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Deception Island

Archaeology of *'Anyapax*, Anacapa Island, California

Torben C. Rick and Leslie A. Reeder-Myers

Contributions by
Kenneth W. Gobalet, John M. Hash, Nicholas P. Jew,
Thomas A. Wake, and Christopher B. Wolff

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ABSTRACT
Rick, Torben C. and Leslie A. Reeder-Myers, with contributions from Kenneth W. Gobalet, John M. Hash, Nicholas P. Jew, Thomas A. Wake, and Christopher B. Wolff. Deception Island: Archaeology of *'Anyapax*, Anacapa Island, California. *Smithsonian Contributions to Anthropology*, number 52, viii + 87 pages, 38 figures, 24 tables, 1 appendix, 2018.—Archaeologists have long been interested in understanding the antiquity and evolution of human occupation of the world's islands, but relatively limited attention has been given to small islands. With evidence for human occupation at least 13,000 years ago, California's eight Channel Islands have a long record of coastal settlement and land use, but key questions remain about the smallest islands of Anacapa and Santa Barbara, each less than 3 km^2. This volume focuses on the archaeology of Anacapa Island by synthesizing data from excavation, survey, and radiocarbon dating on the island, particularly its eastern segment, during the past 15 years. Anacapa was occupied for at least 5,500 years through the Historic period and likely since the terminal Pleistocene or Early Holocene. People resided on the island during all seasons of the year, with several sites indicating occupation during the early part of the Late Holocene (~3,700 and 2,500 years ago). During this period on Anacapa, people were making bone fishhooks and expedient tools from locally obtained chert. Mammal, fish, and bird bones suggest intensive maritime harvest of a variety of animals, especially harbor seals, albatross, and California sheephead. Island fox bones document the only occurrence of this endemic species outside of the six largest islands. Numerous deer bones indicate trade/interaction with the mainland. Surprisingly, only a handful of gull bones were recovered despite the fact that scores of gulls breed on Anacapa today, suggesting shifts in the island's ecosystems during historical and modern times. People were also harvesting a variety of nearshore shellfish, especially California mussel, black abalone, and owl limpet. Although small in size and lacking abundant fresh water, the smallest Channel Islands have much to tell us about human prehistory and environmental change on the California coast and on other islands around the world.

Cover image: Anacapa Island, as viewed looking west from Inspiration Point. Santa Cruz Island is visible in the distance on the far right. Photo by Torben C. Rick.

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1

Introduction

Torben C. Rick

Considered by many who sail by her rugged shores to be little more than a string of three, dry, lifeless rocks, Anacapa Island is a surprisingly beautiful place on closer inspection. (Schoenherr et al., 1999:303–304).

Each year more than 200,000 people visit Channel Islands National Park, taking an exciting boat or plane ride from the mainland to another world right across the Pacific Ocean. Sometimes called California's Galápagos, the Channel Islands are home to a variety of unique plants and animals found nowhere else and others that are closely related to mainland counterparts but have distinct island adaptations. One of the characteristics that makes the islands so special today is that most of them, except Catalina Island, are largely devoid of people. On the five islands that make up Channel Islands National Park (San Miguel, Santa Rosa, Santa Cruz, Anacapa, and Santa Barbara), except for visitors and a few researchers and staff, there is very little human occupation or development and the islands feel very wild.

Despite the dearth of people today, the markings of human activities are everywhere on the islands. The legacy of ranching, which persisted from about the mid-1800s through the 2000s, is particularly evident. The National Park Service, Nature Conservancy, U.S. Navy, and others focus conservation efforts on reversing the cumulative effects of ranching, especially the introduction of domestic animals (cows, sheep, and horses), rats, nonnative grasses, and the widespread erosion and alteration they caused (McEachern et al., 2016; Braje et al., in press). The ranching period is an important piece of Channel Islands history, and the effects of this period are highly visible to the visitor. However, evidence of another human occupation lies right under most people's feet when they visit the islands: the legacy of the Native Americans who lived and thrived on the islands for some 13,000 years.

The Chumash and their predecessors occupied all of the four northern Channel Islands for at least 13,000 years, whereas the Gabrielino-Tongva lived on the southern Channel Islands (Johnson et al., 2002; Erlandson et al., 2011b). The Chumash, when first encountered by Europeans, lived in large villages with stratified social organization and complex exchange systems, all while maintaining a largely hunting and gathering lifestyle (Arnold, 1992; Kennett, 2005; Rick et al., 2005). They also left behind some of the best evidence for Late Pleistocene New World maritime adaptations and the Paleocoastal peopling of the Americas (see Erlandson et al., 2011b). Several large-scale projects during the past 10 to 20 years have explored the archaeological record of the northern Channel Islands from colonization to contact, including projects on Santa Cruz (Johnson, 1982; Arnold, 2001; Perry, 2003; Noah, 2005; Glassow et al., 2008; Thakar, 2014a; Gill, 2015; Gusick, 2012, 2013), Santa Rosa (Kennett, 1998; Rick, 2004, 2009; Jazwa, 2015), and

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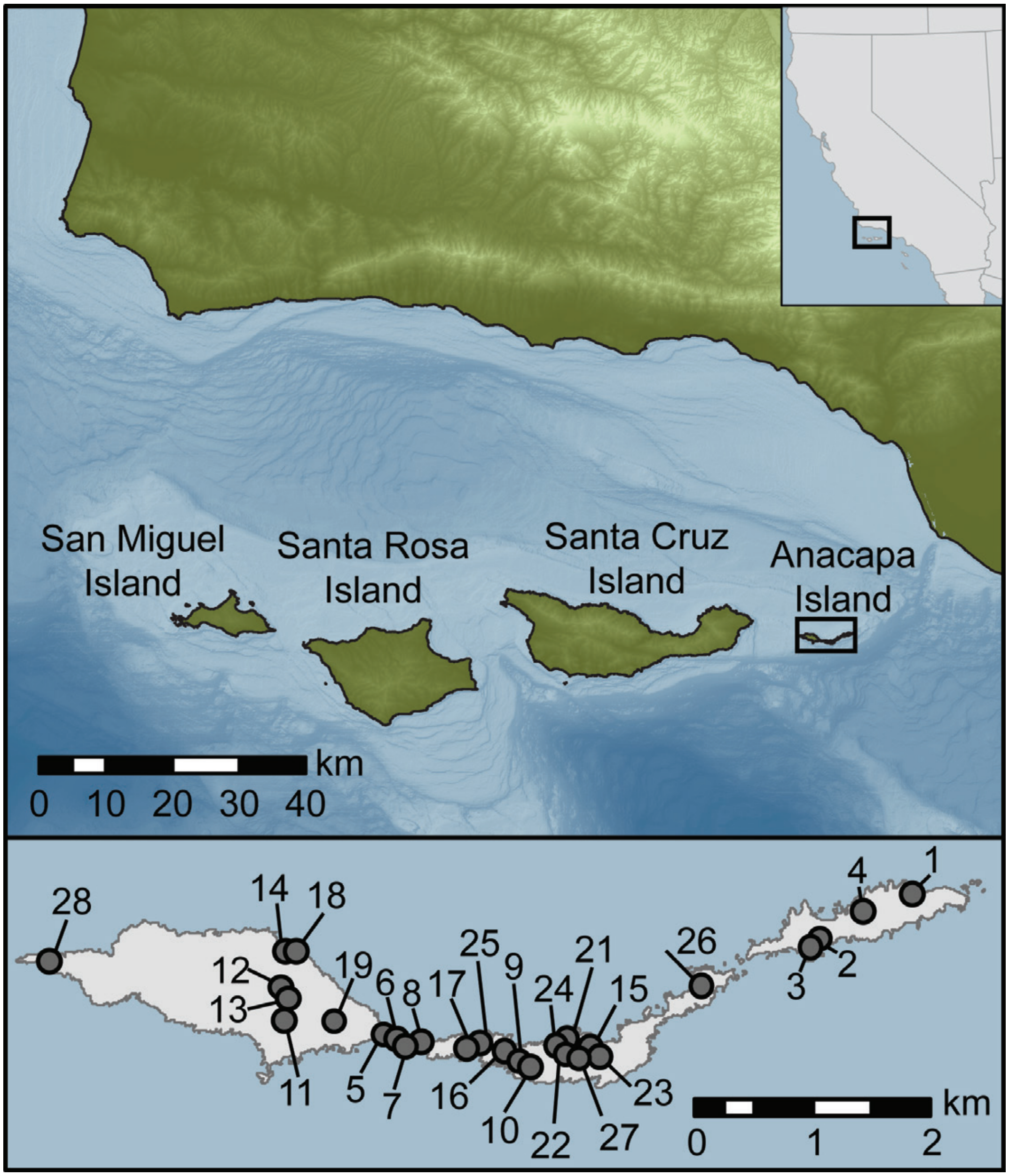

FIGURE 1. Top: Location of Anacapa Island and the Santa Barbara Channel region. Bottom: Anacapa Island, showing the general location of the 28 archaeological sites discussed in the text. Note that site J reported by Charles Rozaire was not relocated by Greenwood (1978:44-45), and so the number CA-ANI-20 was left unassigned.

San Miguel (Rick, 2007; Braje, 2010; Erlandson et al., 2011b). Other important projects have explored the archaeology of the southern Channel Islands (e.g., Vellanoweth et al., 2002a; Raab et al., 2009; Teeter et al., 2013) and Isla Cedros on Baja California's Pacific Coast (Des Lauriers, 2010), and have looked at relationships between the islands and the mainland (Altschul and Grenda, 2002). All of this work has resulted in an incredible database of Channel Islands archaeology and the deep history of the Chumash, Gabrielino-Tongva, and their predecessors, including archaeological sites that span the Holocene. A glaring omission is the archaeology of Anacapa Island.

At just 2.9 km^2 in area, Anacapa is the second smallest of the Channel Islands, but at roughly 20 km offshore, it is the closest to the mainland (Figure 1). It is divided into three smaller sections,

FIGURE 2. Anacapa Island, as seen looking west from Inspiration Point on East Anacapa. Note the steep terrain and small size of each islet, as well as Santa Cruz Island in the distance on the far right. Photo by Torben Rick, 2006.

East, Middle, and West Anacapa, which are separated by narrow channels except at the lowest tides (Schoenherr et al., 1999:304). Like on the slightly smaller Santa Barbara Island (2.6 km^2) in the southern group of islands, people have long argued that Anacapa was occupied primarily as a stopover or seasonal outpost (see McKusick, 1959; Rozaire, 1978; Rick, 2006, 2011). These perspectives were speculative, largely based on the apparent dearth of fresh water and, they assumed, a more limited set of resources compared with the larger islands. It is difficult to evaluate this assertion because there has been limited archaeological work on Anacapa Island during the past 30 years, and many earlier surveys and test excavations were not published (see Glassow, 1977, 2010; Greenwood, 1978; Rozaire, 1978, 1993).

This lack of research about Anacapa is typical of many small islands around the world. As Fitzpatrick et al. (2016:2) noted in the introduction to a special section of the *Journal of Island and Coastal Archaeology* focused on the archaeology of small islands, "Archaeologists who work on islands often assume that larger islands were preferential habitats for human occupation . . . or that smaller islands were more susceptible to human impacts and abandonment." Despite some perceived biases about small islands in the human past, we are in the middle of a renaissance for the archaeology of small islands. As described in the following, new research is enhancing our understanding of the role small islands played in the human past and broader human environmental interactions around the world.

This volume seeks to fill important gaps in California prehistory through an exploration of the archaeology of Anacapa Island (Figure 2). At its core are discussions of field and laboratory analyses at archaeological sites on East Anacapa, especially CA-ANI-2, CA-ANI-3, and CA-ANI-4. These sites offer a vehicle for exploring a series of important research questions about the nature of Anacapa Island's human occupation in the past as well as the ecology of Anacapa Island today. We also present the results of radiocarbon dating at 16 sites scattered around the three islets, which represents 57% of all recorded sites on Anacapa Island. We summarize past work by McKusick (1959), Greenwood (1978), and Rozaire (1978) to put the work at our three sites in broader context. The result is this volume: the first published synthesis of Anacapa Island's archaeology.

This book and our study of Anacapa more generally are guided by five primary research questions that echo throughout the volume:

1. When was Anacapa first settled by Native Americans, and how did human occupation vary through time and across space?
2. Was human occupation of Anacapa permanent, intermittent, or a combination?
3. How did Anacapa Island marine and terrestrial ecosystems change through time?
4. What role did Anacapa play in larger cultural developments, lifeways, and interaction spheres on the Channel Islands and Southern California?
5. Finally, what can data from Anacapa Island tell us about small islands around the world more generally?

Although these questions and the answers to them provided by our research will be of most interest to California archaeologists, we aim to place our work in the broader context of island and coastal archaeology, specifically emerging global research on small islands (e.g., Keegan et al., 2008; Fitzpatrick et al., 2016). To that end and to set the stage for our work, this chapter provides a brief review of recent developments in the archaeology of small islands. This is followed by a short overview of the environmental and cultural context, a brief history of archaeological research on Anacapa Island, and an overview of this book.

WHY STUDY SMALL ISLANDS?

For hundreds or thousands of years or more, people have occupied islands around the world, ranging from small continental islands (1 km^2 or less) to massive islands like Madagascar (>581,000 km^2). Although small islands have often been viewed as less diverse and more marginal than larger islands, their landscapes and seascapes presented a variety of opportunities and challenges for ancient peoples. MacArthur and Wilson's (1967) landmark study of island biogeography highlighted the importance of island size; distance from the mainland or other islands; and currents, nutrients, and many other factors in island biogeography. Keegan and Diamond (1987) expanded on this thinking by applying a biogeographic approach to human colonization of islands, with a key point being that human activities often do not mirror biogeographical expectations.

Drawing on a comparative analysis of Tikopia and Mangaia, two islands in the tropical Pacific, Kirch (1997) produced an innovative study of island archaeology. He demonstrated that although Tikopia (4.8 km^2) was considerably smaller and less biologically diverse than Mangaia (52 km^2), other factors such as greater reef area, soil nutrients, and even the island's small size may have encouraged a variety of cultural practices and customs (infanticide, arboriculture, and sea voyaging as a ritual suicide) that helped facilitate sustainability on Tikopia (Kirch, 1997). In this case, the small size was not a hindrance but instead resulted in unique adaptations that led to lower incidence of violence and greater sustainability on the much smaller Tikopia. In his conclusions, Kirch (1997:38) stated, "On an island the size of Tikopia (which one can walk around in half-a-day or less), everyone is known to each other, face-to-face. The intimate scale surely encourages collective decision making. 'Matou Nga Tikopia' (we, the Tikopia) is a phrase that binds them all as a social unity." In contrast, Mangaia's larger size and more tenuous social connections may have been much more prohibitive to this kind of collective decision-making.

In recent years, analyses of small islands around the world have greatly increased, providing an important window into broader human cultural and environmental issues and challenging previous assumptions about the assumed marginality of small islands (Keegan et al., 2008; Thompson and Turck, 2010; Jew and Rick, 2014). Fitzpatrick et al. (2016) challenge the notion that small islands are somehow marginal or problematic compared with their larger counterparts, providing several key examples of why this is not the case. Drawing on examples from the Caribbean and Pacific to the U.S. states of Georgia and California, they turn this notion on its head, noting the important role that small islands have played in the human past and continue to play today (Fitzpatrick et al., 2016). For instance, some Caribbean islands may have been relatively small but contained abundant coral reefs and rich marine resources similar to those on Tikopia (Keegan et al., 2008). Similarly, some small Pacific islands may have been important to people because of their strategic location in otherwise vast seascapes (Bell et al., 2015; Fitzpatrick et al., 2016). Also in the special section of the *Journal of Island and Coastal Archaeology* mentioned previously are papers that focused on African, Torres Strait and Caribbean islands and highlighted the varied reasons that small islands were important in the human past, including for ritual, subsistence, and other uses (Crowther et al., 2016; Giovas, 2016; McNiven, 2016; Wickler, 2016). Moreover, in North America, research on small islands between larger barrier islands and the mainland demonstrates that these islands have antiquity and human occupational histories similar to those of the larger islands (Thompson and Turck, 2010; Napolitano, 2013).

What about the Channel Islands? As Fitzpatrick et al. (2016) indicate, the small Channel Islands (Anacapa and Santa Barbara) have likely been unduly marginalized. Many archaeologists have speculated about the importance of these islands in California coastal prehistory, occasionally concluding that Anacapa and Santa Barbara were stopovers for people who lived primarily on larger islands or the mainland or perhaps these small islands had more sustained occupation (McKusick, 1959; Glassow, 1977; Greenwood, 1978; Erlandson et al., 1992; Rick, 2001, 2006, 2011; Perry et al., 2017). However, it has been difficult to evaluate these assertions because of a general dearth of information from these two smallest islands. The goal of this volume is to evaluate the nature of Anacapa Island's human past and provide a detailed synthesis of its prehistory that can help us understand the Channel Islands' archaeology and historical ecology (long-term ecological change, which has potential implications for conservation management) and the archaeology of small islands more generally.

ENVIRONMENTAL AND CULTURAL BACKGROUND

Anacapa is one of California's eight Channel Islands, which range in size from 2.6 to 250 km^2 and are located about 30 to 91 km offshore. Anacapa Island (2.9 km^2), which is the second smallest of California's Channel Islands and part of the northern group, has extremely limited fresh water and terrestrial biodiversity. In 1938, Franklin Roosevelt named the Anacapa and Santa Barbara Islands the original landmasses of Channel Islands National Monument. They were incorporated, along with San Miguel, Santa Rosa, and Santa Cruz, into Channel Islands National Park in 1980. East Anacapa Island, where much of our research took place, is the smallest of the three landmasses that make up Anacapa Island, with an area less than 1 km^2 and a coastline of steep, precipitous cliffs. East Anacapa reaches a peak elevation of approximately 80 m, slightly lower than the Middle and West island segments at 99 and 283 m, respectively. Most of the steep, rocky cliffs along its modern coastline are not easily scaled, making for limited access to the main plateau of the island. This plateau slopes downward gently from south to north, providing places to camp and monitor the ocean for kilometers around on clear days (Figure 3).

The four northern islands were connected into one large landmass known as Santarosae during glacial periods of the Pleistocene, but they were never connected to the mainland (Reeder-Myers et al., 2015). Anacapa is important geographically today as the closest island to the mainland at just 20 km away. It also was the eastern end of Santarosae, which was only 7 to 8 km from the mainland when sea level was at its lowest during the Last Glacial Maximum. Anacapa Island was the first to be separated from Santarosae by sea-level rise about 11,000 years ago, with the full separation into four islands occurring by 9,000 years ago (Figure 4; Reeder-Myers et al. 2015).

Today, visitors to Anacapa Island find one of the largest breeding colonies of western gulls on the Channel Islands. The

FIGURE 3. East Anacapa Island, as seen looking west with U.S. Coast Guard buildings (now managed by the National Park Service) and the crane at Landing Cove visible in the center right. West Anacapa is visible in the distance. Photo by Torben Rick, 2004.

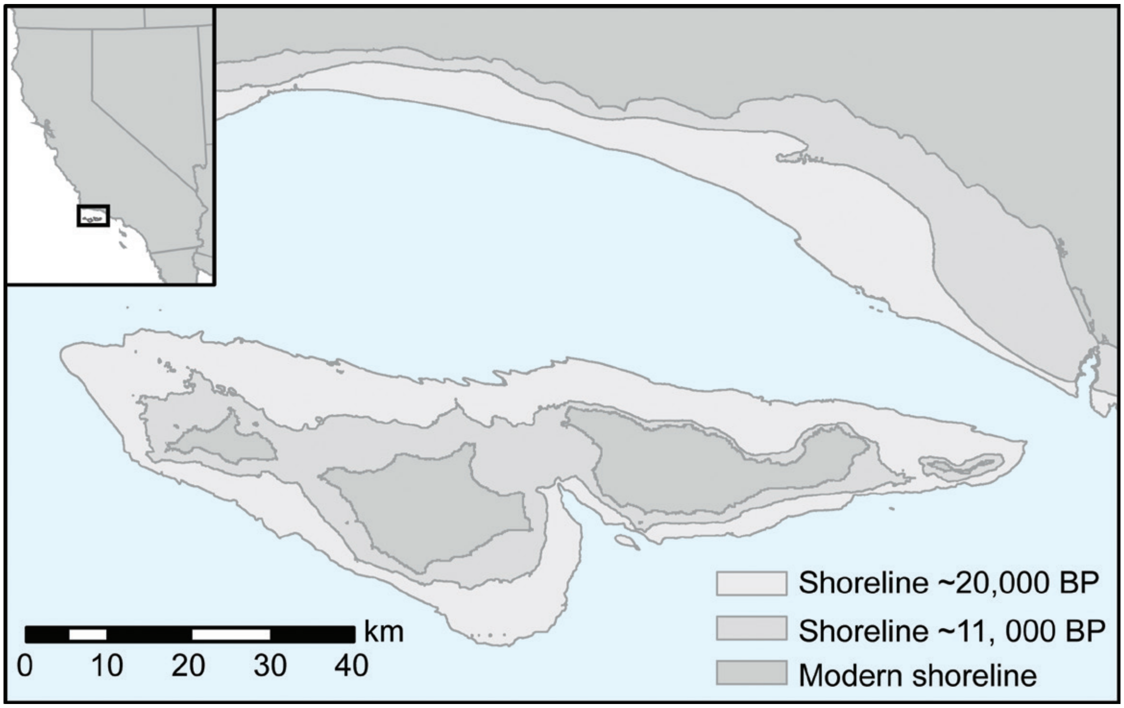

FIGURE 4. The northern Channel Islands and portions of the adjacent mainland, showing Pleistocene Santarosae Island and the timing of the breakup into the current configuration (see Reeder-Myers et al., 2015, for data and methods used to estimate shoreline positions).

island also boasts breeding habitat for brown pelicans, other seabirds, and a number of land birds (Schoenherr et al., 1999). Although mice (*Peromyscus maniculatus*) and a few bats are present, no other terrestrial mammals occupy Anacapa. The limited number of terrestrial mammals is similar to that of the other Channel Islands, where even the largest islands have a maximum of about 10 land mammal species, the largest of which are the island fox (*Urocyon littoralis*) and island spotted skunk (*Spilogale gracilis amphiala*), each of which is about the size of house cat. Similarly, terrestrial plant species are limited on Anacapa, but it is home to a number of native and endemic species. Two gullies or canyons on West Anacapa support island chaparral or woodland communities, but coastal scrub vegetation covers most of the island (Schoenherr et al., 1999). Removal of invasive ice plants and other species are the focus of major restoration by the National Park Service, but exactly what Anacapa's past vegetation communities looked like remains unclear.

The marine life around Anacapa is rich and productive, with kelp forests and rocky coasts that flank much of the shore, portions of which have been protected as part of the national monument since 1938. This coastal ecosystem provides habitat for sea life such as California mussels (*Mytilus californianus*), California spiny lobsters (*Panulirus interruptus*), California sheephead (*Semicossyphus pulcher*), seals (Phocidae), sea lions (Otariidae), and sharks (Elasmobranchs). These productive marine ecosystems and diverse organisms make it an extraordinary place for snorkeling, kayaking, and other activities that give people a sense of why the Channel Islands are called California's Galápagos. All of the Anacapa shell middens contain abundant shellfish and other marine food remains, demonstrating the importance of marine resources and ecosystems in the human past.

The larger northern islands, including Santa Rosa, Santa Cruz, and San Miguel, were home to large, dense Native American (Island Chumash) populations, including extensive villages that maintained sophisticated exchange networks and interaction spheres. A number of researchers have synthesized the archaeology of the Channel Islands and Chumash cultural developments on the islands and mainland (e.g., Arnold, 2001; Kennett, 2005; Rick et al., 2005; Gamble, 2008). This research tradition has resulted in a comprehensive understanding of human use of the islands and interaction with the mainland that spans 13,000 years and culminates in the rich combination of traits that comprise Chumash culture at European contact. The archaeological record includes named Chumash villages on the Channel Islands and mainland coast and interior; hereditary social organization; interaction and exchange between the coast, islands, and interior; maritime voyaging using plank canoes (*tomols*) and other watercraft; and foraging for a wide variety of marine and terrestrial plants and animals (Arnold, 2001; Gamble, 2008). Despite this work and knowledge of how various social, cultural,

FIGURE 5. Anacapa lighthouse, built in 1932. Photo by Torben Rick, 2004.

FIGURE 6. Frenchy's Cove, Anacapa Island, ca. 1940, showing the former fish shacks. Photo courtesy of Santa Cruz Island Foundation.

and environmental patterns vary across space and through time, there have long been questions about the extent and duration of human occupation of Anacapa (see Rick, 2006, 2011)

Although there is currently no permanent human occupation on Anacapa, signs of different human uses are present throughout the three islets. During the nineteenth and twentieth centuries, the island was visited and occupied by sealers, fishermen, sheep ranchers, liquor runners, bird egg collectors, and members of the U.S. Coast Guard (Livingston, 2006). Some buildings that are now used by the National Park Service on East Anacapa are remnants of the Coast Guard occupation, including the current lighthouse that was built in 1932 and automated in 1966 (Figure 5). On Middle Anacapa, remnants of an old sheep ranching facility are present at Shepherd's Landing (also known as Sheep Camp; Daly, 2018), and on West Anacapa there are still a few signs of Frenchy's fishing shack, left behind by squatter Raymond "Frenchy" LeDreau in the 1940s (Figure 6). Numerous shipwrecks are also known to be around the island (Morris and Lima, 1996). Three nonnative vertebrate species—sheep brought by ranchers, European rabbits (*Oryctolagus cuniculus*) brought for the Coast Guard or by fisherman, and rats left behind by shipwrecks—established populations on the island but have now been eradicated. Various reports have suggested that European hares (*Lepus europaeus*), rather than rabbits, were introduced to Anacapa Island, but recent work by Paul Collins confirmed through our work at CA-ANI-2 (see Chapter 5) that European rabbits, not hares, were present on the island (Braje et al., in press; P. Collins, Santa Barbara Museum of Natural History, n.d.).

These historical occupations, however, are just the tip of the iceberg for human occupation of Anacapa Island. The Chumash and their predecessors lived on Anacapa for at least 5,200 years and likely since the Early Holocene or terminal Pleistocene (Rick, 2006). Many shell middens dot the Anacapa landscape, with a total of 28 recorded archaeological sites on its three sections.

These sites range in size from small lithic scatters to dense shell middens and cave sites that span the prehistoric and Historic periods (Greenwood, 1978; Rozaire, 1978; Rick, 2011). Although we have come to learn a great deal about the archaeology of Anacapa during the past 30 years or so, in many ways the ancient human occupation of Anacapa is still a mystery. Interestingly, Anacapa is the only Channel Island that still retains a name derived from the Chumash: *'Anyapax* (*Anyapah, 'Anayapax, Aniapah, Eneepah*), meaning deception or mirage (McKusick, 1959:77; Heizer, 1975:33; Johnson, 1982:80).

The three larger northern Channel Islands have a record of human occupation that predates the breakup of Santarosae. This record includes a nearly continuous Native American occupation from 13,000 years ago up to about AD 1822, when the Spanish removed the last Island Chumash to mainland missions (Johnson, 1982; Arnold, 1990; Kennett, 2005; Rick et al., 2005; Erlandson et al., 2011b). After about 3,000 years ago and certainly during the last 1,500 years, Island Chumash peoples had formed large multifamily villages on all three of these larger northern islands (Arnold, 2001; Kennett, 2005; Rick et al., 2005; Rick, 2007). Along with these large villages, thousands or more shell middens, lithic scatters, and cave sites document the complex and important human occupational history on the northern Channel Islands. Anacapa undoubtedly played a significant role in that history, but the extent of that role remains unclear.

PREVIOUS ARCHAEOLOGICAL RESEARCH ON ANACAPA

Although a number of archaeological projects have been conducted on Anacapa Island, the attempt to synthesize the data has been limited, with most studies resulting from fairly brief visits to the island. Glassow (1977, 2010) provided the most detailed overviews and assessment of the past archaeological research on Anacapa, including entries about all of the known archaeological expeditions to the island. Here, I briefly summarize the major past projects with an eye toward studies that help contextualize our research throughout this volume.

Leon de Cessac, an artifact collector for the Ministry of Public Instruction and Fine Arts in Paris, conducted the first research on Anacapa from 1877 to 1879 as part of a broader French expedition to the Channel Islands. He may have collected artifacts and possibly human remains, but we do not know at which site or sites he may have worked (Glassow, 1977). Similarly, Lorenzo G. Yates visited the island in the 1880s and conducted a limited excavation that resulted in a small collection at the Santa Barbara Museum of Natural History, but little is known about this work. He appears to have visited or excavated at Freshwater Cave, which Rick (2011) determined contained historical (early nineteenth century) Chumash occupation. Sometime during the 1920s, David B. Rogers (1929) briefly visited the island, but no field notes or collections can be attributed to this work (Glassow, 2010).

The next known expedition to include an archaeological component occurred in March 1941, when the Los Angeles County Museum (LACM) sent a team of scientists to explore Anacapa's islets as part of the Channel Islands Biological Survey. Originally speculated to have been led by Richard Van Valkenburgh (see McKusick, 1959; Glassow, 1977), this project recorded several sites and made some collections later discussed by Marshall McKusick (1959). A review of records and notes pertaining to the Channel Islands Biological Survey indicates that it was actually John Schrader who did this work on Anacapa Island archaeology for the LACM in 1941. Moreover, notes published in McKusick (1959) appear to match Schrader's, not Van Valkenburgh's, correspondence with the LACM (Corinne Heyning Laverty, Personal Communication, March 2018).

Phil Orr of the Santa Barbara Museum of Natural History also visited East Anacapa Island in 1956 and West Anacapa at a later, unknown date, recording CA-ANI-1 through CA-ANI-4 and conducting test excavations at CA-ANI-3. Glassow (1977) notes that no collection from this work is known to exist.

Two years after Orr, McKusick (1959) visited the island in 1958 and began one of the more extensive projects. McKusick visited all three segments of the island, made surface collections, excavated at CA-ANI-8 (excavations directed by Charles Rozaire), and did small surface tests of faunal remains and other materials at several other sites. He also published a report on these results that we return to in later chapters.

Another two years later, Rozaire conducted a comprehensive survey of Anacapa Island from 1961 to 1962, recording a number of new and previously recorded sites and excavating at CA-ANI-6. In 1963 and 1965, Rozaire (1978) conducted additional excavation at CA-ANI-8, building on his initial work with McKusick (1959) at the site in 1958. Excavations were conducted at CA-ANI-6 by Rozaire (1978:34) in 1962 and 1965. Like McKusick's work, Rozaire's is one of the few studies to produce excavated artifact and faunal data. These materials were synthesized in an unpublished report in 1978 and a paper on microblades in 1993 (Rozaire, 1978, 1993). Sandefur (1978) provided an analysis of faunal remains from the CA-ANI-6 and CA-ANI-8 samples excavated by Rozaire (1978). Walker et al. (1978) provided an analysis of fish bones from these same samples. In 1970, Clement Meighan of the University of California, Los Angeles, excavated a test unit at CA-ANI-2 to a depth of 45 cm, producing a small collection of stone tools and seal bones, but these data were never published (Glassow, 1977).

After a hiatus, Roberta Greenwood (1978) of Greenwood and Associates performed a systematic survey of Anacapa Island in 1977 and 1978, building on the earlier work by Rozaire and McKusick. This project resulted in identification of new sites and confirmation of or adjustments to previously recorded sites, including CA-ANI-1 to CA-ANI-27, that still form the majority of known sites. During the 1980s, 1990s, and 2000s, the National Park Service conducted some limited work on Anacapa, mostly as cultural resource compliance projects, but it did not include excavation or new survey.

