

Mapping Cades Cove Cemeteries

Investigator's Scientific Study Final Research Report #3

**United States Department of the Interior
National Park Service
Great Smoky Mountains National Park**

**Research Permit GRSM-01120
July 20, 2012 – December 31, 2016**

**William E. Lovekamp, Steven M. Di Naso, and Gary S. Foster
Eastern Illinois University
2017**

Introduction

Cades Cove is a special place, an endearing and enduring place, given the more than two million visitors who come every year. The physical geography tugs on them like a ferrous deposit on the needle of a compass pointing the way home. Drop into the upland-valley floor through Crib Gap, and anticipate Thunderhead Mountain rimming it to the southeast, Gregory's Bald to the southwest, Rich Mountain to the north, and the faint roar of Abram's Falls to the west. Maybe these place names are obscured by the soft, enveloping fog that gave the Smoky Mountains its name. And these are all place names, place names bestowed by the early settlers and residents who ultimately called this place homeⁱ.

Most communities in historical Appalachia were too small to have had public buildings, town halls, libraries, newspapers, or public records, but all had cemeteries. We turned to the cemeteries of Cades Cove and to Cades Cove as a single cemetery, a single resting place for its many residents so that their story and their community might be more completely told. The story is from the individuals resting peacefully in death, speaking to the life of Cades Cove. "...As long as their memory remained alive . . . , the community of Cades Cove would never die"ⁱⁱ and in death, they shared some of their memory.

In 1931, William Howell Oliver of Cades Cove, then 74 years of age and with the foreknowledge of a prophet, realized what the national park proposal would ultimately demand and extract from his heritage, his roots, and his community. Relinquishing their community churches and cemeteries, along with their homesteads and burial grounds would be "like selling our dead," he lamentedⁱⁱⁱ. The Cades Cove experience is a rare instance, one seldom repeated in the development of our nation and our national park system. The National Park Service preserved and protected not only the natural landscape of the Smoky Mountains but some of the

cultural landscape of its early Euro-American settlement, including the mountain community of Cades Cove and its cemeteries. Ironically, that preservation came at the expense of its demise, not unlike preserving the beauty of a specimen of a rare species by sealing it in a flask^{iv}.

There are more visitors to the cemeteries of Cades Cove because of the creation the Great Smoky Mountain National Park than there would have been without its creation. More than 11 million visitors come to the park every year and of them, more than two million visit the cove. Cades Cove cemeteries, protected and preserved, exist as a demographic resource employed in telling a great part of the story of this traditional mountain community. That story could have been told in no other way without those cemeteries.

This research has three components, descriptive, analytical and processual: we descriptively present an historical narrative of and a complete cemetery inventory of Cades Cove; we analytically reconstruct Cades Cove using socio-demographic data from all engraved gravestones; we processually mapped and analyzed all artifacts (monuments, stones, and other markers) likely connected to burials in the three largest (church) cemeteries to permanently document their location using GPS, and other geospatial technologies. This report summarizes the cemetery inventory of Cades Cove.

Mapping of Primitive Baptist, Methodist, and Missionary Baptist Cemeteries

In a collaborative effort between the Department of Sociology & Anthropology, the Department of Geology & Geography, and the GNSS Solutions Group, Kara Company, Countryside, Illinois, under the directive of the Geographic Information Sciences Lab (GISci Lab), our team surveyed three cemeteries in the Great Smoky Mountains National Park, in Cades Cove, TN. Our goal was to provide the National Park Service with the first spatially-accurate, headstone survey and inventory of the Primitive Baptist, Methodist, and Missionary Baptist

churches, and their associated cemeteries. Although interment data gathered by others in previous field surveys is useful, earlier efforts to collect cemetery marker locations and produce accurate maps of these cemeteries yielded poor results.

Previous inventories included tape-and-compass surveys and hand-held GPS studies using sub-meter, differential GPS techniques (DGPS). These types of surveys generally rely on Wide Area Augmentation System (WAAS), or U.S. Coast Guard Navigation Center (NAVCEN) differential corrections, and under optimal conditions will produce meter and sometimes sub-meter accurate positions. However, the physical geography of the Cove precludes the application of differential GPS techniques in this type of environment. Geographically, Cades Cove is an isolated valley and lies some 700m (2,300ft) below the surrounding ridge lines in every direction (Figure 1). All of the cemeteries in the Cove are under, or proximal to, moderately dense canopy and large structures (Figure 2). Because of this configuration, the Cove has limited coverage for most differentially-based GPS methodologies (DGPS). Satellite-Based Augmented Systems (SBAS) such as the WAAS are unavailable, and implementation of more advanced techniques such as cellular (CDMA-enabled), spread spectrum, and UHF radio-based methods are unattainable throughout the Cove for the same reason. The overall impact on GPS surveys in the Cove in general, is poor satellite visibility, high geometric dilution of precision, low signal-to-noise ratios, and potential for abundant multipath errors throughout the region.

