLT occurred during the Medieval Climatic Anomaly (MCA; 1150-600 cal BP), a period of intense and persistent droughts that had broad impacts on human populations living throughout the United States southwest (Jones et al., 1999; Jones and Schwitalla, 2008; Bocinsky and Kohler, 2014). In the Santa Barbara Channel region including the NCI, Lambert and Walker's osteological analyses (1991; Walker, 1989; Walker and Lambert, 1989; Lambert, 1993, 1994) find peaks in health problems and violence during the MLT. They associate these sources of stress with an increase in sedentism and diminishing supplies of fresh water and terrestrial foods. Kennett (2005; also Jones and Schwitalla, 2008) extends the period of drought and violence further back in time to 1500 cal BP. It is possible that population aggregation around wetter, more drought resistant, and resource rich areas may have been a stimulus for increased complexity. Similarly, as violence and warfare increased in the NCI, populations may have condensed to larger villages for protection from competing factions, creating buffer zones between territories. These buffer zones no longer had large, permanent settlement sites and were instead used by smaller populations for ephemeral resource acquisition. Drainage mouths within those buffer zones may have higher suitability than other locations chosen for villages elsewhere on the island. Therefore, the fact that they were not occupied during the Late Period violates predictions of the IFD. Many of the historically documented villages appear to have been at prominent points in the shoreline that provide extensive viewsheds along the coast to allow inhabitants to spot approaching *tomols* (Kennett, 2005). In summary, the MCA broadly, and particularly the MLT, was a period of environmental stress that precipitated a restructuring of settlement patterns that can be modeled as a shift from an IFD to an IDD settlement structure.

5. Fishing on the NCI

Archaeological fish assemblages are particularly valuable for tracing cultural change. In most cases, fishing requires initial investment and maintenance in specialized technologies and fish have higher pursuit costs than shellfish (Glassow, 1993a). Fishing was an important part of the subsistence economy throughout human occupation of the NCI. There is evidence of fishing as early as the terminal Pleistocene and early Holocene (before 7550 cal BP; Connolly et al., 1995; Rick et al., 2001; Erlandson et al., 2011), but fish bone contributes less to the faunal assemblage than during the late Holocene. Typically, shellfish represent by far the most abundant dietary component early in time (Glassow, 1993a; Rick et al., 2005; Erlandson, 1994; Erlandson et al., 2011). During the middle Holocene, shellfish remain the dominant species in most midden assemblages, although some Santa Cruz Island sites have larger amounts of sea mammals and fish (Glassow, 1993a). King (1990; also Erlandson et al., 2009) used data from throughout the southern California Bight and the Central Coast to argue that there was an increase in the importance of fish and expansion in fish taxa and environmental zones that were exploited over the course of the middle Holocene. Rick and Glassow (1999) tentatively support this finding with their work on the mainland along the Santa Barbara Channel.

During the late Holocene, fish increase dramatically in density and ubiquity in recovered archaeological materials (Braje et al., 2007:741; Colten, 2001; Glassow, 1993a; Kennett, 2005; Kennett and Kennett, 2000; Kennett and Conlee, 2002; Raab et al., 1995; Rick, 2007; Rick et al., 2008:81; Jazwa et al., 2012). Fish make up the dominant component of the total meat weight from most of the large late Holocene sites throughout the NCI, with sea mammal in many cases also outpacing shellfish (Glassow, 1993a; Kennett, 1998, 2005; Colten, 2001; Kennett and Conlee, 2002; Gusick, 2007; Jazwa, 2015; Jazwa et al., 2016). One of the technological innovations that allowed for the increase in fishing productivity during this period was the development of the single-piece fishhook by 2500 cal BP (Strudwick, 1986; Rick et al., 2002). Stone net weights and contracting stem points, which aided the shift to more intensive fishing and sea mammal hunting, appeared around the same time (Erlandson, 1997; Glassow, 1997; Glassow et al., 2007; Rick et al., 2002). By 1500 cal BP, the Chumash also developed the *tomol* plank canoe that allowed islanders to travel more quickly, further from shore, and with more cargo. It also provided a more stable platform for off-shore fishing and sea mammal hunting around the islands (Arnold, 1992a, 1995, 2001a; Davenport et al., 1993; Gamble, 2002; Fagan, 2004). After the MLT, there was a further increase in fishing on the islands (Glassow, 1993a; Colten, 2001; Pletka, 2001). Glassow (1993a) argues that the increase in fishing over time, particularly the fish caught offshore from boats, may be related to increased sedentism. Because fishing in this environment is highly intensifiable through the development and use of new technologies (Raab, 1992; Glassow, 1993a), it may have been relied upon more heavily later in time to support larger local population densities and settlement patterns consistent with the IDD. We propose that as population density grew, access to productive nearshore fisheries could have been one of the factors prompting competition and leading to greater territoriality and buffer zones between villages.

The west coast of Santa Rosa Island is well suited to test the relationship between the faunal record and settlement patterns during the late Middle Period, MLT, and the Late Period. The coast is lined by a ~300–700 m wide coastal terrace that runs approximately 12 km between the westernmost and southernmost points on the island. People would have been able to move easily throughout this area and would have had access to good fishing locations because of extensive nearshore kelp forests (see Kinlan et al., 2005), rocky intertidal coastline, and sandy beaches where *tomols* can be launched. Both large village sites and smaller camps contain significant evidence of fishing and reflect human subsistence during the Middle and Late Periods. We use faunal assemblages from three large settlement sites (CA-SRI-15, -31, and –97) and two smaller sites with high fish density (CA-SRI-313 and -333) to track population movement toward large village sites during this interval, consistent with a shift from an IFD to an IDD.

