Assessing Canine Forensic Results with Archaeological Excavations at Protohistoric Site *Síi Túupentak* (CA-ALA-565/H) in the San Francisco Bay Area

Laurel Engbring and Brian F. Byrd
Far Western Anthropological Research Group, Inc.

John Grebenkemper and Adela Morris
Institute for Canine Forensics

Monica V. Arellano
Vice Chairwoman, Muwekma Ohlone Tribe

Alan Leventhal
Muwekma Ohlone Tribal Archaeologist

Data recovery at Late Period site Síi Túupentak (CA-ALA-565/H) provided a unique opportunity to integrate non-destructive methodology into the identification of human remains. In April 2017, the Institute for Canine Forensics conducted an examination of a 21-by-14-meter portion of the site. Three dogs trained to detect the scent of human remains alerted 12 times in seven locations, indicating possible burials. Subsequent excavation and analysis provided preliminary data on canine detection of ancient human remains, including advantages and limitations. The results suggest that this remote sensing technique is an effective identification tool that will improve with further collaboration.

Síi Túupentak (CA-ALA-565/H) lies near the confluence of Alameda Creek and Arroyo de la Laguna in the southeastern San Francisco Bay Area (Figure 1). From February 2016 to November 2017, Far Western Anthropological Research Group, Inc. (Far Western) conducted an extensive program of testing and data recovery at the site, working in collaboration with the Muwekma Ohlone Tribe, who were designated Most Likely Descendants for the project by the Native American Heritage Commission (Byrd et al. 2019). The Chocheño/Thámien Ohlone name *Síi Túupentak* was given to the resource in April 2016 by the Muwekma Ohlone Tribe Language Committee in order to honor their deceased ancestors and reclaim the Tribe's Ancestral Heritage Site (Arellano et al. 2019:24). Fieldwork entailed archaeological excavation of 1,741 square meters (1,778 cubic meters), representing 6.2 percent of the 27,903-square-meter site area. This included 10 backhoe trenches (68.2 cubic meters), 56 control units (33.4 cubic meters), and controlled archaeological stripping of 1,665 square meters (1,671 cubic meters). Excavations exposed 76 burials and 36 features, which were radiocarbon dated from 605 to 101 calibrated years before present (cal B.P.) (1345 to 1805 Common Era [CE]). This time span of Native American settlement began during the Late 1 Period and continued through the Late 2 Period into the Colonial Era.

During the course of the project, the Muwekma Ohlone requested remote sensing techniques be employed prior to archaeological stripping in the 21-by-14-meter Pond Study Area in order to identify and limit damage to human remains. The Institute for Canine Forensics (ICF) trains and certifies Historical Human Remains Detection (HHRD) dogs for this purpose. Their techniques and results are detailed below.

METHODOLOGY

Volatile organic compounds (VOCs) have previously been associated with the decomposition of buried human remains, with over 30 of the 478 identified VOCs determined to be specific to humans (Glavaš and Pintar 2019:1107). The scent of human remains travels away from the decomposing body or skeleton by way of diffusion (Rosier et al. 2015). Trained canines are capable of investigating, detecting,