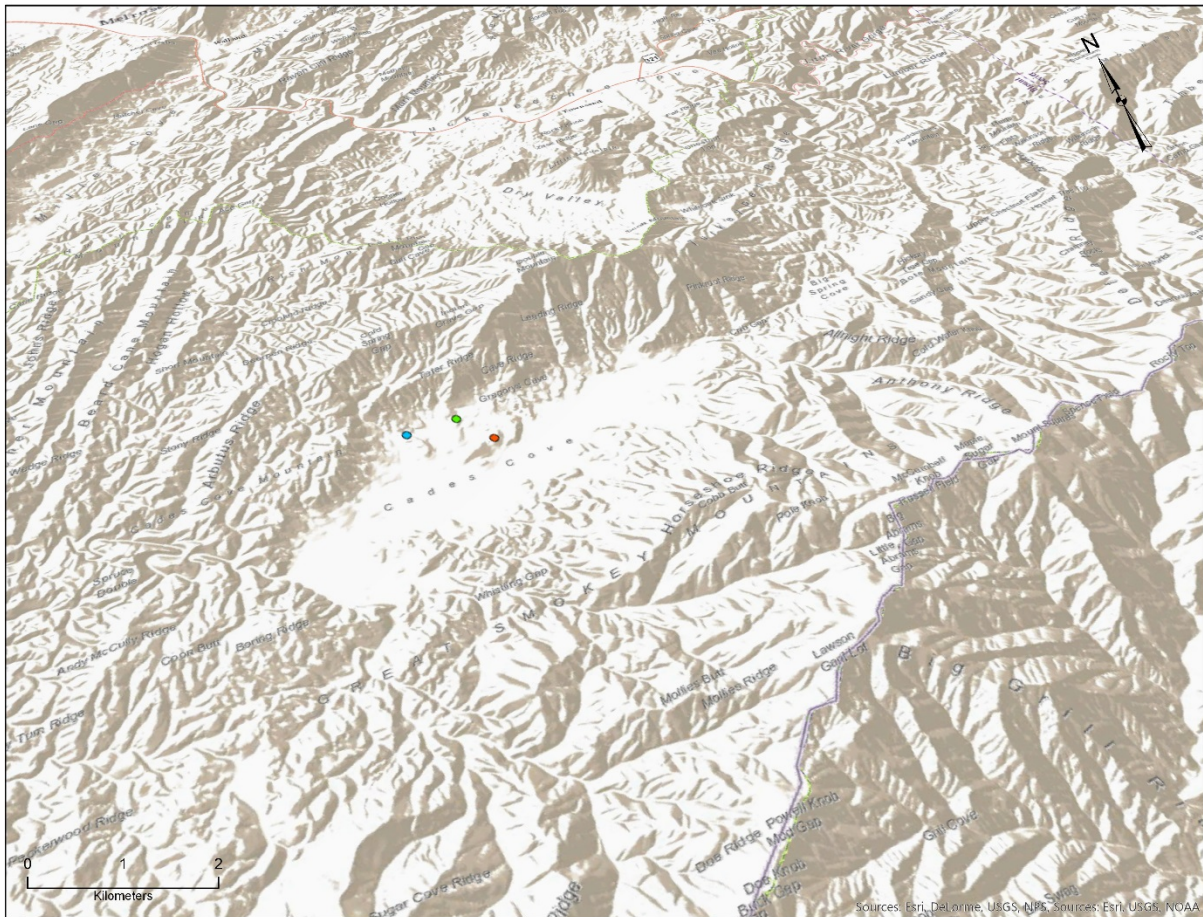


Figure 1 Physical geography of Cades Cove and the location of Missionary Baptist (blue), Methodist (green), and Primitive Baptist (red) cemeteries. Their locations within the Cove relative to the surrounding high ridgelines limit the ability to use differentially-based GPS techniques (DGPS).

To mitigate these effects, we used static GPS techniques, followed by post-processing of the data using the National Geodetic Survey (NGS) Online Positioning User Service (OPUS). We collected GPS ephemeris over extended occupational periods (up to six hours), and followed an appropriate GPS mission plan. This approach allowed us to bringing high-precision/high-accuracy horizontal and vertical geodetic control to each of the three cemeteries (Figure 2). The control points were used to establish short base lines for our Leica TS 15 Robotic Total Station,

where traditional laser-ranging techniques were used to map all markers and planimetric features at survey-grade (cm) accuracy (Plate 2). All positions were fixed to Zone 17, Universal Transverse Mercator, on the North American Datum of 1983 (UTM17N NAD83). As a robotic method, the TS 15 allowed one person to work independent of the other survey crew members while expediting other tasks such as marker photogrammetry, record and inventory, and 3D scanning.



Figure 2. Heavy canopy surrounding each cemetery coupled with the Cove’s low-lying geography within the Smokey Mountains, prevents the use of differentially-corrected GPS methodologies (DGPS). Static GPS methods using long occupational times, when coupled with an appropriate GPS Mission Plan, can provide the necessary high-precision / high-accuracy coordinates needed for accurate mapping of the features within each cemetery. Missionary Baptist (left), Methodist (center), and Primitive Baptist (lower right) Cemeteries, cades Cove, TN.



Plate 3. As an alternative to DGPS, we used an appropriate GPS Mission Plan to focus on a GPS time-window that permitted an ideal geometric dilution of precision (GDOP) during the longest sustained period. The Static GPS method used allowed us to collect ephemeris data over a minimum of four to six hours with an elevation mask of twenty degrees. This resulting high-accuracy / high-precision geographic coordinates were used to establish short baselines within each cemetery. A Total Station was then used to establish supplemental monumentation for the Robotic Total Station and C10 High Definition Laser Scanner for mapping the cemeteries.



Plate 2. A robotic Total Station was used to locate individual headstones, footstones, and cornerstone monuments at each gravesite. Planimetrics (fence lines, tree lines, walking paths, and structures) were also mapped as a reference for the marker surveys for our base maps. Autonomous mapping by Dr. William Lovekamp (foreground - surveying), Dr. Vincent P. Gutowski (background – photographing), Primitive Baptist Cemetery, Cades Cove, TN.

