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A few words from the
NRS systemwide office

Today the NRS's 33 reserve sites,* encompassing roughly 130,000 acres, are protected and managed in support of teaching, research, and outreach activities. The only people who live there now are a handful of reserve personnel — mostly resident managers and stewards — who care for these wildlands, their resources and facilities, and who enable the teaching and research to continue across California. But this was not always the case.

Long before even the *concept* of California, other people lived out their lives on these lands. Hundreds and thousands of years ago, other people were finding ways to feed, clothe, shelter, and protect themselves, trying their

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Photo by Susan Gee Rumsey

The past is nonrenewable: Natural reserves protect rich cultural resources

I've done research at the UC Natural Reserve System's site on Santa Cruz Island for over 20 years, including archaeological field schools (10 summers) and National Science Foundation-supported research (6 years) since 1985. I also did my Ph.D. on the island (1980-83) and recorded the major chert quarries of El Montañón and the microblade production industries in the China Harbor area.

Santa Cruz Island is a remarkable place, and its pre-European cultural resources are among the most important and exceptionally well-preserved in the United States. The coastal Chumash were one of the most complex hunter-gatherer

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Archaeological field school students excavating a Santa Cruz Island midden using trowels, paint brushes, dustpans, and other common implements. Photo by Susan Gee Rumsey

The past is nonrenewable

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cultural groups in the long prehistory of North America and are increasingly coming to the attention of archaeologists all over the world for a variety of reasons, including their political complexity, plank canoe technology, longevity in the region, early water travel, and intensive craft production and exchange.

On some occasions over the years, when major management decisions have been made by the island's owners and stewards — and opportunities arose to better integrate archaeological and biological research to the benefit of both scientific and management concerns — Santa Cruz Island's cultural resources have often remained rather invisible and their unique qualities have perhaps not been fully recognized.

But Santa Cruz Island is an excellent example of the many reasons why it is essential to protect archaeological sites there and throughout the state:

- First, Santa Cruz Island's 600+ recorded Chumash sites are already part of a National Register of Historic Places District, deeming them federally important pre-Columbian cultural resources.
- Second, each site at each reserve throughout California is a *non-renewable*, irreplaceable, non-restorable, scientifically unique resource — a concept sometimes difficult for non-specialists to fully appreciate. Each village site or quarry site represents unique activities in the daily, political, or ritual lives of social groups during some part of the past 10,000

years. It is not scientifically defensible to damage or destroy this village or that campsite because a “similar” one exists nearby. Each constitutes a distinctive part of the record of the leaders, trade relationships, ceremonies, subsistence, marriages, births, and deaths of different families, lineages, or other social units. Thus one archaeological site does not substitute for another.

- Third, respect for archaeological sites is very important to living Indian peoples.
- Fourth, information derived from such sites on reserves has much to offer to other scientists and to the public interested in past environments, past ecosystem organization, ancient DNA work, and many other topics.

Many lessons can be learned about human impacts on ecosystems, environmental (oceanic and atmospheric) effects on human societies, human uses of plants and animals, and other kinds of important triumphs and struggles in the past that are still relevant today. Let me provide two short examples:

We have learned and will continue to learn a great deal about ancient oceanic temperature fluctuations and ancient sequences of drought in California from coordinated research between atmospheric scientists, geographers, marine biologists, and archaeologists. This information allows us to place today's “El Niño” events and harsh droughts in long-range scientific perspective.

On a more particular level, distributions of important species, such as the island foxes and some of the hybrid oaks on Santa Cruz Island Reserve today, are very much a function of past Chumash travel, subsistence, and trade practices — and these histories can be of great importance to the research of biological colleagues. The extraordinary fisheries of the south shore of the island (which have produced some of the highest densities of fish bone at sites anywhere in the world — up to 500,000 bones per cubic meter), have allowed us to study ancient fish distributions and important aspects of paleo-oceanic change in great detail. Considerable high-caliber research at archaeological sites, with results of significance for anthropology, biology, geography, climatology, and other disciplines, has already taken place on NRS reserves. Clearly, strong support for such research should be a priority for the future.

Yet, various factors threaten reserve sites everywhere. Indifference, vandalism, and failure to appreciate the non-



renewable quality of cultural resources are paramount, but education can largely overcome these limitations in time. Another current threat — rampant on Santa Cruz Island, but also common in areas of mainland California — is the large population of feral pigs that selectively roots for such plants as the wild cucumber (*Marah* sp.). Wild cucumber was actually used by the Chumash, probably for medicinal purposes, and its seeds were mixed into the soils of some villages long ago. This plant still appears to thrive in the soft soils of the deep midden sites, as well as in other areas. The pigs pursue the roots with a vengeance.

It is difficult to convey the scientific devastation wrought by the activities of these pigs. And once a part of a site is damaged — whether by pigs, construction, or other disturbance — that particular material can never be replaced. Often its story and its context cannot be even partially reconstructed.

Because Santa Cruz Island does not have burrowing rodents, the distinctive layers of cultural material laid down in these sites over time (stratigraphic levels) are undisturbed, a condition seldom found in other areas of North America. Such finely stratified and undisturbed sites allow archaeologists to conduct unusually precise, refined analytic and chronological work. This condition is of extraordinary importance and means that we can read the past with significantly greater confidence. In contrast, this opportunity is lost to us at most Chumash sites on the mainland (and many sites throughout the Americas), where pocket gophers have disturbed many of the associations among objects and features and active urban development has wrought great damage.

We have been able to boast — until now — that the Channel Islands are home to some of the most pristine, exceptionally well-preserved sites in the country. But each day that pigs or human activities are allowed to damage these sites, we diminish our collective chance to make this claim.

One example: Santa Cruz Island's Prisoners Harbor site has received heavy pig damage directly in the zone where, since 1991, we have been excavating a buried redwood-post circular house. This redwood-post house was built and used by an elite Chumash family of the Late and Historic periods (the 1700s and early 1800s). The bases of the structural members of the house and its floors and contents are exquisitely preserved. The redwood itself is exceptional, having been carried from Monterey Bay on ocean currents; this is the *only* house in Chumash territory known to have been built with redwood. The house

contains artifacts and features informing us about the Chumash islanders' massive bead-production industry, about their cross-channel exchange system, about their economic and political responses to the Spanish Missions on the mainland, and about their feasting events. The adjacent village, of which this house was a part, was a trade center for thousands of years and was the *last* village occupied by the Chumash before they abandoned the island in 1819.

I hope this story will inspire all who support the NRS and use its sites, as well as the personnel of other agencies, archaeologists, and students and colleagues in other fields, to seize the opportunity to work together to "save the past for the future" at all of the UC reserves. — *Jeanne Arnold*

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Above: Jeanne Arnold (center, black sweatshirt) and field school student measure the excavation pit.
Below: Two field students closely examine excavated and screened soil for beads, bone fragments, and other remnants of Chumash society. Photos by Susan Gee Rumsey

The process of archaeology observed: Jeanne Arnold's archaeological field school at Santa Cruz Island Reserve, summer 1996

I arrive on the fourth day of this excavation. Jeanne shows me deep gouges in the earth that the island's feral pigs made the night before at the perimeter of the work area. The pigs root up fennel, another thriving invasive species, and destroy the site. Jeanne uses Pine Sol as a "Pig-Be-Gone" spray on nearby pig paths.

The site is located just back from the beach, beneath a locust tree. Nine field school students spent their entire first day here, sweating in the white-hot July sun, clearing fennel. Our horizon consists of the miles of ocean between here and the mainland. The sky is a flat blue. We hear the cries of ravens, gulls, pelicans, and various shorebirds.

This site is not what might be called "pristine." In the 1920s, the Army Corps of Engineers destroyed about one-third of the area while attempting to change the course of a stream. But what remains may be the most important site on Santa Cruz Island. This was once a classy neighborhood, where high-ranking Chumash families lived. And, for centuries, the village was a major trading and production center.

The excavation pit is covered like a patient on an operating table, left overnight while the doctors and nurses go home to get some rest. The covering is a couple of overlapping layers of boards, plastic sheets on top of those, rocks holding down the edges of the plastic sheets — a barrier not only against weather and animals, but especially against humans, many of whom come to the beach near this site.



Island excavation in progress.
Photo by Susan Gee Rumsey

Once uncovered, the excavation pit looks like a ready and waiting grave. At another dig I attended on the mainland, the pit I observed being excavated literally turned out to be a grave and so required extra-special consideration. But this part of this site is residential, consisting of Chu-

mash house floors, along with food and manufacturing refuse. This year's excavation consists of two adjacent squares, each one meter by one meter — just wide enough to accommodate three archaeologists on each long side and one at either end of the pit.

Orange plastic flagging tape marks the corners of the pit, while the boundaries of the two adjacent squares are drawn with ordinary household string. In fact, all the tools of the archaeologist's trade seem quite ordinary: mason's trowels and clippers, dustpans, five-gallon buckets, small plastic bags, two-inch-wide paint brushes, measuring tapes, carpenter levels, clipboards, pens. The archaeologists-in-training wear gloves to protect their hands and squat on blue foam sheets, which help ease the pressure on their knees that can become painful after many hours spent kneeling by the pit.

We are right on top of a Chumash redwood-pole house, whose location was discovered by archaeological teams in 1991. The redwood arrived here as driftwood from at least as far away as Monterey and was highly valued; this dwelling would have belonged to someone of note. In contrast to the banal assortment of household items used for the actual excavation, ground-penetrating radar and magnetometer signals were used to verify the size and position of the buried house floor a few years after the dwelling was discovered.

The students are taking down the level of their pit, centimeter by centimeter. The process of archaeology is painstakingly slow — and, from the observer's perspective, all backs and backsides. It's dirty work, too, more so because midden soil is greasy. Some students wield trowels; others use paint brushes and dustpans to collect dirt and dislodged materials. There are appropriate techniques for excavation, and learning them is partly what field school is about. Proper trowel technique requires the tool-bearer to use light scrapes to loosen objects rather than popping them out, causing general damage and possibly breaking long-buried artifacts.

At length, two people break off from the group to sift the soil removed from the pit using fine-mesh wire screens. What remains in the screen, and on the board underneath it, is examined. Components are ID'd according to nature, ranked according to relative proportions, and recorded, including the locations where they were discovered. Then the whole works is bagged for transport back to the lab at home for closer analysis. Each bag required four or five hours to



assemble and will require 40 to 50 hours of lab work, since the deposits are so dense and filled with so many artifacts.

(Whole abalone shells are bagged separately and brought to the mainland in a “fragile box.” These whole shells are measured in various ways to estimate growth rate, which is affected by water temperature. Following this method, Jeanne and a marine biology colleague realized they can extrapolate ocean temperatures at various points in time. They have published their results from four other island sites.)

Even the tiniest object must be scrutinized for possible significance. Here’s what gets screened up: mussels, barnacles, sea urchin spines, bits of charcoal, fish and mammal bones, microblades, beads, bead blanks, chert flakes and cores, fish-hooks, ornaments. Some beads were shaped entirely through chipping, while others, rarer types made of glass and metal, were obtained through trade with other peoples. But why did the Chumash want beads? What’s so great about beads? One answer is that they were luxury goods in a society where all kinds of goods were limited. Beads offered the wearer an opportunity to display wealth and status. Beads travel well, easily, and clearly have a long shelf life.

Engaging speculation, to be sure. Although, for me, on this blazing summer afternoon, surrounded by foraging yellow jackets, it seems like a long shot to try to extrapolate from a few cultural fragments an entire lifestyle and social organization that vanished long ago. Jeanne, on the other hand, points out that, for her, the process is considerably more than one of speculation — based as it is on some twenty years of careful analysis and theorizing. She observes that, while we cannot improve the ethnohistoric record, we can gather as much information as possible about the past, seeking ever greater archaeological evidence to support our theories. And we can do our best to preserve sites.

The students trowel away, trying to get down to 20 centimeters all around. The decision to perform an excavation in large or small increments is based mostly on the integrity of the site, and here they are excavating in 5-centimeter increments. At roughly 12 centimeters, the students entered the area below historical perturbation; their ultimate excavation goal is 60 to 65 centimeters. Prehistoric material is present to about 5 meters in depth.