In 2003, Rick and colleagues began the work on Anacapa Island that forms the basis for this project. Details on field and excavation work, which was conducted primarily between 2004 and 2007, are provided in later chapters. Prior to this book we produced a few short publications on Anacapa Island chronology (Rick, 2006, 2011), subsistence (Reeder and Rick, 2009), lithics (Jew et al., 2015b), and seasonality based on stable isotope analysis of shellfish (Jew and Rick 2014).

Former Channel Islands Park archaeologist Kelly Minas and California State University, San Bernardino, archaeologist Nicholas Jew have been conducting site condition assessments of the recorded sites on Anacapa since at least 2003, with Jew conducting most of his work from 2014 to 2016. The most recent project was Jew's resurvey of East Anacapa Island in 2015. Jew did not locate any new sites, but reduced vegetation helped him locate a new chert source adjacent to CA-ANI-2. He also visited West Anacapa in 2016 and recorded one new site (CA-ANI-28). Beyond the terrestrial archaeology, Morris and Lima (1996) recorded a number of historical shipwrecks around Anacapa and other Channel Islands, with a few researchers continuing to work on some of these sites.

To summarize, Anacapa Island has been surveyed by McKusick, Rozaire, and Greenwood, with more recent work by Rick and Jew. However, only limited test excavations have been conducted, and very little of this information has been published. The primary goal of this book is to provide a comprehensive overview of the archaeology and historical ecology of Anacapa Island based on a synthesis of past projects and the results of our excavations and radiocarbon dating.

ORGANIZATION OF THE BOOK

The remainder of this book is divided into five chapters that explore the archaeology and historical ecology of Anacapa Island, placing it in the context of the other Channel Islands, southern California coast, and broader research on small islands around the world. Chapter 2 describes the field and laboratory work that we conducted, providing descriptions of the sites where we worked, the methods and procedures we employed, and a discussion of site preservation and taphonomy. Chapter 3 provides a detailed discussion of the radiocarbon chronology and stable isotope data on seasonality for Anacapa Island. Here, we present new and previously reported radiocarbon dates and present a Bayesian analysis of all of these dates. This analysis is followed by a summary of work reported by Jew and Rick (2014) on the seasonality of site occupation.

Chapters 4 and 5 are the core of the book. We explore all of the artifacts recovered during our analysis as well as all of the vertebrate and invertebrate faunal remains. These results represent a comprehensive investigation of the technology and subsistence of Native Americans on Anacapa Island. Our discussion centers on the late Middle Holocene and beginning of the Late Holocene between about 4,000 and 2,500 years ago. Finally, in Chapter 6 we come full circle and revisit the research questions and framework outlined in this chapter.

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2

Field and Laboratory Research

Torben C. Rick, Christopher B. Wolff, and Leslie A. Reeder-Myers

In consultation with the National Park Service (NPS), we designed a research program for Anacapa Island that integrated question-driven archaeological research and cultural resource management. As one of the most heavily visited islands within Channel Islands National Park and one that had been significantly affected by past human land use such as U.S. Coast Guard activities, it was important to assess the condition of archaeological sites on the island and sample sites that might be threatened by cultural or natural processes. As such, we focused the bulk of our fieldwork on the four sites on East Anacapa, the most frequently visited part of Anacapa. This island contains a trail network that circumnavigates the island; many stations with signposts, including one for CA-ANI-2; and a historic lighthouse. The main East Anacapa trail bisects CA-ANI-2 (Figure 7), and during our work at the site, school groups and other visitors passed by. We spoke with numerous visitors about our work, Anacapa Island, and the importance of preserving archaeological sites.

We visited most of the extant sites on Middle and West Anacapa to place our excavations on East Anacapa into broader context and to assess site conditions for Channel Islands National Park in collaboration with former NPS archaeologist Kelly Minas. We collected samples for radiocarbon dating from small probes at several of the shell middens to gather basic chronological information. We also visited collections from Rozaire's excavations and radiocarbon dated materials from CA-ANI-6 and CA-ANI-8 held at the Natural History Museum of Los Angeles County (Rozaire, 1978; Rick, 2006). Most Anacapa sites have been disturbed by bird activity (nesting gulls and pelicans) that includes the deposition of modern chicken and other animal bones that the birds transport to the islands from the mainland. There is also some evidence of disturbances by burrowing animals (e.g., the invasive European rabbit) on East Anacapa. Because of the island's small size, historical human land use has had an outsized impact on Anacapa Island archaeology. A major component of our work was investigating the taphonomic history of each site.

In this chapter, we discuss our field research and provide descriptions of the archaeological sites on East Anacapa. To help broaden the context, we briefly describe two of the sites where Rozaire (1978) conducted his excavations. We also summarize our radiocarbon dating program and laboratory research methods. More in-depth discussion of the methods used for radiocarbon dating and stable isotope analysis are provided in Chapter 3; detailed discussions of artifact and faunal identification are given in Chapters 4 and 5, respectively.

FIELD RESEARCH

From 2006 to 2007, we mapped all four recorded archaeological sites on East Anacapa, made extensive observations of the condition and preservation of the sites,

FIGURE 7. Hiking trail bisecting site CA-ANI-2 with a highly fragmented shell midden, which gives the dirt path a white hue. Photo by Torben Rick, 2006.

and performed test excavation and sampling at CA-ANI-2, CA-ANI-3, and CA-ANI-4. This work built on previous site visits made during 2003 to 2004. Table 1 summarizes the units, screen size, and volume excavated at each site.

During our work, we determined site boundaries and mapped the surrounding topography with a laser transit. The focus of our research was at CA-ANI-2, which was the most heavily affected by a popular hiking trail. At CA-ANI-2, we used auger holes to determine the extent of subsurface deposits and excavated two 1 × 1 m units and two 25 × 25 cm column samples. At CA-ANI-4, which was also adjacent to a hiking trail, we excavated a 1 × 0.5 m unit. At CA-ANI-3, which is not close to any hiking trails but is eroding from a sea cliff, we excavated two 5 L bulk samples from the cliff edge. We did not excavate at CA-ANI-1, which has been heavily disturbed by nesting birds and twentieth-century human activities. We screened the matrix

TABLE 1. Excavation unit summary data for East Anacapa Island archaeological sites. A dash (—) indicates not applicable.

Site	Unit designation	Dimensions (m)	Mesh size (inches)	Volume (L)
CA-ANI-2	Unit 1	1 × 1	1/8	520
	Unit 1 column	0.25 × 0.25	1/16	31
	Unit 2	1 × 1	1/8	468
	Unit 2 column	0.25 × 0.25	1/16	21
CA-ANI-3	Bulk sample 1	—	1/16	5
	Bulk sample 2	—	1/16	5
CA-ANI-4	Unit 1	1 × 0.5	1/8	50
Total	—	—	—	1,100

from the units through ⅛-inch (~3.2 mm) screens and the column samples through 1⁄16-inch (~1.6 mm) mesh, and we collected bulk soil samples.

We visited East, Middle, and West Anacapa in 2003 to 2007, with an additional visit by Rick to West Anacapa in 2014 and another by Jew in 2016. We evaluated site conditions, took photographs, and collected in situ materials for radiocarbon dating (Rick, 2006, 2011). Through this chronological work, we built a baseline for future research and put the excavations we conducted on East Anacapa and those conducted by Rozaire on West Anacapa in chronological context. In the following, we describe the four East Anacapa sites that are the focus of our research as well as other sites that are pertinent to Anacapa Island archaeology or our larger radiocarbon dating survey.

SITE DESCRIPTIONS

East Anacapa

CA-ANI-1

CA-ANI-1 is a shell midden located near Landing Cove on the northeastern shore of East Anacapa (Figure 8). Our work suggests that the site covers an area of approximately 315 m^2; others estimate that it may have been even larger (see Table 2). The midden deposits are estimated to be about 20 cm deep (Rick, 2006), although Rozaire (1978) and McKusick (1959) estimated a depth of 30 to 56 cm. The primary constituents are shellfish, including abalones (*Haliotis* sp.), owl limpets (*Lottia gigantea*), barnacles, and California mussels (*Mytilus californianus*); however, fish and historic animal bones were also recovered. Few artifacts, none of them diagnostic, were recovered or noted during previous survey or site-surface observations (Greenwood, 1978). Human burials were also reported at the site during past visits (McKusick, 1959), but we did not observe any human remains.

The position of CA-ANI-1 on a slope adjacent to the sea cliff has made it vulnerable to substantial erosion. Moreover, the clay content of the soil matrix has caused significant argilliturbation similar to that noted on some of the other Channel Islands (see Rick et al., 2006). In 1963, Rozaire reported the presence of four pits, and unauthorized excavations appear to have been a problem at the site (Greenwood, 1978). Historic activities, particularly twentieth-century U.S. Coast Guard construction, have affected the preservation of the site as abundant bricks and other construction materials sit on top of and are mixed into the deposits. Scores of ground-nesting seagulls occupy the site and have caused significant disturbance during the

FIGURE 8. Site CA-ANI-1, as seen looking west. Photo by Torben Rick, 2004.

creation of their nests. They have also introduced a variety of noncultural bones (mostly chicken), shellfish, and other materials. These cultural and natural processes have compromised the integrity of CA-ANI-1, causing mixing and fragmentation of deposits and introduction of materials not associated with the Native American occupation.

CA-ANI-2

CA-ANI-2 is a shell midden located on the southern coast of the island (Figure 9). We estimate its main activity area covers roughly 1,000 m^2, although the deposits have been scattered to an area of roughly 2,400 m^2 by the construction and use of a public hiking trail that bisects the site. The midden is composed primarily of California mussel shells but includes abalone, barnacle, and limpet shells and fish and marine mammal bones. The artifact assemblage from CA-ANI-2 contains choppers, a pestle fragment, bifaces, *Olivella biplicata* (*Olivella* hereafter) barrel beads, numerous bone barbs, and various other artifacts (Glassow, 1977). The site also contains expedient chipped-stone tools made from unique local cherts (Jew et al., 2015b).

Like CA-ANI-1, several postdepositional processes have altered the site, some of which continue to disturb the deposits. The hiking trail that leads through the middle of the site—a remnant of an old dirt road—has caused significant erosion, fragmentation, and displacement of its constituents. Although some shell deposits can be seen on the trail, it seems to have cut its way through most of the midden. Moreover, a conspicuous depression on the northern site area may be a pit dug by University of California, Los Angeles archaeologist Clement Meighan, who is known to have worked at the site, but this remains uncertain (see Glassow, 1977). Greenwood (1978) noted that Rozaire observed about 10 pits at the site in 1963.

There is danger of alteration to the site from the eroding cliff face on its southern margin. Although the current position of the site is a few meters from the edge, erosion should be regularly monitored to assess its preservation and stability. Bioturbation has also affected the site. During excavation of Unit 2, we recovered the remains of a large rabbit that had burrowed its way over 40 cm into the midden during the Historic period (Figure 10). Fortunately, the burrow was easily distinguishable from the surrounding matrix because of the looser sediments

FIGURE 9. Site CA-ANI-2, as seen looking east. Photo by Torben Rick, 2006.

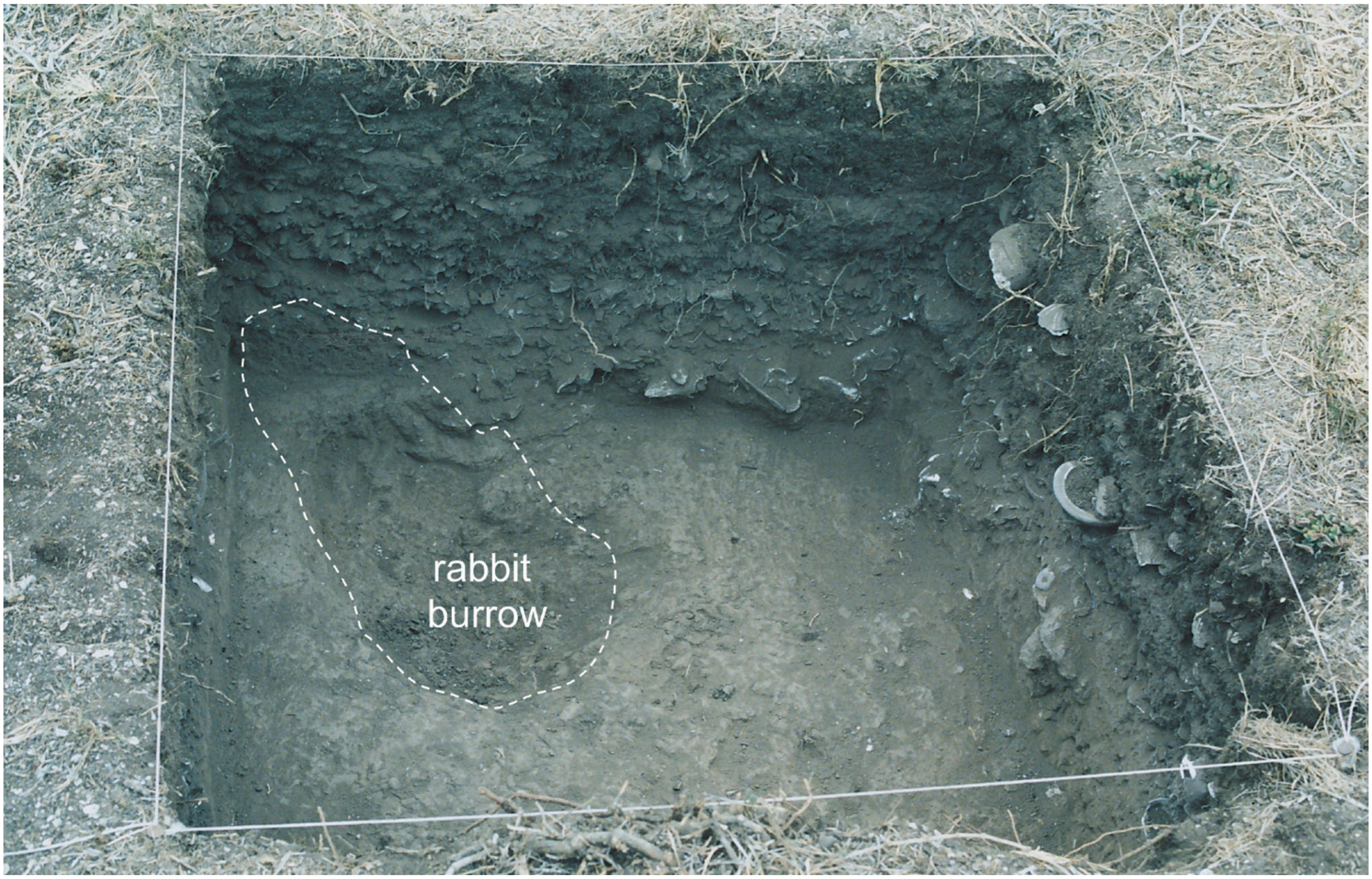

FIGURE 10. Excavation of Unit 2 at CA-ANI-2 on East Anacapa Island showing the outline of a rabbit burrow found at the site. Excavation measured 1 × 1 m. Note the dense abalone and mussel shells visible in the side walls. Photo by Christopher Wolff, 2007.

and the relative lack of cultural materials, which suggests that careful excavation of sites on the island can help reduce interpretational errors created by burrowing rabbits. However, the nesting activity of thousands of seagulls continues to disturb surface materials at CA-ANI-2 and has introduced scores of noncultural constituents. Despite these disturbances, there is still relatively good preservation of faunal remains and artifacts from the site that have been used to evaluate human subsistence, seasonality of site occupation, and lithic procurement (Reeder and Rick, 2009; Jew and Rick, 2014; Jew et al., 2015b).

CA-ANI-3

CA-ANI-3 is a shell midden eroding from the top of a steep cliff on the southern coast of East Anacapa Island (Figure 11). It is a roughly 20 cm lens of shell and bone composed primarily of California mussel but also contains some black abalone and other rocky intertidal and nearshore species. Its position along a ridge that terminates at the cliff suggests that the ridge may have once been accessible to the coast below. The extent of the site is unknown because it runs below the surface and erosion is evident on its southern margin.

Observations of the sea cliff exposure suggested this midden might be relatively intact compared with other East Anacapa sites; however, when obtaining samples for radiocarbon dating from the sea cliff, we found a bullet shell casing embedded in the midden. Greenwood (1978) also noted that Rozaire and McKusick observed evidence of possible digging at the site, potentially attributable to Santa Barbara Museum of Natural History (SBMNH) archaeologist Phil Orr. Gull nests are scattered across the site, suggesting that some of the disturbances affecting the other sites are also operating here.

CA-ANI-4

CA-ANI-4 is a shell midden located farther inland than the other sites on East Anacapa (Figure 12). It sits on the northeast side of a knoll that slopes toward the northern coastline. The site covers an area of approximately 14 × 17 m, with variable thickness. Rozaire estimated that it extended about 46 cm below the

FIGURE 11. Site CA-ANI-3 during excavation of the bulk samples. Photo by Lauren Willis, 2007.

surface (Greenwood, 1978); we excavated a probe through 25 to 30 cm of midden in the northern portion of the site (Rick, 2006), and our excavation unit revealed that deposits were about 65 to 70 cm thick. The midden, like the other sites, was dominated by California mussels but also contained owl limpets, black abalones, as well as fish, bird, and mammal bones (Rick, 2006). A few lithic tools were recovered from the site surface, including a quartzite knife and a sandstone pebble tool (Greenwood, 1978).

The heaviest impact on the site appears to be erosion caused by water runoff downslope into a small ditch along the eastern margin of the deposit. The public hiking trail runs through the southern edge of the site, although it has been elevated to cross the drainage ditch. Construction of the trail and parts of the drainage ditch have probably had an impact on the site to some degree; however, there is no obvious indication of the site from the trail that would attract tourists or potential looters, so future impacts in that regard might be minimal. The main site activity area appears to be close to its western margin near the highest elevation of the site, and the greater extent of the site may be due to erosion downslope.

In 2006, we excavated a single 1 × 0.5 m unit at CA-ANI-4. We found historical construction debris, including bricks and other materials, throughout the deposits, suggesting this site has been badly disturbed. Greenwood (1978) noted that an old storage house used to sit on the site, and the historical debris noted during our work likely came from the construction of that building. Greenwood (1978) also indicated that Rozaire had reported one excavated pit. Gulls nest on the site, and it appears to be the most compromised of the four sites on East Anacapa Island.

Rozaire's West Anacapa Excavations at CA-ANI-6 and CA-ANI-8

CA-ANI-6

This site is located on a north-facing slope, east of CA-ANI-5 and southwest of Frenchy's Cove. Greenwood described the site as a shell midden with numerous lithic tools, covering an area about 10 × 10 m. Shellfish recovered from the site are dominated

FIGURE 12. Site CA-ANI-4, as looking south. Photo by Torben Rick, 2007.

by California mussels, but red and black abalones, owl limpets, and barnacles were also identified as well as fish, mammal, and bird bones (Greenwood, 1978; Sandefur, 1978; Walker et al., 1978). Rozaire's (1978, 1993) work at the site uncovered hundreds of microblades and microdrills, shell fishhooks, *Olivella* and steatite beads, and other artifacts. A large oval glass trade bead was also found on the site surface, but this bead has been lost (Rozaire, 1978:35). Two graded areas, paths, and sheetwash have affected the site, and in 2004 vegetation cover obscured the site surface.

Rozaire (1978, 1993) excavated three test pits at the site, noting the deposits were roughly 30 cm (12 in) deep. The unit was not excavated in separate levels, but since this deposit is shallow, it may be a single component occupation (Rick, 2006; Chapter 3).

CA-ANI-8

CA-ANI-8 is located on a south-facing ridge crest to the southeast of Frenchy's Cove. The site is a small rock-shelter with a shell midden, measuring about 5 × 5 m in area (Greenwood, 1978). Black abalone, California mussel, and trace amounts of owl limpet and cowry shells were observed on the site surface (Greenwood, 1978), and several bird, fish, and mammal taxa were identified by Sandefur (1978). Greenwood noted that back dirt from previous excavations is widely distributed around the site. Rozaire (1978) excavated three human burials as well as microblades, shell beads, shell fishhooks, bone tools, and a variety of vertebrate and invertebrate faunal remains. Roughly 46 m^3 (60 cubic yards) of midden were excavated and poured over ½- or ¼-inch (~6.4 mm) mesh. Rozaire (1978) noted that there were between four and five distinct strata, although he excavated the site in arbitrary 15 cm (6 in) levels. Scattered bits of shell occur to a depth of about 1 m, but the artifacts and shells tend to be densest between 30 and 60 cm (12 and 24 in) deep. The presence of rabbit and artiodactyl bones to a depth of at least 91 to 107 cm (36 to 42 inches) suggests these deposits are disturbed. The site appears to have at least two occupations, one during the Middle Holocene and another during the Late period (AD 1300–1769; Rick, 2006; Chapter 3).

Other Key Sites

In addition to the four sites on East Anacapa and the two sites excavated by Rozaire, we obtained radiocarbon dates from nine additional sites (total number of sites = 16). Table 2 provides a summary description of each of these sites. The chronology of each of these sites is discussed in detail in Chapter 3, but they range in age from greater than 5,000 years old to the early nineteenth century (Rick, 2006, 2011). All of the sites we dated are shell middens, including three located in rock-shelters. Collectively, the 16 sites that have been radiocarbon dated during our study represent 57% of all recorded sites on Anacapa Island.

LABORATORY RESEARCH

All excavated materials were brought to the laboratory for detailed analysis. Materials were dry screened in the field over ⅛-inch mesh for the units and 1⁄16-inch mesh for the column samples and CA-ANI-3 bulk sample. In the laboratory, we wet screened these materials over the same mesh sizes; however, following laboratory procedures for other Channel Islands research, we separated out the ¼-, ⅛-, and 1⁄16-inch size classes (e.g., Kennett, 1998; Rick, 2007). We completely sorted all materials ¼ inch and greater. For the material greater than ⅛ inch and smaller than ¼ inch, we separated a random 25% sample by weight. We sorted all materials from that 25% sample and removed all vertebrate remains and artifacts from the remaining 75% sample. We did not sort material smaller than ⅛ inch.

For the samples that were fully sorted, faunal remains were first sorted into general categories, including shellfish, fish, marine or terrestrial mammal, bird, and other similar categories. Shellfish were then identified to the most specific taxon possible, using standard comparative collections of modern species and Pacific Coast guidebooks. Vertebrate remains were sorted into the general categories, with mammal, reptile/amphibian, and bird remains sent to Thomas Wake at the University of California, Los Angeles, and fish remains sent to Kenneth Gobalet of California State University, Bakersfield, for more detailed identification. Additional details of the identification processes are provided in Chapter 5. Care was taken during faunal analysis to ensure the accuracy of our identifications and to keep with standard zooarchaeological procedures and critiques of faunal identification (Driver, 1991; Gobalet, 2001; Lyman, 2002).

Bone, shell, asphalt, and stone tools were identified during initial sorting and put aside for more detailed analysis. We also separated charcoal, potential macrobotanicals, and Historic

TABLE 2. Brief description of sites that were included in the radiocarbon survey project. Descriptions and dimensions are based on site records from Greenwood (1978), except CA-ANI-28 is from N. Jew 2018, an unpublished site record. A dash (—) indicates not applicable.

Site number	Description	Dimensions (m)	No. of ^{14}C samples
	East Anacapa		
CA-ANI-1	Shell midden with lithics and human burials	20 × 28	1
CA-ANI-2	Dense shell midden with lithics	24 × 30	5
CA-ANI-3	Dense shell midden with lithics	15 × 12	2
CA-ANI-4	Shell midden and lithic scatter	14 × 17	3
	Middle Anacapa		
CA-ANI-9	Shell scatter	5 × 18	2
CA-ANI-15	Large shell midden, possible village with human remains	100 × 65	1
CA-ANI-21	Dense shell midden with lithics in gully	65 × 65	1
CA-ANI-22	Rockshelter and shell midden	60 × 20	1
CA-ANI-23	Shell midden	43 × 25	1
CA-ANI-24	Shell midden with lithics	20 × 35	1
CA-ANI-25	Low-density shell scatter	6 × 5	1
	West Anacapa		
CA-ANI-5	Shell midden, possible temporary habitation site or camp with human remains	12 × 12	1
CA-ANI-6[a]	Small shell midden with dense lithic component	10 × 10	1
CA-ANI-8[a]	Small rock-shelter and shell midden	5 × 5	2
CA-ANI-18	Cave with freshwater source and shell midden	22 × 6	1
CA-ANI-28	Shell midden on far west end of island	70 × 80	2
Total	—	—	26

[a]Sites excavated by Rozaire (1978).

period artifacts such as intrusive metal and glass, but these were not analyzed further. Rick analyzed the shell and asphalt tools following methods consistent with past Channel Islands studies about shell and other tools (e.g., Arnold and Graesch, 2001; Rick, 2007). All lithic artifacts were studied by Nicholas Jew and bone tools were analyzed by Thomas Wake. Additional details of the procedures for these materials are available in Chapter 4.

Radiocarbon dating was the primary means of determining the age of deposits at the Anacapa Island sites. Chapter 3 presents a discussion of the radiocarbon dating methods, including calibration procedures. We also constructed a Bayesian model to analyze the chronology of human occupation of each site, each island segment, and of Anacapa as a whole (see Appendix).

We dated primarily marine shells (California mussel and black abalone) to avoid potential complications from dating old wood (Schiffer, 1986). Although some scholars have suggested that marine shells are less favorable for radiocarbon dating than small twigs or charcoal (see Erlandson, 1988), radiocarbon dates obtained from marine shells on the Channel Islands have been shown to be highly reliable (Erlandson et al., 1996; Kennett et al., 1997; Braje et al., 2005; Rick, 2007).

In addition to the radiocarbon dates, subsets of shells were analyzed for stable carbon and oxygen analysis. These materials provide insights into the seasons when people were collecting marine shell (Kennett, 1998, 2005). Our stable isotope analysis focused on CA-ANI-2 and is discussed in detail in Chapter 3 and by Jew and Rick (2014).

CONSERVATION, PRESERVATION, AND ACCESSIBILITY

A key element of our research is ensuring that all materials are properly curated, conserved, and cared for in perpetuity. We also advocate for the accessibility of the materials for additional study by researchers. To that end, all materials have been housed and stored at the National Museum of Natural History in archival bags and secure museum cabinetry. All materials have also been cataloged in the NPS and SBMNH catalog systems. As of this writing, we plan to transfer all material to the SBMNH for permanent curation following an agreement between the SBMNH and Channel Islands National Park.

SUMMARY

Our research on Anacapa Island focused on excavation of three sites on East Anacapa and radiocarbon dating at a series of sites throughout the island. We employed standard field and laboratory procedures consistent with past research to make our results as comparable to other studies as much as possible. We were also cognizant of issues of site formation and taphonomy at each of the sites.

Although the impacts of nonnative fauna and historical human disturbances have altered the sites of Anacapa, our research offers insight into the duration of occupation and subsistence strategies of inhabitants of this island as well as the broader Channel Islands (Reeder and Rick, 2009; Jew and Rick, 2014; Jew et al., 2015b). The taphonomic processes (human construction, introduced rabbit burrowing, bird roosting and nesting, etc.) affecting Anacapa's sites underscore the need for caution when reconstructing the nature of ancient human use of the island. Greenwood's (1978) survey and our own work on Anacapa Island suggest that many of the disturbances we noted on East Anacapa (e.g., historical construction, introduced animals, and erosion) have also affected the sites on Middle and West Anacapa. These processes will be kept in mind in later chapters. Knowing and understanding the processes that have affected the formation and preservation of Anacapa and other Channel Island sites improves our models of ancient human cultural and environmental developments. In the next chapter, we build on these site descriptions and methods by focusing on the chronology and seasonality of site occupation for Anacapa Island.

3

Chronology and Seasonality

Torben C. Rick and Nicholas P. Jew

Major goals of our research were to understand the antiquity of human settlement on Anacapa and to build a detailed radiocarbon (^{14}C) chronology for the island. We also were interested in determining the seasonality of shellfish harvesting in relation to site occupation. Prior to our research, there were only three radiocarbon dates for Anacapa Island that Rozaire obtained from site CA-ANI-8: one of these was modern, one was beyond the limits of radiocarbon dating, and the other was Late period in age (Rick, 2006). Our initial radiocarbon dating work was carried out on West and East Anacapa sites, provided a chronology spanning some 5,000 years, and determined that most of the sites on East Anacapa dated to a relatively narrow window of time, between about 3,600 and 2,600 years ago (Rick, 2006). We also identified two cave sites that were occupied during the Historic period (eighteenth to nineteenth centuries; Rick, 2011). Despite this work, significant questions remained about the antiquity of human occupation and the duration of occupation on each of the three islets. Consequently, we obtained a series of ^{14}C dates from shell middens on Middle and West Anacapa that were intended to complement our previous radiocarbon dating work.

To build on our chronological framework, we performed stable oxygen isotope analysis of California mussel (*Mytilus californianus*) shells from CA-ANI-2 on East Anacapa (Jew and Rick, 2014). This analysis determined that people were collecting mussels—and therefore were present on the island—during all seasons of the year. This finding proved to be important for helping to evaluate questions about the permanent versus more transitory nature of Anacapa Island settlement (Jew and Rick, 2014).

In this chapter, we present and discuss all radiocarbon dates from Anacapa Island. As noted in Chapter 2, this information includes 26 dates from 16 archaeological sites, which were chosen because they had shell middens with readily identifiable datable material and they were located across the three islets (Table 3). Here, we describe the methods used to obtain the radiocarbon samples as well as pretreatment practices, methods, and protocols used by the radiocarbon laboratories. We also outline the correction and calibration procedures used during our preparation and analysis. We then perform chronological hygiene assessments to determine the reliability of the radiocarbon dates. Finally, we construct a Bayesian model using the OxCal program (Bronk Ramsey, 1995, 2001, 2009) to help evaluate the chronology of Anacapa Island and its three segments. After establishing the chronology for the Anacapa sites, we discuss our stable isotope analysis from CA-ANI-2 to set the context for the remaining chapters.

TABLE 3. Radiocarbon dates from Anacapa Island sites. A dash (—) indicates not applicable.