6. Methods

6.1. Chronology

We incorporated eleven previously published radiocarbon dates from CA-SRI-15, -31, and −97, which were submitted to Beta Analytic, Inc. for standard radiometric dating (Kennett, 1998), and six new dates from CA-SRI-31, -313, and −333, which were cleaned and reduced to carbon dioxide at Pennsylvania State University and submitted to the Keck Carbon Cycle AMS Facility at the University of California, Irvine (UCI) to be graphitized and AMS dated (Table 1). All dates were calibrated in OxCal 4.1 (Bronk Ramsey, 2009) using the most recent marine calibration curve, Marine13 (Reimer et al., 2013). We used a variable ΔR value for the Santa Barbara Channel region (Table 1). ΔR values were calculated by Brendan Culleton (personal communication, 2015) using AMS radiocarbon dates from paired organic and planktonic marine foraminiferal carbonate in laminated varves published by Hendy et al. (2013) from a sediment core from Santa Barbara Basin. We used a Bayesian statistical model in OxCal to further constrain error ranges on dates based on the relative stratigraphic position of the radiocarbon samples within each of the sites.

6.2. Faunal analysis

In 1996, Douglas Kennett and Don Morris excavated two 25 × 25 cm column samples at CA-SRI-15, one at CA-SRI-31, and one at CA-SRI-97 from eroding natural exposures primarily in arbitrary 10 cm levels, with materials from different stratigraphic levels separated. All excavated materials were transported to the University of California, Santa Barbara to be water screened, dried, and then sorted to species. More detailed sorting and checking was later conducted at California State University, Long Beach, and the University of Oregon. During the summer of 2013, Jazwa excavated 25 × 25 cm column samples at CA-SRI-313 and CA-SRI-333, also in arbitrary 10 cm levels. Excavated materials were screened and sorted by species at Pennsylvania State University as in Jazwa et al. (2012, 2013, 2015, 2016; Jazwa, 2015).

7. Results

7.1. Site chronology

Radiocarbon dates from the five sites establish a chronology of settlement for the most densely settled areas along the west coast of Santa Rosa Island (Table 1; Figs. 1 and 3). The overall range of dates is from 1680-1440 cal BP (2σ range; CA-SRI-31, 28–40 cmbs) to 310-135 cal BP (2σ range; CA-SRI-97, 10–26 cmbs). This places the range of permanent settlement of this part of the island from the end of the Middle Period through historic contact. Although there is evidence of occupation of CA-SRI-31 from Unit 2, which dated earlier in the late Holocene (Kennett, 1998; Jazwa et al., 2016), density of faunal remains from that site is rather low. The unit that we are including in this analysis has a much higher density of fish remains and is more indicative of permanent settlement. CA-SRI-31 has the earliest evidence of intensive fishing on the west end of the island, but it also was depopulated early, with its terminal date of 1615-1350 (2σ range; 0–12 cmbs) predating occupation of any other sites in this analysis (1325-1120 2σ cal BP; CA-SRI-333, 55–65 cmbs).

The adjacent CA-SRI-313 and CA-SRI-333, approximately 0.5 km to the southeast, both have their initial occupation soon after the terminal date for CA-SRI-31. CA-SRI-313 was occupied into the MLT, with its terminal occupation during the MLT or at the very beginning of the Late Period (775-565 2σ cal BP; 3.5 cmbs). Occupation at CA-SRI-333, on the other hand, appears to be primarily focused during the Late Period. An intermediate date of 380-170 cal BP (2σ range; 25 cmbs) from the middle of the deposits suggests that the deepest levels, which have a low density of faunal remains, are associated with the early dates during the Middle Period and MLT, but the higher density deposits can be associated with the Late Period. The earliest date available from CA-SRI-97 (795-555 2σ cal BP; 60–70 cmbs) overlaps with the terminal date of occupation at CA-SRI-313 during the MLT and beginning of the Late Period. The densest deposits at the site (10–26 cmbs) are the latest in this study and are almost certainly associated with the historic village of *Nawani* (Johnson, 1982, 1993; Kennett, 1998, 2005; Glassow et al., 2010). CA-SRI-15 is not part of the same cultural landscape as the other four sites. Instead, it is part of the group of sites along the northwest coast of the island. It is coincident with occupation of sites on the west coast (1280-990 2σ cal BP to 580-330 2σ cal BP) and provides an interesting comparative case. Details of the chronology of the site are presented in Jazwa et al. (2012).

7.2. Faunal data

To track temporal and spatial changes in subsistence, we divided the excavation materials into eight components using radiocarbon

Table 1
Radiocarbon dates from the sites in this study. All dates were calibrated in OxCal 4.1 (Bronk Ramsey, 2009) using the most recent marine calibration curve, Marine13 (Reimer et al., 2013).

