SPATIAL AND TEMPORAL VARIABILITY IN CHERT EXPLOITATION ON SANTA CRUZ ISLAND, CALIFORNIA

Jennifer E. Perry and Christopher S. Jazwa

Chert outcrops on eastern Santa Cruz Island were of vital importance to the inhabitants of the Santa Barbara Channel region because of their comparatively limited availability elsewhere on the California Channel Islands. Temporally diagnostic artifacts and radiocarbon dates from associated shell middens suggest that chert quarries were exploited throughout the Holocene. The importance of these quarries has been well documented in regard to microlith production as part of the shell bead industry during the late Holocene. However, relatively little is known about local chert tool manufacture and exchange in earlier times. Systematic documentation of 26 known chert quarries, and sampling at associated shell middens on eastern Santa Cruz Island has resulted in the identification of significant spatial variability in chert exploitation through time. Whereas chert quarrying during the middle Holocene appears to have been opportunistic and dispersed throughout the landscape, comparable activities during the late Holocene became increasingly circumscribed as microlith production was intensified. These trends in chert procurement are interpreted in the context of temporal changes in subsistence, tool manufacture, and residential mobility on the northern Channel Islands, and have broad implications for spatial and temporal patterning in prehistoric lithic exploitation.

The significance of prehistoric chert exploitation on Santa Cruz Island has been recognized since the earliest archaeological inquiry into the Santa Barbara Channel region of the California Bight (Figure 1). Although chert sources have been identified on other islands in recent years (Erlandson et al. 2008), 26 quarries found within an area of 30 km² make eastern Santa Cruz Island (East End) second only to Vandenberg Air Force Base (VAFB) with respect to the quantity and quality of known sources of naturally occurring Monterey chert accessible to the Chumash. Starting with Léon de Cessac in the late 1870s (Heizer and Kelley 1962), Arnold (1987, 1992a), Olson (1930), Pitzer et al. (1974), Rogers (1929), and Rozaire (1978) are among those who have stressed the importance of these intensively used chert quarries and their byproducts, particularly microliths 1 for communities of hunter-gather-fishers in the northern California Bight.

Despite this long-standing interest, formal investigations into the prehistoric exploitation of

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island cherts have been undertaken only in the past 30 years. Arnold (1985, 1987, 1990b, 1992a) was the first to systematically document the microblade industry and evaluate its relationship to shell bead-making, regional exchange, and political complexity. Interested in cultural developments of the late Holocene, she has focused on quarries and coastal village sites, including those where chert microdrills were used to drill the highly valued and widely circulated callus cup beads from the purple olive shell (*Olivella biplicata*) (see Arnold 1987, 1992a, 2001a, 2001b; Arnold and Graesch 2001; Arnold and Munns 1994; Hudson and Blackburn 1987:123–127, 267–282). Lacking until recently, however, was systematic documentation of the chert quarries on the East End and interpretations of their use through time, especially the millennia immediately preceding the microblade industry.

After the East End was acquired by Channel Islands National Park in 1997, Kennett (1998, 2005) and others initiated archaeological surveys in the region and identified other chert quarries in the process, including CA-SCRI-610, the largest one on the islands. Chert outcrops recorded in the late 1990s and early 2000s revealed a high degree of interquarry variability in raw material procure-

**Figure 1. Santa Cruz Island.**

ment and tool-making activities. Between 2004 and 2006, we evaluated 24 of 26 chert quarries on the East End using standardized criteria for intersite comparison (Jazwa 2005; Perry 2003, unpublished field notes on file with author) and conducted testing at associated shell middens. Located within a relatively well-preserved, bounded cultural landscape, the chert quarries of the East End offer unique insights into how lithic exploitation fits within shifting trends in settlement and subsistence on Santa Cruz Island, as well as the regional economy of the Santa Barbara Channel.

Based on an increasing number of radiocarbon dates and the recovery of diagnostic tools, we have identified significant changes in chert exploitation from the middle (4500–1500 B.C.) to late Holocene (1500 B.C.–present), and within the late Holocene from the late Middle (A.D. 900–1150) to Late periods (A.D. 1300–1782) of Chumash prehistory (Table 1). Such trends are best understood within the frameworks of central place foraging in the middle Holocene and collector-based strategies in the late Holocene, as resource prioritization shifted from the seasonal foraging of terrestrial and marine resources to intensified fishing and regional exchange (Glasgow 1993; Kennett 2005). During the middle
Table 1. Radiocarbon Dates from Chert Quarries and Associated Shell Middens on Eastern Santa Cruz Island<sup>a</sup><sup>b</sup>

<table>
<thead>
<tr>
<th>Site Designation</th>
<th>14C Sample&lt;sup&gt;a&lt;/sup&gt;</th>
<th>14C Lab. No.</th>
<th>14C ± 2σ Yrs B.P.</th>
<th>δ13C %e</th>
<th>Cal Yrs ± 2σ</th>
</tr>
</thead>
<tbody>
<tr>
<td>CA-SCRI-395</td>
<td>surface</td>
<td>β-195422</td>
<td>2340 ± 60</td>
<td>-2</td>
<td>A.D. 90–420</td>
</tr>
<tr>
<td>CA-SCRI-396</td>
<td>10–15</td>
<td>β-195423</td>
<td>4280 ± 50</td>
<td>-0.6</td>
<td>2300–1960 B.C.</td>
</tr>
<tr>
<td>CA-SCRI-408</td>
<td>surface</td>
<td>β-195424</td>
<td>4030 ± 70</td>
<td>1.6</td>
<td>2100–1600 B.C.</td>
</tr>
<tr>
<td>CA-SCRI-408</td>
<td>15–25</td>
<td>β-222703</td>
<td>6400 ± 50</td>
<td>-1.7</td>
<td>4790–4520 B.C.</td>
</tr>
<tr>
<td>CA-SCRI-412</td>
<td>surface</td>
<td>β-195425</td>
<td>4600 ± 100</td>
<td>0.2</td>
<td>2870–2280 B.C.</td>
</tr>
<tr>
<td>CA-SCRI-627</td>
<td>surface</td>
<td>β-216760</td>
<td>5480 ± 80</td>
<td>0.6</td>
<td>3890–3500 B.C.</td>
</tr>
<tr>
<td>CA-SCRI-627</td>
<td>surface</td>
<td>β-216761</td>
<td>5700 ± 40</td>
<td>0.6</td>
<td>3900–3780 B.C.</td>
</tr>
<tr>
<td>CA-SCRI-632</td>
<td>surface</td>
<td>β-190380</td>
<td>4780 ± 50</td>
<td>1.2</td>
<td>2910–2630 B.C.</td>
</tr>
<tr>
<td>CA-SCRI-693</td>
<td>30</td>
<td>β-203416</td>
<td>4520 ± 70</td>
<td>1.5</td>
<td>2900–2560 B.C.</td>
</tr>
<tr>
<td>CA-SCRI-693</td>
<td>65</td>
<td>β-203417</td>
<td>4760 ± 70</td>
<td>1.3</td>
<td>3310–2880 B.C.</td>
</tr>
<tr>
<td>CA-SCRI-724</td>
<td>20–30</td>
<td>β-222704</td>
<td>5330 ± 70</td>
<td>-2</td>
<td>3920–3620 B.C.</td>
</tr>
<tr>
<td>CA-SCRI-724</td>
<td>30–40</td>
<td>β-222705</td>
<td>5500 ± 60</td>
<td>1.6</td>
<td>4040–3780 B.C.</td>
</tr>
<tr>
<td>CA-SCRI-724</td>
<td>50–60</td>
<td>β-226843</td>
<td>5680 ± 90</td>
<td>2.6</td>
<td>4330–3940 B.C.</td>
</tr>
<tr>
<td>CA-SCRI-741</td>
<td>24–35</td>
<td>β-172033</td>
<td>3780 ± 80</td>
<td>0.3</td>
<td>1960–1560 B.C.</td>
</tr>
<tr>
<td>CA-SCRI-741</td>
<td>58–66</td>
<td>β-165424</td>
<td>4110 ± 80</td>
<td>0.5</td>
<td>2440–1970 B.C.</td>
</tr>
<tr>
<td>CA-SCRI-753</td>
<td>10–15</td>
<td>β-168347</td>
<td>1180 ± 50</td>
<td>0</td>
<td>A.D. 1300–1470</td>
</tr>
<tr>
<td>CA-SCRI-753</td>
<td>10–15</td>
<td>β-222706</td>
<td>1250 ± 60</td>
<td>0.2</td>
<td>A.D. 1250–1450</td>
</tr>
</tbody>
</table>