Site	Provenience	Lab No.[a]	Materials	$\delta^{13}C$	$^{13}C/^{12}C$ Adjusted	Calibrated age BP (2σ)[b]
			East Anacapa			
CA-ANI-1	Probe, ~18 cm below surface	OS-48488	*Mytilus californianus*	1.52	3820 ± 30	3550–3360
CA-ANI-2	Unit 2, ~34 cm below surface, bottom of unit	OS-63565	*M. californianus*	–0.23	3280 ± 35	2890–2710
CA-ANI-2	Probe, 38–40 cm below surface	OS-48508	*M. californianus*	0.84	3310 ± 35	2920–2730
CA-ANI-2	Unit 1, 2–5 cm below surface, top of unit	OS-60407	*Haliotis cracherodii*	2.10	3330 ± 25	2930–2750
CA-ANI-2	Unit 1	OxA-30069	*Urocyon littoralis bone*	–16.76	2956 ± 27	3210–3010
CA-ANI-2	Unit 1, 52–53 cm below surface, bottom of unit	OS-60632	*M. californianus*	0.5	3560 ± 30	3250–3000
CA-ANI-3	Bulk sample, bottom	DAMS-3996	Marine shell	–8.9	3575 ± 34	3300–3030
CA-ANI-3	BS-1, 15–20 cm below surface	OS-63566	*M. californianus*	0.91	3580 ± 30	3300–3050
CA-ANI-4	Unit 1, top	DAMS-3994	Marine shell	–11.2	3103 ± 37	2720–2460
CA-ANI-4	Unit 1, bottom	DAMS-3995	Marine shell	–4.6	3948 ± 27	3700–3490
CA-ANI-4	Probe, 25–28 cm below surface	OS-48509	*M. californianus*	1.25	3530 ± 30	3210–2970
			West Anacapa			
CA-ANI-5	Midden exposure, ~50 cm	OS-46940	*H. cracherodii*	1.91	5110 ± 35	5280–5010
CA-ANI-6	Test Pit 2	OS-50446	*H. cracherodii*	0.90	1230 ± 30	630–500
CA-ANI-8	Square 12, 91–117 cm	OS-50447	*H. cracherodii*	1.71	4950 ± 35	5030–4820
CA-ANI-8[c]	Pit 3, 31–46 cm	B-031360	Charcoal	—	570 ± 40	650–520
CA-ANI-18	^{14}C probe, 65 cm	B-232738	*H. cracherodii*	–1.0	830 ± 60	320–0
CA-ANI-28	^{14}C probe, 0–10 cm	UGA-27951	*H. cracherodii*	1.01	3240 ± 25	2830–2700
CA-ANI-28	^{14}C probe, 10–20 cm	UGA-27952	*H. cracherodii*	1.14	3760 ± 25	3480–3290
			Middle Anacapa			
CA-ANI-9	^{14}C probe, 10 cm	OS-74596	*H. cracherodii*	1.4	3660 ± 35	3370–3150
CA-ANI-9	Duplicate of 74596	OS-74597	*H. cracherodii*	1.3	3590 ± 30	3310–3060
CA-ANI-15	^{14}C probe, 15–18 cm	OS-74598	*H. cracherodii*	2.1	5340 ± 35	5550–5320
CA-ANI-21	Gully exposure, 50 cm, base of midden	OS-74600	*H. cracherodii*	1.0	1290 ± 35	670–530
CA-ANI-22	^{14}C probe, 25 cm	OS-63567	*M. californianus*	0.61	810 ± 30	280–60
CA-ANI-23	^{14}C probe, 30 cm	OS-74602	*M. californianus*	0.82	3040 ± 25	2670–2380
CA-ANI-24	Sea cliff exposure, 15 cm	OS-74604	*H. cracherodii*	1.23	1310 ± 30	680–540
CA-ANI-25	^{14}C probe, 5–10 cm	OS-74646	*M. californianus*	1.07	3580 ± 30	3300–3050

[a]B = Beta Analytic; DAMS = DirectAMS; OS = National Ocean Sciences Accelerator Mass Spectrometry facility; OxA = Oxford Radiocarbon Accelerator Unit; UGA = University of Georgia Center for Applied Isotope Studies.

[b]All shell dates were calibrated with a ΔR of 261 ± 21 years for all shell samples. The $^{13}C/^{12}C$ ratios were determined by the radiocarbon laboratories.

[c]Date obtained from Breschini et al. (2004).

^{14}C DATING, SAMPLE SELECTION, CALIBRATION, AND BAYESIAN ANALYSIS

In the field, radiocarbon samples were selected in situ from unit sidewalls after excavation. For sites where we did not excavate test units, we used small probes to extract samples in situ from the sidewall of the probe or collected samples from eroding exposures. The depth of the sample and GPS coordinates for the locations were also recorded. For the sites previously excavated by Rozaire, we selected well-preserved samples from Natural History Museum of Los Angeles County collections with known provenience.

The vast majority of the samples that we dated were marine shells (i.e., California mussel or black abalone); other materials included one charcoal sample from CA-ANI-8 and one island fox bone from CA-ANI-2 dated by Hofman et al. (2016). Sample provenience, laboratory identification numbers, and materials are summarized in Table 3. For marine samples, we selected well-preserved shells for accelerator mass spectrometry (AMS) radiocarbon dating. All shells were sampled across multiple growth bands to ensure that we minimized the possibility of intrashell radiocarbon variability (Culleton et al., 2006). Marine shell samples were dated by the National Ocean Sciences Accelerator Mass Spectrometry facility (NOSAMS) at Woods Hole Oceanographic Institution (http://www.whoi.edu/nosams/home), Beta Analytic (https://www.radiocarbon.com/), DirectAMS (https://www.directams.com/), and the University of Georgia Center for Applied Isotope Studies (http://cais.uga.edu/). The island fox bone from CA-ANI-2 was dated by the Oxford Radiocarbon Accelerator Unit at Oxford University (https://c14.arch.ox.ac.uk/). Additional details on the dating procedures are available at the websites for the respective laboratories listed previously.

Marine shell samples were calibrated following procedures outlined in numerous studies for California's Channel Islands (Kennett, 2005; Rick, 2006, 2007; Braje, 2010; Jew et al., 2015a). All of our marine radiocarbon samples were corrected using a ΔR (reservoir correction) value of 261 ± 21 (see Jazwa et al., 2012; Thakar, 2014b). All marine samples were calibrated using the Marine13 calibration curve, and the charcoal and island fox bone sample were calibrated with the Intcal13 calibration curve (Reimer et al., 2013).

Bayesian statistics are an important tool for modeling chronometric data from archaeological sites because they have the ability to incorporate prior information, such as stratigraphy, historic records, and diagnostic artifacts of known ages, as part of the modeling process (Aldenderfer, 2005; Bronk Ramsey, 2009; Bayliss, 2015; Hamilton and Krus, 2018). They have also been used to establish a statistical framework for archaeological site chronologies on the Channel Islands (Jazwa et al., 2013; Jew et al., 2015a). We used OxCal 4.3's Bayesian framework to calibrate ^{14}C determinations and generate modeled chronologies for Anacapa Island (Bronk Ramsey, 1995, 2001, 2009). OxCal's Bayesian platform can be used to create models of dates in a defined sequence and phase or phases and then statistically refine the start and end dates for the span and each individual date (Bronk Ramsey, 2009; Bayliss, 2015). This analysis results in indices of agreement and convergence that help determine the reliability of the model. In Bayesian analysis, outliers are identified by poor agreement indices (A) below the index threshold of 60 (see Bronk Ramsey, 2000).

We produced four phase models for Anacapa Island, including all dates from Anacapa Island and then one each for East, Middle, and West Anacapa. For each model, we ordered the dates from oldest to youngest by their calibrated ages, which also incorporated stratigraphic information that we had for individual sites with multiple dates (e.g., CA-ANI-2 and CA-ANI-4). These dates were then grouped into a sequence and a single phase for each model. We then ran the model in OxCal 4.3, producing the models and data in Figures 13 to 16 (see also Appendix).

A ^{14}C CHRONOLOGY FOR ANACAPA ISLAND

Analysis of all 26 ^{14}C dates from Anacapa produced a 95% probability model chronology ranging between 5530 and 80 cal BP (Figure 13). Agreement indices for all models and each individual date were above 60, suggesting the modeled chronologies are statistically valid (Figures 13–16). Agreement indices for all Anacapa Island dates are A_{model} = 117 and $A_{overall}$ = 104. Bayesian analysis of all dates suggest Anacapa was occupied from as early as the Middle Holocene (~5500 cal BP) up to historic contact. There is general overlap for each island segment, but the earliest dates come from archaeological sites on West and Middle Anacapa, whereas the latest dates come from West Anacapa.

For East Anacapa, 11 ^{14}C dates from archaeological contexts present a 95% probability chronology modeled between 3670 and 2530 cal BP (Figure 14). Agreement indices are A_{model} = 104 and $A_{overall}$ = 93, with each corresponding agreement presented in Figure 14.

For Middle Anacapa, eight ^{14}C dates from archaeological contexts present a 95% probability modeled chronology between 5540 and 60 cal BP (Figure 15). Agreement indices are A_{model} = 106 and $A_{overall}$ = 98, with each corresponding agreement presented in Figure 15. Middle Anacapa produced the earliest radiocarbon date (OS-74598) from CA-ANI-15 with a modeled range between 5540 and 5310 cal BP.

Seven ^{14}C dates from archaeological contexts recovered from West Anacapa present a 95% probability modeled chronology between 5290 and 0 cal BP (Figure 16). Agreement indices are A_{model} = 106 and $A_{overall}$ = 101, with each corresponding agreement presented in Figure 16.

STABLE OXYGEN ISOTOPE ANALYSIS AND SITE SEASONALITY AT CA-ANI-2

To better understand the seasonality of site occupation on Anacapa Island, we conducted stable isotope analysis of California mussels from CA-ANI-2 (Jew and Rick, 2014). Twenty California mussels from Unit 1 were sampled for $\delta^{18}O$ analysis to produce paleo-sea-surface temperature (PSST) data that were used to infer site seasonality. Each shell was inspected for an intact terminal growth band (TGB), rinsed in deionized water, and etched with hydrochloric acid (0.5 M). Calcium carbonate ($CaCO_3$) from exterior layers of each shell was removed using a Sherline 5410 micromill with a carbide drill bit (0.05 mm). Following Jew et al. (2013, 2014), five powder samples were taken in 3 mm intervals along the growth axis, producing PSST estimates for 12 mm of growth. As a profile baseline, nine

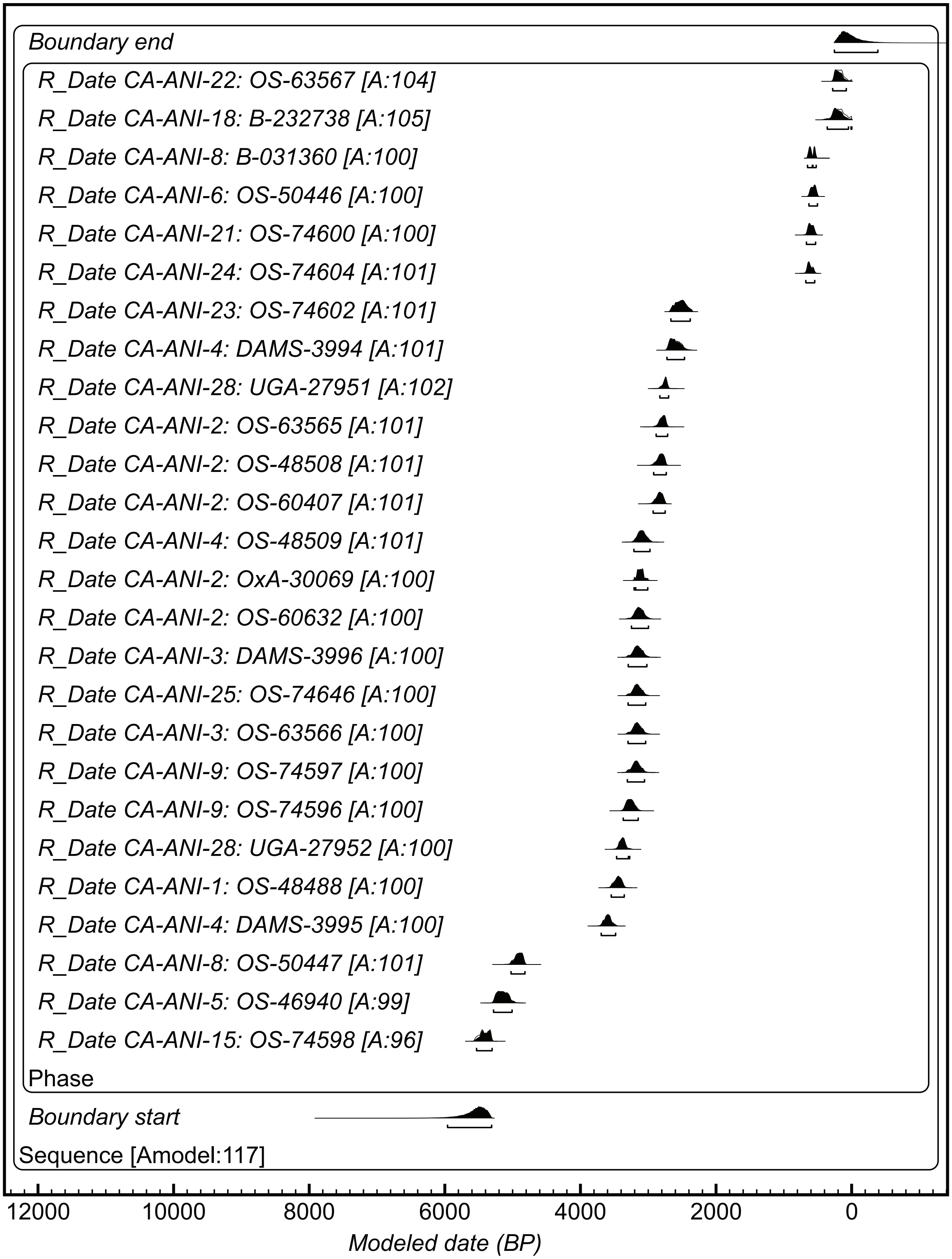

FIGURE 13. Bayesian phase model for radiocarbon dates from Anacapa Island.

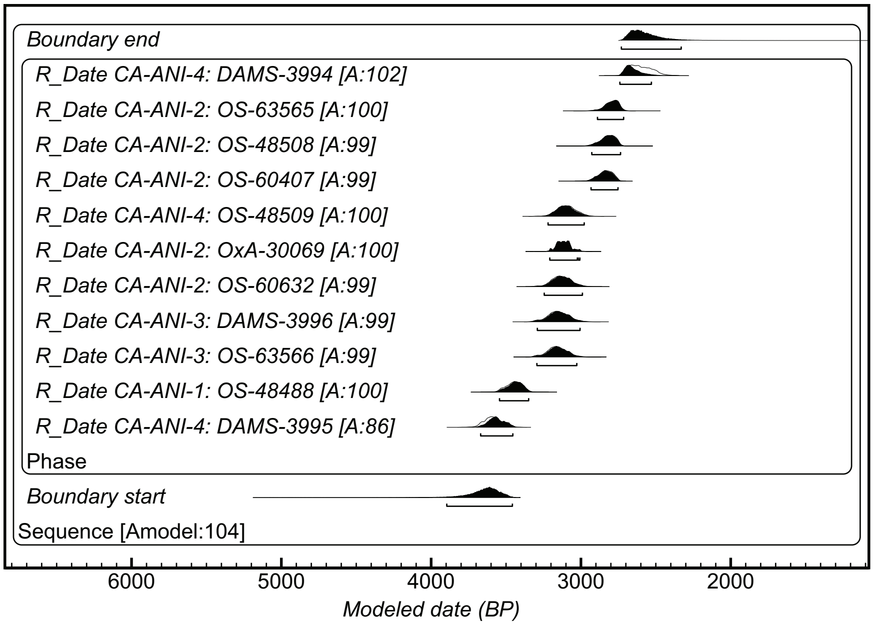

FIGURE 14. Bayesian phase model for radiocarbon dates from East Anacapa.

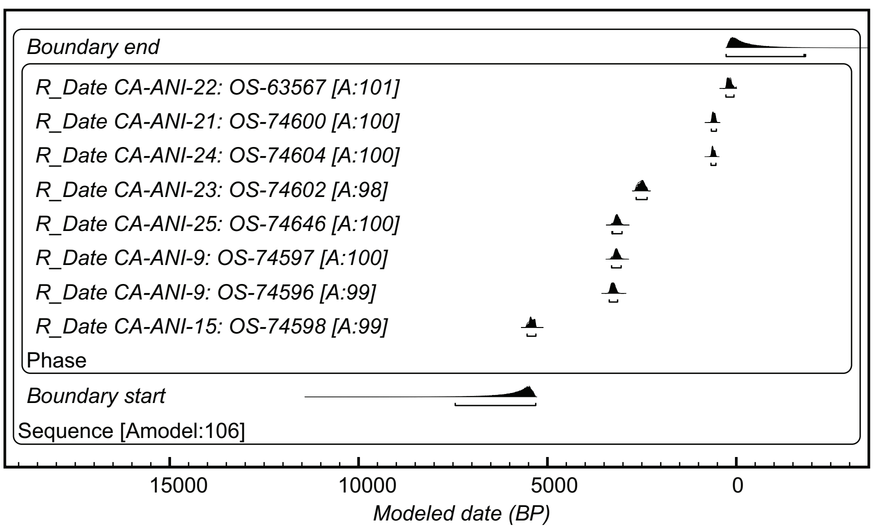

FIGURE 15. Bayesian phase model for radiocarbon dates from Middle Anacapa.

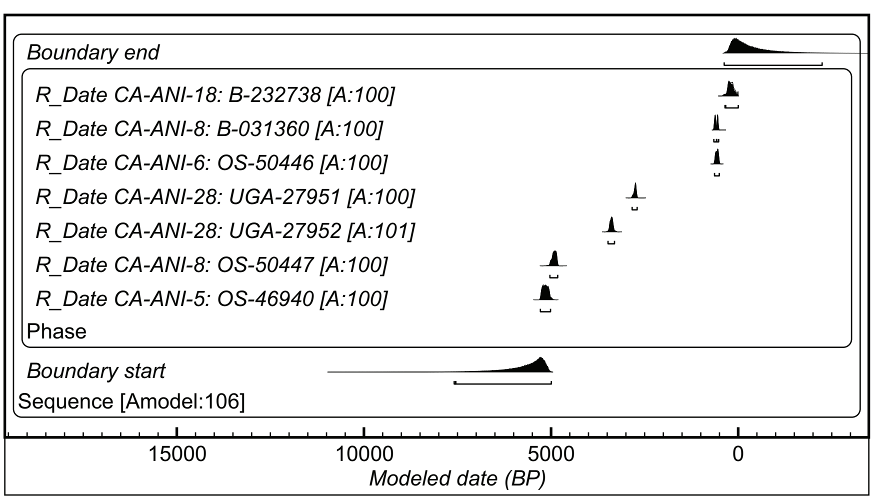

FIGURE 16. Bayesian phase model for radiocarbon dates from West Anacapa.

carbonate samples for ~24 mm of growth were taken from shell CA-ANI-2-1, and estimated temperature values were compared with modern values.

Calcite samples were analyzed at the Stable Isotope Laboratory in the University of Oregon's Department of Geological Sciences. Samples were loaded into Exetainers, placed in an autosampler, and flushed with helium. Samples were reacted with several drops of 100% orthophosphoric acid to produce carbon dioxide. The stable isotope ratios $\delta^{18}O$ and $\delta^{13}C$ were measured using a Finnigan MAT 253 isotope ratio mass spectrometer with continuous helium flow. All values are reported in δ notation in per mil (‰) units relative to the Vienna Pee Dee Belemnite (VPDB) standard using the formula

$$\delta^{18}O = [(R_{sample} - R_{standard})/R_{standard}] \times 1{,}000,$$

where R represents the heavy/light ratio for the abundance of any two isotopes. A positive δ value represents a more enriched heavy isotope in comparison to the standard, and negative δ values are associated with the depletion of heavy isotopes. Following other studies in the region (Glassow et al., 1994; Kennett, 2005), we used Epstein et al.'s (1951) formula for converting $\delta^{18}O$ values to temperature estimates as adapted for California mussels by Killingley (1981; Killingley and Berger, 1979), where

$$T\ (°C) = 16.4 - 4.2(\delta^{18}O_{cc(PDB)} - \delta^{18}O_{water(SMOW)}) + 0.13(\delta^{18}O_{cc(PDB)} - \delta^{18}O_{water(SMOW)})^2.$$

Around 3000 cal BP there is a change in mean ocean water temperature ($\Delta_{0m}\delta^{18}O_{sw}$) in the Pacific Ocean of ~0.07‰ (see LeGrande and Schmidt, 2009). Adjustments to the ice volume correction ($\delta^{18}O_{water(SMOW)}$) are based on an ocean water sample ($\delta^{18}O$ = –0.32‰) from Santa Rosa Island, providing a correction of –.25‰ (Robbins and Rick, 2007).

Modern $\delta^{18}O$ values reported for California mussels from the Santa Barbara Channel region range between ~0.8‰ and –0.6‰ (see Kennett, 1998:451–453). Modern SST for Anacapa ranges from ~14°C to 19°C (Figure 17) with increasing water temperatures (16°C to 19°C) between late June and early September and decreasing (19°C to 15°C) from late September to early December with further declines from late December to early March and an increase from late March to early June (Kennett, 2005:56). The $\delta^{18}O$ values for the CA-ANI-2-1 shell profile range from ~0.8‰ to -0.7‰ (VPDB), which yields a PSST estimate ranging from ~13°C to 19.5°C. The average PSST estimate from shell CA-ANI-2-1 is 16.7°C (Figure 17), within the range of the modern SST average of 16.2°C (±1°C). Consequently, estimated seasonal ranges were modeled after typical modern SST seasonal change. Seasonality for each shell was assigned, where x equals the TGB and estimated PSST at the time of collection and y equals the estimated PSST for the prior season at 12 mm of growth (as described in Table 4). The

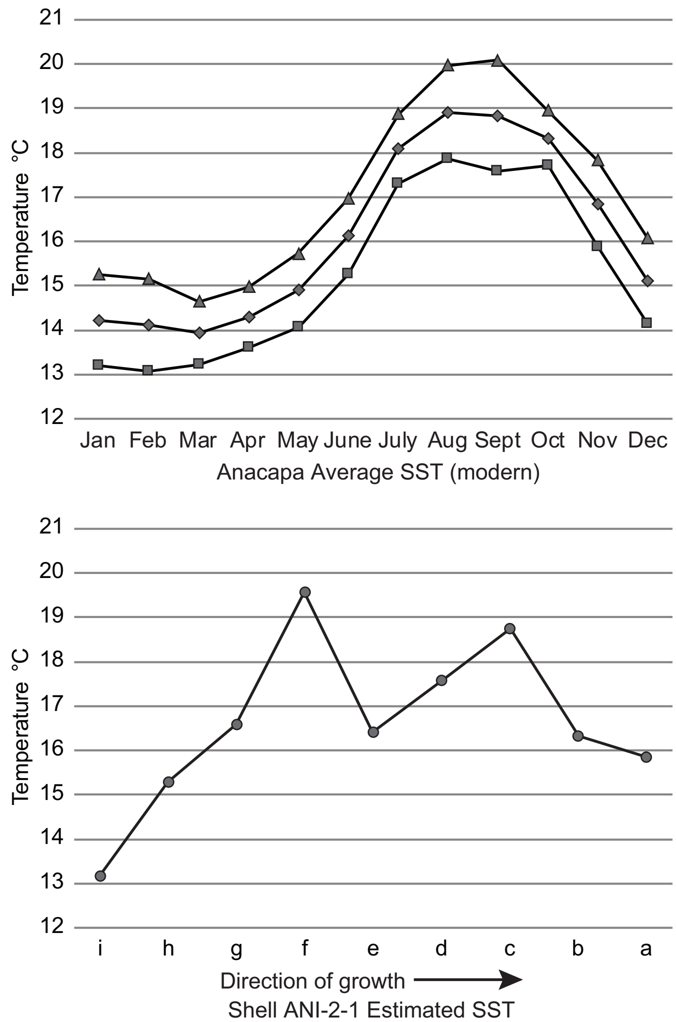

FIGURE 17. Top: Modern seasonal sea-surface temperature (SST) for Anacapa Island, including 95% confidence intervals (see Kennett, 2005:56). Bottom: Estimated SST ranges from shell ANI-2-1. (Letters i–a on the x-axis refer to sample numbers in Table 5). Adapted from Jew and Rick (2014).

directional changes between PSST values above or below the seasonal mean provide parameters to assign a season of harvest (Table 4).

Isotopic analysis suggests that California mussels were harvested in a wide range of water temperatures at CA-ANI-2. The minimum recorded PSST is 12.3°C, and the maximum is 24.8°C, with a mean of 16.6°C and standard deviation of 2.36. Ranges and means for individual shells (Figure 18, Table 5) varied considerably, with the warmest estimated PSST from shell CA-ANI-2-13 and a range of ~16°C to 24°C. Two mussel shells (CA-ANI-2-15 and CA-ANI-2-20) yielded cooler water temperatures between ~12°C and 16.5°C. Mean PSST for most shells

TABLE 4. Expected seasonal sea-surface temperature (SST) changes for Anacapa Island, including directional changes between *x* and *y* values (for additional descriptions of methods, see Jew et al., 2013, 2014), and the assigned seasonal distributions and percentages for 20 mussel shells sampled from site CA-ANI-2, Unit 1.

Season	SST model x value	SST model y value	Results for CA-ANI-2
Summer	$x \geq 16$°C	$x > y$	$n = 7$ (35%)
Fall	$x \geq 15$°C	$x < y$	$n = 4$ (20%)
Winter	$x \leq 15$°C	$x < y$	$n = 7$ (35%)
Spring	$x \leq 16$°C	$x > y$	$n = 2$ (10%)

fall within 15°C to 18°C. The difference between PSST from the TGB and 12 mm of growth showed a minimum of 0.3°C and a maximum of ~9°C. The seasonal distribution of the CA-ANI-2 mussels includes summer ($n = 7$), winter ($n = 7$), fall ($n = 4$), and spring ($n = 2$), demonstrating that CA-ANI-2 was likely occupied during each season (Table 4).

Isotopic evidence of a potentially year-round occupation of CA-ANI-2 does not preclude the island from being used as a stopover by people from the mainland or Santa Cruz Island. These results suggest, however, that if being a stopover was Anacapa's primary function during the early portions of the Late Holocene, these stopovers occurred during all seasons of the year.

SUMMARY

Our radiocarbon dating project, including 26 dates from 16 archaeological sites, documents Native American occupation spanning from roughly 5500 cal BP to the early nineteenth century. The use of OxCal's Bayesian platform provided a statistical framework that helped refine and model this chronology. East Anacapa, where we focused our research, has so far produced occupation between 3700 and 2500 cal BP, a narrower range than for Middle and West Anacapa. Given the presence of occupations >13,000 years on the other northern Channel Islands (see Johnson et al., 2002; Erlandson et al., 2011b), it is likely that Anacapa was occupied prior to 5500 cal BP. A chipped-stone crescent, originally identified as a scraper or crescentic knife, was recovered from CA-ANI-11 on a high ridge of West Anacapa during the 1950s, suggesting terminal Pleistocene or Early Holocene occupation of Anacapa, as was the case on the other northern Channel Islands (McKusick, 1959:85, fig. 2). Stable isotope data from California mussel shells at CA-ANI-2 suggest that people were harvesting shellfish from this site year-round. This result challenges long-held assumptions that Anacapa may have been occupied only during certain seasons of the year (Jew and Rick, 2014). Further isotope and shellfish harvesting data will be important for determining whether other sites may also have been occupied during all seasons of the year or if some sites were occupied on a seasonal basis.

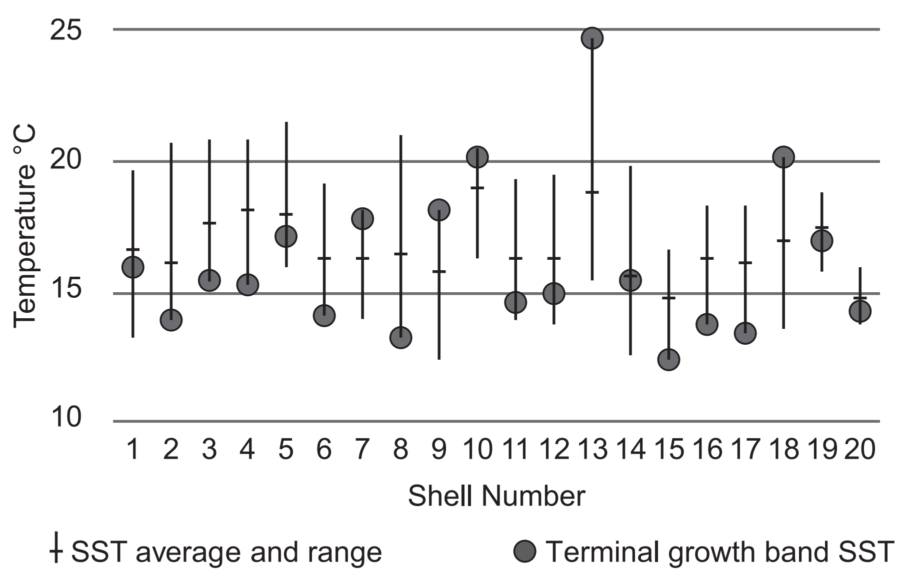

FIGURE 18. Maximum, minimum, and mean sea-surface temperature (SST) for all sampled shells from site CA-ANI-2, Unit 1. Adapted from Jew and Rick (2014).

TABLE 5. Stable isotope results and temperature averages for California mussel shells from site CA-ANI-2 (see Jew and Rick, 2014). SMOW = standard mean ocean water; VPDB = Vienna Pee Dee Belemnite.