Site	Lab #	Provenience	Species	Conventional 14C Age (BP)	ΔR	2σ cal BP	Reference
CA-SRI-97	Beta-96873	Unit 1, 10–26 cmbs	*Mytilus californianus*	790 ± 60	305 ± 42	310–135	Kennett 1998:458
CA-SRI-97	Beta-96872	Unit 1, 60–70 cmbs	*Haliotis rufescens*	1410 ± 40	275 ± 44	795–555	Kennett 1998:458
CA-SRI-333	UCIAMS-130894	Unit 1, 5 cmbs	*M. californianus*	925 ± 15	347 ± 42	315–140	This Study
CA-SRI-333	UCIAMS-147337	Unit 1, 25 cmbs	*Mytilus californianus*	935 ± 20	347 ± 42	380–170	This Study
CA-SRI-333	UCIAMS-130895	Unit 1, 55–65 cmbs	*M. californianus*	1825 ± 15	147 ± 44	1325–1120	This Study
CA-SRI-313	UCIAMS-130891	Unit 1, 3.5 cmbs	*M. californianus*	1390 ± 15	277 ± 44	775–565	This Study
CA-SRI-313	UCIAMS-130890	Unit 1, 34.5 cmbs	*H. cracherodii*	1790 ± 15	155 ± 44	1280–1070	This Study
CA-SRI-15	Beta-96868	Unit 2, 25 cm	*Haliotis rufescens*	1140 ± 60	321 ± 43	580–330	Kennett 1998:456
CA-SRI-15	Beta-96867	Unit 2, 40–50 cm	*Mytilus californianus*	1270 ± 60	304 ± 43	650–480	Kennett 1998:456
CA-SRI-15	Beta-95454	Unit 1, 0–10 cm	*Haliotis cracherodii*	1380 ± 80	279 ± 44	770–550	Kennett 1998:456
CA-SRI-15	Beta-100511	Unit 1, 19–30 cm	*Haliotis rufescens*	1440 ± 60	267 ± 44	890–650	Kennett 1998:456
CA-SRI-15	Beta-107041	Unit 1, 65–75 cm	*Mytilus californianus*	1690 ± 60	193 ± 44	1100–850	Kennett 1998:456
CA-SRI-15	Beta-107042	Unit 1, 80–95 cm	*Mytilus californianus*	1690 ± 70	193 ± 44	1150–910	Kennett 1998:456
CA-SRI-15	Beta-92290	Unit 1, 117–126 cm	*Haliotis rufescens*	1690 ± 70	193 ± 44	1200–940	Kennett 1998:456
CA-SRI-15	Beta-107043	Unit 1, 126–135 cm	*Mytilus californianus*	1760 ± 90	167 ± 44	1280–990	Kennett 1998:456
CA-SRI-31	UCIAMS-147340	Unit 1, 0–12 cmbs	*Mytilus californianus*	2085 ± 20	94 ± 44	1615–1350	This Study
CA-SRI-31	Beta-95455	Unit 1, 28–40 cmbs	*Haliotis rufescens*	2050 ± 60	97 ± 44	1680–1440	Kennett 1998:456

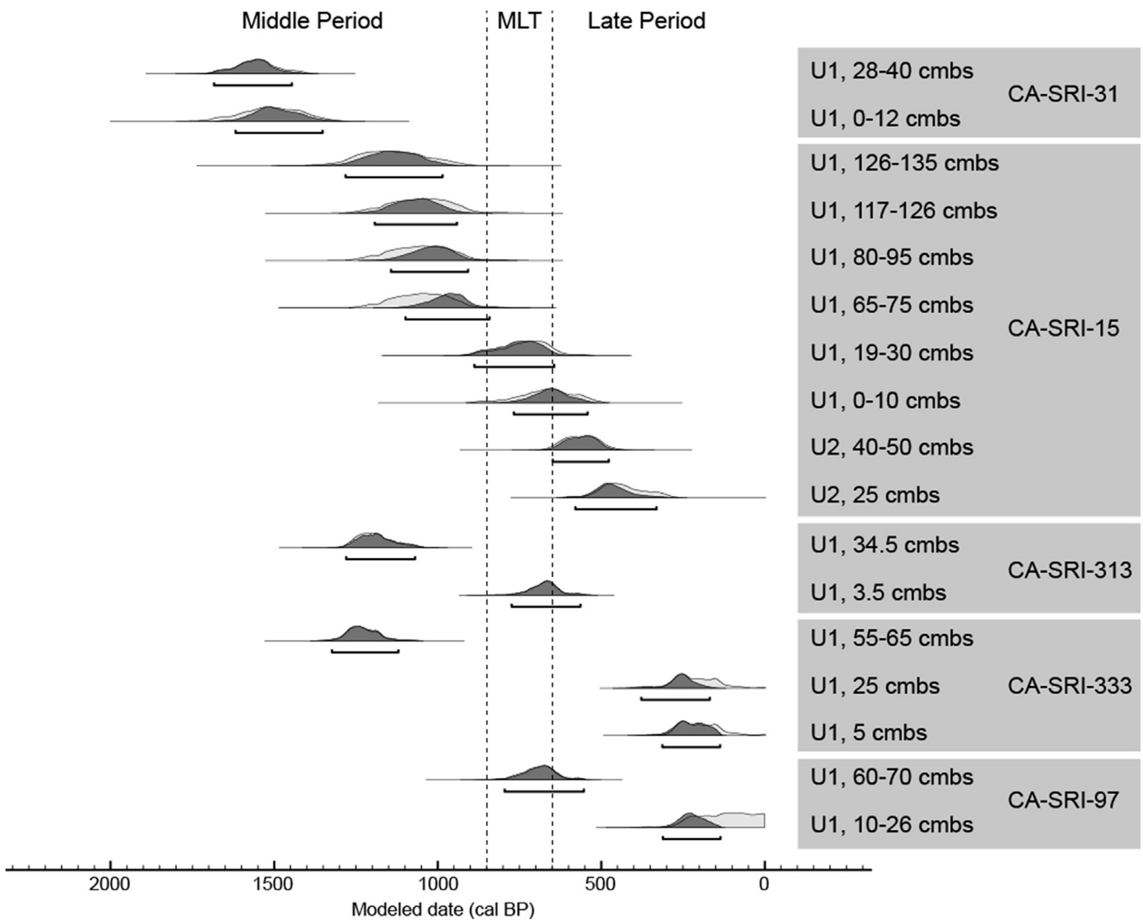

Fig. 3. 2σ ranges for the radiocarbon dates from the excavated sites. All dates were calibrated in OxCal 4.1 (Bronk Ramsey, 2009) using the most recent marine calibration curve, Marine13 (Reimer et al., 2013). Dark gray distributions are modeled based on stratigraphy. Light gray distributions are not.

dates and patterns in the faunal record (Table 2). We divided the materials from CA-SRI-97 and -333 into two components each and kept each of the other excavation units separate. In all the assemblages included in this study, shellfish are by far the dominant subsistence component by weight, comprising at least 80 percent of the total in each. With the exception of the later component of CA-SRI-333 (0–50 cmbs; Late Period), shellfish made up a larger proportion of the faunal record during the Middle Period and MLT than the Late Period components. Fish made up the second highest proportion in all components except the earlier deposits from CA-SRI-97 (30–100 cmbs; MLT/Late Period), in which sea mammal was present in a higher weight. Bird bone was always the smallest contributor to the faunal record.