<sup>a</sup> All radiocarbon samples are marine shell, and were dated by Beta Analytic, Inc.

<sup>b</sup> Other radiocarbon dates reported in Arnold (1987) and Kennett (2005).

Note: INTCAL98 Radiocarbon Age Calibration (Stuiver et al. 1998).

Holocene, islanders appear to have been engaged in opportunistic quarrying throughout the landscape for the production of bifaces, macrodrills, and other chert tools. In contrast, increased coastal sedentism, intensified fishing, and the microblade industry characterize the latter parts of the late Holocene (see Arnold 1987, 1992a, 2001a, 2001b; Kennett 2005; King 1990). The particular chert outcrops targeted appear to change primarily in response to (a) tool preferences and raw material requirements, (b) subsistence and resource scheduling, and (c) residential mobility and transportation costs.

Spatial and temporal patterning in quarrying and tool production on eastern Santa Cruz Island have implications for lithic studies throughout North America given their potential to shed light on the interrelationships between chert exploitation and subsistence, residential mobility, and exchange. As the largest and most terrestrially diverse of the northern Channel Islands, Santa Cruz Island is well-suited for exploring different spheres of trade and interaction, namely intervillegage, interisland, and island-mainland relations. What makes eastern Santa Cruz Island unique is the scale of exploitation compared to the other islands and the small area within which most of the chert quarries are found. In comparable studies, distinctions are commonly made between lithic sources on large geographic scales, sometimes as much as hundreds of kilometers apart, such as different geologic formations or mountain ranges (e.g., Andrefsky 1994; Austin 1996; Beck and Jones 1990; Beck et al. 2002; Gramly 1980; Hoard et al. 1993; Jones et al. 2003; Julig 1988; Julig et al. 1992; Luedtke 1979; Moore 1989; Newman 1999; Tankersley 1998). However, what is evident on eastern Santa Cruz Island is that people were making distinctions on much smaller scales, sometimes between outcrops just a few hundred meters apart. Such proximity allows us to examine different levels of decision-making with respect to the use and control of chert outcrops, tool production and distribution, local and long-distance exchange, and regional interaction.

**Chert Exploitation in the Santa Barbara Channel Region**

Lithic resources are patchily distributed throughout the northern California Bight. Those most commonly used in the Santa Barbara Channel region include chert, basalt, and other igneous materials, fused shale, sandstone, and quartz (see Pletka 2001:142–143). In contrast to the abundance of chert outcrops north of Point Conception and on Santa Cruz Island, comparable raw materials are absent from coastal areas further to the south where
the densest populations lived, with local toolstone being limited to stream cobbles and other small sources (Moore 1989:81). Instead, the occupants of the southern parts of Chumash territory relied primarily on Monterey chert from the VAFB region 40–80 km away and Franciscan chert from the interior of the Santa Ynez Valley, requiring a journey through an intervening mountain range (Arnold 1990a:8–20, 54; Moore 1989). Although the nearest obsidian source is over 300 km to the east in the Coso Mountains, obsidian tools were also imported to the Channel Islands during the middle and late Holocene (Arnold 1987; Kennett 2005; *Pierce et al. 1990; Pletka 2001; Rick et al. 2001). The most abundant and highest quality chert sources on the mainland are located north of Point Conception in the Vandenberg Air Force Base (VAFB) region, the interior of the Santa Ynez Valley, and the Temblor Range 100 km to the north (Arnold 1987, 1990a, 1990b, 1992b; Grivetti 1982; Moore 1989; Pierce et al. 1990; Pletka 2001). Franciscan chert is found most abundantly in the Santa Ynez Valley and adjacent mountains, and consists of quality stone of red, brown, and green coloration with dull surfaces (Arnold 1987:91–92; Moore 1989:82; Pierce et al. 1990). In contrast, Monterey chert in the VAFB region is generally dark brown to black in color, lustrous, and of high quality (Glassow et al. 1990:CH 8:22; Grivetti 1982). Starting around 8,000 years ago, these chert quarries were utilized to manufacture bifaces including dart points, knives, and harpoons (Arnold 1990a, 1992b; Glassow 1996:141–142). The advantages of the VAFB Monterey chert for bifaces and other large tools derive from the relative abundance of high-quality chert in layers or bands thick enough to be able to routinely find and work with large chunks or cores (Arnold 1990a:8–79; Glassow et al. 1990:CH 8:22–23; Grivetti 1982).

Compared to the mainland of the northern California Bight, high-quality lithic materials on the northern Channel Islands are limited, with less variety and lower quality of workable materials. Based on lithic assemblages described in site records from across the island, chert, basalt, and quartzite were the types most commonly exploited on Santa Cruz Island. Obsidian, Monterey chert, Franciscan chert, fused shale, and other stones were also imported from the mainland, and steatite was introduced from Santa Catalina Island to the south. Most of these materials were transported to the island as finished tools rather than as unworked nodules. The relative scarcity of obsidian is reflected in the form it most often takes on Santa Cruz Island: thin, small flakes no larger than a fingernail, likely the product of tool retouch (Michael Glassow, personal communication 2007).

Chert was of great importance to residents of the northern islands throughout prehistory, and sources have been documented on Santa Cruz, Santa Rosa, San Miguel, and Anacapa Islands. Erlandson et al. (1997, 2008) have identified several chert sources on San Miguel Island in recent years, and Rick (2006) has found exposed chert deposits on Anacapa Island. Lower-quality and/or smaller outcrops of chert are also present on Santa Cruz Island in canyons south of Prisoners Harbor and possibly in contexts further to the west (see Dibblee 2001). However, none of these come close to comparing with the vast quantities of usable materials on eastern Santa Cruz Island, an area that has long been recognized as a major chert source for at least 7,000 years.

The most abundant and highest-quality chert sources are situated on and around El Montañon, the prominent ridgeline that separates the East End from the rest of the island (Arnold 1987; Kennett 1998, 2005; Perry 2003; see Figure 1). Often referred to as Santa Cruz Island blonde chert due to the light brown color observed in archaeological contexts, it is well-suited for flint-knapping due to its high silica content and blocky rather than laminar structure (Arnold et al. 2001:115). The prevalence of chert on the East End results from the relationship between the two geologic substrates that underlay this region: the Monterey Formation and Santa Cruz Island (SCI) Volcanics (Dibblee 2001; Weaver and Meyer 1969). In many places where the contact between these two formations is exposed, such as along the western flanks of El Montañon, chert outcrops are easy to locate and exploit (Arnold 1987:101).

