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Exploring Baja California's Submerged Landscapes

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Recent research utilizing paleolandscape reconstruction and targeted underwater survey has led to the discovery of prehistoric cultural material on the submerged landscape off of Espíritu Santo Island, Baja California Sur. Our ability to identify preserved inundated cultural remains suggests that Baja California's unique geography and environment may be favorable for identifying evidence of late Pleistocene coastal occupations. Indeed, survey data identifying unique geomorphological and environmental characteristics clarifies the various factors that made this region attractive to early hunter-gatherer populations, and also explains why Baja California may be integral in the search for some of the earliest coastal inhabitants of the New World.

Baja California Sur has historically been depicted as a region uncomplicated in its cultural landscape, due—in part—to its geographic isolation and the marginality of its resources (Laylander 2000:96–100). However, we argue that the cultural development in this region, and our ability to study that development, has not suffered, but instead has been positively shaped by the region's unique geography and environment. Indeed, the cultural landscape within Baja California may be one of the most ancient in the New World, dating to the first wave of migrants into the Americas. The rich marine resources and the temperate, predictable environment would have been attractive to the small populations present during the late Pleistocene, when the initial occupation of the Americas is considered to have occurred. Although some evidence of this early habitation may have been inundated during the post-glacial sea level rise, Baja California's arid environment and position between the open Pacific Ocean and the protected Gulf of California presents unparalleled potential for the preservation of inundated archaeological deposits. It is because of this unique geography and environment that we are afforded the opportunity to explore Baja California's submerged landscape and not only carry out research into the cultural development of some of the New World's earliest inhabitants, but also help clarify a major issue within archaeology—the timing and manner of the peopling of the New World.

NEW WORLD COASTAL MIGRATION

The first discovery of a fluted point associated with extinct megafauna (Cook 1925) began a "predilection to envision the first inhabitants of the Americas as stout-hearted, daring, and voracious big game hunters" (Easton 1992:31) who dutifully followed their prey from Beringia, through an ice-free corridor, into middle latitude North America at the end of the Pleistocene. However, if one accepts the fact that humans were at Monte Verde before Clovis hunters appeared in North America (Dillehay 1997; Erlandson et al. 2008; Meltzer et al. 1997), then questions arise as to whether the initial human migration actually passed through an ice-free corridor or occurred along other travel routes. Arguments based on geological evidence cast doubt on the existence of an ice-free corridor prior to 12,000 B.P. (Mandryk and Rutter 1996; Mandryk et al. 2001), placing temporal limits on the viability of an interior route of entry. Moreover, given the position of an accepted pre-Clovis occupation in coastal Chile and an apparent absence of equivalent sites that bear the qualities of Monte Verde's MV-II cultural component throughout the interior regions of North, Central, and South America, it is reasonable to hypothesize that the New World may have been settled by way of a Pacific coastal route of entry (Dixon 2001; Easton 1992; Fladmark 1979; Gruhn 1998; Mandryk et al. 2001).

The coastal entry hypothesis maintains that humans moved into the New World during the late Pleistocene along the northern and eastern edges of the Pacific Ocean, probably through a combination of boat and pedestrian travel. Early coastal travelers would have been sustained by exploiting maritime resources and a chain of habitable biotic terrestrial refugia along the proglacial portions of the Pacific coast. Various regions of this coastal section of North America would have been deglaciated during the end of the Last Glacial Maximum, making entry prior to 13,000 B.P. possible (Charbit et al. 2002; Peltier 1994). However, due to the eustatic sea level rise that occurred throughout the early Holocene, much of the original Pleistocene Pacific coastal landscape has been inundated as deeply as 95 m. (Peltier 2002). This inundation obviously complicates the process of identifying evidence of a Pleistocene coastal migration. More recently, however, technological advances in undersea exploration and a growing interest in identifying inundated Pleistocene landforms have renewed enthusiasm in First Americans research.

Even with this revival of interest, there has been a lack of progress towards the evaluation of a coastal migration hypothesis. This can be mainly attributed to the fact that comparatively little directed exploration has yet occurred along the great expanse of the habitable New World Pacific coastline, and extremely little of the now-submerged ancient landscape has been studied. This paucity of research into submerged terrains may partly be attributed to the difficulty of identifying a section of landscape along the vast Pacific coastline that is likely to present evidence of preserved cultural remains. The constant waves and the currents they generate along the Pacific Coast erode away land surfaces, creating sea cliffs and cut terraces (Inman 1983), and possibly destroying evidence of late Pleistocene occupation. This wave and tidal action can also encourage extreme sedimentation rates that can deeply bury archaeological materials, making it difficult if not impossible to identify submerged sites (Punke and Davis 2003). Moreover, the shoreline of the eastern Pacific is a collision coast characterized by narrow continental shelves, deep basins and ocean trenches, and irregular sea cliffs and mountain ranges (Inman 1983:4; Inman and Nordstrom 1971; Perlman 1980). Though this geomorphology can provide protected habitats that support great biological productivity, it makes underwater archaeological investigations within these areas difficult.

With various structural and environmental impediments to submerged site preservation on the Pacific Coast, it is important to consider that evidence of early habitation is likely to be found only in regions with characteristics that favor preservation. Along the Pacific Coast, these areas are not as abundant as they are on the continental margins of the Gulf of Mexico, where dedicated underwater research has resulted in the identification of numerous prehistoric sites on this region's expansive submerged continental shelf (Clausen et al. 1979; Dunbar et al. 1988; Faught 2002, 2004; Webb 2006). There are, however, Pacific Coast locales that do present favorable conditions for underwater prehistoric archaeological investigations. Researchers working in Hecate Strait off of British Columbia have identified numerous submerged Pleistocene landforms and have recovered a stone tool lying 55 m. below current sea level (Fedje and Josenhans 1999; Josenhans et al. 1995). Their ability to recover submerged cultural materials is due, in part, to the region which they chose to investigate, as it exhibits a morphology that is not only biologically productive and attractive for habitation, but also shows physical constraints that allow for preservation and accessibility (Fedje and Christensen 1999:650).

Recently, we have been able to identify another Pacific coastal region that exhibits similar morphological characteristics to the British Columbia locale and similar oceanographic conditions to the Gulf of Mexico: the submerged landscape off Espíritu Santo Island in the Cape Region of Baja California Sur. This area has numerous characteristics that make it ideal for submerged site exploration. The terrestrial archaeology on the subaerial portion of the landscape has already yielded sites dating to the late Pleistocene (Fujita 2002), the paleolandscape morphology presents numerous areas that would have facilitated site preservation, and the oceanographic conditions are mild in comparison with the coastlines exposed to the open Pacific Ocean. In fact, a preliminary investigation of this submerged terrain has already yielded preserved evidence of cultural activity (Gusick and Davis 2009).

