PINE NUT PROCESSING IN SOUTHERN CALIFORNIA IS THE ABSENCE OF EVIDENCE THE EVIDENCE OF ABSENCE?

Lynn H. Gamble and Scott Mattingly

Burned rock features that were used for heat, light, the processing of resources, cooking, roasting, ceremonial purposes, and other functions are encountered all over the world. Over 200 prehistoric fire-altered rock (FAR) features have been documented at Torrey Pines State Natural Reserve, an area ethnographically occupied by the Kumeyaay Indians along the central coast of San Diego County in southern California. These features are more densely concentrated at sites within the boundaries of the reserve than at other nearby coastal locations, suggesting an association with a specific resource in the area. Although many FAR features found in southern California and the Southwest are often interpreted as Agave deserti or Yucca whipplei roasting pits, these species are rare at the reserve; the few that exist there today are believed to be modern introductions. We propose that the FAR features in the project area were probably used to process Torrey pine nuts, a high-ranked resource that was valued by the Kumeyaay.

Las características de las piedras quemadas encontradas alrededor del mundo, muestran que fueron utilizadas para lograr distintos propósitos, como la calefacción, la luz, el procesamiento de recursos, para cocinar y asar, intenciones ceremoniales y otras funciones. Hay cientos de funciones de piedra quemada prehistórica (FAR) que han sido documentadas en la Reserva Natural Estatal Torrey Pines, que está ubicada a lo largo de la costa central del condado de San Diego en el sur de California, una región etnográficamente ocupada por los Indios Kumeyaay. Estos rasgos se encuentran más densamente concentrados en emplazamientos dentro de los límites de la Reserva, en comparación con ubicaciones costeras cerca del área, lo cual sugiere que en los alrededores de la reserva hay una asociación a este recurso específico. Aunque hay varios rasgos de la FAR que se encuentran en el sur de California y en el suroeste de los Estados Unidos, son frecuentemente interpretados como pozos de asar para las especies Agave deserti *o* Yucca whipplei. *Estas especies son extremamente raras en la reserva, las pocas que existen hoy en día, se cree que han sido por alteración moderna. Proponemos que estos rasgos de la FAR en la zona del proyecto, han sido utilizados para procesar piñones de Torrey, los cuales eran un recurso muy valioso para los Indios Kumeyaay.*

The high density of fire-altered rock features at Torrey Pines State Natural Reserve (TPSNR) poses an enigma for the archaeologist. Over 200 fire-altered rock (FAR) features have been recorded within the reserve (Mealey 2005), an area of approximately 5.9 km^2. Most are surface features, although some are found in stream cuts buried by up to several meters of alluvial or dune deposits, suggesting that additional buried features are present. These features are particularly difficult to interpret because they lack food remains. Most have very few or no faunal remains, even though these sites are within a few kilometers of the coast, where sandy beaches and rocky intertidal zones are common.

In this article we assess indirect and direct evidence for the use of these features and then propose an interpretation of their function within the theoretical framework of optimal foraging. This study illustrates a systematic analysis of the spatial patterning between FAR features and their locations in relation to plant communities and viewsheds. Ethnographic sources supplement the archaeological data. We consider all of the FAR features that have been identified at TPSNR, with a focus on two sites: CA-SDI-15557 and CA-SDI-9595. We conclude with a discussion of the possible function of these features and the relevance of this study to the larger archaeological community.

Lynn H. Gamble ■ Department of Anthropology, University of California, Santa Barbara, CA 93106-3210 (gamble@anth.ucsb.edu)
Scott Mattingly ■ Department of Anthropology, San Diego State University, 5500 Campanile Dr., San Diego, CA 92182

American Antiquity 77(2), 2012, pp. 263–278

Human behavioral ecology (HBE) was introduced in archaeology as a framework for understanding hunter-gatherer decision-making processes. By seeking simple, generalist solutions to research topics concerned with specific categories of behavior, HBE does not attempt to be a holistic discipline. It is reductionist at its core. This does not lessen the usefulness of HBE in archaeology, however. HBE is most applicable to research in specific behavioral categories, such as the sexual division of labor or resource intensification (Winterhalder and Smith 2000:51–54).

Optimal foraging theory (OFT) was the focus of much HBE research during the 1980s. OFT is composed of a series of models that are concerned mainly with resource selection and habitat movement in relation to resource patches and is often most applicable to ethnographic research due to its dependence upon choices made by individuals (Winterhalder and Smith 2000:54–57).

In particular, central place foraging (CPF) models address residential movement and field processing (Winterhalder and Smith 2000:57). CPF assumes that foragers will exploit resources that require the least energy expenditure while maximizing energy intake. Since resources are rarely distributed evenly in space, CPF theory predicts that primary habitation sites (central places) will be located in areas that maximize foraging returns from different patches.

An example from southern California is Kennett's (2005:225) study of the Santa Barbara Channel Island Chumash. Kennett demonstrates that the Island Chumash located their primary village sites in areas with relatively easy access to a wide range of resources. This choice, however, did not eliminate logistic exploitation of resources from more distant patches. Logistical foraging resulted in temporary occupation sites located near significant resources. Specifically, Kennett (2005:226) interprets sites that have thin lenses of red abalone shell and limited tool and fauna diversity as specialized processing camps. Thus, in general, sites with relatively little material data can be understood as logistical resource-processing sites that were repeatedly reoccupied, perhaps seasonally (Kennett 2005:226). Many sites within TPSNR, including CA-SDI-15557 and CA-SDI-9595, fit this description. The sites are dominated by dense concentrations of FAR, with few other cultural remains or artifacts. Furthermore, the sites are easily accessed from several known village sites.

Another effective archaeological application of OFT is a set of models within CPF theory that address the field processing of resources (Bettinger et al. 1997; Kennett 2005; Winterhalder and Smith 2000). Bettinger et al. (1997:887) use a CPF model to consider the archaeological implications of black oak (*Quercus kelloggii*) and mussel (*Mytilus californianus*) processing. They address the efficiency of field processing in cases where foragers attempt to move usable resources quickly to a central place (Bettinger et al. 1997; Kennett 2005; Winterhalder and Smith 2000). Resource processing involves the elimination of excess material that is of low or no utility, i.e., nut- and seed shells, mollusk shells, and lithic cortices. At the core of CPF modeling is the determination of the difference between the amounts of time involved in field processing and travel. Field processing may increase the amount of useful material per trip, therefore decreasing total travel time required to obtain the resource. However, the amount of time involved in the field processing may be greater than the amount of time required to make more than one trip. For example, it will take more time to collect and decorticate 2 kg of raw lithic material into 1 kg of useful tools than it would to transport 2 kg of the raw material to the central place (Bettinger et al. 1997:888). According to Bettinger et al., the decision to field process is dependent upon the following:

> (1) the amount of time processing takes; (2) the amount by which processing increases the utility of material being transported; and (3) the distance to the central place. If processing time is low enough, and the resulting increase in resource utility is high enough, field processing will increase the rate at which useful material reaches the central place. Even if processing is time costly, it may still increase efficiency if the distance between the central place is large, because fewer trips will have to be made [1997:888].

Applying HBE and CPF modeling to the current project is a productive avenue of research, as it provides a conceptual framework to understand the context of archaeological sites in the area.