The History of Archaeological Research on East End Chert

The significance of chert exploitation on eastern Santa Cruz Island—especially with respect to microlith production—has long been known, and is mentioned specifically in Léon de Cessac’s
accounts of his 1878 expedition to the island (Heizer and Kelley 1962). Olson (1930:14–15) conducted the first excavations on eastern Santa Cruz Island in 1927–1928, recovering “flint points” as well as drills and picks from two cemeteries at Smugglers Cove (CA-SCRI-504 and SCR-306). Subsequent analyses of microblade caches indicate that lithic specialists were among those interred there, providing evidence that microblade production was one of the major craft specializations on Santa Cruz Island during the late Holocene (Hollimon 1990; Hoover 1971; King 1976; Pitzer et al. 1974).

In spite of such early recognition, Arnold (1985, 1987, 1991, 1992a, 1993) was the first to bring considerable attention to the roles of the microblade and *Olivella* shell bead industries in the regional economy based on excavations at 11 late Holocene sites on Santa Cruz Island (Arnold et al. 2001; Arnold and Munns 1994; Pletka 2001; Preziosi 2001). Of these sites, four—CA-SCRI-240, the historic village and economic center of *Xaxas* at Prisoners Harbor; SCR-392 and SCR-306, a quarry and the Late period village, *Lu upsh*, respectively; and SCR-93, a quarry and shell midden on El Montañon—exemplify different stages of microblade production and distribution, around which the economy of eastern Santa Cruz Island seems to have revolved after ca. A.D. 900 (Arnold 1987, 2001b; Arnold et al. 2001; Dietler 2003; Pletka 2001).

Resulting from the accumulation of microlith data from different sites, Arnold (1987:191, 1992a, 2001a, 2001b) established a chronological sequence of microblade types spanning much of the late Holocene. Radiocarbon dates and diagnostic shell beads from stratified deposits at CA-SCRI-240 and SCR-306 place the beginning of the microblade industry around A.D. 900–950 (Arnold 1987:194; Arnold et al. 2001:116–117). Although the terminology has varied, three different microblade types have long been recognized (Figure 2). The trapezoidal and triangular with dorsal retouch (TDR) types are quantitatively associated with the late Middle and Late periods, respectively, whereas the nondiagnostic triangular form was produced throughout the span of the microblade industry, frequently as part of the manufacturing of the other types (Arnold 1987:194; Arnold et al. 2001:116–117).²

Despite the attention given to microliths, until Arnold (1987:99–100, 124) surveyed the western side of El Montañon in 1981, CA-SCRI-93 was the only chert quarry that had been formally documented on the Channel Islands. Arnold (1987:148) describes this site as “a microblade production area, and a small, circumscribed food processing/occupation area” encompassing an area of 1,875 m². Thousands of trapezoidal microblades and cores have been recovered from these shallow deposits, indicating that their production was among the primary activities conducted at this locale (Arnold 1987:126). Overall, the trapezoidal form represents 80–100 percent of the microblades and 65–100 percent of the microcores at nine quarries documented on El Montañon, whereas none are dominated by the subsequent TDR type (Arnold 1987:161). Based on these data, Arnold (1987) has made the following general conclusions regarding spatial patterning in chert exploitation: “all major chert quarries are used, no matter how remote; ... smaller quarries are used relatively less intensively except where highly accessible [and of higher quality]; and “permanent or temporary occupation areas were established at or near several of the quarries” (1987:163).
### Table 2. Summary of Quarry Characteristics.

<table>
<thead>
<tr>
<th>Site number</th>
<th>Geographic cluster</th>
<th>Quarry size (m²)</th>
<th># of mining pits</th>
<th>Presence of shell midden</th>
<th>Middle Holocenea</th>
<th>Late Middle Periodb</th>
<th>Late Periodb</th>
</tr>
</thead>
<tbody>
<tr>
<td>CA-SCRI-93</td>
<td>El Montañon</td>
<td>1,875</td>
<td>0</td>
<td>Yes</td>
<td>X</td>
<td>X</td>
<td>-</td>
</tr>
<tr>
<td>392</td>
<td>Beach</td>
<td>840</td>
<td>0</td>
<td>Yes</td>
<td>-</td>
<td>-</td>
<td>X</td>
</tr>
<tr>
<td>394</td>
<td>El Montañon</td>
<td>3,380</td>
<td>0</td>
<td>Yes</td>
<td>X</td>
<td>X</td>
<td>-</td>
</tr>
<tr>
<td>395</td>
<td>El Montañon</td>
<td>5,720</td>
<td>0</td>
<td>Yes</td>
<td>-</td>
<td>X</td>
<td>-</td>
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<td>408</td>
<td>El Montañon</td>
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<td>X</td>
<td>X</td>
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<tr>
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<td>El Montañon</td>
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<td>-</td>
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<tr>
<td>417</td>
<td>El Montañon</td>
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<td>419</td>
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<td>-</td>
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<tr>
<td>609</td>
<td>Scorpion</td>
<td>6,000</td>
<td>7</td>
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<td>X</td>
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<td>610</td>
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<td>26</td>
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<td>627</td>
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<td>3</td>
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<td>X</td>
<td>X</td>
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<td>628</td>
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<td>-</td>
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<tr>
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<td>Nearby</td>
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<td>-</td>
<td>-</td>
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<td>638</td>
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<td>0</td>
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<td>-</td>
<td>-</td>
<td>X</td>
</tr>
</tbody>
</table>

aBased primarily on radiocarbon dates.
bBased primarily on the relative distribution of major microblade types.
cCA-SCRI-395 also dates to the earlier part of the Middle Period (1500 B.C.–A.D. 900) based on one radiocarbon date.
dThe large site areas for CA-SCRI-627 and SCR-630 pertain to extensive lithic scatters; CA-SCRI-610 is the largest quarry.

In contrast to SCR-93 and other quarries around El Montañon, the strong emphasis on TDR microblade production at coastal sites in the area of China Harbor. Late period village sites and the nearby quarry at CA-SCRI-392 suggest that microblade activities shifted from the quarries of El Montañon to the coast over time. Prior to SCR-392 being buried by a landslide in 1998, Arnold (1987:100) observed that “large boulders of chert have eroded down from the section of the Contact Zone just above the harbor and now rest on the shore,” and were exploited primarily for the manufacture of TDR microblades. Shell middens in the China Harbor region, such as SCR-306, have yielded strong evidence for household-level production of TDR microblades and shell beads, but nothing earlier (Arnold 1987:179–187, 2001b; Dietler 2003).