PARADIGMS OF ISOLATION AND MARGINALITY

Our study in the Cape Region of Baja California is one more contribution to the growing body of knowledge about this once "forgotten peninsula" (Krutch 1961). Indeed, there has been a renewed research focus on understanding the complexity of the Baja California peninsula (see Blackburn and Anderson 1993; Hyland 1997; Laylander and Moore 2006; Lighfoot and Parrish 2009). How has the geography of this region affected cultural development? How isolated were the populations that inhabited the peninsula? How marginal was their existence? While our research does not speak directly to the issue of the extent of their isolation or the effect this isolation may have had on the development of human behavioral adaptations in the region, it does present Baja California as being essential to our insight into significant anthropological issues, specifically early hunter-gatherer mobility and economy and a Pleistocene human coastal migration into the New World.

The geography that may have encouraged cultural isolation in the Cape Region of Baja California Sur has also encouraged the preservation of late Pleistocene cultural remains. Terrestrial archaeological deposits benefit from the peninsula's arid environment, and archaeological deposits submerged in the Gulf of California benefit from the region's halcyon oceanographic conditions. Indeed, Baja California has already yielded evidence of late Pleistocene occupation (Dillehay 2003; Fujita 2002; Gonzáles-José et al. 2003); in light of the fact that the indigenous cultures in northern Baja California continue to thrive today (Lightfoot and Parrish 2009), the prehistory of this peninsula must be considered one of the most protracted and ancient in the New World.

While this extended occupation can provide myriad data for understanding long-term human adaptations to coastal and arid environments, our research focuses on the earliest component of this occupation. Baja California has a unique potential to yield preserved inundated cultural materials that may date to a time period relevant to a Pleistocene migration into the New World.

Geographic, Geological, and Environmental Characteristics

Espíritu Santo Island is located in the Gulf of California approximately 30 km. northeast of the city of La Paz (Fig. 1). Due to the effects of the regional transform fault system, which is slowly transporting the Baja California peninsula away from mainland Mexico, the island, like the peninsula, dips to the west. This structural context has resulted in a series of elongated rocky points that form divides between shallow bays with gently sloping nearshore bathymetry on the western side of the island. This bathymetry promotes the preservation of inundated archaeological deposits in nearshore contexts, as site disturbance caused by the hurricanes in this region of North America is mitigated by the rapid sedimentation that can occur on a glacis during sea level rise.

Though there are several local fault systems in the peninsula, estimates on the amount of uplift that occurs in Baja California vary by region. South of Santa Rosalía, where Espíritu Santo Island is located, the uplift rate is considered to be low, approximately 3 cm. per thousand years (Ortlieb 1979). Additionally, the consistent presence of marine terraces along the peninsula's margin indicates that "neotectonic movement has been homogenized during the late Quaternary" (Davis 2006; Ortlieb 1979). Due to the minimal amount of uplift that has occurred within the last 15,000 years, general regional sea level curves can be employed to model the depth of relic shorelines.

Much like the Gulf of Mexico and the inside areas of the British Columbia archipelago, wave action in the Gulf of California is significantly reduced compared to the Pacific because of its protected position on the leeward side of the Baja California peninsula. These conditions promote reduced erosion of the island's submerged shelf and the preservation of any archaeological sites it may hold. There is, however, significant tidal energy in the Gulf of California because of its co-oscillation with the Pacific and the resonance of the semidiurnal component (Bray and Robles 1991:511). Wave action associated with rising and falling tides has the potential to disturb sites that are not covered by sediment.

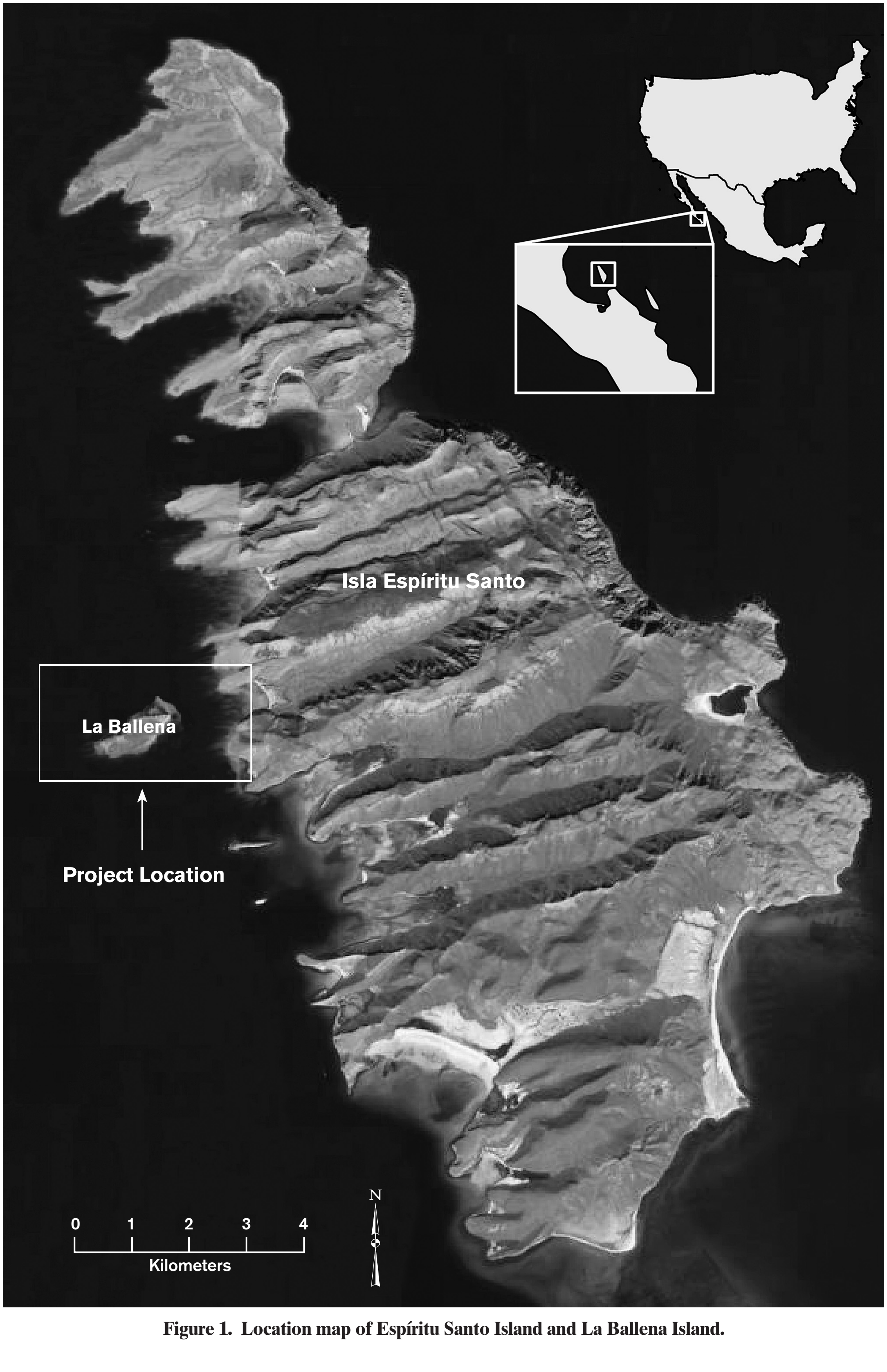

Figure 1. Location map of Espíritu Santo Island and La Ballena Island.