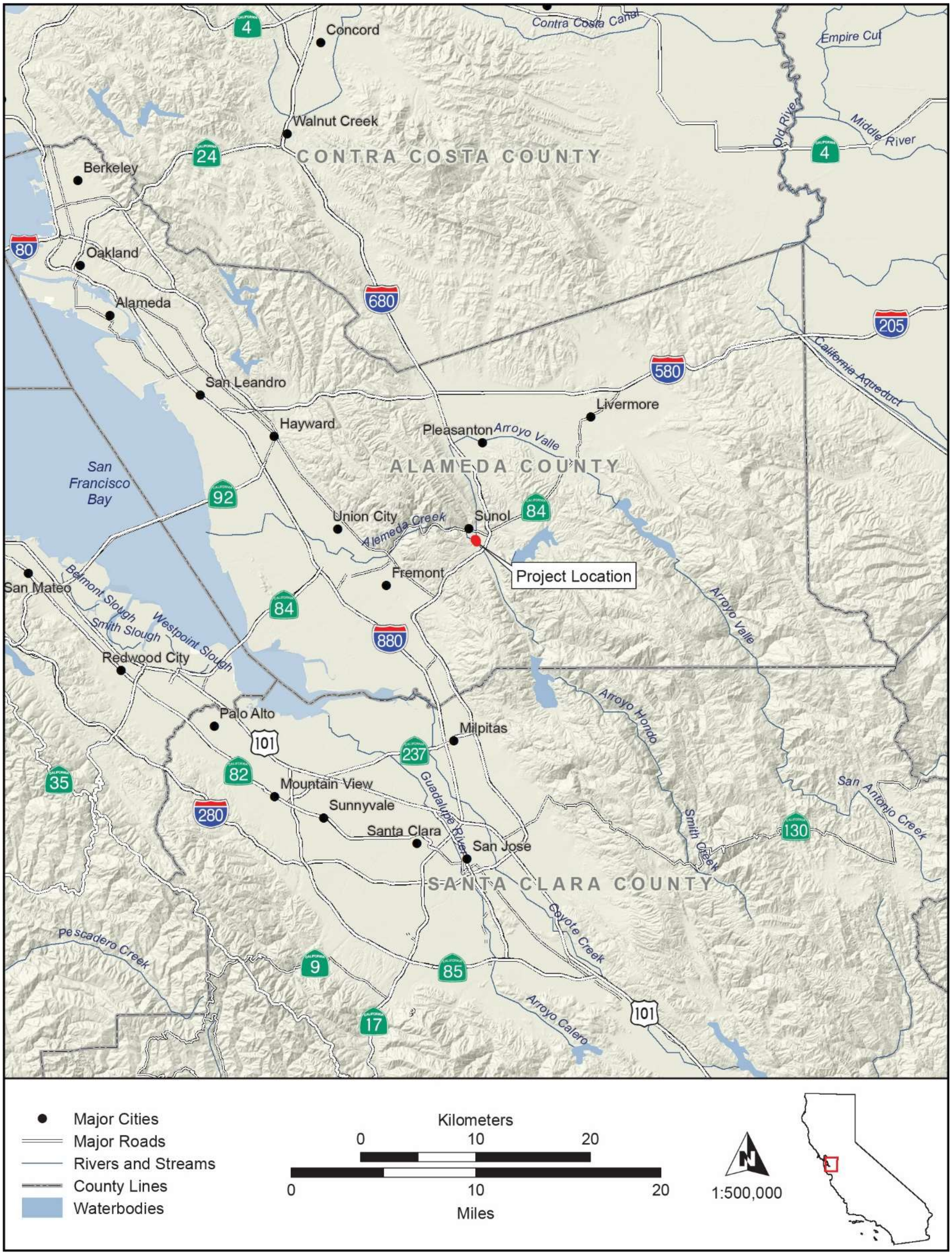

Figure 1. Project location map.

and communicating the presence of this scent with their handlers. However, this is a complex process into which we are still gaining insights.

Identification

The HHRD dogs employed by the ICF have received unique and specialized training to locate historic-era and precontact human remains through scent detection, but the dogs do not necessarily alert directly over a burial. Human, rodent, insect, vegetal, and natural movement of the earth such as floods or landslides can spread the scent of human remains. Disturbed burials will often create larger scent pools, making it more difficult for the dogs to pinpoint a specific burial location.

Weather and ground temperature also play a critical role in the dogs' ability to locate scent. When present, water physically displaces odor molecules, thus causing human remains scent to appear to be stronger in locations of moist soil, and in and around photosynthesizing vegetation which is transpiring. As vegetation transpires, it releases water into the atmosphere and bumps the odor molecules off whatever they are bound to, making odor in the air stronger. Conversely, bones that have been on the surface for extended periods of time deteriorate, losing most of their scent, especially when exposed to direct wind, sunlight, and heat.

Fluctuating ground temperatures also directly affect the availability of scent during searches. Hot weather conditions, especially ground temperatures of 85°F and higher, decrease the scent available to the dogs. Ideal ground temperatures are between 40 and 85°F, and dogs are generally not worked when ground temperatures reach 100°F or more, due to safety concerns and decreased potential for human remains detection.

Alerting and Documentation

The dogs are trained to locate the area of strongest scent and give an "alert." The alert is either a sit or a down at the strongest source of the scent they have located. If the scent is on the lower level of their threshold of detection, they may continue to work an area looking for a stronger scent location until they are able to find it. This is demonstrated by intense working and either brief, scattered alerts or an unwillingness to commit.