### Current Research on East End Chert Quarries

Through her research, Arnold (1987:121–125) made significant contributions to the understanding of the microblade industry and documented 10 chert quarries in the process. However, little was known about the broader temporal or geographic scope of chert exploitation when Arnold completed her fieldwork on eastern Santa Cruz Island. Since the acquisition of the East End in 1997 and the Isthmus in 2000 by Channel Islands National Park and their subsequent accessibility to archaeologists, 16 other quarries have been found in this region by Kennett (1998, 2005), Rick et al. (archaeological site records on file at the Central Coastal Information Center), Perry (2003, 2004, 2005), and Jazwa (2005). Of the 26 known quarries, we visited 24 of them from 2004 to 2006, assessing the original site...
records and current site conditions as well as collecting standardized data on quarry characteristics (Table 2). In doing so, we evaluated different artifact types, particularly bifaces and microliths; the sizes, densities, and constituents of nearby shell middens; and other indicators of the functions of these quarries.

Spatial variability in chert exploitation is influenced by a variety of factors including the quality, abundance, and accessibility of the material; tool morphology and function; and residential patterns and transportation costs (Andrefsky 1994; Bamforth 1992; Beck and Jones 1990; Beck et al. 2002; Jones et al. 2003; Kelly 1988, 1992; Kuhn 1994; Moore 1989; Newman 1999; Parry and Kelly 1987; Torrence 1983, 1989). Among the most relevant quarry characteristics is raw material availability, referring to both abundance and quality, which Andrefsky (1994) argues can have greater influence on tool production than the settlement strategies in which chert exploitation is embedded. Bamforth (1992:132) emphasizes the importance of “the distribution of source areas in space” or overall abundance; “the accessibility of stone at the source” including “its density or concentration within the source area, and its ease of extraction”; and “the knapping and use qualities of that stone.”

Chert quality on eastern Santa Cruz Island varies significantly due to its banded nature, with clear differences between high and low quality (Arnold 1987; Junak et al. 1995). Large blocks or nodules of homogeneous chert are rare. Rather, the best quality material tends to be layered between bands of Monterey shale and siltstone, making pieces suitable for the production of tools larger than microblades difficult, but not impossible, to find. In contrast, low-quality chert tends to occur in thin bands and/or contains numerous flaws, cracks, and shale inclusions.

Color has commonly been used to assess quality and as a criterion for differentiating local from mainland chert (see Pletka 2001). Arnold (1987:97) noted the presence of white, blonde, light brown, dark brown, gray, and bluish cherts in the 11 quarries west of El Montañon; we have also documented reddish brown, yellowish brown, red, reddish yellow, and very dark gray to black. Such variation in chert color frequently occurs within individual sites, with adjacent outcrops often displaying different hues. Similarly, chert quality varies not only between quarries, but also within individual outcrops. Although Monterey and Franciscan cherts are relatively easy to distinguish based on color, less clear are the differences between cherts from Santa Cruz Island, San Miguel Island, and the VAFB region (Erlandson et al. 2008). In fact, the high degree of intra- and inter-site variability in chert color is evident on the East End calls into question some of the existing interpretations regarding imported tools of Monterey chert (Arnold 1987; Arnold et al. 2001; Pletka 2001; Kennett 2005:200).

Employing multiple criteria we identified four distinct types of quarries. Out of 26 quarries, five have no associated shell middens or known chronological affiliation. From the remaining 21 quarries we were able to identify three distinct quarry types that represent significant differences in resource scheduling and tool production through time: (a) those for which there is no evidence of microblade production; (b) those for which there is abundant evidence of trapezoidal and triangular undiagnostic microblade production; and (c) those for which there is evidence of TDR microblade production and/or mining pits. In general, quarries of the first type are dispersed throughout the East End; quarries of the second type are largely confined to El Montañon; and quarries of the final type are found in the vicinity of Scorpion Canyon. CA-SCRI-392 and quarried cobbles at Potato Harbor are the only two chert sources that are situated directly on the coast, whereas the rest are located at higher elevations. Of the 21 quarries for which chronological data are available, 11 have yielded evidence of use during the middle Holocene; 18 during the late Holocene; and 8 during both time periods.

Chert Exploitation in the Early Holocene

Significant spatial and temporal variability is evident in chert exploitation and associated tool production, with important shifts occurring from the middle to late Holocene and, with respect to microblade production, from the late Middle to Late period. Despite the abundant evidence of chert exploitation dating to the past 6,500 years, comparable data for early Holocene activities on Santa Cruz Island are limited to one chert quarry, CA-SCRI-610. Evidence found elsewhere on the northern Channel Islands includes chert in early and
Figure 3. Spatial distribution of chert quarries with Middle Holocene deposits (4500–1500 B.C.).

middle Holocene deposits at Daisy Cave on San Miguel Island (Erlandson et al. 1997). Although few in number, these sites indicate that island chert sources were exploited beginning with the earliest colonization of the northern Channel Islands. Along with evidence for intensive biface production in the VAFB region, it is clear that exchange networks existed in the Santa Barbara Channel since the early Holocene, in which island cherts presumably played an ongoing and important role. Intra-island transportation of chert is indicated by the debitage and tools recovered from deposits dating between 6,800 and 100 cal B.C. at Punta Arena (SCRI-109) on the southwestern coast of Santa Cruz Island, among other sites (Glassow et al. 2008).

Extending over an estimated 56,000 m², CA-SCRI-610 is by far the most intensively exploited chert quarry on the Channel Islands. Its surface is littered with at least 56 large mining pits, 5–10 m in diameter, and populated with exceptionally dense concentrations of chert cobbles, cores and microcores, microblades, flakes, and other debitage (Central Coast Information Center, CA-SCRI-610 archaeological site record, 1997; Clifford 2001:67). At Locus A, a small shell midden directly associated with the quarry, one sample of black abalone (*Haliotis cracherodii*) shell yielded a radiocarbon date of 5060–4625 cal B.C. (1σ) (Kennett 1998:463; Kennett 2005:130–133). Evidence of microblade production of all types is present in and around the mining pits. Due to the high quality and abundance of the raw material, intensity of quarrying activities, early radiocarbon date, and evidence of microblade production, it seems possible that SCRI-610 was quarried throughout the Holocene.

Chert Exploitation in the Middle Holocene

In contrast to the lack of data pertaining to the early Holocene, middle Holocene chert exploitation is clearly represented at 11 of the 26 quarries on eastern Santa Cruz Island (Figure 3). Comparable to other middle Holocene sites on the northern Chan-
nel Islands, these sites are dispersed throughout the landscape in a variety of environmental contexts from the coast to the highest elevations on El Montafon. Four of these quarries (CA-SRCI-632, SCR1-633, SCR1-637, and SCR1-638) are located south of Smugglers Canyon, the second largest watershed on the East End (Kennett 2005:50). Its mouth is Smugglers Cove, the location of the historic village of Nanawani (CA-SRCI-504 and SCR1-506) (Hoover 1971; Johnson 1993; Kennett et al. 2000; Olson 1930). In general, chert at these quarries is of the poorest quality on the East End and the outcrops are relatively small. Despite significant evidence for quarrying, there is none for microblade production or mining pits at any of these sites.

Of these four quarries, only CA-SRCI-632 is directly associated with a shell scatter; the rest are comprised exclusively of quarried chert outcrops and large lithic scatters. Located uphill from Smugglers Cove, SCR1-632 is a small, low-quality chert quarry and a small, low-density shell scatter (36 m²) surrounded by an extensive low-density chert lithic scatter (7,200 m²). The shell scatter consists almost exclusively of wavy top (Lithopoma undosum) with no associated carbonaceous soil and no apparent depth to the cultural materials. One complete contracting stem dart point made of island chert was recovered from the site surface, which is consistent with a radiocarbon date of 2910–2630 cal B.C. (2σ) from a large wavy top fragment. No evidence of microblade production has been found despite its proximity to Smugglers Cove and Nanawani.