We estimated meat weights of the various faunal constituents for each cultural component (Fig. 4) using the meat weight multipliers summarized by Rick (2004). The multipliers are 0.724 for shell (Koloseike, 1969; Erlandson, 1994:59; Vellanoweth et al., 2000), 27.7 for fish (Tartaglia, 1976), 24.2 for sea mammal (Glassow and Wilcoxon, 1988), and 15.0 for bird (Ziegler, 1975). Taking this into account, fish is the dominant faunal constituent in

Table 2
Summary of faunal data by cultural component, including meat weight calculations.

Site	Period	Shellfish			Fish			Sea Mammal			Bird			C. biplicata	
		Weight (g)	% Fauna	% Meat	Weight (g)	% Fauna	% Meat	Weight (g)	% Fauna	% Meat	Weight (g)	% Fauna	% Meat	Weight (g)	% Fauna
SRI-15 Unit 1	Late Middle/ MLT	17252.2	93.7	28.5	1026.4	5.6	64.9	88.6	0.5	4.9	48.4	0.3	1.7	50.0	0.3
SRI-15 Unit 2	Late	3757.4	86.2	14.8	323.4	7.4	48.8	275.6	6.3	36.3	0.5	0.0	0.0	101.9	2.3
SRI-31	Middle	5561.6	95.2	35.2	184.1	3.1	44.5	93.9	1.6	19.9	3.3	0.1	0.4	17.6	0.3
SRI-97 0–30 cmbs	Late	2085.6	80.4	9.7	483.8	18.7	86.5	24.0	0.9	3.8	0.2	0.0	0.0	388.0	15.0
SRI-97 30–100 cmbs	MLT/Late	3992.6	88.4	17.8	201.5	4.5	34.4	317.0	7.0	47.3	4.8	0.1	0.4	143.8	3.2
SRI-313	Late Middle/ MLT	5532.0	96.7	43.9	181.3	3.2	55.1	3.9	0.1	1.0	0.0	0.0	0.0	6.3	0.1
SRI-333 0–50 cmbs	Late	3707.9	96.1	38.9	152.4	3.9	61.1	0.0	0.0	0.0	0.0	0.0	0.0	107.7	2.8
SRI-333 50–65 cmbs	Late Middle/ MLT	333.1	97.8	55.2	4.1	1.2	26.0	3.4	1.0	18.9	0.0	0.0	0.0	0.2	0.1

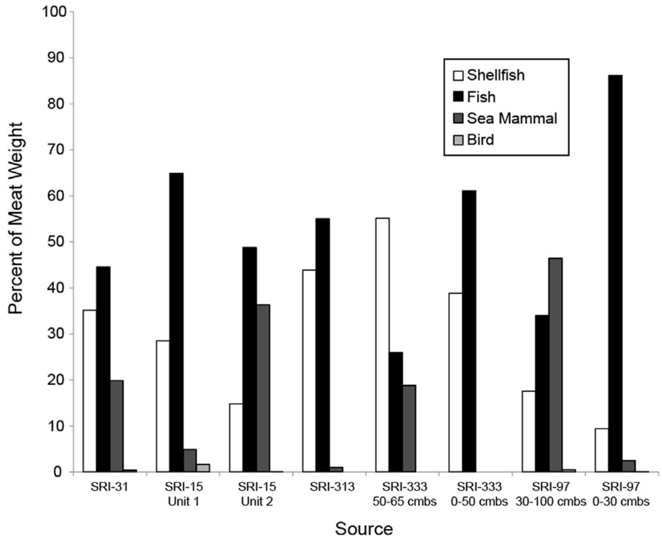

Fig. 4. Major faunal constituents for the cultural components in question by percent of estimated meat weight.

all cultural components except the early component of CA-SRI-333 (shellfish; 50–65 cmbs; Late Middle/MLT) and the early deposits from CA-SRI-97 (sea mammal). Fish makes up 87% of the meat weight in the later deposits at CA-SRI-97 (0–30 cmbs; Late Period), which are associated with the historic village of *Nawani*. This is consistent with higher population density at the site. Finally, *Callianax biplicata*, which was used exclusively for making shell beads because it individuals are too small to contribute to diet, increased in shell weight from the Middle Period and MLT to the Late Period. All components that predate the Late Period have less than 1 percent *C. biplicata* by measured weight, and all Late Period components have more than 1 percent *C. biplicata* by measured weight. The latest deposits from CA-SRI-97 are 15% *C. biplicata*, reflecting the important role of bead making late in time. The overall trajectory demonstrates an intensification of bead making through time (see also Jazwa et al., 2013).

In general, those cultural components that were deposited during the Middle Period and MLT have more fish bone than those dating to the Late Period (Fig. 5). There is a decrease from Unit 1 to Unit 2 of CA-SRI-15 in the weight density of fish bones. Similarly, there are higher densities of fish bone at CA-SRI-31, -313, and −15, Unit 1, than at the Late Period deposits from CA-SRI-333. The major exception to this trend is the deposit from CA-SRI-97, 0–30 cmbs, where the overall total weight density of fish remains is more than twice that at any other component. There is a density of 25,802 g/m^3 of fish at CA-SRI-97, 0–30 cmbs, but only 12,165 g/m^3 at CA-SRI-15, Unit 1, 7737 g/m^3 at CA-SRI-313, and 4605 g/m^3 at CA-SRI-97, 30–100 cmbs. This suggests that while fishing occurred more evenly at different sites during the Middle Period and MLT, it was much more concentrated at village sites during the Late Period.