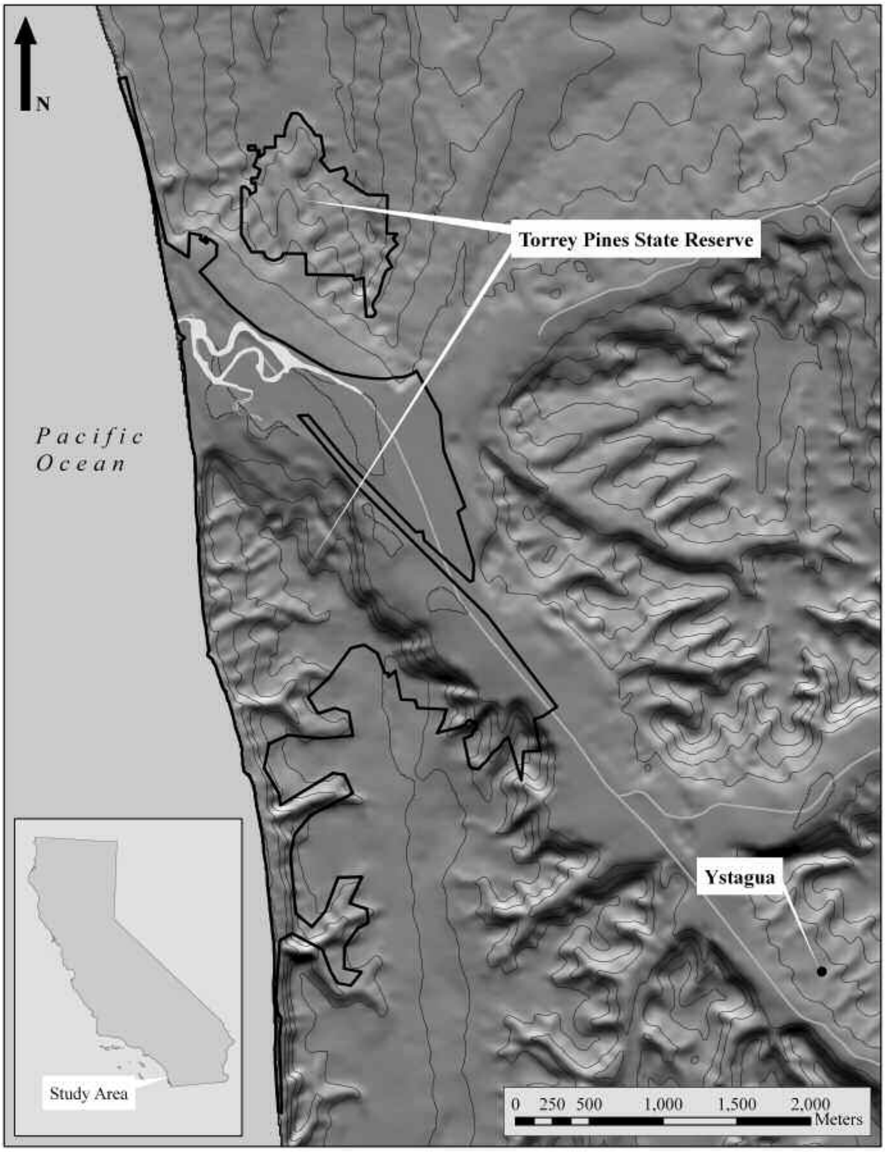

Figure 1. Torrey Pines State Reserve.

Torrey Pines State Natural Reserve

TPSNR is situated in southern California along the coast just north of San Diego on two eroding sandstone terraces (Del Mar Heights and the Scripps Plateau), which are bisected by Los Peñasquitos Creek (Figure 1). Elevations in the study area, which is approximately 5.4 km from east to west and 14.5 km from north to south, range from sea level to approximately 132 m above mean sea level.

The topography in the region is fragile (Johnson 2004), with FAR features and sites actively eroding. Eocene sandstones and siltstones are exposed in steep cliffs that are capped by basal sandstones and conglomerates of the Plio-Pleistocene seafloor known as the Linda Vista Terrace (Inman 1983:27). Cobbles at the base of the Linda Vista Formation provided a readily available source of rock for the features.

Coastal sage scrub and chaparral are the dominant natural vegetation communities (Holland

and Keil 1995). Common shrubs of economic significance to the Kumeyaay at the reserve include black sage (*Salvia mellifera*), lemonade berry (*Rhus integrifolia*), coastal sagebrush (*Artemesia californica*), coastal prickly pear, manzanita (Arctostaphylus spp.), California scrub oak (*Quercus dumosa*), toyon (*Heteromeles arbutifolia*), *Muhlenbergia microsperma*, *Juncus*, Mohave yucca (*Yucca schidigera*), ceanothus (*Ceanothus* spp.), and Torrey pines (*Pinus torreyana* [Gamble 2002]). Torrey pines are one of the rarest and most restricted pines in North America. Today they are present only on the northeastern portion of Santa Rosa Island and on the southern California coast between Del Mar and San Diego (Biondi et al. 1997). The greatest concentration is on the mainland at TPSNR. Charcoal samples and pollen spores of core samples from the Los Peñasquitos Lagoon indicate that the Torrey pine has been in the area at least 3,600 years (Cole and Wahl 2000). Pollen studies on Santa Rosa Island indicate that the species persisted on the island during the middle and late Holocene (Cole and Liu 1994:334). To date, no archaeological research related to pine nut processing has been conducted in the vicinity of the Torrey pines on Santa Rosa Island.

Fire-Altered Rock Features

Two hundred fifty-five FAR features have been recorded at 47 sites at TPSNR (Mattingly 2007; Mealey 1997, 2002, 2005, 2006). The features range in appearance from concave pits filled with burned rock, interpreted as rock ovens, to dense scatters of fire-altered rock that can be over 2 m in diameter. Although shell middens have been recorded at TPSNR, most FAR features in the reserve are not associated with middens or sites with many artifacts or faunal remains. The majority of artifacts associated with these features are lightly used groundstone artifacts, most of which are burned, and chipped stone, primarily debitage. No projectile points have been found in association with the features, and flaked tools are rare or nonexistent. Of the 28 radiocarbon dates of FAR features from the reserve, 24 have conventional radiocarbon ages between 260 and 1,900 years ago, two are older than 5000 B.P., and two are less than 100 years old (Table 1).

Malcolm Rogers, who worked in the region in the 1930s, was one of the first archaeologists to note the profusion of these features at TPSNR. He recorded nine sites at the reserve, commenting that every knoll in the reserve had small middens with hearths scattered between them (Barter 1987:2). Our observations (Gamble 2002; Mattingly 2007) and those of others (Mealey 1997, 2005) confirm Rogers's observations. Marla Mealey (1997, 2002, 2005) recorded 223 prehistoric burned features at 40 prehistoric archaeological sites within TPSNR, most of which were observed on the surface.

At one site in the reserve, CA-SDI-15557, Gamble excavated a large buried cluster of fire-altered rocks, Feature A, with a field class from San Diego State University in 2001. The site rests on a marine terrace approximately 1 km east of the Pacific Ocean that is cut by a small drainage that bisects the Linda Vista and Torrey Sandstone formations. Of the five FAR features at the site, two were buried features observed in the vertical section of the drainage (Gamble 2002). Hammerstones, debitage, and a few chipped-stone tools were a short distance from the FAR features. None of the FAR features appeared to be in direct association with the quarrying activity. The chipped stone, which consisted of quartzite and volcanics, lacked evidence of heat treatment, implying that the features were not used for heat-treating lithics to facilitate production.

Feature A at CA-SDI-15557 was buried under approximately 65 cm of colluvium and, prior to excavation, appeared to be a small cluster of fire-altered rocks (Figure 2). After excavation it became clear that the feature was larger than originally thought and was intact (Figure 3), unlike most FAR features at TPSNR that are dispersed scatters of rocks. Feature A measured approximately 160 cm in diameter and 40 cm in depth and consisted of 237 fire-altered rocks in a matrix of blackened soil with charcoal in a concave depression (Table 2). The soil near the exterior of the feature was light brown and differed markedly from that in the interior, which was dark brown to black with a greater abundance of charcoal. Two charcoal samples from the central part of the feature indicate that it was used approximately 1,600 years ago (Table 1).

Table 1. Radiocarbon Dates (Presented in Conventional Radiocarbon Years) of Fire-Altered Rock Features at Torrey Pines State Reserve.