Our Leica ScanStation C10, a compact, pulsed, dual-axis compensated, very high speed, laser scanner can scan up to 50,000 points per second (millions of points per setup), at mm-grade accuracy with distances as far as 400ft (Plate 3). Set up of the instrument required that we locked its position onto the high-accuracy grid that was established using the Static GPS methods. This was necessary to tie the

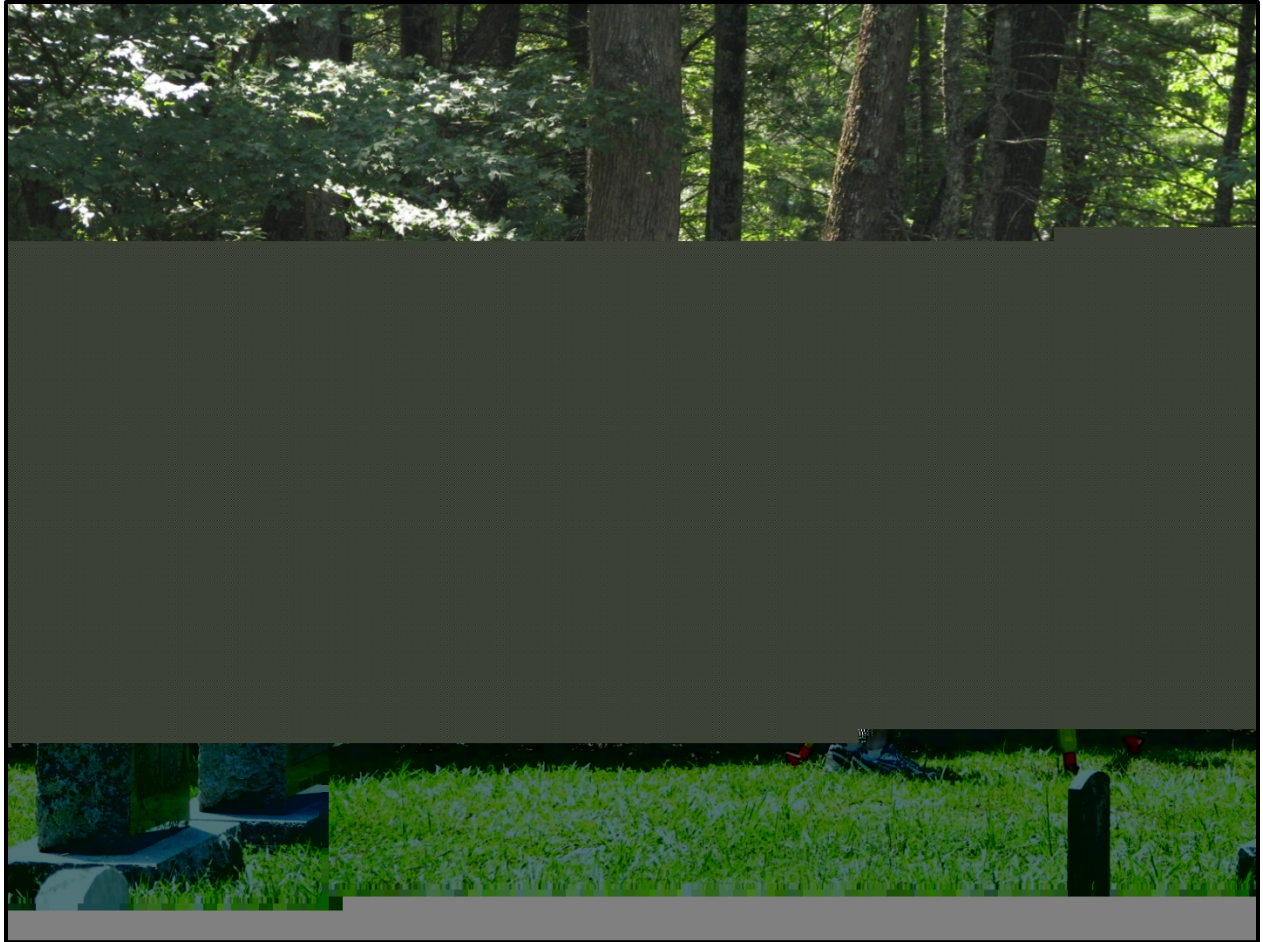


Plate 3. Douglas McClintic, PLS, uses the Leica ScanStation C10 High Definition Laser Scanner to collect millions of points from multiple perspectives. The scanner contemporaneously collects imagery with the point cloud to produce interactive, dynamic animations. Primitive Baptist Cemetery, Cades Cove, TN.

A resection methodology was used to determine the ScanStation's position from multiple perspectives within each cemetery using the monumentation and baseline surveyed with the TS 15 Robotic Total Station. We captured data from an array of no less than eight positions, strategically placed throughout each cemetery for the acquisition of three-dimensional data used in our virtual cemetery models (Plate 4 and Plate 5). The high definition scanning produced 3D point clouds and photogrammetry that could be viewed from each of the instrument setup perspective in three-hundred-and-sixty degrees.

