

# Digitizing Ancient Muir Woods

Entering Firm: GEO1 | Hawthorne, California

Muir Woods | Northern California

Clients: The Earth Archive | Fort Collins, Colorado; USGS | Menlo Park, California

July 2021

*GEO1 recognizes that the scope area for this project, Muir Woods National Monument, encompasses land that was historically inhabited and unceded by the Coast Miwok people. We honor the Coast Miwok community, their ancestors, and the enduring ties they hold to this land.*

## Objective

In the summer of 2021, GEO1 acquired lidar, RGB, and NIR imagery of the Muir Woods National Monument. The endeavor was planned and executed in partnership with The Earth Archive, who will receive the data at no cost to support their ultimate goal of lidar scanning areas around the world. Additionally, the data will be donated to USGS to be incorporated into their 3DEP database and made publicly accessible for download and independent analysis.



## Technical Details

The project deliverables include lidar data upwards of 300 ppsm, as well as 150 megapixel RGB/NIR imagery that will be used to create 4-Band data. The data was acquired with a multi-sensor pod housing a Riegl VUX240 lidar sensor, an Applanix AV610 IMU, and an Applanix AV39 Antenna. It was then processed by BayesMap using Wavex and StripAlign. The pod also included four Phase One IXM-RS150F cameras positioned in distinct oblique angles, and one Phase One IXM-RS150F 4-Band camera in a nadir position.



## Consultants

GEO1

The acquisition was managed by Phil Carter, Aerial Systems Director for GEO1. GEO1 operators Kainalu Chun and Gray Mitchell acquired the data in a Bell 206L3 helicopter provided by Mercury Aviation with pilot Coyt Bailey.



Partners

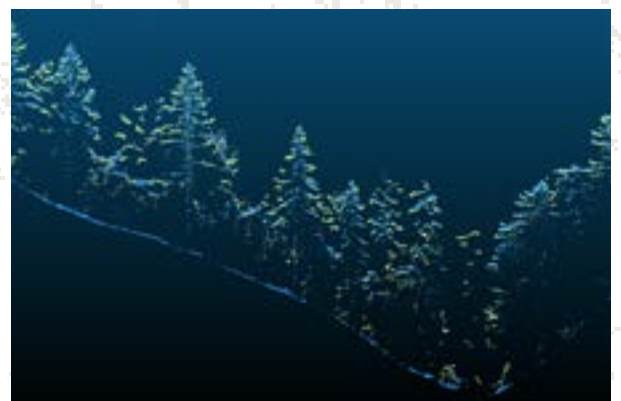


## Clients

The Earth Archive and USGS

GEO1 delivered the data to The Earth Archive, a non-profit group dedicated to digitally archiving the world's most endangered areas for preservation and scientific study. The data will also be contributed to the USGS 3D Elevation Program (3DEP), as part of the organization's effort to acquire and consolidate high resolution lidar data of the entire nation.

The data will first be visualized on an online platform powered by Voxelmaps, then uploaded to the USGS 3DEP database. The Voxelmaps platform offers the capability to perform AI-driven data analysis at an individual tree level. Potential uses of this data, as well as the project's larger message of conservation and public education, align with the goals and objectives of the National Park Service, which granted GEO1 permission to obtain the data.





## Innovation

Flight restrictions and hazardous weather conditions added several days of delay to the overall project timeline. Careful planning ahead of time allowed for the GEO1 acquisition team to select a base close to the scope area, allowing them to safely land during inclement weather and rapidly deploy as soon as favorable flight conditions were observed.

Flight paths were strategically planned with NPS and USGS representatives to account for various limitations and requirements. Flight altitude needed to be high enough to minimize disruptions to local wildlife and park visitors. The project occurred during nesting season, and birds of prey have been observed to be especially sensitive to aircraft flying overhead.

*"The whole wilderness seems to be alive and familiar, full of humanity." - John Muir*

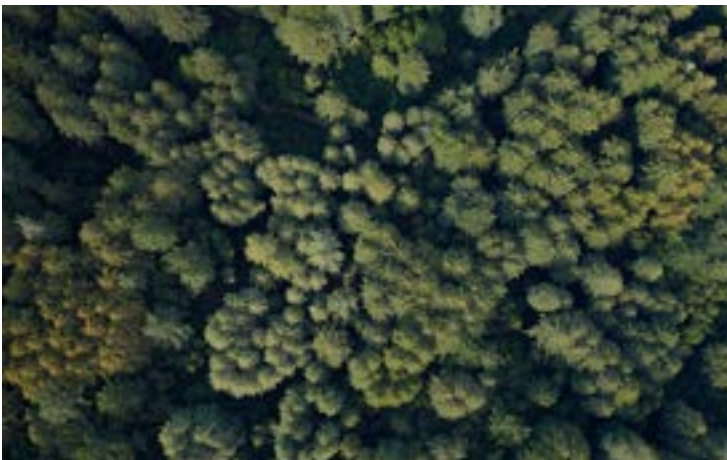
## Site Significance

Muir Woods National Monument is an old growth Coast Redwood forest just north of San Francisco, California.