Further to the south, La Cañada Del Aguaje is fed by three springs that are among the most reliable freshwater sources on the East End (Perry 2003:124–125). Eight sites have been identified in the vicinity, including three shell middens, one chert quarry, and four lithic scatters. SCR1-741 is the largest and densest of the shell middens (3,700 m²), located 200 m downslope of the quarry at SCR1-637 (Perry 2003, 2005). All radiocarbon samples and temporally diagnostic artifacts from SCR1-741 and nearby sites date to the middle Holocene. La Cañada Del Aguaje exemplifies the general pattern south of Smugglers Cove: there is evidence of quarrying and biface manufacture during the middle Holocene, but no indications that these quarries were utilized on any significant scale after this time. In fact, except for the village sites at Smugglers Cove (CA-SRCI-504 and SCR1-506), there is no evidence of occupation south of Smugglers Cove at any point during the late Holocene.

**Scorpion Anchorage (CA-SRCI-611, SCR1-627, and SCR1-724)**

In contrast, the vicinity of Scorpion Canyon appears to have been inhabited for the past 8,000 years, and was the location of Swaxil, an important historic village that the Chumash occupied into the 1810s (Johnson 2001; Kennett 2005; Kennett et al. 2000). Dispersed throughout this region are large, dense shell middens and evidence of extensive chert exploitation, including mining, at nearby quarries. Overlooking Scorpion Anchorage, CA-SRCI-627 is comprised of a large (6,000 m²), moderate- to high-density lithic scatter extending across the entire landform; a chert quarry with three mining pits that are dotted with variously sized igneous hammerstones; and a small (225 m²), ephemeral shell midden situated just five meters away from the cluster of mining pits (Central Coast Information Center, CA-SRCI-627 archaeological site record 1997; Perry 2007). Based on two radiocarbon dates of 3990–3780 and 3890–3500 cal B.C. (2σ), the shallow, low-density shell midden seems reflective of short-term habitation during the middle Holocene. Despite the quarry’s proximity to Scorpion Anchorage and Swaxil, there is little evidence of microblade production aside from the two triangular undiagnostic microblades and one small core with trapezoidal blade removals. Instead, the vast majority of the chert flakes and debitage analyzed, as well as the recovery of one large nondescript chert biface fragment, suggest that biface manufacture accounts for at least a portion of the chert extracted and tested at the site.

Situated 150 meters uphill and 700 meters south of Scorpion Anchorage are a large chert quarry, CA-SRCI-611, and a large high-density shell midden, CA-SRCI-724, located within 100 meters of each other. The chert is of high quality and occurs in a variety of colors including white, tan, brown, red, gray, and blue. A total of 26 distinct mining pits averaging 5–10 m in diameter were observed by Kennett et al. (Central Coast Information Center, CA-SRCI-611 archaeological site record, 1997) when the site was first recorded in 1997. Chert cores, microblades, flakes, and other debitage, as well as igneous and chert hammerstones of all sizes,
are evident on the site surface. Indicators of microblade production are present, including all three microblade forms, of which triangular undiagnostic microblades are the most abundant. With no clear pattern in the proportions and distribution of the trapezoidal and TDR types, it is difficult to determine chronological affiliation beyond inferring that the quarry was likely used throughout the time of the microblade industry.

Nevertheless, radiocarbon dates and temporally diagnostic artifacts from the nearby shell midden at CA-SCRI-724 make this quarry one of those that dates to both the middle and late Holocene. Large pieces of wavy top that Perry excavated from a 1-x-1-m unit (Unit 5S/5W) and an adjacent 20-x-20-cm column sample yielded dates of 3920–3620, 4040–3780, and 4330–3940 cal B.C. (2 s) from levels at 20–30 cm, 30–40 cm, and 50–60 cm, respectively. Evidence that the occupants of this shell midden intensively utilized the nearby quarry includes the recovery of chert biface fragments, macrodrills, flake tools, cores, and thousands of

Figure 4. Chert bifaces recovered on eastern Santa Cruz Island.
flakes anddebitage (Figure 4 andTable 3). Of the 13 chert bifaces recovered from the excavations, seven are members of the highly variable Vandenberg contracting stem dart point type, which Justice (2002:243) observes “probably functioned for spear and harpoon tips as well as knives.” Significantly, sea mammal bones are well represented in the midden deposits, providing insights into local subsistence during the middle Holocene.

Biface production was an important facet of the regional economy during the middle Holocene, as best represented by the wide circulation of VAFB bifaces throughout the Santa Barbara Channel (Arnold 1990a, 1992b; Glassow 1996; Glassow et al. 1990). Dietter (2003), Noah (2005), and Pletka (2001), among others, have noted that at Late period coastal villages on Santa Cruz Island “most or all projectile points are imports from the mainland” (Arnold 1987:207). Pletka (2001:144) observed a significant difference in material types between finished and unfinished bifaces; 54 percent of the finished bifaces \( n = 108 \) recovered from excavations at CA-SCRI-191, SCRI-192, SCRI-240, and SCRI-330 were made from mainland chert and other imported materials. In contrast, all except one of the unfinished bifaces \( n = 22 \) were manufactured from island chert. Additional studies at SCRI-240 yielded 63 bifaces from the Historic period, of which 17 were made of island chert (Noah 2005:125). However, we know far less about the relative emphasis on local and imported lithic materials, and associated biface manufacture, on Santa Cruz Island prior to the late Holocene.

Finished bifaces made of imported materials including Franciscan chert, fused shale, and obsidian, and representing every major time period have been found on eastern Santa Cruz Island (Arnold 1987; Perry 2003). It is also evident that the majority of large bifaces found on the East End are made of island chert. Chert tools, flakes, anddebitage from sites around Scorpion Anchorage and La Cañada Del Aguaje suggest that biface production may have been a focus of middle Holocene activities on the East End, thereby influencing resource scheduling and site placement. Sites such as CA-SCRI-724 indicate that islanders produced large bifacial tools (e.g., harpoon and spear points), some of which were transported to Punta Arena and other western locales either through embedded procurement strategies or trade (Glassow et al. 2008).

**Central Place Foraging in the Middle Holocene**

Similar to settlement and subsistence trends documented throughout the northern Channel Islands, middle Holocene inhabitants of eastern Santa Cruz Island engaged in seasonal foraging activities, with some instances of coastal sedentism in particularly productive locales (Glassow 1993; Kennett 1998, 2005; Perry 2003, 2004, 2005). Islanders relied on a combination of marine and terrestrial resources, placing a strong emphasis on shellfish gathering supplemented by fishing, sea mammal and bird hunting, and plant gathering. Twenty-two shell middens on the East End have deposits dating to the middle Holocene, most of which are interpreted as seasonal residential bases. Their spatial distribution reflects residential mobility between marine and terrestrial resource patches. That 11 of these 22 shell middens are located near quarries high-
lights the probable influence of chert exploitation on site placement.

Central place foraging (CPF) provides a useful framework for interpreting the spatial distribution and cultural constituents of middle Holocene shell middens (Beck et al. 2002; Bettinger et al. 1997; Binford 1979; Kennett 2005; Orians and Pearson 1979). Kennett (2005) has stressed the relevance of CPF to the prehistory of the Channel Islands:

CPF theory provides a set of principles for estimating the optimal settlement location on the islands. The model predicts that, all other variables being equal, foragers will select residential base locations that maximize the net central place foraging returns given the pursuit, handling, and transport costs of resources from different patches [2005:225].

