

The Sweetwater Site: Archaeological Recognition of Surf Fishing and Temporary Smelt Camps on the North Coast of California

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Beach spawning smelt are a small fish that were mass harvested and dried for storage at temporary summer camps by native Californians north of San Francisco Bay. Despite the importance of smelt in the ethnographic diet, we have much to learn about its prehistoric use. Archaeological recognition of smelt camps can be problematic due to a number of cultural and natural taphonomic processes; the identification and fine-grained analysis of roasting pits are one means of associating these otherwise ephemeral sites with smelt fishing. Investigations at Sweetwater, a Tolowa fish camp in Del Norte County, included site survey, archival and ethnographic research, and micro-scale analysis of a roasting pit feature, providing us with a snapshot of what people were eating in a temporary camp. The study provides a model for identification and salvage of these culturally and scientifically significant places, which are severely threatened by coastal erosion and climate change.

SMELT (OSMERIDS) ARE SMALL FORAGE FISH that were a key food source for north coastal native Californians. Key beach spawning species include surf smelt (*Hypomesus pretiosus*) and night smelt (*Spirinchus starksii*), which were mass harvested by ethnographic groups at late summer fish camps that were set up along the sandy beaches where the fish swarmed to spawn and lay their eggs. Groups around Humboldt Bay and to the north (Tolowa, Yurok, Wiyot, Mattole, Sinkyone) used similar technology, procurement, and processing methods (Gould n.d., 1966a, 1966b, 1975; Kroeber and Barrett 1960:44). Men caught the fish with ‘V’-shaped scoop nets after the fish began to “hit,” typically in the late evening. Women then prepared the smelt for storage in a drying process that took about two to three days to complete, depending on weather conditions. The fish were then transported back to villages where they were kept in houses and eaten on an “as needed” basis.

Despite the importance of smelt in the ethnographic diet, we have much to learn about early use of the fishery. Archaeological recognition of smelt fishing can be challenging. Since smelt bone is very small, it can be missed if small (1/16 in.) screen sizes are not used, and—until recently—no fine-grained studies of fish bone have been conducted in northwestern California north of the King Range. Studies that employ flotation techniques and micro-scale analyses provide a wealth of information about coastal resources, even with small sample sizes. For example, more than 2,800 identified fish bones (mostly smelt), 17 species of shellfish, bird, terrestrial and marine mammal bone, and burned nuts and seeds including bay, acorn, and hazelnut from the interior were identified in an analysis of only a total of 12 liters of soil salvaged from the base of looter pits at *Tatitun* village at southern Point St. George (CA-DNO-13) (Tushingham and Bencze 2013).

In addition to fine-mesh sieving, it is also important to consider how smelt camps were laid out and formed over time. The internal structure of these sites can be temporally and spatially complex, with numerous loci consisting of concentrations of cultural materials, which most likely represent discrete family camps. Ethnographically, multiple camps were set up in the same year by different families, who each had their own area where they slept, ate, and dried fish. The complicated nature of how these sites were formed can make their recordation an issue—leading to questions of lumping vs. splitting. The sites are often quite large and ephemeral, and significant midden buildup is atypical. Natural erosional processes also dramatically impact the visibility of these endangered sites. Wind action and coastal processes constantly shift and erode the dunes and sandy beaches where smelt camps are located; archaeological exposures vary considerably from year to year, and—as will be shown—even from month to month.

Ethnohistoric smelt camps recorded in Humboldt and Del Norte counties are typically characterized as sparse to moderate-density shellfish scatters, with lesser amounts of chipped stone debris and tools. Fire-affected rock and/or imported stone concentrations are common, and faunal remains (often pinniped and bird) are sometimes present. As the dried fish were entirely removed from the sites to be stored in home base villages, the only place where a significant accumulation of smelt bone is expected is in the remains of roasting pits, where people cooked their meals during smelt camp. Thus, recognition and fine-grained analysis of these features is essential to associating temporary camps with smelt fishing.

SWEETWATER

Investigations at Sweetwater, an ethnohistoric surf-fish camp located in Del Norte County, exemplify the complexities inherent in recognizing and recording these scientifically and culturally significant sites. Sweetwater is situated along a long strip of sandy beach that lies between Point St. George and Lake Earl, and that has been used by generations of Tolowa people for smelt fishing and shellfish collecting, a fact that is supported by ethnography, by members of the modern Tolowa

community, and—as will be described—by the current archaeological research (Fig. 1).

