Archaeological survey, paleogeography, and the search for Late Pleistocene Paleocoastal peoples of Santa Rosa Island, California

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The northern Pacific Coast is an important area for understanding human colonization of the Americas, but Late Pleistocene coastal sites are rare and interglacial sea level rise has inundated the continental shelf and the primary areas where Paleocoastal archaeological sites are likely to occur. Here we outline a terrestrial archaeological survey project designed to identify Paleocoastal sites on Santa Rosa Island, California. Using reconstructions of ancient shorelines and paleogeography, we predicted that sites might be found where lithic resources, freshwater springs, caves or rockshelters, and strategic vistas drew Paleocoastal peoples into the island interior. We identified nine new Paleocoastal sites, including four radiocarbon dated to >11,000 CAL B.P. that are among the oldest sites on North America's Pacific coast. Our targeted survey demonstrates an important technique for investigating island and coastal settings where sea level rise remains a significant challenge for locating early sites.

Keywords: Paleoindian, Channel Islands, lithic scatter, coastal migration, sea level rise

Introduction

The Late Pleistocene human colonization of the Americas has been a focus of archaeological research for more than a century (Dixon 1999; Meltzer 2009). Researchers have increasingly looked to the Pacific coast for evidence of an early coastal migration (Dixon 1999; Erlandson 1994; Erlandson *et al.* 2007; Fladmark 1979), but Late Pleistocene coastal archaeological sites in North America are limited to a handful of localities between Alaska and Baja California, with all but one (Arlington Springs) postdating ca. 13,000 CAL B.P. (Des Lauriers 2006; Fedje and Mathewes 2005; Erlandson *et al.* 2008b, 2011; Johnson *et al.* 2002). Finding early coastal archaeological sites is complicated by a variety of issues, especially postglacial sea level rise, which has inundated most Terminal Pleistocene shorelines where the settlements of early maritime peoples were likely to be concentrated. Underwater archaeology is an important avenue for identifying early coastal sites (Bailey and Flemming 2011; Gusick and Faught 2011), but preservation and visibility issues, high costs, and logistical challenges have limited discoveries of drowned terrestrial sites in most areas, especially for Late Pleistocene shorelines that are found in relatively deep water.

On land, a number of researchers have noted what Erlandson (2001: 322) called Richardson's Rule: that early coastal sites are much more likely to be found in coastal zones where bathymetry is relatively steep and the continental shelf relatively narrow (Richardson 1998; Waselkov 1987). This helps explain why early coastal shell middens are both older and more abundant along the Pacific Coast compared to the Atlantic Coast of North America (Erlandson 2001). Even where bathymetry is steep, sea level rises of 25, 50, or 100 m can result in substantial lateral movements of coastlines, along with significant coastal erosion and geographic changes that make finding Terminal Pleistocene sites difficult. Careful consideration of pericoastal features that would have drawn early maritime peoples away from now submerged coastlines and into the interior, however, can lead to focused and successful searches for evidence of early human settlement of islands or coastal zones.

Here we discuss a terrestrial archaeological survey project designed to locate Paleocoastal (>9000 CAL B.P.) archaeological sites on Santa Rosa Island, California (FIG. 1). Our earlier work on the arid and wind-blown San Miguel Island focused on searching for caves, springs, lithic raw material sources,

