

Canopy Mortality Mapping in Marin and San Mateo Counties

Background

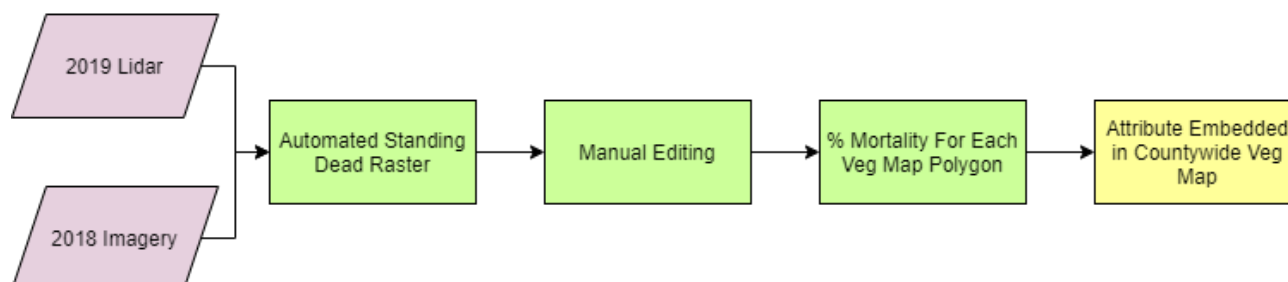
In June of 2021 the [Tamalpais Lands Collaborative](#) (One Tam) [completed](#) the first-ever countywide fine scale vegetation map and landscape database for Marin County, largely based on the standards developed by the California Department of Fish and Wildlife Vegetation Classification and Mapping Program ([CDFW VegCAMP](#)). In April of 2022, a similar project was [completed in San Mateo County](#) led by the [Golden Gate National Parks Conservancy](#) along with many other partners including the National Park Service, Midpeninsula Regional Open Space District, County of San Mateo, Peninsula Open Space Trust, and others. These projects have spurred additional similar ongoing efforts around the region, including in Santa Cruz, Santa Clara, Alameda, and Contra Costa counties.

Partners in both the Marin and San Mateo projects worked with the consulting team of [Tukman Geospatial](#) and [Aerial Information Systems](#) (AIS) to add canopy mortality mapping of forested stands into the fine scale vegetation map GIS deliverable. This work built upon similar efforts previously done between [2005 and 2015 by Marin Municipal Water District](#) as part of an effort by that agency to detect and track the impacts of *Phytophthora ramorum* in forests and woodlands on Mt. Tamalpais Watershed Lands.

Current Methods

In Marin and San Mateo, the project team mapped canopy mortality (standing dead trees), primarily in forest and woodland stands. These methods are detailed in the fine scale vegetation mapping final reports for both [Marin](#) and [San Mateo](#) counties. Countywide standing dead vegetation was mapped using semi-automated techniques that combine automated object-based image analysis with manual photointerpretation. Standing dead forest areas were mapped using 2018 high resolution countywide imagery and available lidar data. Object based image analysis resulted in a 1-meter raster of living v. dead areas. The resulting map of standing dead was integrated into the forest and woodland stands of the fine scale vegetation map, and each forested stand was assigned a value representing the percentage of the woody canopy over 7 feet tall that was standing dead in 2018. AIS manually edited the percent dead assignments up or down based on expert image interpretation, adjusting the attribute upward where automated techniques underestimated standing dead and adjusting the attribute downward where automated techniques overestimated standing dead area (Figure 1)

Figure 1 - Basic workflow diagram, percent mortality mapping in Marin and San Mateo counties.



The resulting percent mortality attribution reflects the state of the landscape in June 2018 when the imagery was collected. Some qualifications and specifications for the standing dead data product are:

- Standing dead mortality applies to woody vegetation greater than or equal to 7 feet in height. Standing dead areas include entire tree crowns and parts of tree crowns that have died back.
- Each vegetation map polygon receives a percent of the polygon that is standing dead. This number was calculated as the area of the polygon over 7 feet in height that is dead, divided by the total area of the polygon over 7 feet in height.
- Living vs. dead is defined by the presence of green leaves as viewed from above in the summer, 2018 high resolution imagery. It is possible that some areas mapped as dead could be trees defoliated by insects or fire in 2018 that regrew their leaves in the summer 2019 growing season.
- *Note that this product does not provide species-specific mortality information.* In a stand with 5% mortality labeled *Sequoia sempervirens* alliance in the vegetation map, for example, the dead trees may include a mix of hardwoods and this product does not include details on the species of the dead trees *or the cause of canopy mortality*.
- Standing dead was assigned to forested stands in increments of 1%. In San Mateo County, stands where one or more standing dead canopy tree was present, but the standing dead was less than 0.5 percent, the stand was assigned a value of 'Present' for the attribute called SD_PRESENCE. This attribute is meant to capture stands where standing dead trees were present but represented less than 0.5 percent of the canopy over 7 feet.