Ethnographic Background

Sweetwater was first recorded ethnographically as “*ta'gœnuLxuntun*, ‘Sweetwater Place,’ a camp site with several houses and a sweat house” (Drucker 1937:228). Though spellings differ, the site is consistently referred to in the literature and by the Tolowa community today as “Sweetwater”: *tawašnašrən* (Gould 1966a), TO-GHÔR’ S-NO-ĤXUN in Tolowa unifon (Bommelyn 1989; Reed 1999; Tolowa Language Class 1972), *Taa-gha'sr-naa-lhxvn* (where *Taa-gha'sr-naa*=water and *Lhxvn*=sweet) in Tolowa Practical Alphabet (Loren Bommelyn, personal communication 2007). The site was used as a smelt camp by Tolowa people until about the 1930s (Loren Bommelyn, personal communication 2004). The 1930s date is supported by testimony by Eunice Bommelyn (Loren’s mother and an esteemed elder from the Smith River Rancheria), who stated in a 2009 interview that she used to camp with her family at Sweetwater as a young girl (Greg Collins, personal communication 2012).

Sweetwater is situated north of two Tolowa villages at Point St. George, *Tatitun* (CA-DNO-13) and *Tagian* (CA-DNO-11), and southwest of *Etchulet* village (CA-DNO-21) on Lake Earl. According to Drucker (1937:228) *Etchulet* villagers collected shellfish at Sweetwater and at “razor-clams clean creek,” a site directly to the south (likely CA-DNO-53), but “for some reason could not take surf fish when they ran on the beach there.” This could be because Sweetwater’s last *Etchulet* owner transferred rights to the site to his son-in-law, who was from *Tatitun* (a village once located at present-day Crescent City) (Drucker 1937:228). Perhaps this transfer of rights allowed for shellfish collecting but not surf fishing. The ultimate answer to this question, however, remains unclear.

Based on oral histories from Tolowa elders recorded in the early 1960s, Gould (1966a) found that Sweetwater was also associated with the ethnographic village of *Tatitun* (CA-DNO-13) at southern Point St. George. He hypothesized that prehistoric villagers at *Tagian* (CA-DNO-11), a village on the northern end of Point St. George and the location of his 1964 excavations (Gould 1966a), also used Sweetwater, based on clear