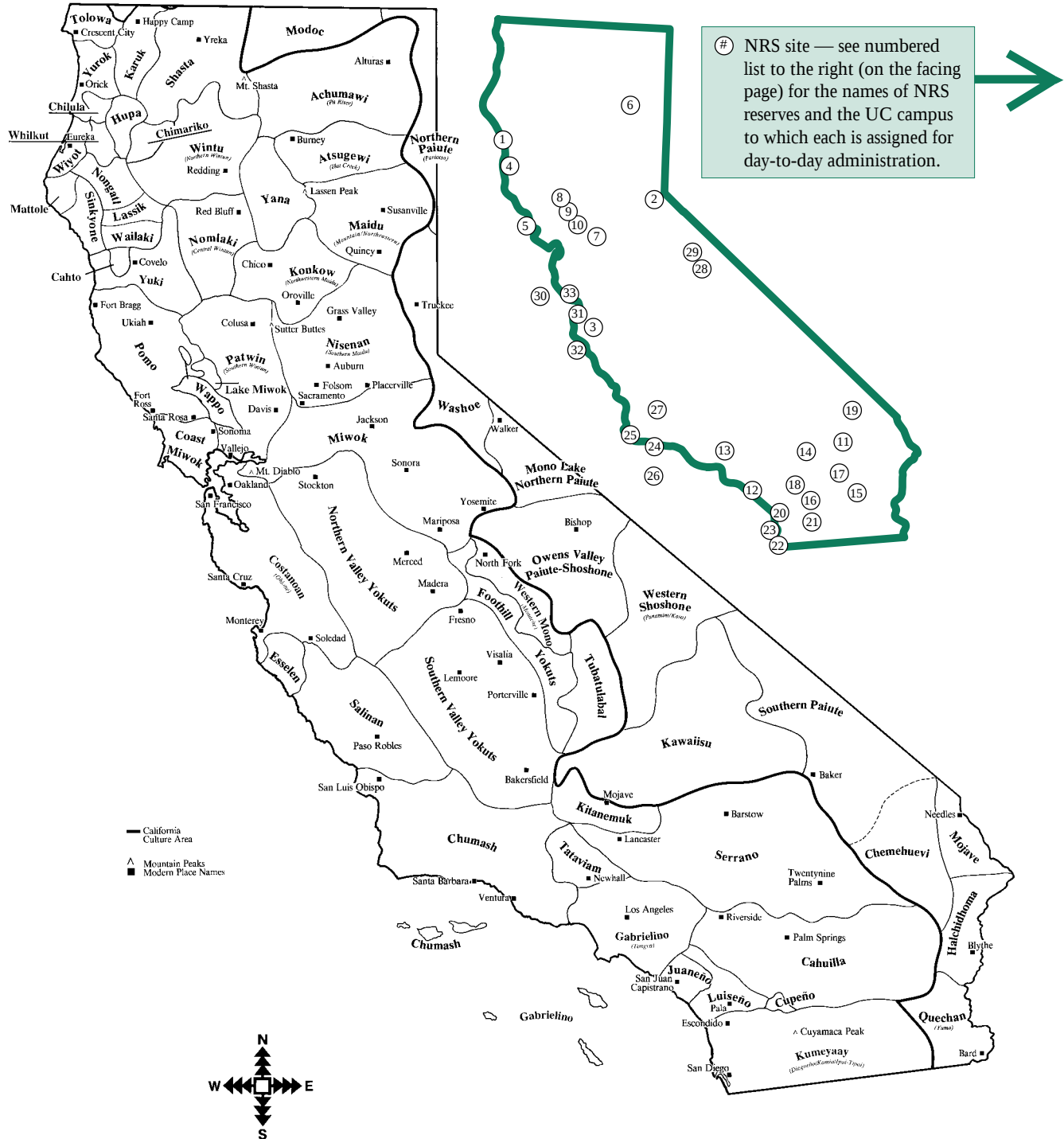
Close examination of screened soil.
Photo by Susan Gee Rumsey

One of yesterday’s most important finds was a sizable fragment of a steatite vessel — positive evidence of upper-class goods having been obtained from elsewhere (in this case, Santa Catalina Island). This afternoon, excitement spiked when examples of English black glass from the 1790s turned up. Finally, at the day’s end, someone uncovers, at the 25- to 30-centimeter level (same level as the black glass), a bronze crucifix, about an inch long, with figures on both sides and a metal loop at the top. The group’s sense of being able to reach back across two centuries to the time when these objects were in everyday use is strong as the little cross is passed around from hand to hand, and everyone feels this long day of crouching in the dirt was well spent. — SGR



Jeanne Arnold (2nd from left) with teaching assistant Anne Munns (far right) and her archaeology field school students at Santa Cruz Island, summer 1996. Photo by Susan Gee Rumsey

A comparison of the tribal areas of California with the approximate locations of UC reserve system sites



This map of "Tribal Areas of California" (copyright 1996) was provided by Pacific Western Traders, 305 Wool Street, Folsom, CA 95630-2550; phone: 916-985-3851. It is reprinted here with their permission.



NRS reserves listed by administering UC campus

UC Berkeley

- 1• Angelo Coast Range Reserve
- 2• Chickering American River Reserve
- 3• Hastings Natural History Reservation
- 4• Jenny Pygmy Forest Reserve

UC Davis

- 5• Bodega Marine Reserve
- 6• Eagle Lake Field Station
- 7• Jepson Prairie Reserve
- 8• McLaughlin Natural Reserve
- 9• Quail Ridge Reserve
- 10• Stebbins Cold Canyon Reserve

UC Irvine

- 11• Burns Piñon Ridge Reserve
- 12• San Joaquin Marsh Reserve

UC Los Angeles

- 13• Stunt Ranch Santa Monica Mountains Reserve

UC Riverside

- 14• Box Springs Reserve
- 15• Boyd Deep Canyon Desert Research Center
- 16• Emerson Oaks Reserve
- 17• James San Jacinto Mountains Reserve
- 18• Motte Rimrock Reserve
- 19• Sweeney Granite Mountains Desert Research Center

UC San Diego

- 20• Dawson Los Monos Canyon Reserve
- 21• Elliott Chaparral Reserve
- 22• Kendall-Frost Mission Bay Marsh Reserve
- 23• Scripps Coastal Reserve

UC Santa Barbara

- 24• Carpinteria Salt Marsh Reserve
- 25• Coal Oil Point Natural Reserve
- 26• Santa Cruz Island Reserve
- 27• Sedgwick Reserve
(Components of the Valentine Eastern Sierra Reserve:)
- 28• Sierra Nevada Aquatic Research Laboratory (SNARL)
- 29• Valentine Camp

UC Santa Cruz

- 30• Año Nuevo Island Reserve
- 31• Fort Ord Natural Reserve
- 32• Landels-Hill Big Creek Reserve
- 33• Younger Lagoon Reserve

One archaeologist, two decades of investigations, and 6,400 years of Big Creek prehistory

In 1983, I got involved doing research at Big Creek because a number of researchers doing early flora inventories and geological studies had come across a few unrecorded archaeological sites away from the immediate coast. Before then, archaeologists had tended to overlook the Big Sur coast.

We started by doing an inventory. We sent students out to walk the ground systematically — all the reserve acreage, the Gamboa Point properties, and the adjoining acreage of Los Padres National Forest — looking for middens, collecting surface artifacts.

We carefully documented everything we found and mapped all the deposits. When we were done, we had recorded about 40 prehistoric archaeological sites, many in locations where nobody ever expected them: two to three miles inland, 2,000 to 3,000 feet above sea level.

We finished our inventory in 1984. In 1985 there was the fire. *[Editor's note: The Rat Creek Fire of July 1985, started by a lightning strike, burned nearly all of the Landels-Hill Big Creek Reserve in one of the largest and most severe conflagrations in the Big Sur Area in recent years. In all, the fire consumed more than 57,000 acres, including most of the 7,600+ acres that made up the reserve and Gamboa Point properties.]* It was so depressing. All these historic structures we had gone to great lengths to record were gone. But the fire created a sense of immediacy about further archaeological research. On one hand, the vegetation had been opened up temporarily: now you could find and access sites that had been completely overgrown. On the other hand, the fire

caused a lot of the archaeological sites to erode significantly. Right after the fire, you could literally see midden deposits cascading down the cliffs.

In 1986, we started our first excavations at Big Creek. We began to get a much more substantive handle on the antiquity of human occupation at Big Creek and a better idea of subsistence and settlement practices.

Of those who came before us

The sequence of Big Creek prehistory begins about 6,400 years ago. The divisions between the periods correspond to two spans of time during which things seemed to change significantly: the first about 5,500 years ago and the second about 1,000 years ago.

The earliest period appears to be a local manifestation of what's commonly known as the California Milling Stone Culture, which dates to at least 6,000 to 8,000 years ago and is represented by dense accumulations of tools often called metates and manos. Metates are big round grinding slabs used in conjunction with manos, which are hand-held, flat, often rectangular tools used for grinding seeds.

Based on the recovery of large numbers of handstones and milling slabs, the Milling Stone Culture can clearly be linked with gathering economy. Dense accumulations of shellfish remains found in the Milling Stone component at Big Creek and elsewhere likewise testify to a heavy reliance on gathered foods. Projectile points, markers of hunting, were found in very low frequencies, along with few animal and fish bones.

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One archaeologist

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At about 5,500 years ago, there were significant cultural changes. Deposits made after that time are marked by a very different kind of tool assemblage: many more projectile points, with a significant change in style (stemmed points). We also get a lot more ornamental artifacts, such as rectangular-shaped shell beads and pendants made out of talc schist or serpentine. We have evidence of greater emphasis on fish eating, such as pointed-bone fish gorges that were baited and put on the ends of lines. We also have appearing at this same time a pretty significant technological innovation: the first stone mortars and pestles, used to process acorns rather than tiny seeds. Finally, we see the appearance of the first obsidian, volcanic glass not native to the south coast ranges.

This complete change in tool assemblage about 5,500 years ago is the beginning of what I call, for lack of a better term, the Early Period or the Hunting Culture. Around 2,500 years ago, at the onset of the Middle Period in central California prehistory, Hunting Culture peoples began to fish more intensively, as indicated by the appearance of curved shell fishhooks and increased frequencies of fish bone in the middens. Aside from this rather modest addition, Hunting Culture tool inventories seem to have continued without great changes for about 4,000 or 5,000 years through to the end of the Middle Period.

However, toward the end of the Middle Period, we again start to see some innovations. In deposits from about 1,000 to 1,500 years ago, we find very small leaf-shaped points that are

associated with the first bows and arrows. By about 1,200 A.D. — 800 years ago — the bow and arrow seems to have taken over completely and the older archaic points disappear almost entirely. Other changes that occurred at about this same time include the appearance of new bead types and a shift in milling equipment, from mortars and pestles to mortar cups ground into rock outcrops. So about 1,200 A.D. is where I place the transition from the Middle Period to the Late Period.

Reaching these conclusions about the basic sequence of artifact types, dating, settlement shifts, and changes in subsistence patterns concluded an important stage in the study of Big Creek prehistory. With this baseline of knowledge established, I started to turn my attention to another issue: why did major changes occur at 5,500 years ago and at 800 years ago?



Terry Jones (right) taking notes in 1982, with field student Jane Carr (left) and Sonoma State staff archaeologist Michael Baldrice (center), on prehistoric artifacts found at the Big Creek Reserve. Photo by Galen Rowell

Much ado about mussels

I began to look at this problem from several different angles, and one angle had to do with mussels. More than 90 percent of the material in the middens at Big Creek are mussel shells — millions of mussel shells, representing thousands of decisions that people made in the course of trying to feed themselves. I realized I didn't know anything about collecting mussels, so I thought we ought to find out, to see if replicating the activity could provide insight into some of the changes we saw in the record. This is what is called "experimental archaeology."

We decided that there must be at least two different ways to collect mussels. One is plucking, in which you go for just the big mussels. The other is something we called stripping, in which you go into a mussel colony and you rip the whole thing out.

I had four students collect mussels using these two different strategies. One person would collect for 20 minutes, just plucking, picking the big ones, while another person would collect in the same patch for 20 minutes, just stripping, taking out entire colonies. Then they would switch strategies. At last, we loaded all the mussels into bags, brought them back to camp, and started to quantify what we found. We cooked the mussels first and measured the amount of time it took to process them. We quantified the meat yield that we got with each strategy and also the size profile of the shells obtained. We quantified our data exactly the same way that mussel biologists quantify theirs, so that we could com-

pare the archaeological populations to biological populations.

We wanted to compare Big Creek with a less pristine setting, so we went to Santa Cruz County and repeated the experiment at Davenport Landing, where people are actively harvesting mussels all the time. Because of this ongoing harvesting, we figured those mussel populations might have a different size distribution than at Big Creek, where the mussel beds hadn't been harvested by anyone for 20 or 30 years.

The data showed the expected differences in the size profiles of the mussels collected: with the stripping strategy, we wound up with many more mussels, but a much smaller average size, than we did with the plucking strategy.

In terms of net efficiency — how much effort it takes to collect and process the mussels versus what you get back in kilocalories — plucking is always the best way to go. In terms of total food value, however, stripping gives you the greatest amount of food, at least in a setting that's regularly harvested. So if you regularly exploit your mussel beds and are willing to spend time getting the meat out of all those little mussels, you're going to get the most amount of food value using the stripping strategy.

We measured mussel shells — over 10,000 of them — from all of the investigated archaeological sites. We plotted that data exactly as biologists do in summarizing the age–size structure of mussel beds. Then we compared these data with our experimental results. What we found was this: for site after site after site, the experimental stripping curve and the archaeological curve matched almost exactly. At least 90 percent of the archaeological deposits



A field school student sifting midden soil — it's a dirty job, but someone's gotta do it. Photo by Susan Gee Rumsey

show that people were using this less-efficient strategy for exploiting mussels. Stripping seems to have been the preferred strategy for harvesting mussels during most of the last 6,000 years in the Big Creek area.

However, the findings from the oldest deposit (Milling Stone Period, 5,500 to 6,400 years ago) suggested that these particular people were plucking. Following this early occupation, we then see a decline in the mean shell size that I think goes hand in hand with a shift to stripping. After that, for the next 4,000 to 5,000 years, the mean size stays very constant.