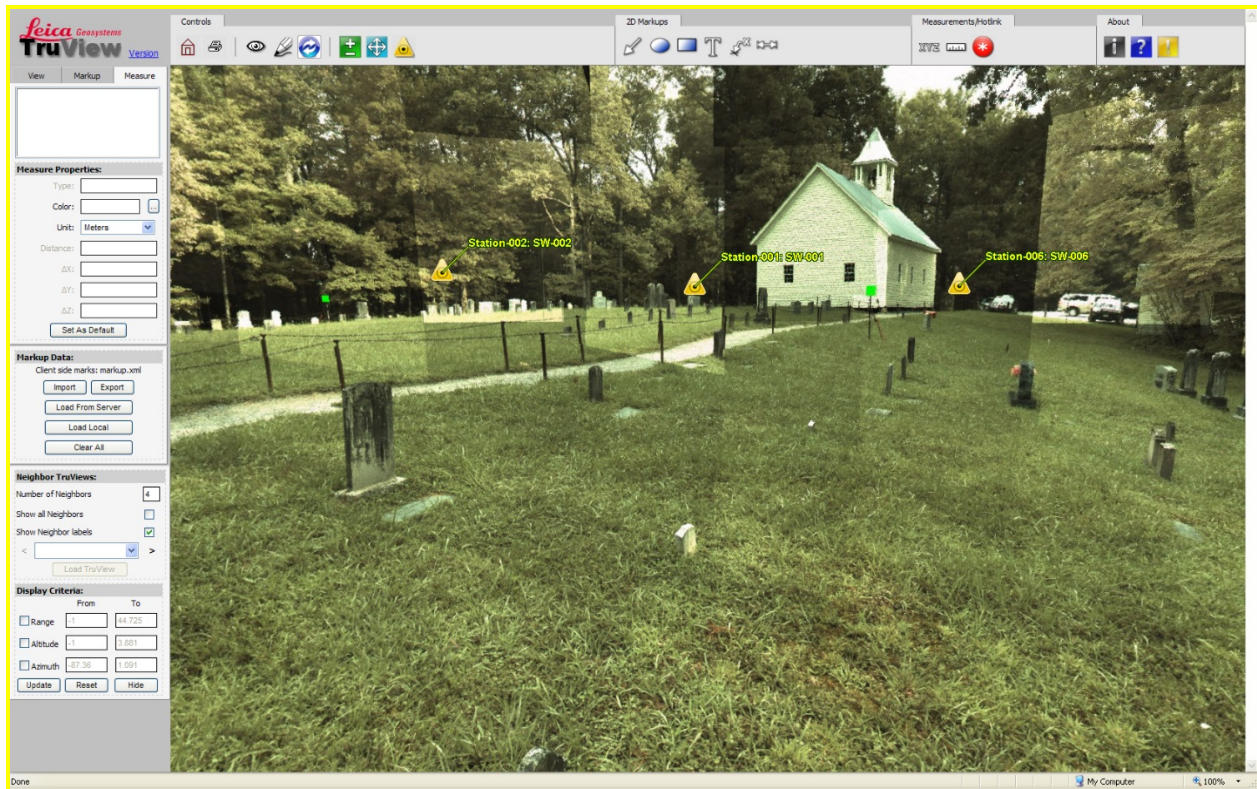


Plate 4. The imagery and point clouds that were collected by the high-def scanner permitted us to produce virtual ‘walk-throughs’ in each of the cemeteries. The scanner’s high-resolution camera captures each headstone with sufficient detail to read and document inscriptions on the monuments. Image shown using Leica TruView 3D Viewing software, Primitive Baptist Church and Cemetery. View is to the northwest.