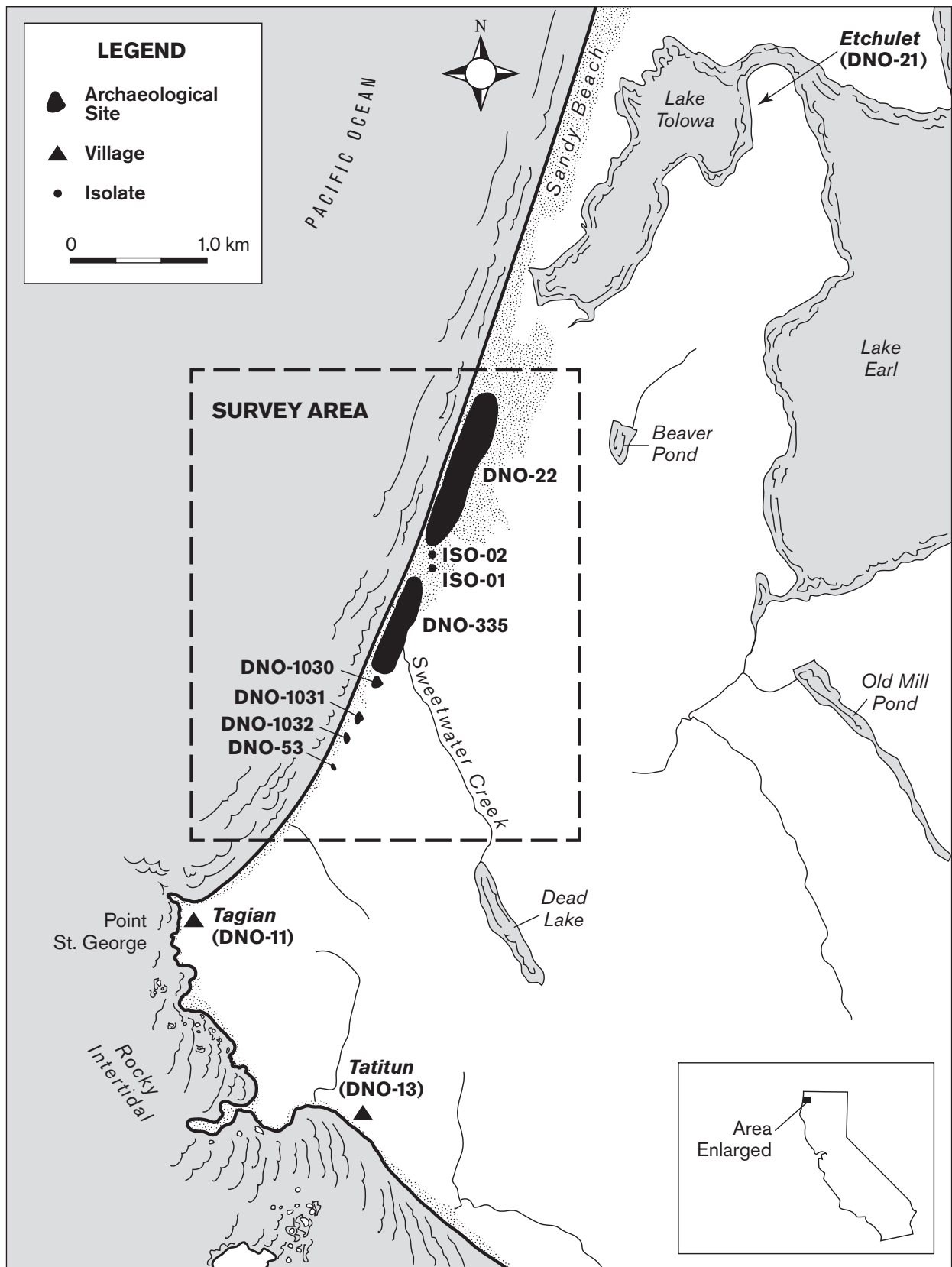


Figure 1. Tolowa villages and archaeological sites in the Sweetwater area.

connections between the two sites (Tushingham and Bencze 2013). Based on ethnoarchaeological research, Gould reconstructed the annual round of Point St. George inhabitants, which began in the late summer when villagers travelled to Sweetwater to harvest smelt (Gould 1966a:88–92, 1976).

Tolowa villages were essentially economically independent entities (Drucker 1937). Each village, for instance, may have had members who owned acorn groves and salmon trap locations in the interior, shellfish procurement locations and smelt camps along the beach, sea mammal hunting grounds on offshore islands, and whale claim rights to specific stretches of the beach (Drucker 1937; Gould 1966a). As seasonal resources became available, villagers would move to temporary camps to procure and prepare food, and then transport the food back to their home base for storage and later consumption. Individuals within villages, usually rich men, owned rights to resource patches throughout the area. And since ownership was inherited by individuals and not by groups, these rights could be transferred to others—a condition exemplified by the previously described transfer of Sweetwater from an *Etchulet* man to his *Tatatun* son-in-law.

Archaeological Sites

The low sandy dunes between Point St. George and Lake Tolowa contain the remnants of numerous small seasonal camps used by generations of Tolowa people. Six sites have been recorded in the surveyed strip between the Pacific Ocean and the coastal spruce forest within Tolowa Dunes State Park (Fig. 1; Table 1). As mapped, the sites appear practically continuous. On the ground, the sites consist of concentrations of cultural materials (containing mostly shellfish, lithics, bone, and fire-affected rock) that are often barely connected by sparse shellfish scatters, making site recordation a challenge. The sites are located on stabilized coastal sand dunes with vegetation consisting mostly of scrub brush and dune grasses, and the entire area is subject to many impacts due to dune erosion, water action, foot traffic, horse trails, and all-terrain vehicle (ATV) use. During high tide the ocean erodes the western portion of both CA-DNO-22 and CA-DNO-335, and coastal erosion and dune shifting periodically exposes archaeological deposits.

Table 1
ARCHAEOLOGICAL SITES AND ISOLATES
IN THE SWEETWATER AREA

Site Name
Sweetwater (CA-DNO-335) Extensive shellfish scatter, with fire-affected rock, cores, chert tools and flakes, ground stone fragments, flaked historic green glass, and faunal bone. Wood planks were observed buried in the coastal bluff which may be modern or part of a prehistoric or protohistoric structure. A circular depression with an adjacent area of dark midden soil is located near Sweetwater Creek; the depression may be the remains of a semi-subterranean housepit. Site originally recorded by Tushingham (2006) who associated site with Sweetwater based on location matching description in Drucker (1937), and confirmation by Tolowa tribal member. Re-recorded by Burns and Rhode (2009).
Sweetwater (CA-DNO-22) Extensive lithic and shell scatter with concentrations of fire-affected rock, faunal bone and charcoal. Originally recorded by Gould in 1964 who associated site with the Sweetwater fish camp, used by villagers at Point St. George; Re-recorded by Roscoe et al. (1998) and Burns and Rhode (2009).
CA-DNO-1030 Small site with ocean shell (mussel, snail and clam), chert flakes, faunal bone, and fire-affected rock. Originally recorded by Tushingham (2006). Re-recorded by Burns and Rhode (2009).
CA-DNO-1031 Small site with clam and mussel shell, fire-affected rock, chert flakes, faunal bone, and a ground stone fragment. Originally recorded by Tushingham (2006). Re-recorded by Burns and Rhode (2009).
CA-DNO-1032 Small scatter of clam and mussel shell fragments and fire-affected rock. Originally recorded by Tushingham (2006). Re-recorded by Burns and Rhode (2009).
"Razor-Clams Clean Creek" (CA-DNO-53) A concentration of mussel, olivella, barnacle, chiton and clam shell debris, with fire-affected rock and chert cobbles. Originally recorded by French and Stradford (1976) who associated site with "Razor-clams clean creek", a shellfish gathering area in Drucker (1937). Re-recorded by Hood and Nesbitt (1981), Tushingham (2006) and Burns and Rhode (2009).
Isolate 1 Concentration of approximately 50 clam shell fragments; no other cultural materials were recorded. Recorded by Burns and Rhode (2009).
Isolate 2 Concentration of approximately 50 clam shell fragments; no other cultural materials were recorded. Recorded by Burns and Rhode (2009).