So why was there a change in mussel-foraging strategy around 5,500 years ago? We have every reason to believe that the folks who were here about 6,400 years ago were relatively mobile. They had a relatively low population density and probably moved around a fair amount. As a result, they had the luxury of using the more-efficient plucking strategy because they weren't

harvesting the same mussel beds on a regular basis. But I think this situation changed when people began to settle down, around 5,500 years ago. That's when we see a change in artifact assemblage, when the obsidian and mortar and pestles come in. Trade networks were established, people hunted more, and they moved from the more conservative plucking strategy to the less-efficient, but higher yielding stripping strategy. — Terry Jones

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Editor's note: A different line of research Jones has been working on recently attempts to reconstruct paleoenvironmental changes and to link them to cultural changes, especially during the transition from the Middle Period to the Late Period between A.D. 800 and A.D. 1,400.



Young archaeologist-in-training. Photo by N. H. (Dan) Cheatham

Prehistoric camp-out cuisine at Hastings Reservation offers some surprises for contemporary gourmands

A variety of food-preparation artifacts found at the NRS's Hastings Natural History Reservation, located in Carmel Valley 20 miles inland from the rocky Monterey County coastline, indicates the area was occupied — at least, part time — by Native Americans.

While locations closer to the coast and at lower elevations no doubt provided much better subsistence for permanent settlements, the Hastings area offered a number of features that made it convenient and desirable for temporary camps: fairly level ground, a perennial stream, seasonally abundant acorns and game, and placement in the most easily accessible passage across the Santa Lucia Mountains.

Artifacts discovered at Hastings include artful arrow points made of flint from Devil's Post Pile (located on the eastern side of the Sierra Nevada), which the local Essalen people probably obtained through cross-state trade. Pestles and fixed-rock mortars, also found at Hastings, indicate the area was probably used seasonally for all stages of acorn processing: collecting, breaking, and rinsing (to leach out toxic tannic acid).

The edges of some of the mortars were coated with tar, which probably came from Santa Barbara beaches. This tacky goop was used to keep tall-sided baskets firmly stuck inside the mortars, enabling the food preparer to pound more acorns at a time. The acorn meat was probably transferred to a sand bowl for washing; water poured over the acorn mush percolated through the mush and down into the sand, leaving clean mush on top.

Archaeological evidence suggests that *whole* animals, particularly gophers, were then mashed right into the acorn mush. This hearty mixture was wrapped in gopher skins — fur and all — fashioning a kind of prehistoric burrito. Contemporary studies conducted with other native groups in the far north have revealed that rodent pelts contain essential nutrients that animal flesh and organs lack. — EMB

Marsh site materials used for prehistoric replica

Taking a page from the “learning-by-doing” book of early boat-making, archaeologist Michael E. Macko recently constructed a tule balsa, the basic canoe used by many prehistoric peoples along the coasts of North and South America. The native tules, or reeds, Macko needed for his project came from the NRS's San Joaquin Freshwater Marsh Reserve, in Orange County, through coordination with Reserve Manager William Bretz, who later served as fellow paddler when the canoe went to sea last fall.

This was not Macko's first tule *tomol* (Chumash word for boat). He constructed his first prehistoric craft in 1977 and rowed it for 10 miles along the Southern California coast. “Making a boat was a natural thing for me,” says Macko. “My childhood was oriented all around boats and the Navy. Some friends and I served as naval sea cadets during Vietnam at Treasure Island in San Francisco Bay when we were twelve years old.”

Experimental replication has been a research strategy and absorbing avocation for Macko ever since he was a student of anthropology at UC Santa Barbara during the 1970s. He has also made arrow points and discovered an exact procedure for making bead money. Professionally, as head of his own archaeological consulting firm, he has been responsible for many important digs in Southern California, such as the Newport Coast Archaeological Project (one of the largest, privately funded excavations in history) and the ORA-64 excavations in Newport Bay (one of the largest projects funded for a single site, involving the extremely sensitive care of 600 human burials).

Macko gathered reeds for his *tomol* in the fall, that season when they are most easily picked and dried. Experience has taught him that the reeds must be carefully plucked from the earth, roots and all. If they are cut at the bottom or broken, the pithy insides soak up far too much water. It took Macko two days to collect reeds, individually separate



Archaeologist Mike Macko (left) and NRS reserve manager Bill Bretz (right) sea-tested Macko's Chumash-style tule craft last fall. Photo courtesy of Macko, Inc.

and lay them out, then dress them by removing the roots and tweezing out the burrs. The tules took two weeks to dry on a warm, barren surface.

Nine to 12 feet (3 to 4 meters) long, each slender reed (*Scirpus californicus*) measures about 1 inch in diameter at the bottom, gradually thinning to a point at the top. Macko tied the tules neatly together in tight bundles to make planks. The difference in reed thickness helps to give the planks a natural curve; the thick ends shape the wide hull of the boat and the thin ends point upward to form the bows.

To tie the tule bundles, Macko used store-bought sisal twine instead of making it himself from reeds as the native Chumash probably did. Making his own rope would have increased his construction time by a month. However, a family of four (who probably made rope regularly for fishing nets and other purposes) could likely have made enough in a few days.

After sewing the planks together with twine, Macko sealed the seams with tar, a resource readily available from natural seeps nearby in the Santa Barbara region. He used wooden paddles, which he carved by hand, according to tradition.

Boat assembly took Macko four days. He received some direction from ethnographic notes gathered from Chumash elders in the early twentieth century. But much of his success came by trial and error. Previously Macko followed notes that called for covering the entire bottom of a boat with tar. The tar is "like a bullet-proof coating," says Macko. "It also added structure and buoyancy, but increased the canoe's weight by 300 pounds. The native people probably didn't have access to 30 gallons of tar for a boat that only lasted one season."

Other notes suggested that willow poles be used to frame the boat. But "that was ridiculous," he said. "In the water, the willows bend like crazy and shred the reeds. We can tie the reeds extremely tight without any frame."

Last fall, old met super-old when Macko and Bretz tested the *tomol's* prehistoric design in Newport Bay by paddling out to meet the historic HM Bark *Endeavour*, a recently constructed replica of Captain Cook's eighteenth-century exploration ship, during its brief visit to the West Coast. In this sea trial, the archaeologist and the reserve manager were able to maintain speeds of 2 to 3 knots by working hard against the current.

"We were definitely high and dry," says Macko. The canoe's buoyancy was remarkable, with the craft drafting just a few inches of water despite carrying more than 350 pounds of crew. The boat soaked up only a few gallons of water after four hours (and 4 tough nautical miles) of constant use, and it dried out completely after two days in the sun.

Macko explains: "It is strong, but very flexible. It kind of molds to waves or swell and sinews to the shape of the water. Even if it got swamped, it just would not sink." Approximately 3 feet wide and 17 to 20 feet long, *tomols* were used primarily for nearshore fishing. The largest canoes may have carried four paddlers and up to 800 to 1,000 pounds of cargo.

Continued on page 12



Macko and Bretz rowed their prehistoric replica out to meet the HM Bark *Endeavour* in Newport Bay. Photo courtesy of Macko, Inc.

Marsh site materials

Continued from page 11

“These boats were a fall specialty,” Macko emphasizes. “They may have been popular for inter-island use, too, for the harvest festival season. Santa Ana winds would flatten the ocean and blow you straight across the Santa Barbara Channel. That’s also the time of year when the seeds were harvested from the reeds and most other important plants, such as oaks, and when reeds were most easily picked and dried for renewing your house.”

Although *tomol* construction is what Macko does for fun, his project is also yielding serious data on the economic restrictions on marine adaptations faced by early Californians, such as available technology, materials, cost, and risk. He explains: “The freshwater marsh was a critical area; there are jewels of information about Indian life here.”

Macko donated the craft to the Juaneño Band of Mission Indians, who placed it on display in the Blas-Aguilar Museum across from Mission San Juan Capistrano. This summer he began constructing another craft for more vigorous sea trials, including multiple-day excursions with Bretz to offshore islands, possibly this fall. The next boat will also be offered to Native American education programs in Southern California. — *EMB*

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Scripps Reserve offers surf-and-turf archaeology

It is located right across the street from UC San Diego. On a fair day from its sheer coastal bluffs, one can look 30 miles out to sea. These bluffs, generally known as the Knoll, plummet 330 feet to the ocean’s surface. From that plane, the teeming marine portion of the site begins, plunging to a depth of 745 feet below sea level into the dark and chilly tributaries of the Scripps and La Jolla Submarine Canyons. Both portions, land and sea, of

this UC San Diego-administered NRS site — the Scripps Marine Reserve — reveal long-ago aspects of California’s prehistoric coastal culture.

UCLA Professor Gail Kennedy is one paleoanthropologist who really “digs” this site. For 23 years, she has been loading her car with trowels, screens, paint brushes, dental tools, baggies, and other excavating gear — then taking groups of students to the Scripps Re-

serve to practice field techniques. On one trip in 1976, she and her students made the discovery of a lifetime while digging on the bluff just north of the reserve. “Suddenly there it was,” she said, “a truly unusual double burial of a man and a woman almost 10,000 years old. This makes it the oldest known burial of its kind in this hemisphere.”

“This double burial reveals a very peculiar burial practice,” said Kennedy. She cannot explain why, but two of the man’s fingers and a part of his thumb were placed in his mouth.

The remains of this ancient man also revealed that he had had what is colloquially known as “swimmer’s ear.” Because these bony growths, called “auditory exostoses,” appear only in people who habitually go into cold water, their presence provides evidence that this cultural group — probably big-game hunters who migrated westward from the Great Plains — did indeed exploit marine resources after they settled along the coast. Kennedy conducted a worldwide survey and learned that these 10,000-year-old remains were the oldest uncovered with this ear pathology.



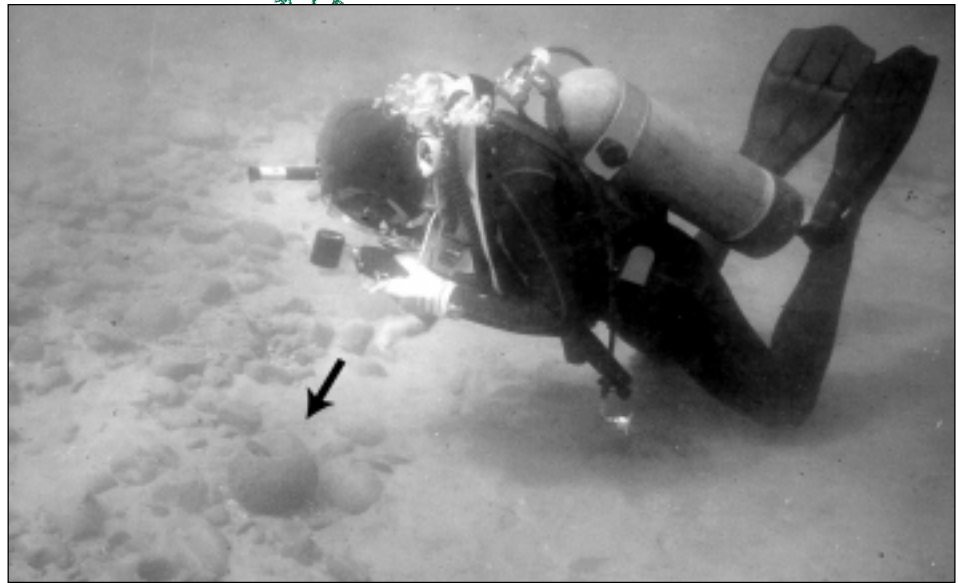
Scripps Pier at the Scripps Coastal Reserve.
Photo by N. H. (Dan) Cheatham

[Editor's note: The final resting place of these human remains found near the Scripps Coastal Reserve will be determined by a process described by the Native American Graves Protection and Repatriation Act. See the sidebar that appears on page 14.]

More evidence that prehistoric people exploited marine resources comes directly from the cool, green coastal waters. Independent archaeologist Patricia Masters, formerly affiliated with the Scripps Institution of Oceanography, has studied hundreds of prehistoric cobble mortars. Some of these artifacts were discovered by scientists and divers in the kelp beds up to 66 feet deep and were likely lost from prehistoric fishing rafts or canoes. Many artifacts were also found in shallow reefs 6.5 to 16.5 feet deep, but they are rarely found on inland archaeological sites of the San Diego area. They were probably made and used 4,000 to 5,000 years ago, when the sea level was lower and the coastline extended 500 feet further seaward.

More information about this early coastline is emerging from the upper portion of the reserve's seacliffs. Heavy storms erode the cliffs, exposing the top three to six feet of midden (a prehistoric disposal site) studded with shells, animal bones, and artifacts. This layer cake of archaeological data helps give Masters a slice-of-life picture of marine resource use and population changes over millennia. "As we excavate the middens, we peel back the layers of time," said Masters. "When the first people inhabited the coast, it was very different from today's sandy beaches."

At the base of middens dating back 6,000 to 8,000 years, she found several types of shellfish, including rock oysters, mussels, and turban snails.