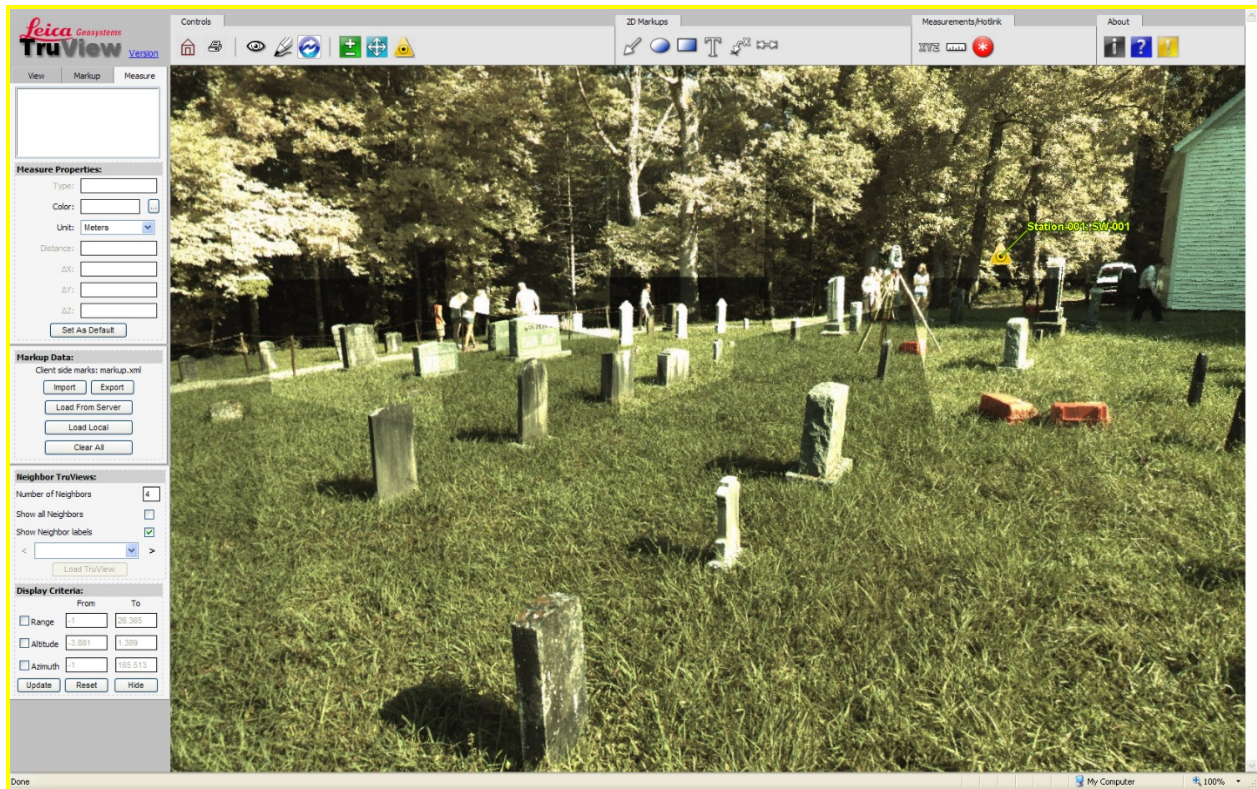


Plate 5. The high-resolution photogrammetry and high-density point clouds that were captured provided additional detail, accurate location, and superb documentation of all features in all directions in each of the three cemeteries studied. Image shown using Leica TruView 3D Viewing software, Primitive Baptist Church and Cemetery. View is to the northwest. Note Robotic Total Station used to collect marker positions and planimetric detail in background.

As a supplement to the marker survey and high-definition scanning, photographs of the front, back, and periphery of each marker were taken using the built-in camera onboard the Viva CS15 data Collector and were supplemented using a Canon PowerShot G5, used as a backup (Plate 6). In addition to archival purposes, photographing the individual markers was a necessary and easy means with which we could collect attribute information (names, dates of birth and death, etc.) for the GIS relational database. The attributes for all mapped features were then hyperlinked to each surveyed point using a unique identifier. A one-to-many cardinality between database tables permits association of multiple tables (with unlimited attributes) to individual points.

Ultimately, these data were mapped and modeled using the Geographic Information System (GIS) which allowed us to create charts, graphs, and highly detailed maps. As a final supplement, the survey information was stored in an ‘Enterprise’ level relational database management system (RDBMS), which allowed us to disseminate this information as a mapping service on the world-wide web, and as an application on mobile devices (Plate 7).



Plate 6. Dr. Vincent Gutowski photographs a flat headstone using the Canon PowerShot G5. All photographs of headstones, footstones, and corner markers were hyperlinked to the precision point data collected by the Robotic Total Station. This permitted easy retrieval of the photographs and associated attributes by simply clicking on the data points in the GIS. Cades Cove, TN, Methodist Cemetery.

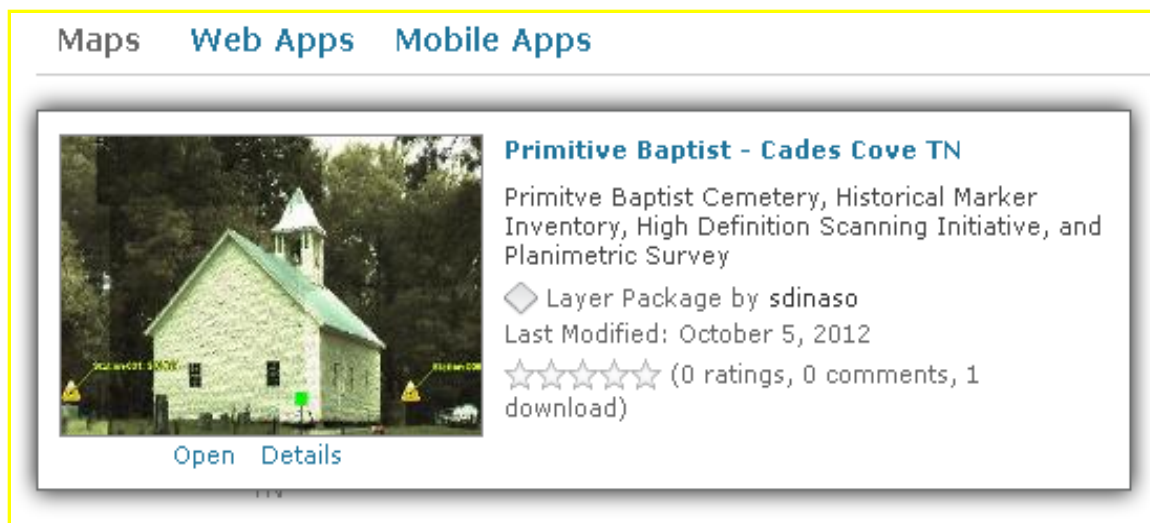


Plate 7. EIU ArcGIS Online – Cades Cove Cemetery Data

The surveys conducted represent a new and accurate assessment of the Primitive Baptist, Methodist, and Missionary Baptist cemeteries of Cades Cove. Moreover, the ability for the public, research professionals, and park staff to interact with these data visually, dynamically, and interactively, presents a new approach to historical preservation and modelling in Cades Cove, and in other U.S. National Parks. We compared our surveys to those conducted using alternative methodologies, and concluded that the resolution of these data was significantly better than any of the earlier inventories (Figure 3).

Equipment used in the surveying of these cemeteries included two Leica Viva GS12 Dual Frequency GPS receivers, a Leica TS 15 Robotic Total Station with a Viva CS15 controller, a Leica ScanStation C10 High Definition Laser Scanner, a Panasonic ‘Semi-Rugged’ CF-52, and CF-19 ‘Fully-Rugged’ Toughbook computers, and a Canon PowerShot G5.