8. Discussion

We interpret changes in the distribution of settlements during the MLT and Late Period as indicative of increasing territoriality and the transition from an IFD to an IDD on the NCI. These changes are reflected in the faunal record from the west coast of Santa Rosa Island. The late Middle Period was the culmination of the expansion in the number of permanent settlement sites to the mouths of all major drainages around the island (Kennett et al., 2009; Winterhalder et al., 2010; Jazwa et al., 2016). However, around the time of the MLT, the number of settlement sites on the NCI appears to have decreased, in part because drought conditions reduced the suitability of some locations (Arnold, 1991, 1992a, 1992b; Raab and Larson, 1997; Yatsko, 2000; Munns and Arnold, 2002; Perry, 2003; Kennett, 2005; Rick et al., 2005; Rick, 2007; Glassow et al., 2010; Jazwa et al., 2012, 2016). After this period, population on the islands continued to increase (Glassow, 1999; Kennett, 2005). By the time of historic contact, permanent settlement centers were restricted to fewer locations along the coastline, even after the amelioration of drought conditions and the end of the MCA. This is evident in the faunal data from the west coast of Santa Rosa Island. There is a shift from at least four sites with evidence for fishing that we consider here along the coastal terrace to

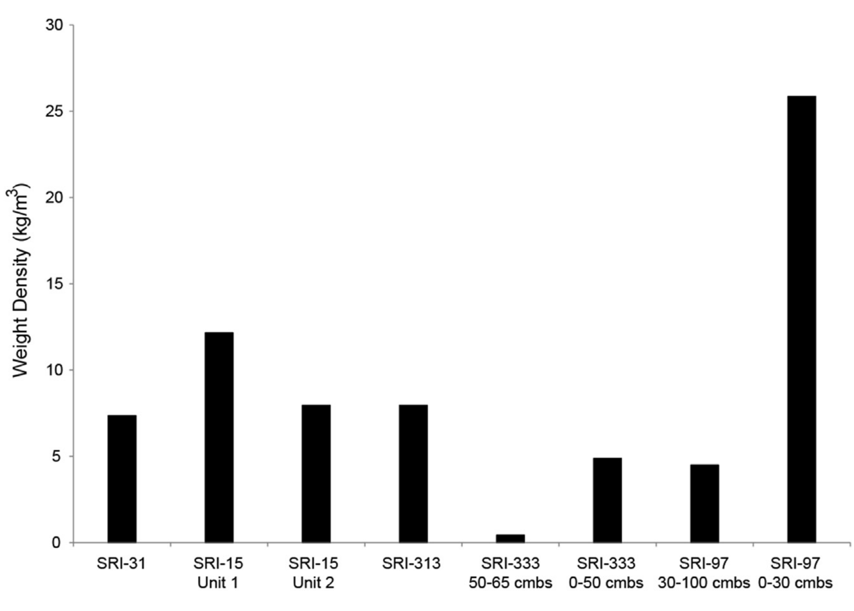

Fig. 5. Density of fish bone for the cultural components by total weight density.

a high-density concentration of fish remains at the historic village of *Nawani* and a smaller fishing camp (Fig. 1; Table 3). The increase in population density of the villages without expansion to previously occupied areas is consistent with the IDD and territoriality.

The shifts in settlement patterns during the late Middle Period and MLT occurred at the same time as a series of technological and environmental changes. Markers for warfare and deterioration of human health in the Chumash region, including the NCI, also increased contemporaneously (Fig. 6). The introduction of the shell fishhook was coincident with an initial increase in projectile point injuries. It is likely that these two trends are symptomatic of larger patterns. The shell fishhook allowed for more intensive fishing, which in turn allowed village sites to support larger population densities. Increasing violence and unstable environmental conditions would have prompted people to aggregate at villages in some (but not all) high suitability locations for protection and access to more secure water sources and other resources. The bow and arrow appeared on the NCI sometime between 1300 and 1050 cal BP, exacerbating social instability (Kennett et al., 2013). Soon after this time, and coincident with the extended droughts of the MCA, projectile point injuries reach a maximum frequency on the NCI and Santa Barbara coast (Lambert, 1994). There is also a continued increase in cribra orbitalia and periosteal lesions and decline in stature, both suggesting nutrient deficiencies, either through recurrent food shortages, illness, or lack of clean water (Lambert, 1994). The contemporaneous appearance of the *tomol* served multiple purposes, including better access to offshore and trade resources, and perhaps facilitating intervillage conflict by allowing for rapid transportation during raids.

Although there is some evidence for logistical shellfish collecting sites during the middle Holocene (Jazwa et al., 2015), the first evidence of permanent settlement along the west coast of Santa Rosa Island occurred at CA-SRI-31 at the beginning of the late Holocene (Kennett, 1998). The expansion of settlement in this part of the island mirrored the expansion of fishing throughout the NCI. The progressive investments in new technologies, particularly plank canoes and shell fishhooks, allowed the Island Chumash to catch larger quantities of fish. This ultimately helped to support higher population densities (Raab, 1992; Glassow, 1993a).

The settlement pattern in the final centuries leading up to the MLT included a series of habitation sites with extensive fish remains on the coastal plain along the west coast of Santa Rosa Island. CA-SRI-31 was still a major settlement hub at the mouth of Bee Canyon. Radiocarbon dates from this site (Table 1) place the deposits from 1680-1440 2σ cal BP to 1615-1350 2σ cal BP, roughly the same time as the development of the *tomol*. The nearby sites of CA-SRI-313 and -333 were first occupied soon after, as was Unit 1 of CA-SRI-15. Two large sites farther south were also occupied during this period, showing that settlement was distributed along the west coast of the island (Kennett, 1998:456–458). With the exception of the low-density early deposits at CA-SRI-333, fish is the dominant component at these sites by meat weight, suggesting an increased reliance on fishing. In all, people seem to be taking advantage of nearby rocky shoreline to catch abundant nearshore fish either from shore or by boat.