Anthropologist Pat Masters photographing a mortar in situ among the cobbles. This particular underwater site is located about one mile south of the Scripps Coastal Reserve — although the same type of small mortar has also been found in the underwater component of the Scripps Reserve. Photo by Michael Clark, Center for Coastal Studies, Scripps Institution of Oceanography

These are all types of creatures that inhabit rocky intertidal shoreline, a highly productive habitat no longer there. Moving up through the middens, Masters identified 3,000- to 4,000-year-old mollusks more commonly found in sandy beach habitats. "That's when the present shoreline was developing," explained Masters. "What made beaches possible was slowing in the rate of sea-level rise, allowing rivers to fill coastal bays and bring sand directly to the sea shore."

But these shifting sands brought hard times to the prehistoric economy, because they ruined a major fishery. "Sand is not a productive fishery habitat," said Masters. "We have found evidence of a population crash or exodus from coastal areas of San Diego County about 3,500 years ago, the same time the beaches were forming." Since the coast has always been the most heavily populated area, "things must have gotten pretty tight economically for people to have to leave by one mode or another."

Masters reflected on the range of possibilities within her field and the opportunities presented by the Scripps Coastal Reserve: "The only science I'm aware of that spans the upland, canyons, beach, intertidal, and subtidal zones is archaeology. Scripps is such a unique resource. Where else in this very urbanized and overbuilt section of coast can you find this combination of ecology, biology, and other natural-science resources as well as this incredible archaeological resource?" — *EMB*

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About the Native American Graves Protection and Repatriation Act (1990)

The Native American Graves Protection and Repatriation Act (NAGPRA), signed into federal law in 1990, protects cemeteries on federal and tribal lands. It also provides a method for the return of human skeletal remains, as well as associated funerary objects in the nation's scientific and museum collections, to culturally affiliated tribes.

This law does not apply to such finds on private land or in the Smithsonian Institution's collections. However, it is the first legislation of its kind and perceived by many as an important step in what some call the "Native American Repatriation Movement."

Cultural items repatriatable under NAGPRA include:

- *human remains* (excluding hair or other tissues naturally shed or freely given prior to death)
- *funerary objects* (made specifically for burial purposes or to house human remains)
- *sacred objects* (ceremonial objects needed for present-day Native American practices), and
- *objects of cultural patrimony* (objects so significant that they are considered inalienable or community owned; these objects may also be considered "sacred objects").

NAGPRA specifies that cultural items may be claimed by an Indian* tribe, Indian tribe official, Native American, Native Hawaiian, Native Hawaiian organization, or lineal descendent (who can trace an unbroken chain of ancestry to a known Native American or Native Hawaiian individual).

In addition to existing collections in museums and scientific institutions (such as universities), NAGPRA extends to *new* discoveries on federal and tribal lands. When human remains are found during a scientific excavation, land development, or other activities, the local coroner determines whether or not the find meets NAGPRA-site criteria. Further investigation of the area is sometimes necessary to ascertain the extent of the site.

A monitor — an individual specially trained in NAGPRA procedures — is then stationed on site to oversee the removal of funerary objects and skeletal remains and to assure compliance with NAGPRA and tribal procedures. In some cases, the federal Native American Heritage Commission provides guidance and support through the NAGPRA process.
— EMB

*NAGPRA legislation employs the term *Indian*.

Former financier still employs cost/benefit analysis

What young man with a promising career in high finance gives it all up to become a professional archaeologist? That's exactly what Michael Kennedy did in 1995 when he realized that people and the history of how they have lived was the abiding interest of his own life. Now, instead of swimming with the sharks on Wall Street, this UC Davis graduate student conducts archaeological research at the NRS's Bodega Marine Reserve, investigating the foraging patterns of prehistoric hunter-gatherers.

Coast Miwok people occupied Bodega Bay, located about 50 miles north of San Francisco, at the time of historic contact with Europeans; their ancestors may have occupied the region for quite some time before that. The area was also used by other groups of people, such as the Kashaya Pomo.

A site excavated by archaeologists at Duncan's Landing, on nearby state park land, contained material that was radiocarbon dated to 8,000 years ago. While working on a nearby site at Bodega Marine Reserve, Kennedy found artifacts including stone tools, bone tools, ornaments, and such "cooking features" as wood (charcoal), fish and shell remains, cooked sand (the Native Americans used hot sand to cook shellfish), and cooking stones (used to boil food). When Kennedy had pieces of charcoal and shell radiocarbon dated, they matched at approximately 5,000 years ago, making this coastal site one of the oldest in California north of San Francisco. (There are older sites in southern California, southeast Alaska, and British Columbia. Several coastal sites in Oregon are



roughly the same age.) Kennedy estimates that the region was most intensively used around 1,500 years ago, but that has not been confirmed.

“Our evidence shows that a wide array of resources was used from all habitats,” explains Kennedy, “including the protected bay where they procured shellfish, fish, and fowl; the rocky shoreline where they used shellfish, fish, and sea mammals; and the terrestrial areas where they used game and many plants.”

Kennedy uses “foraging theory optimization models” to derive predictions about how particular resources are represented in the archaeological record. “The models are based on evolutionary theory and economic principles,” he says. “Essentially, human subsistence decisions are viewed in terms of costs (searching, pursuing, capturing, processing, and cooking prey) and benefits (nutritional value).” Costs are measured in time; benefits are measured in calories.

Kennedy has been conducting shellfish experiments using Native American techniques described in ethnographic accounts, such as those of Smithsonian field anthropologist Isabel Truesdell Kelly (1906-1982). Kennedy takes a collecting basket out to the mudflats and picks clams by hand — or uses a wooden stick to pry mussels, chitons, and limpets from the rocky shore. He times his actions and correlates the time costs with calorie benefits on various species.

“The higher-ranked species have the highest benefit/cost ratio — they have more of a calorie benefit for less effort,” explains Kennedy. He says mussels are higher ranked because they were abundant, and easy to gather and to prepare.



Excavation in the dunes at Bodega Marine Reserve.
Photo by Michael Kennedy

Red abalone, Kennedy says, was not eaten as much by the Native Americans as we might imagine. “You might think they said, ‘Whoa, here’s a great big piece of meat with lots of nutrition!’ But it’s a low-ranked species because of the cost (time and effort) needed to collect and prepare it. They would have had to swim and dive to get the abalone, then expend a lot of energy pounding the meat, then face the effort of cooking it. The handling costs were too high.”

Another low-ranked species is dogwinkles, which are really small gastropods. “Even though they are abundant,” says Kennedy, “they are very small and it’s incredibly hard to extract the meat.”

Kennedy has conducted most of his Bodega Bay fieldwork during the past three summers as part of the six-week UC Davis Archaeological Field School. This field school is composed of three or four staff members (Kennedy served as school director for the 1998 and 1999 seasons) and 15 to 22 students. Their investigations have ranged from Bodega Head, Salmon Creek Beach, Salmon Creek, Estero Americano, the coastal uplands, and the rocky shoreline south of the Russian River. Kennedy is spending the next few months analyzing artifacts in the lab,

including oxygen isotope analyses of shellfish to determine the seasons in which the Native Americans were eating them.

Like the generations of archaeologists that came before him, Kennedy has discovered a major drawback to conducting archaeological investigations in California’s coastal region: field sites have not stood up well to the elements. Wind and wave ac-

tion and alluvial runoff have eroded many sites. For example, Mussel Point, on the ridge at the reserve, has shrunk to just two feet due to erosion. Kennedy says it’s tough to tell what the original size of the site was. He took cores from behind Mussel Point to see if anything existed below the surface, but nothing else was left. Other archaeological field sites have succumbed to modern development.

“It’s fabulous and rare to have an asset like the Bodega Marine Reserve where archaeology sites are protected from development and vandalism.”

One of Kennedy’s goals is to help consolidate the archaeological research that has been done in the region by various entities. Much of the previous work has focused on reclamation efforts that are necessary prior to development. Kennedy recently presented papers at meetings of the Society of California Archaeology and the American Fisheries Conference. — PP

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Zooarchaeology field students at Eagle Lake investigate the remains of the day

Each July for the past 13 years, students have come from across the country to attend a unique zooarchaeology field school held at the NRS's Eagle Lake Field Station (ELFS), located in Lassen County in California's remote northeastern corner.

Zooarchaeology is the study of animal remains recovered from archaeological sites. "The course is the only interdisciplinary field school of its kind, meshing together concepts of ecology, natural history, and archaeology, with a faculty that includes an ecologist (myself) and two archaeologists," explains Jay Bogiatto, staff station manager of the ELFS and professor of biological sciences at California State University (CSU) Chico. "And we teach the course in a field context, using archaeological materials recovered from the Eagle Lake region or at least nearby." Bogiatto co-teaches the three-credit, three-week course (limited to 10 students each season) with CSU Chico anthropology professors Frank Bayham and Antoinette Martinez.

The area surrounding ELFS is unique. Eagle Lake is California's fourth largest freshwater lake, covering 30,000 acres (~12,000 hectares) and stretching for nearly 14 miles (~23 kilometers). This clear, cold, high-altitude remnant of an immense Pleistocene lake sits on the volcanic Modoc Plateau at the western fringe of the arid Great Basin, with the Cascades to the west, the Sierra Nevada to the south, and the rest of the Great Basin to the east. Around Eagle Lake, diverse habitats on lava flats accessible from the field station include fir and pine forests, mixed conifers, juniper and sagebrush scrub, and mountain mahogany, with localized assemblages of manzanita and ceanothus brushfields, riparian woodlands, wet meadows, and freshwater marshes.

These pristine habitats support a rich biological diversity, including more than 70 mammal species, 180 birds, 7 amphibians, 22 reptiles, and 5 native fish. It is the remains of these fauna, usually bone fragments, that students in the



Zooarchaeology field school students may be given only bone fragments and asked to identify species and ages.

Photo by Jay Bogiatto

zooarchaeology field school at ELFS investigate in order to reconstruct past environments, understand paleoecological relationships, and determine how prehistoric people utilized native animals. Bogiatto says the region was used concurrently by Northern Paiute, Maidu, and Pit River groups.

The first week covers a lot of territory: the vertebrate taxa of Eagle Lake and the Great Basin Desert; basic zooarchaeological and ecological theory; the major ecological communities of the region; the osteology of fishes, amphibians, reptiles, mammals, and birds; and an introduction to the use of CSU Chico's vertebrate osteology comparative collection. "The students identify bone using prepared skeletons obtained from known specimens," says Bogiatto. "Each year, we transport the comparative collection in boxes from the university to Eagle Lake. The students' job is to identify the species and age based on whole bones or fragments, thus getting familiar with the techniques of a zooarchaeologist."

During the second week, the students continue fieldwork begun the first week, and in lab they continue identifying fragmented bones. For the last



Identifying a species and the age of a representative individual is a lot easier when you're given the whole skull.

Photo by Jay Bogiatto

week, students focus on their own research projects, emphasizing biological and archaeological interpretations. “A student might investigate the relative importance of deer and other ungulates in the diet of those occupying the cave site,” explains Bogiatto. “Or a student might look at bone detritus collected from beneath both osprey and bald eagle nests. Once bones are identified and quantified, some interesting ecological comparisons of ospreys and eagles could then be made in addition to a basic analysis of their diet.” On the last day, the students present their projects to the group. — PP

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Virtual archaeology

The Web contains thousands of archaeology-related sites, many housed on university servers. Some generalist sites list a multitude of links; others specialize in such subtopics as environmental or marine archaeology. A useful number provide searchable databases or back issues of journals. Here are just a very few of interest:

- ArchNet —
<<http://archnet.uconn.edu>>
- Society for CA Archaeology —
<<http://www.scanet.org>>
- Official publication of the
Archaeological Institute
of America —
<<http://www.archaeology.org>>
- Rock Art of Native CA:
A Visitor's Guide —
<<http://www.ca.blm.gov/caso/rockart.html>>



Photo courtesy of the Santa Barbara Museum of Natural History

Mammoths downsized for living on Santa Barbara Channel Islands

Back in the Pleistocene — the Pleistocene Glacial Epoch, 10,000 to 1.6 million years ago — when our climate was moister and the California coastline lay further offshore, the northernmost four of today's Santa Barbara Channel Islands formed one big land mass known as “Santarosae,” then five or six miles from the mainland. About 60,000 years ago, a small group of giant Columbian mammoths (*Mammuthus columbi*), standing 14 feet from heel to shoulder, dogpaddled their way to Santarosae, using their trunks as snorkels. There they found Elephantopia: an isolated, predator-free haven, covered with edible greenery.

Back in 1994, Professor Tom Rockwell, from San Diego State University, flew by plane 19 miles across the Santa Barbara Channel to Santa Rosa Island, one of the four remnant islands that once comprised Santarosae. He went to study paleoseismology and fault zones. What he found, quite by accident, was the first nearly complete skeleton of a dainty *pygmy* mammoth, which — just 12,840 years ago — stood 5.5 feet tall and lived to be 50 years old.

At that point, he recruited mammoth expert Professor Larry Agenbroad, from Northern Arizona State University, who has since been investigating the island evolution of this miniature species, *M. exilis* (the “exiled mammoth”). So far, Agenbroad has inventoried mammoth remains at 140 localities (collecting those in immediate danger of loss by erosion) on Santa Rosa Island, San Miguel Island, and Santa Cruz Island, the locale of the NRS's Santa Cruz Island Reserve.

“Elephants can smell farther than they can see,” says Agenbroad. “There's nothing more attractive to a mammoth than the smell of fresh green vegetation on the sea breeze.” And if food was at one time scarce on the mainland, due to fire or other causes, then it's likely mammoths were drawn to Santarosae by their trunks. Strong and determined swimmers, they would have found the relatively

Continued on page 18

Dwarf or pygmy?