The two largest and northernmost of the recorded sites have been associated with the ethnographic Sweetwater smelt fish camp. Site CA-DNO-335 (Fig. 2) is bisected by Sweetwater Creek, a northwest-flowing freshwater stream that drains Dead Lake, and is in the same area where Drucker (1937:Map 3) plots the site. The site was first recorded by U.C. Davis anthropologists in 2004 and was identified by Smith River Rancheria tribal



**Figure 2. Sweetwater (CA-DNO-335). View to south.
The rocky headlands of Point St. George are visible in the right background.**

member and field participant Brock Richards as the Sweetwater site (Tushingham 2006:26). A midden area and adjacent circular depression, most likely associated with a semi-subterranean house, is located within the site just north of Sweetwater Creek (Burns and Rhode 2009). If the depression is indeed a house, it may be one of the “several houses and a sweat house” at Sweetwater mentioned by Drucker (1937). This seems quite possible, as this is the only archaeological site in this section of the coast where midden has been recorded, and it is also the only ethnographic camp with houses, according to Drucker (1937).

Site CA-DNO-22, a quarter km. to the north of CA-DNO-335, was recorded in 1963 by Richard Gould as the Sweetwater site (Fig. 3). Gould did not attempt a complete survey, and indicates in the 1964 site record for CA-DNO-53 that the site may have extended much

further south: “the full area of occupation has not been determined. Patches of shell and cultural debris occur intermittently along dunes at distances between 50 ft. and 200 ft. behind the row of dunes fronting the ocean for at least 2 miles.” James Roscoe resurveyed DNO-22 in 1998 (Roscoe et al. 1998) and references Loren Bommelyn, who stated that Sweetwater was located in this area. In 2008, California State Parks contracted with the Humboldt State University Cultural Resources Facility to conduct an intensive pedestrian survey of the southern portion of Tolowa Dunes State Park. The resulting work significantly expanded the boundaries of both CA-DNO-335 and CA-DNO-22 (Burns and Rhode 2009).

While site CA-DNO-335 is likely associated with the area Drucker (1937) refers to as “Sweetwater Place,” other sources place Sweetwater slightly to the north at CA-DNO-22. Both sites, however, seem to be part



Figure 3. Sweetwater (CA-DNO-22). From Gould's 1964 site survey, courtesy of Richard A. Gould. Richard Gould Archives, California State Parks, Eureka, Cal., Image 333. Photo notes: "Historic Tolowa Indian smelting camp. Note surface erosion and poor preservation of site."

of a very large area used primarily for smelt fishing and shellfish collecting by many generations of Tolowa people. Both contain numerous loci containing mostly concentrations of shellfish, lithics, and/or fire-affected rock. Two areas between the sites each contain approximately 50 "clam" shell fragments (no other cultural materials were observed) that were recorded as isolates by Burns and Rhode (2009). Breaks between and within the sites can be attributed to a number of factors. For instance, the sites may have been used by many different families, who each set up their own discrete camp. The breaks may also relate to differences in site ownership—as described above, at least two villages laid claim to or owned sections of this beach, and ownership shifted over time. The patchy appearance of these sites has also been influenced by the dynamic nature of the sandy dune environment. Natural dune shifting continually exposes and conceals cultural resources, which has led to tremendous year to year variability in site visibility.

SMELT CAMP ROASTING PIT FEATURE (CA-DNO-335)

Without prior ethnohistoric information, archaeological recognition of smelt camps can be difficult because most of the captured smelt was dried for storage and transported back to home villages. Smelt bone, however, can be recovered in the remains of roasting pits or hearths—features associated with the cooking and immediate consumption of fish and other collected resources during the occupation of fish camps. These features are important because they not only provide a means to associate coastal sites with the mass harvest of smelt, they also offer an extremely rich snapshot of what people were eating while at these temporary camps.