Although the number of settlements decreases throughout the NCI during the MLT, there is evidence of continued occupation at CA-SRI-15 and -313 along with the initial evidence for settlement at CA-SRI-97. It is unclear if occupation at CA-SRI-333 continued during this period or if there was a gap and the site was reoccupied later. It is difficult to differentiate the deposits from the end of the Middle Period from those dating to the MLT at most of these sites. However, the initial deposits at CA-SRI-97 have an increased focus on sea mammal hunting. The density of fish at this stage of occupation at CA-SRI-97 is less than at the contemporaneous assemblages from CA-SRI-15 and -313.

Major settlement shifts occurred during the Late Period, with the population condensing to a small number of large coastal villages. Along the northwest coast, the hub of settlement at CA-SRI-15 moved from the more exposed western part of the prominence adjacent to a long sandy beach (Unit 1) to the eastern side (Unit 2), adjacent to a smaller but more sheltered cove (Jazwa et al., 2012). Fish remained the most important dietary component by meat weight, although sea mammal overtook shellfish as the second most prominent contributor in these deposits. The overall density of faunal remains was lower during the Late Period, but a

Table 3
Summary of the drainages on Santa Rosa Island, grouped by Late Period territory. Terminal dates of occupation for each drainage are indicated, demonstrating consolidation of settlement within each territory to a single primary village. Rankings from Jazwa et al., (2016) and important environmental variables are included.

Drainage	Jazwa et al., 2016 Rank	Village Territory	Village Location	Settlement Site	Terminal Date (cal BP)[a]	Water Flow (m^3/day)	Resilience (% Flow)	Sandy Beach (km)	Date Source
Tecolote	1	Nimkilkil	Yes	CA-SRI-2[b]	225–130	338.36	2.83	0.71	Rick 2004
Garanon	6	Nimkilkil	Yes	CA-SRI-2[b]	225–130	199.53	3.40	0.02	Rick 2004
Arlington	2	Niaqla	Yes?	CA-SRI-6?[c]	510–315	303.70	2.63	1.54	Rick 2004
Soledad	5	Niaqla	No	CA-SRI-19[b]	1260–1090	285.29	3.65	1.95	Jazwa et al., 2016
Dry	8	Niaqla	No	CA-SRI-19[b]	1260–1090	227.67	3.56	1.95	Jazwa et al., 2016
Trancion	3	Nawani	Yes	CA-SRI-97[b]	310–135	302.61	3.59	2.10	Kennett 1998
Acapulco	9	Nawani	Yes	CA-SRI-97[b]	310–135	158.34	2.98	2.47	Kennett 1998
Bee	13	Nawani	No	CA-SRI-313	775–565	160.08	2.69	2.49	This Study
Whetstone	15	Nawani	No	CA-SRI-96	2100–1750	184.87	3.50	3.17	Kennett 1998
Verde	4	Silimihi	Yes	CA-SRI-40	365–130	242.11	3.94	0.30	Kennett 1998
Cow	11	Silimihi	No	CA-SRI-115	2115–1915	249.66	5.53	0.29	Jazwa et al., 2016
Lobos	18	Silimihi	No	CA-SRI-541	730–545	112.91	3.78	0.30	Jazwa et al., 2016
Old Ranch House	7	Qshiwqshiw	Yes	CA-SRI-85[b]	540–310	160.12	3.97	2.51	Jazwa et al., 2013
Old Ranch	12	Qshiwqshiw	Yes	CA-SRI-85[b]	540–310	193.50	2.09	2.98	Jazwa et al., 2013
Water	10	Hichimin	No	CA-SRI-77	360–130	277.14	3.62	2.55	Kennett 1998
Cherry	14	Hichimin	Yes	CA-SRI-60	365–130	132.82	3.12	1.90	Kennett 1998
San Augustin	16	He'lewashkuy	Yes?	CA-SRI-436	420–140	215.09	3.60	1.72	Kennett 1998
La Jolla Vieja	17	Nilal'uy	No[d]	CA-SRI-138	645–530	167.98	4.47	1.43	Jazwa et al., 2016
Wreck	19	Nilal'uy or He'lewashkuy	No	?	Unknown	155.91	5.67	1.36	–

[a] Terminal dates of 130 cal BP (historic depopulation) are assigned for dates that extend to the present.
[b] Sites at the mouth of multiple adjacent drainages.
[c] This site is the most likely location of the village Niaqla, although there is no direct evidence of historic occupation at CA-SRI-6.
[d] Nilal'uy is likely located west of La Jolla Vieja Canyon near Johnson's Lee, not at the mouth of a drainage but along extensive sandy beach.