Question: What's the difference between dwarves and pygmies?

Answer: While dwarves may give birth to normal-sized offspring, pygmies always produce pygmy young.

The Channel Islands are the only known place in the world where true pygmy mammoths have been found. Very small mammoths have been discovered near Moscow, and small mammoths have been documented on Wrangel Island off the coast of Siberia, which survived all the way to 3,700 years ago. However, scientists think the Wrangel Island dwarves never evolved into true pygmies, perhaps because their populations never existed in prolonged isolation. Unlike the Channel Islands — which have always remained isolated — Wrangel Island was, at times, connected to the mainland, allowing mammoths to travel back and forth in search of adequate food. — *EMB*

Mammoths downsized

Continued from page 17

short, five-mile distance to the delectably lush island well worth the effort. Elephants living today can easily swim much greater distances. Agenbroad tells of a timber harvester from an island in the Bay of Bengal who was concerned when his work bull went missing and presumed that he had drowned in the surf. But some time later, his frisky male elephant was found on an island 25 miles away — with a girlfriend! Apparently, he had been drawn there by her fragrance, *Eau d'Éléphante*.

Agenbroad and others have found both pygmy mammoth remains and Columbian mammoth remains in the Channel Islands — ten pygmies for every one Columbian. However, no pygmies have been found on the mainland. It is not known whether the pygmy mammoths were especially strong swimmers. However, with no island competition for food and no scent-laden winds reaching them from the mainland (the wind direction is away from the islands, to-

ward the mainland), the pygmy mammoths probably had neither reason nor inclination to ever venture to the mainland.

Evolution on islands often leads to gigantism or dwarfism. Small animals can become big; big animals can become small. On the one hand, little animals can afford to become large, because islands — hard for most mainlanders to get to — typically lack predators and offer less competition for food. And “living large” has its advantages: more efficient water and fat storage allows an individual to survive during leaner times and also confers greater ability to compete with other members of the same species for food and mating opportunities.

In contrast, dwarfism of large animals seems to be encouraged by a reduced food supply on islands, compared to the mainland. The young of such large animals may become malnourished and stunted. Also, less competition for food may mean that the individuals of a species may have less need to “throw their weight around.” Finally, if compactness helps a species to achieve reproductive success, generation after generation, then a general “downsizing” of that

Where did they come from and where did they go?

Two million years ago, the first mammoth species, *M. miridianalis*, crossed over into the New World. From that beast, some believe, descended the imperial mammoth and the Columbian mammoth — from which, in turn, the pygmy mammoth evolved. The familiar woolly mammoth, which evolved from *M. trogonfila* in Russia's Ural Mountains, was the last to migrate to the New World, around 50,000 to 100,000 years ago. As mammoth expert Professor Larry Agenbroad sums it up: “The first mammoths here were Eurasian migrants. The ones in the middle were ‘made in the USA.’”

Mammoths radiated geographically and biologically during the last glacial period, but began to go extinct worldwide 11,000 years ago, near the end of the Pleistocene. Why? Some scientists blame overhunting, or hyperdisease, or temperature change. Agenbroad contends that any one of these reasons, by itself, is too simple an explanation: “I like to say it was over-kill, over-ill, and over-chill.” — *EMB*



species may eventually be the result. On the Channel Islands — where, at one time, giant deer mice coexisted with miniature mammoths — it is possible an elephant really *could* have been afraid of a mouse.

As the mammoths shrank in size — adapting to limited food and space — they also adapted to the islands' mountainous topography, evolving into the biological equivalent of all-terrain vehicles. Their lower leg bones became short in relation to their height, allowing them to climb higher and steeper slopes to greener pastures more easily. (Imagine you are walking up a hill. Equipped with shorter shin bones, you can readily hike a steeper grade.) Agenbroad calls the adaptation “low-gear locomotion.” The much larger

Columbian mammoths, ill suited for climbing, stayed in the lower elevations of the islands, and that is where most of their remains have been found. — *EMB*

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Did mammoths ever share habitat with humans?

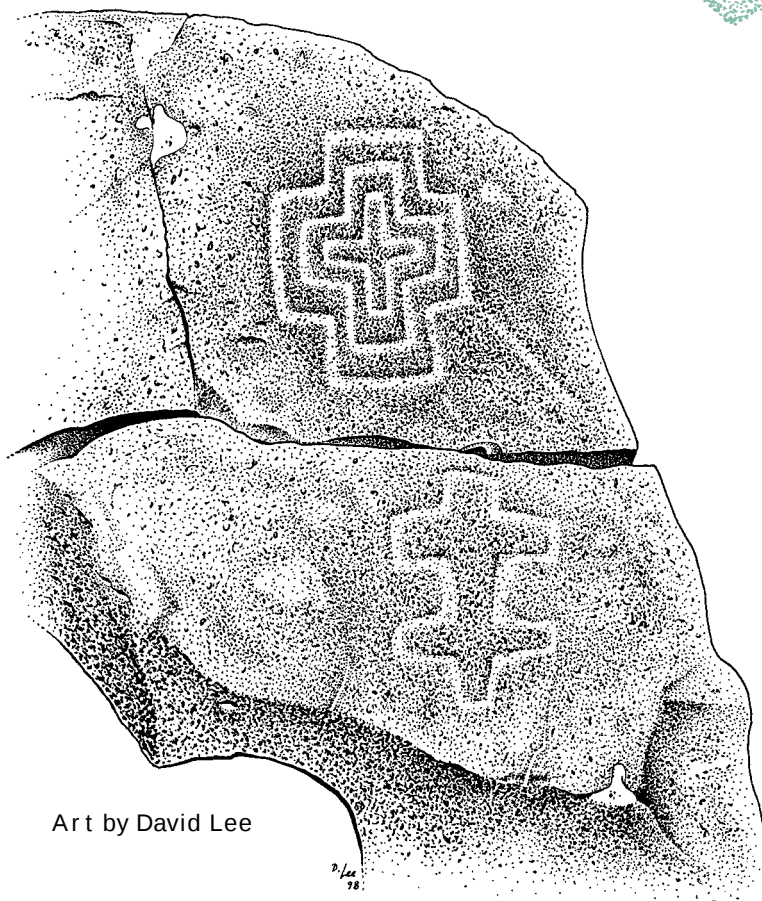
Hard evidence exists in many regions around the world that mammoths coexisted, at least for awhile, with humans. Dating techniques for remains, long-surviving rock art, and legends — such as the “six-legged monster” described in Greenland Inuit legend (interpreted as four legs and two giants tusks) — point strongly to a relationship between prehistoric humans and these giant animals.

But did pygmy mammoths and humans ever share habitat on what is now the NRS's Santa Cruz Island Reserve? Quite possibly. In 1959, Phil C. Orr, curator from the Santa Barbara Museum of Natural History, made an exciting discovery of human remains: a complete thigh bone, femur fragment, and knee cap buried under 30 feet of sediment on another Channel Island, Santa Rosa. These remains of a 5-foot tall woman, now known as “Arlington Springs Woman,” may represent the oldest human remains found in North and South America.

It could be said that the current curator of the Santa Barbara Museum of Natural History, John Johnson, is “dating an older woman.” He is heading up a team working to check the age of Arlington Springs Woman by radiocarbon dating several different materials: the woman's bone (using proteins collagen and osteocalcin), the bones of an extinct giant deer mouse found in the same stratum, and associated charcoal from surrounding strata. Johnson and his team are also analyzing the soils in which the woman was found to make sure she died in the area where she was later discovered and was not transported there by water or other means.

Based on their findings, Johnson believes the woman's remains date back approximately 10,960 radiocarbon years, which calibrates to 13,000 calendar years. (When translating radiocarbon years into calendar years, the fluctuations of radiocarbon in the atmosphere over the millennia are taken into account.) Says Johnson: “Ten thousand to 11,000 radiocarbon years is what we have for everything converging — the charcoal, the sediment, and the mouse bones. We think that's the age of the human bones.”

Mammoths made it to the Channel Islands much earlier than humans did. Agenbroad has dated Channel Island mammoth bones as old as 47,000 years, the point at which the radiocarbon method gives out. But how recently did mammoths live there? The youngest confirmed bone date for a Channel Island mammoth comes from the first find, in 1994: 12,840 radiocarbon years (approximately 14,500 calendar years). Then, last spring, Agenbroad found a pygmy mammoth, and the charcoal associated with those remains was dated at 11,010 radiocarbon years. Now the mammoth bone must also be dated, and if it turns out that the age of the bone matches that of the charcoal, he'll know the mammoth and Arlington Springs Woman lived during roughly the same period. Says Agenbroad: “We have gone back, cored the mammoth vertebrae, and it's in the cooker for a bone date now. If it's in the same range as the charcoal, we'll have real excitement.” — *EMB*



Art by David Lee

Mojave desert rock art paints pictures of the past

With pen, ink, and a keen eye for detail, David Lee, resident reserve steward at the NRS's Sweeney Granite Mountains Desert Research Center in the East Mojave Desert, recreates on paper the same images that Native Americans rendered on granite rock centuries and millennia ago. For four years, he has been part of a three-man team — with Don Christensen, of UC Irvine, and Jerry Dickey, an independent researcher — which records rock art sites at the reserve, throughout the Mojave Desert, and beyond.

Their main goal is preservation of these ancient artworks. “It’s been estimated that we’ve lost more rock art in the last 20 years than in the last 200,” says Lee. “We need to preserve this expression of early humans. If we don’t do it now, it’ll never have a chance. It’s a true nonrenewable resource.”

The team has recorded and rerecorded both newly discovered sites and sites previously recorded by others — filing with the state archives, so far, over 200 Mojave rock art sites, in addition to 170 archaeological sites in the Granite Mountains. Recording a site with the California State His-

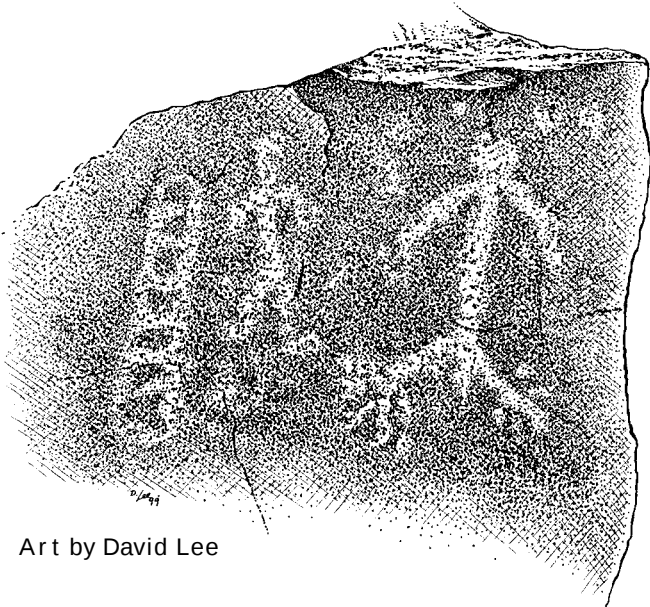
torical Preservation Office requires paperwork and photographs. But Lee also lends his own draftsmanship to the effort, making painstakingly precise and beautiful scale drawings of each art panel, plus every distinct glyph element in the panel and associated artifact and feature. Each site report runs from 3 to 68 pages long; for one site alone, Lee submitted 50 pages of drawings, with two to three drawings per page. “The drawings can often provide *more* information than the photos because of the details,” says Lee. “They help with research and comparative analysis.”

Archaeologists believe the Granite Mountains may have been one of the most densely inhabited areas in the Mojave. More examples of rock art — as well as other types of archaeological sites — have been found there than in any other area of the Mojave Desert. Some archaeologists believe the richness in human expression was influenced by the presence of the granitic rock (offering a natural canvas) and wide variety of plants representative of three deserts — Mojave, Sonora, and Great Basin (in turn, supporting a wide variety of fauna and ensuring human survival). In addition, three Pleistocene lakes (whose locations appear on contemporary maps as Ancient Lake Mojave, Danby Dry Lake, and Bristol Dry Lake) once encircled the reserve, making the area a natural place to pass through.

The Mojave has been a desert for a relatively short amount of time, approximately 4,500 years. The region has experienced many cycles of lake filling and drying up — even into historic times — with climates in the past that have been both wetter and drier. Scientists believe the environment before desertification was similar to that of the U.S. Great Plains today.

The team of Christensen, Dickey, and Lee has discovered and recorded 1,050 individual pictographs (images drawn or painted onto rock, using pigment, usually red iron oxide or sometimes black charcoal) and 1,200 petroglyphs (images carved into rock). All four known methods of petroglyph-making have been discovered in the Mojave Desert:

- *pecking* (making tiny dots with a hammerstone)
- *abraded* (rubbing back and forth to make an impression)
- *engraving* (carving a groove with a sharpened rock), and
- *scratching* (incising very fine lines into a smooth surface with a sharp little stone, a method less suited to granite).



Art by David Lee

At the base of four petroglyph panels, the team made a rare and thrilling discovery: the actual hammerstones used to make the petroglyphs. The wear marks and degree of weathering on the hammerstones correlate precisely to the peck marks on the panels. Three of the four hammerstones are quartz, a rock considered special and used in ceremonies.