Beta #	Catalog #	Site	Unit	Level (cm BD)	Material	Analysis	Years B.P.	Reference
217718	P1476-2-38[a]	CA-SDI-16409	A	10–20	Charcoal	AMS	260 ± 40	Mealey 2006
217719	P1477-3-86[a]	CA-SDI-10637	A	20–30	Charcoal	AMS	5740 ± 40	Mealey 2006
217720	P1477-6-19[a]	CA-SDI-10637	B	10–20	Charcoal	AMS	1900 ± 50	Mealey 2006
217721	P1477-7-20[a]	CA-SDI-10637	B	20–30	Charcoal	AMS	1750 ± 40	Mealey 2006
217728	P1477-17-98	CA-SDI-10637	C	70–80	Charcoal	AMS	1800 ± 40	Mealey 2006
217729	P1477-21-96	CA-SDI-10637	D	20–30	Charcoal	AMS	1510 ± 40	Mealey 2006
217730	P1478-1-55[a]	CA-SDI-14448	A	0–10	Charcoal	AMS	680 ± 40	Mealey 2006
217731	P1478-4-21[a]	CA-SDI-14448	A	10–20	Charcoal	AMS	400 ± 40	Mealey 2006
217732	P1478-5-25[a]	CA-SDI-14448	B	0–10	Charcoal	AMS	20 ± 40	Mealey 2006
217733	P1479-08-29[a]	CA-SDI-16404	C	20–30	Charcoal	AMS	710 ± 40	Mealey 2006
217734	P1479-10-28[a]	CA-SDI-16404	C	30–40	Charcoal	AMS	740 ± 40	Mealey 2006
217735	P1479-11-27[a]	CA-SDI-16404	C	20–30	Charcoal	AMS	590 ± 40	Mealey 2006
217736	P1480-2-95	CA-SDI-16407	A	10–20	Charcoal	AMS	840 ± 40	Mealey 2006
217737	P1480-3-99	CA-SDI-16407	A	20–30	Charcoal	AMS	900 ± 40	Mealey 2006
217738	P1480-10-31[a]	CA-SDI-16407	B	0–10	Charcoal	AMS	1270 ± 40	Mealey 2006
217739	P1480-12-97	CA-SDI-16407	C	0–10	Charcoal	AMS	100 ± 40	Mealey 2006
92481	P1141-12-01	CA-SDI-9605	3	20–30	Shell	Radiometric	2120 ± 70	Mealey 1996
92482	P1141-14-03	CA-SDI-9605	3	40–50	Charcoal	Radiometric	1500 ± 60	Mealey 1996
92480	P1141-06-02	CA-SDI-9605	2	10–20	Charcoal	AMS	500 ± 50	Mealey 1996
156919	Sample #14	CA-SDI-15557	Feature A	110	Charcoal (*Ceanothus* sp.)	Radiometric	1550 ± 50	Gamble 2002
156918	Sample #2	CA-SDI-15557	Feature A	114	Charcoal	Radiometric	1650 ± 60	Gamble 2002
217806	Sample #5	CA-SDI-9595	7, Feature F	14	Charcoal	AMS	830 ± 40	Mattingly 2007
217807	Sample #7A	CA-SDI-9595	6, Feature D	15	Charcoal (*Adenostoma fasciculatum* and *Ceanothus* sp.)	AMS	1190 ± 50	Mattingly 2007
217808	Sample #17A	CA-SDI-9595	10, Feature D	11	Charcoal (*Ceanothus* sp.)	AMS	830 ± 50	Mattingly 2007
167268	P1264-57-013	CA-SDI-9595	1	10–20	Charcoal	Radiometric	970 ± 60	Mealey and Jenkins 2003
167269	P1264-61-003	CA-SDI-9595	2	20–30	Charcoal	AMS	960 ± 40	Mealey and Jenkins 2003
167270	P1265-15-001	CA-SDI-14451	1	0–10	Charcoal	AMS	780 ± 40	Mealey and Jenkins 2003
167271	P1266-10-002	CA-SDI-14452	1	10–20	Charcoal	Radiometric	7110 ± 120	Mealey and Jenkins 2003

Note: AMS = accelerator mass spectrometry.
[a]Extended counting.

Figure 2. CA-SDI-15557, Feature A, in creek bank prior to excavation.

Figure 3. CA-SDI-15557, Feature A, after excavation.

Table 2. Weight and Number of Fire-Altered Rocks in Feature A at CA-SDI-15557.

Material	Weight (g)	Number
Quartzite	39,496	139
Igneous	43,209	42
Sandstone	628	1
Unidentified	27,033	55
Total	110,366	237

All of the soil (70.3 liters) from Feature A was manually floated using a decanting process (Gamble 2002). Virginia Popper (2001), at the Cotsen Institute of Archaeology at the University of California, Los Angeles, completed the ethnobotanical analyses of 12 soil samples and eight hand-picked samples. Interestingly, only wood charcoal was recovered in the samples, almost all of which was *Ceanothus* sp. (buckhorn). *Ceanothus verrucosus*, a hard, dense wood that burns for a long period of time at a high temperature, is found at TPSNR and probably was the species recovered. It would be a very suitable wood for keeping rocks warm for cooking or roasting. In addition to *Ceanothus* sp., a few fragments of Rosaceae (rose family), which includes the species chamise (*Adenostoma fasciculatum*) and toyon (*Heteromeles arbutifolia*), were recovered. Both chamise and ceanothus have been identified by Chester King (1993:297) as fuel associated with rock ovens and hearths in other parts of southern California. *Ceanothus* sp., chamise, and toyon are common at TPSNR today and probably were for thousands of years. Although relatively large samples of plant remains were examined from Feature A, the data only provide information about the fuel used in the oven.

More recently, we conducted archaeological investigations at CA-SDI-9595, a site that is approximately 220 m southeast of CA-SDI-15557 and in a similar habitat, with an abundance of cobbles littering the surface. Southern maritime chaparral and Torrey pine forest represent the most common vegetation habitats at the site. Diegan coastal sage scrub is present at its southwestern edge near an unnamed drainage. Forty-seven FAR features have been recorded at CA-SDI-9595, more than at any other site at TPSNR. We excavated two features at the site in 2006 with a field class from San Diego State University. Features D and F were selected for excavation because they looked more intact than many of the other features at the site. Feature D was larger than Feature F and not too heavily eroded. The soil from the features was dry screened through 1/8 inch, and several soil samples were collected from various portions of the feature and where there was a concentration of charcoal. Ten soil samples were processed by Popper (2006) using the decanting procedure.

Feature D at CA-SDI-9595 consisted of a large concentration of fire-altered rock and charcoal that was approximately 4 m in diameter and 20 to 25 cm in depth (Figure 4). The soil surrounding Feature D, a friable sandy loam, was light brown in color and in stark contrast to the dark brownish black sandy loam within the feature. The dark soils were visible just below the surface and between the fire-altered rocks throughout the feature, with the greatest concentration in the approximate center of the feature. Of the 237 fire-altered rocks that were excavated from Feature D, most were igneous (49 percent, $n = 116$, weight = 28,559.9 g). Quartzite was the second most common rock material (10 percent, $n = 24$), followed by metamorphic (3 percent, $n = 7$), sandstone (2 percent, $n = 5$), and metavolcanic materials (.4 percent, $n = 1$), all of which occur in the immediate vicinity of the site. Thirty-five percent ($n = 84$) of the fire-altered rock material types were unidentifiable. Discoloration, cracking, spalling, and crazing were used to determine that a rock had been affected by fire. Although the FAR in Feature D did not appear to have been placed in any particular order, baked clay and fire-reddened soils were immediately beneath the charcoal concentrations and FAR, especially at the eastern edge of the feature.