		$\delta^{18}O$					$\delta^{18}O$		
Sample ID[a]	$\delta^{13}C$	SMOW	VPDB	Temperature (°C)	Sample ID[a]	$\delta^{13}C$	SMOW	VPDB	Temperature (°C)
ANI-1a	1.0	31.0	0.2	15.9	ANI-5d	0.2	30.8	−0.1	16.6
ANI-1a	1.1	31.0	0.2	15.9	ANI-5e	1.4	30.8	−0.1	16.6
ANI-1b	1.1	31.0	0.1	16.1	ANI-5e	1.3	30.6	−0.3	17.2
ANI-1b	1.1	30.9	0	16.6	ANI-6a	0.6	31.4	0.6	13.9
ANI-1c	1.4	30.4	−0.4	18.4	ANI-6a	0.6	31.3	0.5	14.3
ANI-1c	1.3	30.2	−0.6	19.2	ANI-6b	0.8	31.3	0.5	14.3
ANI-1d	0.9	30.7	−0.2	17.3	ANI-6b	0.8	31.2	0.4	14.7
ANI-1d	0.7	30.5	−0.3	17.9	ANI-6c	1.3	30.3	−0.5	18.4
ANI-1e	0.6	31.0	0.1	16.1	ANI-6c	1.2	30.1	−0.7	19.2
ANI-1e	0.4	30.8	−0.1	16.8	ANI-6d	1.7	30.2	−0.7	18.9
ANI-1f	0.1	30.5	−0.4	18.2	ANI-6d	1.6	30	−0.8	19.5
ANI-1f	−0.4	29.8	−1.1	21.0	ANI-6e	0.8	31.4	0.5	14.1
ANI-1g	0	31.0	0.1	16.0	ANI-6e	0.7	31.2	0.4	14.7
ANI-1g	−0.2	30.7	−0.1	17.2	ANI-7a	1.2	30.5	−0.3	17.4
ANI-1h	0.7	31.3	0.4	14.9	ANI-7a	1.1	30.4	−0.5	18.1
ANI-1h	0.6	31.1	0.2	15.7	ANI-7b	0.7	30.7	−0.1	16.7
ANI-1i	0.8	31.8	1.0	12.7	ANI-7b	0.6	30.5	−0.3	17.6
ANI-1i	0.6	31.6	0.7	13.7	ANI-7c	1.0	31.5	0.6	13.7
ANI-2a	0.1	31.7	0.8	13.2	ANI-7c	1.0	31.4	0.5	14.2
ANI-2a	−0.2	31.3	0.4	14.7	ANI-7d	1.2	31.4	0.5	14.1
ANI-2b	0.2	31.4	0.6	14.3	ANI-7d	1.2	31.4	0.5	14.2
ANI-2b	−0.2	30.9	0	16.4	ANI-7e	1.2	30.5	−0.4	17.8
ANI-2c	0.2	31.2	0.3	15.1	ANI-7e	1.1	30.3	−0.5	18.4
ANI-2c	−0.1	30.7	−0.2	17.2	ANI-8a	0.3	31.7	0.8	12.9
ANI-2d	0.2	31.4	0.5	14.4	ANI-8a	0.2	31.5	0.6	13.7
ANI-2d	0.1	31.3	0.4	14.9	ANI-8b	0.7	31.4	0.6	13.9
ANI-2e	0.3	30.0	−0.8	20.0	ANI-8b	0.6	31.3	0.4	14.4
ANI-2e	0.1	29.6	−1.2	21.5	ANI-8c	0.8	30.5	−0.3	17.6
ANI-3a	1.0	31.3	0.4	14.8	ANI-8c	0.6	30.4	−0.5	18.1
ANI-3a	0.8	31.0	0.1	16.1	ANI-8d	0.1	29.8	−1.0	20.3
ANI-3b	0.7	30.3	−0.6	18.8	ANI-8d	−0.1	29.5	−1.3	21.6
ANI-3b	0.5	29.9	−0.9	20.3	ANI-8e	−0.1	31.1	0.2	15.3
ANI-3c	0.8	29.9	−0.9	20.2	ANI-8e	−0.2	31.0	0.1	15.8
ANI-3c	0.7	29.6	−1.2	21.5	ANI-9a	0.5	30.4	−0.4	17.8
ANI-3d	0.8	31.1	0.2	15.8	ANI-9a	0.5	30.3	−0.6	18.5
ANI-3d	0.6	30.8	−0.1	16.8	ANI-9b	0.3	31.3	0.5	14.3
ANI-3e	0.2	31.0	0.1	16.1	ANI-9b	0.2	31.1	0.2	15.3
ANI-3e	0.1	30.8	0	16.7	ANI-9c	0.5	31.9	1.0	12.2
ANI-4a	1.5	30.9	0.1	15.9	ANI-9c	0.5	31.8	0.9	12.5
ANI-4a	1.5	31.2	0.4	14.7	ANI-9d	0.9	30.7	−0.2	17.0
ANI-4b	1.3	30.9	0	16.0	ANI-9d	0.8	30.5	−0.3	17.4
ANI-4b	1.2	30.7	−0.2	16.9	ANI-9e	0.4	30.9	0	16.1
ANI-4c	1.1	29.9	−1.0	20.1	ANI-9e	0.2	30.6	−0.2	17.1
ANI-4c	0.9	29.5	−1.3	21.6	ANI-10a	1.5	30	−0.9	19.7
ANI-4d	0.8	30.3	−0.6	18.5	ANI-10a	1.3	29.7	−1.1	20.7
ANI-4d	0.5	29.8	−1.0	20.4	ANI-10b	1.0	30	−0.8	19.5
ANI-4e	0.7	30.4	−0.5	18.0	ANI-10b	0.7	29.5	−1.3	21.6
ANI-4e	0.7	30.2	−0.6	18.7	ANI-10c	1.3	29.9	−0.9	19.9
ANI-5a	1.2	30.7	−0.2	16.8	ANI-10c	1.1	29.7	−1.1	20.8
ANI-5a	1.1	30.5	−0.3	17.6	ANI-10d	1.0	30.7	−0.2	16.9
ANI-5b	1.0	29.6	−1.2	21.0	ANI-10d	0.9	30.5	−0.4	17.7
ANI-5b	0.8	29.3	−1.5	22.2	ANI-10e	0.6	31	0.1	15.8
ANI-5c	0.7	30.4	−0.5	18.0	ANI-10e	0.5	30.8	−0.1	16.6
ANI-5c	0.6	30.1	−0.7	19.1	ANI-11a	1.3	31.3	0.5	14.3
ANI-5d	0.4	31.1	0.3	15.1	ANI-11a	1.3	31.2	0.3	15.0

TABLE 5. *Continued*

		δ18O					δ18O		
Sample ID[a]	$\delta^{13}C$	SMOW	VPDB	Temperature (°C)	Sample ID[a]	$\delta^{13}C$	SMOW	VPDB	Temperature (°C)
ANI-11b	0.2	30.4	–0.5	18.1	ANI-15c	0.9	31	0.1	15.8
ANI-11b	0.2	30.2	–0.6	18.7	ANI-15c	0.8	30.7	–0.1	16.7
ANI-11c	0.8	30.2	–0.7	18.9	ANI-15d	0.6	30.8	0	16.3
ANI-11c	0.7	30	–0.9	19.7	ANI-15d	0.5	30.7	–0.2	17.0
ANI-11d	0.5	31.1	0.2	15.3	ANI-15e	–0.1	31.4	0.5	14.1
ANI-11e	0.7	31.5	0.6	13.6	ANI-15e	–0.2	31.2	0.4	14.7
ANI-11e	0.6	31.3	0.5	14.3	ANI-16a	0.3	31.5	0.6	13.6
ANI-12a	1.3	31.2	0.3	14.8	ANI-16a	0.3	31.4	0.5	14.0
ANI-12a	1.2	31.2	0.3	15.0	ANI-16b	0.7	31.4	0.5	14.1
ANI-12b	1.1	31.5	0.6	13.7	ANI-16b	0.6	31.2	0.4	14.7
ANI-12b	1	31.4	0.6	13.9	ANI-16c	0.9	30.7	–0.1	16.7
ANI-12c	0.8	30.8	0	16.3	ANI-16c	0.8	30.5	–0.3	17.6
ANI-12c	0.8	30.8	–0.1	16.6	ANI-16d	0.4	30.6	–0.2	17.2
ANI-12d	0.8	30.1	–0.8	19.3	ANI-16d	0.2	30.3	–0.5	18.3
ANI-12d	0.8	29.9	–0.9	19.8	ANI-16e	0.4	30.4	–0.4	17.9
ANI-12e	0.6	30.8	0	16.3	ANI-16e	0.3	30.2	–0.6	18.6
ANI-12e	0.6	30.8	–0.1	16.6	ANI-17a	1.0	31.7	0.8	13.0
ANI-13a	–0.4	28.8	–2.0	24.4	ANI-17a	0.9	31.4	0.6	13.9
ANI-13a	–0.5	28.6	–2.2	25.1	ANI-17b	0.9	31.6	0.7	13.4
ANI-13b	0.9	30.3	–0.5	18.3	ANI-17b	0.7	31.3	0.5	14.3
ANI-13b	0.9	30.2	–0.6	18.8	ANI-17c	0.9	30.7	–0.2	16.8
ANI-13c	0.6	30	–0.8	19.6	ANI-17c	0.6	30.3	–0.6	18.5
ANI-13c	0.5	29.9	–0.9	19.9	ANI-17d	0.6	30.8	0	16.3
ANI-13d	0.2	31.1	0.3	15.1	ANI-17d	0.4	30.6	–0.3	17.4
ANI-13d	0.1	31	0.1	15.7	ANI-17e	0.4	30.6	–0.3	17.3
ANI-13e	–0.2	31.1	0.2	15.2	ANI-17e	0.1	30.1	–0.8	19.3
ANI-13e	–0.2	31	0.2	15.6	ANI-18a	1.9	29.9	–1.0	20.1
ANI-14a	0.3	31.2	0.3	14.9	ANI-18b	1.5	30.8	0	16.4
ANI-14a	0.2	31	0.1	15.8	ANI-18c	1.4	30.3	–0.5	18.3
ANI-14b	0.4	30.1	–0.8	19.4	ANI-18d	1.3	30.9	0	16.1
ANI-14b	0.3	29.9	–1.0	20.1	ANI-18e	1.1	31.5	0.7	13.5
ANI-14c	0.8	31.1	0.3	15.1	ANI-19a	1.4	30.6	–0.2	17.0
ANI-14c	0.7	31	0.1	15.6	ANI-19b	1.3	30.9	0.1	15.8
ANI-14d	0.2	31.3	0.4	14.6	ANI-19c	1.1	30.6	–0.3	17.3
ANI-14d	0.2	31.2	0.4	14.7	ANI-19d	1.3	30.3	–0.6	18.5
ANI-14e	–0.4	31.8	0.9	12.4	ANI-19e	0.9	30.2	–0.6	18.8
ANI-14e	–0.5	31.7	0.8	12.8	ANI-20a	1.5	31.3	0.5	14.3
ANI-15a	1.1	31.9	1.0	12.0	ANI-20b	0.6	30.9	0.1	15.9
ANI-15a	1.0	31.7	0.8	12.8	ANI-20c	0.7	31.5	0.6	13.8
ANI-15b	1.0	31.5	0.6	13.8	ANI-20d	0.5	31.3	0.4	14.4
ANI-15b	0.9	31.2	0.3	14.9	ANI-20e	0.7	31.1	0.2	15.2

[a]Note that “CA-” and -2” in sample numbers have been dropped for brevity.

4 Technology and Tool Production

Torben C. Rick, Nicholas P. Jew, and Thomas A. Wake

We recovered a wide variety of artifacts during our research on Anacapa Island. These objects include expedient and formal tools as well as beads from our excavations at sites CA-ANI-2, CA-ANI-3, and CA-ANI-4. In this chapter, we present the results of our analysis of these artifacts and provide a detailed discussion of the types of technologies that people were using on the island, focusing on four major categories: bone, chipped-stone, shell, and miscellaneous artifacts such as tarring pebbles.

The bone tools we recovered provide evidence for production of mammal-bone gorges that were used for making fishhooks and other tools. The bone-tool assemblage includes everything for the production of gorges and transport of raw materials from the mainland. Our analysis follows previous bone-tool research by Wake (2001) for Santa Cruz Island. Shell artifacts were limited to just three objects, and our analysis follows Bennyhoff and Hughes (1987), Arnold and Graesch (2001), and Rick (2007).

For chipped-stone tools, we build on the work of Jew et al. (2015b) that described an initial analysis of tools from CA-ANI-2, CA-ANI-3, and CA-ANI-4 and the use of a possible local Anacapa Island chert source. We describe this newly confirmed chert source in the following on the basis of Jew's 2015 fieldwork and present the chipped-stone tools from CA-ANI-3 and CA-ANI-4.

After summarizing the artifacts from our excavations, we discuss previous Anacapa Island artifact studies, including research on microblades and other tools from excavations at sites CA-ANI-6 and CA-ANI-8 (Rozaire, 1978, 1993). We also discuss other descriptions of artifacts observed during surveys and small collections from earlier research (Glassow, 1977; Greenwood, 1978).

BONE ARTIFACTS

Bone artifacts recovered from East Anacapa Island include utilitarian tools ($n = 45$) such as bipointed fish gorges, bird-bone awls, worked antler, and miscellaneous bits of scraped and ground bone from CA-ANI-2 and CA-ANI-4 (Table 6). One additional mammal bone, a pointed tip of a barb or awl, was the only bone artifact recovered from CA-ANI-3. Similar types of diagnostic artifacts from Santa Cruz Island are discussed by Wake (2001) and have been classified throughout California by Gifford (1940) and Bennyhoff (1950).

The most common bone artifacts recovered from CA-ANI-2 and CA-ANI-4 are ground and smoothed bipointed splinters of dense mammalian cortical bone, often

TABLE 6. Bone gorge measurements. A dash (—) indicates not determinable.

Site	Catalog No.	Unit	Level	Length (mm)	½ length[a] (mm)	Estimated length[b] (mm)	Width (mm)	Condition
CA-ANI-2	57	1c	2	—	18.88	37.76	3.69	Half complete
CA-ANI-2	18	1	4	26.83	18.34	36.68	2.33	One tip missing
CA-ANI-2	14	1	4	40.83	24.59	49.18	3.18	One tip missing
CA-ANI-2	15	1	4	—	17.77	35.54	3.35	Half complete
CA-ANI-2	16	1	4	—	18.21	36.42	3.35	Half complete
CA-ANI-2	17	1	4	28.06	16.37	32.74	2.53	One tip missing
CA-ANI-2	27	1	5	19.38	—	—	2.06	Complete
CA-ANI-2	22	1	5	23.77	—	—	2.09	Complete
CA-ANI-2	25	1	5	35.71	—	—	3.13	Complete
CA-ANI-2	26	1	5	38.82	21.48	42.96	3.92	One tip missing
CA-ANI-2	28	1	5	—	18.64	37.28	3.41	Half complete
CA-ANI-2	29	1	5	—	17.86	35.72	3.82	Half complete
CA-ANI-2	30	1	5	—	24.45	48.90	3.49	Half complete
CA-ANI-2	513	2c	4	37.88	—	—	3.52	Complete
CA-ANI-2	512	2c	4	35.74	—	—	3.96	Complete
CA-ANI-2	508	2c	3	—	23.50	47.00	4.21	Half complete
CA-ANI-2	518	2	2	40.53	—	—	3.46	Complete
CA-ANI-2	515	2	2	44.58	—	—	3.63	Complete
CA-ANI-2	539	2	4	—	24.68	49.36	4.09	Half complete
CA-ANI-2	537	2	4	—	16.79	33.58	3.84	Half complete
CA-ANI-2	538	2	4	—	26.07	52.14	4.49	Half complete
CA-ANI-2	514	2	2	—	18.33	36.66	3.23	Half complete
CA-ANI-2	37	1	6	—	20.26	40.52	3.17	Half complete
CA-ANI-2	32	1	6	—	19.92	39.84	2.80	One tip missing
CA-ANI-2	521	2	3	36.12	—	—	2.76	Complete
CA-ANI-2	535	2	3	24.94	—	—	2.13	Complete
CA-ANI-2	523	2	3	35.97	27.21	54.42	4.04	One tip missing
CA-ANI-2	522	2	3	—	32.16	64.32	5.33	Half complete
CA-ANI-2	527	2	3	—	32.98	65.96	4.36	Half complete
CA-ANI-2	533	2	3	24.10	13.88	27.76	2.48	One tip missing
CA-ANI-2	528	2	3	—	24.75	49.50	4.79	Half complete
CA-ANI-2	525	2	3	—	21.24	42.48	4.10	Half complete
CA-ANI-2	519	2	3	29.32	21.20	42.40	3.97	One tip missing
CA-ANI-2	524	2	3	—	18.52	36.50	3.37	Half complete
CA-ANI-2	532	2	3	—	13.62	27.24	2.12	Half complete
CA-ANI-4	—	1	4	30.84	—	—	3.10	Complete
CA-ANI-4	—	1	4	—	27.23	54.46	4.55	One tip missing

[a]Specimens that were at least half complete were measured from the thickest part of the barb to the tip. That measurement was then doubled to estimate the length of the whole specimen. ½ length = measurement from midpoint to tip, approximating half of the total gorge.

[b]Estimated length = ½ measurement times 2, yielding estimated total length.

referred to as fish gorges (Figure 19). These artifacts are relatively short and slender, with the thickest portion located at the midsection and tapering to a sharp point at either end. Several worked splinters from both CA-ANI-2 and CA-ANI-4 appear to be either rejected or unfinished, representing gorges in production.

A bone gorge is a simple yet effective piece of toggling fishing gear that was tied to the end of relatively fine, strong cordage at the midpoint. Some archaeological examples have a band of asphalt or a dark mastic at the lashing point (midsection) of the artifact, ostensibly to help secure the line to the gorge. Similar

FIGURE 19. Bone gorges from sites CA-ANI-2 (left) and CA-ANI-4 (right). Photo by Thomas Wake, 2017.

gorges are prepared for use in fishing today by folding one end of the bipoint against the line and inserting it into a chunk of bait. When swallowed by a fish, tension on the line causes the gorge to toggle in the throat or mouth and the fish then can be hauled to the surface (Salls, 1988). Recent use of replicated gorges observed that successful captures involved gorges piercing the lips and mouthparts of fish, not deeper in the throat as might be presumed (Kevin Smith, University of California, Davis, personal communication 2016).

The 10 complete gorges from CA-ANI-2 and CA-ANI-4 were measured to better understand their morphological characteristics and range of sizes. The average length of these gorges is 32.95 mm, with a range of 19.38 to 44.58 mm. The ends of these gorges are ground to a fine, sharp point. The most robust part of each gorge is located at its center, which is probably the lashing point. The maximum thickness of the lashing point averages 2.98 mm, with a range of 2.06 to 3.96 mm (Table 6).

Broken gorges are more common in the collection than complete ones. Most of these specimens appear to be broken at or near the thickest part of the gorge, at the lashing point, suggesting they were broken inside of a fish and represent an equipment failure. Wake (e.g. 2001) also measured all of the broken specimens from their thickest part to the pointed end and then multiplied by 2 to approximate a complete gorge. The resulting larger sample size suggests a slightly greater average size for deer-bone fish gorges from these sites: 40.18 mm in length (ranging from 65.96 to 19.38 mm) and 3.46 mm in thickness (ranging from 2.06 to 5.33 mm; Table 6).

Worked Bird Bone

Two worked large-bird (albatross-sized) radii (Figure 20) were recovered from CA-ANI-2, Unit 1, Levels 5 and 6. One (Figure 20, top) is ground to a point and smoothed at one end with numerous longitudinal scraping and smoothing marks on its surface. The other (Figure 20, middle) is a shaft fragment missing both ends but covered in longitudinal scrape marks, indicating removal of the periosteum. Another large-bird wing bone (Figure 20, bottom), possibly an albatross ulna, was recovered from CA-ANI-2, Unit 1, Level 3. This midshaft fragment shows numerous longitudinal scraping and smoothing marks and appears polished. Two worked albatross (*Phoebastria* sp.) proximal radii (Figure 21) were recovered from CA-ANI-2, Unit 1, Level 3. Both specimens were circumferentially cut or scored close to the proximal articular end and snapped off,

FIGURE 20. Artifacts made from bird radii. Photo by Thomas Wake, 2017.

FIGURE 21. Cutoff proximal albatross (*Phoebastria* sp.) radii. Photo by Thomas Wake, 2017.

perhaps part of the process for producing bird-bone tubes for unknown use.

Worked Deer-Antler Fragments

Three deer, probably black-tailed deer (BTD; *Odocoileus hemionus*), antler tine tips (Figure 22) were recovered from CA-ANI-2, Unit 2, Levels 2 and 3. All of these tips appear to be lightly burned or fire hardened. They all also have ground and/or worn facets, similar to those found on antlers used as pressure flakers by Wake (1997) at Fort Ross in northern California. One of these tine tips has been circumferentially chopped and snapped off the antler shaft.

A Deer-Bone Fish Gorge Industry on East Anacapa Island

A demand for the appropriate raw material for the production of bone fishing equipment could explain the unusually large BTD bone assemblage recovered from CA-ANI-2 and CA-ANI-4. Although the importance of BTD in relation to subsistence strategies and other vertebrate and invertebrate remains is discussed in Chapter 5, we summarize important aspects of the BTD bone assemblage and other vertebrate remains here to help document the BTD tool industry on East Anacapa Island.

Bone fragments identified as BTD or probably BTD constitute 11.1% of the identified mammal bone assemblage (as quantified by count, including fragments identified only to size class) at CA-ANI-2, 19.9% of all mammal specimens identified to at least order, and 76.6% of the terrestrial mammal assemblage recovered from CA-ANI-2 (Chapter 5). When intrusive Historic period invasive European rabbit (*Oryctolagus cuniculus*) specimens are removed from the sample, BTD represent 95.5% of the terrestrial mammal bone specimens recovered from CA-ANI-2. BTD represent 67% of the identified terrestrial mammal specimens (not including undifferentiated terrestrial mammals) from CA-ANI-4 and 80% when invasive mammals from the Historic period are removed.

The majority of the identified BTD bones represent portions (Figure 23) that have very low meat utility values, such as carpals, tarsals, metacarpals, and metatarsals (Binford, 1978; Jacobson, 2000; Madrigal, 2004). Ten BTD specimens are identified as tibia fragments. Tibiae have higher meat utility values than metapodials because of the presence of the calf muscle covering the proximal third of the element, but only one BTD specimen is identified as a proximal tibia. The remaining nine BTD tibia specimens are either distal articulation or shaft fragments. The distal shaft of the tibia is straight and similar in thickness to the metapodials. The terrestrial mammal bone splinters identified as limb bone most likely represent fragments of the lower

FIGURE 22. Deer (*Odocoileus hemionus*) antler tine artifacts. Photo by Thomas Wake, 2017.

FIGURE 23. Smashed deer (*Odocoileus hemionus*) metapodial, tibia, and bone splinters. Photo by Thomas Wake, 2017.

limb elements that dominate the identified BTD assemblage. It is not likely, therefore, that the BTD bone specimens represent meat from the mainland transported to and consumed on East Anacapa Island. Instead, the BTD metapodials and distal tibiae from CA-ANI-2 and CA-ANI-4 most likely represent raw material transported to East Anacapa Island for the manufacture of fish gorges. Deer metapodials are sources of raw material widely used by California Indians to make a variety of bone tools, especially those that pierce, such as awls, pins, and bipoints (Gifford, 1940; Bennyhoff, 1950; Fauvelle and Perry, in press).

Although marine mammal bones and bone fragments constitute the bulk of the identified mammal specimens from both CA-ANI-2 and CA-ANI-4, they generally are not as good of a raw material for bone tools as large terrestrial mammal bones. The bones of dolphins, pinnipeds, and sea otters are adapted to locomotion in an aquatic environment, where they do not need to support an individual's mass against the forces of gravity. Instead, marine mammals contend primarily with buoyancy and crushing pressures when diving to pressures of 10 atmospheres or more (e.g., LeBoeuf et al., 1986). Bones of marine mammals tend to be relatively porous and have thinner cortical bone and marrow cavities filled with cancellous tissue, which better accommodate life in the sea. Although whale bone is often used to make bone artifacts by circumpolar coastal peoples, those implements tend to be robust and designed to take advantage of the less-dense properties of marine mammal bone (Heizer, 1956; Wake, 1997).

The bones of terrestrial mammals such as BTD have evolved to withstand rapid movement over rough terrain. Their weight-bearing bones have relatively thick, dense cortical bone surrounding open marrow cavities with cancellous tissue concentrated at the ends of each bone. The greater density of BTD cortical bone as opposed to that of seal or sea lion bone most likely translates to greater resistance to breakage, especially of long, thin splinters of bone. The better strength of BTD long-bone splinters makes them the preferred material for the manufacture of bone gorges.

On the basis of the BTD specimens and terrestrial mammal bone fragments recovered from CA-ANI-2 and CA-ANI-4, we propose the following gorge production sequence for East Anacapa Island. BTD metapodials and a few tibiae were brought from the mainland to East Anacapa Island whole and most likely fresh. These skeletal elements were then smashed open with a stone hammer at the proximal and distal ends as well as along the shafts with the goal of producing many long, slender splinters of dense cortical bone. Preferred bone splinters were then selected and ground on all surfaces into a slender bipoint with a thicker midsection. Sometimes these splinters were rejected or left unfinished, producing worked splinters or gorges in production. The finished gorge was then lashed to a line, sometimes using an adhesive, and used to catch fish. Figures 24, 25, and 26 illustrate a refinement of the dimensions of deer bone splinters progressing from raw bone splinters (Figure 24), to worked bone splinters (Figure 25), to finished products (Figure 26). When broken, the gorges were cast aside, and a new one was used, resulting in a collection dominated by short, slender, and sharp broken gorges.

LITHIC RAW MATERIAL SOURCES AND CHIPPED-STONE ARTIFACTS

Lithic artifacts from East Anacapa Island include a variety of expedient chipped-stone tools (see Jew et al., 2015b). Most of what we know regarding lithic technologies from Anacapa Island relates to early Late Holocene assemblages recovered from CA-ANI-2 (Jew et al., 2015b), basic descriptions of artifacts noted during surface survey or small-scale testing (e.g., Greenwood, 1978), and the analysis of microblades and other artifacts from CA-ANI-6 and CA-ANI-8 (Rozaire, 1978, 1993). We focus on chipped-stone lithic analysis of CA-ANI-2, CA-ANI-3, and CA-ANI-4, building on our previous research (Jew et al., 2015b) and providing new insights into lithic raw material sources on Anacapa Island.

In 2015, during an archaeological survey of East Anacapa, Jew returned to CA-ANI-2 and other East Anacapa Island sites. With excellent ground visibility from a prolonged drought and ongoing removal of invasive vegetation by the National Park Service, Jew identified a local Anacapa Island chert source on East Anacapa Island. Previous studies had identified a source of low-quality chalcedonic chert on West Anacapa (known as Anacapa Cico; Greenwood, 1978; Rick, 2006, 2011), but many artifacts did not appear to be from this West Anacapa material source or to be like stone from the other Channel Islands (Jew et al., 2015b). This new source on East Anacapa, referred to as *'Anyapax* polychromatic chert, includes several large outcrops and nodules (Figure 27). The polychromatic chert source is situated approximately 300 m northeast of CA-ANI-2 on a ridge above the sloping northern face of the island. The location would have been easily accessible to the occupants of CA-ANI-2, CA-ANI-3, and CA-ANI-4, and it might have influenced the decision for the location of some of these archaeological sites. In 2016, Jew surveyed a portion of West Anacapa and found several isolated artifacts on the surface, including several cores and chipped-stone artifacts made from similar polychromatic chert and also chalcedonic chert from known sources at Frenchy's Cove.

All chipped-stone artifacts recovered from CA-ANI-2, CA-ANI-3, and CA-ANI-4 were analyzed by Jew in a manner consistent with his previous work on Anacapa and other Channel Island stone-tool assemblages (Jew and Erlandson, 2013; Jew et al., 2015b). A total of 859 chipped-stone artifacts were recovered from the three sites, including 667 from CA-ANI-2, 43 from CA-ANI-3, and 149 from CA-ANI-4. Anacapa stone-tool technologies include end and side scrapers, macrodrills/punches, winged-side notched tools, hammerstones, and core tools (Figures 28, 29). Ninety-five percent (n = 814) of chipped-stone artifacts, including flakes, shatter, cores, and crude bifaces, were manufactured from local Anacapa Cico (chalcedonic chert found

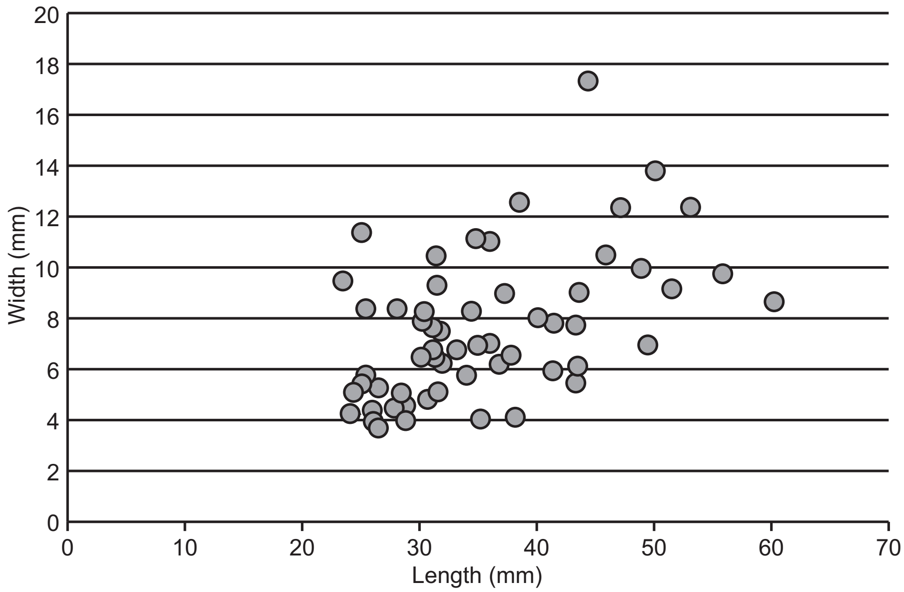

FIGURE 24. Unworked bone splinter dimensions (mm).

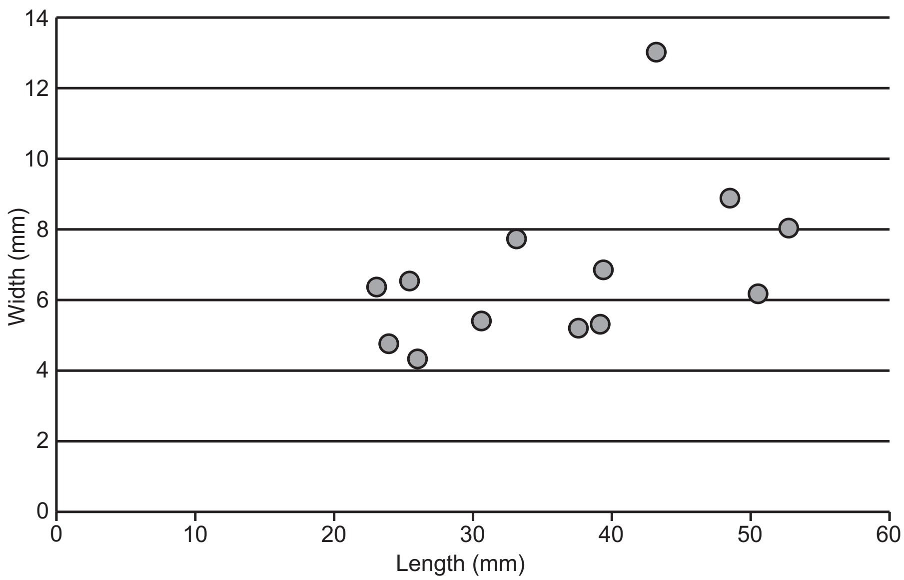

FIGURE 25. Worked bone splinter dimensions (mm).

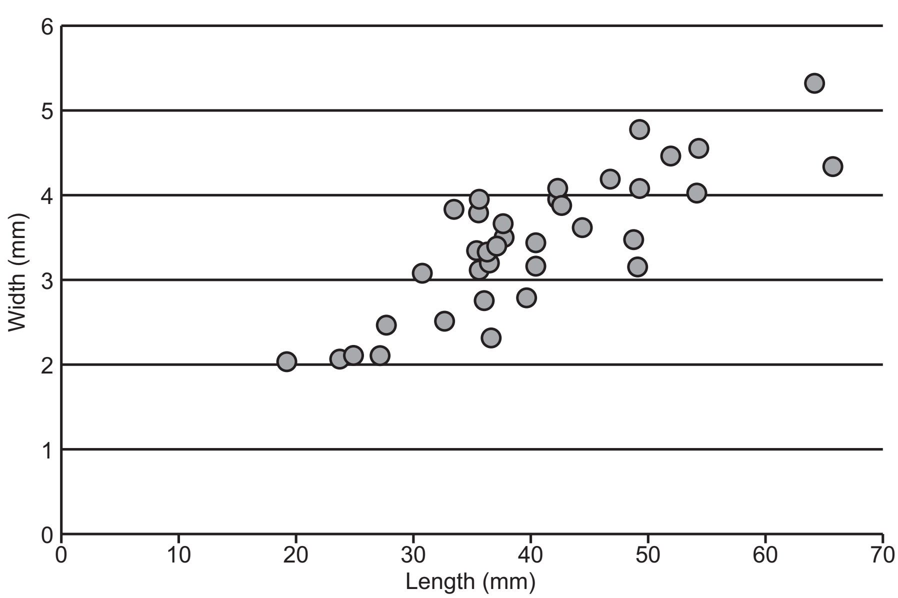

FIGURE 26. Completed bone gorge dimensions (actual and extrapolated, mm). Note the progression of gorge production, as the overall width-to-length ratio narrows from unworked bone to worked bone to completed bone gorges.

FIGURE 27. Close-up of polychromatic chert source outcrop located on East Anacapa near site CA-ANI-2. Photo by Nicholas Jew, 2015.

at Frenchy's Cove on West Anacapa) and polychromatic material found East Anacapa (Table 7, Figure 30).

