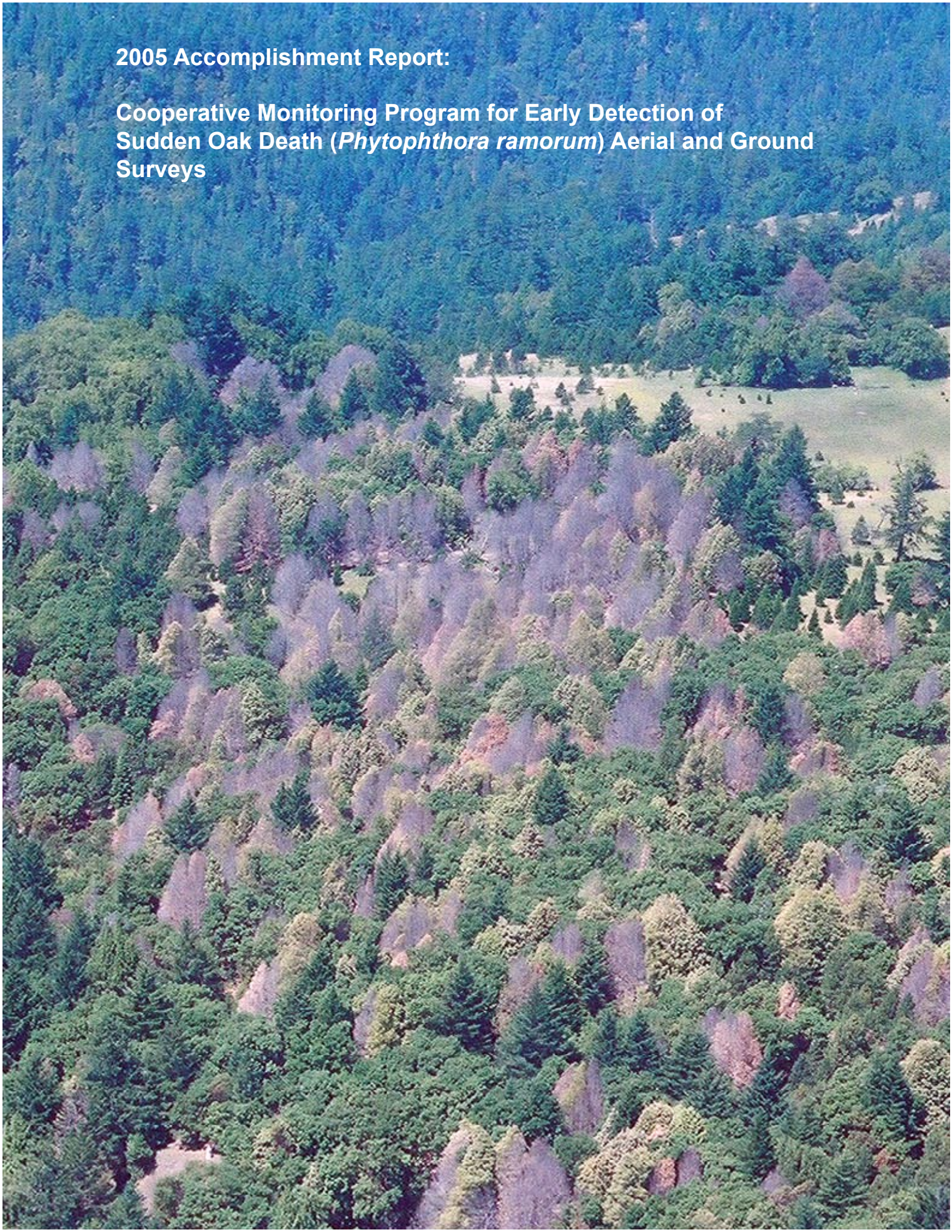
2005 Accomplishment Report:

Cooperative Monitoring Program for Early Detection of Sudden Oak Death (*Phytophthora ramorum*) Aerial and Ground Surveys



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Cover: Oak mortalty caused by *Phytophthora ramorum* on the Sonoma County coast; observed by helicopter in June of 2005. Photo: Mark Stanley

2005 Accomplishment Report: Cooperative Monitoring Program for Early Detection of Sudden Oak Death (*Phytophthora ramorum*) Aerial and Ground Surveys

Aerial surveys covering 23 California counties were conducted to map current host tree mortality and subsequently target ground-based sampling for early detection of *Phytophthora ramorum,* the cause of Sudden Oak Death. Areas surveyed coincided with much of the areas flown in previous years. The intent of this survey was twofold: 1) to document mortality that has spread from areas within known infested counties not mapped for several years, and 2) to continue efforts to detect *P.ramorum* within relatively high risk, currently uninfested, host habitats. This report will discuss 2005 accomplishments and look at how the disease has spread since our surveys began in 2001.