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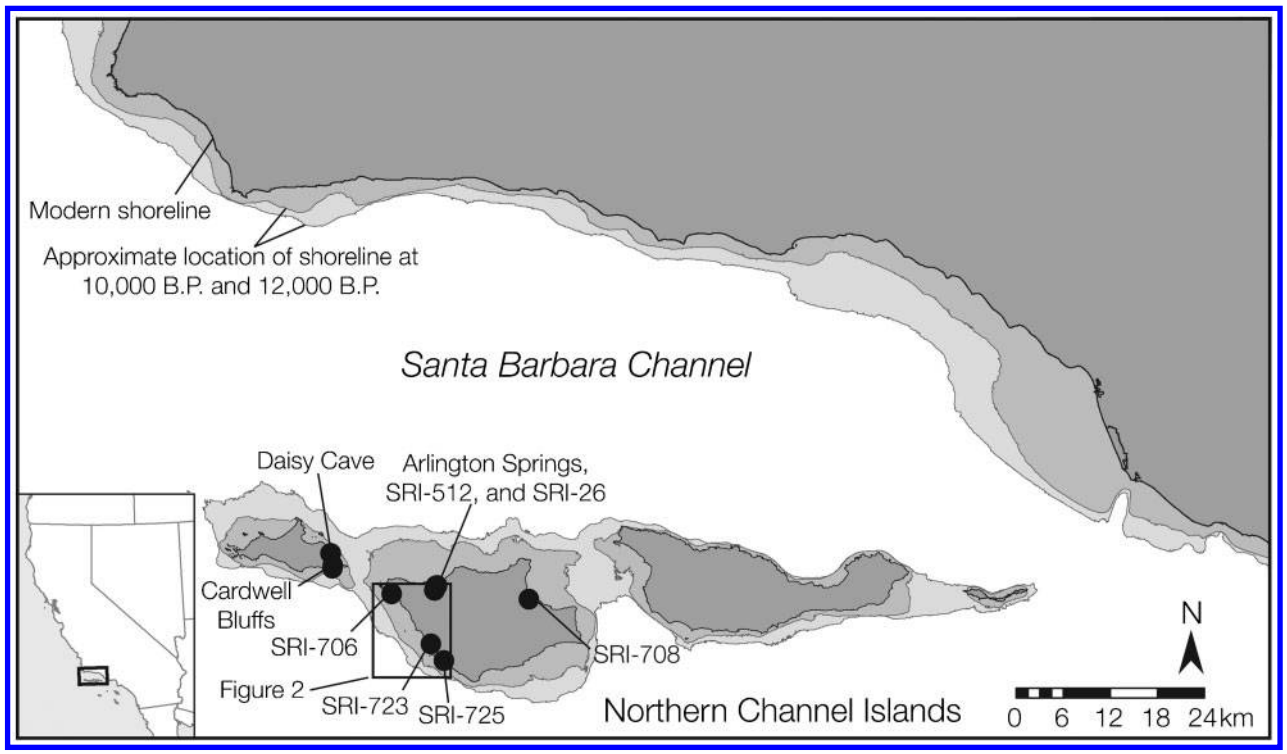

Figure 1 The northern Channel Islands, estimated Terminal Pleistocene and modern shorelines, and key Paleocoastal sites.

geographic features that would have provided shelter, potable water in the dry season, and high quality cherts often favored by Paleocoastal peoples. Previous research has identified seven Terminal Pleistocene sites on the Channel Islands securely dated to between ca. 13,000 and 11,000 CAL B.P. and dozens dated between 10,000 and 8000 CAL B.P., making the region a focus of research on early coastal settlement in the Americas (Erlandson *et al.* 2008b, 2011). These earliest sites were located 1–7 km from the coastline at the time of occupation. During previous surveys, we also noted that many Paleocoastal sites were located on elevated landforms with broad strategic views of the coast, the coastal plain, and in some cases the interior. Based on these findings, we designed a targeted survey strategy for Santa Rosa Island that focused on pedestrian reconnaissance of the rim of the high southern escarpment, which had panoramic views; raised beach deposits that provided sources of lithic raw materials, especially chert; and occasional springs, caves, and rockshelters that would have attracted Paleocoastal peoples. We applied these predictions to marine terraces on the southwestern end of Santa Rosa Island that had not been studied previously, testing the utility of targeted pedestrian survey to identify early sites around the world where rising seas complicate discovery.

Context and Background

California's eight Channel Islands are divided into northern and southern groups. The northern islands (San Miguel, Santa Rose, Santa Cruz, and Anacapa) were connected into a larger island (Santarosae) during the Last Glacial Maximum, when sea level was about 100–120 m lower than today (Muhs *et al.* 2012; Peltier and Fairbanks 2006). Always separated from the mainland by at least 6–8 km, Santarosae lost roughly 70% of its area after ca. 15,000 years ago and started to break up ca. 12,000 to 10,000 calendar years ago (Kennett *et al.* 2008; Reeder 2012). Our survey project focused on finding sites older than 9000 CAL B.P., when sea levels were between about 30 and 70 m below modern levels (Bard *et al.* 2010; Muhs *et al.* 2012). The Channel Islands have relatively steep offshore topography, which results in less dramatic shoreline movement than areas with more gradually sloping bathymetry. This is especially true of the southern coast of Santa Rosa Island, which increased the likelihood of finding early sites (Erlandson 2001; Richardson 1998).