Although the majority of artifacts appear to have been made of local chert obtained on East Anacapa or the chalcedonic source on West Anacapa, at least one tool was made from what appears to be higher-quality chert likely obtained from Santa Cruz Island (Jew et al., 2015b; see Perry and Jazwa, 2010 for a discussion of Santa Cruz Island cherts). There is also evidence that people on Anacapa participated in broader regional exchange networks. This participation in regional exchange networks is supported by an obsidian chipped-stone flake recovered in Unit 1 at CA-ANI-4. Energy dispersive X-ray fluorescence chemical analysis of this flake by Northwest Research Obsidian Studies Laboratory in Corvallis, Oregon (see http://www.obsidianlab.com for methods and discussion of procedures), suggested that it came from the Coso volcanic field West Sugarloaf source located in eastern California (Table 8). These data join 69 previous X-ray fluorescence analyses of California island obsidian, most of which also derives from the Coso source in eastern California (Rick et al., 2001). Included in these analyses were three obsidian projectile points that are from an unknown site on Anacapa Island and are housed in the Santa Barbara Museum of Natural History collections (Figure 31). Of these three previously analyzed points, two derive from the Coso source, and one derives from the Casa Diablo source, also in eastern California (Rick et al., 2001). In addition to the obsidian artifacts, Rick also recovered a fused shale, chipped-stone stemmed biface from the surface of CA-ANI-5, which likely came from the Grimes Canyon source on the mainland in Ventura County. These data demonstrate that people on Anacapa Island were engaged in far-reaching exchange networks that extended well into eastern California.

SHELL ARTIFACTS

Compared with bone and stone tools, shell artifacts are rare in the excavated East Anacapa sites. None were recovered in the relatively small assemblages from CA-ANI-3 and CA-ANI-4, and there were only three *Olivella biplicata* shell beads at CA-ANI-2 (Table 9, Figure 32; Reeder and Rick, 2009). These include two *Olivella* barrel beads, with one each from Units 1 and 2, and an *Olivella* cap bead recovered from

FIGURE 28. Examples of expedient chipped-stone tools from East Anacapa, illustrating the diversity in form and material types from sites CA-ANI-2 (top row) and CA-ANI-4 (bottom row). Scale is in centimeters. Photo by Torben Rick.

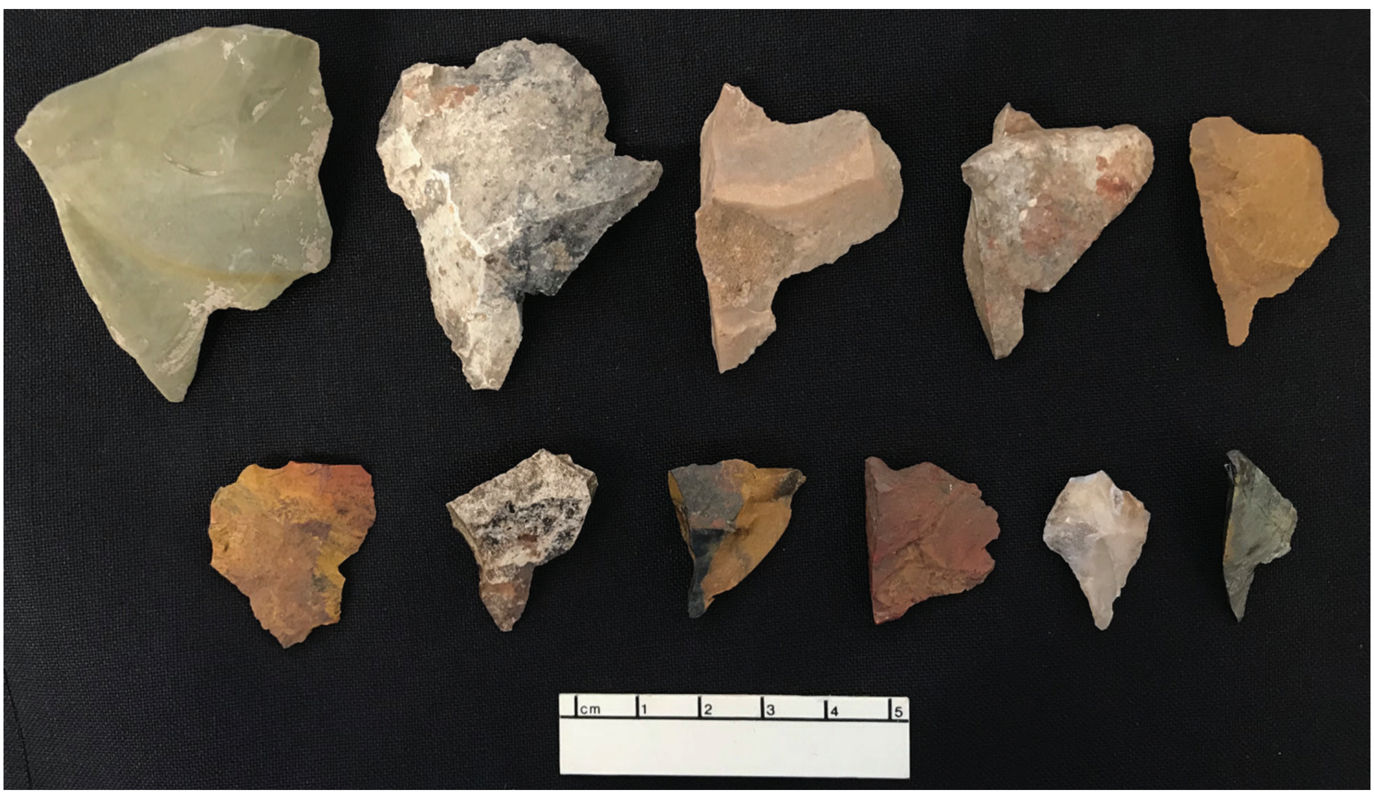

FIGURE 29. Expedient chipped-stone, winged flake artifacts and fragments from East Anacapa Island from sites CA-ANI-2 (top row), CA-ANI-4 (first five artifacts, bottom row), and CA-ANI-3 (bottom row, far right artifact). Scale is in centimeters. Photo by Torben Rick.

TABLE 7. Stone-tool materials categorized by material, artifact type, and site on East Anacapa Island. A dash (—) indicates not applicable.

Material type	Debitage	Cores	Flake tools	Hammerstones	Total counts
			CA-ANI-2		
Basalt	—	—	—	4	4
Quartzite	1	4	2	—	7
Miscellaneous	8	—	2	—	10
Anacapa Cico	65	6	20	—	91
Polychrome	444	67	44	—	555
CA-ANI-2 subtotal	518	77	68	4	667
			CA-ANI-3		
Cico	—	—	1	—	1
Basalt	1	—	—	—	1
Quartzite	2	—	—	—	2
Miscellaneous	2	—	—	—	2
Anacapa Cico	14	—	3	—	17
Polychrome	17	1	2	—	20
CA-ANI-3 subtotal	36	1	6	—	43
			CA-ANI-4		
Shale	—	—	2	—	2
Obsidian	—	—	1	—	1
Basalt	2	—	—	—	2
Franciscan	2	—	—	—	2
Miscellaneous	11	—	—	—	11
Anacapa Cico	22	3	7	—	32
Polychrome	80	6	13	—	99
CA-ANI-4 subtotal	117	9	23	—	149
Total	671	87	97	4	859

Unit 1. These bead types have wide temporal distribution but are consistent with the early Late Holocene ages of these sites (Bennyhoff and Hughes, 1987). The age of these bead types is also supported by the absence of *Olivella* wall, callus, or other beads that are cultural hallmarks of the latter half of the Late Holocene (Arnold and Graesch, 2001).

Consistent with the dearth of *Olivella* or other shell beads is the limited amount of *Olivella* shell recovered at each of the sites (Chapter 5). At CA-ANI-4, we recovered just 1.5 g of *Olivella* (minimum number of individuals = 2, <1% of weight or minimum number of individuals). At CA-ANI-2 only 0.6 g from a single individual was recovered in the Unit 1 column sample. No *Olivella* shell was recovered from CA-ANI-3 or in the other contexts at CA-ANI-2. We also did not uncover any shell fishhooks or other clearly worked shell artifacts.

OTHER ARTIFACTS

Beyond the chipped-stone, bone, and shell artifacts recovered from the East Anacapa sites, the only other artifacts were tarring pebbles and fragments of asphalt. We recovered three tarring pebbles from CA-ANI-2, including one (27.0 g) from Unit 1 and two (72.6 g) from Unit 2. In Unit 2, we found 2.7 g of asphalt in Unit 1 and 2.5 g in Unit 2. We recovered no tarring pebbles or asphalt in the samples from CA-ANI-3 or CA-ANI-4.

Intrusive historical artifacts were recovered at all three excavated sites. At CA-ANI-2 we found a bullet shell casing in the uppermost level of Unit 1. Another bullet shell casing was recovered from a bulk sample at CA-ANI-3. As described in Chapter 2, we found broken glass and a few pieces of brick throughout the CA-ANI-4 excavation unit.

ANACAPA ISLAND ARTIFACTS NOTED BY OTHER RESEARCHERS

Although only limited research has been conducted on Anacapa Island, a few of the previous projects described artifacts from East Anacapa Island sites, including descriptions of materials from CA-ANI-1, -2, -3, and -4. In 1970, Meighan excavated at CA-ANI-2, and although no report was produced, Glassow

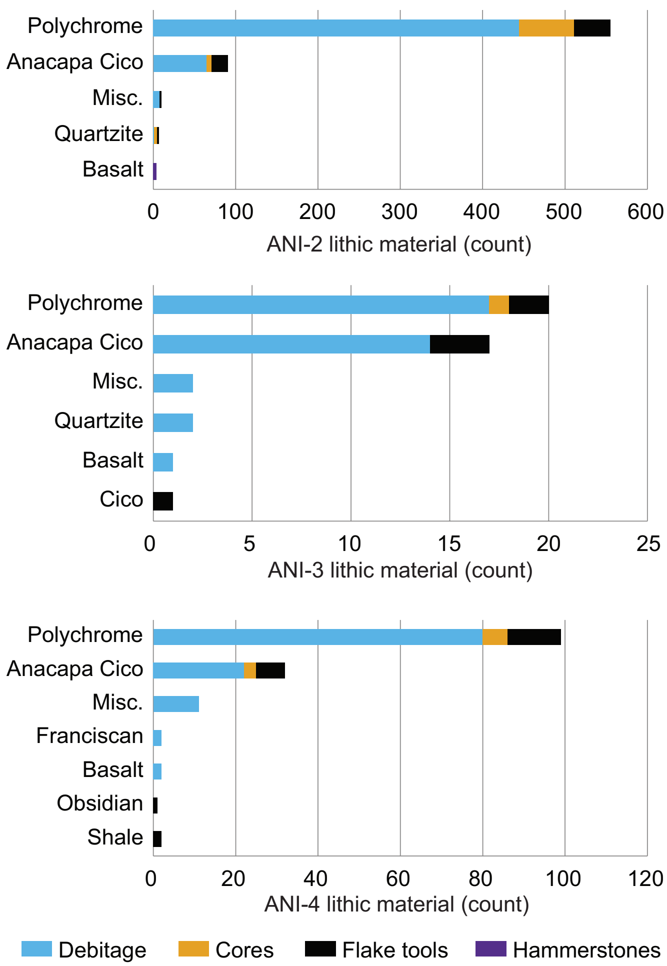

FIGURE 30. The proportion of lithic assemblages from different sources.

(1977:76–77; see also Greenwood, 1978:53) describes a catalog that lists 26 faunal fragments and 16 artifacts. These artifacts include chert and quartzite utilized flakes, a chert reamer, a sandstone pestle fragment, a quartzite chopper, a chert core, and a quartzite biface (Glassow, 1977). Greenwood (1978) also mentions a worked seal tooth recovered from CA-ANI-2 by Rozaire and McKusick. Aside from the presence of a pestle, these artifacts are consistent with our results, including no shell artifacts. However, the absence of any bone artifacts is surprising given the large number we recovered.

Greenwood (1978) suggested that CA-ANI-3 had a high concentration of lithics relative to the modest amount of shell and noted the presence of one formal tool, a tan chert side scraper, as well as chert, quartzite, and basalt debitage. She also mentioned that Rozaire collected a pestle, mano, polyhedral platform core, and side scraper at the site and noted the presence of a human tibia (Greenwood, 1978:54).

At CA-ANI-4, Greenwood (1978:55) described chert, chalcedony, and quartzite flakes, a quartzite knife with unifacial modification, and a sandstone pebble tool that she argued may have been a knife or scraper. Although we did not work at CA-ANI-1 other than to radiocarbon date the site and produce a map, Greenwood (1978:51) reported chipped-stone debitage, a scraper, a core, and other materials that are generally consistent with the other sites.

The other large assemblage of artifacts comes from West Anacapa and Rozaire's work at CA-ANI-6 and CA-ANI-8 (Rozaire, 1978, 1993). The CA-ANI-6 artifact assemblage supports the late Middle or Late period age of the site (Rozaire, 1993; Rick, 2006). Rozaire's (1978, 1993) work at CA-ANI-6 uncovered microblades (bladelets), microblade cores, and microdrills; leaf-shaped bifaces; shell fishhooks; *Olivella* and steatite beads; and other artifacts. A large oval glass trade bead was also found on the site surface (Rozaire, 1978:35). At CA-ANI-8, Rozaire (1978) excavated three human burials and recovered

TABLE 8. X-ray fluorescence analysis of Anacapa Island obsidian samples. Rb = rubidium, Sr = strontium, Y = yttrium, Zr = zirconium, Nb = niobium, Ba = barium, Fe = iron, Mn = manganese, Ti = titanium, NM = not measured.

		Trace element concentration						Ratios		
Site	Artifact	Rb	Sr	Y	Zr	Nb	Ba	Fe:Mn	Fe:Ti	Artifact source
CA-ANI[a]	Projectile point	273 ± 4	14 ± 9	51 ± 3	163 ± 7	44 ± 1	4 ± 27	49.4	92.3	Coso (West Sugarloaf)
CA-ANI[a]	Projectile point	171 ± 4	100 ± 9	17 ± 3	192 ± 7	16 ± 1	975 ± 28	44.7	49.7	Casa Diablo (Lookout Mountain)
CA-ANI[a]	Projectile point	272 ± 4	10 ± 9	52 ± 3	141 ± 7	51 ± 1	0 ± 27	31.4	105.2	Coso (West Sugarloaf)
CA-ANI-4	Debitage	348 ± 4	14 ± 2	61 ± 2	153 ± 3	51 ± 3	0 ± 35	NM	NM	Coso (West Sugarloaf)

[a]Samples from Rick et al. (2001). Santa Barbara Museum of Natural History catalog numbers from top to bottom for first three artifacts: NA-CA-129-3A-14, NA-CA-129-3A-15, NA-CA-129-3A-16. Specific site(s) or location(s) are unknown.

FIGURE 31. Obsidian projectile points from Anacapa Island (from left to right, Santa Barbara Museum of Natural History catalog number NA-CA-129-3A-14, NA-CA-129-3A-15, and NA-CA-129-3A-16). Rick et al. (2001), *Pacific Coast Archaeological Society Quarterly*.

microblades, shell beads, shell fishhooks, bone gorges and other bone tools, and a variety of vertebrate and invertebrate faunal remains, with radiocarbon dates suggesting Late and Middle Holocene occupations.

McKusick (1959) described artifacts from his work at Anacapa, as well as material from the 1941 Los Angeles County Museum (LACM) expedition. One of the artifacts listed as a scraper from CA-ANI-11 on West Anacapa and attributed to the LACM collection housed at the University of California, Los Angeles, is morphologically similar to the midsection of Paleocoastal crescents dated to the Early Holocene and terminal Pleistocene on other Channel Islands (Erlandson et al., 2011b). Pictures of this artifact suggest that it is a Paleocoastal crescent and, as noted previously, demonstrates that Anacapa was likely occupied earlier than the 5,500-year-old dates suggested by radiocarbon dating.

TABLE 9. *Olivella biplicata* shell beads from site CA-ANI-2, East Anacapa Island.

Provenience	Description	Diameter (mm)	Height (mm)
Unit 1, Stratum 4	*Olivella* barrel bead	4.9	4.8
Unit 1, Stratum 5	*Olivella* cap bead	6.1	2.3
Unit 2, Stratum 3	*Olivella* barrel bead	4.9	5.7

Rick (2011) reported eight *Olivella* wall disk beads (four with evidence of needle drilling), two utilized/retouched flakes, a chert core, a chert flake, and a trapezoidal microblade core at Freshwater Cave (CA-ANI-18). Along with radiocarbon dates these artifacts suggest a Historic period occupation of Freshwater Cave. Finally, Greenwood (1978) and others have reported additional artifacts observed during surface work or from previous small-scale testing, but these artifacts don't differ significantly from the materials described here.

DISCUSSION

Collectively, the artifacts from East Anacapa Island demonstrate the production of bone, stone, and shell tools. The production of bone gorges demonstrates a tool industry that relied heavily on transport of BTD limb elements from the mainland. These gorges also emphasize the importance of Anacapa as a site for intensive fishing, a topic we turn to in Chapter 5, which discusses subsistence. The presence of abundant BTD remains raises another question about whether people were based permanently on Anacapa Island or used it as a stopover while traveling to and from the adjacent mainland. The deer bones suggest there was interaction between Anacapa and the mainland, and perhaps people on the mainland even used the island as a fishing ground. We return to this topic in Chapter 6.

The stone tools suggest the opposite pattern, with people appearing to focus largely on the procurement of raw materials from local sources close to both CA-ANI-2 and CA-ANI-4. We suspect the chert source adjacent to the site was a possible reason for settlement at CA-ANI-2 and other East Anacapa sites. Although the vast majority of the tools at the early Late Holocene sites are from local materials, some likely Santa Cruz Island chert and an obsidian flake from CA-ANI-4 suggest trade with other islands and the mainland interior, respectively. Shell and other tools were relatively rare, but the beads generally support an early Late Holocene site chronology. Work by other researchers, including surface collections and excavated materials, suggest a wide range of artifacts from Anacapa, including Late Holocene microblade materials and Paleocoastal crescents. In the next chapter, we place these data within the context of faunal remains and subsistence data from the sites.

FIGURE 32. *Olivella* cap and barrel beads from site CA-ANI-2 (left bead from Unit 1, Stratum 5; middle bead from Unit 2, Stratum 2; and right bead from Unit 1, Stratum 4). Photo by Torben Rick, 2017.

5

Subsistence, Diet, and Environmental Interactions

Leslie A. Reeder-Myers, Kenneth W. Gobalet, John M. Hash, Torben C. Rick, and Thomas A. Wake

Given its rugged coastline and dearth of safe boat landings, ancient foraging on Anacapa Island must have been relatively challenging. Today, fresh water is found only in an isolated spring, with no perennial running water on any of the island segments. As a result, vegetation is currently dominated by coastal bluff scrub and coastal sage scrub, with trees and shrubs limited primarily to two protected gullies on the northern slope of West Anacapa and at Shepherd's Landing on Middle Anacapa (Schoenherr et al., 1999:307). California sea lions and harbor seals are commonly seen in the waters and rocks around the island, but the absence of extensive beaches, except at Frenchy's Cove on West Anacapa, limits the area for pinnipeds to haul out. The rocky coasts of Anacapa support rich rocky intertidal and kelp-forest ecosystems, and the island is more exposed to the warm, southerly waters of the California Countercurrent than some of the other northern Channel Islands (Figure 33). The steep slopes of the island (see Chapter 1, Figure 2, and Chapter 2, Figure 11) likely made it difficult for people to bring marine resources to sites on the top of the island, although access may have been easier in the past. Anacapa Island hosts enormous colonies of nesting birds, especially western gulls (*Larus occidentalis*) and brown pelicans (*Pelecanus occidentalis*), the latter of which use Anacapa and Santa Barbara Islands as a primary nesting area along the West Coast of the United States (Schoenherr et al., 1999). Given these issues, how did people forage on Anacapa Island, and what animal resources were the focus of their subsistence strategies?

Vertebrate and invertebrate faunal remains recovered from archaeological sites on Anacapa Island tell us which animal resources people exploited and provide insight into why they spent time on this small island. In this chapter, we describe material recovered from sites CA-ANI-2 (3250–2710 cal BP), CA-ANI-3 (3300–3030 cal BP), and CA-ANI-4 (3700–2460 cal BP) on East Anacapa, as well as material reported from earlier excavations by McKusick (1959) on Middle Anacapa and at sites CA-ANI-6 (630–500 cal BP) and CA-ANI-8 (5030–4820 cal BP and later) on West Anacapa (Rozaire, 1978; Sandefur, 1978; Walker et al., 1978). These collections reveal a diverse assemblage of shellfish, fish, birds, and mammals, demonstrating similarities to both the mainland and other northern Channel Islands. Ultimately, these data challenge previous perspectives on the role of Anacapa Island in past human settlement and subsistence systems.

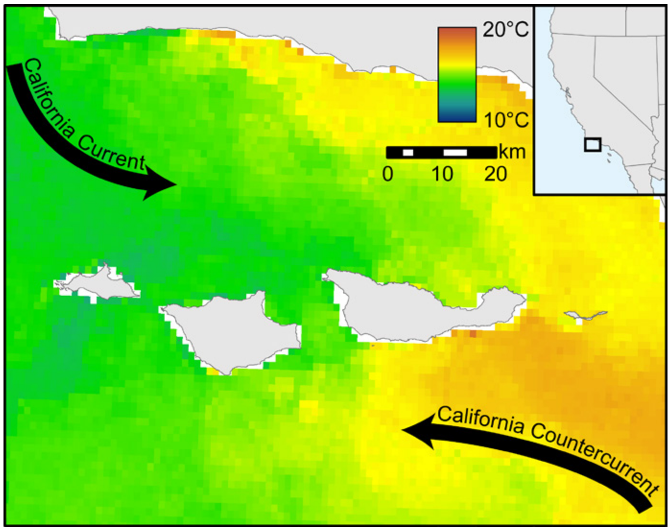

FIGURE 33. Average sea-surface temperature in the Southern California Bight, including the general directions of the cool, northerly California Current and warm, southerly California Countercurrent. Note the warmer waters surrounding Anacapa Island.

METHODS

The assemblage from CA-ANI-2 includes vertebrate remains from two 1 × 1 m units, excavated in arbitrary 10 cm levels and screened over ⅛-inch mesh (see Chapter 2). Also included are the vertebrate and invertebrate remains from two 0.25 × 0.25 m column samples, excavated in stratigraphic levels and screened over 1⁄16-inch mesh. At CA-ANI-3, vertebrate and invertebrate remains were recovered from two small bulk samples (5 L each) screened over 1⁄16-inch mesh. At CA-ANI-4, vertebrate and invertebrate remains come from a 1 × 0.5 m unit excavated in arbitrary 10 cm levels and screened over ⅛-inch mesh. This site was badly disturbed, and only one of the lower levels (Level 4, 54 to 64 cm below the surface) was sufficiently intact for detailed analysis of faunal remains.

The two 1 × 1 m units at CA-ANI-2 were sorted in the field. Vertebrate remains greater than ⅛ inch were retained for analysis (see Chapter 2). Shellfish with hinges or spires appropriate for determining the minimum number of individuals (MNI) were counted in the field, and whole California mussel, black abalone, and owl limpet valves were measured. Invertebrate remains from the 1 × 1 m units were then discarded. For all other samples, including the column samples from CA-ANI-2, we followed sampling procedures similar to those of other projects on the northern Channel Islands (Kennett, 1998; Rick, 2007). All material greater than 1⁄16 inch was returned to the lab. It was then screened through ¼-, ⅛-, and 1⁄16-inch mesh.

The entire invertebrate sample greater than ¼ inch was sorted and analyzed, and a 25% by weight sample of invertebrates greater than ⅛ inch and less than ¼ inch was sorted and analyzed by Rick, Reeder-Myers, and students trained in sorting shell midden. All student-identified samples were reviewed by either Rick or Reeder-Myers. Material less than ⅛ inch was saved for future analysis. Shellfish were sorted and identified using comparative material at the National Museum of Natural History. Nomenclature for invertebrates follows Integrated Taxonomic Information System (ITIS) standards for shellfish and other invertebrates.

All nonpiscene vertebrates greater than ⅛ inch from CA-ANI-2, CA-ANI-3, and CA-ANI-4 were sorted and analyzed by Wake (mammals, birds, and reptiles) one class at a time. Gobalet identified the fish remains from CA-ANI-3 and CA-ANI-4, and Hash completed the bulk of the identifications from CA-ANI-2. The CA-ANI-2 data were published as part of a summary of the Native American fishery of the islands of Southern California (Turnbull et al., 2015). We also summarize fish remains from CA-ANI-6 and CA-ANI-8 that were identified by Steve Craig and reported by Walker et al (1978).

The comparative specimens used in this study include fish in Gobalet's personal collection, which were recently donated to the Department of Ichthyology at the California Academy of Sciences. The nomenclature and order of listing for fish in the tables follows the standard of the American Fisheries Society (Page et al., 2013). The biology of these fish is described in Allen et al. (2006), Love (2011), and Kells et al. (2016).

At the University of California, Los Angeles, Wake consulted skeletal specimens housed in the Zooarchaeology Laboratory's Comparative Osteological Collection at the Cotsen Institute of Archaeology and used the Dickey Bird and Mammal Collection to identify the reptile, bird, and mammal remains from CA-ANI-2 and CA-ANI-4. Nomenclature for the higher vertebrates follows ITIS standards for the birds, mammals, and reptiles.

RESULTS OF FAUNAL ANALYSIS

Shellfish

Invertebrate remains are similar to those found elsewhere on the northern Channel Islands, dominated by California mussel with contributions from black abalone, sea urchin, and a number of other species (Figure 34). The assemblage at CA-ANI-2 (Table 10) is dominated by California mussel (81.7% by weight, 83.1% by MNI), followed by black abalone (3.0% by weight, 2.6% by MNI). Various species of limpets are also common (0.6% by weight, 10.6% by MNI). In all samples from Anacapa, limpet MNI is somewhat inflated by the frequency of extremely small (<10 mm) limpets. Both column samples at CA-ANI-2 were excavated stratigraphically, and results suggest minimal differences in shellfish composition across the strata (Figure 35).

California mussel (79.3% by weight, 72.7% by MNI) is also the most abundant shellfish at CA-ANI-3 (Table 11), followed by black abalone (6.2% by weight, 5.1% by MNI), undifferentiated abalone (1.5% by weight, 3.0% by MNI), and owl limpets (1.5%

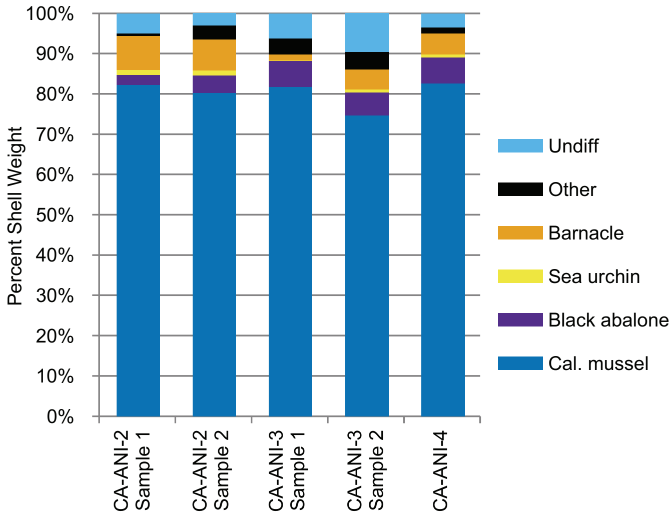

FIGURE 34. Relative contribution of major shellfish by weight for excavation units on East Anacapa Island. Cal. = California; Undiff = undifferentiated.

by weight, 6.1% by MNI). The two samples from CA-ANI-3 were chronologically distinct (see Chapter 2), but differences in the composition of these two samples are minimal (Table 11, Figure 34). Because of severe disturbance in the upper portion of CA-ANI-4, we analyzed only the lowest stratum, which appeared to be less fragmented and more intact. The results are very similar to those for the other sites (Table 12), including (in rank order) California mussel (82.6% by weight, 86.7% by MNI), black abalone (6.4% by weight, 0.4% by MNI), and owl limpets (0.5% by weight, 3.2% by MNI; Table 12, Figure 34).

We also measured whole California mussel, black abalone, and owl limpet shells from Unit 1 at CA-ANI-2 to document possible human predation pressure on these shellfish species (Erlandson et al., 2008, 2011a). Unfortunately, the other sites and units did not yield enough whole shellfish for meaningful analysis. Because of potential issues with stratigraphic mixing at CA-ANI-2 and uneven sample sizes throughout the different levels in Unit 1, we lumped all measurements together for an average shell length for each species. Fifty-four black abalone shells produced an average of 65.6 mm, 85 whole owl limpet shells produced an average of 35.8 mm, and 674 California mussel shells produced an average of 45.7 mm. The California mussel measurements are roughly comparable to similarly aged samples from San Miguel Island, but about 4 to 7 mm larger than both the Middle (n = 15 assemblages) and Late (n = 12 assemblages) Holocene averages for all assemblages from San Miguel Island (Erlandson et al., 2008). The black abalone average from CA-ANI-2 is smaller than both the Middle (n = 9 assemblages) and Late (n = 7 assemblages) Holocene averages for San Miguel Island, including all but two Late Holocene assemblages. The owl limpet measurements from CA-ANI-2 are also smaller than all but one of 19 trans-Holocene assemblages from San Miguel Island and are about 6 mm smaller than the one similarly aged sample (Erlandson et al., 2011a). This variability could be the result of differing environmental conditions since Anacapa and San Miguel are in parts of the Santa Barbara Channel with different temperatures and currents (Figure 33). Future research on Anacapa shellfish size could aid in the understanding of the effects of environmental and anthropogenic factors on shellfish size.

Vertebrates

Although shellfish remains on East Anacapa are similar in diversity to other northern Channel Island shell middens of a similar age (see the following Discussion), vertebrate remains are remarkably diverse and suggest that people who spent time on Anacapa Island maintained a complex subsistence system. CA-ANI-2 is particularly interesting, with at least 13 species of fish, 15 species of birds, one reptile, seven species of marine mammals, and three species of terrestrial mammals (excluding exotics and undifferentiated fish; number of identified specimens [NISP] = 2,931). At CA-ANI-3, we identified at least 10 species of fish, three species of birds, and two species of marine mammal (NISP = 369). CA-ANI-4 produced 11 species of fish, six species of birds, three species of marine mammal, and two species of terrestrial mammals (excluding exotics, NISP = 1,458). Although we have less information about analyses from previous excavations on West Anacapa, it appears that species richness was similar.

California sheephead (*Semicossyphus pulcher*) is the most common fish by NISP at all three excavated sites (42.2% at CA-ANI-2, 54.1% at CA-ANI-3, and 48.6% at CA-ANI-4). Various surfperches (15.0% at CA-ANI-2, 25.9% at CA-ANI-3, and 26.3% at CA-ANI-4) were also abundant (Table 13). Blacksmith (*Chromis punctipinnis*) was common at CA-ANI-2 (8.4% of NISP) and CA-ANI-4 (8.4% of NISP) but was not identified at CA-ANI-3. Rockfish (*Sebastes* spp.) remains were extremely common at CA-ANI-2 (25.3% of NISP) but rare at CA-ANI-4 (1.1% of NISP) and not identified at CA-ANI-3. Fish diversity was similar at CA-ANI-6 and CA-ANI-8 reported by Walker et al. (1978) for West Anacapa, including California sheephead, various surfperches, rockfishes, and cabezon (*Scorpaenichthys marmoratus*). Species identified from the West Anacapa sites but not on East Anacapa include lingcod (*Ophiodon elongatus*), yellowtail jack (*Seriola lalandi*), jack mackerel (*Trachurus symmetricus*), and yellowfin croaker (*Umbrina roncador*; Rozaire, 1978; Walker et al., 1978).