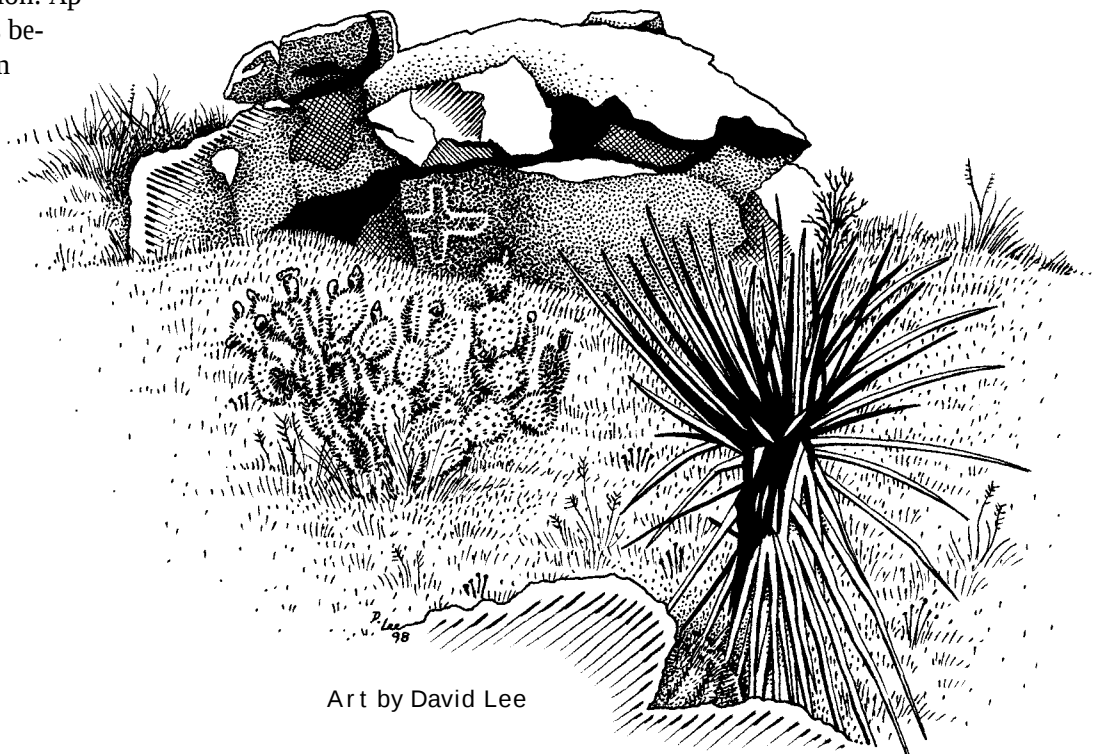
Rock art and artifacts found in the Granite Mountains indicate the area was inhabited at least 4,000 years ago. Scientists believe the oldest art yet discovered was made by the ancestors of the Aha Ma Kav, a Yuman-speaking group also known as the River Mohave, who were possibly the first culture to live in the region. Approximately 500 to 200 years before European contact (in 1776), the Chemehuevi, part of the more numerous and widespread, Numic-speaking Southern Paiute group, defeated these ancestral Mohave and took over the region, according to Chemehuevi historical accounts. By 1860, the U.S. military had driven the Chemehuevi out of the desert to protect the interests of prospectors and homesteaders.

Rock art found in the Granite Mountains is mostly abstract. Domi-

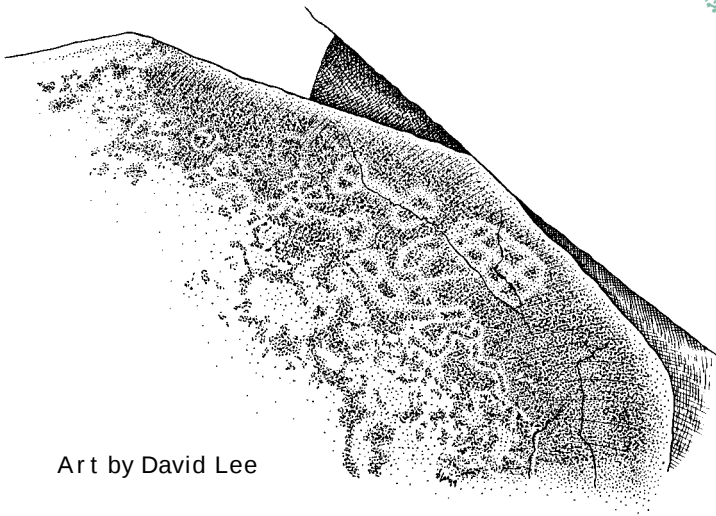
nant motifs include circles, dots, lines, wavy lines, grids, geometric designs, and combinations of all, with a few representational elements, such as stickfigures, digitated anthropomorphs (possibly lizard men), and bighorn sheep. Scientists refer to the rock art style found here and elsewhere in eastern California and southern Nevada as Great Basin Abstract. This regional style is considered part of the broader Western Archaic Rock Art Tradition, which is generally characterized by abstract motifs which may be based on a variety of shamanic experiences of individuals within hunter-gatherer cultures.

It is difficult to tell, simply by looking at the art, which works were made by which group at the Granite Mountains, and scientists are reluctant to interpret the meaning of the rock art.* Most Granite Mountains rock art is found in uninhabitable rock shelters (perhaps used for shade), suggesting that it was created for ceremonial purposes. However, it is widely believed that some artistic elements, particularly the bighorn sheep, a spirit helper of the rain shaman, represent rainmaking magic. The theme of water flows through much Chemehuevi legend. Their primary deity is named Old Ocean Woman, and legends tell of when the Chemehuevi inhabited the coast. "Nobody appreciates water and where it comes from like people from the desert," explains Lee. "Everything that happens in the desert has something to do with water."

Continued on page 22



Art by David Lee



Art by David Lee

Mojave Desert rock art

Continued from page 21

To promote protection, study, and appreciation of rock art, Lee's team and the Sweeney Granite Mountains Desert Research Center host an annual East Mojave Rock Art Conference. This event brings together archaeologists, museum curators, members of the Aha Ma Kav tribe, and rock art researchers from organizations as diverse as the Museum of Man, Desert Research Institute, and U.S. Bureau of Land Management. The fifth conference is scheduled for January 2001. — *EMB*

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Editor's note: The Sweeney Granite Mountains Desert Research Center thanks John Smiley, manager of the NRS's Landels-Hill Big Creek Reserve, in Big Sur, for his donation of the archaeological library assembled by his father, renowned geochronologist Terah Smiley. This newly available literary resource is an outstanding complement to the diverse natural and prehistoric resources of the Granite Mountains Reserve.

**Archaeologists believe the Aha Ma Kav and Chemehuevi had different shamanic beliefs and motivations behind their creations. Often two groups do what looks like the same thing, but for different reasons.*

Reading between the rocks: Exploring the connection between land and humans in the Granite Mountains

In the spirit of the Renaissance Man, Michael Rodarte, graduating senior in anthropology at California State University (CSU) San Bernardino (and cross-registered at UC Riverside), leads an interdisciplinary field-survey team that is working to piece together the cultural landscape of the NRS's Sweeney Granite Mountains Desert Research Center. The team, including its leader, consists of seven experienced undergraduate and graduate students from both of Rodarte's universities, using their training in archaeology, paleobotany, ethnology, climatology, geology, and other sciences to understand how humans have used this dynamic environment over the last 10,000 years.

Since 1998, Rodarte has been working to unlock the mysteries of the human-land connection at this reserve, which is located within the recently established Mojave National Preserve, roughly 80 miles east of Barstow. "The land has more secrets than I could ever hope to learn," he says. "It's a living landscape with a personality. I think that's what the prehistoric people really revered."

Rodarte's team, called the Granite Mountains Archaeological Survey Project (GMASP), is conducting a *stratified survey sample* by identifying and analyzing archaeological sites in the context of the environment. This nondestructive research technique involves surface investigation, without excavating or digging into the ground. The team, with help from faculty and other reserve experts, employs all forms of evidence, including archaeological artifacts, natural resources, environmental models, even packrat middens (which shed light on paleoclimatic conditions), to form a more complete picture of what life in that region has been like over the millennia.

The Granite Mountains make an excellent testing ground. Geographically, they are fairly isolated and one of the wettest and most ecologically diverse



ranges in the Mojave Desert, making them a focal point of the whole region. According to historical accounts and remnant evidence, the range lies at the convergence of two major trade routes and overlaps several different cultural core areas. Ancestors of the nomadic Aha Ma Kav (referred to, by anthropologists, as Desert Mohave), the oldest known inhabitants of the area, were famous for long-distance travel. The Mohave Trail stretched from the lower Colorado River through San Bernardino County to the coast, with links (northeast of the Granite Mountains) branching to other southwestern tribes across Arizona. Another trail complex on the eastern side of the range helps Rodarte's team retrace the footsteps of ancient travelers. Some of the trails are still identifiable and used by feral burros. The team hopes to map Mojave Desert trail systems and figure out the relationships between the sites they connect.

The sculptured boulders and balancing rocks that create the unique landscape of the Granite Mountains add challenges to the survey process. "It can take two to three days to survey one square-kilometer, because there are so many pockets in the granite," explains Rodarte. "It seems like you could crawl forever in them." However, amongst the dogpiled boulders, Rodarte found two *tinajas*, natural water tanks in the rock that trap and store rainwater. One *tinaja* at the reserve holds an astonishing 300 gallons! It is believed prehistoric groups maintained these water tanks, which enabled them to survive for long periods in the hills and evade U.S. government attempts to remove them during the nineteenth century.

Rodarte also investigated what is believed to be a processing station for seeds of the desert almond (*Prunus fasciculata*). A member of the rose family (along with the chokecherry), this small, deciduous shrub, with a much-branched stem, clustered leaves, and white to yellowish flowers, produces edible seeds that can be pounded into a meal. The drawback is they contain cyanide. But native groups in the Mojave Desert probably washed the desert almond seed meal to leach out toxins, just as many other native California groups washed acorn meal to leach

out the tannic acid it contains. It is rare to find a processing station with all its elements intact, but the team identified a milling slab and small hearth for grinding flour located in a desert wash, where the seeds were rinsed in a sand basin. At higher elevations, desert almond gives way to pinyon, another likely food source for prehistoric cultures. These findings were presented at the 1998 Kelso Conference on Mojave Prehistory.

Rodarte's team began its survey at the lower elevations of the Granite Mountains Reserve, near the on-site facilities, and will soon move into the higher elevations. So far the GMA SP team has analyzed 25 known archaeological sites and discovered and recorded five new sites over 60 percent of the 3.5-square-mile reserve. Rodarte hopes to spend his years in graduate school surveying the entire 25-square-mile Granite Mountains range. "I probably have three to four more years of work out there," Rodarte says. "You can miss a lot of things doing a limited study. It takes a long time to become familiar with an area. It took these cultures thousands of years to understand the area and its resources. We scientists can't expect to learn everything in a few months." — EMB

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Desert bighorn sheep recorded in rock art. Photo by B. Dale

Neophyte archaeologists receive hands-on training at NRS reserves in the Eastern Sierra



Students Bobbie Mehrhof (left) and Chris O'Dell (right) experiment with tule-reed boat-making. The Paiutes made canoe-like boats out of tule reeds to float into marshes in search of bird eggs and, up north where there were native fish, to fish. Photo by Leslie Dawson

Each fall, fourth-grade students from Mammoth Elementary School, in the Eastern Sierran setting of Mammoth Lakes, make the trek to the NRS's Sierra Nevada Aquatic Research Laboratory (SNARL) to learn archaeology and anthropology hands-on. For the past five years, this field trip has complemented their classroom study of California Indians.

At first, in school and with the children's regular teachers, SNARL's Outdoor Science Education Program Coordinator Leslie Dawson presents a classroom unit on Paiute pottery. The students create their own coil pots and clay beads. The following week, the kids head out to SNARL, where some will assume the roles of members of a native tribe, while others will take on the tasks of archaeologists.

When the kids arrive at the reserve, they dig a hole in the ground for their pottery, fill the pit with pine needles and cow pies, then place their pottery

there to fire it, a process that takes four hours. Then, one group of students becomes a Paiute tribe. They enter a full-sized wickiup (a Paiute summer home) in an open meadow by a stream. There, Dawson teaches shelter construction techniques used by the nomadic group. Sitting in the shelter, the kids use native dogbane fiber and learn to make rope. They weave at least six inches, enough to complete a bracelet or necklace to hold their clay beads.

Meanwhile, a second group will have already begun their training as archaeologists by simulating an excavation of a prehistoric Paiute village site. "Armed with trowels and paint brushes, the students remove sand from the village site to discover an abundance of arti-

facts, including a bow and arrows, an atlatl (a projectile propulsion device whose invention predated the bow and arrow), a fire pit, pottery shards, bits of obsidian, piñon pine cones, yucca root (used for making soap), and some sea shells," explains Dawson. Leaving their findings in place, the students rope off the area and map the artifacts on gridded paper.