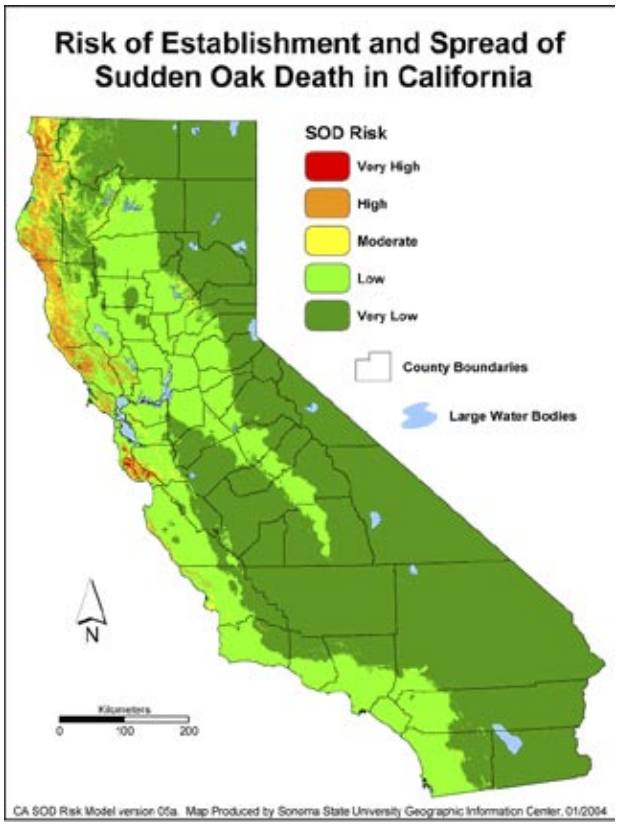

Figure 1—Statewide Risk Map (Meentemeyer, Sonoma State University) used to aid planning and implementation of aerial and ground efforts.

Targeted ground-based sampling was completed in seven counties in 2005. Findings include detection of *P. ramorum* in four new areas in Humboldt County, expanding the known infested area into two watersheds, Seely Creek and Salmon Creek. Other damage agents including *Phytophthora pseudosyringae and Phytophthora nemorosa* were confirmed resulting from fieldwork and tissue samples forwarded for lab analysis. *P. pseudosyringae* was recovered from seven locations sampled in 2005 and *P. nemorosa* was recovered from eight sites. Results from the 2005 ground survey indicate that the disease has yet to spread into San Luis Obispo county to the south or Del Norte county to the north, the two most likely counties for the disease to spread into based on habitat, climate and proximity to currently infested areas.

Objectives for the 2005 survey include:

- Conduct aerial surveys for the early detection of *Phytophthora ramorum* and map hardwood mortality in uninfested areas at risk of *P. ramorum*,
- Conduct aerial surveys to delimit areas of known infestation of *P.ramorum* (coinciding with delimitation survey completed in previous years) in Del Norte, Humboldt, Mendocino, Lake, Trinity and portions of Siskiyou, Napa and Sonoma in the north; and Monterey, San Benito, San Luis Obispo, Santa Barbara and portions of Santa Clara, Santa Cruz and Ventura counties in the south, and,
- Prioritize and ground check select mortality polygons from 2005 (and a portion remaining from 2004) to sample hosts for presence of *P. ramorum* and other *Phytophthora* including *P. nemorosa* and *P. pseudosyringae*.

Counties flown include SOD host types ranging from the “Moderately Low” to “Very High” risk categories based on the most current California Sudden Oak Death risk map by Meentemeyer, et. al. (2004) (Figure 1).

A multi-stage stratification was used to target field efforts including fixed-wing surveys to initially map hardwood mortality. Mortality polygons mapped from the air are stratified by the Meentemeyer et.al. California risk map (2004). In select areas helicopter flights are completed and use a hand-held GPS to better target hardwood mortality, making the field exercise more efficient. Several factors drive which areas

are flown with helicopter and include:

1. Number of trees mapped within a polygon during the fixed-wing survey,
2. Distance of newly mapped polygons from infested areas within regulated counties,
3. Unregulated counties adjacent to infested counties, and
4. Distance and flight time from helicopter fuel.