In 2004, a feature interpreted as a roasting pit was discovered in an eroding coastal foredune at CA-DNO-335 (Fig. 4). The basin-shaped feature was exposed in cross-section and measured approximately 100 cm. wide by 50 cm. deep. The feature consisted of

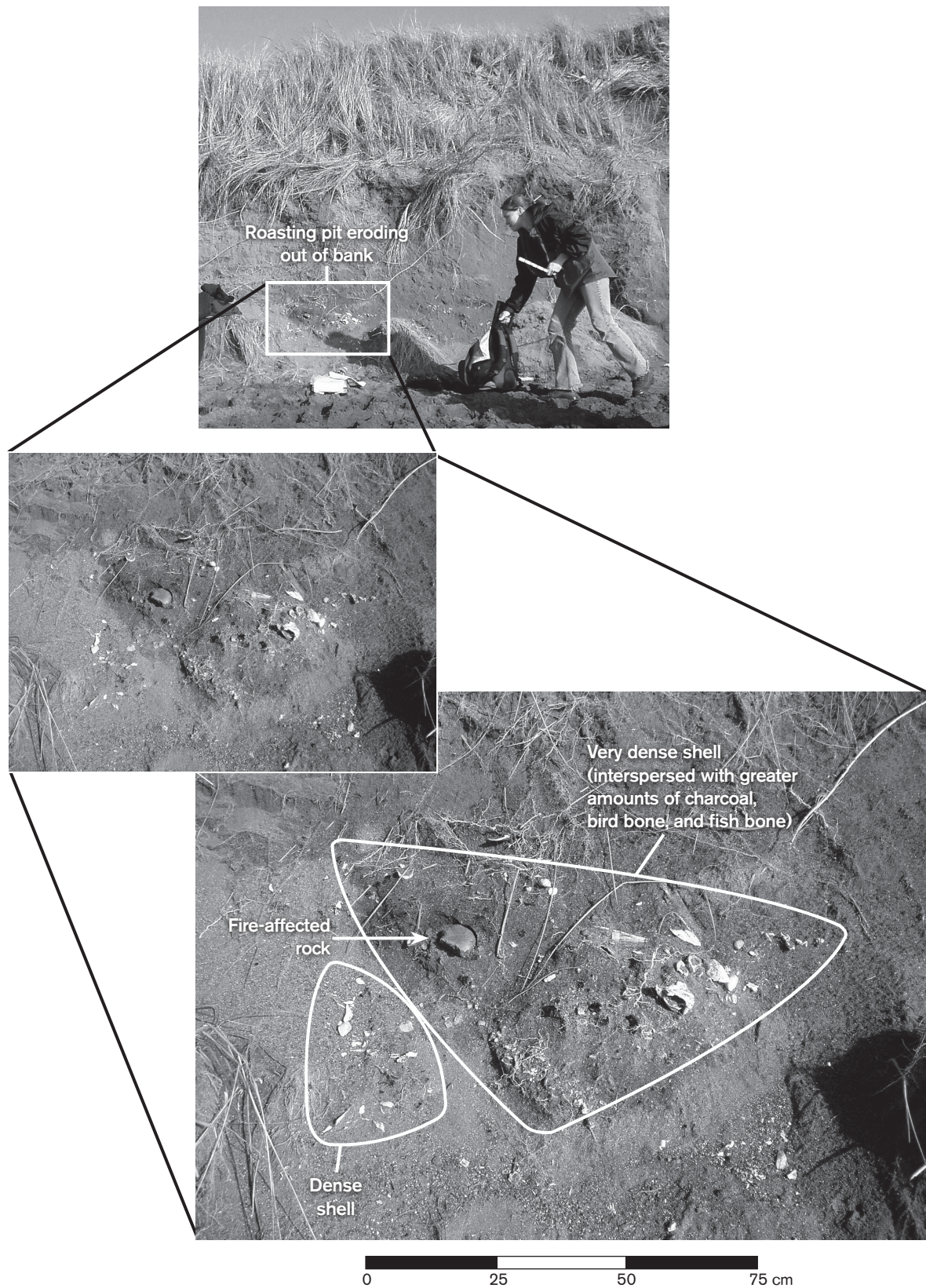


Figure 4. Roasting pit feature at Sweetwater (CA-DNO-335).

a dense concentration of shell with fish bone, mammal bone, and charcoal surrounded by sterile sand. An eight liter sample of its contents was salvaged. The sample was processed at the U.C. Davis archaeological laboratory using a Flote-Tech flotation machine and separated into non-buoyant “heavy” and buoyant “light” fractions. Heavy fractions were sorted into >1/4 in., 1/8 in., 1/16 in., and <1/16 in. size grades; cultural materials were analyzed in all size grades. Eric Wohlgemuth scanned light fractions for charred plant remains, but none were identified.