"Back at school, the teachers help students use their maps to recreate the life of the tribe," Dawson says. The teachers take students on follow-up field trips to the Paiute Indian Cultural Center in Bishop and to see petroglyphs south of the nearby town of Mammoth Lakes. — PP

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Outdoor Science Education

Program Coordinator

Sierra Nevada Aquatic

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Email: ldawson@msi.ucsb.edu



At SNARL, children learn traditional life skills by doing. Here fourth graders construct a Paiute-style summer home. It took 20 students four hours to place the willows on the shelter.

Photo by Leslie Dawson



Glossary of terms related to anthropological study

The following terms — most of which were selected because they appear in this issue of *Transect* — were drawn from an exceptionally useful glossary created by John Kantner and Kevin Vaughn while they were graduate students in anthropology at UC Santa Barbara. Kantner is now an assistant professor of anthropology at Georgia State University, while Vaughn is a doctoral candidate at UCSB. Their glossary appears in its entirety, as a searchable database, on the Internet at: <http://www.anth.ucsb.edu/glossary>.



Anthropology: the study of humanity — our physical characteristics as animals, and our unique nonbiological characteristics we call culture. The subject is generally broken down into three subdisciplines: biological (physical) anthropology, cultural (social) anthropology, and archaeology.

Archaeology: a subdiscipline of anthropology involving the study of the human past through its material remains.

Archaeozoology: sometimes referred to as zooarchaeology, this involves the identification and analysis of faunal species from archaeological sites, as an aid to the reconstruction of human

diets and to an understanding of the contemporary environment at the time of deposition. (See also *Zooarchaeology*.)

Artifact: any manually portable product of human workmanship. In its broadest sense, it includes tools, weapons, ceremonial items, art objects, all industrial waste, and all floral and faunal remains modified by human activity. Any physical remains of human activity.

Assemblage: a group of artifacts recurring together at a particular time and place, and representing the sum of human activities.

B.P.: “Before Present.” the notation commonly used on radiocarbon dates, e.g. 1000 B.P. = 1,000 years before 1950 A.D. [*Editor’s note: now, of course, 2000 A.D.*], or approximately 1000 A.D.

Chert: a mainly opaque, fairly granular, silicate rock with a dull shiny luster and a great range of colors, used as raw material for the manufacture of chipped stone artifacts. Varieties include jasper and flint.

Environmental archaeology: a field in which interdisciplinary research, involving archaeologists and natural scientists, is directed at the reconstruction of human use of plants and animals, and how past societies adapted to

changing environmental conditions.

Ethnography: that aspect of cultural anthropology concerned with the descriptive documentation of living cultures.

Ethnohistory: the study of ethnographic cultures through historical records.

Ethnology: a subset of cultural anthropology concerned with the comparative study of contemporary cultures, with a view to deriving general principles about human society.

Excavation: the principal method of data acquisition in archaeology, involving the systematic uncovering of archaeological remains through the removal of the deposits of soil and the other material covering them and accompanying them.

Experimental archaeology: the study of past behavioral processes through experimental reconstruction under carefully controlled scientific conditions.

Half-life: the time taken for half the quantity of a radioactive isotope in a sample to decay. (See also *Radioactive decay*.)

Historic period: the time after European contact, or the beginning of written recording.

Midden: the accumulation of debris and domestic waste products resulting from human use. The long-term disposal of refuse can result in stratified deposits, which are useful for relative dating.

Osteology: the study of bones.

Paleoanthropology: the study of the fossil record and archaeology.

Paleontology: that specialized branch of physical anthropology that analyzes the emergence and subsequent evolution of human physiology.

Pleistocene: the latest major geological epoch, colloquially known as the “Ice Age” due to the multiple expansion and retreat of glaciers. Circa 3,000,000-10,000 years B.P.

Prehistoric: the period prior to written records for any given area.

Prehistory: the period of human history before the advent of writing.

Radioactive decay: the regular process by which radioactive isotopes break down into their decay products with a half-life which is specific to the isotope in question. (See also *Radiocarbon dating*.)

Radiocarbon dating: an absolute dating method based on

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Glossary

Continued from page 25

the radioactive decay of Carbon-14 contained in organic materials.

Steatite: soapstone or talc; a soft gray to green stone used as a carving medium.

Zooarchaeology: the study of faunal remains found in archaeological sites and their cultural significance. (See also *Archaeozoology*.)

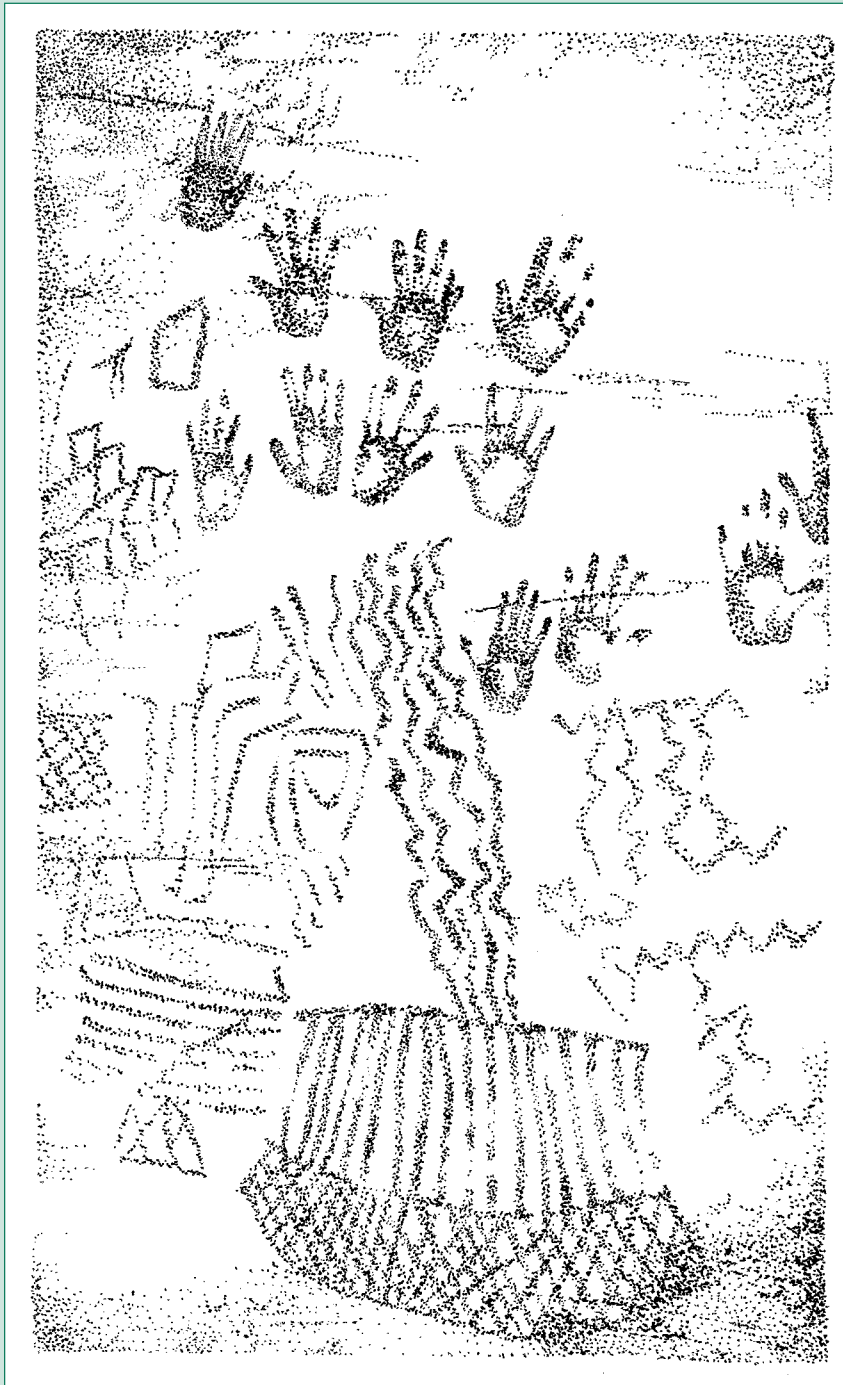


Thanks a Motte!

The new millennium started off right for Motte Rimrock Reserve, in Riverside County, when that NRS site received a gift of 10 acres of land from David Halper. The gift was presented in loving memory of his mother, Fay Halper.

This land is vegetated primarily by southern California coastal sage scrub and contains several pairs of the threatened California gnatcatcher.

The parcel has not been surveyed yet. However, based on its location, the NRS expects to discover that its resources include several Native American sites as well. (See sidebar and pictograph art to the right for an example of Motte's archaeological riches.) — SGR



Art by Margaret L. Herring

These pictographs, listed with the National Register of Historic Places, are protected at the Motte Rimrock Reserve, an NRS reserve located in the Perris Valley about 15 miles south of UC Riverside. This archaeological site is thought to have been used by the Luiseño Indians for various religious ceremonies, including the Luiseño girls' rites of passage. Upon puberty, these girls took part in a ritual that revealed their place and purpose in life. At the conclusion of the ritual, boulders were painted with a variety of designs and marked with the handprint of each initiated girl.



First Mathias winners to enter the new millennium

Since 1988, the NRS system-wide office has awarded grants to support student research. The Mildred E. Mathias Student Research Grants program has awarded 165 students since the program's inception; Mathias grants have totaled approximately \$265,000.

These grants offer a real-life exercise in raising money for research. Students receive first-hand experience in applying for grants, meeting deadlines, and managing budgets. Each awardee submits a progress report to the NRS director.

The maximum amount for a single award is \$2,500. An annual call for proposals is generally issued in September; awards are announced in December. Applications for Mathias grants may be obtained directly from an NRS campus representative or through the NRS systemwide office.

For the 1999-2000 cycle of Mathias awards, 16 students were chosen from the eight general UC campuses to share a total of \$30,488. The awardees, their projects, and research sites are:

From UC Berkeley —

Sarah Cunningham, *Natal dispersal and female reproductive tactics in the dusky-footed woodrat*, *Neotoma fuscipes*, at Hastings Natural History Reservation.

Meredith Thomsen, *Influence of arbuscular mycorrhizal fungi on invasion of north coast prairie by the exotic perennial grass Holcus lanatus*, at Bodega Marine Reserve.

From UC Davis —

Jason Hoeksema and Jenn Rudgers, *Interaction among above- and below-ground herbivores: Impact on fitness of an annual plant*, *Lupinus nanus*, at Bodega Marine Reserve.

James A. Fordyce, *Mortality, growth and behavioral consequences of gregarious feeding in the California pipevine swallow*, at Stebbins Cold Canyon Reserve.

April M. Boulton, *Ants as allochthonous vehicles for aboveground transport: Impacts on belowground foodwebs*, at McLaughlin Natural Reserve.

From UC Los Angeles —

Aviva Liebert, *Division of labor and reproduction in Polistes wasps*, at Stunt Ranch Santa Monica Mountains Reserve.

Todd A. Haney, *The leptotraca of coastal California: A survey based on morphological and molecular evidence*, at the Bodega, Landels-Hill Big Creek, Carpinteria, Santa Cruz Island, Coal Oil Point, Scripps, Kendall-Frost, and Younger Lagoon Reserves.

From UC Riverside —

Paul A. Aigner, *Geographic variation in pollinator-mediated selection within the Dudleya caespitosa species complex: Evidence for the role of pollinators in floral divergence and plant speciation*, at Santa Cruz Island Reserve.

Yvonne C. Moore, *The relationship between food availability and population abundance of kangaroo rats*, *Dipodomys spp.*, at Motte Rimrock Reserve.

From UC San Diego —

Matthew A. Streisfeld, *Maintenance of floral variation in the Mimulus aurantiacus species complex*, at the Dawson Los Monos Canyon, Elliott Chaparral, Hastings, Bodega, Stunt Ranch, James, Motte Rimrock, Landels-Hill Big Creek, and Santa Cruz Island Reserves.

Next call for Mathias proposals: September 2000

To obtain a grant application, contact your NRS campus rep through our website:
<<http://nrs.ucop.edu/info/grants.html>>.

(Or contact the systemwide office:
Mathias Research Grants
UC Natural Reserve System
1111 Franklin Street, 6th Floor
Oakland, CA 94607-5200
Phone: 510-987-0150)

From UC Santa Barbara —

Emmanuel J. Gabet, *The influence of cattle grazing on soil erosion by overland flow*, at Sedgwick Reserve.

Noah Fierer, *The effects of periodic rainfall events on soil microbial processes and microbial community structure*, at Sedgwick Reserve.

Peter Paige, *The development of Middle Period fishing practices of the Island Chumash*, at Santa Cruz Island Reserve.

From UC Santa Cruz —

Dawn P. Noren, *Body reserve utilization strategies during the postweaning fast of northern elephant seals (Mirounga angustirostris): Implications for survivorship*, at Año Nuevo Island Reserve.

Lisa Ann DiGirolamo, *The effects of Argentine ant invasions on plant community composition*, at Ford Ord Natural Reserve.

Thomas S. Hofstra, *Molecular ecology of wetwood: Relationships between host variables and prokaryote community composition*, at the Angelo, Stebbins, McLaughlin, Valentine, Sierra Nevada Aquatic Research Laboratory, Landels-Hill Big Creek, and Hastings Reserves.
— PP

Where to find your current UC campus reps to the NRS Universitywide Advisory Committee

The organizational infrastructure of the NRS is complex, encompassing eight general UC campuses, 33 natural reserves, and a systemwide office — all geographically distributed across the entire state of California. Each reserve is assigned a faculty manager; many also have staff managers and stewards (who may or may not live on site). Additionally, some campuses have a campus director or an academic coordinator, who oversees the use of all reserves managed by a specific campus.