Botanical remains recovered from Feature D include some seeds and high densities of charcoal. Wood charcoal dominated the botanical remains with a total weight of 136.99 g, 13.79 g of which were identifiable (Mattingly 2007:63; Popper 2006). The most common type of wood identified was *Ceanothus* sp. (8.56 g), followed by *Adenostoma* sp. (4.72 g), *Rhamnus* sp. (.49 g), and *Salvia* sp. (.02 g [Mattingly 2007:63; Popper 2006]). Only 101 seeds were recovered; all of the identifiable seeds ($n = 96$) were *Adenostoma* sp. and found in Units 10 and 14. *Adenostoma* sp. leaves

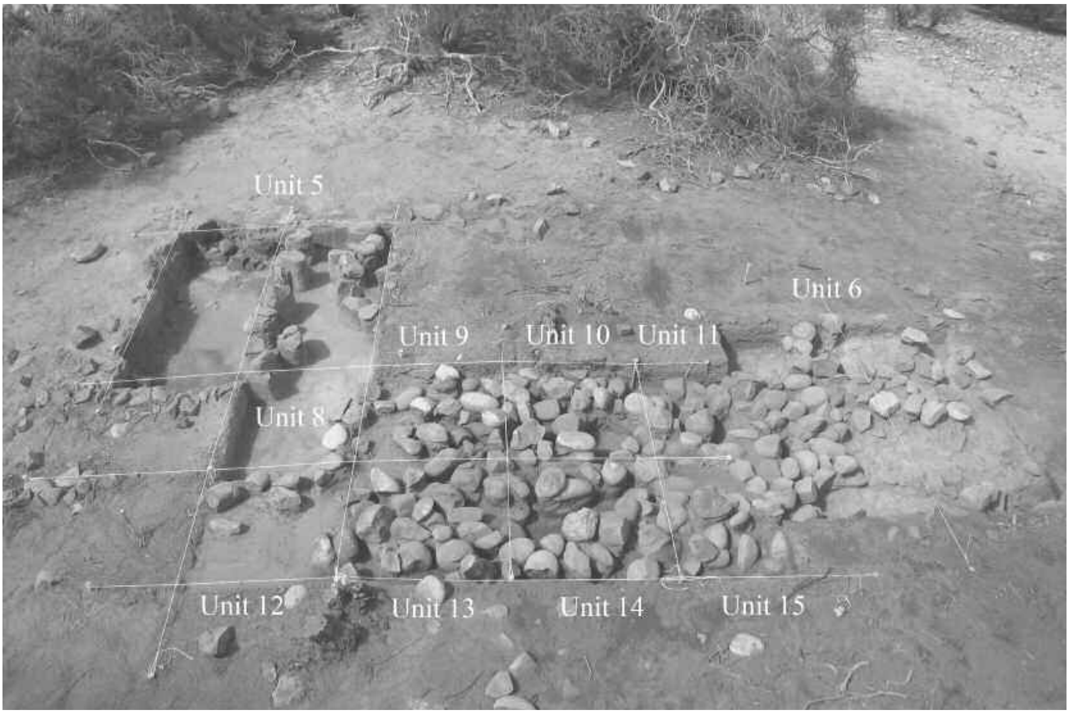

Figure 4. CA-SDI-9595, Feature D after excavation. Units 5 and 6 are 1 by 1 m; Units 8, 9, 10, 12, 13, and 14 are 50 by 50 cm; Units 11 and 15 are 36 by 50 cm.

were also in these units. These data suggest that *Adenostoma* sp. was used as fuel and was not a result of a natural fire. Ethnographic accounts offer no mention of the use of *Adenostoma* sp. seeds as a food in California (see Bean and Saubel 1972; Hedges and Beresford 1986; Lightfoot and Parrish 2009; Timbrook 2007), although the leaves were sometimes boiled in a tea for medicinal purposes. The wood was used for a number of technological purposes, including for construction materials, arrows, and bull-roarers. Among the Cahuilla Indians of southern California, the wood coals of *Adenostoma* sp. were preferred for the roasting of foods (Bean and Saubel 1972:30).

Chipped stone was rare at CA-SDI-9595. Of the 30 chipped-stone flakes and shatter recovered from Feature D, none appeared utilized when viewed under 10× magnification. All of the chipped-stone materials are available locally.

Discussion

Although the preponderance of FAR features at TPSNR is well documented, the function of these features remains enigmatic. The relative paucity of shell, ceramics, faunal remains, and chipped-stone artifacts suggests that the burned rock features were not used for shellfish processing, kilns, animal or plant roasting, or heat treatment of lithic materials. Human remains and ritual items have not been found with any of the features, suggesting that they were not used in mortuary rites or ritual contexts. Viewshed analyses from CA-SDI-9595 and two other sites at the reserve demonstrate that these sites lack clear, unobstructed views of the surrounding area, making it unlikely that they were used as observation stands or for signaling. A view of the entire lagoon and much of the Scripps Plateau is afforded from atop a ridge just half a kilometer to the southeast of CA-SDI-9595, where no prehistoric sites are recorded.

The most common types of FAR features at the reserve have no definable structure and are less than 30 cm in depth (Mealey 2006:62–64). Rocks used to construct these features tend to be fairly uniform in size and shape and from the immediate vicinity. All the FAR features are similar in that cobbles were heated to relatively high temperatures, causing them to crack, craze, and spall. At CA-SDI-9595, the rocks burned hot enough to bake the clay soils below the feature but not hot enough to calcine the rocks. The presence of FAR in direct association with dense concentrations of charcoal at CA-SDI-15557 and CA-SDI-9595 also indicates that the rocks were heated in hot fires.

FAR features in south-central and southwestern America are frequently interpreted as being associated with *Agave deserti* and *Yucca whipplei* processing (Dering 1999; King 1993; Phippen 1999; True and True 1992). These interpretations are well supported by ethnographic accounts that describe the importance of *A. deserti* and *Y. whipplei* as food and utilitarian resources in these regions (Castetter et al. 1938:9; Hedges and Beresford 1986:45–48; Hicks 1963:108–109; Michelsen 1974). Although Diegan coastal sage scrub supports the natural growth of *Y. whipplei*, less than 10 *Y. whipplei* plants are present at TPSNR today, and these probably were recently introduced. It is unlikely that *Y. whipplei* was ever common at the reserve (Darren Smith, California State Parks Environmental Scientist, pers. comm., February 22, 2007). Vegetation communities in which *A. deserti* grow naturally do not occur anywhere at TPSNR (Holland and Keil 1995). Other species of agave and yucca (*Agave shawii* and *Yucca schidigera*) do occur in the reserve; however, *A. shawii* probably was not used as a resource by the indigenous communities, and *Y. schidigera* was used primarily for its strong fibers (Hedges and Beresford 1986:45). The process of extracting yucca fibers involved burying the leaves in wet soil until the fleshy parts deteriorated, leaving only the fibers behind (Hedges and Beresford 1986:45). Sometimes the leaves were simply split into strips for lashing things together (Shipek 1991:98). Delfina Cuero remarked that some people ate the flowers of the *Y. schidigera* and used the seeds in tea or for mush (Shipek 1991:98). None of these processes would warrant the construction of roasting features.

Other types of plants that may have been processed in hearths or pit ovens are bulbs and roots (Bean and Saubel 1972). The heating of roots in earth ovens has been well documented in the Columbia and Canadian plateau regions of North America (cf. Peacock 2002). Bulbs and roots such as mariposa lily (*Calochortus weedii*), brodiaea (*Dichelsostemma capitatum*), and wild onion (*Allium haematochiton*) occur in some areas of TPSNR but also are found outside the boundaries of the reserve. It is possible that the FAR features at TPSNR were used to heat bulbs and roots such as these. If so, however, one would expect that FAR features would be common in areas where these resources have been documented outside the reserve. To our knowledge, no one in the general region has found hearths or pit ovens that have been interpreted as features used to process roots and bulbs.

High densities of wood charcoal, especially *Ceanothus* sp. (wild lilac) and *Adenostoma fasciculatum* (chamise), and relatively few seeds or other plant remains have been associated with the features at TPSNR (Barter 1987; Gamble 2002; Mattingly 2007; Mealey 2006; Mealey and Jenkins 2003; Popper 2006). Identifiable macrobotanical items associated with FAR features at the reserve are presented in Table 3. *Ceanothus* sp. and *A. fasciculatum* were most likely used as a fuel in the features at CA-SDI-9595 (Popper 2006) and in other FAR features in the reserve (Barter 1987; Mealey 2002, 2006; Mealey and Jenkins 2003). To date, no agave, yucca, or Liliaceae remains have been identified from FAR features in the reserve.

Palynological research at TPSNR (Cole and Wahl 2000) and Las Flores Creek (Anderson and Byrd 1998) indicates that modern vegetation communities in the region have been in place for at least the last 2,600 years. Although macrobotanical remains from features at TPSNR provide evidence on the fuels used in the features, they offer limited information as to the use of these features. No carbonized Torrey pine remains have been positively identified by macrobotanists (Gamble 2002; Mealey 2006; Mealey and Jenkins 2003; Popper 2006); however, probable Torrey pine nut impressions have been found with FAR features at TPSNR. Mealey and Jenkins (2003) recorded molds in soils adhering to a fire-affected rock at CA-SDI-9595 that are interpreted as areas where pine nuts were once located. A similar mold was noted within an FAR feature at CA-SDI-14452 (Mealey and Jenkins 2003).