Faunal remains were identified using comparative collections at the University of California, Davis. Specimens were weighed, sorted by element (e.g., ulna, femur), element portion (e.g., proximal end, distal end, midshaft fragment), and if possible identified to species. Following Grayson (1984), a specimen is a bone or tooth or fragment thereof, whereas an element is a complete anatomical unit. NISP refers to the number of identified specimens. When the condition of the bone (i.e., fragmentation or degree of burning) precluded species/genus level identification, fragments were identified to the family, order, or size-class level. Specimens for which element could not be determined were divided into categories, including long bone and indeterminate bone fragments.

Results of Analysis

An Accelerator Mass Spectrometry (AMS) date of 165 ±50 radiocarbon years before present (B.P.) (CAMS-114834) was obtained from wood charcoal associated with the feature. There were two 2-sigma calibrated date ranges associated with the date: A.D. 1657–1891 (relative probability=0.826) and A.D. 1908–1953 (relative probability=0.174) (Calib 6.0), demonstrating that the site was in use in the late prehistoric to post-contact period.

Dietary remains identified in the sample included fish bone (Table 2), bird bone (Table 3), and shellfish (Table 4). All of the fish bone (n=2,385) were identifiable as—or compare favorably to—surf smelt, suggesting this mass-harvested species was the focal or target species. The Minimum Number of Individuals (MNI) in the sample was 24. This was indicated by the number of ultimate vertebrae (n=24), of which each fish has only one. MNI can also be figured by counting the number of vertebrae and dividing by the number of vertebrae

Table 2

IDENTIFIED FISH

Common Name	Scientific Name	NISP	Weight (g.)
Surf Smelt	<i>Hypomesus pretiosus</i>	1,291	2.68
cf. smelt	Osmeridae	1,094	1.08
TOTAL:		2,385	3.76

cf. smelt = compares favorably to smelt

Table 3

IDENTIFIED BIRD BONE

Bird Size Class	NISP
Medium to Large Bird	1
Small Shorebird	52
Indeterminate Size	6
TOTAL NISP:	59

Table 4

IDENTIFIED SHELLFISH

Common Name	Scientific Name	Weight (g.)	% of Total
Mussel	<i>Mytilus</i> sp.	191.6	59.22%
Barnacle	<i>Balanus</i> sp.	53.0	16.37%
Sea Urchin	<i>Strongylocentrotus</i> sp.	7.9	2.44%
California Jackknife Clam	<i>Tagelus californianus</i>	3.1	0.97%
Sea Snail		63.7	19.67%
Crab		0.1	0.04%
Unidentifiable Fragments		4.1	1.27%
TOTAL WEIGHT (g.):		323.54	3.76

present in individual surf smelt, but in this case this method gave us a lower MNI than simply counting the number of ultimate vertebrae. We divided the number of identified vertebrae (n=1,053) by the number of vertebrae present in individual surf smelt—between 64–67 according to Luna (2011)—which gave us a resulting MNI of 16 (1,053/ 67=15.7).

The finding of both cranial and post-cranial bones (Table 5) is consistent with the traditional preparation of surf smelt, in which no bones were consumed; according to Tolowa and Yurok consultants, prior to consumption the head of the fish was popped off, the body opened like a book, and the innards and the vertebral column

Table 5

REPRESENTATION OF SURF SMELT (*HYPOMESUS PRETIOSUS*) AND CF. SMELT SKELETAL ELEMENTS BY SCREEN SIZE

	< 1/16 in.		1/16 in.		1/8 in.		1/4 in.	
	NISP	(WT)	NISP	(WT)	NISP	(WT)	NISP	(WT)
Cranial elements								
Articular	2	(0.01)	13	(0.02)	—	—	—	—
Basioccipital	—	—	12	(0.03)	—	—	—	—
Basipterygium	—	—	14	(0.03)	—	—	—	—
Brachial Rays	14	(0.01)	2	(0.01)	—	—	—	—
Ceratohyal	—	—	18	(0.02)	—	—	—	—
Coracoid	—	—	—	—	19	(0.02)	—	—
Dentary	—	—	—	—	8	(0.01)	—	—
Epihyal	—	—	8	(0.01)	—	—	—	—
Frontal	—	—	—	—	11	(0.03)	—	—
Hyomandibular	—	—	10	(0.01)	—	—	—	—
Hypobranchial 1	—	—	13	(0.01)	6	(0.01)	—	—
Hypohyal	7	(0.01)	22	(0.01)	—	—	—	—
Lower Hypohyal	7	(0.01)	—	—	—	—	—	—
Maxilla	—	—	8	(0.02)	—	—	—	—
Opercle	—	—	4	(0.01)	6	(0.02)	5	(0.03)
Parasphenoid	—	—	11	(0.01)	—	—	—	—
Preopercle	—	—	2	(0.01)	12	(0.01)	—	—
Pterotic	—	—	10	(0.01)	—	—	—	—
Quadrate	—	—	8	(0.01)	—	—	—	—
Urohyal	—	—	3	(0.01)	—	—	—	—
Cranial/element indeterminate	13	(0.01)	57	(0.07)	29	(0.04)	—	—
Post-Cranial Elements								
Pectoral Ray 1	12	(0.01)	—	—	—	—	—	—
Pterygiophore	34	(0.02)	4	(0.02)	—	—	—	—
Ribs	96	(0.09)	386	(0.21)	—	—	—	—
Scapular	8	(0.01)	5	(0.01)	—	—	—	—
Spines indeterminate	84	(0.03)	—	—	—	—	—	—
Vertebrae	34	(0.01)	977	(2.38)	42	(0.07)	—	—
Ultimate Vertebrae	—	—	24	(0.03)	—	—	—	—
Body area indeterminate								
Scales	—	—	23	(0.04)	48	(0.1)	5	(0.06)
Indeterminate	111	(0.09)	95	(0.08)	43	(0.08)	—	—
GRAND TOTAL	422	(0.27)	1729	(3.02)	224	(0.38)	10	(0.09)