Kennett (2005:32) notes that residential mobility is likely to occur “under conditions of low population density and unlimited access to spatially separated resources” and may be employed to “capitalize on seasonal foraging opportunities in highly productive and distant resource patches.” Substantial transportation costs can be associated with toolstone as well as bulky plant products, which can be minimized through site placement and field processing (Andrefsky 1994; Beck et al. 2002). On eastern Santa Cruz Island, islanders presumably attempted to minimize the transportation costs of terrestrial resources by establishing residential bases near resource patches around El Montañon.

In the context of the high residential mobility and low population density that characterizes the middle Holocene (Glassow 1999; Kennett 2005; Perry 2003; Rick et al. 2006), biface production and the exploitation of seemingly every chert source on eastern Santa Cruz Island conform well to models of central place foraging. The strong spatial correlation between chert quarries and shell middens is consistent with notions of direct procurement, which “is likely to occur when a valued stone is available within a short distance of a residential base” (Bamforth 1992:132; Beck et al. 2002). East End inhabitants of the middle Holocene appear to have exploited chert resources proximal to their habitation bases regardless of quality, as exemplified by quarrying activities at lower quality sources south of Smugglers Cove. Embedded within the subsistence schedule, such quarries may have been used to manufacture informal tools, whereas higher quality sources may have been targeted specifically to make formal tools. Overall, it is clear that formal and informal tools were produced from chert quarries on the East End during the middle Holocene, which is consistent with expectations regarding contexts of high lithic quality and abundance (see Andrefsky 1994:30).

Chert Exploitation in the Late Holocene

Considering the shell midden data from throughout Santa Cruz Island, it is evident that changes in chert exploitation from the middle to late Holocene mirror broader shifts from central place foraging to collector-based strategies. The late Holocene is characterized by (a) increased marine resource productivity influenced by generally cooler sea surface temperatures, along with (b) an increasingly maritime orientation among island populations that included increased coastal sedentism, intensified fishing, and increased regional exchange (e.g., Arnold 1987, 1992a, 1993, 2001; Glassow 1993; Kennett 1998, 2005; Kennett and Kennett 2000; Perry 2003). As populations became increasingly concentrated in coastal locales, certain quarries appear to have been ignored, such as south of Smugglers Cove, while others were mined more intensively, such as those around Scorpion Canyon. This spatial patterning suggests that decision-making was influenced by several environmental and cultural factors including (a) inter-quarry variability in quality, (b) material requirements for different tools or tool morphologies, (c) scale of tool production, and (d) transportation costs in the context of (e) degree of residential mobility (see Andrefsky 1994; Bamforth 1992; Beck et al. 2002; Torrence 1983, 1989).

Eighteen quarries have yielded evidence of significant changes in the microblade industry on eastern Santa Cruz Island. Four of the shell middens associated with these quarries have been radiocarbon dated to the late Holocene, whereas the rest have been dated based solely on the presence of different microblade types. The quarries at CASRI-93, CASRI-394 (associated with the shell middens of SCRI-396 and SCRI-753), and SCRI-395 are located in saddles at elevated locales just west of El Montañon, whereas SCRI-392 is along the coast at China Harbor. Only one of these, SCRI-
Figure 5. Spatial distribution of chert quarries with evidence of trapezoidal microblade production during late Middle and Transitional periods (A.D. 900–1300).

395, dates to the early part of the late Holocene prior to the large-scale introduction of the microblade industry. This highlights a substantial gap in chronological data that is problematic for our understanding of quarry use on the East End. Nonetheless, the limited evidence of late Holocene habitation near chert quarries arguably reflects logistical forays from coastal villages such as those at Scorpion Anchorage and Smugglers Cove.

The Beginning of the Microblade Industry (A.D. 900–1300)

Comparing the relative distribution of trapezoidal and TDR microblades at quarries with that of late Holocene shell middens, patterns emerge with respect to differences in chert exploitation between the late Middle and Late periods of Chumash prehistory (Figures 5 and 6). Based on the abundance of trapezoidal-dominated microblade debris at quarries on El Montañon, Arnold (1987:148–149, 161–163) argues that nearby shell middens were all associated with microblade production, and therefore indicative of short-term occupation of the quarries during such activities. However, the radiocarbon dates we obtained from six shell middens associated with these quarries (CA-SCRI-393, SCR-395, SCR-396, SCR-408, SCR-412, and SCR-753) refute this interpretation. Except for SCR-395 and SCR-753, both situated near the quarry at SCR-394, all of the shell middens appear to date to the middle Holocene, well before the quarries became chert sources for microblades.

Combined with five other middle Holocene shell middens with surface evidence of microblade production (CA-SCRI-406, SCR-612, SCR-699, SCR-724, and SCR-751), there is a significant overlap between the locations of trapezoidal microblade production and earlier biface manufacture. Evident at sites such as CA-SCRI-724 is the use of flakes generated during earlier quarrying activities, including during the early stages of biface manufacture. Microblades were habitually removed from these flakes, as people presumably minimized time and labor investments by utilizing...
suitable materials that had already been quarried and decorticated. However, not all middle Holocene sites were targeted, which is particularly evident at quarries and shell middens south of Smugglers Cove.

The particular chert locales selected for microblade manufacture at this time, whether quarries or middle Holocene lithic scatters, are almost always of moderate to high quality, but not necessarily in abundant quantities in any given place. Most of the quarries with evidence for trapezoidal microblade production but not middle Holocene habitation, such as CA-SCRI-414, SCRI-415, SCRI-417, and SCRI-419, are found in narrow saddles of steep ridgelines and are by far some of the most difficult to access today. Because access to other resources (i.e., marine and plant foods) is fairly limited at these locales, they do not fit within the model of central place foraging outlined for the middle Holocene. Rather, the relatively small shell scatters and middens dating to the late Holocene indicate that individuals or small groups conducted logistical forays to these quarries to manufacture microblades on site.

The contrast between middle and late Holocene strategies is exemplified at the El Montañon Complex (CA-SCRI-394, SCRI-396, and SCRI-753). Located in close proximity to one another, these three sites include a large, dense quarry (CA-SCRI-394) and two shell middens (SCRI-396 and SCRI-753), all of which have abundant evidence for trapezoidal microblade production (Arnold 1987:161). Three radiocarbon dates from the nearby shell middens and evidence of intensive trapezoidal microblade production date chert exploitation at CA-SCRI-394 to the middle and late Holocene (Perry 2003:205–209). CA-SCRI-396 is a small moderate-density shell midden situated on an exposed, flat area about 100 meters north of the quarry at SCRI-394. Based on the trapezoidal microblades collected from the site surface, Arnold (1987:134–136, 161) interprets SCRI-396 as a “village site devoted to microblade production” during the late Middle period. How-

Figure 6. Spatial distribution of TDR microblade production during the Late period (A.D. 1300–1782).
ever, this site has since yielded a radiocarbon date of 2300–1960 cal B.C. (2σ) from California mussel (*Mytilus californianus*) fragments recovered from intact deposits 10–15 cm in depth, which suggests middle Holocene occupation overlain by microblade manufacture from the late Middle period.