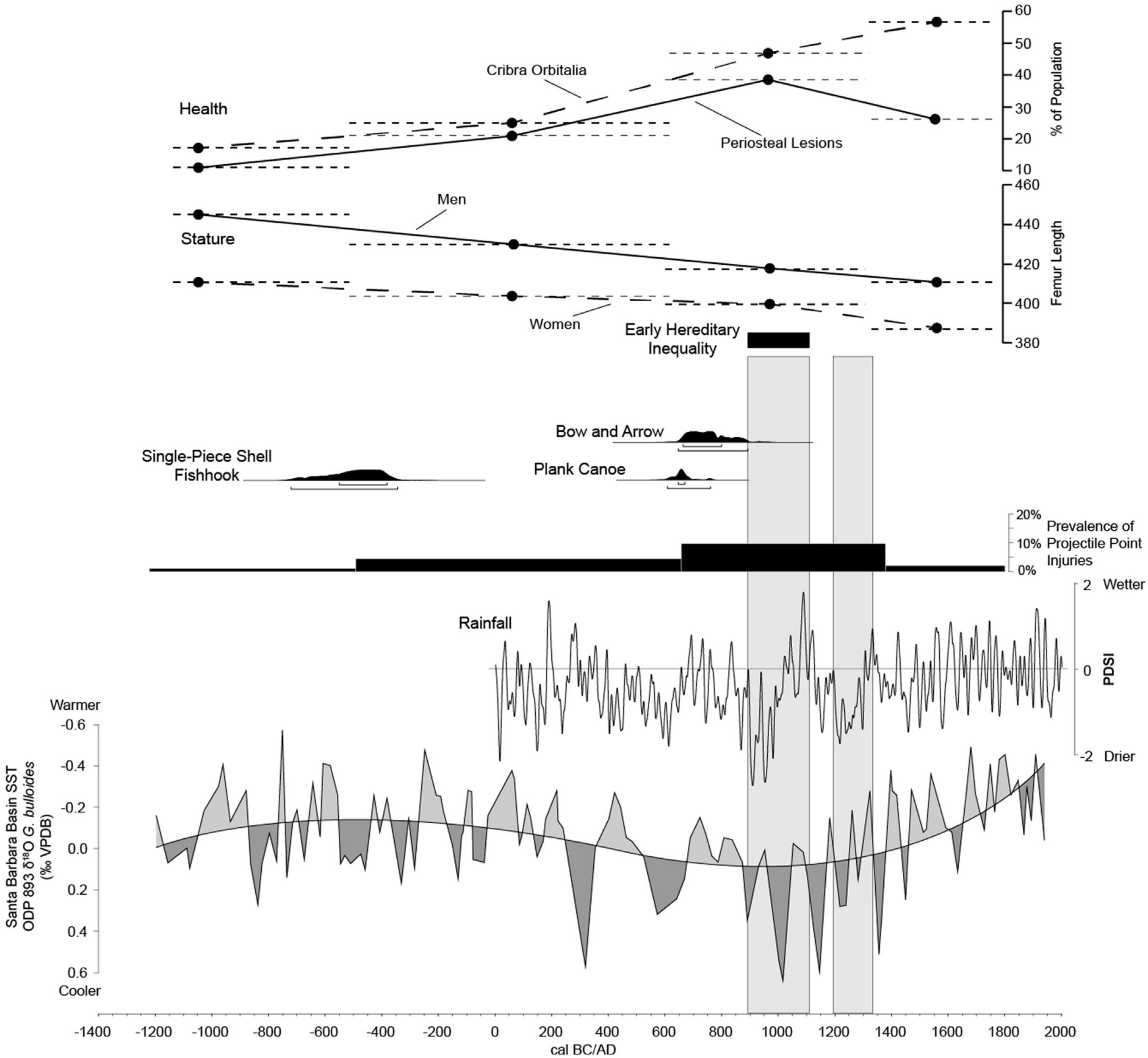

Fig. 6. Climate data, technological developments, and health indicators for the Northern Channel Islands. Gray boxes indicate the two longest drought periods identified by Stine (1994) for the Medieval Climatic Anomaly. Health, stature, and projectile point data are from Lambert (1994). Sea-surface data are from Kennett and Kennett (2000) and Palmer Drought Severity Index (PDSI) is from Cook and Krusic (2004). Ranges for single-piece shell fishhook, bow and arrow, and plank canoe are 2σ calibrated radiocarbon ranges (Kennett et al., 2013). Early hereditary inequality is a range coincident with MCA droughts and inequality continues through island depopulation in the 1820s (after Kennett et al., 2013; Kennett, 2005). Note the coincidence of drought conditions, increased violence, appearance of hereditary inequality, and indicators of poor health. This is also contemporaneous with the shift from an IFD to an IDD settlement pattern. Modified and compiled from Kennett et al. (2009:Fig. 20.5; 2013:Fig. 3).

seasonality study has suggested that people occupied the site year-round (Jazwa, 2015). Although Johnson (1982, 1993) initially suggested that CA-SRI-15 was the location of the historic village of *Nimkilkil*, there is no evidence that this site was occupied at the time of historic contact (Kennett, 2005; Glassow et al., 2010). Much like CA-SRI-97 on the west coast, the nearby historic village at Skull Gulch (CA-SRI-2) was the hub of settlement for that part of the island at the end of the Late Period (Kennett, 2005) and may have drawn in the population from CA-SRI-15. CA-SRI-2 had been interpreted as the village of *Niaqla*, but it may in fact have been the larger village of *Nimkilkil* (Glassow et al., 2010).

The only west coast sites in this study that have evidence for occupation during the Late Period are CA-SRI-97 and -333. These two sites have different faunal records and each represents a component of the settlement and subsistence system. The density of fish bone at CA-SRI-97 is by far the highest of any of the sites investigated as a part of this study, with fish comprising 87% of the overall meat weight. CA-SRI-333 is a smaller site contemporaneous with CA-SRI-97. It has a lower density of fish and other faunal remains. People at CA-SRI-333 were likely fishing along the rocky coast, opportunistically catching species they encountered. CA-SRI-333 was a small site likely occupied by a group of people who may or may not have had some connection with the nearby village.

Changes in settlement patterns that we argue are associated with increased territoriality occurred during the Late Period across Santa Rosa Island. The population aggregated at larger village sites in high-ranking locations to access resources that were diminished by poor environmental conditions like drought and for protection from competing groups. Village locations are assigned based on the most recent work of Johnson (1982, 1993, 1999; Glassow et al., 2010; John Johnson, personal communication, 2015; see also Kennett, 2005). When combining drainages into territories of the most likely associated village based on geographic distribution (Fig. 1; Table 3), it appears that people generally chose to focus their settlement within the territories in those locations ranked highest by the IFD. For example, the village of *Nawani* (CA-SRI-97) is located adjacent to a beach connecting Trancion and Acapulco Canyons, the two highest ranked drainages on the west coast of Santa Rosa Island (Jazwa et al., 2016). Trancion is an especially wet drainage. Similarly, *Nimkilkil* is likely located at the highest ranked location on all of Santa Rosa Island (Tecolote Canyon), and the landform containing CA-SRI-15 was subsumed under it.