WT=weight in grams

were removed (Melvin Brooks and Richard Brooks, personal communication 2009). This contrasts with butchery and discard patterns associated with large-bodied mass-harvested fish (i.e., salmon), which were typically processed at temporary riverine camps (where some body parts, especially heads, were often discarded)

prior to the transportation of the dried fish cuts back to home base. Thus, unlike smelt, culturally-deposited salmon bone assemblages should be represented by fewer skeletal elements and less complete skeletons, an expectation developed and demonstrated by Butler (1990, 1993).

The identified shellfish were mostly California Sea Mussel (*Mytilus californianus*), representing 59.2% of the total weight. Less common identifiable species included barnacle (*Balanus* sp.), sea urchin (*Strongylocentrotus* sp.) spines and body parts, and California jackknife clam (*Tagelus californianus*). Sea snail and crab were also recovered. Interestingly, two of the most abundant identified species—mussel and barnacle—are not found in the sandy beaches in the immediate area; they are, however, common in rocky intertidal areas, the closest of which is Point St. George, approximately 3,200 meters (2 miles) south of Sweetwater Creek. Transport of rocky intertidal species to Sweetwater may have involved “in bulk” provisioning (i.e., brought to the site at the beginning of smelt camp when village inhabitants initially moved to Sweetwater), and/or they were simply collected during daily forays while people were camped at the site. Either way, it appears that people selectively brought larger sized mussels to the camp.

Although limited, mussel size data indicate that most of the mussels found in the roasting pit were large (Table 6). The presence of all large-sized mussel could be interpreted as being the result of people employing a “plucking” versus a “stripping” strategy of collection, with “plucking” referring to the selective harvesting of large-sized mussels from beds, and “stripping” referring to the removal of patches of mussels from beds with no concern for size (White 1989). As Whitaker (2008) has shown, plucking is the expected strategy when people are harvesting for immediate consumption, as they are selecting mussels with larger meat weight. In contrast, the stripping strategy is associated with the long-term productivity of mussel beds. In the current case, either strategy could have been employed, but only large-sized mussels were brought to Sweetwater, perhaps to simply save on transport costs. Obviously, the small sample size of the current analysis precludes a resolution of this issue, but we point this out as a potential research problem for the future.

None of the 59 bird bones could be identified to species. They were, however, divided into size classes, with 52 bird bones identified as small shorebirds, one as a medium-to-large juvenile, and six of indeterminate size. The small bird bones likely belonged to one or more species of perching birds (order Passeriformes), which includes jays, larks, swallows, wrens, warblers, sparrows, and finches; representative native species common in the area include the Steller’s Jay (*Cyanocitta stelleri*), Northern Rough-winged Swallow (*Stelgidopteryx serripennis*), Bewick’s Wren (*Thryomanes bewickii*), Yellow Warbler (*Dendroica petechia*), White-crowned Sparrow (*Zonotrichia leucophrys*), Purple Finch (*Carpodacus purpureus*), and the American Goldfinch (*Spinus tristis*) (Barnhart et al. 1992; Harris 2006; U.S. Fish and Wildlife Service 1999). The medium to large juvenile specimen may represent a duck (subfamily Anatinae), gull (family Laridae), loon (family Gaviidae), storm petrel (family Hydrobatidae), heron (family Ardeidae), Common Raven (*Corvus corax*), or tern (family Sternidae).

DISCUSSION

Despite the importance of smelt in the diet of north coast aboriginal groups, prehistoric evidence of smelt fishing has remained elusive. Archaeological recognition of smelt fishing requires an understanding of where we might expect to find smelt bone, based on ethnographic parallels (Tushingham 2011a), coupled with the application of fine-grained methods and analyses. A number of recent studies employing this approach have demonstrated the pre-Contact origins of the mass harvest and bulk storage of smelt.