Native Americans lived on the northern Channel Islands beginning at least 13,000 CAL B.P. (Johnson *et al.* 2002; Orr 1968; Reeder *et al.* 2008). During the Holocene, the number of sites increased greatly, including thousands of shell middens and lithic scatters (Kennett 2005; Rick *et al.* 2005). Although pygmy (*Mammuthus exilis*) and Columbian (*M. columbi*) mammoths lived on the northern islands from before 200,000 years ago to ca. 13,000 CAL B.P. (Agenbroad 2012), terrestrial mammals and other fauna are much more limited on the islands than the mainland (Schoenherr *et al.* 1999). Consequently, marine organisms, including shellfish, finfish, marine mammals, and seabirds, complemented by terrestrial

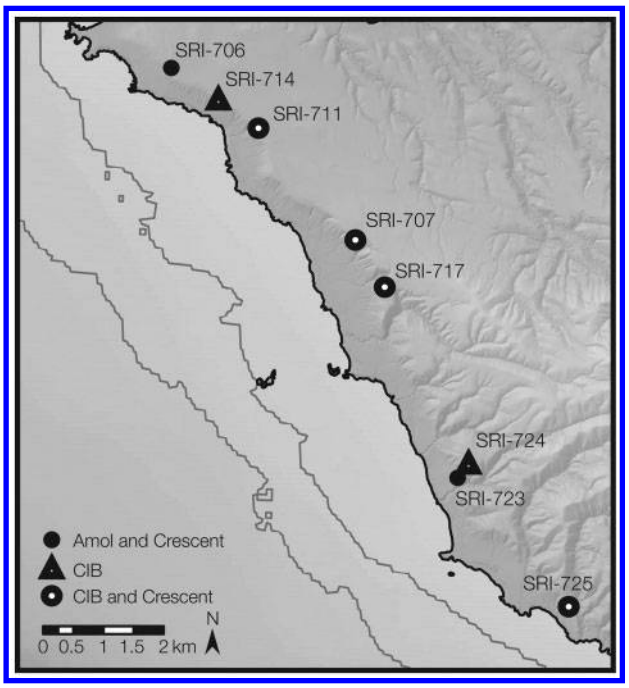

Figure 2 The survey area, estimated paleoshorelines, and approximate locations of newly identified Paleocoastal sites. Stone tool types are indicated. Amol = CIA points; CIB = Channel Island Barbed points.

plants and other foods, were the focus of subsistence activities from initial colonization until the 1820s (Rick *et al.* 2005; Erlandson *et al.* 2011; Reddy and Erlandson 2012). The islands currently have a mild climate with most rainfall during winter, but Paleocoastal peoples lived during cooler and wetter conditions with more conifers and other trees (Anderson *et al.* 2010).

Methods

Based on previous research (Erlandson *et al.* 2011), we predicted that high marine terraces on the southwestern end of Santa Rosa Island would contain archaeological sites occupied by Paleocoastal peoples who traveled to the interior to obtain cherts, plant foods, and/or expansive views of the coastal plain and near-shore marine waters. To test our predictions and better understand early Pacific Coast settlement and land use, we conducted an archaeological survey for 12 km along the margin of a raised marine terrace (90–275 masl) separated from the coastal plain by a steep escarpment (FIG. 2). Our survey covered the terrace rim to about 100–500 m inland, for a total area of 3.8 sq km. We also included one previously unreported site (CA-SRI-708) that we had recently recorded and radiocarbon dated to the Terminal Pleistocene; it is located on the northeastern end of Santa Rosa Island outside of our survey area.

We employed standard pedestrian survey techniques for the region with four to five people systematically walking across the landscape spaced 10–20 m apart depending on topography and surface visibility (Braje *et al.* 2010). Archaeological sites were identified by the presence of artifacts (e.g., chipped stone tools and debitage) and/or shell and bone on the surface or in erosional exposures. Most sites were identified at the contact point between the top of the steep southern escarpment and the high terrace, where erosion had exposed soils and enhanced visibility. In portions of most sites, dense grasses obscured visibility and occasionally posed challenges for determining site boundaries. Sites were recorded on California State site records and entered into a Geographic Information System (GIS) database. For our study, we also reconstructed paleoshorelines based on the ICE-5G model of sea level rise (Muhs *et al.* 2012) and bathymetric models by the National Geophysical Data Center (Carignan *et al.* 2009).