Located 100 meters downhill from SCRI-394 on the same ridgeline, CA-SCRI-753 is a rockshelter with a small, high-density shell midden with evidence for short-term occupation during late Middle period (Perry 2003:205–209). In addition to affording protection from the elements, the rockshelter is not visible from most angles and therefore would have provided a good defensive locale. Both the quarry and rockshelter floor are covered with thousands of trapezoidal microblades and microcores. Two radiocarbon dates were obtained from California mussel fragments excavated from a depth of 10–15 cm just inside the drip line of the rockshelter in intact deposits: 1300–1470 cal A.D. and 1250–1450 cal A.D. (2σ). The overlap of these dates is noteworthy; this rockshelter is one of the only East End sites potentially dating to the Medieval Climatic Anomaly, a period of intense environmental stress and prolonged droughts in southern California (Jones et al. 1999). Its proximity to chert and an “oak-lined stream valley” with reliable freshwater would certainly have made it attractive to islanders (Arnold 1987:134).

The few late Middle period midden deposits that are associated with chert quarries suggest that little control was asserted over the quarries themselves. No definitive evidence of regulation, control, or centralization of trapezoidal microblade production has been identified thus far (Arnold 1987, 2001a, 2001b; Arnold et al. 2001; Kennett 2005; Perry 2003). Instead, it seems that some quarries were ignored at this time. The rest do not appear to have been occupied for any meaningful length of time during the late Middle period with respect to territorial signaling or resource defense. These interpretations are consistent with Kennett’s observations that “the dispersed nature of microlith-production sites suggests opportunistic exploitation of chert and an industry that was not highly organized or specialized” (2005:207).

We argue that the initial stages of the microblade industry were supported by the discarded debris of earlier biface manufacture, in which the knapping activities of middle Holocene populations influenced the spatial distribution of trapezoidal microblade production. In general, Bamforth (2000:283, 2003:210) has argued that the flakes generated from biface reduction would be unlikely to serve as the basis for an overall technological strategy. However, he does acknowledge that early-stage biface production flakes are more likely than mid- to late-stage thinning flakes to be potentially useful. Many of the lithic scatters that we argue were used to support trapezoidal microblade production are at or near chert outcrops, where early-stage reduction would have previously taken place. Also, because people would not have been using the flakes as tools themselves; the acute and fragile edges of the flakes would not have been a deterrent. These edges would have been removed initially as triangular unprepared microblades before one or more trapezoidal microblades were removed.

Although both Bamforth (2000:282–283, 2003:283) and Keeley (1980:158) have argued that usable flakes from earlier tool manufacture were relatively few, both recognize that they must have been produced incidentally, if only on the scale of a few useful flakes out of hundreds. Considering the expediency manifested in the early periods of microblade manufacture, the fact that many of the lithic scatters that were revisited are relatively near to their initial outcrops and were sites of early-stage reduction, and the sheer quantity of flakes present, we argue that it was quite possible for these flakes to have supported the initial stages of a microblade industry characterized by independent, dispersed, and opportunistic tool production that revolved around field processing (Arnold 1987, 2001a, 2001b; Arnold et al. 2001; Kennett 2005; Perry 2003).

**Mining and Microblade Production in the Late Period (A.D. 1300–1782)**

The dispersed and opportunistic nature of the beginning of the microblade industry contrasts significantly with the intensified production, increased standardization, and greater circumscription of the Late period (Arnold 1987, 1992a, 1993, 2001a, 2001b; Arnold and Graesch 2001; Preziosi 2001). Evidence of the TDR form is associated with intensive chert exploitation at a smaller number of quarries, supporting interpretations of intensified
manufacturing efforts and increased circumscription. Field processing seems to have been a common practice during the late Middle period, when it appears that microblades were manufactured in their entirety at the source of raw material. During the Late period, after initial reduction, the remaining stages of production appear to have been most frequently conducted at coastal residential bases. Trapezoidal microblade production took place at 16 quarries ranging in size from small to large, most of which are located in the interior at higher elevations around El Montañon. Comparable data for the TDR microblade industry of the Late period is limited to five quarries, of which two (SCRI-392 and Potato Harbor) are located directly on the beach and three (SCRI-610, SCRI-611, and SCRI-630) are very large and dense quarries in the vicinity of Scorpion Canyon.

In contrast to the pattern on El Montañon, TDR microblades are the dominant form at the two quarries that are situated directly on the beach, CA-SCRI-392 at China Harbor and an unrecorded quarry area at Potato Harbor. For both sites, large boulders of chert eroded downslope and became partially buried in sediment, subsequently mimicking in situ outcrops (Arnold 1987:100). Both quarries are associated with dense shell middens and are most easily accessed by boat (Arnold 1987:206). Combined with radiocarbon dates from middens at China Harbor, their use appears to date primarily to the Late period. Both of the beach quarries appear to reflect aspects of the increasingly maritime-oriented activities of the late Holocene, as their exploitation makes sense only in the context of regular boat use. Decreased transportation costs and the ability to transport heavier loads, making load weight a much smaller concern, may have transformed these quarries from being regarded as inaccessible or not worth the effort, to lucrative (see Ames 2002; Andrefsky 1994). In fact, Potato Harbor is located along the major boat route between Scorpion Anchorage and China Harbor, and could have been accessed from either direction.

Arnold (1987, 2001a, 2001b) and Dietler (2003) interpret variability in the spatial distribution of microblade types in the context of the industry’s intensification from the late Middle to Late period. Arnold (1987:235–241) argues that in association with the transition from trapezoidal to TDR microblade production, islanders increasingly invested in transporting raw material or chert nodules back to their village sites to intensively manufacture microblades, rather than conducting the initial stages of microblade production at the quarries. Such interpretations are supported by evidence from Late period coastal villages and quarries including the village complex at China Harbor, which seems to have been established in association with the microblade industry (Arnold 1987, 2001a, 2001b; Dietler 2003; Hoover 1971; Kennett et al. 2000; Olson 1930).

Conversely, chert once attractive to microblade makers may have been subsequently ignored because the demand for larger quantities of high-quality materials made the higher transportation costs to coastal villages impractical or inefficient. The high-quality chert at quarries on El Montañon is commonly found along narrow ridgelines with limited access. Exploited intensively during the late Middle period, when the microblade industry was more opportunistic and individually motivated, they played a less significant role during the Late period. Although more chronological data are needed to evaluate this hypothesis, we posit that the mining pits at the quarries around Scorpion Canyon reflect Late period pressure on larger chert quarries closer to the coast. Resulting from increased circumscription, and presumably changes in boat transportation, intensified quarrying at these locales is consistent with Kennett’s observations that “decreased residential mobility also promotes more intensified use of localized resources” (2005:32).

Conclusion

Chert quarries and habitation sites on Santa Cruz Island reflect significant changes in lithic exploitation and tool production through time that relate to broader shifts in subsistence, residential mobility, and exchange in the northern California Bight. The transition from foraging to collector-based strategies, and from mixed marine-terrestrial to intensively maritime-focused activities, is manifested in which quarries were targeted and the intensity of their use. Throughout this time, East End residents were engaged in the regional economy of the Santa Barbara Channel through the production of chert tools including bifaces, microblades, and macro-
drills for making canoes, fishhooks, digging stick weights, and other equipment (Arnold 1987, 2001a, 2001b; Arnold et al. 2001; Kennett 2005). In return, islanders imported a variety of products, including finished chipped tools of mainland obsidian, chert, and fused shale, as evidenced even at chert quarries such as CA-SCRI-93 (Arnold 1987).