Most FAR features at and near the reserve are densely concentrated within the geographically restricted Torrey pine forests and in the immediately adjacent southern maritime chaparral com-

Table 3. Quantities of Identifiable Macrobotanical Remains Recovered from Fire-Altered Rock Features at Torrey Pines State Reserve.

Macrobotanical Remains	Quantity
Adenostoma sp. charcoal	208
Adenostoma sp. leaves	47
Adenostoma sp. seeds	114
Asteraceae charcoal	1
Brassicaceae seedpod	1
Ceanothus sp. seeds	1
Ceanothus sp. charcoal	418
Convulvulaceae seeds	1
Cuscata sp. seeds	3
Cyperaceae seeds	1
Galium sp. seeds	3
Pinus sp. seeds	5
Polygonum seeds	1
Quercus sp. charcoal	6
Rhamnaceae charcoal	11
Rhamnus sp. charcoal	36
Rhus sp. charcoal	7
Rosaceae charcoal	15
Salvia sp. charcoal	2
Salvia sp. seeds	1

Source: Barter 1987; Mealey 2006; Mealey and Jenkins 2003; Popper 2006; Scott Cummings 2002.

Table 4. Comparison of Average Seed Lengths of Edible Pine Nuts.

Species	Common Name	Seed Length (mm)
Pinus coulteri	Big-cone pine	15–22
Pinus jeffreyi	Jeffrey pine	≈10
Pinus lambertiana	Gray pine	10–20
Pinus monophylla	Piñon pine	15–20
Pinus ponderosa	Ponderosa pine	4–9
Pinus sabiniana	Sugar pine	≈20
Pinus torreyana	Torrey pine	17–24

Source: Adapted from Farris 1982:89 and http://www.efloras.org (accessed February 17, 2007).

munities (Figures 5 and 6). Torrey pine nuts are the only resource in these two communities that would warrant field processing.

Pine nut exploitation throughout the Holocene has been well documented in California and the Great Basin (Bettinger 1977; Campbell 1999; Farris 1982, 1992, 1993; Hildebrandt and Ruby 2006; McGuire and Garfinkle 1976; Rhode and Madsen 1998; Simms 1985; Sullivan et al. 2001). Pine nuts were and still are widely recognized by many different Native American peoples as valuable resources, in part because they are an important nutritious food source, high in polyunsaturated fat content (Farris 1993:230–231). Although the specific nutritional value of Torrey pine nuts compared with other pine nuts has not been determined, the relatively large nut of the Torrey pine, in comparison with other edible pine nuts (Table 4), suggests that it is also likely to be highly nutritious (Warren 1964:75–76).

The Kumeyaay living in the area of Sierra Juárez, Mexico, are known to have established camps near pine forests in the fall, when the nuts were ready to harvest (Campbell 1999:160–161). The best ethnographic description on the use of Torrey pine nuts as food among the Kumeyaay Indians of the region is based on an account by Delfina Cuero, a Kumeyaay Indian elder who was familiar with traditional hunting and gathering practices in the region (Shipek 1991:27–28). Cuero stated the following in an interview with Shipek:

> We used to gather pine nuts right near the ocean near San Diego beyond mat kula·xu·y (La Jolla or "land of holes"). If there weren't so many houses maybe I could find my way to all the places again. It wasn't far from Mission Valley to the place for pine nuts [probably Torrey Pines, now a state park]. The men got fish and other things from the ocean when we got pine nuts [Shipek 1991:27–28].

Cuero added that "the pine nuts are generally collected in September (when ripened); sometimes the cones had to be roasted to get the seeds out" (Shipek 1991:94).

Glenn Farris (1982) describes of the process of pine nut extraction based on ethnographic accounts in central and northern California, noting that the cones were taken to a clearing, placed in piles, covered with pine needles, and ignited. He argues that the firing process did not actually open the cones but simultaneously removed the pitch, slightly roasted the nuts, and rendered the cone easier to split. At this point, the pine nuts could be accessed by simply pressing down on the scales of the cone. In some cases, however, the cone may have been split lengthwise using a stone tool (Farris 1982:20–21). Farris (1982:137) adds that in areas where cobbles are prevalent, distinguishing those that were used for pine nut pro-

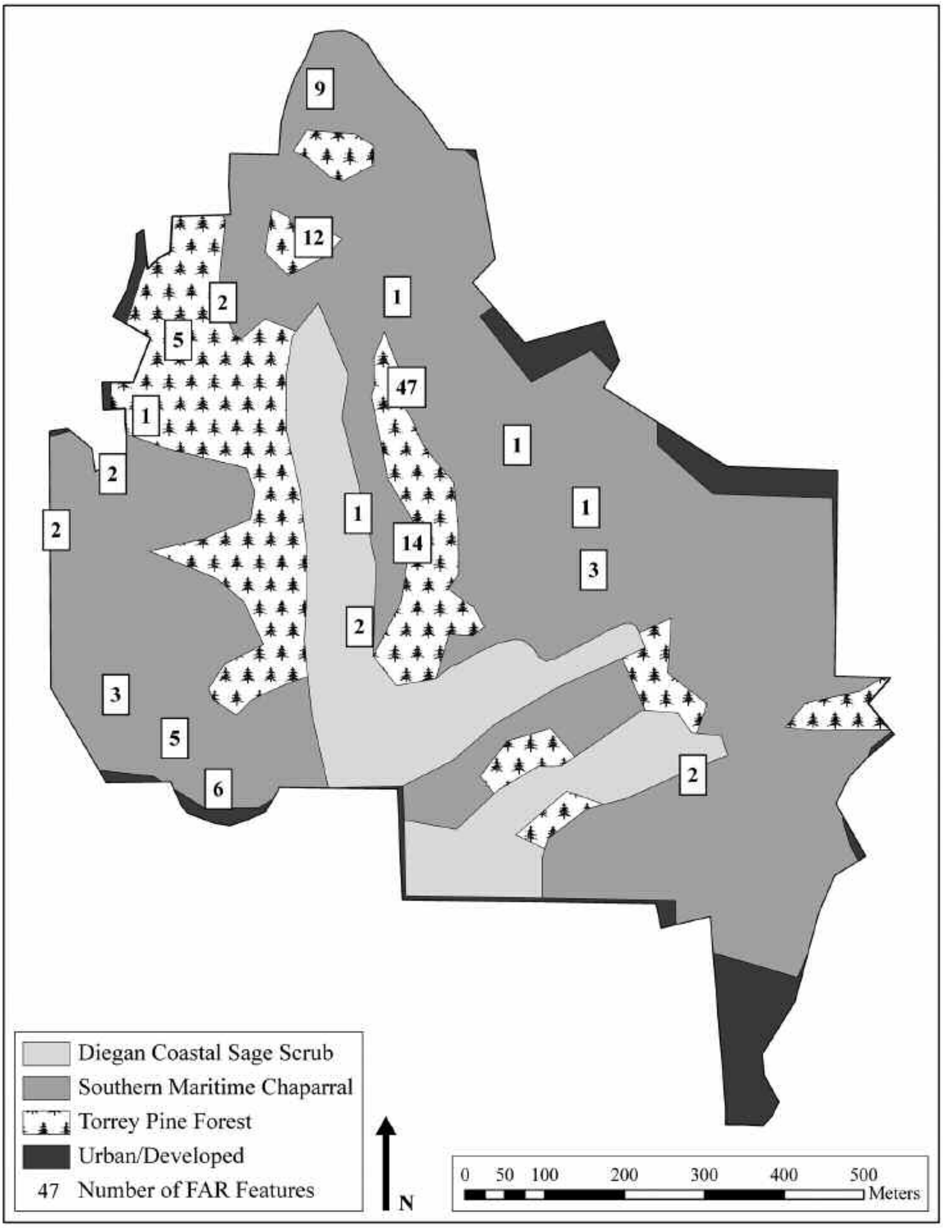

Figure 5. Plant communities and number of fire-altered rock features in the Torrey Pines State Reserve Extension.

cessing may be quite difficult, considering that the process leaves little wear on the tools. Farris discusses the type of evidence one might find at a pine nut–processing site:

> The probable artifacts one might expect to find in such a processing site would be discarded stone cobbles, cobble choppers, and crude flat stones on which to chop or pound the cones. There is occasional mention of the cones being cut off the tree with a knife. Kroeber speaks of the Hill Patwin using a "flint" [obsidian?] to cut off the digger pine cones. If such a tool needed re-sharpening or simply broke and was discarded, one might expect some remains, particularly in the form of trimming flakes or the broken remnants of a biface which may

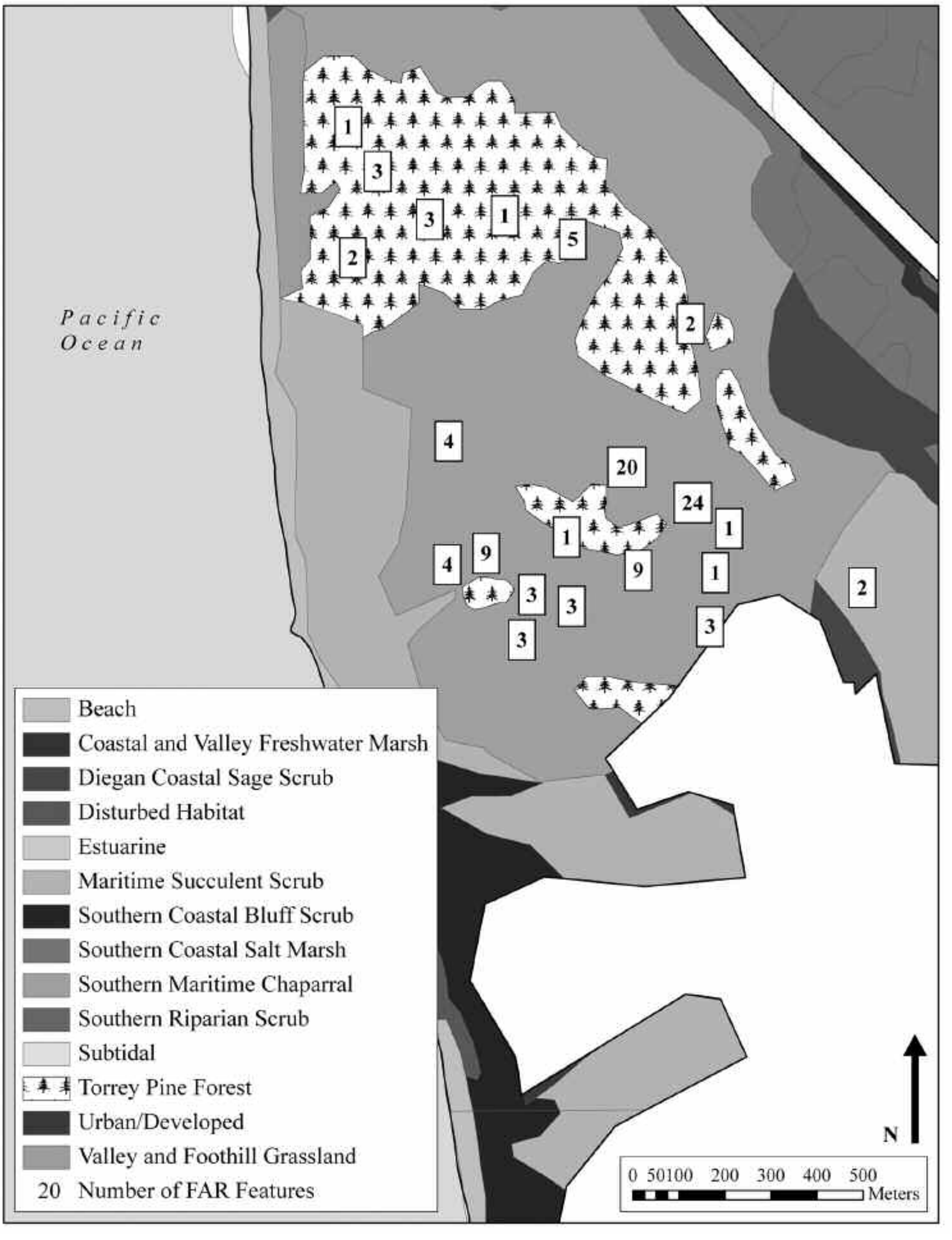

Figure 6. Plant communities and number of fire-altered rock features in the main portion of the Torrey Pines State Reserve.

have been used as a knife. Finally, if the burning of the cones did get out of control, there may be charred remnants of the cones or nuts. This would require ideal conditions, however, since such small processing sites would most likely be thin deposits with no midden accumulation [1982:131].

Except for the absence of charred remains of pinecones or nuts, sites at TPSNR with dense concentrations of FAR features are almost identical to the pine nut–processing sites described by Farris (1982). The high density of the features and their proximity to the pines, along with direct ethnographic evidence (Shipek 1991), all strongly suggest the use of these sites as Torrey pine nut–processing areas.

We propose that the Kumeyaay actively exploited Torrey pines and that the FAR features at TPSNR were used to field process pine nuts by collectors traveling from nearby village sites. The majority of the features are densely concentrated within Torrey pine forests and the contiguous vegetation communities. The most likely resources that would necessitate field processing in these vegetation communities are Torrey pine nuts. At sites that are characterized primarily by the presence of FAR features and few other cultural items, the features are only located in Torrey pine forests, southern maritime chaparral, and Diegan coastal sage scrub communities. Fire-altered rock features at these sites are greater than three times more densely concentrated within Torrey pine forests than in the neighboring southern maritime chaparral and Diegan coastal sage scrub communities (Figures 5 and 6).

The scarcity of direct botanical evidence for the roasting of Torrey pine nuts at TPSNR is disappointing but understandable since charred cones or seeds would be a result of a failed attempt at roasting the cones properly. An example of prehistoric root processing on the Canadian Plateau serves to illustrate the point. Sandra Peacock (2002) focused her research at Komkanetkwa, where she interpreted the remains of 170 earth ovens as root-processing facilities. Peacock supports her hypothesis with extensive ethnographic data in conjunction with archaeological evidence from 11 earth ovens. In her analysis of the archaeobotanical remains from the features, she found that wood charcoal, which probably was used as fuel in the cooking of the roots, dominated the assemblages. Peacock found no evidence of charred root resources and concludes that this would be expected since the users of the ovens did not want to char the roots they were cooking. If we assume that the features at TPSNR were used for the processing of pine nuts, their users also wanted to avoid burning the seeds or cones.

During the Late Prehistoric period in the San Diego region, diet breadth expanded considerably to include a wide range of botanical and animal food resources (Byrd and Raab 2007; Reddy 1999). Dietary expansion that includes the use of more peripheral resources has been described as resource "intensification" by human behavioral ecologists and is often a result of population growth and the overexploitation of staple resources (Winterhalder and Smith 2000:58). Interpreted as pine nut–processing areas, the sites at TPSNR reflect resource intensification. Radiocarbon dates for 26 of 28 FAR features at TPSNR indicate that most features are less than 2,000 years old (Table 1). The greater quantities of FAR features at the reserve during the last two millennia may reflect the increasing importance of the Torrey pine nut as a supplementary dietary item and possibly as an important trade item during the late Holocene.

Several radiocarbon dates suggest that the sites with FAR features at TPSNR and the Kumeyaay village of Ystagua were contemporaneous (Carrico and Taylor 1983:147–149; Harris et al. 1999). The Torrey pines area was close to Ystagua, and people could have easily traveled along the eastern and northern shores of the Los Peñasquitos Lagoon and north through the canyon at the reserve. Interestingly, Florence Shipek, the ethnographer who worked with Delfina Cuero, recorded the archaeological site for a portion of Ystagua and noted that the name translates to "Trees are there" and that it was this village that "would have had control of Torrey Pines" (1976:2). To date, no studies of the Ystagua collections have indicated the presence of Torrey pine nuts.