To determine the presence of Paleocoastal components, we relied on the recovery of chipped stone crescents, Channel Island Barbed (CIB), and Amol (CIA) points, likely used for hunting waterfowl, marine mammals, and other animals and known to date to the Terminal Pleistocene and earliest Holocene (Erlandson 2013; Erlandson *et al.* 2011). Where possible, we also obtained radiocarbon samples from midden deposits. Four radiocarbon dates reported below are from marine shell samples recovered in situ from Paleocoastal shell middens identified during our survey. Accelerator Mass Spectrometry (AMS) radiocarbon dates were analyzed by the National Ocean Sciences AMS Facility at Woods Hole Oceanographic Institute and DirectAMS Radiocarbon Dating Services. All samples were calibrated using Calib 6.0 (Stuiver and Reimer 1993; Reimer *et al.* 2009) and applying a reservoir correction of 261 ± 21 (Jazwa *et al.* 2012).

Results

We located 19 new archaeological sites and re-examined two sites recorded in the 1950s. Nineteen of these 21 sites n = 19 included lithic scatters, but eight also contained shell middens and two sites were shell middens without associated lithic scatters. The sites ranged from >75,000 to 225 sq m in area. The biggest sites were lithic scatters with early shell midden components generally confined to a smaller area within the site, or were badly deflated making it difficult to determine the extent of the original midden. Sites were generally positioned adjacent to the terrace edge with commanding views of the coastal plain, ocean, San Miguel Island, and island interior (FIG. 3). The panoramic views at some localities may have been used by early peoples to spot marine mammals and other animals, identify interior locations with productive plant resources, and perhaps to watch for other people. The sites are currently less than 1 km from the coast, but when

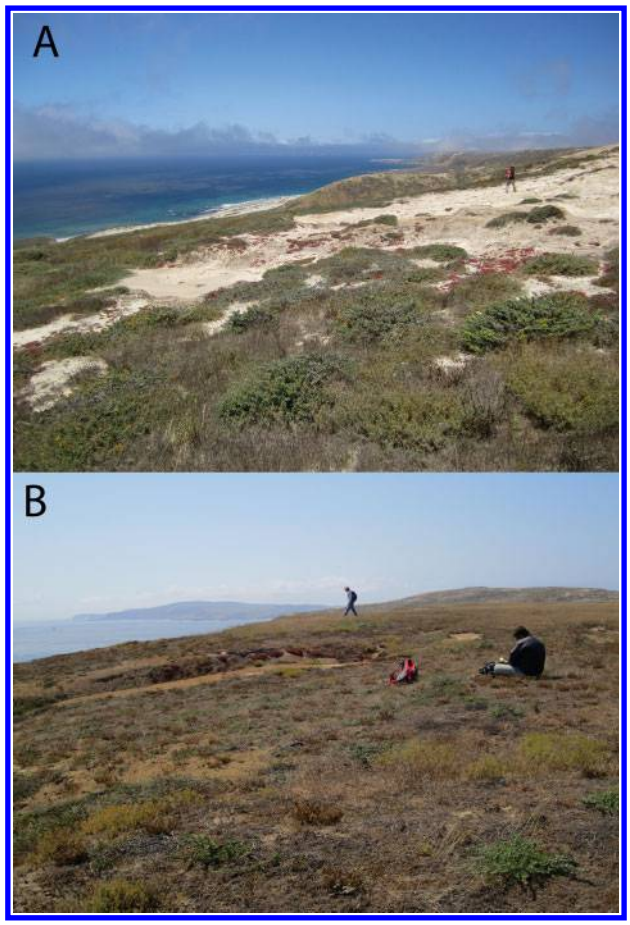

Figure 3 General topography and terrain of Paleocoastal survey sites. A) A lithic scatter with a view to the far western survey boundary. B) A Paleocoastal lithic scatter with sparse vegetation and a view of San Miguel Island in the distance.

occupied they would have been between about 3–5 km from the shore.

Nine sites (43%) contained definitive evidence of Paleocoastal occupation (TABLE 1). Two others produced possible Paleocoastal artifact preforms, but these were too small or fragmentary to allow confidence in their identification. The definitive Paleocoastal sites include five sites with both crescents and CIB points, two with just CIB points, and two with a crescent and a CIA point (FIGS. 4, 5). Taking just the eight sites in our southwestern survey area produces a density of over two Paleocoastal sites per sq km, a density much higher than anticipated. We also identified a few artifacts typical of Late and Middle Holocene occupations, suggesting that some of the sites contain multiple temporal components.