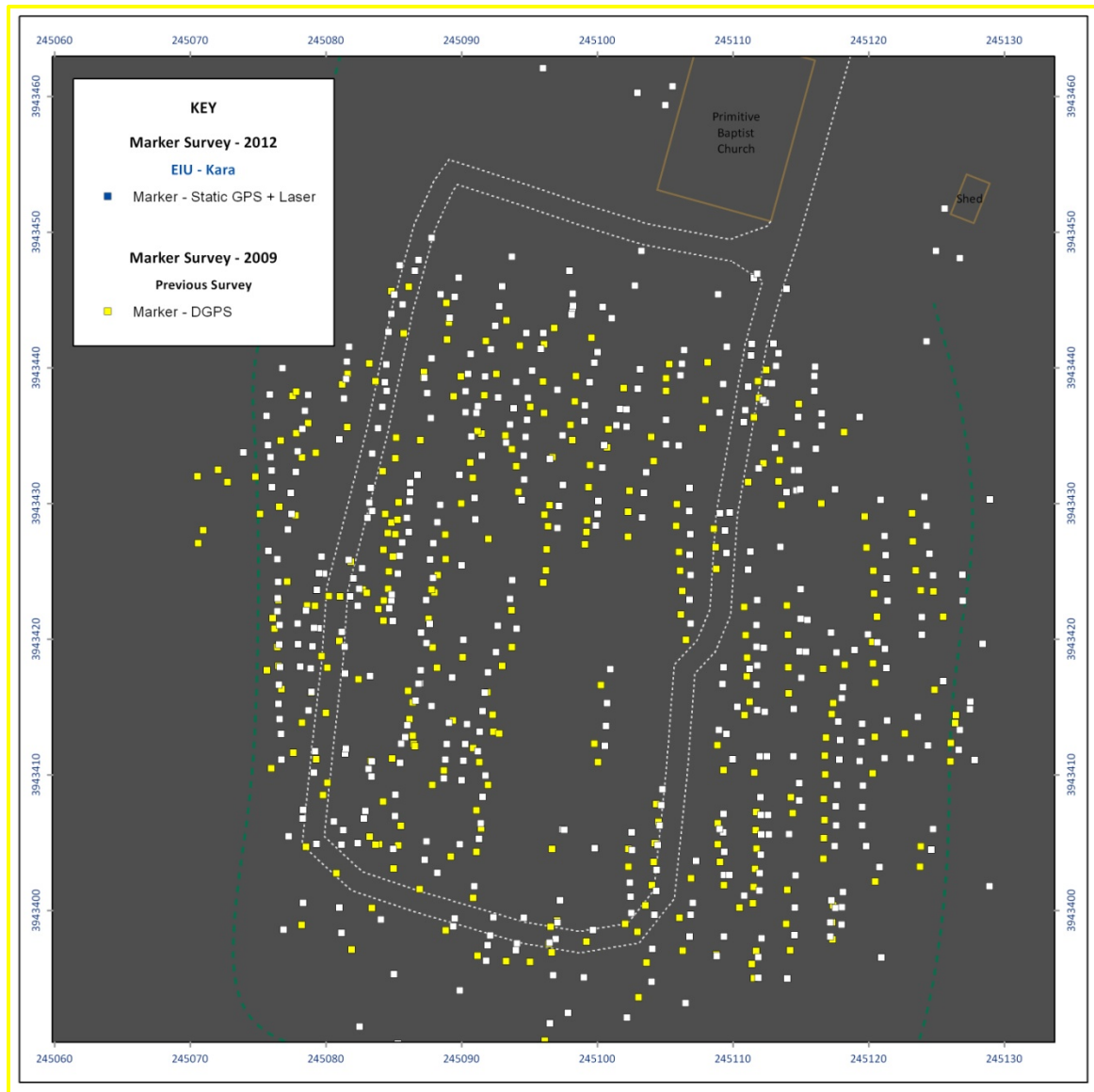


Figure 3. Comparison of the previous marker survey (2008, yellow) with the recent marker survey and planimetrics collected with the improved methodology (2012, white). Note the more precise positioning and linearity of the headstones collected in the 2012 survey in comparison to the ‘wandering,’ often non-linear, patterns in the survey data documented previously. The positioning error introduced in the earlier surveys was likely the result of GPS multipath errors produced when the GPS signal is reflected off nearby objects such as trees and large structures. This is particularly evident in the previously collected data in areas along tree lines where multipath errors are expected to be the greatest. Weak / absent signals also resulted in poor positioning.