Thousands of smelt bone have been recovered in samples from two prehistoric villages at Point St. George: CA-DNO-13 (Tushingham and Bencze 2013) and CA-DNO-11 (Whitaker and Tushingham 2011). Similar evidence is found at temporary camps, including

Table 6
SIZE SORTED MUSSELS

	0–2 cm.	2–3 cm.	3–4 cm.	4–5 cm.	5–6 cm.	6–7 cm.	7–8 cm.	8–9 cm.	9–10 cm.
Number of hinges	0	0	0	1	1	1	3	1	1

the current study site and one at CA-DNO-22 (Arpaia and Tushingham 2011). Finally, while complete fish bone analyses are pending, smelt bone has been recovered in residential midden associated with HUM-321, a site on Humboldt Bay (Tushingham 2011b). This latter site is tremendously important, as smelt bone has been found in levels radiocarbon dated to as early as 1,300 calibrated years B.P., providing evidence that the mass harvest and bulk storage of small forage fish was an important procurement strategy by the early Late Period.

Screen Size and Faunal Bone Recovery Rates

Fine-mesh screening is necessary to prevent bias in the analysis of fish bone (Casteel 1972, 1976a, 1976b). While large-bodied fish are often assumed to be the preferred target species, the application of fine-grained techniques is demonstrating the importance of small fish in the diet of native Californians (Fitch 1969, 1972; Gobalet 1989; Gobalet et al 2004; Tushingham and Bencze 2013). Such fine-grained analyses were essential for the complete analysis and proper interpretation of the roasting pit feature at Sweetwater. Here we offer a few comments concerning screen size and faunal bone recovery rates which may be helpful to researchers who seek to determine the most appropriate methods to use in future studies.

In the Sweetwater sample, 90% ($n=2,151$) of the fish bone was recovered in 1/16 in. or smaller mesh screens (Table 5). The use of 1/4 in. screens is clearly inadequate, with less than one-half of one percent ($n=10$) of fish bone recovered in this screen size. As all of these bones are smaller than 1/4 in., it appears that their recovery in the 1/4 in. screens was fortuitous—in other words, they were simply caught in the screen along with other, larger materials. In terms of species level identifications, only one opercle could be identified to species (surf smelt) in the 1/4 in. sample. In the 1/8 in. sample, 53 of the 224 smelt were surf smelt, including dentary ($n=8$), coracoid ($n=15$), preopercle ($n=12$), frontal ($n=8$), and hypobranchial 1 ($n=6$) elements.

The Sweetwater example indicates that many fish bone elements might also be missed if 1/16 in. or smaller samples are not analyzed. Of the post-cranial elements, only vertebrae were identified in the 1/8 in. sample. More cranial element taxa were found ($n=6$ categories), but 14 taxa were only identified in

the 1/16 in. or smaller samples. Thus an analysis of 1/16 in. samples not only increases the number of bones identified and the chance of species-level identifications, it also significantly improves our understanding of the skeletal completeness as many smaller element taxa were recovered only in these samples. It is also important to note that, if present, some of the smaller species of smelt (e.g., night smelt), would be less likely to be recovered if fractions from 1/16 in. or smaller screen sizes are unanalyzed.

CONCLUSIONS

Identification of smelt fishing at archaeological sites on the north coast of California can provide a more nuanced understanding of hunter-gatherer organization and subsistence-settlement patterns in the past. Archaeological recognition and fine-grained analysis of roasting pit features provide a means to identify sites as smelt camps if smelt bones are present in considerable numbers. The ethnographic mass-harvest of smelt is associated with sophisticated mass-capture techniques and technology, seasonal scheduling, the logistical procurement of resources, and storage. Studies demonstrating prehistoric use of the smelt fishery provide evidence that these strategies were in place as early as 1,300 years ago (Tushingham 2011b).

Smelt camps are important and occur in association with incredibly fragile sites that require our immediate attention. These sites are heavily impacted by animal, pedestrian, and illegal off-highway vehicle (OHV) traffic. Archaeologists and land managers are increasingly aware of, and developing responses to, the effects of climate change on California's coastal sites (e.g., Newland 2012). Sweetwater and the other sites described in this report are severely threatened by coastal erosion and sea level rise. For example, the DNO-335 roasting pit feature was discovered in a foredune bank being impacted by wave action at high tide. The site was revisited three months after initial recording and the coastal bluff had collapsed due to water erosion, completely obliterating the feature. Under the current environmental conditions, these sites clearly require regular monitoring, and exposed features, especially those found in ocean-facing foredunes, should be salvaged immediately in partnership with the Tolowa community.

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