There is greater variability between sites in the recovered bird remains (Table 14). At CA-ANI-2, albatross species make up half of the identified specimens, especially short-tailed albatross (*Phoebastria albatrus*, NISP = 46, 28.4% of all birds excluding undifferentiated birds), followed by cormorants (genus *Phalacrocorax*, NISP = 45, 27.8%). Among the cormorants, the pelagic cormorant (*Phalacrocorax pelagicus*, NISP = 16, 9.9%) and Brandt's cormorant (*Phalacrocorax penicillatus*, NISP = 6,

TABLE 10. Weight (Wt) and minimum number of individuals (MNI) of shellfish from site CA-ANI-2. A dash (—) indicates not applicable; undiff. = undifferentiated.

		Unit 1 column				Unit 2 column				CA-ANI-2 total			
Taxon	**Common name**	**Wt (g)**	**% Wt**	**MNI**	**% MNI**	**Wt (g)**	**% Wt**	**MNI**	**% MNI**	**Wt (g)**	**% Wt**	**MNI**	**% MNI**
Bivalvia	Clam, undiff.	0.7	<0.1	0	0.0	—	—	—	—	0.7	<0.1	0	0.0
Brachyura	Crab, undiff.	1.1	<0.1	0	0.0	0.4	<0.1	0	0.0	1.5	<0.1	0	0.0
Cirripedia	Barnacle, undiff.	1,096.3	7.8	0	0.0	311.5	6.2	0	0.0	1,407.8	7.4	0	0.0
Fissurella volcano	Volcano limpet	—	—	—	—	0.2	<0.1	2	0.3	0.2	<0.1	2	0.1
Gastropoda	Gastropod, undiff.	—	—	—	—	0.4	<0.1	5	0.6	0.4	<0.1	5	0.2
Gastropoda	Land snail, undiff.	1.4	<0.1	8	0.5	4.6	0.1	18	2.3	6.0	<0.1	26	1.1
Gastropoda	Limpet, undiff.	19.6	0.1	122	8.0	7.7	0.2	84	10.7	27.3	0.1	206	8.9
Haliotis cracherodii	Black abalone	354.8	2.5	31	2.0	217.1	4.3	28	3.6	571.9	3.0	59	2.6
Haliotis sp.	Abalone, undiff.	1.3	<0.1	0	0.0	—	—	—	—	1.3	<0.1	—	—
Lottia gigantea	Owl limpet	7.0	<0.1	0	0.0	75.5	1.5	25	3.2	82.4	0.4	25	1.1
Megathura crenulata	Giant keyhole limpet	4.2	<0.1	2	0.1	6.4	0.1	10	1.3	10.6	0.1	12	0.5
Mollusca	Nacre, undiff.	469.8	3.4	0	0.0	138.3	2.8	0	0.0	608.0	3.2	0	0.0
Mollusca	Shell, undiff.	226.5	1.6	0	0.0	14.5	0.3	0	0.0	240.9	1.3	0	0.0
Mytilidae	Mussel, undiff.	4.6	<0.1	0	0.0	—	—	—	—	4.6	<0.1	0	0.0
Mytilus californianus	California mussel	11,509.3	82.2	1,325	86.9	4,008.2	80.2	592	75.6	1,5517.5	81.7	1,917	83.1
Neobernaya spadicea	Chestnut cowry	2.2	<0.1	1	0.1	—	—	—	—	2.2	<0.1	1	<0.1
Norrisia norrisi	Norris's top snail	—	—	—	—	14.4	0.3	1	0.1	14.4	0.1	1	<0.1
Olivella biplicata	Purple olive shell	0.6	<0.1	1	0.1	—	—	—	—	0.6			
Pollicipes polymerus	Gooseneck barnacle	78.9	0.6	0	0.0	77.1	1.5	0	0.0	156.0	0.8	0	0.0
Polyplacophora	Chiton, undiff.	8.2	0.1	0	0.0	34.4	0.7	0	0.0	42.6	0.2	0	0.0
Septifer bifurcatus	Platform mussel	16.1	0.1	32	2.1	5.8	0.1	10	1.3	21.9	0.1	42	1.8
Strongylocentrotus sp.	Sea urchin	179.0	1.3	0	0.0	60.5	1.2	0	0.0	239.5	1.3	0	0.0
Tegula funebralis	Black turban	1.0	<0.1	1	0.1	9.0	0.2	8	1.0	10.0	0.1	9	0.4
Tegula sp.	Turban, undiff.	0.6	<0.1	1	<0.1	—	—	—	—	0.6	<0.1	1	<0.1
Vermetidae	Tube worm, undiff.	21.2	0.2	0	0.0	10.0	0.2	0	0.0	31.2	0.2	0	0.0
Total shellfish		14,004.4	100.0	1,524	100.0	4,996	100.0	783	100.0	1,9000.1	100.0	2,306	100.0

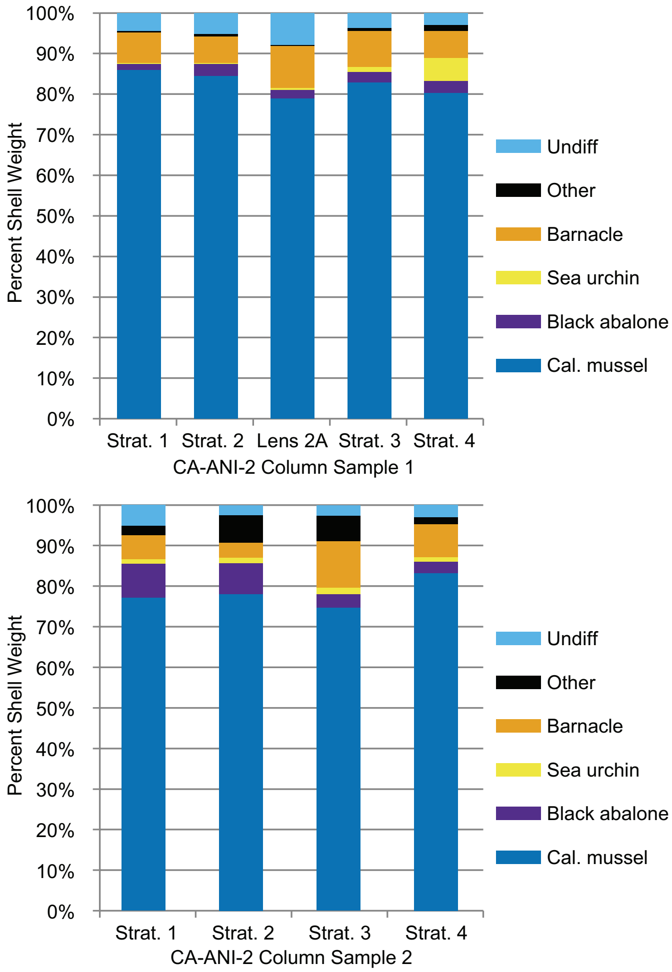

FIGURE 35. Relative contribution of major shellfish by weight for each stratum (Strat.) at site CA-ANI-2, as determined from column sample 1 (top) and column sample 2 (bottom). Cal. = California; Undiff = undifferentiated.

3.7%) are most common. Members of the Laridae (gulls and terns) make up 9.3% (NISP = 15) of the CA-ANI-2 assemblage, whereas only seven specimens (4.3%) were identified to the Alcidae family (auks, auklets, and murrelets). At CA-ANI-3, the relatively small sample is dominated by cormorants (NISP = 7), with both Brandt's and pelagic cormorants identified. One Cassin's auklet (*Ptychoramphus aleuticus*) specimen was identified at CA-ANI-3 as well. At CA-ANI-4, on the other hand, the alcids are most common (NISP = 48, 60.8%), especially Cassin's auklet (NISP = 44, 55.7%), whereas no albatross were found in the assemblage. Cormorants were well represented (NISP = 25, 31.6%) but dominated by Brandt's cormorant (NISP = 13, 16.5%). Only three bones were identified as Laridae (3.8% of NISP). At both CA-ANI-2 and CA-ANI-4, a single specimen was identified as pelican. Relatively few birds were identified at CA-ANI-6 and CA-ANI-8 on West Anacapa, including a member of the duck family, the pelagic cormorant and Brandt's cormorant, an albatross, and Cassin's auklet (Rozaire, 1978; Walker et al., 1978).

Assemblages of marine mammals at all three sites are dominated by pinnipeds, with smaller contributions from sea otters and cetaceans, especially dolphins (Table 15). Harbor seals (*Phoca vitulina*) are the most common pinniped at CA-ANI-2 (NISP = 197, 27.9% of identified marine mammals) and also include one specimen at CA-ANI-3. California sea lions (*Zalophus californianus*, NISP = 11, 1.6%), Guadalupe fur seals (*Arctocephalus townsendi*, NISP = 1, 0.1%), and northern elephant seals (*Mirounga angustirostris*, NISP = 1, 0.1%) were also present at CA-ANI-2. At CA-ANI-4, harbor seals were again the most common marine mammal (NISP = 37, 35.6%), followed by California sea lions (NISP = 7, 6.7%). California sea otters (*Enhydra lutris*) were more common at CA-ANI-2 (NISP = 54, 7.6%) than at CA-ANI-4 (NISP = 3, 2.9%), and a single specimen was also present in the bulk sample at CA-ANI-3. Dolphins and porpoises were relatively rare at CA-ANI-2 (NISP = 17, 2.4%) but included several individuals and possibly a baleen whale. Cetaceans were more common at CA-ANI-4 (NISP = 14, 13.5%), but none could be identified to a more exclusive taxon. On West Anacapa, Rozaire (1978) reported the remains of Guadalupe fur seals, harbor seals, northern elephant seals, California sea lions, and dolphins from CA-ANI-6 and CA-ANI-8.

The large terrestrial mammal assemblage at CA-ANI-2 is composed almost exclusively of black-tailed deer (NISP = 190, 95.5%), with most specimens being metapodials or other long bones used for tool making (see Chapter 4). A few specimens identified as island fox (*Urocyon littoralis*, NISP = 6, 3.0%) were also recovered from CA-ANI-2. The island fox, endemic to the Channel Islands, is not currently found on any of the three sections of Anacapa Island (Hofman et al., 2016). Black-tailed deer dominate the terrestrial mammal specimens from CA-ANI-2 (NISP = 16, 69.6%). Deer mouse (*Peromyscus maniculatus*) bones were present at CA-ANI-4 (NISP = 4, 17.4%), and a single deer mouse bone was found at CA-ANI-2. No foxes were identified at CA-ANI-3 or CA-ANI-4. On West Anacapa, a single artiodactyl metapodial at CA-ANI-8 is the only terrestrial mammal bone in the sample (Sandefur, 1978).

Invasive species include a largely complete skeleton of a European rabbit at CA-ANI-2, where the animal's burrow was evident in the unit sidewall during excavation and excavated separately from the rest of the unit (see Chapter 2). Two intrusive bones from a cow, one from a sheep or goat, and one from a rabbit were recovered in the sample from CA-ANI-4. At CA-ANI-8, Rozaire (1978) reported the bones of a juvenile goat (NISP = 73, MNI = 1) from near the top of Square 3, a European rabbit (NISP = 10, MNI = 1) near the top of Square 8, and another European rabbit near the bottom of Square 13, suggesting that, like CA-ANI-4, this site suffered stratigraphic mixing and historical disturbances.

TABLE 11. Weight (Wt) and minimum number of individuals (MNI) of shellfish from site CA-ANI-3. A dash (—) indicates not applicable; undiff. = undifferentiated.

		Bulk sample 1				Bulk sample 2				CA-ANI-3 total			
Taxon	**Common name**	**Wt (g)**	**% Wt**	**MNI**	**% MNI**	**Wt (g)**	**% Wt**	**MNI**	**% MNI**	**Wt (g)**	**% Wt**	**MNI**	**% MNI**
Brachyura	Crab, undiff.	—	—	—	—	<0.1	<0.1	0	0.0	<0.1	<0.1	0	0.0
Cirripedia	Barnacle, undiff.	8.5	1.0	0	0.0	20.3	4.4	0	0.0	28.8	2.2	0	0.0
Gastropoda	Land snail, undiff.	0.6	<0.1	2	4.0	1.0	0.2	2	4.1	1.6	0.1	4	4.0
Gastropoda	Limpet, undiff.	—	—	—	—	0.6	0.1	6	12.2	0.6	0.0	6	6.1
Haliotis cracherodii	Black abalone	55.4	6.4	4	8.0	26.7	5.7	1	2.0	82.1	6.2	5	5.1
Haliotis sp.	Abalone, undiff.	17.9	2.1	1	2.0	1.7	0.4	2	4.1	19.6	1.5	3	3.0
Lottia gigantea	Owl limpet	10.3	1.2	3	6.0	9.9	2.1	3	6.1	20.3	1.5	6	6.1
Mollusca	Nacre, undiff.	39.6	4.6	0	0.0	43.6	9.4	0	0.0	83.2	6.2	0	0.0
Mollusca	Shell, undiff.	14.2	1.6	0	0.0	1.0	0.2	0	0.0	15.2	1.1	0	0.0
Mytilus californianus	California mussel	710.6	81.8	38	76.0	347.0	74.6	34	69.4	1,057.5	79.3	72	72.7
Neobernaya spadicea	Chestnut cowry	3.5	0.4	1	2.0	—	—	—	—	3.5	0.3	1	1.0
Pollicipes polymerus	Gooseneck barnacle	4.0	0.5	0	0.0	3.1	0.7	0	0.0	7.1	0.5	0	0.0
Polyplacophora	Chiton, undiff.	1.1	0.1	0	0.0	—	—	—	—	1.1	0.1	0	0.0
Septifer bifurcatus	Platform mussel	—	—	—	—	0.1	0.0	1	2.0	0.1	0.0	1	1.0
Strongylocentrotus sp.	Sea urchin, undiff.	1.2	0.1	0	0.0	3.4	0.7	0	0.0	4.6	0.3	0	0.0
Tegula funebralis	Black turban	1.4	0.2	1	2.0	—	—	—	—	1.4	0.1	1	1.0
Vermetidae	Tube worm, undiff.	0.5	<0.1	0	0.0	6.6	1.4	0	0.0	7.1	0.5	0	0.0
Total shellfish		868.8	—	50	—	465	—	49	—	1,333.8	—	99	—

TABLE 12. Weight (Wt) and minimum number of individuals (MNI) of shellfish from site CA-ANI-4, Level 4. Undiff. = undifferentiated.

Taxon	Common name	Wt (g)	% Wt	MNI	% MNI
Calliostoma sp.	Calliostoma top shell	0.5	0.0	0	0.0
Cirripedia	Barnacle, undiff.	869.8	4.4	0	0.0
Crassadoma gigantea	Giant rock scallop	15.2	0.1	0	0.0
Gastropoda	Land snail, undiff.	3.3	0.0	4	0.4
Gastropoda	Limpet, undiff.	21.0	0.1	64	7.0
Fissurella volcano	Volcano limpet	0.7	0.0	5	0.5
Haliotis cracherodii	Black abalone	1,262.0	6.4	4	0.4
Lottia gigantea	Owl limpet	102.3	0.5	29	3.2
Megathura crenulata	Giant keyhole limpet	0.9	0.0	5	0.5
Mollusca	Nacre, undiff.	680.2	3.5	0	0.0
Mollusca	Shell, undiff.	7.5	0.0	0	0.0
Mytilus californianus	California mussel	16,280.5	82.6	794	86.7
Norrisia norrisii	Norris's top snail	61.4	0.3	5	0.5
Nucella sp.	Dog whelk	0.3	0.0	1	0.1
Olivella biplicata	Purple olive shell	1.5	0.0	2	0.2
Pollicipes polymerus	Gooseneck barnacle	150.4	0.8	0	0.0
Polyplacophora	Chiton, undiff.	22.5	0.1	0	0.0
Strongylocentrotus sp.	Sea urchin	166.2	0.8	0	0.0
Tegula sp.	Turban, undiff.	22.7	0.1	3	0.3
Vermetidae	Tube worm, undiff.	45.1	0.2	0	0.0
Total shellfish		19,714	100.0	916	100.0

DISCUSSION

All of the most commonly identified shellfish species from Anacapa Island middens (California mussel, black abalone, and owl limpets) and even most of the less common species (sea urchin, turban, and platform mussel) live in the rocky intertidal zone. Shellfish from sandy shore or bay environments, which are rare around Anacapa Island's rocky shore, are virtually absent from the sample, suggesting shellfish were largely collected locally, near where they were consumed. Most of the common finfish at the three East Anacapa sites (i.e., California sheephead, surfperch, rockfish, blacksmith, California scorpionfish, and señorita) are all found in rocky intertidal, subtidal, and kelp-forest ecosystems. Small numbers of open-water fish such as Pacific chub mackerel and Pacific bonito are present in the assemblage, as are bottom-dwelling fish such as midshipmen. The presence of cetaceans may also indicate a broader foraging strategy, but they are similarly infrequent.

The middens on East Anacapa discussed here were deposited between 3700 and 2500 cal BP, during a period of widespread subsistence change on the northern Channel Islands near the beginning of a relatively cold and unstable period in marine climate (see Kennett and Kennett, 2000; Kennett, 2005). Neither the bow and arrow nor the plank canoe are thought to have been used during this period (Erlandson, 1997; Bernard, 2004; Glassow et al., 2007). The circular fishhook was introduced at the very end of this period around ~2,500 years ago (Rick et al., 2002), and the CA-ANI-2 and CA-ANI-4 artifact assemblages indicate only the use of bone gorges for fishing (see Chapter 4). Red abalone middens are common at some sites on San Miguel and Santa Rosa Islands during the earliest occupation of CA-ANI-4 (Braje, 2007; Glassow et al., 2007; Braje et al., 2009), but no such sites have been identified on Anacapa during any time period, and red abalones are absent in the three assemblages reported in this chapter (Tables 10–12). The warmer surface waters around Anacapa may not have supported large red abalone populations close enough to the shore for human harvest.

McKusick (1959) presented the only other shellfish data from Anacapa Island sites, including data from surface scrapes or small units at sites on Middle and West Anacapa. Because of differences in excavation and sampling strategies our data are not directly comparable to McKusick's, but both studies document abundant California mussels, black abalones, and limpets. These data suggest that during the end of the Middle Holocene and the beginning of the Late Holocene people on Anacapa were primarily gathering rocky intertidal shellfish from nearshore habitats that were readily available on the island.

TABLE 13. Number of identified specimens (NISP) for fish remains from Anacapa Island sites. Order and nomenclature follow Page et al. (2013). An X identifies taxa that were present but for which the precise NISP is not known. Parenthetical numbers for site CA-ANI-8 come from a partial analysis of Test Pit 13 (Walker et al., 1978: tab. 36) but might not include all remains identified. A dash (—) indicates not identified in this deposit.

Taxon	Common name	CA-ANI-2 NISP	CA-ANI-3 NISP	CA-ANI-4 NISP	CA-ANI-6	CA-ANI-8
Elasmobranchiomorphi	Sharks, skates, rays	—	—	—	—	X (1)
Triakidae	Houndsharks	—	—	2	—	—
Actinopterygii	Ray-finned fishes, undiff.	>1,000	174	120	n/a	n/a
Muraenidae	Morays	—	—	—	—	—
Gymnothorax sp.	Moray	2	—	—	—	—
Gymnothorax mordax	California moray	—	—	—	X	—
Batrachoididae	Toadfishes	—	—	—	—	—
Porichthys sp.	Plainfin or specklefin midshipman	—	1	—	—	—
Atherinopsidae	New World silversides	9	—	—	—	—
Atherinops affinis	Topsmelt	1	—	—	—	—
Scorpaenidae	Scorpionfishes	—	9	12	—	—
Scorpaena guttata	California scorpionfish	3	—	—	—	—
Sebastes sp.	Rockfishes	205	—	2	X	X (25)
Hexagrammidae	Greenlings	1	—	—	—	—
Ophiodon elongatus	Lingcod	—	—	—	X	X
Cottidae	Sculpins	—	—	—	—	—
Scorpaenichthys marmoratus	Cabezon	19	1	2	—	X
Epinephelidae	Groupers	—	1	—	—	—
Serranidae	Sea basses	—	—	—	—	—
Paralabrax sp.	Sea basses	1	—	8	—	—
Carangidae	Jacks	—	—	—	X	—
Seriola lalandi	Yellowtail jack	—	—	—	X	—
Trachurus symmetricus	Jack mackerel	—	—	—	X	—
Sciaenidae	Drums and croakers	—	—	—	—	X (1)
Umbrina roncador	Yellowfin croaker	—	—	—	X	—
Embiotocidae	Surfperches	120	20	37	X	X (6)
Damalichthys vacca	Pile perch	2	2	5	X	—
Embiotoca sp.	Striped seaperch or black perch	—	—	5	—	—
Pomacentridae	Damselfishes	—	1	—	—	—
Chromis punctipinnis	Blacksmith	68	—	15	—	—
Hypsypops rubicundus	Garibaldi (possibly)	—	—	2	—	—
Labridae	Wrasses	1	—	—	—	—
Oxyjulis californica	Señorita	31	1	1	—	—
Semicossyphus pulcher	Sheephead	342	46	87	—	X (16)
Stichaeidae	Pricklebacks	—	—	—	—	—
Cebidichthys violaceus	Monkeyface prickleback	—	1	—	—	—
Clinidae	Blennies	1	—	—	—	—
Heterostichus rostratus	Giant kelpfish	4	2	—	—	—
Sphyraenidae	Barracudas	—	—	—	—	—
Sphyraena argentea	Pacific barracuda	—	—	1	—	—
Scombridae	Mackerels	—	—	—	—	—
Sarda sp.	Bonito	—	—	—	X	—
Scomber japonicus	Chub mackerel	1	—	—	X	—
Total[a]		811	85	179	—	—

[a]Total does not include undifferentiated fish bones (Actinopterygii).

TABLE 14. Number of identified specimens (NISP) for bird and reptile remains from Anacapa Island sites. An X identifies taxa that were present but for which precise NISP is not known. A dash (—) indicates not applicable; undiff. = undifferentiated.

Group and taxon	Common name	CA-ANI-2	CA-ANI-3	CA-ANI-4	CA-ANI-6	CA-ANI-8
		Birds				
Alcidae	Auklets and murrelets					
Ptychoramphus aleuticus	Cassin's auklet	5	1	44	X	X
Synthliboramphus sp.	Murrelet, undiff.	1	—	—	—	—
Undifferentiated	Undiff.	—	—	3	—	—
Undifferentiated	Auklet, undiff.	—	—	1	—	—
Undifferentiated	Auklet/murrelet, undiff.	1	—	—	—	—
Subtotal		**7**	**1**	**48**	**X**	**X**
Anatidae	Ducks, geese, and swans					
Branta bernicla	Black brant	—	—	1	—	—
Melanitta sp.	Scoter, undiff.	—	—	1	—	—
Undifferentiated	Duck undiff.	—	—	—	—	X
Subtotal		**0**	—	**2**	—	**X**
Ardeidae	Wading birds					
Ardea sp.	Heron, undiff.	**1**	—	—	—	—
Diomedeidae	Albatrosses					
Phoebastria albatrus	Short-tailed albatross	46	—	—	—	—
Phoebastria cf. *albatrus*	Albatross, possibly short-tailed	12	—	—	—	—
Phoebastria nigripes	Black-footed albatross	1	—	—	—	—
Phoebastria sp.	Albatross, undiff.	22	—	—	X	X
Subtotal		**81**	—	**0**	**X**	**X**
Laridae (subtotal)	Gulls and terns					
Larus cf. *heermanni*	Gull, possibly Heerman's	7	—	—	—	—
Larus sp.	Gull, undiff.	7	—	3	—	—
Sterna sp.	Tern, undiff.	1	—	—	—	—
Subtotal		**15**	—	**3**	—	—
Pandionidae	Osprey					
Pandion haliaetus	Osprey	1	—	—	—	—
Pelecanidae	Pelicans					
Pelecanus occidentalis	Brown pelican	1	—	—	—	—
Pelecanus sp.	Pelican, undiff.	—	—	1	—	—
Subtotal		**1**	—	**1**	—	—
Phalacrocoracidae	Cormorants					
Phalacrocorax auritus	Double-crested cormorant	1	—	—	—	—
Phalacrocorax pelagicus	Pelagic cormorant	16	2	—	X	X
Phalacrocorax penicillatus	Brandt's cormorant	6	4	13	X	X
Phalacrocorax sp.	Cormorant, undiff.	22	1	12	—	—
Subtotal		**45**	7	**25**	**X**	**X**
Phasianidae	Pheasants, quails, etc.					
Gallus gallus	Chicken	2	—	—	—	—
Procellariidae	Shearwaters, petrels, and fulmars					
Ardenna sp.	Shearwater, undiff.	4	—	—	—	—
Fulmarus glacialis	Northern fulmar	4	—	—	—	—
Scolopacidae	Medium shorebird, undiff.	1	—	—	—	—
Subtotal		9	—	0	—	—
Undifferentiated birds (subtotal)						
Aves, undiff.	Bird, undiff.	201	4	151	—	—
Aves, medium	Medium bird, undiff.	1	—	2	—	—
Aves, large	Large bird, undiff.	97	—	—	—	—
Aves, very large	Very large bird, undiff.	1	—	—	—	—
Subtotal		**300**	**4**	**153**	—	—
Total birds		**462**	**12**	**232**	—	—
		Reptiles				
Squamata						
Elgaria multicarinata	Southern alligator lizard	1	—	—	—	—
Total reptiles		1	—	—	—	—

TABLE 15. Number of identified specimens (NISP) for terrestrial and marine mammal remains from Anacapa Island sites. An X identifies taxa that were present but for which precise NISP is not known. A dash (—) indicates not applicable; undiff. = undifferentiated.

Group and taxon	Common name	CA-ANI-2	CA-ANI-3	CA-ANI-4	CA-ANI-6	CA-ANI-8
Undifferentiated mammals						
Mammalia	Mammal, undiff.	392	89	219	—	370
Mammalia	Large mammal, undiff	32	—	—	—	—
Subtotal		**424**	**89**	**219**	**—**	**370**
Marine mammals						
Cetacea						
Cetacea cf. Mysticeti	Whale, possibly baleen	1	—	—	—	—
Delphinidae	Dolphin, undiff.	4	—	—	—	1
Delphinus sp.	Dolphin, undiff.	5	—	—	—	—
Lagenorhynchus obliquidens	Pacific white-sided dolphin	—	—	—	X	—
Phocoena phocoena	Pacific harbor porpoise	—	—	—	—	1
Tursiops truncatus	Bottlenose dolphin	2	—	—	—	—
Undifferentiated	Whale, undiff.	5	—	14	—	—
Subtotal		**17**	**—**	**14**	**X**	**2**
Mustelidae						
Enhydra lutris	Sea otter	**54**	**1**	**3**	—	—
Pinnipedia						
Arctocephalinae	Fur seals, undiff.	1	—	—	—	—
Arctocephalus townsendi	Guadalupe fur seal	1	—	—	X	1
Mirounga angustirostris	Northern elephant seal	1	—	—	X	1
Otariidae	Eared seals, undiff.	36	—	19	—	—
Phoca vitulina	Harbor seal	197	1	37	X	1
Phocidae	Earless seal, undiff.	26	—	1	—	1
Zalophus californianus	California sea lion	11	—	7	—	4
Undifferentiated	Seals/sea lions, undiff.	362	1	23	—	—
Subtotal		**635**	**2**	**87**	**X**	**8**
Undifferentiated	Marine mammal, undiff.	328	4	539	—	—
Total marine mammals		**1,034**	**7**	**643**	**X**	**10**
Terrestrial mammals						
Artiodactyla						
Cervidae	Deer, undiff.	—	—	12	—	—
Odocoileus hemionus	Black-tailed deer	190	—	4	—	—
Undifferentiated	Even-toed ungulate, undiff.	—	—	2	—	1
Subtotal		**190**	**—**	**18**	**—**	**1**
Canidae						
Urocyon littoralis	Island fox	6	—	—	—	—
Undifferentiated	Fox/dog, undiff.	1	—	—	—	—
Subtotal		**7**	**—**	**—**	**—**	**—**
Cricetidae						
Peromyscus maniculatus	Deer mouse	2	—	4	—	—
Undifferentiated	Terrestrial mammal, undiff.	—	2	39	—	—
Total terrestrial mammals		**199**	**2**	**61**	**—**	**1**
Introduced mammals						
Bos taurus	Cow	—	—	2	—	—
Caprinae	Sheep/goat, undiff.	—	—	1	—	73
Oryctolagus cuniculus	European rabbit	51	—	1	—	11
Subtotal		**51**	**—**	**4**	**—**	**84**
Total mammals		**1,708**	**98**	**927**	**—**	**465**

Other than a few red abalone middens in the western reaches of the northern Channel Islands, most other sites occupied between 4500 and 2500 cal BP (Table 16, Figure 36) have shellfish assemblages dominated by California mussel, similar to those at the three Anacapa Island sites discussed here (see Braje et al., 2012). However, some sites on San Miguel Island—which is more exposed to the cool California Current than any of the other islands—contain greater shellfish diversity and relatively high proportions of red abalone (Braje, 2007, 2010; Glassow et al., 2007; Rick, 2007; Braje et al., 2012). The exceptions to this are CA-SMI-87, with two components dating to 3200 to 2860 and 2860 to 2340 cal BP, and deposits at CA-SMI-603 and CA-SMI-261, with similar ages, which have limited red abalone components and are more similar to the Anacapa Island sites (Vellanoweth et al., 2002b; Rick, 2007; Ainis et al., 2011). Some Santa Cruz Island middens at Christy Beach during the early part of the Late Holocene contain small, but significant, proportions of Pismo clam (Thakar, 2012), but these clams were likely not available or rare along the rocky shores of Anacapa Island. Perry and Hoppa (2012) discuss the importance of *Lithopoma undosa* (wavy top turban snail) in some sites on eastern Santa Cruz Island. This snail's absence in Anacapa's archaeological record, despite the island's warm waters, suggests that people were not taking this species from kelp forests or other habitats that were exploited and available on Santa Cruz Island.

The vertebrate assemblages at the Anacapa Island sites are generally more surprising than the invertebrates. Most northern Channel Island sites that date to the end of the Middle Holocene or early Late Holocene are dominated by fish remains, with few birds or mammals. When compared with data reported from other contemporaneous northern Channel Island sites, Anacapa sites have a relatively high frequency and diversity of vertebrate remains (Figure 37). Vertebrate frequency at CA-SMI-603, Stratum 4 on San Miguel Island is much higher than the Anacapa sites, but this site is a cave with extremely rich deposits and excellent preservation. CA-SCRI-236 on Santa Cruz Island is similar to CA-ANI-2 in overall NISP but is not entirely comparable because its vertebrate remains were recovered from floated samples screened over 1/16-inch mesh, rather than the dry 1/8-inch mesh used on Anacapa. Even the numerically larger samples from CA-SCRI-236 have lower richness in terms of both vertebrate classes and identified species.

Fish remains from Anacapa Island are comparable to those from other sites of similar antiquity, with a focus on surfperch, rockfish, and California sheephead (Rick, 2007; Braje, 2010; Turnbull et al., 2015). Fish remains are relatively similar among Late Holocene sites across the northern Channel Islands, although we caution that the available sample from Anacapa Island is relatively small (i.e., this volume and Walker et al., 1978). In a comparison of Native American fisheries on the Channel Islands and Isla Cedros, including one of the sites reported here, Turnbull et al. (2015) concluded that the Native American fisheries were primarily inshore and at predictable localities, a proposition that agrees with all the evidence from the Anacapa sites. CA-ANI-2, -3, and -4 are notable for the abundance of labrid remains, especially California sheephead, which are abundant in the warmer waters of Santa Cruz, Anacapa, and some of the southern Channel Islands (see Braje et al., 2017) and are one of the most commonly identified species found in Channel Island middens in general (Turnbull et al., 2015).