Handlers use designations of 1–3 to rate the alerts the dogs give at each at location. This is based on each handler's previous experience working with his or her dog. Alert ratings are designated as follows:

- Strongly Committed: The dog immediately identifies and alerts at a specific location.
- Committed: The dog took time to locate and alert at the strongest source of scent.
- Scent Pool: The dogs are getting scent but are unable to locate the exact source. Scent pools may be the result of disturbed, scattered, or fragmentary remains; or, they may be created by wind and/or moving water. It could be scent remaining in the soil where a burial was located but where physical remains are no longer identifiable.

Once a dog has alerted on the scent of human remains, the handler uses a pin flag of a distinctive color to mark the location and then uses a hand-held Garmin GPS unit to take a position. Alert waypoints use the handler's initials and their GPS waypoint number. A Far Western archaeologist also took a Trimble position for this study. Handlers did not flag multiple alerts within two meters of each other, as burials within a few meters of each other create an overlapping scent pattern, and this is within the expected range of uncertainty of the dogs.

This survey involved both free search and a fine-grid search. Free search lets the dog choose the area it wants to search and is not as controlled as a grid search. It can be useful when speed is needed, but it can be more difficult to keep track of the areas the dog has searched. The benefit of this search mode is that if the dog has a scent, it will gravitate to that location and work it first. A fine-grid search is commonly used at locations suspected to be cemeteries. It typically uses grid spacing from three to five meters and often is searched with a cross-grid for the most systematic coverage, to increase the probability of detection.

Field Conditions

The team conducted fieldwork on April 24, 2017, after the area's vegetation had been cut and raked, allowing the dogs to access the ground surface. Weather conditions were well suited for the study—cool, cloudy, with an occasional drizzle of rain, and the ground was still moist from recent rains. Air temperature ranged from 60°F at 9:20 am to 65°F at 10:30 am, while ground temperature was 67°F at 9:20 am and 71°F at 10:30 am, when fieldwork ended. Wind ranged from one to six miles per hour from the west at 9:20 am, shifting to the east at 10:30 am. It is estimated that the percent of terrain accessible to the dogs was from 75 to 90 percent.

RESULTS

At *Síi Túupentak*, three teams of handlers and dogs (Adela Morris and Jasper, Lynne Englebert and Piper, and John Grebenkemper and Kayle) performed an intensive search of the Pond Area (Figure 2). The triple coverage was employed in order to limit individual biases of dogs and handlers.

Figure 2. Institute for Canine Forensics HHRD dog Kayle alerting with trainer John Grebenkemper.