Because most of the sites were lithic scatters with no material available for radiocarbon dating, we do not know the exact ages of several of the identified Paleocoastal sites, but they likely date between about 13,000 and 10,000 CAL B.P. or slightly later (Erlandson *et al.* 2011). Four sites produced intact shell midden deposits that could be radiocarbon dated (TABLE 2). CA-SRI-706, located on the far western edge of our survey area, produced four crescents and a large red abalone (*Haliotis rufescens*) shell found in situ at the base of a truncated soil. This shell produced an AMS radiocarbon date of 10,600±65 B.P. (OS-67611) (uncalibrated here and below) and a calibrated age range of 11,560 to 11,210 CAL B.P. (Reeder *et al.* 2011; Rick and Erlandson 2012). A second site, CA-SRI-723, located on a high knoll overlooking the southwestern coast, produced six crescents, a CIA point, and an in situ red abalone shell that was AMS dated to 10,940±47 B.P. (D-AMS-1093) with a calibrated age range of 12,170 to 11,930 CAL B.P. CA-SRI-725, located on a small bench below the high terrace overlooking a perennial freshwater stream and the south coast, produced a crescent and CIB point, and a red abalone shell found in situ that was AMS dated to 10,585±50 B.P. (D-AMS-1089), with a calibrated age range of 11,360–11,220 CAL B.P. Finally, CA-SRI-708, situated on a lower marine terrace adjacent to a perennial stream near the mouth of Water Canyon on the northeastern end of Santa Rosa Island, produced two crescents, a CIB point preform, and an estuarine clam shell dated to 10,400±47 B.P. (D-AMS-1097). The site dates between 11,190 and 11,120 CAL B.P.

Table 1 Paleocoastal artifacts recovered during survey (see Figs. 1 and 2 for site locations). CIA= Amol points; CIB= Channel Island Barbed points. Tuqan, Wima, and Cico cherts are found locally on Santa Rosa and San Miguel islands. Franciscan chert is believed to be from mainland sources.

Site #	CIA*	CIB*		Crescent*	Biface				Uniface	
(CA-)	*Tuqan*	*Tuqan*	*Wima*	*Tuqan*	*Tuqan*	*Wima*	*Cico*	*Franciscan*		Total
SRI-706**	1	–	–	4	8	1	–	–	–	14
SRI-707	–	2	–	4	13	–	1	–	4	24
SRI-708**	–	1	–	2	–	–	–	–	–	3
SRI-711	–	1	–	1	2	–	–	–	–	4
SRI-714	–	2	–	–	2	–	–	–	–	4
SRI-717	–	–	1	2	5	–	2	1	–	11
SRI-723**	1	–	–	6	6	–	–	–	2	15
SRI-724	–	1	–	–	4	–	1	–	–	6
SRI-725**	–	1	–	1	2	–	–	–	–	4
Total	2	8	1	20	42	1	4	1	6	85

*Includes preforms.
**Sites produced Terminal Pleistocene ^{14}C dates (see TABLE 2).

Figure 4 Crescents identified during survey. Top row (from left to right): CA-SRI-707 #3, 25, and 5. Bottom row: CA-SRI-717 #13, CA-SRI-706 #4, and CA-SRI-717 #8.

Discussion and Conclusions

Our research demonstrates the value of terrestrial archaeological survey for locating Late Pleistocene/earliest Holocene archaeological sites occupied by coastally adapted peoples. Based on predictions about the locations of resources that may have drawn coastal peoples to island interiors, we targeted high marine terraces that provided access to lithic resources, strategic views, and at some locations, fresh water. Our survey of predicted site locations identified nine new Paleocoastal sites on Santa Rosa Island and has also been fruitful on San Miguel Island for locating Paleocoastal sites, including shallow lithic scatters and shell middens with intact subsurface deposits (i.e., Braje *et al.* in press; Erlandson *et al.* 2008b, 2011). This work further emphasizes the need for additional terrestrial survey in coastal areas for evidence of early occupation, especially in areas with steep bathymetry where lateral movement of the coastline has been limited during Pleistocene/Holocene sea level rise.

