

Multi-scale Data to Assess and Monitor Sudden Oak Death¹

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The USDA Forest Service (FS) and California Department of Forestry and Fire Protection (CDF) are monitoring Sudden Oak Death (SOD) under the umbrella of the larger California Land Cover Mapping and Monitoring Program (LCMMP). The LCMMP is a statewide cooperative effort among the FS and CDF focused on mapping and monitoring California's vegetation and land cover.

Under the LCMMP the FS and CDF conduct change detection as a basis for monitoring and for identifying land cover change across all ownerships. This program has successfully used satellite imagery and change detection techniques to map and monitor changes in vegetation due to drought-induced insect mortality, fire mortality and subtle changes due to selective harvest methods. The current project has been easily adapted under the larger program to identify oak mortality, potential SOD areas and develop a basis for establishing a monitoring program for SOD.

The distribution of SOD in California might stretch from the Oregon border to Monterey County, however, to date there are 10 counties confirmed with SOD. These 10 counties are included in the project area that spans Humboldt County in the north to Monterey County in the south.

The objective of the SOD project is to use multi-scale remotely sensed data to identify "hot spots" of oak mortality, and verify these areas with a combination of airborne imagery, aerial surveys and field verification. Given the size of the affected land area, detection and monitoring SOD would not be practical without the use of remotely sensed data.

Landsat Thematic Mapper (TM) satellite imagery was acquired for two time periods, July 1994 and May 2000, to detect changes in oaks and develop a base from which to identify and map oak mortality. Land cover changes are derived from the TM imagery, employing a multi-temporal Kauth-Thomas transformation. This process produces three components, a greenness component, brightness component and wetness component. These components portray subtle differences in land cover. If a group of trees experienced mortality during the 1994 and 2000 timeframe it would be indicated in the levels of greenness, brightness and wetness, possibly less wet and green, and more bright. Vegetation data is used to stratify the brightness,

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greenness, wetness image into lifeform and change. Unsupervised image classification is performed and each resultant class is placed into a particular change class, according to its level of change.

Areas depicting large decreases in change were evaluated with existing fire history and stand history data. Areas of small decrease were further evaluated to determine the potential for change due to oak mortality. Vegetation layers, spectral reflectance values, comparison to aerial imagery from known SOD affected areas, and other ancillary data were used to assist in this labeling process. If mortality due to SOD was suspected, the class was then labeled as potential SOD. Because of the possibility that areas of potential SOD might be eliminated during an aggregation process this particular class has been left at the pixel level. Additional remotely sensed data of various scales including two-meter digital camera imagery were acquired from flights over affected counties and adjacent areas. Digital camera data in conjunction with the satellite imagery were analyzed to identify the extent of oak mortality. Each photo was examined for signs of hardwood mortality that could not be attributed to known cause. Areas of potential SOD were compared to the digital camera data for further confirmation of mortality. In areas of confirmed SOD the digital camera data provided a valuable reference tool and allowed for a more detailed assessment of both the visual appearance of SOD, as well as the extent of the mortality. As a final step in the validation process an accuracy assessment will be performed.

Aerial surveys provide another means for detection, monitoring and calibration, and discrimination of various spectral reflectance values important to image classification. The surveys were conducted from a fixed-wing aircraft over a period of three days using a crew of two and a pilot. Approximately 10 million acres of California's coastal hardwood rangelands and mixed hardwoods were surveyed. Mortality areas were identified visually, sketch mapped, and photographed on 35mm color film. A handheld global position system (GPS) was used on the aircraft to record the flight line and pinpoint potential SOD sites. The GPS line and point data were exported to aid in creating a geographic information system (GIS) coverage of mortality areas. The combination of GPS, photography, and detailed notes were used to map and characterize potential areas of mortality. Field verification is currently being performed to confirm or refute presence of the disease and evaluate the accuracy of the survey and change data.

This collaborative effort is essential to a low-cost, long-term monitoring and sampling strategy for SOD. These data are prerequisite for identifying future management opportunities that include allowing for more focused field efforts, acquiring future data more efficiently and providing a critical look at current SOD related mortality conditions. The resultant maps will provide a baseline for future monitoring efforts and may streamline field confirmation of areas affected by SOD.