The Anacapa Island sites are distinguished by the diversity of bird, terrestrial mammal, and marine mammal remains recovered. The presence of large numbers of birds in the Anacapa middens suggests that the island was an important habitat for nesting birds in the past, as it is today. Some of the species that compose the archaeological bird assemblages, however, are quite different from those present today on Anacapa. The historical introduction of black rats to Anacapa Island devastated small ground-nesting bird populations, especially alcids and petrels. Introduced rabbits competed for nesting sites and, along with sheep, may have resulted in erosion and habitat alteration that could have reduced habitat for seabirds (McChesney and Tershy, 1998). Pushed to the verge of extinction by DDT exposure, brown pelican populations have steadily rebounded since the 1980s and were taken off the endangered species list in 2009 (Anderson et al., 2013). The National Park Service reports that between 1969 and 1984 there was an average of 900 brown pelican nest attempts per year, but between 1985 and 2006, the mean was 4,600 nests per year (National Park Service, 2016a). Western gull populations on Anacapa are currently strong, with some 10,000 gulls occurring during nesting season annually between May and July (National Park Service, 2016b). The eradication of rats and other invaders in 2001 has also allowed smaller species such as the ashy storm petrel to begin nesting on Anacapa again (Harvey et al., 2016; Newton et al., 2016).

Despite large modern populations of gulls and pelicans, these species are rare in the known archaeological faunal assemblages of Anacapa Island, including sites on East and West Anacapa (Table 14). Alcids (murrelets, auks, and auklets), cormorants, and albatross dominate instead. Since isotopic seasonality data from CA-ANI-2 indicate that people were on the island during all seasons of the year (Chapter 3), seasonality of site occupation is not likely a factor in the dearth of gull and/or pelican bone. On the basis of the archaeological data it appears that the bird populations of Anacapa Island have significantly restructured since the early part of the Late Holocene. Larger species that were less threatened by rats may have had a competitive advantage on Anacapa Island during the twentieth century, whereas gulls that can forage widely may have been able to expand their populations concomitant with growing urban refuse on the mainland (Pierotti and Annett, 2001). Although the bird assemblages from Anacapa suggest that this island has been an important nesting site for seabirds throughout the Late Holocene, the massive nesting populations of gulls, and possibly pelicans, may be relatively recent historical anomalies, a hypothesis that requires additional analysis and investigation.

The number and presence of marine mammals at Anacapa Island sites are also exceptional for the early part of the Late

TABLE 16. Shellfish data from contemporary sites on the northern Channel Islands and Santa Barbara Island. Values in parentheses indicate percentage by weight.

		Shellfish weight (g)									
Site	Age (cal BP)	California mussel	Red abalone	Black abalone	Sea urchin	Owl limpet	Turban	Platform mussel	All other shell	Total shell (g)	Reference
CA-SMI-87 West	3200–2860	13,480.1 (69.7%)	195.0 (1.0%)	424.5 (2.2%)	580.2 (3.0%)	2.3 (0.0%)	1,205.8 (6.2%)	1,165.4 (6.0%)	2,279.5 (11.8%)	19,332.8	Braje et al. (2011)
CA-SMI-87 East	2860–2340	11,423.9 (65.3%)	194.8 (1.1%)	482.8 (2.8%)	885.5 (5.1%)	7.2 (<0.1%)	924.2 (5.3%)	1,347.2 (7.7%)	2,223.7 (12.7%)	17,489.3	Braje et al. (2011)
CA-SMI-261 SA	3700–2860	2,536.2 (53.3%)	387.6 (8.1%)	285.0 (6.0%)	479.5 (10.1%)	16.0 (0.3%)	669.0 (14.0%)	4.1 (0.1%)	384.4 (8.1%)	4,761.8	Braje et al. (2011)
CA-SMI-503	3830–3680	434.6 (43.1%)	33.4 (3.3%)	165.5 (16.4%)	91.8 (9.1%)	24.8 (2.5%)	116.1 (11.5%)	11.3 (1.1%)	131.3 (13.0%)	1,008.8	Braje et al. (2011)
CA-SMI-603 S3	4280–3840	1,256.6 (18.6%)	1,634.3 (24.2%)	1,187.7 (17.6%)	1,658.7 (24.6%)	0.0 (0.0%)	236.3 (3.5%)	69.6 (1.0%)	701.0 (10.5%)	6,744.2	Braje et al. (2011)
CA-SMI-603 S4	4520–4070	1,427.1 (15.8%)	1,765.8 (19.5%)	587.9 (6.5%)	3,573.7 (39.5%)	48.7 (0.5%)	574.4 (6.3%)	246.0 (2.7%)	829.6 (9.2%)	9,053.2	Braje et al. (2011)
CA-SMI-628	4520–3830	1,296.0 (36.6%)	420.9 (11.9%)	240.4 (6.8%)	409.6 (11.6%)	12.2 (0.3%)	444.4 (12.6%)	94.5 (2.7%)	618.6 (17.5%)	3,536.6	Braje et al. (2011)
CA-SRI-50	4830–4140	21,432.5 (83.4%)	83.8 (0.3%)	58.4 (0.2%)	97.0 (0.4%)	16.7 (0.1%)	993.4 (3.9%)	290.7 (1.1%)	2,725.1 (10.6%)	25,697.6	Jazwa (2015)
CA-SRI-191	4400–4240	1,882.7 (68.3%)	47.8 (1.7%)	0.0 (0.0%)	583.3 (21.2%)	0.0 (0.0%)	74.3 (2.7%)	48.4 (1.8%)	120.4 (4.4%)	2,756.9	Braje et al. (2011)
CA-SRI-667, Stratum 1	4490–4200	2,938.3 (74.0%)	13.7 (0.3%)	4.7 (0.1%)	39.6 (1.0%)	0.0 (0.0%)	27.4 (0.7%)	338.2 (8.5%)	609.9 (15.4%)	3,971.8	Braje et al. (2011)
CA-SCRI-236	2945–2775	1,2651.6 (66.3%)	449.6 (2.4%)	2,140.6 (11.2%)	1,443.8 (7.6%)	27.1 (0.1%)	131.8 (0.7%)	654.7 (3.4%)	1,581.3 (8.3%)	19,080.5	Thakar (2014a)
CA-SCRI-568	3357–3156	14,199.1 (93.7%)	0.0 (0.0%)	262.3 (1.7%)	22.3 (0.1%)	12.7 (0.1%)	19.1 (0.1%)	43.6 (0.3%)	589.2 (3.9%)	15,148.3	Thakar (2014a)
CA-SCRI-823	3208–2964	3,303.6 (89.2%)	43.4 (1.2%)	27.2 (0.7%)	7.2 (0.2%)	4.4 (0.1%)	73.9 (2.0%)	7.4 (0.2%)	234.7 (6.3%)	3,701.8	Thakar (2014a)
CA-ANI-2	3270–2750	15,517.5 (81.7%)	0.0 (0.0%)	571.9 (3.0%)	82.4 (0.4%)	10.1 (0.1%)	239.5 (1.3%)	21.9 (0.1%)	2,556.7 (13.5%)	19,000	This study
CA-ANI-3	3640–3160	1,057.5 (79.3%)	0.0 (0.0%)	82.1 (6.2%)	20.3 (1.5%)	1.4 (0.1%)	4.6 (0.3%)	0.1 (0.0%)	167.7 (12.6%)	1,333.7	This study
CA-ANI-4	4145–2850	16,280.5 (82.6%)	0.0 (0.0%)	1,262.0 (6.4%)	102.3 (0.5%)	22.7 (0.1%)	166.2 (0.8%)	0.0 (0.0%)	1,880.3 (9.5%)	19,714	This study
CA-SBI-2	3910–2960	3,197.9 (14.0%)	0.0 (0.0%)	835.6 (10.7%)	1.5 (0.0%)	27 (0.3%)	379 (4.9%)	5.8 (0.1%)	3,353.2 (43.0%)	7,800	Rick et al. (2009)

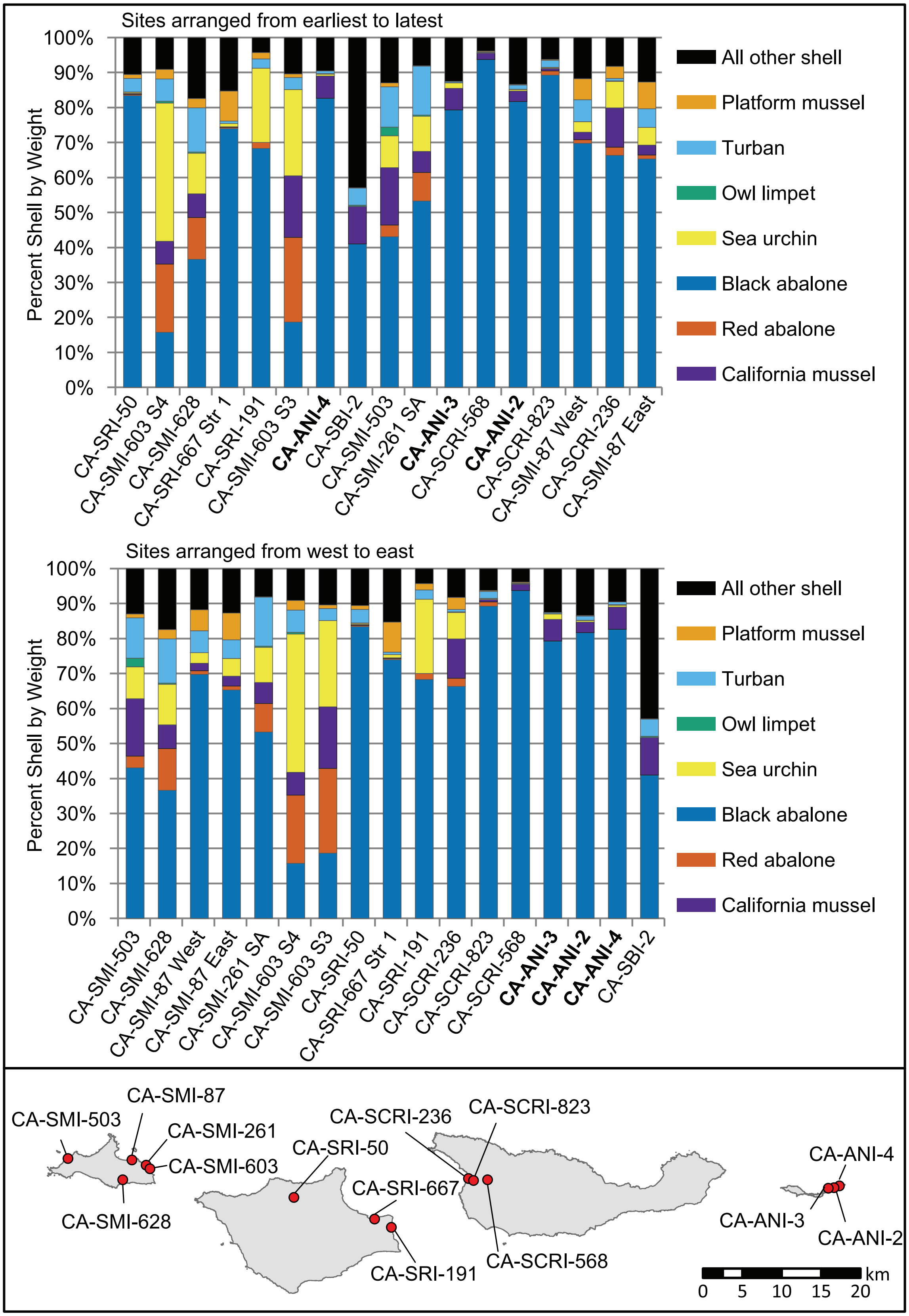

FIGURE 36. Relative contribution of major shellfish for sites on the northern Channel Islands from 4500 to 2500 cal BP, ordered from earliest to latest (top) and from west to east (middle), along with a map showing the location of each site (bottom; islands from left to right: San Miguel, Santa Rosa, Santa Cruz, and Anacapa). See text for references for data for each site.

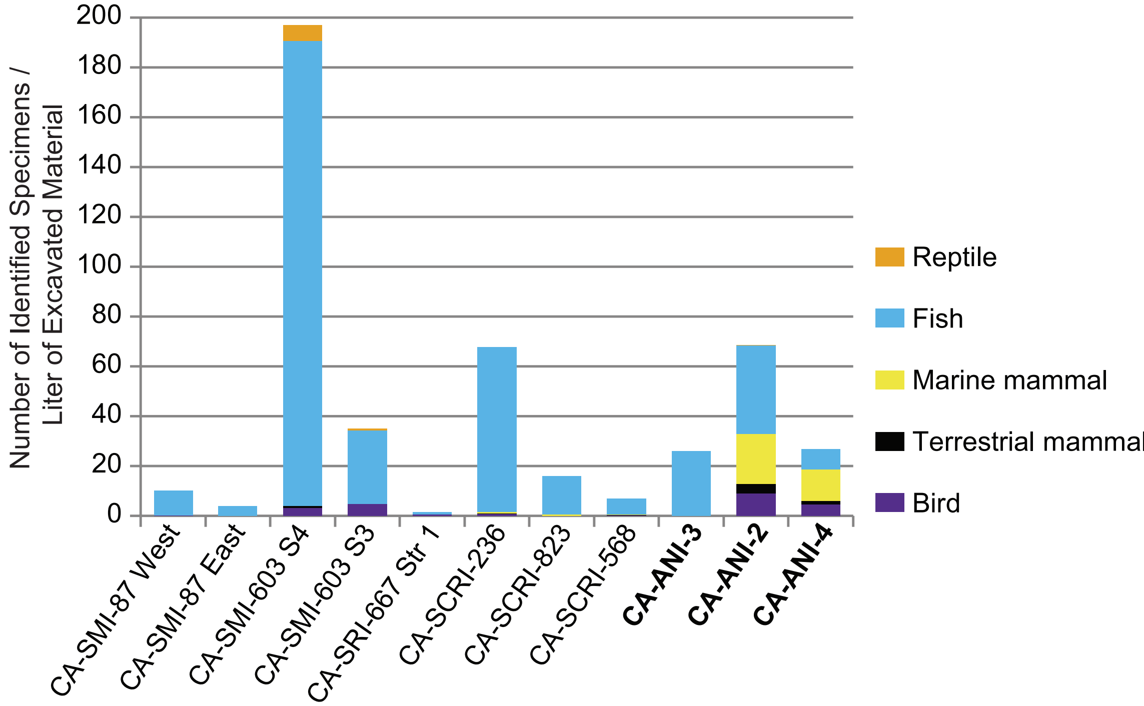

FIGURE 37. Relative contribution of vertebrate classes to archaeological sites occupied between 4500 and 2500 cal BP on the northern Channel Islands (SMI=San Miguel Island, SCRI=Santa Cruz Island, and ANI=Anacapa Island). Vertebrate data are from Rick (2004) for CA-SMI-87, Ainis et al. (2011) for CA-SMI-603, Wolff et al. (2007) for CA-SRI-667, and Thakar (2014a) for SCRI sites.

Holocene. Although a few other contemporaneous sites contain marine mammal remains, they are often poorly preserved and constitute a small proportion of excavated material. On Anacapa, they are both unusually abundant and diverse. Thakar (2014a) identified harbor seal and California sea lion at CA-SCRI-236 (2945–2775 BP) and CA-SCRI-823 (3208–2964 BP), but in very small numbers. Sea otters were identified at CA-SCRI-568 (3357–3156 BP) and CA-SCRI-823 by Thakar (2014a) and CA-SMI-87 (3200–2340 BP) by Rick (2004, 2007) but again were infrequent. Cetaceans are also rare at other northern Channel Islands sites during the early part of the Late Holocene, including a few Risso's dolphins (*Grampus griseus*) from CA-SMI-87 (Rick, 2007) and Prisoners Harbor (CA-SCRI-240) on Santa Cruz Island (T. Wake, University of California, Los Angeles, unpublished data).

Perhaps the most remarkable component of the Anacapa Island faunal assemblage is the number of deer bones present, which appears to represent elements transported from the mainland and largely used for tool making (Table 15; see Chapter 4). Deer bones were also found at two sites on Santa Cruz Island from this period, one bone each at CA-SCRI-236 and CA-SCRI-823 (Thakar, 2014a). During the Late period, deer bones, especially metatarsals, were common trade items brought to the islands from the mainland for use as tools (Wake, 2001). Because deer were available only on the mainland, the number of bones and the variety of elements suggest that the people who were living on Anacapa during this earlier period also maintained close ties to the mainland or were living primarily on the mainland and making long visits out to Anacapa and possibly other Channel Islands. Rozaire (1978) tentatively identified two deer metapodials from West Anacapa sites, including one from the earlier site at CA-ANI-6. Although these bones might represent goat or sheep, the frequency of BTD metapodials at East Anacapa sites supports that tentative identification.

CONCLUSIONS

The faunal assemblages reported here defy the expectation that middens on Anacapa Island were relatively depleted in vertebrates or represented exclusively intermittent and short-term occupations. These vertebrate assemblages are particularly rich, with a variety of fish, birds, and mammals, raising additional questions. For instance, were there prehistoric populations of island foxes on Anacapa Island, or did people transport live foxes or fox parts to the island from adjacent Santa Cruz or other islands? Were people living on Anacapa Island and trading with the other Channel Islands and the adjacent mainland for deer bone and other materials, or were these itinerant people from the mainland or Santa Cruz Island? Did fishing strategies change during the second half of the Late Holocene when people had access to circular fishhooks, or did they remain similar through time as the current Anacapa data suggest? We return to these and other issues in the next chapter as we draw broad conclusions about the nature of human occupation of Anacapa Island.

6 Conclusion

Torben C. Rick and Leslie A. Reeder-Myers

This volume has focused on the archaeology and historical ecology of Anacapa Island, largely through field and laboratory work conducted at three early Late Holocene sites on East Anacapa Island. To put our work on East Anacapa in broader context, we obtained radiocarbon dates from archaeological sites across the island and discussed previous work at other Anacapa Island archaeological sites. Collectively, our data provide a framework for understanding the place of Anacapa in larger Southern California settlement and subsistence systems and interaction spheres. Although much of our study concerns a fairly brief window of time—between about 3,700 and 2,500 years ago—it provides a framework for documenting broader human use of Anacapa Island and a window into the historical ecology of the Channel Islands.

At 2.9 km^2 in area, Anacapa is slightly larger than Santa Barbara Island (2.6 km^2), the smallest of the eight Channel Islands. Both Anacapa and Santa Barbara contain little or no fresh water and, to an extent, terrestrial plant communities and biodiversity when compared with the larger and more topographically diverse islands. This perceived marginal setting has led some researchers to speculate that Anacapa was occupied as an intermittent stopover and may have played a somewhat minor role in broader Santa Barbara Channel prehistory (see Chapter 1). In some ways, this speculation echoes archaeological thinking about the nature of small islands around the world, which are often marginalized or overlooked by researchers in favor of larger and more topographically diverse islands (Fitzpatrick et al., 2016).

In this chapter, we revisit this theme by exploring the significance of Anacapa Island in ancient human lifeways on the Channel Islands. To frame our discussion, we return to the five questions that we asked in Chapter 1:

1. When was Anacapa first settled by Native Americans, and how did human occupation vary through time and across space?
2. Was human occupation of Anacapa permanent, intermittent, or a combination?
3. How did Anacapa Island marine and terrestrial ecosystems change through time?
4. What role did Anacapa play in larger cultural developments, lifeways, and interaction spheres on the Channel Islands and Southern California?
5. Finally, what can the data from Anacapa Island tell us about small islands around the world more generally?

We address each of these questions in the five sections that follow.

ANTIQUITY AND EVOLUTION OF HUMAN SETTLEMENT

During the past 20 years, archaeologists have made significant strides in understanding the antiquity and evolution of human occupation of the Channel Islands. With the redating of the Arlington Springs human remains and work at early habitation sites, we can now say with confidence that people occupied the Channel Islands by at least 13,000 years ago, with significant coastal adaptations evident at a series of sites by 12,000 to 11,000 years ago (Johnson et al., 2002; Erlandson et al., 2011a). Sites dating to the terminal Pleistocene and Early Holocene have now been identified on San Miguel, Santa Rosa, and Santa Cruz islands (Erlandson et al., 2011a, 2016; Gusick, 2013). There is evidence for continuous occupation of the northern Channel Islands from 10,000 years ago through the early nineteenth century (Kennett, 2005; Rick et al., 2005).

When was Anacapa first settled by Native Americans, and how did human occupation vary through time and across space? Rick (2006) provided the first sequence of radiocarbon dates from Anacapa Island, including dates from several of the sites reported in this volume. These dates documented human occupation of Anacapa from ~5200 cal BP through the Late period, with several sites dating to the early part of the Late Holocene. Rick (2011) later provided evidence of human occupation of Freshwater Cave (CA-ANI-18) on Anacapa during the Historic period. Despite evidence for Middle and Late Holocene occupation, any evidence of Early Holocene or earlier occupation of Anacapa was still lacking.

For this study, we expanded previous radiocarbon dating efforts and built a record for Anacapa consisting of 26 radiocarbon dates from 16 archaeological sites. When calibrated, corrected, and placed in a Bayesian statistical framework, these dates suggest a more or less continuous occupation spanning 5540 cal BP through the early nineteenth century. Occupation on West and Middle Anacapa appears to extend back to 5280 and 5540 cal BP, respectively, whereas the occupation of East Anacapa is more constrained between about 3700 and 2500 cal BP. These dates extend the initial human occupation of Anacapa by about 300 years, but they still lag behind the other northern Channel Islands, which have sites dated more than five millennia earlier than Anacapa. The chipped-stone crescent recovered from CA-ANI-11 in the 1950s extends this occupation to the terminal Pleistocene or Early Holocene (see Chapters 3 and 4), but so far no radiocarbon dates from any middens document any sites older than 5540 cal BP.

Why are sites on Anacapa older than 5,500 years ago so rare? The answer to this question is not entirely clear but could reflect scattered human occupation during the Early Holocene, site discovery and visibility issues, and a lack of research. The absence of early human occupation seems unlikely given the recovery of a crescent and the fact that the island's proximity to the mainland would have made it attractive to early human land use and subsistence. During the terminal Pleistocene and Early Holocene, Anacapa Island was the most likely entry point for excursions from the mainland to Santarosae. More likely, early sites have yet to be discovered and dated or have been destroyed by rising seas and marine erosion or perhaps U.S. Coast Guard activities (see Chapter 2). Two cave sites on West Anacapa (CA-ANI-12 and CA-ANI-13) have never been radiocarbon dated, and similarly, only the upper levels of CA-ANI-18 have been probed and dated. These cave sites may represent the likeliest candidates for yielding earlier occupations on Anacapa. A more thorough surface survey of some of the island's lithic scatters might also turn up additional chipped-stone crescents or Channel Island barbed points associated with terminal Pleistocene and Early Holocene occupation (Erlandson et al., 2011a).

Anacapa was occupied more or less continuously from 5,500 years ago through the Late Holocene. There is extensive evidence that people on the island spent their time harvesting its rich and productive marine ecosystems. Like on other northern Channel Islands, people also made shell and bone artifacts on Anacapa, buried their dead, and made microblades and other stone tools (Rozaire, 1978, 1993; Rick, 2006; Jew et al., 2015b).

AN INTERMITTENT STOPOVER OR SOMETHING MORE PERMANENT?

Was occupation of Anacapa permanent, intermittent, or a combination? Virtually everyone who has worked on Anacapa Island or thought about the place of Anacapa Island in broader Southern California prehistory has grappled with the degree to which Anacapa was an intermittent stopover or had more permanent occupation (McKusick, 1959; Glassow, 1977; Rozaire, 1978; Rick, 2006; Jew and Rick, 2014:201). In some ways, these arguments parallel similar debates about the nature of human settlement of Santa Barbara Island (which is about the same size of Anacapa) in the southern Channel Islands (see Erlandson et al., 1992; Rick, 2001; Perry et al., 2017). The dearth of research on Anacapa has long hindered our ability to address this question, but with new faunal and artifact assemblages we have a much better perspective than in years past.

Nearly 60 years ago, McKusick (1959:85) speculated that "the settlement pattern appears to have been seasonal or infrequent for the island was not occupied at the time of the Spanish exploration." He went on to add, "No great time depth appears to be represented by the archaeology, and it seems probable that the cultural occupation was limited to the Late Horizon, that is, within the last 2000 years" (McKusick, 1959:86). Glassow (1977:81) challenged this position, arguing that "there is good justification for proposing that the island was occupied by a permanent population at least during certain portions of its prehistory. The fact that it was not permanently occupied by the Chumash at the time of European contact may be more a result of the logistical constraints imposed on island settlement patterns by the nature of Chumash socio-economic organization than the lack of adequate resources on the island for human survival." Although Rozaire (1978:52) touched on the issue only briefly, he noted that "the natural resources of Anacapa Island would provide support to at least a small number of aboriginal occupants on a year-round basis, particularly if the adjacent ocean area were exploited effectively." Rick (2006, 2011) supported Glassow's position by speculating that the island had a mix of both short-term stopover occupations and perhaps some longer, more sustained occupations on the basis of the larger and denser middens, the presence of human burials, and diversity of artifacts and faunal remains at some sites. Because of the dearth of research, however, questions persisted about the nature of ancient settlement patterns on Anacapa Island.

Our work at Anacapa Island demonstrates that the truth lies somewhere in the middle. Anacapa, like the other northern Channel Islands, has a clear mix of short-term sites that appear to have had limited occupation as well as sites with longer-term and more sustained occupations. Data from CA-ANI-2, in particular, demonstrate the relatively intensive settlement and diverse activities at some sites. Here, people were exploiting local tool-stone sources and making expedient stone tools (Chapter 4); producing bone gorges with fresh deer bones acquired from the mainland; obtaining a wide range of fish, marine mammals, birds, and shellfish; and perhaps even transporting island foxes and other canids (or their bones) to Anacapa. Stable isotope data also demonstrate that people were collecting shellfish at this site during all seasons of the year, perhaps suggesting a year-round occupation (Chapter 3; Jew and Rick, 2014). The presence of abundant mainland deer bone raises the possibility that this island did indeed serve as a stopover for people traveling between the islands and the mainland. Like the other Channel Islands, Anacapa's sites suggest both short-term and longer-term occupations.

Despite evidence for more sustained occupation, it should be noted that some of Anacapa's archaeological sites are qualitatively different from those on the other three northern Channel Islands. For instance, there are no massive Late or Historic period village sites, complete with dense middens, house depressions, and cemeteries. As Glassow (1977) suggested, Anacapa may have been limited in some ways by the marginal nature of its resources when compared with the other islands. Although present environmental conditions are not direct correlates for the Anacapa of the past, the island does lack abundant surface fresh water, has a rugged coastline, and has fewer plant and animal foods in general than the larger islands. Collectively, these environmental conditions suggest that Anacapa—barring a unique prehistoric management strategy—likely had a lower threshold for human population size and extensive settlement than the other islands. We return to this important topic later in the chapter.

An interesting and perhaps related issue is why East Anacapa seems to have been occupied exclusively between 3700 and 2500 cal BP. It is possible that during this earlier period before the introduction of the plank canoe, Anacapa Island was especially important as a stopover point for people traveling between the islands and the mainland, with people perhaps spending more time on the island when doing so. While there, they took advantage of abundant shellfish, fish, and bird resources on the island and spent more time than previously presumed. Characterizing the complex nature of Anacapa's human occupations clearly requires more research, but for now we can demonstrate that people conducted a wide range of activities on the island and that it had a mix of more sustained and perhaps year-round occupation as well as shorter-term occupations.

HISTORICAL ECOLOGY OF ANACAPA ISLAND

Although small, Anacapa is home to unique terrestrial and marine ecosystems. It has long been known for its role in providing breeding habitat for seabirds, especially gulls and pelicans, as well as its rich kelp-forest ecosystems (Schoenherr et al., 1999). The National Park Service, in tandem with a variety of other groups, has been working to actively remove invasive plants and restore native plant communities on the island (National Park Service, 2016c; see also Hale, 2013) The groups have engaged local students and other community members in Anacapa Island's conservation and restoration.

Anacapa has extensive colonies of breeding gulls during the summer months, and much of Middle and West Anacapa is often closed for the majority of the year to protect breeding pelicans. However, Anacapa is also a breeding habitat for smaller birds such as murrelets and alcids. Introduced black rats, which likely colonized the islands from historical shipwrecks, were preying on these seabird eggs and chicks for decades, greatly reducing their populations. As a consequence, the National Park Service initiated a program to eradicate black rats from Anacapa and promote breeding success of seabirds (National Park Service, 2013; see also Howald et al., 2010). The program was complicated by the presence of native deer mice, which could be inadvertently affected by rat removal (Pergams et al., 2000). With populations of deer mice taken into captivity, the National Park Service eradicated rats from the island in an effort to promote the restoration of seabirds. Although seabirds and native plants are the focus of much of the restoration on Anacapa, the National Park Service also manages kelp-forest ecosystems and intertidal habitats and helps monitor marine mammals.

How did Anacapa Island terrestrial and marine ecosystems change through time? Data from our Anacapa Island archaeological research document the types of resources that people were harvesting on Anacapa but also inform the historical ecology and conservation of the island more generally. Human influences on past island ecosystems are particularly apparent in the bird, fish, and marine mammal artifact assemblages from these islands; this can have implications for understanding contemporary ecosystems.

Interestingly, the CA-ANI-2 assemblage we analyzed is dominated by albatross remains, suggesting either that once there was a breeding population on Anacapa or that people obtained these birds offshore. Albatross are occasionally documented at other Channel Island archaeological sites (e.g., Porcasi, 1999), but they no longer breed on Anacapa or the other Channel Islands. At CA-ANI-2, cormorants are the next most abundant, which is not surprising given their presence around the island today. Alcids, including murrelets and Cassin's auklet, are present at CA-ANI-2 and CA-ANI-3 and are the most abundant birds at CA-ANI-4, suggesting the presence of these birds deeper into the past. Perhaps most surprising about the seabirds from the Anacapa sites is the relative dearth of both gull and pelican bones. A single brown pelican bone was identified at CA-ANI-2, and an undifferentiated pelican bone was found at CA-ANI-4. Pelicans are not generally abundant at Channel Islands sites, but given their presence on Anacapa Island today, we might expect more in the past.

Still more surprising is the dearth of gull bones, of which there were only 15 from CA-ANI-2 and three from CA-ANI-4. In contrast, we identified three times as many cormorant bones and more than five times as many albatross bones at CA-ANI-2 (see Chapter 5). This finding is interesting given the hyperabundance of gulls on the island today. It is possible that this small number of gull bones is due to a seasonal occupation of the island by humans because gulls are most abundant during early summer for breeding. We know from stable isotope data that people were occupying CA-ANI-2 at all seasons of the year, however, and it would have been uncomfortable to live among gull populations as dense as those on Anacapa Island today. Although seasonal trends might contribute to the lack of gulls, it seems more likely that gull populations on the island were much smaller in the past or restricted to areas where people were not living. Future research of ancient and modern gull DNA and isotopes could help us better understand any shifting dynamics and changes in gull behavior and biogeography during the last several millennia.