The location of the historic villages around the island took advantage of adjacent drainages with a relatively reliable water supply during the drought conditions that occurred during the MCA (see Jazwa et al., 2016). Supported by nearby adjacent sandy beaches, shell beads and plank canoes would have expanded the abundance and diversity of subsistence resources accessible from these village locations through trade with the mainland and other locations on the islands, increasing the rank of the habitats within the IFD. Plank canoes would have also increased access to offshore sea mammal and fish, both of which increase in the archaeological record during the late Holocene (Arnold, 1992a, 1995, 2001a; Gamble, 2002; Fagan, 2004). This would have allowed these villages to support growing populations. The only village that was not located at the mouth of the highest ranked drainage in its territory was *Hichimin*, which is at Cherry Canyon rather than Water Canyon. Both drainages have sites with radiocarbon dates that overlap the time of historic contact, suggesting that they may have been occupied at the same time. Because there was only one historic village (CA-SRI-60) along that stretch of the coastline (Bechers Bay), it is possible that they may have been part of the same territory.

The villages throughout Santa Rosa Island were positioned at strategic points along the coastline that provided extensive viewsheds and allowed people time to prepare for approaching canoes (Kennett, 2005). This was particularly important during a period of increasing intervillage hostilities. Finally, the highest density of villages overall is along the north coast of Santa Rosa Island, which had the highest ranked drainages overall under the IFD. In contrast, the west coast, which is generally low-ranked in the IFD, was the location of a single village.

If we consider the territory under the control of each historically documented village as a habitat, settlement during this period is consistent with the IDD. This change in settlement began during the Medieval Climatic Anomaly. During that period of resource stress, the increase in violence during this period and radiocarbon and faunal data presented in this study suggest that residents of high-ranking habitats prevented some people from moving into nearby locales within their territory. They push others to extra-territorial and lower-ranked habitats than would have been settled within an IFD regime. Protection from residents of other territories through higher population density (i.e., safety in numbers) can also be modeled as an Allee effect that increased the suitability of habitats with Late Period village sites. Many previously occupied habitats have dates of terminal occupation at the beginning of the Late Period or earlier (Table 3). People congregated at central villages, but protected the rest of their territories, creating buffer zones for protection and resource acquisition (cf., Bayham et al., this issue). In doing so, people are no longer focused on individual drainage mouths (drainage as habitat), and instead include multiple drainages within expanded territories. The appearance of buffer zones helps explain why areas like the mouth of Bee Canyon that had permanent settlement during the Middle Period were depopulated during the Late Period. Bee Canyon would have been within the territory of the village of *Nawani* at the mouth of nearby Trancion and Acapulco Canyons. Similarly, the landform with CA-SRI-15 was likely within the territory of the nearby village of *Nimkilkil* to the east. Fishing was the primary source of marine food during the Late Holocene and the distribution of fish remains in the archaeological record reflects these changes in settlement.

In a summary of the literature, Mattison et al. (2016) argue that there are three primary variables driving the appearance of institutionalized inequality cross-culturally: (1) defensible natural resources, (2) material wealth transmission, and (3) population and resource pressure. On Santa Rosa Island, the MCA was a time of resource stress, with individuals or family groups choosing to condense to the best locations (Variable 3). Conflict increased at this time, in part to defend the natural resources at the locations of primary villages. The protection afforded by higher population density likely outweighed the benefits of living a more isolated existence (Variable 1).

As offshore and kelp forest fishing became more prominent later in time, the benefits of plank canoes for fishing and trade increased. Since these were owned by chiefs and their production was limited to specialists (Arnold, 1992a, 2001b), there was an economic benefit for people to allow chiefly lineages to maintain influence and not defect. Ethnographic and mission baptismal records provide evidence for hereditary chiefdoms across the islands. Chiefs were usually male and polygynous, with their wives typically moving to their husbands' native villages (Johnson, 1988, 1999). Marriages in general were frequently used to integrate villages around the islands (Johnson, 1982, 1993). Although there was competition between villages, there was also evidence for cooperation and alliances between them as well. These lineages allowed for the transmission of wealth to offspring (Variable 2). Therefore, the benefits of protection and increased access to economic resources through offshore fishing and trade enforced the IDD.

9. Conclusion

This case study from the west coast of Santa Rosa Island provides an opportunity to better understand the relationship between the development of territoriality, settlement patterns, and changes in subsistence. As populations grew on the NCI during the late Holocene, technological innovations helped intensify marine food production to support them. During the MLT and Late Period, environmental and cultural shifts led to an aggregation of people at fewer more densely populated village sites around the islands. This is contrary to earlier patterns and consistent with the IDD rather than the IFD. Prior to this time, the population on the west end of Santa Rosa Island was spread out at a series of permanent settlement sites. Afterward, people moved to larger consolidated villages. Growth of the shell bead industry and use of canoes for offshore fishing and trade reflect increasing complexity and greatly enhanced the suitability of these village locations. The transition to an IDD system led to a Late Period settlement pattern in which some of the villages were in habitats (i.e., drainage mouths) with lower basic suitability than would be expected in the IFD, in part because drainages with higher basic suitability may have been within the territories of other villages and in apparent buffer zones.

California's NCI provide a case study for understanding the appearance of territoriality among chiefdoms and the transition from IFD to IDD settlement systems. The social and technological changes that occurred during the late Holocene suggest a change in how the Island Chumash viewed the landscape and made decisions about where to live. Moving to villages with higher population densities and abandoning interceding buffer zones as residential settlement sites had several benefits during periods of environmental stress. Relinquishing influence to chiefs was perhaps a trade-off for protection and the greater quantity and diversity of resources that were made available by living in a village where canoes could facilitate access to trade goods and offshore resources. Unlike most other hierarchically organized complex societies, the inhabitants of the NCI never had agriculture, so they relied on the intensification of marine resources to support larger and more complex populations. By looking at archaeological correlates of culture change, in this case settlement patterns and the faunal record, it is possible to trace the appearance of territoriality and better understand the mechanisms behind it.

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