Results

Figure 2 below shows the results of canopy mortality mapping in Marin County. While pockets of canopy mortality are present throughout the county, areas of concentrated canopy mortality include Mt. Tamalpais Watershed where impacts of *Phytophthora ramorum* (sudden oak death) have shown concentrated mortality, and areas with *Fusarium circinatum* (pitch canker) impacts. Figure 3 shows the distribution of percent canopy mortality across forest types in the Marin countywide fine scale vegetation map.

In San Mateo County (Figure 4), incidence of canopy mortality is scattered throughout the northern end of the Santa Cruz Mountains in mixed hardwood and conifer stands, which could potentially indicate the extent of *P. ramorum* impacts to *Notholithocarpus densiflorus* (tanoak) and other susceptible tree species in that region. Other notable species with concentrations of mortality include several *Pinus* alliances/associations as well as some riparian forest types. Figure 5 shows the distribution of percent mortality across forest types in the San Mateo countywide fine scale vegetation map. Notably, some areas of concentrated canopy mortality fall within the 2020 CZU Lightning Complex Fire footprint.

Next Steps

Percent canopy mortality mapping can be a useful metric for land managers and researchers wishing to stratify monitoring or sampling locations, conduct field investigations, and track changes over time. As part of the [Marin Regional Forest Health Strategy](#), the One Tam collaborative is using mortality indices as an input into modeling designed to help managers design and prioritize forest health and resiliency projects. Similar canopy mortality mapping will be a component of fine scale vegetation mapping in Santa Cruz and Santa Clara Counties led by the [Santa Cruz Mountains Stewardship Network](#).

Figure 2 - Percent canopy mortality mapping, 2018 Marin countywide fine scale vegetation map. Available at PacificVegMap.org