Because of the high rate of water evaporation typical of the Gulf of California, the waters off of Espíritu Santo Island can be characterized as a high salinity, warm water mass. The increased density of the high salinity water results in thermohaline circulation that constantly imports cold, nutrient rich water into the gulf and exports the warm, salty water. This not only provides ample nutrients for the extremely biologically productive waters of the Gulf of California (Bray and Robles 1991:517), but also allows for a clear, warm-water environment. Such conditions promote high underwater visibility, which can afford SCUBA divers or underwater cameras a wider visible range, promoting greater survey coverage in a shorter period of time.

The unique geology of Espíritu Santo Island is another factor favoring the preservation of inundated cultural materials. The island is composed of Cretaceous plutonic rocks with a thick sequence of Miocene volcanic and volcanoclastic rock (Carreño and Helenes 2002:28). This geology has produced myriad rockshelters on the island. In a submerged context, rockshelters or large rock outcroppings may hold evidence of early habitation if they promoted the accumulation and preservation of stratified archaeological materials when present in a terrestrial environment. Archaeological occupations extending back to the late Pleistocene and early Holocene are known from rockshelters eroded into the softer volcanoclastic rock (Fujita 2002; Fujita and Poyatos de Paz 1998). Moreover, coastal caves and rockshelters have consistently produced early and often long archaeological sequences, attesting to their universal attractiveness to prehistoric coastal peoples (Dixon et al. 1997; Erlandson 1993; Erlandson et al. 1996; Fedje et al. 2004; Fujita and Poyatos de Paz 1998; Gruhn and Bryan 2009).

Environmentally, the coast of Baja California in general is rich in marine resources—an important consideration for groups migrating along a coastal route. Indeed, archaeological materials from numerous New World sites provide direct evidence that humans successfully exploited a wide range of coastal resources during the late Pleistocene. Daisy Cave and Covacha Babisuri in North America (Erlandson et al. 1996; Fujita 2008, respectively), Quebrada Jaguay and Quebrada Tachahuay in Peru (Sandweiss et al. 1998; Keefer et al. 1998, respectively), and Quereo and Monte Verde in Chile (Núñez et al. 1994; Dillehay 1997, respectively) all present evidence of marine resource exploitation by Paleocoastal peoples. The marine environment surrounding Espíritu Santo Island is similar in biodiversity and abundance of resources to those of the paleocoastal sites mentioned above.

Though marine productivity in Baja California was "drastically lower during past cool stadials and the Last Glacial Maximum than it was during the Holocene and past warm episodes" (Ortiz et al. 2004:523), we do not expect that the littoral and nearshore environments of Espíritu Santo Island were so degraded under late Pleistocene oceanographic conditions that they could not support paleocoastal peoples. Conversely, we do not expect that these early coastal environments could have supported densely populated human settlements. Instead, early population densities probably approximated values between 0.01–0.1 persons per square kilometer, which is consistent with dispersed ethnographic hunter-gatherer peoples such as the !Kung or Aka (MacDonald 1999:Figure 3). It is likely that population densities remained low until after the early Holocene, after which time marine and terrestrial (especially vegetative) productivity increased throughout Baja California (Douglas et al. 2003; Herbert et al. 1996; Ortiz et al. 2004; Van Devender 1990).

Archaeological Record

Current data indicate that the Baja California peninsula has been occupied for at least the past 10,000 years, and possibly longer (Fujita 2006). Beginning in the late 1800s and early 1900s, the earliest archaeological investigations on the peninsula focused on the discovery of burial caves and rock art in the Cape Region (Diguet 1895, 1905; Rivet 1909; ten Kate 1979). The numerous human crania uncovered drew attention from researchers due to their unusual craniofacial morphology. That morphology, described as dolichocephalic or "long-headedness," is a common characteristic of crania discovered in North America that date to the Paleoindian period (Dillehay 2003; Gonzáles-José et al. 2003). Although the Baja California crania themselves do not date to this time period, the craniofacial morphology has been hypothesized to be the result of inheritance through descent from the initial Paleoindian populations that entered the New World (González-José et. al 2003).

Beginning in the 1950s, and then again in the 1990s and more recently, researchers have discovered fluted projectile points in Baja California (Aschmann 1952; Des Lauriers 2008; Hyland and Gutiérrez 1995). None have been found *in situ* with Pleistocene faunal remains and therefore they cannot be used as unequivocal evidence of a Paleoindian occupation; however, the presence of a flute extending to the basal end of the point is characteristic of points made by the Clovis culture, and it is a trait that is generally accepted as dating to the Paleoindian period. This same pattern of fluted point finds that are not in a datable context has been identified in both California and the Great Basin (see Beck and Jones 1997; Rondeau et al. 2007:Table 5.1). The dearth of additional Clovis-period material may be due, in part, to a lack of surveys conducted within Baja California (Hyland 2006).

During the 1990s, Harumi Fujita began an intensive investigation of the Cape Region of the Baja California peninsula that has resulted in the documentation of 450 archaeological sites of varying types and time periods. As part of this investigation, Fujita (Fujita and Poyatos de Paz 1998; and Fujita, this issue) began an intensive study of Espíritu Santo Island, and she has identified 127 archaeological sites there. Shells from two of these sites have been radiocarbon dated to the late Pleistocene: J69E (11,284 RCYBP) and Covacha Babisuri (10,970 RCYBP— uncorrected for marine reservoir effect) (Fujita 2002, and this issue). Her research has also demonstrated that rockshelters were an integral aspect of both habitation and ritual among the past human groups that utilized the island.

UNDERWATER PREHISTORIC ARCHAEOLOGY IN BAJA CALIFORNIA SUR

The above discussion demonstrates that Baja California has numerous characteristics that make it favorable for research into submerged landscapes relevant to a Pleistocene coastal migration. Methodological approaches for studying these landscapes are grounded in modeled reconstructions of late Pleistocene paleoenvironmental conditions and coastal paleolandscapes (Adovasio and Hemmings 2009; Davis et al. 2009; Faught 2002; Fedje and Christensen 1999; Josenhans et al. 1995, 1997). Indeed, mapping and reconstructing the locations of paleodrainage and paleolandscape features and seeking out preserved sediment beds are effective tools for predicting where to look for archaeological sites in local submerged settings. For our work in the Gulf of California, we combined environmental reconstructions with bathymetric surveys and coastal settlement patterns to create a paleolandscape model. This allowed us to delineate underwater survey areas with high archaeological potential and subsequently conduct a targeted underwater survey.

Model Development

Archaeological investigations of submerged terrains should begin with a focus on key aspects of local geomorphology as a means of narrowing the search area (Faught 1996:295). The reconstruction of underwater topography from bathymetric information reveals the configuration of past terrains and provides the basis for the addition of numerous environmental and archaeological data layers. Although bathymetric surveys have been conducted in the Gulf of California (Eakins et al. 2004; Klimley 1993:12), no high-resolution data were available for our study area off of Espíritu Santo Island. Through necessity, we began by collecting bathymetric readings coupled with GPS locational information for the bay and open waters between Espíritu Santo Island and La Ballena Island.