One of the most extensively researched aspects of the prehistory of the northern California Bight has been the development of exchange and complexity, particularly as evidenced by the highly visible microblade and *Olivella* shell bead industries (Arnold 1987, 1992a, 1993, 1995, 2001a, 2001b; Arnold and Graesch 2001; Arnold and Munns 1994; Dietler 2003; Kennett 2005; Kennett and Kennett 2000; Preziosi 2001). Although the importance of chert sources on eastern Santa Cruz Island to the microblade industry of the late Holocene has long been known, and biface production in the VAFB region has been well documented, the manufacture of chert bifaces on the Channel Islands has largely gone unrecognized (Erlandson et al. 2008). Continued excavation of middle Holocene habitation sites near chert quarries (e.g., CA-SCRI-611 and SCRI-724) will undoubtedly result in greater insights into the biface industry and its relationship to residential mobility and resource use. In certain contexts, such as at Punta Arena (SCRI-109) and SCRI-724, hunting sea lions, seals, and dolphins appears to have been an important aspect of middle Holocene subsistence (Glassow 2002, 2005a, 2005b; Glassow et al. 2008; Porcasi and Fujita 2000). Through future lithic and faunal analyses we will be able to better understand how this was conducted as well as the preferential roles of local and imported bifacial tools in associated activities. Furthermore, as more middle Holocene sites are documented on the northern Channel Islands, different models of residential mobility and trade may be evaluated through the intra- and inter-island distribution of chert tools.

Ongoing investigations into variability in chert exploitation on eastern Santa Cruz Island have significant implications not only for the prehistory of the northern California Bight, but also for lithic studies throughout North America. Lithic studies comparable to those conducted in the Santa Barbara Channel may involve a range of lithic materials and/or distinct chert sources separated from each other by distances as large as hundreds of kilometers (e.g., Andrefsky 1994; Austin 1996; Beck et al. 2002; Beck and Jones 1990; Granly 1980; Hoard et al. 1993; Jones et al. 2003; Julig 1988; Julig et al. 1992; Luedtke 1979; Moore 1989; Newman 1999; Tankersley 1998). Eastern Santa Cruz Island provides the rare opportunity to explore questions of procurement strategies and mobility in a relatively small, bounded landscape that is dominated by a single type of toolstone. Whereas other lithic materials such as obsidian had to be imported via boat from the mainland, imposing certain standardized costs, on-island chert procurement varied considerably depending on the availability of material, amount of effort required to access it (e.g., mining pits), functional requirements of different tool morphologies, and transportation.

What makes toolstone useful depends not only on the desired tool type and its function, but on the size and quality of the raw material (Bamforth 1992; Beck et al. 2002:491). Whether a particular quarry is used also depends on the mode and distance of transportation as well as residential mobility. Studies commonly focus on how decision-making regarding lithic exploitation was influenced by broader settlement and subsistence patterns, or “the limitations and complexities of the overall resource procurement and mobility strategy” (Beck and Jones 1990:287; Beck et al. 2002; Jones et al. 2003). However, Andrefsky (1994), among others, has argued that raw material availability may have greater direct influence on tool production than settlement strategies. Especially interesting is how the beginning of the microblade industry was seemingly influenced by the distribution of materials discarded during biface manufacture and other flint-knapping activities in the middle Holocene. Earlier periods of chert exploitation on Santa Cruz Island are analogous in some ways to high mobility among late Pleistocene/early Holocene populations of the Great Basin, in which lithic procurement was “embedded in the Paleoarchaic subsistence schedule” (Beck and Jones 1990; Beck et al. 2002:483; Jones et al. 2003). Future research on chert exploitation on the northern Channel Islands, with particular attention given to the early and middle Holocene, will undoubtedly provide comparative data for mainland studies, but with very different mobility and transportation constraints.
Continued studies of chert exploitation on the northern Channel Islands will also provide additional insights into microblade industries throughout North America (see Odell 1994). The microblade industry most similar to that documented on eastern Santa Cruz Island was concentrated at the very large urban and economic center of Cahokia (Arnold 1987; Dietler 2003; Yerkes 1983:499), indicating that the relevance of this study is not confined to hunter-gatherer societies. The example of Cahokia is particularly interesting because of the many parallels that it has with craft specialization on Santa Cruz Island, including distinct spatial differences between where microliths and shell beads were manufactured (Mason and Perino 1961:554; Yerkes 1983:500). Further research is needed to better understand the striking similarities between the two microlith industries and their antecedents despite the substantial environmental and cultural differences between Cahokia and the northern California Bight.

Finally, boats and coastal environments rarely are specifically incorporated into models of hunter-gatherer foraging, although Ames (2002) and others have considered the differential costs of field processing and boat transportation, among other factors, based on archaeological and ethnographic accounts from the Northwest Coast of North America. Traveling by boat would have been faster than walking in some cases, and would have decreased transportation costs by requiring fewer trips for the same amount of material. As the costs of transporting unprocessed materials decrease, so too do the advantages of field processing (Ames 2002; Beck et al. 2002:486, 492). On Santa Cruz Island, reliance on boats to travel to and from quarries as well as transport quarried materials is implied by the exploitation of chert outcrops at Potato Harbor and China Harbor. The use of boats also explains the prevalence of chert at Xaxas at Prisoners Harbor, which at over 15 km away from the nearest large quarry would have been a strenuous hike but less substantial paddle. Further study of these quarries and their by-products can provide important perspectives on the relationship between craft specialization and regular boat use on the northern Channel Islands and in other littoral settings.

Chert studies in the California Bight can be conducted on different scales of analysis from inter-village, to intra-island, to inter-island, to island-mainland, providing different levels of comparison with those of mainland North America. Different spheres of trade and interaction, both local and regional, can be explored, including those involving boats. Furthermore, it is possible to evaluate changes in chert exploitation through time, since some of the same quarries have likely been used from the earliest occupation of the islands to the early 1800s, and thus offering perspectives on developments in quarrying practices and tool technologies in the broader context of cultural change. In sum, island chert quarries and the industries with which they were involved will continue to yield important insights into diachronic changes and synchronous variability in chert quarrying and tool production in the California Bight, as well as their dynamic interrelationships with subsistence, residential mobility, exchange, and complexity.

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Notes

1. Although “microlith” is the most appropriate term for this artifact class, for historical reasons we employ the following terms, most often used in the archaeological literature in the Santa Barbara Channel: microblades, microblade cores, and microdrills. Arnold, Preziosi, and Shattuck (2001:114) define microblades as “whole or fragmentary microlithic specimens (narrow and <50 mm long) produced from formal microblade cores, with no bits.” Microdrills are “modified microblades and must include some or all of a retouched bit to be so classified.”

2. According to Arnold et al. (2001), trapezoidal microliths are “broad, thin, and trapezoidal in cross-section” and “detached from cores exhibiting many overlapping microblade scars” (2001:115). The triangular with dorsal retouch type, also referred to as TDR, is “narrow, thick, and triangular in cross section and exhibits multiple, small dorsal flake scars. These microblades were detached from cores that were prepared by percussion retouch along a prominent ridge” (2001:116). There are also triangular undiagnostic microliths that are “triangular in cross section but lack dorsal retouch” (Arnold et al. 2001:116).

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