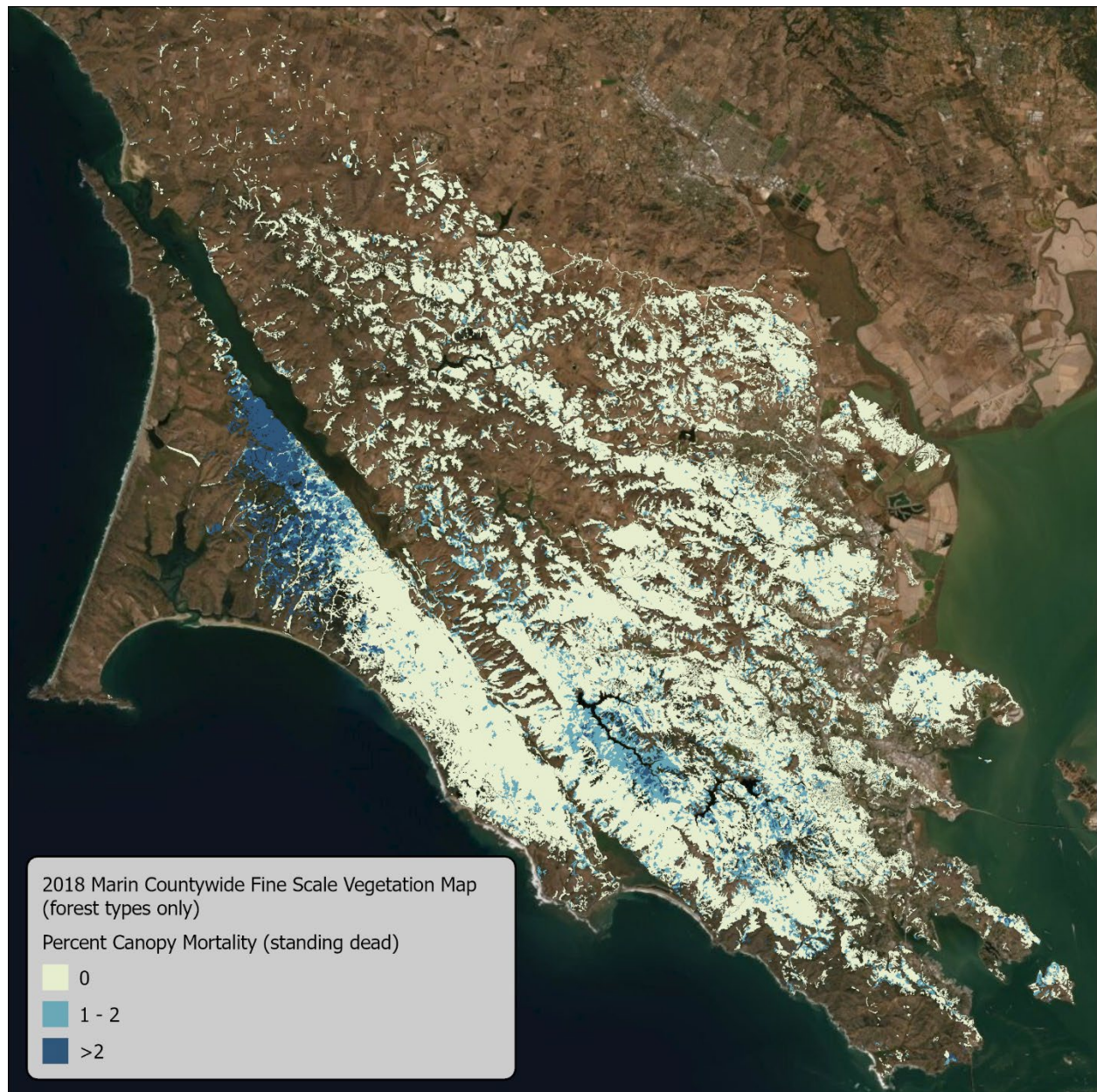


Figure 3

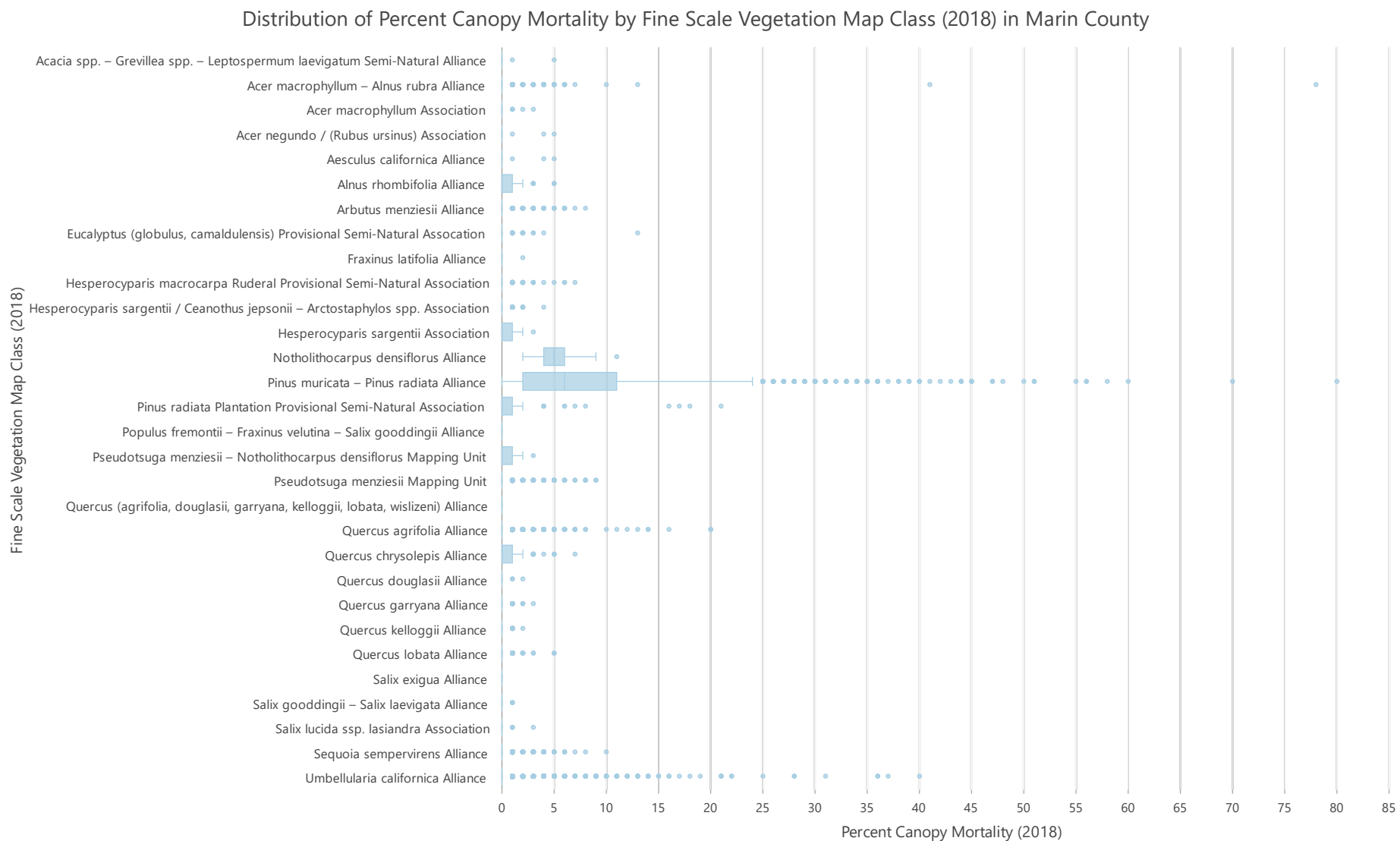


Figure 4 - Percent canopy mortality mapping, 