The fish identified from the Anacapa sites are generally from kelp forest or other nearshore habitats similar to fish identified at other Channel Islands sites (see Chapter 5). One of the more interesting aspects of the fish assemblage is the fact that gorges appear to have been the primary harvest method and there is no evidence of the single-piece shell fishhook. Given that single-piece shell fishhooks may have first appeared on the northern Channel Islands around 2500 cal BP (Rick et al., 2002), these assemblages seem to represent fishing just before these important artifacts appeared. Still, the general taxa present at these sites is consistent with those from other Channel Islands sites with no clear differences related to the differing technologies (Rick, 2007; Braje, 2010; Turnbull et al., 2015). California sheephead are the most abundant fish at these sites, and they are common around Anacapa today. Braje et al. (2017) placed the data from some of our Anacapa sites in the context of long-term changes in the sheephead fishery throughout the Channel Islands. Interestingly, California sheephead from Anacapa Island archaeological sites occur in some of the highest concentrations on the northern Channel Islands. Measurement of sheephead pharyngeals from these sites provided total length estimates of ~423 mm, a value comparable to that from other prehistoric sites but significantly larger (~31 mm) than modern estimates. These data suggest that overfishing is likely reducing local sheephead sizes today (Braje et al., 2017).

The mammalian assemblages from Anacapa Island sites are also interesting and provide evidence of human subsistence and the historical ecology of Anacapa. The presence of cetacean and delphinid remains as well as sea otter, California sea lion, Guadalupe fur seal, northern elephant seal, and harbor seal is consistent with other Channel Island sites but adds to the diversity of activities that people were conducting on Anacapa and at CA-ANI-2 in particular. The CA-ANI-2 marine mammal assemblage is dominated by harbor seals, with 197 bones compared with just 11 California sea lion bones. This large number of harbor seal bones stands in contrast to San Miguel Island sites during the Late Holocene, which are dominated by otariids and have comparatively few harbor seals (see Braje, 2010; Braje et al., 2011; Rick, 2007). Similarly, bones of harbor seals are found in Late Holocene sites on Santa Cruz Island, but they are often in numbers equal to or fewer than that of California sea lions (Colten, 2001; Noah, 2005). Harbor seals commonly haul out on the rocks around Anacapa today and may have in the past, where people could have taken them. As a variety of researchers have noted, harbor seals are among the more skittish and flight-prone pinnipeds, making them more difficult to obtain and often less desirable than some higher-ranking otariids (see Hildebrandt and Jones, 1992; Braje et al., 2011). The presence of a single elephant seal bone each at CA-ANI-2 and CA-ANI-8 and their occurrence at CA-ANI-6 are interesting given how rare the remains of elephant seals are at Channel Island sites (Rick et al., 2011). Elephant seals require sandy beaches for hauling out, so on the basis of current shorelines, the island's only suitable habitat for them would be the fairly small beach at Frenchy's Cove on West Anacapa, which is near both CA-ANI-6 and CA-ANI-8.

The terrestrial mammal remains recovered at the Anacapa sites are mostly deer bones, which appear to have come in as parts used for producing tools. However, there are also six bones from an island fox at CA-ANI-2 and a few deer mouse bones. The island fox remains are very interesting as foxes do not occur on the island today. Hofman et al. (2016) directly dated this fox to 3200 to 3000 cal BP, or the same age as the CA-ANI-2 occupation, suggesting that it is not intrusive. It remains unclear if live foxes or their parts were transported from another island or, even more exciting, if there was an Anacapa population in the past. The latter would be surprising, but future genetic research will help better address these questions.

Six island deer mouse (*Peromyscus maniculatus*) bones were recovered from CA-ANI-2 and CA-ANI-4, a small number given how abundant deer mice are on the islands today. However, except in caves or at other sites with owl roosts, deer mice are generally rare at Channel Island archaeological sites, so this finding is generally consistent with other open-air Channel Island archaeological sites.

Much remains to be learned about the historical ecology of Anacapa Island, but data from the sites we excavated provide important glimpses into human environmental interactions on Anacapa Island and how its ecosystems may have changed through time. Future research can continue to fill this gap, especially work on the island's paleobotanical remains and future isotope and genetic studies that could help better document its historical ecology.

ANACAPA IN THE BROADER CHUMASH WORLD

What role did Anacapa play in larger cultural developments, lifeways, and interaction spheres on the Channel Islands and in Southern California? We have already addressed some aspects of this question previously, especially in terms of Anacapa's use as a stopover or for more permanent habitation. With Anacapa's occupation containing a mix of intermittent and more sustained occupation, Anacapa was important both geographically and culturally as a gateway connecting the Channel Islands and mainland. Given its proximity to the mainland and the much larger Santa Cruz Island, researchers have long speculated about the role it may have played in broader island interaction spheres. The important role Anacapa played is now confirmed by the abundance of deer bones at CA-ANI-2 and, to an extent, CA-ANI-4. Deer-bone tools have been identified in a number of island archaeological sites, and deer parts were an important trade item for the Chumash on the mainland and the Channel Islands (see Perry and Glassow, 2015; Fauvelle and Perry, in press). Our work suggests fresh deer parts also were transported to Anacapa for making gorges (see Chapter 4). Whether an islander acquired these directly or someone from the mainland was spending time on Anacapa remains unclear. Either way, these data show that people on Anacapa were connected to the adjacent mainland, a proposition also supported by the presence of small amounts of mainland obsidian.

Despite these connections, people also used the available resources on Anacapa, including its lithic sources and subsistence resources, suggesting a clear connection to the local environment. This use of materials mirrors occupation of the other Channel Islands, which show a mix of local use and engagement in broader Chumash exchange systems. Given that most of our data are from the early Late Holocene before the late Middle (AD 500–1300) and Late (AD 1300–1760) period explosion in Chumash exchange and interaction (Arnold, 2001; Kennett, 2005; Rick et al., 2005), we do not have evidence of widespread bead and other exchange like what occurred later in time. However, Rozaire (1993) documented abundant late Middle and Late period microblade tools at CA-ANI-6 and CA-ANI-8, and Rick (2011) noted beads and other microlithic materials in a small probe and surface reconnaissance at CA-ANI-18. Anacapa was clearly a component of the broader Chumash world and, if anything, was a central player rather than a peripheral oddity.

Were the people who occupied Anacapa perhaps from nearby Santa Cruz Island or the adjacent mainland? Rick (2006) noted that a number of sites on eastern Santa Cruz Island date to the same early Late Holocene time period as the sites occupied on Anacapa. Perry (2004, 2005) has suggested that people of eastern Santa Cruz Island had mobile subsistence and settlement strategies at this time, which led Rick (2006) to speculate that Anacapa could have been part of this broader system and could have been used during the Late and Historic periods by people occupying eastern Santa Cruz's two historic named Chumash villages. Glassow (1977) similarly speculated that Santa Cruz's populations could have periodically expanded to Anacapa when needed. With the large suite of faunal and artifact data now available from the early Late Holocene sites on East Anacapa, it seems equally probable that people on Anacapa could have been from the mainland rather than Santa Cruz Island. The abundance of deer bones, presence of an obsidian flake, and use of local Anacapa cherts at these sites suggests that there was potentially greater affinity to the mainland than the closer Santa Cruz Island during the early Late Holocene. However, questions still remain about precisely who was occupying these sites and how well connected they were to the other islands (and mainland), especially during the most recent 1,500 years or so of occupation when microblades (Rozaire, 1993) and other artifacts point to the presence of more materials perhaps obtained on Santa Cruz Island.

Archaeologists have long argued that the Channel Islands contain a more marginal suite of resources compared with the adjacent mainland, especially less freshwater availability and terrestrial plant resources (Arnold, 2001; Kennett, 2005; Rick et al., 2005; Rick, 2007). Discussions around marginality have helped frame debates about broader Channel Island interaction spheres and sociopolitical systems. More recently, researchers have begun to turn arguments about the islands' apparent marginality on their head, noting that much of our perception of resource availability on the Channel Islands has been obscured by the major transformations of island landscapes and seascapes during the historical ranching period (Braje et al., in press; Erlandson et al., in press). As Channel Island ecosystems continue to be restored under National Park Service, U.S. Navy, Nature Conservancy, and other management, it is becoming clear that ancient Channel Islanders had a wide variety of resources available to them, including a range of plants (especially geophytes), a great number of freshwater sources, numerous lithic sources, asphalt seeps for use as a sealant or adhesive, and, of course, rich marine ecosystems (Gill, 2015; Gill and Hoppa, 2016; Erlandson et al., in press). Although the Channel Islands were certainly not without resource limitations, they were places with great opportunities for people who lived on and visited the islands for millennia.

What about Anacapa Island's marginal resources? As noted previously, conversations about the marginality of Anacapa Island are also important with regard to how intensively people may have settled on the island, as well as the place of Anacapa in the broader Chumash world. Glassow (1977:81) suggested that

FIGURE 38. Hadley English's fourth-grade class from California's Ojai Valley School restoring native plants on Anacapa Island. Photo by Linda Rick, 2017.

"Anacapa, as on Santa Barbara Island, may be relevant to testing hypotheses concerning resource marginality and its relationship to population growth and environmental change." We have discussed the relatively marginal nature of this island throughout this volume. Although efforts to restore the island have made significant progress (Figure 38), it remains unclear what a "restored" Anacapa might look like compared with the Anacapa of the distant past. Would there be more springs and sources of fresh water? Would there be more terrestrial plants and other resources? The answer to these questions seems likely to be yes, but we argue that compared with the other islands, Anacapa was still relatively marginal. Although one can overgeneralize that island size is a limiting factor (e.g., Kirch, 1997), Anacapa's size of just 2.9 km^2 in area and rugged shoreline likely were prohibitive, and its lack of surface fresh water also would have been limiting. Similar to arguments about the degree of permanence of Anacapa's ancient human occupations, the reality probably lies in the middle. Our work at CA-ANI-2 and previous work at West Anacapa sites clearly show that Anacapa had diverse human occupations and was an important part of broader Santa Barbara Channel networks. Still, the island appears to lack the large Late period and Historic Chumash villages found on the mainland and larger northern islands. It does have numerous sites and dense shell middens that indicate a more sustained occupation, but its geography and limited resources appear to have constrained this occupation to a degree. Future research should seek to tackle this issue of perceived marginality and the nature of Anacapa's occupation through the full duration of prehistory, which we now know spans more than 5,500 years, into the Historic period.

ANACAPA: MORE THAN JUST A SMALL ISLAND?

Archaeologists have become increasingly interested in the archaeology of small islands, often tackling many of the same issues that we have explored in our research on Anacapa Island (see Fitzpatrick et al., 2016). With work on small islands in Oceania, North America, Africa, and beyond increasing, we can no longer argue that all small islands were marginal or insignificant in the broader lives of people in the past, and there is no universal correlation between human occupation and island size. As noted in Chapter 1, people occupied small islands around the world, often with surprisingly diverse and successful strategies (e.g., sustainability of Tikopia; Kirch, 1997). Small islands have played important roles in the human past that range from basic settlement and subsistence to ritual centers, thereby challenging the idea of marginality (Thompson and Turck, 2010; Napolitano, 2013; Crowther et al., 2016; Fitzpatrick et al., 2016; Giovas, 2016; McNiven, 2016; Wickler, 2016).

What can data from Anacapa Island tell us about small islands around the world more generally? Anacapa is definitely small in size and somewhat resource limited, but like other islands noted previously, Anacapa has yielded surprisingly diverse past human occupations. No longer can Anacapa be viewed as solely a marginal place for a quick stopover as people headed to larger, more desirable islands or the mainland. At various times in the past (especially during the early Late Holocene), Anacapa sustained occupations during which people took the time to make bone and chipped-stone tools, harvested everything from cetaceans to albatross to shellfish, and transported deer parts and potentially island foxes or their remains to the island. Anacapa, like other small islands, appears to have played an integral role in ancient human lifeways, and continued research will help us better evaluate the nature of these relationships.

FUTURE DIRECTIONS AND CONCLUSION

We have worked to fill a significant gap in our understanding of Channel Islands and broader California archaeology through our excavation, survey, and radiocarbon dating of sites across Anacapa Island. Our synthesis of archaeological research on Anacapa Island spanning the past several decades as well as our own research during the past 10 to 15 years provides much food for thought about the archaeology of Anacapa and small islands around the world. It has also produced many new questions. Although the island has been surveyed several times in the past, a systematic survey of both Middle and West Anacapa Islands would be useful for identifying any new cultural resources and assessing the condition of previously recorded sites. With prominent underwater archaeological surveys for potentially submerged Pleistocene or Holocene archaeological sites underway on the Channel Islands (T. Braje, California Academy of Sciences, personal communication, 2017), underwater archaeological survey around Anacapa should be a high priority. The island has relatively steep bathymetry, suggesting the shoreline has moved less than parts of the other Channel Islands following Holocene sea-level rise (see Chapter 1, Figure 4). Along with its proximity to the adjacent mainland, submerged portions of Anacapa's coastline could yield early sites.

Our research has focused on the period from about 3700 to 2500 cal BP, with more limited discussion of earlier and later occupations. Future research should target the latter half of the Late Holocene, Middle Holocene, and potential Early Holocene occupations of Anacapa. Studies like this could help put Anacapa in a broader diachronic framework and could better explore the issues of marginality, permanence of occupation, relationship to other islands and the mainland, and historical ecology that we explored in this volume.

Finally, our work did not address issues of past exploitation of terrestrial plant communities on Anacapa. Given the concerted efforts at restoring Anacapa's plant communities and expansion in Channel Island archaeobotanical research more generally (Hoppa, 2014; Gill, 2015; Gill and Hoppa, 2016), work on Anacapa archaeobotany should be of the highest priority.

We opened this volume with a quote by Schoenherr et al. (1999:303–304): "Considered by many who sail by her rugged shores to be little more than a string of three, dry, lifeless rocks, Anacapa Island is a surprisingly beautiful place on closer inspection." We agree that although many people perceive Anacapa as a small island that is not as exciting as the larger islands, with deeper exploration, Anacapa is indeed an exciting and unique place. Our analysis has revealed important results on the nature of its ancient human occupation and historical ecology, often challenging previous notions about Anacapa Island, such as the lack of foxes and the prominence of gulls. With concerted effort and renewed attention by other archaeologists, we anticipate that Anacapa has many more surprising things to reveal that can help improve perspectives on California and Channel Island prehistory and the archaeology of other islands around the world.

Appendix: Bayesian Outputs and Specifications

TABLE A1. Bayesian outputs for all Anacapa Island dates, showing unmodeled and modeled ages, date names, and agreement indices (summarized in Figure 13). A dash (—) indicates output does not apply to this model; a percent symbol (%) indicates the confidence interval of the modeled chronology.

	Unmodeled (BP)			Modeled (BP)			Indices: A_{model} = 117.3, $A_{overall}$ = 103.9	
Name	**From**	**To**	**%**	**From**	**To**	**%**	**Agreement**	**Convergence**
Sequence								
Boundary start	—	—	—	5960	5310	95.4	—	97.1
Phase								
Curve Marine13								
Delta_R LocalMarine	219	303	95.4	224	306.5	95.4	99.4	99.4
R_Date ANI-15: OS-74598	5552	5316	95.4	5532	5303	95.4	96.4	99.6
R_Date ANI-5: OS-46940	5284	5012	95.4	5282	5008	95.4	99.4	99.6
R_Date ANI-8: OS-50447	5030	4821	95.4	5024	4818	95.4	100.9	99.5
R_Date ANI-4: DAMS-3995	3700	3485	95.4	3694	3481	95.4	99.7	99.7
R_Date ANI-1: OS-48488	3551	3357	95.4	3546	3354	95.4	100.4	99.7
R_Date ANI-28: UGA-27952	3476	3294	95.4	3467	3273	95.4	99.8	99.7
R_Date ANI-9: OS-74596	3371	3152	95.4	3369	3148	95.4	99.5	99.6
R_Date ANI-9: OS-74597	3312	3060	95.4	3308	3055	95.4	100	99.7
R_Date ANI-3: OS-63566	3304	3045	95.4	3298	3038	95.4	100	99.7
R_Date ANI-25: OS-74646	3304	3045	95.4	3297	3038	95.4	100.1	99.5
R_Date ANI-3: DAMS-3996	3303	3028	95.4	3295	3020	95.4	100.1	99.4
R_Date ANI-2: OS-60632	3254	2999	95.4	3248	2997	95.4	100	99.7
Curve IntCal13								
R_Date ANI-2: OxA-30069	3209	3005	95.4	3209	3007	95.4	100	99.8
Curve Marine13								
Delta_R LocalMarine	219	303	95.4	221	297	95.4	105.3	99.5
R_Date ANI-4: OS-48509	3210	2967	95.4	3211	2974	95.4	101	99.7
R_Date ANI-2: OS-60407	2927	2749	95.4	2928	2750	95.4	100.6	99.7
R_Date ANI-2: OS-48508	2922	2733	95.4	2920	2734	95.4	100.6	99.7
R_Date ANI-2: OS-63565	2887	2712	95.4	2883	2714	95.4	100.7	99.7
R_Date ANI-28: UGA-27951	2833	2697	95.4	2829	2699	95.4	102.1	99.6
R_Date ANI-4: DAMS-3994	2721	2458	95.4	2724	2465	95.4	101.3	99.6
R_Date ANI-23: OS-74602	2666	2378	95.4	2666	2381	95.4	100.8	99.6
R_Date ANI-24: OS-74604	675	540	95.4	676	545	95.4	101.3	99.6
R_Date ANI-21: OS-74600	665	530	95.4	667	532	95.4	100.2	99.7
R_Date ANI-6: OS-50446	631	504	95.4	630	504	95.4	100.4	99.8
Curve IntCal13								
R_Date ANI-8: B-031360	652	522	95.4	651	523	95.4	99.6	99.8
Curve Marine13								
Delta_R LocalMarine	219	303	95.4	223	303.5	95.4	102.5	99.7
R_Date ANI-18: B-232738	315	—	95.4	360	−2	95.4	104.8	99.7
R_Date ANI-22: OS-63567	278	60	95.4	280	79	95.4	104	99.7
Boundary end	—	—	—	255	−387	95.4	—	96.8
Span duration	—	—	—	5129	6172	95.4	—	97

TABLE A2. Bayesian model specifications for all Anacapa Island dates underpinning Figure 13. A dash (—) indicates the measure is not applicable to a particular parameter.

Parameter	Name	Type	mu	sigma	llim	ulim
0	intcal13	NoOp	—	—	−48054.5	1965.5
1		NoOp	—	—	NaN	NaN
2	start	Boundary	−3619.82	194.287	−9464.5	−3154.5
3		NoOp	—	—	NaN	NaN
4	Marine13	Curve	—	—	−48054.5	1965.5
5	LocalMarine	Delta_R	265.26	20.6963	130	395
6	ANI-15: OS-74598	R_Date	−3455.63	63.5051	−3749.5	−3154.5
7	ANI-5: OS-46940	R_Date	−3195.49	75.1834	−3524.5	−2854.5
8	ANI-8: OS-50447	R_Date	−2960.43	56.2488	−3349.5	−2629.5
9	ANI-4: DAMS-3995	R_Date	−1643.98	52.4424	−1944.5	−1384.5
10	ANI-1: OS-48488	R_Date	−1493.05	50.4306	−1784.5	−1209.5
11	ANI-28: UGA-27952	R_Date	−1427.53	43.4511	−1689.5	−1154.5
12	ANI-9: OS-74596	R_Date	−1311.11	57.2751	−1619.5	−964.5
13	ANI-9: OS-74597	R_Date	−1222.1	62.4051	−1504.5	−889.5
14	ANI-3: OS-63566	R_Date	−1207.63	62.4285	−1499.5	−879.5
15	ANI-25: OS-74646	R_Date	−1207.86	62.4973	−1499.5	−879.5
16	ANI-3: DAMS-3996	R_Date	−1200.2	66.2754	−1504.5	−864.5
17	ANI-2: OS-60632	R_Date	−1178.94	61.9216	−1479.5	−859.5
18	IntCal13	Curve	—	—	−48054.5	1965.5
19	ANI-2: OxA-30069	R_Date	−1164.45	46.1794	−1419.5	−914.5
20	Marine13	Curve	—	—	−48054.5	1965.5
21	LocalMarine	Delta_R	259.133	18.7527	130	395
22	ANI-4: OS-48509	R_Date	−1146.21	60.1453	−1439.5	−814.5
23	ANI-2: OS-60407	R_Date	−884.734	46.4693	−1199.5	−704.5
24	ANI-2: OS-48508	R_Date	−868.29	48.8651	−1214.5	−569.5
25	ANI-2: OS-63565	R_Date	−841.79	43.6114	−1169.5	−519.5
26	ANI-28: UGA-27951	R_Date	−804.467	32.508	−1054.5	−514.5
27	ANI-4: DAMS-3994	R_Date	−652.871	71.528	−929.5	−329.5
28	ANI-23: OS-74602	R_Date	−573.108	75.5981	−809.5	−314.5
29	ANI-24: OS-74604	R_Date	1333.12	35.4291	1115.5	1500.5
30	ANI-21: OS-74600	R_Date	1348.33	36.5155	1115.5	1525.5
31	ANI-6: OS-50446	R_Date	1385.01	34.547	1210.5	1555.5
32	IntCal13	Curve	—	—	−48054.5	1965.5
33	ANI-8: B-031360	R_Date	1362.39	37.4358	1245.5	1625.5
34	Marine13	Curve	—	—	−48054.5	1965.5
35	LocalMarine	Delta_R	263.33	19.8681	130	395
36	ANI-18: B-232738	R_Date	1745.24	74.088	1415.5	1965.5
37	ANI-22: OS-63567	R_Date	1760.02	53.2942	1505.5	1965.5
38	end	Boundary	1949.13	192.074	1505.5	7680.5
39	duration	Span	5568.95	287.706	0	17145

TABLE A3. Bayesian outputs for East Anacapa Island dates, showing unmodeled and modeled ages, date names, and agreement indices (summarized in Figure 14). A dash (—) indicates output does not apply to this model; a percent symbol (%) indicates the confidence interval of the modeled chronology.

	Unmodeled (BP)			Modeled (BP)			Indices: A_{model} = 104.3, $A_{overall}$ = 93.2	
Name	**From**	**To**	**%**	**From**	**To**	**%**	**Agreement**	**Convergence**
Sequence								
Boundary start	—	—	—	3896	3458	95.4	—	95.4
Phase								
Curve Marine13								
Delta_R LocalMarine	219	303	95.4	224	314	95.4	93.3	99.4
R_Date ANI-4: DAMS-3995	3700	3485	95.4	3670	3455	95.4	86.2	98.9
R_Date ANI-1: OS-48488	3551	3357	95.4	3544	3349	95.4	99.9	99.5
R_Date ANI-3: OS-63566	3304	3045	95.4	3294	3028	95.4	98.5	99.4
R_Date ANI-3: DAMS-3996	3303	3028	95.4	3291	3006	95.4	98.5	99.2
R_Date ANI-2: OS-60632	3254	2999	95.4	3245	2990	95.4	98.6	99.3
Curve IntCal13								
R_Date ANI-2: OxA-30069	3209	3005	95.4	3208	3007	95.4	99.9	99.5
Curve Marine13								
Delta_R LocalMarine	219	303	95.4	215	295	95.4	101.3	99.6
R_Date ANI-4: OS-48509	3210	2967	95.4	3220	2978	95.4	100.1	99.4
R_Date ANI-2: OS-60407	2927	2749	95.4	2933	2753	95.4	99	99.5
R_Date ANI-2: OS-48508	2922	2733	95.4	2928	2736	95.4	99.2	99.2
R_Date ANI-2: OS-63565	2887	2712	95.4	2890	2715	95.4	99.8	99.6
R_Date ANI-4: DAMS-3994	2721	2458	95.4	2740	2530	95.4	101.7	99.4
Boundary end	—	—	—	2730	2331	95.4	—	96.3
Span duration	—	—	—	791	1457	95.4	—	96.2

TABLE A4. Bayesian model specifications for East Anacapa Island dates underpinning Figure 14. A dash (—) indicates the measure is not applicable to a particular parameter.

Parameter	Name	Type	mu	sigma	llim	ulim
0	intcal13	NoOp	—	—	−48054.5	1965.5
1		NoOp	—	—	NaN	NaN
2	start	Boundary	−1702.14	119.149	−3559.5	−1384.5
3		NoOp	—	—	NaN	NaN
4	Marine13	Curve	—	—	−48054.5	1965.5
5	LocalMarine	Delta_R	268.902	22.2554	130	395
6	ANI-4: DAMS-3995	R_Date	−1613.08	55.4083	−1944.5	−1384.5
7	ANI-1: OS-48488	R_Date	−1488.25	50.3283	−1784.5	−1209.5
8	ANI-3: OS-63566	R_Date	−1202.31	63.4744	−1499.5	−879.5
9	ANI-3: DAMS-3996	R_Date	−1194.83	67.4949	−1504.5	−864.5
10	ANI-2: OS-60632	R_Date	−1174.25	63.1046	−1479.5	−859.5
11	IntCal13	Curve	—	—	−48054.5	1965.5
12	ANI-2: OxA-30069	R_Date	−1164.4	46.1787	−1419.5	−914.5
13	Marine13	Curve	—	—	−48054.5	1965.5
14	LocalMarine	Delta_R	255.105	19.7079	130	395
15	ANI-4: OS-48509	R_Date	−1151.73	60.8936	−1439.5	−814.5
16	ANI-2: OS-60407	R_Date	−889.166	47.4429	−1199.5	−704.5
17	ANI-2: OS-48508	R_Date	−872.203	50.0382	−1214.5	−569.5
18	ANI-2: OS-63565	R_Date	−845.227	44.3286	−1169.5	−519.5
19	ANI-4: DAMS-3994	R_Date	−701.188	55.4256	−929.5	−329.5
20	end	Boundary	−612.767	119.027	−929.5	1285.5
21	duration	Span	1089.38	181.069	0	4845

TABLE A5. Bayesian outputs for Middle Anacapa Island dates, showing unmodeled and modeled ages, date names, and agreement indices (summarized in Figure 15). A dash (—) indicates output does not apply to this model; a percent symbol (%) indicates the confidence interval of the modeled chronology.

	Unmodeled (BP)			Modeled (BP)			Indices: A_{model} = 106.4, $A_{overall}$ = 98.4	
Name	From	To	%	From	To	%	Agreement	Convergence
Sequence								
Boundary start	—	—	—	7441	5310	95.4	—	96.8
Phase								
Curve Marine13								
Delta_R LocalMarine	219	303	95.4	230.5	309	95.4	99.1	99.9
R_Date ANI-15: OS-74598	5552	5316	95.4	5539	5306	95.4	98.9	99.9
R_Date ANI-9: OS-74596	3371	3152	95.4	3363	3143	95.4	99.0	99.8
R_Date ANI-9: OS-74597	3312	3060	95.4	3302	3049	95.4	99.7	99.9
R_Date ANI-25: OS-74646	3304	3045	95.4	3292	3025	95.4	99.9	99.9
R_Date ANI-23: OS-74602	2666	2378	95.4	2651	2361	95.4	98.1	99.8
R_Date ANI-24: OS-74604	675	540	95.4	670	540	95.4	99.5	99.9
R_Date ANI-21: OS-74600	665	530	95.4	661	527	95.4	100.2	99.9
R_Date ANI-22: OS-63567	278	60	95.4	275	62	95.4	100.8	99.9
Boundary end	—	—	—	270	−1833	95.4	—	96.9
Span duration	—	—	—	5124	8601	95.4	—	97.3

TABLE A6. Bayesian model specifications for Middle Anacapa Island dates underpinning Figure 15. A dash (—) indicates the measure is not applicable to a particular parameter.

Parameter	Name	Type	mu	sigma	llim	ulim
0	intcal13	NoOp	—	—	–48054.5	1965.5
1		NoOp	—	—	NaN	NaN
2	start	Boundary	–4028.83	715.478	–9464.5	–3154.5
3		NoOp	—	—	NaN	NaN
4	Marine13	Curve	—	—	–48054.5	1965.5
5	LocalMarine	Delta_R	270.183	18.9663	130	395
6	ANI-15: OS-74598	R_Date	–3463.18	62.8223	–3749.5	–3154.5
7	ANI-9: OS-74596	R_Date	–1305.96	57.1734	–1619.5	–964.5
8	ANI-9: OS-74597	R_Date	–1214.97	61.5479	–1504.5	–889.5
9	ANI-25: OS-74646	R_Date	–1200.47	61.3567	–1499.5	–879.5
10	ANI-23: OS-74602	R_Date	–553.557	77.0651	–809.5	–314.5
11	ANI-24: OS-74604	R_Date	1341.48	35.16	1115.5	1500.5
12	ANI-21: OS-74600	R_Date	1355.43	35.8858	1115.5	1525.5
13	ANI-22: OS-63567	R_Date	1771.94	57.7561	1505.5	1965.5
14	end	Boundary	2338.88	711.438	1505.5	7680.5
15	duration	Span	6367.72	1127.78	0	17145

TABLE A7. Bayesian outputs for West Anacapa Island dates, showing unmodeled and modeled ages, date names, and agreement indices (summarized in Figure 16). A dash (—) indicates output does not apply to this model; a percent symbol (%) indicates the confidence interval of the modeled chronology.

	Unmodeled (BP)			Modeled (BP)			Indices: A_{model} = 105.6, $A_{overall}$ = 100.7	
Name	From	To	%	From	To	%	Agreement	Convergence
Sequence								
Boundary start	—	—	—	7589	4993	95.4	—	97
Phase								
Curve Marine13								
Delta_R LocalMarine	219	303	95.4	216	296	95.4	101.5	99.8
R_Date ANI-5: OS-46940	5284	5012	95.4	5285	5015	95.4	99.5	99.8
R_Date ANI-8: OS-50447	5030	4821	95.4	5031	4823	95.4	99.5	99.8
R_Date ANI-28: UGA-27952	3476	3294	95.4	3478	3305	95.4	101.1	99.9
R_Date ANI-28: UGA-27951	2833	2697	95.4	2834	2700	95.4	100.4	99.8
R_Date ANI-6: OS-50446	631	504	95.4	633	505	95.4	100.2	99.9
Curve IntCal13								
R_Date ANI-8: B-031360	652	522	95.4	651	522	95.4	99.5	99.9
Curve Marine13								
Delta_R LocalMarine	219	303	95.4	219.5	304.5	95.4	100.1	99.9
R_Date ANI-18: B-232738	315	—	95.4	353	–2	95.4	100.4	99.8
Boundary end	—	—	—	374	–2243	95.4	—	97.3
Span duration	—	—	—	4800	9022	95.4	—	97.6

TABLE A8. Bayesian model specifications for West Anacapa Island dates underpinning Figure 16. A dash (—) indicates the measure is not applicable to a particular parameter.

Parameter	Name	Type	mu	sigma	llim	ulim
0	intcal13	NoOp	—	—	–48054.5	1965.5
1		NoOp	—	—	NaN	NaN
2	start	Boundary	–3880.47	838.855	–9014.5	–2854.5
3		NoOp	—	—	NaN	NaN
4	Marine13	Curve	—	—	–48054.5	1965.5
5	LocalMarine	Delta_R	255.673	19.5965	130	395
6	ANI-5: OS-46940	R_Date	–3197.02	74.8218	–3524.5	–2854.5
7	ANI-8: OS-50447	R_Date	–2970.12	58.0812	–3349.5	–2629.5
8	ANI-28: UGA-27952	R_Date	–1437.74	42.1042	–1689.5	–1154.5
9	ANI-28: UGA-27951	R_Date	–807.275	33.3318	–1054.5	–514.5
10	ANI-6: OS-50446	R_Date	1382.83	34.5128	1210.5	1555.5
11	IntCal13	Curve	—	—	–48054.5	1965.5
12	ANI-8: B-031360	R_Date	1362.64	37.4718	1245.5	1625.5
13	Marine13	Curve	—	—	–48054.5	1965.5
14	LocalMarine	Delta_R	262.013	20.9468	130	395
15	ANI-18: B-232738	R_Date	1750.62	81.37	1415.5	1965.5
16	end	Boundary	2431.21	830.88	1415.5	7455.5
17	duration	Span	6311.67	1331.68	0	16470

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