Integrating data from our bathymetric survey with sea level elevations through time, we utilized ArcGIS to build a digital elevation model (DEM) of the sea floor. By merging the elevation data from the terrestrial landscape and the DEM of the submerged landscape, we created a visual representation of the late Pleistocene coastal landscape at ca. 12,000 B.P. Using existing knowledge of relevant archaeological site distributions from surveys of the modern terrestrial landscape (Fujita and Poyatos de Paz 1998), we made predictions about the distribution of paleoenvironmental features that might have attracted early hunter-gatherers and might therefore have subsequently retained archaeological evidence of occupation. This enabled us to extend the site location model, derived from the terrestrial data, into currently submerged landscapes. We then targeted "high-potential" areas for investigation, including morphological characteristics such as river channels, bedrock depressions, and complex topography. These geological features were used to model economically important locales such as riparian environments, estuaries, rocky headlands, and rocky intertidal habitats (Fig. 2).

Targeted Survey Design

At 12,000 B.P., the landscape on the western coast of Espíritu Santo Island appeared as a large coastal plain extending out to La Ballena Island, with a rocky shoreline and a steep cliff to the north and a gradual slope to the south. Evidence of a paleoriver channel is apparent across the terrace, continuing along the north side of La Ballena Island to the ocean. Considerations for attractive locales for Pleistocene hunter-gatherers include the rocky slope for biological productivity, the possible presence of rockshelters for habitation, and the freshwater system with adjacent riparian environment for potable water and biological productivity.

Although the identification of both attractive landforms for protected habitation and environmental areas that might provide resources essential to human habitation is the first step in logical underwater survey selection, erosional processes and the physical constraints of underwater work are major factors that should be considered in the development of a survey design. For instance, shoreface erosion can have a destructive effect on Pleistocene open-air archaeological sites, but in low-energy environments such as the river terrace predicted in our paleoenvironmental model, sites that have been buried by sediment prior to marine transgression have a higher preservation rate. Rapid sea-level rise will produce rapid sediment buildup, lowering the effect of shoreface erosion and favoring site preservation (Stright 1986:350). Additionally, although a part of our modeled area covers submerged landscapes 30 – 95 m. underwater, the physical and logistical constraints of open-circuit diving prevented us from adequately investigating landscapes deeper than 30 m. below current sea level.

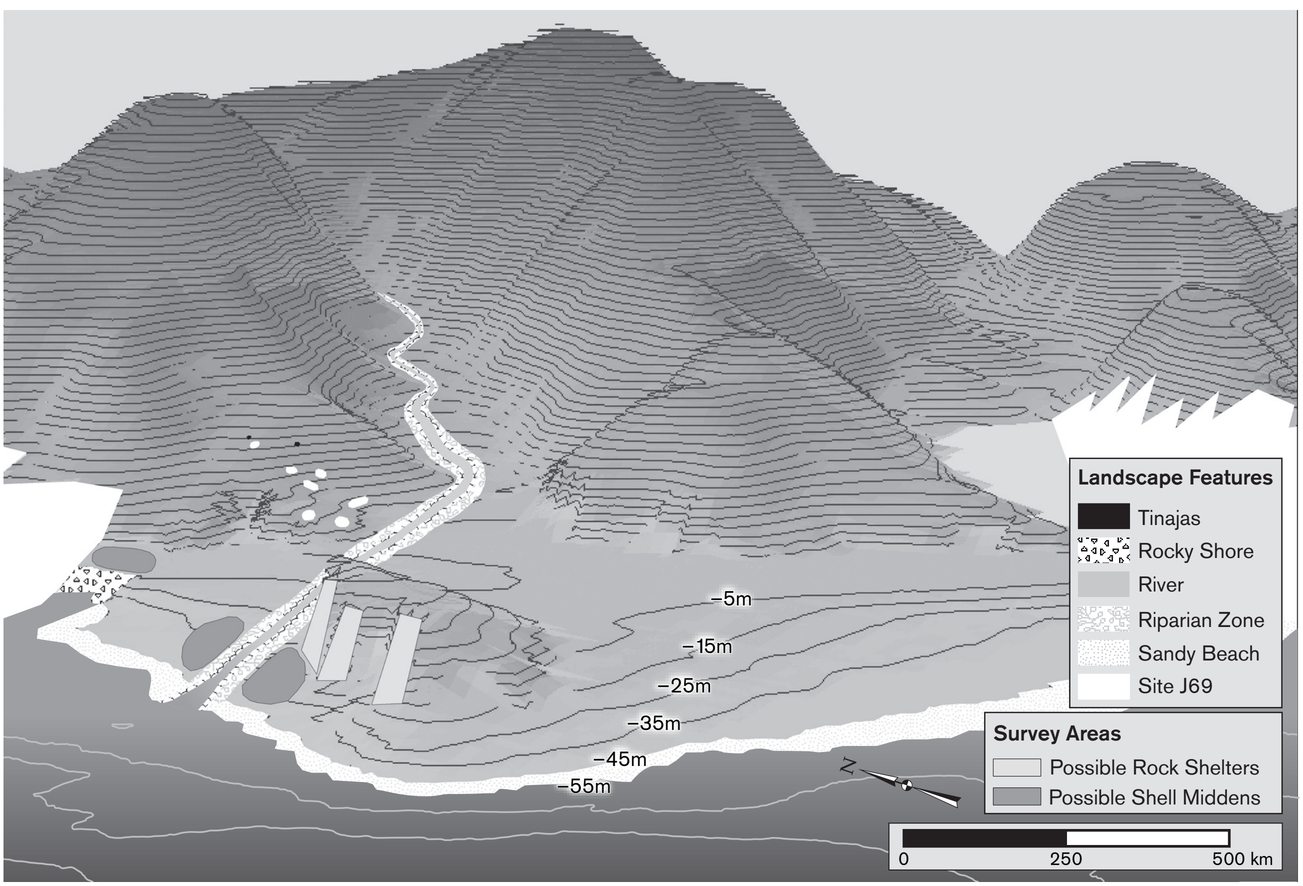

Figure 2. Paleolandscape model of Espíritu Santo Island showing the extent of sea level rise at 12,000 B.P. Model shows probable environmental features as well as the location of a known late Pleistocene site, J69E, on the subaerial portion of Espíritu Santo Island. Meter measurements are in negative and indicate depth below current sea level.

Underwater Investigation

Our project began with a reconnaissance phase that included SCUBA surveys to collect information from the "high-potential" areas outlined in the survey plan. Areas were critiqued for type of sediment, sediment cover, presence of rock outcrops or rockshelters, areas of positive or negative relief, and feasibility of extended bottom time to enable thorough search techniques. Information collected from each area was used to determine locales for extensive survey and testing.

By the completion of the reconnaissance phase, we had identified four rockshelters and numerous rock outcroppings located along the north side of La Ballena Island. Both of these types of features provide protected enclaves where archaeological deposits, and possibly petroglyph features, may be preserved. Therefore, underwater sampling efforts were focused on this northern side, with particular attention paid to rockshelter locales. To determine the amount of sedimentation and for the possible location of terrestrial sediment, we placed three test pits directly in front of a rockshelter at approximately 18 m. (TP1), 19 m. (TP2), and 20 m. (TP3) in depth, with the goal of discovering either bedrock or a terrestrial soil layer. Each unit was hand fanned to approximately 80 cm. in depth. At that point, the walls of the unit became too unstable, and without any shoring mechanism, the hand fanning became unproductive and was halted.