On the Channel Islands, Terminal Pleistocene peoples focused on marine resources, but made use of interior areas that offered raw materials, plant foods, or other resources not readily available on the coast. Excavations at three Paleocoastal sites on Santa Rosa and San Miguel islands document the technologies of these early peoples and show that they were transporting the remains of shellfish, aquatic birds, marine mammals, and finfishes several kilometers into the interior (Erlandson *et al.* 2011). Such knowledge about these early North American coastal peoples would not have been gained had we not first located these sites through our targeted surveys. Our work builds on previous research by demonstrating a high density (over two sites per sq km) of Paleocoastal sites on the elevated marine terraces of Santa Rosa Island. The radiocarbon dates from CA-SRI-706, CA-SRI-708, CA-SRI-723, and CA-SRI-725 now bring the total number of securely dated sites on the Channel Islands older than 11,000 CAL B.P. to 11, with several other lithic scatters likely also dating to the same interval. This surprising abundance of Terminal Pleistocene sites is more than would have been thought possible just a decade ago (Erlandson *et al.* 2008b).

The four new Santa Rosa Island sites that were radiocarbon dated to >11,000 CAL B.P. further confirm the Terminal Pleistocene age of chipped stone crescents, CIA points, and CIB points on the northern Channel Islands. They also support the idea that undated lithic scatters we have identified on Santa Rosa and San Miguel islands that contain these same artifact types likely date to the Terminal Pleistocene or earliest Holocene. The three dated sites (CA-SRI-706, CA-SRI-723, and CA-SRI-725) on the southwestern end of Santa Rosa Island all produced large red abalone shells, which were also a primary constituent of Terminal Pleistocene shell middens on eastern San Miguel Island (Erlandson *et al.* 2011), demonstrating that red abalones were an important early food source and were being transported to the island interior. CA-SRI-708 produced *Chione undatella* and other shells obtained from an estuary, providing the oldest evidence for human exploitation of estuarine resources in Alta California at ca. 11,100 CAL B.P.