A digital sketch mapping system (DASM) is used on all fixed-wing flights to more precisely map hardwood mortality and to easily bring the data into a geographic information system environment. Fixed-wing flights initiated on May 25th, 2005 were completed July 1st, 2005 with an additional flight on August 24th 2005 in Humboldt county for a total of 14 flight days. Helicopter flights occurred on June 6th and 7th in the southern half of the project area and July 8th, 9th, and 19th in the northern half of the project area. Helicopter flights were completed over portions of San Benito, Monterey, San Luis Obispo, Santa Barbara, Lake, Mendocino, Humboldt, and Del Norte Counties.

An additional flight, funded separately and serving a duel purpose, was made over portions of Sonoma County on June 15th. The purpose of this flight was to provide researchers, congress, and representatives from CDF and USDA an aerial view of an area of interest where the disease is steadily spreading (Figure 2). The picture in Figure 2 shows how the disease is advancing within infected sites. Recent tanoak mortality is clearly visible near trees that died 3-4 years ago. *P.ramorum* is believed to have been vectored into this site via outplanting infected rhododendron nursery stock. Other areas of advancing mortality (source of infestations unspecified) were mapped 15-20 miles south of this site. We suspect that nearly all remaining host habitat to the south will be occupied by the disease within just a few years. The disease seems to be “marching” through the forest. North and east of the area photographed there exists vast areas of largely uninfested, high risk, forest.