TP2 exposed a shell layer that appeared with less density in TP1 and TP3. To determine the extent of the deposit, we placed transects laterally from TP2 and hand fanned a small hole every 2 m. to identify the presence or absence of the shell layer. The boundary of the shell deposit extended 4 m. to either side of TP2. We then collected a sample of shells and lithic material from TP2. As a control, we also collected samples from 36 test pits within an area of Ballena Bay that has no known cultural shell middens.

In addition to the testing mentioned above, we surveyed and placed test pits in three of the four rockshelters identified during the reconnaissance phase. The fourth rockshelter had large lobsters present in the interior; therefore, no testing was conducted in this area. Although the settlement pattern data from Espíritu Santo Island suggests that rockshelters are ideal locales to survey for archaeological deposits, all lithic material inside of and directly outside of the submerged rockshelters was rounded due to tidal action. This, unfortunately, made identification of culturally flaked material impossible.

Results

Much of the lithic material recovered from TP2 was covered in a hard calcium carbonate coating that completely obscured the shape and definition of the material. Once this outer coating was dissolved, we were able to identify two manuports (possibly hammerstones) and 15 lithic flakes (Fig. 3). This material was not identified until the last day of the project, and as a result, we were unable to revisit the area for further testing and mapping. However, based on the discovery of apparent culturally modified lithics, our observations of the shell deposit, and the results of the shell assemblage analysis (Table 1), there is a high probability that the shell deposit is cultural in origin, as discussed below. The geographic location of the shell midden is downslope from a rockshelter and is in proximity to a modeled estuary on our paleolandscape model. Rockshelters are known for habitational use on Espíritu Santo Island, and estuary locales are ideal areas for resource extraction. The shell deposit itself has distinct boundaries, with *Ostrea palmula* shells laying disarticulated and flat in the 50–80 cm. depth interval of TP2. Moreover, *O. palmula* is known from excavations on Espíritu Santo Island to have been an economically important resource (Fujita 2002, 2006). Remains of other economically important shellfish, (*Chama frondosa*, *C. mexicana*, and *Argopeten circularis*) dominate the remainder of the shell assemblage. Lastly, the identified flakes and possible hammer stones show a range of technology that is consistent with lithic assemblages in nearby archaeological sites. One valve of an *O. palmula* and one valve of an *A. circularis* returned radiocarbon dates of 680 cal B.P. (Beta–248676) and 510 cal B.P. (Beta–248677).

DISCUSSION

Although our results are very promising, there are a few issues that require clarification and further research. First, the radiocarbon dates obtained from the shells were surprising, given their context. The landscape the deposit is located on would have been inundated approximately

Figure 3. Lithic flakes and possible hammerstones from TP2. One specimen was left with the calcium carbonate coating that was present on the majority of lithics from the test pit.

Table 1

BIVALVES

	Level 1	Level 2
Anadara multicostata	8	7
Arca pacifica	5	
Argopecten circularis	41	16
Barbatia reeveana	3	4
Chama frondosa	41	17
Chama mexicana	61	22
Chione californiensis	10	8
Chione undatella	73	30
Chione tumens	9	1
Glycymeris maculata		1
Glycymeris multicostata	16	8
Isognomon janus	2	1
Laevicardium elatum	7	1
Lyropecten subnodosus	6	
Megapitaria squalida	13	5
Modiolus capax	1	
Ostrea palmula	60	41
Ostrea fisheri	2	1
Pecten vogdesi	6	2
Pinctada mazatlanica		1
Periglypta multicostata	1	
Pseudochama sp.	11	1
Spondylus calcifer	2	
Spondylus princeps	1	3
Tivela sp.	2	2
Trachycardium panamense		1
Trigonocardia biangulata		
Lima tetrica	3	
Lima sp.	1	
Veneridae	63	32
Divalinga sp.	7	4
Macoma sp.	2	3
Cardita sp.	2	
Psammobiidae		4
No identification	9	3

CIRRIPEDIA

	Level 1	Level 2
Balanus sp.	9	6

GASTROPODS

	Level 1	Level 2
Collisella sp.	244	238
Conus sp.	9	7
Crepidula sp.	3	
Crucibulum sp.		6
Hexaplex erythrostomus		1
Natica chemnitzii	6	5
Oliva porphyria	2	2
Oliva sp.	6	
Olivella dama	5	7
Strombus granulatus	5	4
Terebra sp.	1	
Turritella sp.	1	
Oliva spicata	8	2
Patella sp.	4	
Fissurellidae	6	5
Columbella strombiformis	5	5
Columbella fuscata		1
Potamidae	2	
Muricidae	2	
Trochidae	1	1
Mitridae	1	3
	7	
Crucibulum spinosum	5	
Crucibulum sp.	13	
Anomias sp.	4	
Columellar	3	
Turbo fluctuosus (operculum)	1	
No identification	3	1

ECHINODERMATA

	Level 1	Level 2
Eucidaris thouarsii (spine)	70	60
Clypeaster sp.	2	1

SCLERACTINA (CORALS)

	Level 1	Level 2
Pocillopora sp.	1	

8,000 years ago. This obviously begs the question of how the cultural material was found in association with the shell deposit. While we do not have any unequivocal answer for this, we can provide some speculation. During our collection of the lithic and shell material, it was difficult to keep stratigraphic control, and our two arbitrary levels within the unit were large, approximately 30-40 cm. in depth. The shells collected for radiocarbon dating were selected in the lab, not in the field. Therefore, we had no way of determining the specific provenience of the shells within the levels. Additionally, though we know the lithic material came from the lower level, we again did not have a specific provenience for the material within that level. The lithic material could have been 40 cm. deeper in the unit than the shell selected for radiocarbon dating.

Another possibility is that the cultural material was redeposited from further up the slope. As mentioned earlier, there is significant tidal energy in the Gulf of California, and the rising and falling tides may have loosened the lithic material from its original location and redeposited it within a natural shell bed. Similarly, the cultural material could have been deposited on a rocky shore over 8,000 years ago, and a shell bed could have been generated on this same shore after that time. Unfortunately, we collected only a small sample from the site, and a much larger sample is needed for further clarification and analysis. Due to time constraints, we were unable to return to the site for the collection of additional material or for mapping. Both of these tasks are necessary for meaningful analysis and discussion of the locale and its larger context.

Though our overarching goal with this research is to identify submerged late Pleistocene landforms and cultural materials, the fact that we were able to recover inundated cultural materials in this region of Baja California is significant in itself. Indeed, little is known about the mobility and behavioral adaptations of late Pleistocene Pacific coastal hunter-gatherers, and Baja California is a region that may be integral in the search for knowledge about these early groups. Baja California is one of a small group of Pacific coastal locales with attributes favorable for underwater prehistoric archaeology. Its unique geological, geographic, and oceanographic conditions are ideal for both preserving inundated cultural materials and conducting efficient surveys to identify preserved inundated archaeological deposits. The convergence of these unique conditions pushes Baja California to the forefront of research into a Pleistocene Pacific coastal migration into the New World.