2018 San Mateo countywide fine scale vegetation map. Available at PacificVegMap.org

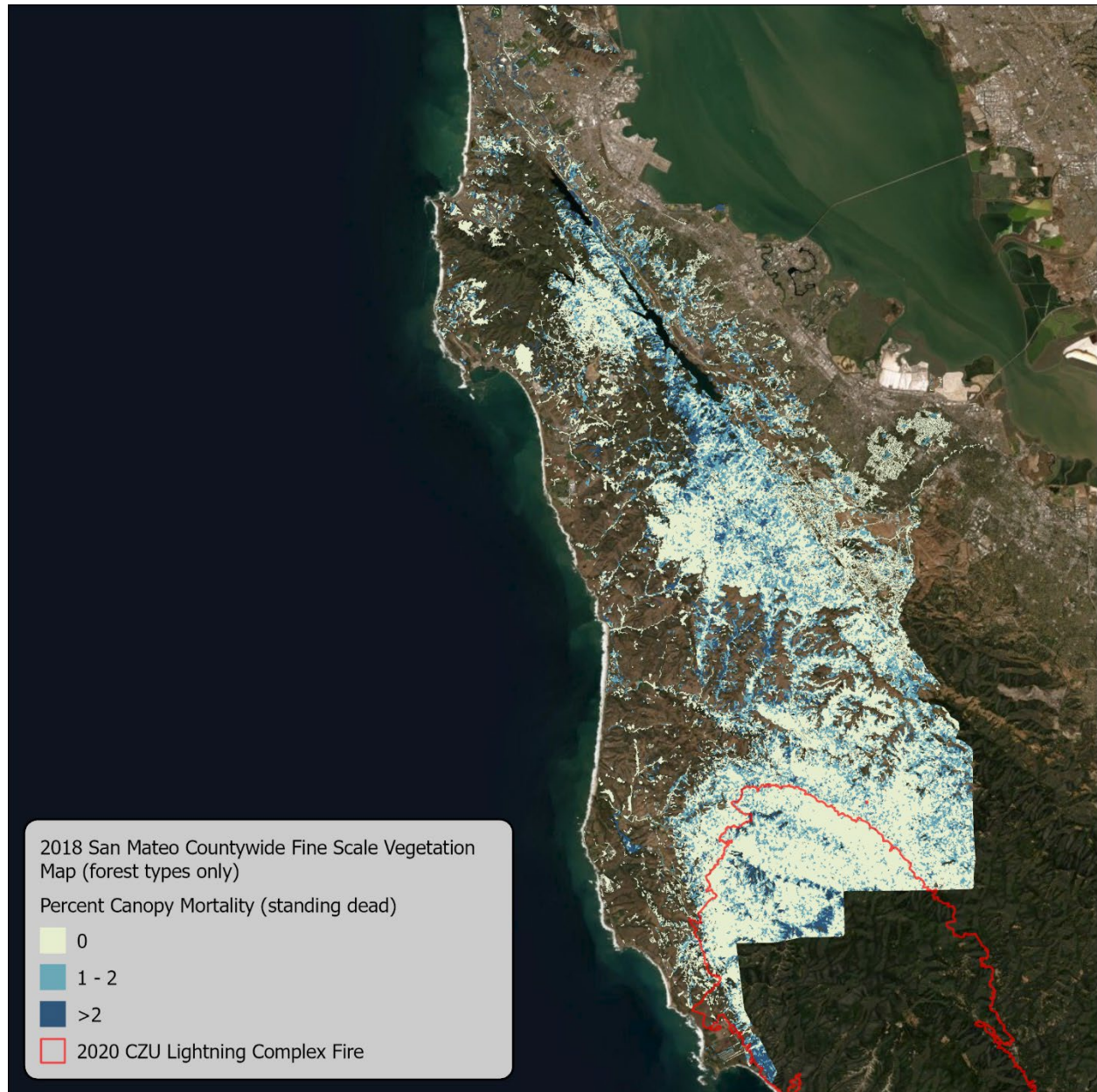


Figure 5