A Universitywide Advisory Committee, largely comprised of faculty members who represent their respective campuses, meets twice a year to discuss issues relevant to all reserves and maintain long-term planning objectives for the system.

Each Universitywide Committee member acts as NRS contact for his or her campus and can refer inquiries regarding individual reserve sites to the person best able to address them. Current committee members include:

Chair & UC Berkeley Representative

David B. Wake
Museum of Vertebrate Zoology
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University of California
Berkeley, CA 94720
Phone: 510-642-3567
Email: wakelab@uclink4.berkeley.edu

UC Davis Representative

Susan Harrison
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Email: spharrison@ucdavis.edu

UC Irvine Representative

Peter A. Bowler
Ecology & Evolutionary Biology

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UC Los Angeles Representative

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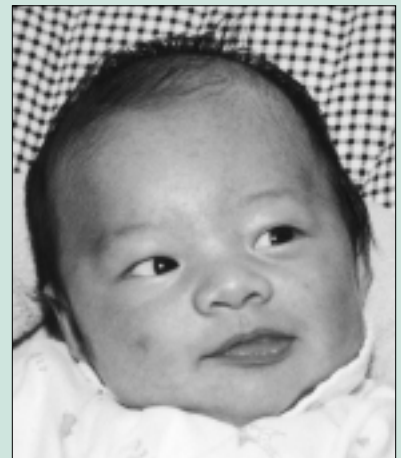
UC Santa Cruz Representative

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Biology
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University of California
Santa Cruz, CA 95064

Phone: 408-459-2786
Email: costa@biology.ucsc.edu

Also currently serving on the NRS Universitywide Advisory Committee:

- Mary E. Power, UC Berkeley / At-large member & former chair
- John A. Endler, UC Santa Barbara / At-large member: President's appointee
- Allan Muth, Boyd Deep Canyon Desert Research Center / Managers & coordinators representative
- Lyndal Laughrin, Santa Cruz Island Reserve / Managers & coordinators representative
- Jim André, Sweeney Granite Mountains Desert Research Center / Managers & coordinators representative (alternate)
- Alexander N. Glazer, Director, NRS Systemwide Office / Ex-officio member



Jacob Bello —
born Mother's Day 2000.
Congratulations to
former NRS webmistress
Jennifer Bello
and her husband, Mark Bello!

NRS systemwide bids farewell to long-time associate director and welcomes a worthy successor

The close of the century and millennium also signaled the departure from the NRS systemwide office of its long-time associate director, Liza Riddle. After eight years and many NRS accomplishments, Riddle joined the San Francisco-based Trust for Public Land as director of projects for its western region, which includes California, Nevada, and Hawaii.

Riddle helped to expand the reserve system's teaching and research potential by completing the complex and prolonged negotiations that brought Sedgwick Reserve and Stunt Ranch Santa Monica Mountains Reserve into the NRS. She was also successful in obtaining funds to restore Carpinteria Salt Marsh Reserve and San Joaquin Freshwater Marsh Reserve. Additionally, she did much to stabilize funding for NRS support staff and reserve operations. In particular, she led systemwide efforts to secure from the Packard Foundation a much-needed \$4-million endowment grant.

A former field biologist, Riddle had extensive experience studying, preserving, and restoring habitats before she came to the NRS in January 1992. For five years (1987-91), she was manager of the Resource Enhancement Program



Newly appointed NRS Associate Director Chen Yin Noah.
Photo by Randy Noah

at the California State Coastal Conservancy, administering a \$10-million budget and coordinating more than 100 wetlands projects.

Riddle is also a talented photographer, who produces her own digital Iris prints from photographs she has taken around the world.

NRS Director Alexander Glazer complimented Riddle's many contributions to the reserve system and said: "She has a secure place in the history of the NRS. Her departure poses a real challenge for us in the quest of a worthy successor."

Happily for the NRS, that worthy successor *did* appear in the person of Chen Yin Noah. As senior analyst in UC Berkeley's Office of Resource Development, Business and Administrative Services, Noah had been project manager for a variety of revenue-generating business initiatives. In that capacity, she worked in close collaboration with many campus units and with private industry to create strategic partnerships throughout the Berkeley campus and beyond.

Before joining UC in 1995, Noah was a corporate real estate attorney at the law firm of Pettit & Martin in San Francisco. Her undergraduate degree is in environmental studies, with a concentration in environmental policy.

Of herself, she says: "I truly believe the preservation of natural areas for the purposes of studying and understanding natural systems is one of the most important functions of the University. I cannot think of a more deeply gratifying way to apply my legal skills, environmental training, and broad University experience for the betterment of this great institution and society at large."

In Memoriam

For many years a steady friend of the NRS, A. E. Stewart ("Dick") Chaffey, died on December 31, 1999. He was 87.

This California native graduated from UC Berkeley in economics in 1935. For many years, Chaffey was a self-employed rancher. He retired in 1968 and spent the final 31 years of his life in Carmel, California. His passions included hunting and fishing.

Chaffey took special interest in the UC Berkeley-administered NRS reserves: Angelo, Chickering, Hastings, and the Jenny Pygmy Forest. He also made specific gifts to Hastings Natural History Reservation, located in Carmel Valley, including funds to enable acquisition of on-site housing for a resident manager.

Chaffey's generosity extended to the UC Santa Cruz-administered Landels-Hill Big Creek Reserve, located on the Big Sur coast. Chaffey is responsible for the footbridge across the Big Creek tributary, part of that reserve's four-mile interpretative trail.



Former NRS Associate Director Liza Riddle.
Photo by Ethan Michaels

Renowned botanist remembered for his contributions to our understanding of the evolution of plants

Gledyard Stebbins Jr., world-renowned plant geneticist and long-time UC professor, died on January 19, 2000, at the age of 94. To honor this scientist, whose lengthy and exceptional career proved him one of the 20th century's leading evolutionary biologists and botanists, the NRS, in 1980, named a Solano/Napa-Counties wildland site the Stebbins Cold Canyon Reserve.

Stebbins was born in Lawrence, NY, in 1906. In 1924, he entered Harvard University to study law, but changed to botany in 1926. He emerged from Harvard with his doctorate in 1931 and became a professor at Colgate University in Hamilton, NY.

In the thirties and forties, a small group of scientists in genetics, paleontology, biology, and taxonomy began merging their findings and integrating their knowledge with the theories of Charles Darwin to create the new field of evolutionary biology. Stebbins pulled together findings from these diverse fields and applied them specifically to the study of plants, giving botanists a framework for understanding the evolution of plants and, in the process, founding the field of evolutionary botany.

From 1939 to 1950, Stebbins was a professor of genetics at UC Berkeley and widely known as a charismatic teacher. In 1950, he joined the faculty at UC Davis and founded the genetics department. In 1951, he was elected to the National Academy of Sciences.

From 1966 to 1972, he served as president of the California Native Plant Society and founded its rare plant program. He created an active field trip program that brought statewide attention to native flora and stimulated interest in documenting rare plants, while

promoting the conservationist ethic of “taking nothing but pictures, leaving nothing but footprints.” Stebbins was well known for his encyclopedic knowledge of California flora. Francisco Ayala, an evolutionary biologist at UC Irvine, said that Stebbins seemed to know every plant in the world — not just scientifically, but personally.

Stebbins wrote several hundred journal articles and six books, including the influential *Variation and Evolution in Plants* (1950) and *Flowering Plants: Evolution above the Species Level* (1974). He produced high school texts as well, working hard to improve the science curriculum at both the secondary-school and university levels.

Bruce Baldwin, curator of the Jepson Herbarium at UC Berkeley, described Stebbins as “a very public man who shared his insights, knowledge, humor, and enthusiasm freely with everyone and inspired and educated generations of amateur and professional botanists in the process.” Stebbins served as president of the American Society of Natu-

ralists, the Western Society of Naturalists, and the California Botanical Society. In 1979, he was awarded the National Medal of Science by U.S. President Jimmy Carter.

Susan Harrison, professor of Environmental Science and Policy and director of the UC Davis-administered NRS reserves, said recently:

*I was fortunate to attend the last field class Ledyard ever taught, which was a series of day trips across the Coast Range on Highway 128, about five years ago. The purpose was to look at plant evolutionary phenomena that interested him, such as the proliferation of *Ceanothus* species. It was physically challenging for him, especially one day that it rained and he got cold and miserable. But he was obviously eager to keep his legacy alive by keeping people interested in studying California plant diversity.*

Stebbins is survived by three children, seven grandchildren, and nine great-grandchildren. His ashes were scattered at Cold Canyon. — SGR



Botanist G. Ledyard Stebbins Jr. and Susan Harrison, who became director of the UC Davis NRS reserves in 1998, on a field trip out of the Davis campus in the mid-1990s. Photo courtesy of Susan Harrison



Semper In Memoriam



Ken Norris.
Photo by N. H. (Dan) Cheatham

Fans of Kenneth S. Norris (1924-1998) are enjoying a collection of written tributes to the late NRS founder entitled *A Tribute to the Spirit and Memory of Our Friend Ken Norris*. Compiled following the October 1998 Norris memorial at UC Santa Cruz, this 215-page, photocopied and spiral-bound volume includes personal letters, obituaries from major newspapers, newsletter articles, postings to the Ken Norris website (<<http://www.realsurf.com/KenNorris/index.htm>>), a glossary of “Ken-isms,” and Ken’s curriculum vitae with a list of publications and graduate students.

To order a copy of this tribute book, send a check or money order for \$15 — payable to “Craig Strang” — to:

Craig Strang
Norris Tribute
1324 Derby Street
Berkeley, CA 94702

All labor for this project was provided by volunteers. The \$15 charge covers production costs and includes shipping and handling. Please allow two weeks for delivery. — SGR

Reserve system finds a place “West of Eden”

Fans of the NRS will find the reserve system, its founders and facilitators, well represented in the Spring 2000 *Chronicle of the University of California* No. 3, entitled “West of Eden: The University and the Environment.” This 140-page journal of University history presents 18 articles, four book reviews, and many wonderful photographs, some dating back to the 1890s, drawn from University archives. Two articles are directly related to the NRS:

- “A Personal View of Mildred Mathias,” by Roger Samuelsen (founding director of the NRS, who served the system for nearly 25 years, recalls internationally recognized botanist, conservationist, educator, and NRS “founding mother”)
- “The History of the University’s Natural Reserve System,” by Margaret Herring (long-time NRS science writer, editor, and illustrator).

Elsewhere in this volume, NRS-savvy readers will also note the names of many other folks who have contributed to the reserve system, including (but not limited to) Christopher Adams, Martha Brown, N. H. (Dan) Cheatham, Willis Linn Jepson, James B. Kendrick, Jr., Starker Leopold, and Donald H. and Sylvia McLaughlin.

To order a copy of this journal, send a check for \$16.25 — payable to “UC Regents” — to:

Chronicle of the University of California
Center for Studies in Higher Education
South Hall Annex
University of California
Berkeley, CA 94720-4650

Two-volume subscriptions are also available for \$27 and may include your choice of *UC Chronicles* No. 2 (“Ladies Blue and Gold”) and No. 3 (“West of Eden”), No. 3 and No. 4 (“The University at the Turn of the Century”), or No. 4 and No. 5 (probably “Fine Arts and Culture on the Campuses”). — SGR



Mildred Mathias.
Photo by N. H. (Dan) Cheatham

A few words

Continued from page 1

best to stay alive and well, as people in every time and place must do.

In this *Transect*, we turn our attention to these long-ago people and to the present-day archaeologists who spend their own lives discovering what they can about the daily lives of the many folks who came before us. We give this issue of *Transect* over to such subjects as anthropology, archaeology, and paleontology as they are practiced at NRS sites, because in our striving to understand other species, we may tend to lose sight of our own. Too often we think of ourselves either neutrally, as observers without effect, or negatively, as destroyers who ruin everything we touch. But the truth is that we, human beings, are merely another part of the natural world, like every other type of living creature.

All NRS sites exist within the boundaries of the sixty or more traditional Native American tribal territories now encompassed by California's borders. At each reserve, there is precious, often rapidly degrading evidence of the fact that humankind has been part of

the natural environment for a long, long time.

Archaeology is long-term monitoring on a grand, yet manageable scale. And even those aloof scientists who find no reason to take an interest in their fellow human beings as the focus of research may still be seduced by how nicely archaeological information often reflects upon other areas of investigation. A prehistoric midden discovered high upon a 3,000-foot ridge, well back from the ocean, yet full of clam shells, is likely to reveal something valuable about the past configuration of the coastline and the evolution of certain mollusks, as well as about the original diners and their lifestyle predilections.

As always, one piece of the ecological puzzle offers a commentary on the whole. We hope this *Transect* helps to nudge one more puzzle piece into place. — SGR

**The NRS will soon be numbered at 34 sites, as the 600-acre Rancho Marino Reserve, located in San Luis Obispo County near the town of Cambria, becomes available for teaching and research use.*

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