The relationship between the features at TPSNR and Ystagua fits well with predictions of central place foraging theory. The village of Ystagua is a logistically located central place between two major drainages and less than 5 km from Los Peñasquitos Lagoon and the Pacific Ocean. This location facilitated the exploitation of a wide range of marine and terrestrial resources, including the use of plant resources. Of particular relevance to this argument is Farris's statement that

> in virtually all accounts of the collecting of digger pine cones one reads that the cones were processed in the immediate vicinity where they were obtained. This was due to the heavy pitch accumulation that had to be removed from the cones, plus the sharp nature of the scales, and, finally, the fact that the edible kernels amounted to only 5% or less of the total weight of the cones. . . . Rather than process the cones back at camp, it made more sense to extract

the seeds near the place where the cones were obtained [1982:129].

Descriptions of green pinecone–processing sites used by the Paiute of eastern California support this argument (Eerkens et al. 2002). Eerkens and his colleagues (2002:23) state that one benefit of green cone processing (as compared with collecting nuts from brown cones that have fallen) is that it reduces competition with rodents. They also note that most extracted nuts probably were brought to the valley, not consumed in the field.

From the perspective of central place foraging theory, sites with FAR features at TPSNR may very well have been used by inhabitants of Ystagua to field process Torrey pinecones. In a discussion on the basic principles of CPF models, Bettinger et al. (1997:888) propose that field processing is worth the effort if the efficiency of delivering resources from foraging locations to a central place is increased. The requirements described by Bettinger et al. (1997:888) that are involved in the decision to field process appear to have been met in the Torrey pines situation. Field processing of Torrey pinecones would have been a logical decision for people traveling to these locations from nearby habitation sites because of the ratio of pine nut to cone weight. Cracking the nutshell and extracting the seed probably were completed once the unshelled nuts had been transported, because the shell is relatively small and lightweight. The collector's time would have been more efficiently spent extracting the pine nuts from the cones and taking the nuts back to the central place for further processing. This may help explain why no carbonized Torrey pine nuts or shells associated with FAR features in the study area have been identified. Finally, the Torrey pine forests are less than 7 km over relatively easy terrain from Ystagua (Mattingly 2007).

In this article we consider why such a high density of FAR features exists in the Torrey Pines State Natural Reserve. Although we lack direct macrobotanical evidence of charred pinecones or nuts, we use multiple lines of evidence within the framework of optimal foraging theory to suggest that the FAR features were used for the processing of Torrey pine nuts. Evidence to support this proposition includes (1) the high density of fire-altered rock features in proximity to the Torrey pines, in contrast to the surrounding areas that have no Torrey pines trees and few, if any, FAR features; (2) the high density of fuel associated with the features; (3) the absence of agave and yucca in the region and in the macrobotanical remains from the features; (4) the high density of FAR features in sites that lack evidence of habitation; (5) the paucity of artifacts, especially those that might be associated with a habitation site or with religious activities; (6) the lack of faunal remains associated with these features; (7) the ethnographic accounts that specifically mention that the local Kumeyaay Indians visited the Torrey pine forests to collect and roast pinecones; and (8) the region's proximity to Ystagua, a historic and prehistoric habitation site whose inhabitants most likely would have utilized the pine nuts.

Acknowledgments. Without the permission, support, and funding from the California State Parks, this research would not have been possible. We are especially grateful to a number of people at California State Parks, including Marla Mealey, John Foster, Therese Muranaka, Mike Sampson, Mike Wells, Darren Smith, and Glenn Farris (now retired). We thank the South Coastal Information Center for its help with archaeological records of the region. We are also grateful for the assistance of the SDSU students who excavated the fire-altered rock features at CA-SDI-9595 and CA-SDI-15557. Moreover, we acknowledge the help and support of Carmen Lucas, the Kwaaymii elder who served as monitor for the project. We appreciate the advice of Glenn Russell, Patricia Masters, Douglas Inman, Linda Scott Cummings, Kristina Gill, Amber VanDerwarker, Greg Wilson, Susan Hector, Allison Jaqua, Gail Wright, Brian F. Smith, Johnna Buysse, Richard Carrico, and Eric Wohlgemuth. Finally, we acknowledge the editor of *American Antiquity*, Alison Rautman, Glenn Farris, and three additional anonymous reviewers who provided comments that helped improve the article.

References Cited

Anderson, R. Scott, and Brian F. Byrd
1998 Late-Holocene Vegetation Changes from the Las Flores Creek Coastal Lowlands, San Diego County, California. *Madroño* 45:171–182.

Barter, Eloise R.
1987 *CA-SDI-10636, the Cache Site, Torrey Pines State Reserve: A Report of Work Done Under Statewide Resource Management Program Project 403-630-3-2*. State of California Department of Parks and Recreation, Southern Service Center. Submitted to the State of California Department of Parks and Recreation. Copies available from South Coastal Information Center, San Diego State University, San Diego.

Bean, Lowell John, and Katherine Siva Saubel
1972 *Temalpakh: Cahuilla Indian Knowledge and Usage of Plants*. Malki Museum Press, Banning.

Bettinger, Robert L.
1977 Aboriginal Human Ecology in Owens Valley: Pre-

historic Change in the Great Basin. *American Antiquity* 42:3–17.

Bettinger, Robert L., Ripan Malhi, and Helen McCarthy
1997 Central Place Models of Acorn and Mussel Processing. *Journal of Archaeological Science* 24:887–899.

Biondi, Franco, Daniel R. Cayan, and Wolfgang H. Berger
1997 Dendroclimatology of Torrey Pine (*Pinus torreyana* Parry ex Carr.). *American Midland Naturalist* 138(2):237–251.

Byrd, Brian F., and L. Mark Raab
2007 Prehistory of the Southern California Bight: Models for a New Millennium. In *California Prehistory: Colonization, Culture, and Complexity*, edited by Terry L. Jones and Kathryn A. Klar, pp. 215–227. AltaMira Press, Lanham, Maryland.

Campbell, Paul D.
1999 *Survival Skills of Native California*. Gibbs-Smith, Salt Lake City.

Carrico, Richard, and Clifford V. Taylor
1983 *Excavation of a Portion of Ystagua: A Coastal Valley Ipai Settlement*. Westec Services, Inc. Submitted to the City of San Diego Environmental Quality Division. Copies available from South Coastal Information Center, San Diego State University, San Diego.

Castetter, Edwin Franklin, Willis Harvey Bell, and Alvin R. Grove
1938 *The Early Utilization and the Distribution of Agave in the American Southwest*. University of New Mexico Bulletin: Ethnobiological Studies in the American Southwest Vol. 6. University of New Mexico, Albuquerque.

Cole, Kenneth L., and Geng-Wu Liu
1994 Holocene Paleoecology of an Estuary on Santa Rosa Island, California. *Quaternary Research* 41:326–335.

Cole, Kenneth L., and Eugene Wahl
2000 A Late Holocene Paleoecological Record from Torrey Pines State Reserve, California. *Quaternary Research* 53:341–351.

Dering, Phil
1999 Earth-Oven Plant Processing in Archaic Period Economies: An Example from a Semi-Arid Savanna in South Central North America. *American Antiquity* 64:659–674.

Eerkens, Jelmer W., Jerome King, and Eric Wohlgemuth
2002 The Prehistoric Development of Intensive Green-Cone Piñon Processing in Eastern California. *Journal of Field Archaeology* 29(1/2):17–27.

Farris, Glenn J.
1982 *Aboriginal Use of Pine Nuts in California: An Ethnological, Nutritional, and Archaeological Investigation into the Uses of the Seeds of* Pinus lambertiana *Dougl. and* Pinus sabiniana *Dougl. by the Indians of Northern California*. Ph.D. dissertation, Department of Anthropology, University of California, Davis. University Microfilms, Ann Arbor.
1992 "Women's Money": Types and Distributions of Pine Nut Beads in Northern California, Southern Oregon, and Northwestern Nevada. *Journal of California and Great Basin Anthropology* 14(1):55–71.
1993 Quality Food: The Quest for Pine Nuts in Northern California. In *Before the Wilderness: Environmental Management by Native Californians*, edited by Thomas C. Blackburn and Kat Anderson, pp. 229–240. Ballena Press, Menlo Park.

Gamble, Lynn H.
2002 *Archaeological Investigations at CA-SDI-15557, Torrey Pines State Reserve with Appendix 1 by Virginia S. Popper*. San Diego State University and Cotsen Institute of Archaeology at University of California, Los Angeles. Submitted to the California Department of Parks and Recreation. Copies available from California Department of Parks and Recreation, Southern Service Center, San Diego.