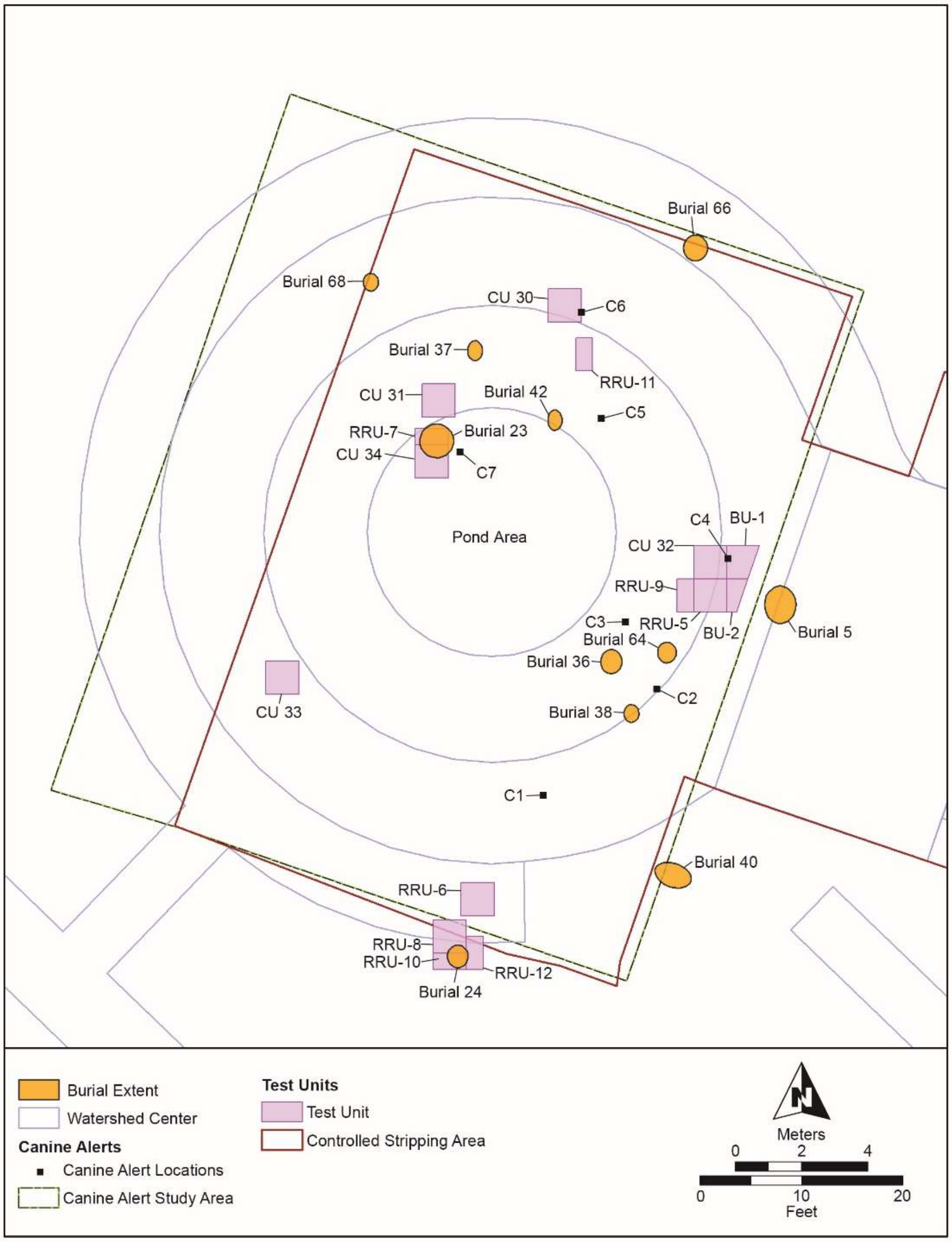

Figure 3. Pond Area showing canine alerts, test units, and burials.

The three HRRD dogs alerted a total of 12 times in seven locations, which are mapped along with burials and units in Figure 3. Three one-by-one-meter control units (Control Units 30, 32, and 34) were placed in the locations where multiple dogs alerted, locating Burial 23 in Control Unit 34 and disarticulated human remains in Control Unit 30 and Control Unit 32.

Subsequent full excavation of the Pond Area provides to our knowledge the first empirical information on the accuracy of canine alerts at a pre-1800s archaeological site. Eleven burials were recovered from and immediately adjacent to the study area. They were directly dated from 525 to 382 cal B.P. (1425 to 1568 CE), with the top depth varying between 10 and 100 cm below surface. A total of 165 isolated/disarticulated human remains were also recovered during excavation of the study area.

Canine alerts were an average of 1.6 meters away from the nearest burial, with a range of 0.3 to 3.4 meters (Table 1). Burials were an average of 2.5 meters from the nearest canine alert, with a range of 0.3 to 5.5 meters (Table 2). When a series of 12 random points were plotted three times in the Pond Area, the points were an average of 3.6 meters away from the nearest burial, 1.1 meters farther than the mean distance that the dogs alerted. This indicates that the dogs were not alerting randomly, despite the many challenges they faced. While a t-test showed that the two-tailed P value equals 0.0730, a difference that is not quite statistically significant, it is important to keep in mind the disturbed nature of the deposit and the 165 isolated human remains that were recovered. These isolated remains were widely distributed horizontally and vertically across the Pond Area, with many closer to the surface than the intact burials. The presence of these isolated remains (generally considered to represent elements from burials that had been highly bioturbated and dispersed) undoubtedly added to the challenges of the canine forensic team to successfully identify intact burials.

Table 1. Canine Alerts Showing Testing and Results, and Nearest Burial After Full Pond Area Excavation.

Canine Alert	Number of Dogs	Details	Testing	Testing Results	Nearest Burial	Distance (m)
1	1	JG4	--	--	38	3.4
2	1	AM1	--	--	38	0.8
3	1	JG5	--	--	36	0.9
4	2	AM3, JG3	CU 32, RRUs 5 and 9, BUs 1 and 2	4 isolated remains	5	1.6
5	1	JG2	--	--	42	1.2
6	3	LE1, JG1, AM2	CU 30	3 isolated remains	42	3.0
7	3	LE2, JG6, AM4	CU 34, RRU 7	Burial 23	23	0.3
Mean	--	--	--	--	--	1.6

Notes: CU = Control Unit; RRU = Rapid Recovery Unit; BU = Bulk Unit.