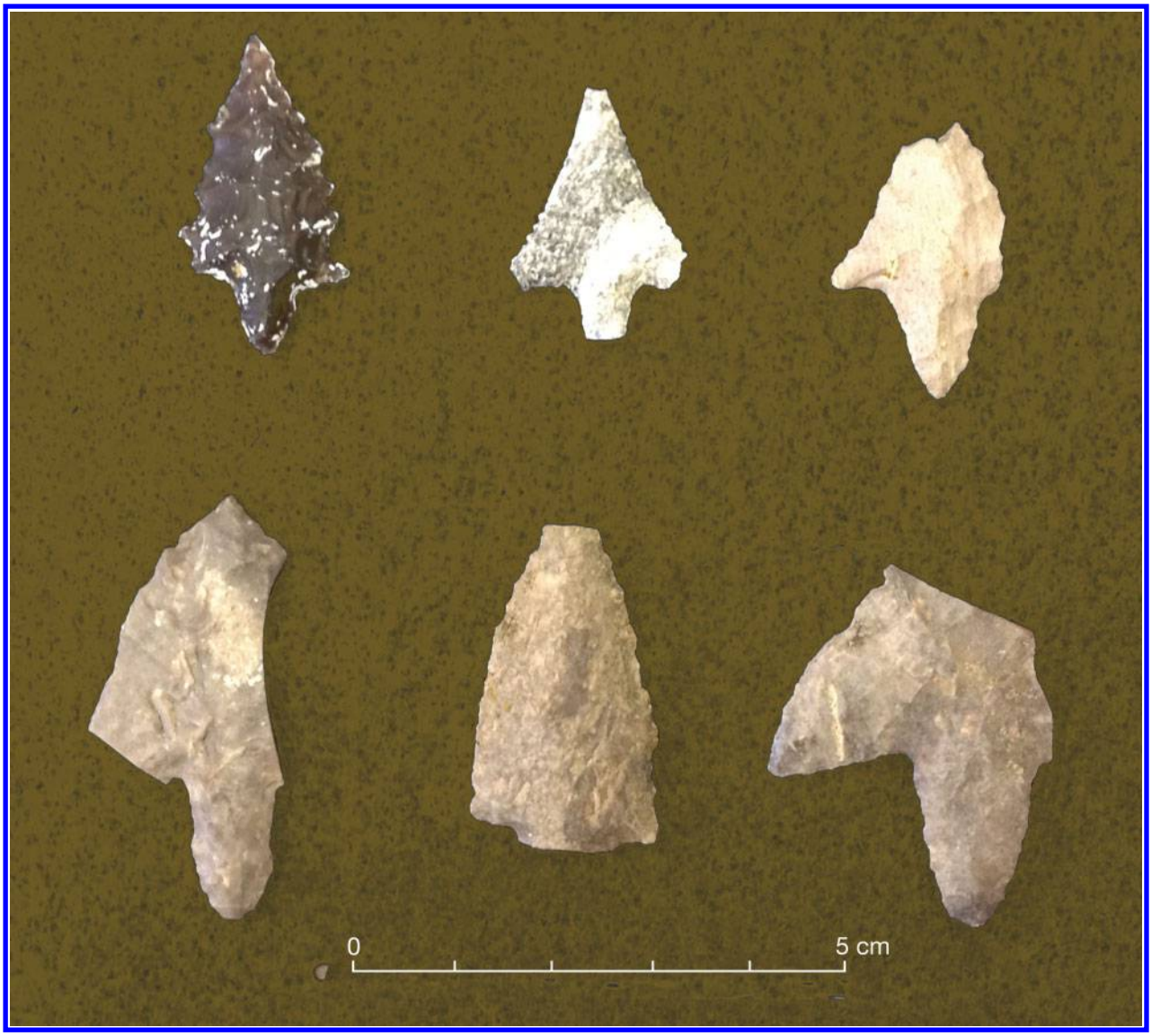

Figure 5 CIB points identified during survey: Top row (left to right): CA-SRI-723 #2, CA-SRI-725 #5, and CA-SRI-717 #12. Bottom row: CA-SRI-707 #7, CA-SRI-714 #2, and CA-SRI-707 #6.

Beyond the Channel Islands, Terminal Pleistocene sites occupied by coastal peoples have been identified on the interior of Isla Cedros in Baja California (Des Lauriers 2006) and in areas of Peru adjacent to *lomas* (small hills) (deFrance *et al.* 2001; Sandweiss *et al.* 1998), suggesting that targeted surveys similar to our Channel Islands work can enhance knowledge of the adaptive diversity of early coastal and island peoples around the world. Given that Monte Verde in Chile dates to ca. 14,000 CAL B.P. (Dillehay *et al.* 2008; Erlandson *et al.* 2008a), similar targeted survey projects may also identify even older sites in coastal North America that have thus far eluded discovery.

Sea level rise has inundated thousands of archaeological sites around the world, posing significant problems for understanding the colonization and early prehistory of coastal regions. As global warming accelerates sea level rise over the next few decades, archaeological survey for coastal sites is crucial to document these important and endangered

Table 2 Radiocarbon dates from recently recorded Paleocoastal sites on Santa Rosa Island.*

Site	Provenience	Material	Sample #	^{14}C Age B.P.	CAL B.P., 1σ
CA-SRI-706	Feature 1, in situ	*H. rufescens*	OS-67611	10,600±65	11,560–11,210
CA-SRI-708	Basal soil, 0–5 cm	*Chione undatella*	D-AMS-1097	10,400±47	11,190–11,120
CA-SRI-723	SW area, basal soil	*H. rufescens*	D-AMS-1093	10,940±47	12,170–11,930
CA-SRI-725	Upper midden	*H. rufescens*	D-AMS-1089	10,585±50	11,360–11,220

*OS = NOSAMS lab, Woods Hole Oceanographic Institute. D-AMS = DirectAMS lab. All dates calibrated in Calib 6.0 (Stuiver and Reimer 1993; Reimer *et al.* 2009) with a standard reservoir correction of 261±21 years for all marine shells (obtained from Jazwa *et al.* 2012), and calibrated age ranges rounded to the nearest decade.

cultural resources (Erlandson 2008). Although underwater archaeology focused on submerged terrestrial sites in the Americas has been limited, the discovery of a stone tool and other materials off British Columbia's Haida Gwaii (Fedje and Christensen 1999), identification of submerged Paleoindian sites along paleostream channels in Florida (Faught 2002), and a possible Paleoindian fluted point found in the Sea of Cortez off Baja California (Faught and Gusick 2011; Gusick and Davis 2010) demonstrate the promise of underwater research for finding Paleocoastal sites offshore. Our research demonstrates that terrestrial surveys guided by reconstructions of local resource availability, paleogeography, and other variables are another important tool for locating early coastal sites around the world and for understanding the early prehistory of the Americas.

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