Harris, Nina M., Tracy Stropes, and Dennis R. Gallegos
1999 *Cultural Resource Monitoring Report for the Village of Ystagua Water Main Break City of San Diego, California*. Gallegos & Associates. Submitted to the City of San Diego Water Department. Copies available from South Coastal Information Center, San Diego State University, San Diego.

Hedges, Ken, and Christina Beresford
1986 *Santa Ysabel Ethnobotany*. San Diego Museum of Man Ethnic Technology Notes No. 20. San Diego.

Hicks, Frederic
1963 *Ecological Aspects of Aboriginal Culture in the Western Yuman Area*. Ph.D. dissertation, Department of Anthropology, University of California, Los Angeles. University Microfilms, Ann Arbor.

Hildebrandt, William R., and Allika Ruby
2006 Prehistoric Pinyon Exploitation in the Southwestern Great Basin: A View from the Coso Range. *Journal of California and Great Basin Anthropology* 26(1):11–31.

Holland, V. L., and David J. Keil
1995 *California Vegetation*. Kendall/Hunt, Dubuque.

Inman, Douglas L.
1983 Application of Coastal Dynamics to the Reconstruction of Paleocoastlines in the Vicinity of La Jolla, California. In *Quaternary Coastlines and Marine Archaeology: Towards the Prehistory of Land Bridges and Continental Shelves*, edited by P. M. Masters and N. C. Flemming, pp. 1–49. Academic Press, London.

Johnson, Jeffery A.
2004 *Coastal Erosion Survey Torrey Pines State Reserve*. Jeffery A. Johnson, Inc. Submitted to the California Department of Parks and Recreation. Copies available from California Department of Parks and Recreation, Southern Service Center, San Diego.

Kennett, Douglas J.
2005 *The Island Chumash: Behavioral Ecology of a Maritime Society*. University of California Press, Berkeley.

King, Chester
1993 Fuel Use and Resource Management: Implications for the Study of Land Management in Prehistoric California and Recommendations for a Research Program. In *Before the Wilderness: Environmental Management by Native Californians*, edited by Thomas C. Blackburn and Kat Anderson, pp. 279–298. Ballena Press, Menlo Park.

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

Mattingly, Scott A.
2007 Archaeological and Geospatial Investigations of Fire-Altered Rock Features at Torrey Pines State Reserve, San Diego, California. Unpublished Master's thesis, Department of Anthropology, San Diego State University, San Diego.

McGuire, Kelly M., and Allen P. Garfinkle
1976 The Development of Pinyon Exploitation in Central Eastern California. *Journal of California Anthropology* 3(2):83–85.

Mealey, Marla M.
1996 *Statewide Resource Management Project Status Report: Salvage of Eroding Cultural Deposits at Three Archaeological Sites in Torrey Pines State Reserve*. Submitted to the California Department of Parks and Recreation. Copies available from South Coastal Information Center, San Diego State University, San Diego.

1997 *Statewide Resource Management Project Status Report: Archaeological Site Reevaluation and Mapping at Torrey Pines State Reserve*. State of California Department of Parks and Recreation, Southern Service Center. Submitted to the California Department of Parks and Recreation. Copies available from South Coastal Information Center, San Diego State University, San Diego.

2002 *Cultural Resource Management Program Project Status Report: Archaeological Survey of the Extension Area of Torrey Pines State Reserve*. State of California Department of Parks and Recreation, Southern Service Center. Submitted to the California Department of Parks and Recreation. Copies available from South Coastal Information Center, San Diego State University, San Diego.

2005 *Archaeological Site Condition Assessment Within Torrey Pines State Reserve for Storm Damage Following 2004/2005 Rainfall Season*. State of California Department of Parks and Recreation, Southern Service Center. Submitted to the California Department of Parks and Recreation. Copies available from South Coastal Information Center, San Diego State University, San Diego.

2006 *Data Recovery at Storm-Damaged Sites in Torrey Pines State Reserve*. State of California Department of Parks and Recreation, Southern Service Center. Submitted to the California Department of Parks and Recreation. Copies available from South Coastal Information Center, San Diego State University, San Diego.

Mealey, Marla, and S. Jenkins

2003 *Cultural Resource Management Program Project Status Report; Testing and Data Recovery at Three Sites in the Extension Area of Torrey Pines State Reserve*. State of California Department of Parks and Recreation, Southern Service Center. Submitted to the California Department of Parks and Recreation. Copies available from South Coastal Information Center, San Diego State University, San Diego.

Michelsen, Ralph C.

1974 Ethnographic Notes on Agave Fiber Cordage. *Pacific Coast Archaeological Society Quarterly* 10(1):39–47.

Peacock, Sandra L.

2002 Perusing the Pits: The Evidence for Prehistoric Root Resource Processing on the Canadian Plateau. In *Hunter-Gatherer Archaeobotany: Perspectives from the Northern Temperate Zone*, edited by Sarah L. R. Mason and Jon G. Hather, pp. 45–63. Institute of Archaeology, University College, London.

Phippen, Robert

1999 Burned Rock Features and Middens: 4,800 Years of Roasting in Southeastern New Mexico. In *Sixty Years of Mogollon Archaeology: Papers from the Ninth Mogollon Conference, Silver City, New Mexico, 1996*, edited by Stephanie M. Whittlesey, pp. 173–181. Statistical Research, Tucson.

Popper, Virginia S.

2001 *Macrobotanical Analysis of Soil Samples and Hand-Picked Specimens from CA-SDI-15557, San Diego County, California*. Cotsen Institute of Archaeology at University of California, Los Angeles. Report submitted to L. Gamble. Copies available from South Coastal Information Center, San Diego State University, San Diego.

2006 *Macrobotanical Analysis of Soil Samples from CA-SDI-9595 San Diego County, California*. Cotsen Institute of Archaeology at University of California, Los Angeles. Report submitted to L. Gamble. Copies available from South Coastal Information Center, San Diego State University, San Diego.

Reddy, Seetha N.

1999 Plant Usage and Prehistoric Diet: Paleoethnobotanical Investigations on Camp Pendelton, Southern California. *Pacific Coast Archaeological Society Quarterly* 35(4):25–44.

Rhode, David, and David B. Madsen

1998 Pine Nut Use in the Early Holocene and Beyond: The Danger Cave Archaeobotanical Record. *Journal of Archaeological Science* 25:1199–1210.

Shipek, Florence C.

1976 *San Diego Museum of Man Archaeological Site Record Sheet for SDM-W-939*. F. C. Shipek. Submitted to the San Diego Museum of Man. Copies available from the San Diego Museum of Man, San Diego.

1991 *Delfina Cuero: Her Autobiography, an Account of Her Last Years, and Her Ethnobotanic Contributions*. Ballena Press, Menlo Park.

Simms, Steven R.

1985 Pine Nut Use in Three Great Basin Cases: Data, Theory, and a Fragmentary Material Record. *Journal of California and Great Basin Anthropology* 7:166–175.

Sullivan, Alan P., III, Robert A. Cook, Matthew P. Purthill, and Patrick M. Uphus

2001 Economic and Land Use Implications of Prehistoric Fire-Cracked-Rock Piles, Northern Arizona. *Journal of Field Archaeology* 28:367–382.

Timbrook, Jan

2007 *Chumash Ethnobotany: Plant Knowledge Among the Chumash People of Southern California*. Santa Barbara Museum of Natural History, Santa Barbara.

True, Delbert L., and Jack L. True

1992 Earth Ovens and Hearths in Prehistoric Southern California: A Dated Example from Western Riverside County. *Pacific Coast Archaeological Society Quarterly* 28(4):1–24.

Warren, Claude N.

1964 Cultural Change and Continuity on the San Diego Coast. Unpublished Ph.D. dissertation, Department of Anthropology, University of California, Los Angeles.

Winterhalder, Bruce, and Eric Alden Smith

2000 Analyzing Adaptive Strategies: Human Behavioral Ecology at Twenty-Five. *Evolutionary Anthropology* 9(2):51–72.

Submitted November 28, 2010; Revised January 31, 2011; Accepted February 23, 2011.