Table 2. Pond Area Burials, Nearest Canine Alert, and Age.

Burial (n = 11)	Nearest Canine Alert	Distance (m)	Top Depth (cm)	Component	^{14}C Date (cal B.P.)
Burial 5[a]	4	1.6	40	Late 1	477
Burial 23	7	0.3	40	Late 1	518
Burial 24	1	5.2	45	Late 1	442
Burial 36	3	0.9	40	Late 1	477
Burial 37	7	3.1	30	None	-
Burial 38	2	0.8	35	Late 2a	382
Burial 40	1	4.0	10	Late 1	525
Burial 42	5	1.2	35	Late 1	478
Burial 64	2	0.8	95	Late 1	468
Burial 66	6	3.6	100	Late 1	521
Burial 68	7	5.5	50	Late 1	504
Mean	--	2.5	--	--	--

Note: [a] Burial 5 previously recovered directly to the east.

Considering all burials in the Study Area, the six burials closest to the surface (10- to 40-cm depth) were an average of 1.7 meters from the nearest canine alert, while the four deepest burials (45 to 100-cm depth) were an average of 3.8 meters away. The four younger burials (478-382 cal B.P.) were an average of 1.8 meters from the nearest Canine Alert, while the four older burials (525-504 cal B.P.) were an average of 3.3 meters away. Age, sex, and macroscopic completeness of burials did not generally appear to correlate with Canine Alert distance, but Burial 68, which was farthest from the nearest Canine Alert at 5.5 meters, was the youngest individual (six months old), and the skeletal remains were only 10 percent complete.

This study has several implications for future work. First, despite the many challenges that the dogs faced working in this location, canine detection can be an effective tool for locating precontact burials. While preservation condition, soil composition, disturbance, weather, and temperature may be key factors in accurate canine identification of human remains, burial depth and age also appear to influence Canine Alerts. Therefore, more recent sites or sites with burials near the surface may be best suited for this technique. Increasing test unit size in the area of Canine Alerts will also increase the likelihood of locating human remains, and the newly calculated 1.6-meter mean distance between Canine Alerts and the nearest burial should aid in the development of future testing plans. Future projects would also benefit from employing HHRD dogs prior to beginning excavation, in order to prevent recently discovered burials from distracting the dogs from locating unexposed burials. With additional tests such as this one, techniques can be refined to increase the accuracy of this remote sensing method and determine where and when is best to employ it.

REFERENCES CITED

Arellano, Monica V., Alan Leventhal, Charlene Nijmeh, Sheila Guzman-Schmidt, and Gloria E. Arellano-Gomez

2019 Ethnohistory, Historic Ties, and Tribal Stewardship of Sunol/Pleasanton, Santa Clara Valley, and Adjacent Areas. In *Protohistoric Village Organization and Territorial Maintenance: Archaeological Data Recovery at Sii Túupentak (CA-ALA-565/H), Sunol Long-Term Improvements Project, Alameda County, California*, edited by Brian F. Byrd, Laurel Engbring, Michael Darcangelo, and Allika Ruby, pp. 23-66. Report on file at the San Francisco Public Utilities Commission, San Francisco, CA.

Byrd, Brian F., Laurel Engbring, Michael Darcangelo, and Allika Ruby

2019 *Protohistoric Village Organization and Territorial Maintenance: Archaeological Data Recovery at Sii Túupentak (CA-ALA-565/H), Sunol Long-Term Improvements Project, Alameda County, California*. Report on file at the San Francisco Public Utilities Commission, San Francisco, CA.

Glavaš, Vedrana, and Andrea Pintar

2019 Human Remains Detection Dogs as a New Prospecting Method in Archaeology. *Journal of Archaeological Method and Theory* 26(3):1106-1124. https://doi.org/10.1007/s10816-018-9406-y.

Rosier, E., S. Loix, W. Develter, W. Van de Voorde, J. Tytgat, and E. Cuypers

2015 The Search for a Volatile Human Specific Marker in the Decomposition Process. *PLoS ONE* 10(9):e0137341. doi:10.1371/journal.pone.0137341.