Additionally, our research has made a more practical contribution to the development of underwater archaeological methods. Systematic exploration to locate submerged prehistoric sites, though not a new endeavor, can certainly be considered a nascent discipline. This is particularly true with regard to submerged prehistoric archaeological materials in the New World. Over the past few decades, researchers have been developing effective methods for various types of underwater archaeological research, and our study has benefitted greatly from the efforts of our predecessors in the field. Over time, a set of core principles have developed that provide a solid foundation on which individuals can build their research design; however, because conditions for underwater work can vary greatly, researchers working in the field do need to be innovative and be able to develop methods that are appropriate for the given project conditions. Over the years, these types of adaptations have helped to advance the field of prehistoric underwater archaeology and have made it more accessible to a wider range of researchers.

With regard to our contribution to the methodological development of prehistoric underwater archaeology, we have shown that simplified and inexpensive bathymetric surveys and paleolandscape reconstructions can be effective research tools. Underwater archaeology is certainly time-consuming and can be very costly. These factors undoubtedly cause numerous individuals working in coastal areas to dismiss the submerged landscape as a viable research option. However, if a submerged locale has characteristics that link it to a terrestrial research area of interest, that submerged locale should be considered a logical extension for purposes of research. If funding and resources are available for the use of advanced sonar systems, these systems will provide an accurate high-resolution model of the sea floor; however, a more simplified sea floor model can be created if expenses are an issue.

We created a simplified paleolandscape model using commercially available equipment: a Garmin GPS unit, a fathometer ('fishfinder'), and a small fishing boat with navigational equipment. With the aid of these instruments, we meticulously collected x, y, and z coordinates, and we were able to manipulate these data in ArcGIS to create a DEM. This was used to develop a paleolandscape model accurate enough to predict the locations of rockshelters, a paleostream channel, and possible shell midden locales (Gusick and Davis 2007). The predicted locations of these features were tested during our survey and found to be accurate. The methods employed in the recovery of cultural materials were mostly successful, but also show areas where improvement is needed. Our methods for sampling and recovering the material were appropriate for the sediment and substrate conditions in the region; however, additional equipment is required to maintain stratigraphic control. This will enable more exact provenience information for both shell and lithic material. This type of trial and error in the field is an important contribution to the development of effective methodologies in recovering underwater prehistoric cultural materials in Baja California Sur, and in other submerged regions with similar sediments.

FUTURE RESEARCH

Our first phase of research focused on the shallower portions of the submerged landscape off of Espíritu Santo Island and on a physical SCUBA survey; however, evidence of a Pleistocene coastal migration is likely to be found in the deeper portions of the study area. The methodological framework for our next research phase will incorporate surveys using side-scan sonar, sub-bottom profiling, underwater camera imaging, physical dive surveys, and various subsurface testing techniques. The focus of all the survey and testing will be the 10,000 B.P., 13,000 B.P. and 18,000 B.P. shorelines, including the paleolandscape between these areas.

The sub-bottom and side-scan sonar surveys will identify high-potential targets, including areas of weathered and/or smoothed rock outcrops, paleoriver channels, bedrock depressions, relict beach features, terrestrial flora, and shell accumulations. Physical SCUBA divers can then collect samples from these targets. The three primary objectives of this phase of research will be to identify and document evidence of past human occupation on the submerged landscape, collect soil core samples to identify the sediment stratigraphy and conduct pollen analysis to recreate the paleoenvironment, and to collect flora or faunal materials for radiocarbon dating. The data will be used to understand the coastal processes and environmental changes that have occurred in this region of Baja California over the last 15,000 years, and determine how these changes affect site preservation and our ability to locate inundated cultural material. The data will also be used to develop a detailed map of the submerged paleolandscape of this region of Baja California Sur. Merging this detailed map with elevation data from Espíritu Santo Island will provide imagery of the landscape in this region over the past 15,000 years. This type of imagery can be an additional aid to understanding the geomorphological and environmental changes that have occurred since the Last Glacial Maximum and to understanding the effect of the sea level rise on the landscape.

CONCLUSIONS

The discovery of archaeological materials on submerged Pleistocene landscapes in this region of Baja California Sur will confirm that hunter-gatherer groups were present along the eastern Pacific shoreline at a time period relevant to an initial human migration into the New World. The lack of knowledge about the potential distribution of early sites on nearshore portions of the continental shelf is a significant obstacle for First Americans research today. Not only can the discovery of inundated early sites provide some of the most important information for evaluating the timing of a coastal migration, but a more comprehensive understanding of submerged sites may also clarify New World archaeological chronology in general.

Our project can also have an impact on the "epistemological orientation of archaeology to *terra firma*" (Easton 1992:35). The remotely-sensed data will allow us to develop a detailed map of an entire paleolandscape, showing both the currently submerged and subaerial portions as one continuous landscape. Presenting the data in this fashion may begin to convince researchers interested in ancient coastal cultures to consider investigating the submerged portions of their research areas. The process of discovering submerged sites should not be an esoteric enterprise within archaeology; instead, it should be a standard research method for many studies conducted in coastal areas. The consideration of entire paleolandscapes can be vital to understanding the migration patterns, resource procurement strategies, and settlement patterns of many coastal hunter-gatherer groups.

Lastly, this area of Baja California is uniquely situated not only for the investigation of broad questions concerning coastal migration, but also for questions related to the timing and nature of colonization within this peninsular region of Mexico. Outdated archaeological paradigms depict this area as being uncomplicated in its cultural landscape and home to human populations struggling to survive. However, recent research is interpreting the archaeological record of Baja California without prior assumptions about cultural passivity or ecological marginality. Indeed, populations within Baja California have deftly negotiated their environment and flourished in the peninsula for over 10,000 years. This longevity of occupation and adaptation can afford researchers new insights into such significant anthropological issues as migration, behavioral ecology, and long-term cultural development

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REFERENCES

Adovasio, J. M., and A. Hemmings
2009 Inner Continental Shelf Archaeology in the Northeast Gulf of Mexico. Paper presented at the annual meeting of the Society for American Archaeology, Atlanta, Georgia.

Aschmann, H.
1952 A Fluted Point from Central Baja California. *American Antiquity* 17:262–263.

Beck, C., and G. T. Jones
1997 The Terminal Pleistocene/Early Holocene Archaeology of the Great Basin. *Journal of World Prehistory* 11:161–236.

Blackburn, T. C., and K. Anderson
1993 *Before the Wilderness: Environmental Management by Native Californians*. Menlo Park: Ballena Press.

Bray, N. A., and J. M. Robles
1991 Physical Oceanography of the Gulf of California. In *The Gulf and Peninsular Province of California*, P. J. Dauphin and B. R. T. Simoneit, eds., pp. 511–553. Tulsa: The American Association of Petroleum Geologists.