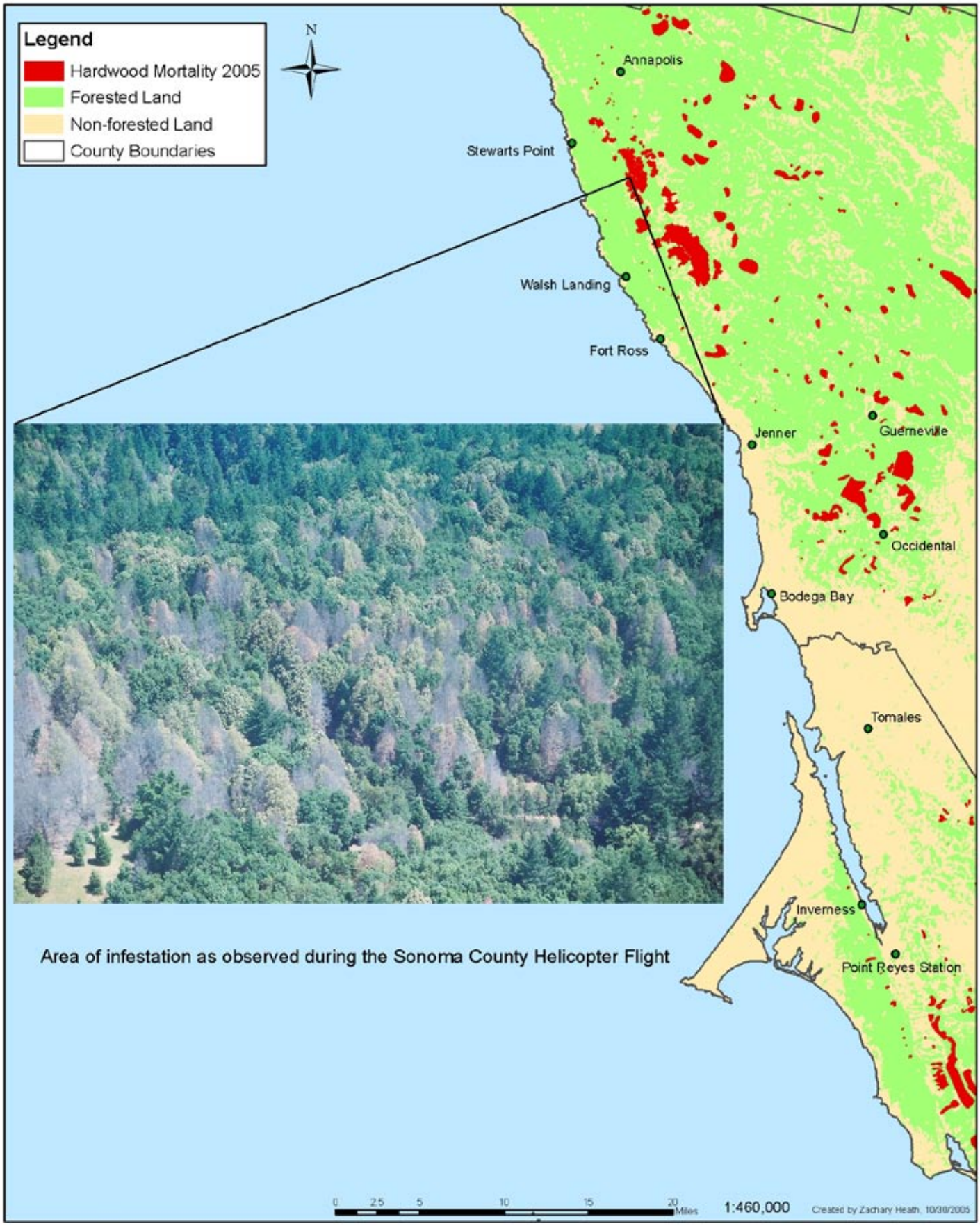

Figure 2. Area of *P. ramorum* infestation on private property along the Sonoma coast near Sea Ranch as photographed from the June 15th helicopter flight.

Figure 3. 2005 Flown area

County	Polygons Detected (2005 flights)	Acres Mapped (2005 flights)	Polygons Added from Helicopter (2005 flights)	Ground Checks (2004 Sites)	Ground Checks (2005 Sites)	Sites Sampled	Samples Positive *P. ramorum*	Samples Positive *P. nemorosa*	Samples Positive *P. pseudo-syringae*
Alameda	18	66	0	0	0	0	0	0	0
Contra Costa	10	88	0	0	0	0	0	0	0
Curry	0	0	0	1	0	1	0	1	0
Del Norte	10	76	0	6	4	7	0	1	0
Humboldt	165	3,718	7	31	47	59	10	6	4
Lake	1	6	0	2	1	1	0	0	0
Marin	97	11,783	0	0	0	0	0	0	0
Mendocino	127	1,869	0	2	0	2	0	0	0
Monterey	86	9,587	0	0	0	0	0	0	0
Napa	9	51	0	0	0	0	0	0	0
San Benito	14	32	0	0	2	0	0	0	0
San Luis Obispo	94	592	0	0	45	14	0	0	3
San Mateo	45	10,730	0	0	0	0	0	0	0
Santa Barbara	32	138	0	0	8	1	0	0	0
Santa Clara	50	11,812	0	0	0	0	0	0	0
Santa Cruz	43	7,812	0	0	0	0	0	0	0
Solano	10	75	0	0	0	0	0	0	0
TOTAL	**1006**	**81,258**	**7**	**42**	**107**	**84**	**10**	**8**	**7**

Table 1. Results from 2005 aerial and ground survey.

The total area aerially surveyed for the 2005 program included approximately 13.5 million acres across eight counties in the northern portion of the state and seven counties in the south (Figure 3). Approximately 9,250 miles were flown with a fixed-wing survey. Helicopter flights don't employ the use of DASM's so miles flown are not easily recorded. However, portions of eight counties were flown using helicopters.

Polygons mapped from the 2005 aerial survey indicating hardwood mortality in host tree species totaled 1,006. Helicopter flights mapped an additional seven polygons (Table 1).

Ground sampling was prioritized based on the following:

1. Proximity to confirmed infection,
2. Areas identified as "Very High" to "High" risk categories based on Meentemyer, et.al. (2004) risk map, in uninfested portions of infested counties, and,
3. High priority, uninfested counties including Del Norte and northern San Luis Obispo that are at "Very High" to "High" risk based on the Meentemeyer, et.al. (2004) risk map for California.

In 2005 there were 149 sites visited for ground sampling. Column 6 in Table 1 shows the total number of sites visited in 2005. It is important to note that many polygons are prioritized for ground visits but not all are visited in any one given year. This is due to a variety of constraints including denied access, inaccessibility due to downed trees, closed roads or inclement weather. Column 5 in Table 1 shows the number of sites carried-over from 2004 and visited in 2005.

Out of the 149 sites visited, 84 sites were sampled. Only symptomatic plants were sampled. Ten of the total sites sampled are positive for *P. ramorum* and located in Humboldt county. More importantly, 74 of the samples are negative for *P. ramorum*. Over the past 5 years sampling has become more intensive in Del Norte and San Luis Obispo counties (the counties on the northern and southern ends of the regulated and infested counties for P. ramorum) the results of this year's survey suggest that these counties remain "free" from SOD.