Before its integration into the National Park System, Muir Woods was actively managed by the indigenous Coast Miwoks, who lived off of the land and served as its primary caretakers. Insufficient historical records and scientific research offers us a limited understanding of their lifestyle and relationship with the environment. The data collected by GEO1 has the potential to reveal remnants of indigenous infrastructure and lifestyle, help formulate theories of the extent and success of forest management activities like prescribed burns, and indicate the ecological impact of the absence of indigenous populations in the area.

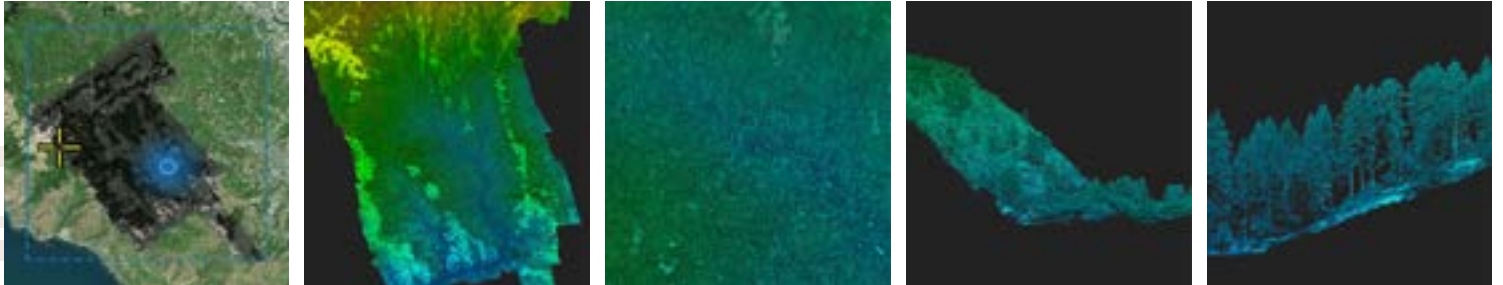
Muir Woods is one of the most treasured areas in the US National Park System. The forest is one of the last remaining sites of old growth Coast Redwoods, a once abundant tree species native to California, known for being some of the oldest and tallest trees in the world. The site is also iconic for its roots in the early American conservation movement. The land was the first to





be incorporated into the National Park System by a donation from private individuals — symbolizing the steadily increasing appreciation and support for the natural environment among the American public. An accurate forest inventory and archive of this forest would enhance scientific studies and ensure the preservation of an incredibly rare ecosystem and a historically rich site.

### Project Significance



Lidar data was processed by BayesMap, and will be hosted on an online platform by Voxelmaps. An endless range of analytical capabilities offered by Voxelmaps and independent researchers can be utilized with this dataset to enhance forest management practices and deepen existing scientific understanding of the ecosystem. Participation in this project from a variety of groups in the geospatial industry, as well as federal organizations, reveals the importance of collaboration to advance common educational and environmental missions.

Traditional methods of data collection to produce forest inventory data involves manually producing datasets from sample plots across the area of interest. Accurate readings of some tree specific metrics have, until recently, only been collected by climbing the trees. In areas such as Muir Woods, inaccessible and heavily forested terrain can mean the process is prohibitively laborious and time intensive, preventing the collection of immensely valuable data. The first trees in Muir Woods to be climbed and surveyed for height and age were in 2014, which revealed the tallest Redwood tree in Muir Woods to be less than 800 years old.

For a species that has been observed to be thousands of years old, this relatively young tree reshaped existing perspectives of the forest's profile, growth, and ecological history.

This groundbreaking observation demonstrates the power of tree-specific data for forest research. GEO1's recent acquisition of data demonstrates an efficient and cost-effective method to produce data at the individual tree-level, dramatically improving the accuracy and depth of existing forest studies.

With this data, scientists can reliably produce key measurements such as tree counts, height, volume and biomass calculations. Tree specific measurements are coupled with coordinates of each tree derived from AI based classification. These data points can be used to develop a comprehensive forest inventory, with accurate metrics and visuals of each tree in the area. High resolution data of the full tree column, including understory growth and canopy assessments, can be used to form accurate models for fire behavior, while a DEM produced with lidar can be used for watershed analysis.

These measurements are integral in producing an accurate assessment of forest health and growth, and can be used to inform efforts related to forest maintenance, public recreation management, and wildfire mitigation. Furthermore, this project demonstrated the efficiency and reliability of wide area lidar acquisition, suggesting the feasibility of producing a digital archive of trees on a much larger scale.