Charbit, S., C. Ritz, and G. Ramstein
2002 Simulations of Northern Hemisphere Ice-Sheet Retreat: Sensitivity to Physical Mechanisms Involved During the Last Deglaciation. *Quaternary Science Reviews* 21(1–3):243–265.

Carreno, A. L., and J. Helenes
2002 Geology and Ages of the Islands. In *A New Island Biogeography of the Sea of Cortez*, T. J. Case, M. L. Cody, and E. Ezcurra, eds., pp. 14–40. Oxford: Oxford University Press.

Clausen, C. J., A. D. Cohen, C. Emiliani, J. A. Holman, and J. J. Stipp
1979 Little Salt Spring, Florida: A Unique Underwater Site. *Science* 203: 609–614.

Cook, H. J.
1925 Definite Evidence of Human Artifacts in the American Pleistocene. *Science* 62:459–460.

Davis, L. G.
2006 Baja California's Paleoenvironmental Context. In *The Prehistory of Baja California: Advances in the Archaeology of the Forgotten Peninsula*, D. Laylander and J. D. Morre, eds., pp. 14–23. University of Florida Press, Gainesville.

Davis, L. G., S. A. Jenevein, M. Punke, J. S. Noller, J. A. Jones, and S. C. Willis
2009 Geoarchaeological Themes in a Dynamic Coastal Environment, Lincoln and Lane Counties, Oregon. *The Geological Society of America Field Guide* 15:331–348.

Des Lauriers, M. R.
2008 A Paleoindian Fluted Point from Isla Cedros, Baja California. *The Journal of Island and Coastal Archaeology* 3(2):271–276.

Diguet, L.
1895 Notes sur la pictographie de la Basse-Californie. *L'Anthropologie* 6:160–175.
1905 Anciennes sépultures indigènes de la Basse-Californie méridionale. *Journal de la Société des Américanistes* 2:329–333.

Dillehay, T. D.
1997 *Monte Verde, a Late Pleistocene Settlement in Chile: Vol. 2, The Archaeological Context and Interpretation*. Washington, D.C: Smithsonian Institution Press.
2003 Tracking the First Americans. *Nature* 425:23–24.

Dixon, E. J.
2001 Human Colonization of the Americas: Timing, Technology and Process. *Quaternary Science Reviews* 20:277–299.

Dixon, E. J., T. H. Heaton, T. E. Fifield, T. D. Hamilton, D. E. Putnam, and F. Grady
1997 Late Quaternary Regional Geoarchaeology of Southeast Alaska Karst: A Progress Report. *Geoarchaeology* 12:689–712.

Douglas, R., O. Gonzalez-Yajimovich, D. Gorsline, F. Staines-Urias, and J. F. Arreloa-Hernandez
2003 Holocene Ocean-Climatic Variations in the Gulf of California, Mexico. *PAGES* 11(2–3):26–28.

Dunbar, J. S., M. K. Faught, and S. D. Webb
1988 Page/Ladson (8Je591): An Underwater Paleo-Indian Site in Northwestern Florida. *The Florida Anthropologist* 41:442–452.

Eakins, B. W., P. F. Lonsdale, J. M. Fletcher, and J. V. Ledesma
2004 Geomorphology of the Southern Gulf of California Seafloor. Paper presented at the Fall meeting for the American Geophysical Union, San Francisco, California.

Easton, N. A.
1992 Mal De Mer Above Terra Incognita, or, "What Ails the Coastal Migration Theory?" *Arctic Anthropology* 29(2):14.

Erlandson, J. M.
1993 Evidence for a Pleistocene Human Occupation of Daisy Cave, San Miguel Island. *Current Research in the Pleistocene* 10:17–21.

Erlandson, J. M., D. J. Kennett, B. L. Ingram, D. A. Guthrie, D. P. Morris, M. A. Tveskov, G. J. West, and P. L. Walker
1996 An Archaeological and Paleontological Chronology for Daisy Cave (CA-SMI-261), San Miguel Island, California. *Radiocarbon* 38:355–373.

Erlandson, J. M., M. L. Moss, and M. Des Lauriers
2008 Life on the Edge: Early Maritime Cultures of the Pacific Coast of North America. *Quaternary Science Reviews* 27:2232–2245.

Faught, M. K.
1996 *Clovis Origins and Underwater Prehistoric Archaeology in Northwestern Florida*. Tucson: University of Arizona.
2002 Submerged Paleoindian and Archaic Sites of the Big Bend, Florida. *Journal of Field Archaeology* 29:273–290.
2004 The Underwater Archaeology of Paleolandscapes, Apalachee Bay, Florida. *American Antiquity* 69:235–249.

Fedje, D., and H. Josenhans
1999 A Prehistoric Stone Tool Recovered from a Deeply Drowned Fluvial Fan in Hecate Strait, British Columbia, Canada. MS on file at Parks Canada, Capital Regional District, Victoria, B.C.

Fedje, D. W., and T. Christensen
1999 Modeling Paleoshorelines and Locating Early Holocene Coastal Sites in Haida Gwaii. *American Antiquity* 64:635–652.

Fedje, D. W., R. J. Wigen, D. McClaren, and Q. Mackie
2004 Pre-Holocene Archaeology and Environment from Karst Cases in Haida Gwaii, West Coast, Canada. Paper presented at the annual meeting for the Northwest Anthropological Association, Eugene, Oregon.

Fladmark, K. R.
1979 Routes: Alternative Migration Corridors for Early Man in North America. *American Antiquity* 44:55–69.

Fujita, H.
2002 Evidencia de una Larga Tradición Cultural en la Espíritu Santo Island, B.C.S. *In Memorias de Balances y Perspectivas de la Antropologia e Historia de Baja California*, Centro INAH Baja California, ed. La Paz: Baja California.

2006 The Cape Region. In *The Prehistory of Baja California: Advances in the Archaeology of the Forgotten Peninsula*, D. Laylander and J. D. Moore, eds., pp. 82–98. Gainesville: University Press of Florida.

2008 *Informe Preliminar de la Cuarta Temporada del Proyecto "El Poblamiento de América Visto Desde La Isla Espíritu Santo*, B.C.S." Document on file in the Technical Archives of INAH, México City.

Fujita, H., and G. Poyatos de Paz
1998 Settlement Patterns on Espiritu Santo Island, Baja California Sur. *Pacific Coast Archaeological Society Quarterly* 34(4):67–105.

Gonzalez-Jose, R., A. Gonzalez-Martin, M. Hernandez, H. M. Pucciarelli, M. Sardi, A. Rosales, and S. Van der Molen
2003 Craniometric Evidence for Palaeoamerican Survival in Baja California. *Nature* 425:62–65.

Gruhn, R.
1988 Linguistic Evidence in Support of the Coastal Route of Earliest Entry into the New World. *Man* 23(1):77–100.

Gruhn, R., and A. L. Bryan
2009 An Interim Report on Two Rockshelter Sites with Early Holocene Occupation in the Northern Baja California Peninsula. *Pacific Coast Archaeological Society Quarterly* 42(2-3):1–16.

Gusick, A. E., and L. G. Davis
2007 Mal de Mer no Mas: Searching for Early Underwater Sites in the Sea of Cortez. Paper presented at the annual meeting of the Society for American Archaeology, Austin, Texas.