PRIMITIVE BAPTIST CEMETERY

Permit #: GRSM-2012-SCI-1120

United States Department of the Interior, National Park Service

GREAT SMOKY MOUNTAINS NATIONAL PARK

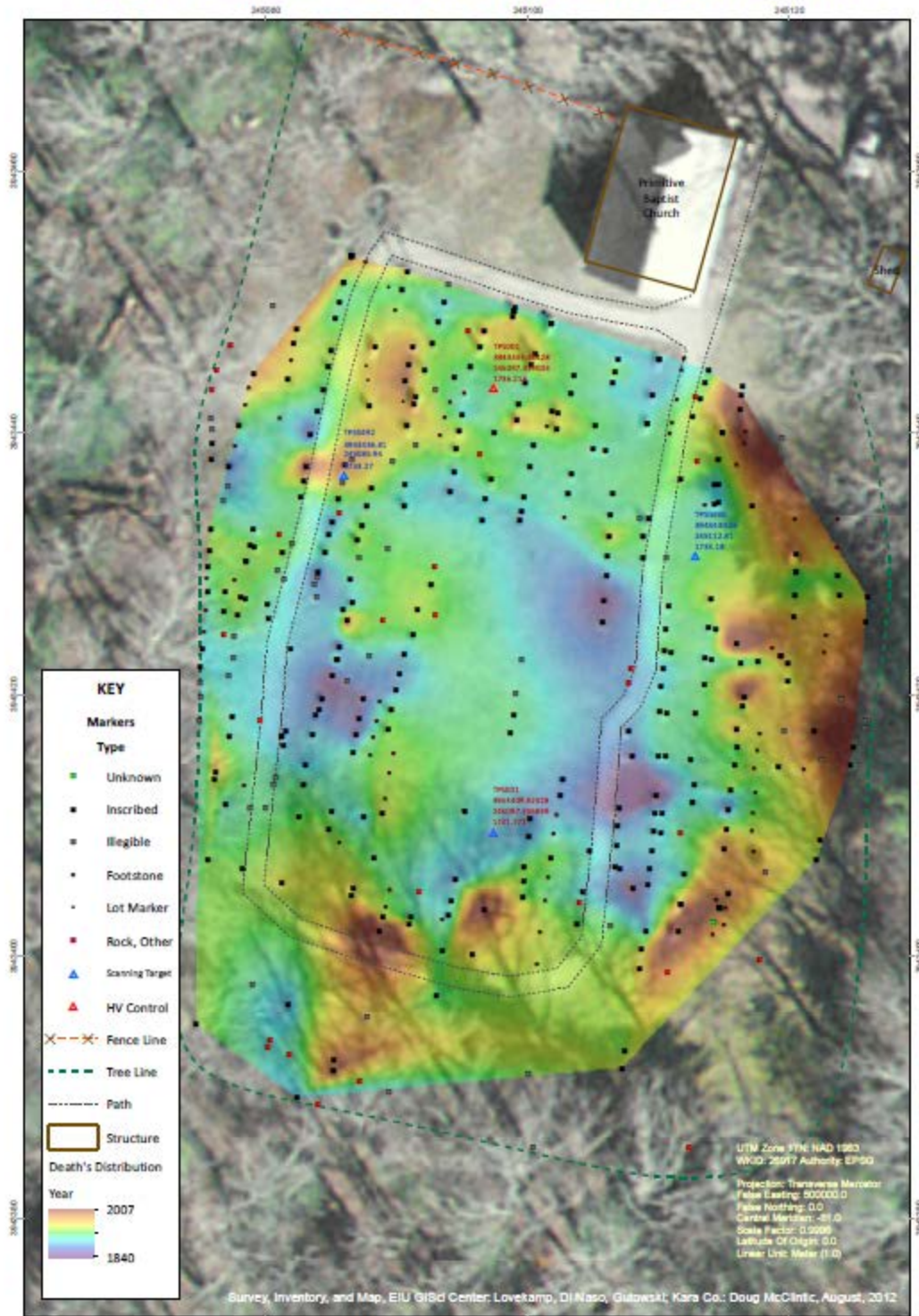


PRIMITIVE BAPTIST CEMETERY

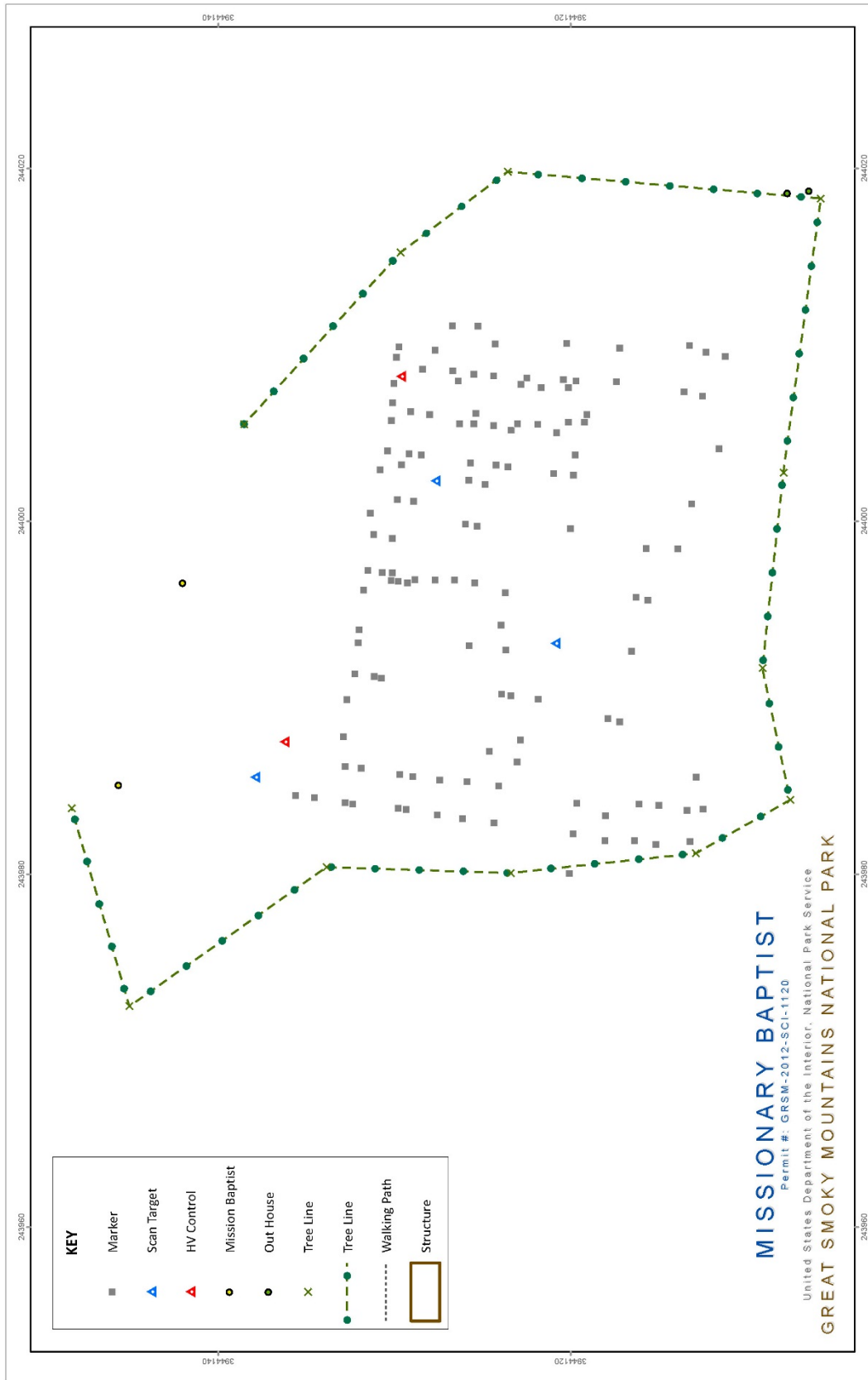
Permit #: GRSM-2012-SCI-1120

United States Department of the Interior, National Park Service

GREAT SMOKY MOUNTAINS NATIONAL PARK



Interment History - Year of Death 1840 -2010

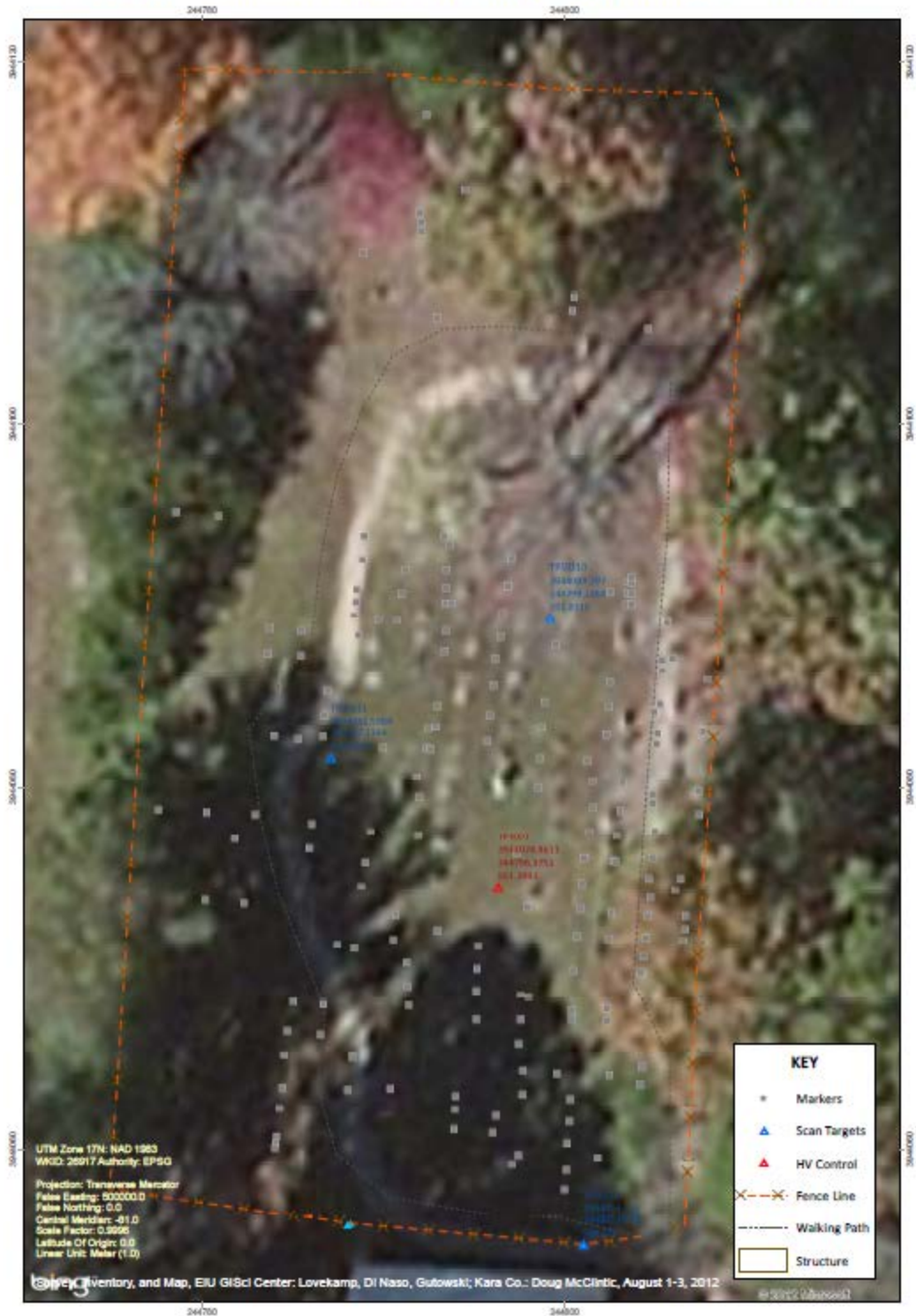




METHODIST CEMETERY

Permit #: GRSM-2012-SCI-1120

United States Department of the Interior, National Park Service
GREAT SMOKY MOUNTAINS NATIONAL PARK



ⁱ The early settlers are the ones who really made Cades Cove a special place, an endearing place. Had they not come and cleared the valley floor of its forests, those promontories would not be seen and would not be named. That is part of the debt of gratitude to those early settlers that is owed, and it is a debt that is partially repaid with each visit of wonder and appreciation.

ⁱⁱ Dunn, 1988, p.254.

ⁱⁱⁱ Dunn, 1988, p.252.

^{iv} The establishment of the Mammoth Cave National Park on July 1, 1941, also involved the mechanism of condemnation, and while most of the cemeteries still allow descendants of the residents to be interred, the associated churches and their communities were not preserved.