2009 Mal de Mer no Mas: Discovery of an Underwater Site in the Sea of Cortez. Paper presented at the annual meeting of the Society for American Archaeology, Atlanta, Georgia.

Herbert, T. D., J. Schuffert, J. C. Herguera, K. Lange, and A. Weinheimer
1996 Two Timescales of Temperature-Phytoplankton Productivity Relations, California Margin. *EOS Transactions, American Geophysical Union* 77(46):286–287.

Hyland, J. R.
1997 *Image, Land, and Lineage: Hunter-Gatherer Archaeology in Central Baja California, Mexico*, Ph.D. dissertation, University of California, Berkeley.

2006 The Central Sierras. In *The Prehistory of Baja California: Advances in the Archaeology of the Forgotten Peninsula*, D. Laylander and J. D. Moore, eds., pp. 117–134. Gainesville: University Press of Florida.

Hyland, J. R., and M. L. Gutierrez
1995 An Obsidian Fluted Point from Central Baja California. *Journal of California and Great Basin Archaeology* 17:126–128.

Inman, D. C.
1983 Application of Coastal Dynamics to the Reconstruction of Paleocoastlines in the Vicinity of La Jolla, California. In *Quaternary Coastlines and Marine Archaeology: Towards the Prehistory of Land Bridges and Continental Shelves*, P. M. Masters and N. C. Flemming, eds., pp. 1–50. London: Academic Press.

Inman, D. L., and C. E. Norstrom
1971 On the Tectonic and Morphologic Classification of Coasts. *Journal of Geology* 79:1–21.

Josenhans, H. W., D. Fedje, R. Pienitz, and J. Southon
1997 Early Humans and Rapidly Changing Holocene Sea Levels in the Queen Charlotte Islands-Hecate Strait, British Columbia, Canada. *Science* 277(5322):71–74.

Josenhans, H. W., D. W. Fedje, K. W. Conway, and J. V. Barrie
1995 Post Glacial Sea Levels on the Western Canadian Continental Shelf: Evidence for Rapid Change, Extensive Subaerial Exposure, and Early Human Habitation. *Marine Geology* 125:73–94.

Keefer, D. K., S. D. deFrance, M. E. Moseley, J. B. I. Richardson, D. R. Satterlee, and A. Day-Lewis
1998 Early Maritime Economy and El Niño Events at Quebrada Tacahuay, Peru. *Science* 281(5384):1833–1835.

Klimley, A. P.
1993 Highly Directional Swimming by Scalloped Hammerhead Sharks, *Sphyrna lewini*, and Subsurface Irradiance, Temperature, Bathymetry, and Geomagnetic Field. *Marine Biology* 117:1–22.

Krutch, J. W.
1961 *The Forgotten Peninsula: A Naturalist in Baja California*. New York: W. Sloane Associates.

Laylander, D.
2000 *Early Ethnographies of the Californias: 1533–1825*. Salinas: Coyote Press.

Laylander, D., and J. D. Moore (eds.)
2006 *The Prehistory of Baja California: Advances in the Archaeology of the Forgotten Peninsula*. Gainesville: University Press of Florida.

Lightfoot, K. G., and O. Parrish
2009 *California Indians and Their Environment: An Introduction*. Berkeley: University of California Press.

MacDonald, D. H.
1999 Modeling Folsom Mobility, Mating Strategies, and Technological Organization in the Northern Plains. *Plains Anthropologist* 44(168):141–161.

Mandryk, C. A. S., H. Josenhans, D. W. Fedje, and R. W. Mathewes
2001 Late Quaternary Paleoenvironments of Northwestern North America: Implications for Inland Versus Coastal Migration Routes. *Quaternary Science Reviews* 20:301–314.

Mandryk, C. A. S., and N. W. Rutter (eds.)
1996 *The Ice-Free Corridor Revisited*. Oxford: Pergamon Press.

Meltzer, D. J., D. K. Grayson, G. Ardila, A. W. Barker, D. F. Dincauze, C. V. Haynes, F. Mena, L. Nunez, and D. J. Stanford
1997 On the Pleistocene Antiquity of Monte Verde, Southern Chile. *American Antiquity* 62:659–663.

Núñez, L., J. Varla, R. Casamiquela, and C. Villagrán
1994 Reconstrucción multidisciplinaria de la ocupación prehistórica de Quero, Centro de Chile. *Latin American Antiquity* 5:99–118.

Ortlieb, L.
1979 Quaternary Shorelines around Baja California Peninsula. *Geological Society of America Abstracts with Program* 11(7):490.

Ortiz, J.D., S. B. O'Connell, J. DelViscio, W. Dean, J. D. Carriquiry, T. Marchitto, Y. Zheng, and A. van Geen
2004 Enhanced Marine Productivity off Western North America During Warm Climate Intervals of the Past 52 K.Y. *Geology* 32(6):521–524.

Peltier, W. R.
1994 Ice Age Paleotopography. *Science* 265(5169):195–201.
2002 On Eustatic Sea Level History: Late Glacial Maximum to Holocene. *Quaternary Science Reviews* 21:377–396.

Perlman, S. M.
1980 An Optimum Diet Model, Coastal Variability, and Hunter-Gatherer Behavior. *Advances in Archaeological Method and Theory* 3:257–310.

Punke, M. L., and L. G. Davis
2003 Finding Late-Pleistocene Sites in Coastal River Valleys: Geoarchaeological Insights from the Southern Oregon Coast. *Current Research in the Pleistocene* 20:66–68.

Rivet, P.
1909 Recherches anthropologiques sur la Basse-California. *Journal de la Société des Américanistes de Paris* 6:147–253.

Rondeau, M. F., J. Cassidy, and T. L. Jones
2007 Colonization Technologies: Fluted Projectile Points and the San Clemente Island Woodworking/Microblade Complex. In *California Prehistory: Colonization, Culture, and Complexity*, T. L. Jones and K. A. Klar, eds., pp. 63–70. Lanham: AltaMira Press.

Sandweiss, D. H., H. McInnis, R. L. Burger, A. Cano, B. Ojeda, R. Paredes, M. C. Sandweiss, and M. D. Glascock
1998 Quebrada Jaguay: Early South American Maritime Adaptations. *Science* 281(5384):1830–1832.

Stright, M. J.
1986 Human Occupation of the Continental Shelf During the Late Pleistocene/Early Holocene: Methods for Site Location. *Geoarchaeology* 1:347–364.

ten Kate, H.
1979 Materiales Para Servir a la Antropologia de Baja California. *Calafia* 4(1):7–20.

Van Devender, T. R.
1990 Late Quaternary Vegetation and Climate of the Sonoran Desert, United States and Mexico. In *Packrat Middens: The Last 40,000 Years of Biotic Change*, J. L. Betancourt, T. R. Van Devender, and P. S. Martin, eds., pp. 134–165. Tucson: University of Arizona Press.

Webb, S. D.
2006 *First Floridians and Last Mastodons: The Page-Ladson Site in the Aucilla River*. Dordrecht: Springer.