New confirmations in Humboldt County do expand the area of previously know *P. ramorum* infestation into two new watersheds, Seely Creek and Salmon Creek, presenting a challenge to local efforts to slow the spread of the disease into other important watersheds (Figure 4).

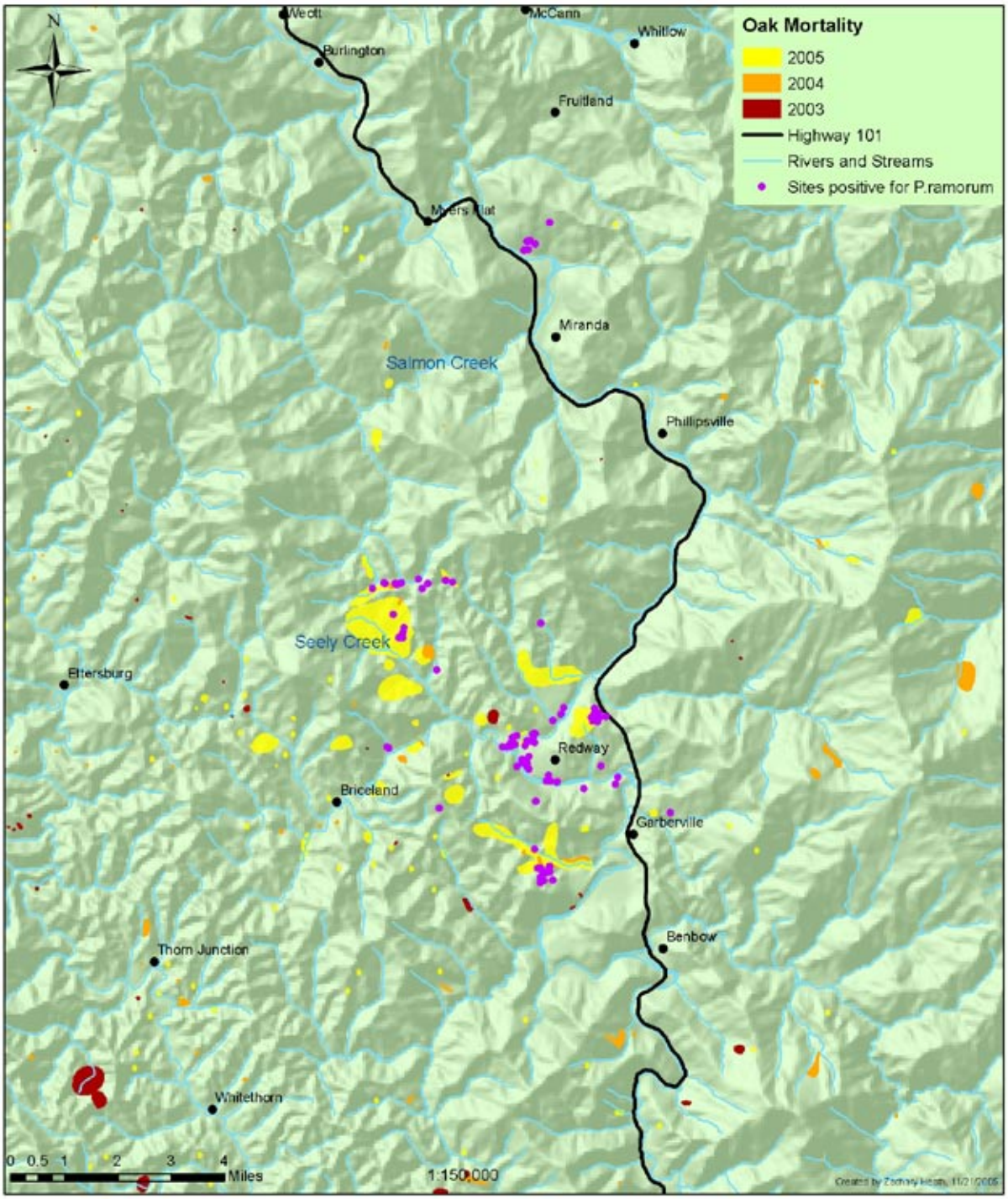

Figure 4. Mortality mapped in southern Humboldt County. Positive samples current to 12-12-05.

Mortality trends by host type are shown in Figure 5. Host type was determined visually during the aerial survey mapping. The trend, shown in Figure 5, suggests that SOD had initially affected coast live oak more than other host species in the past, but is now increasingly affecting tan oak.

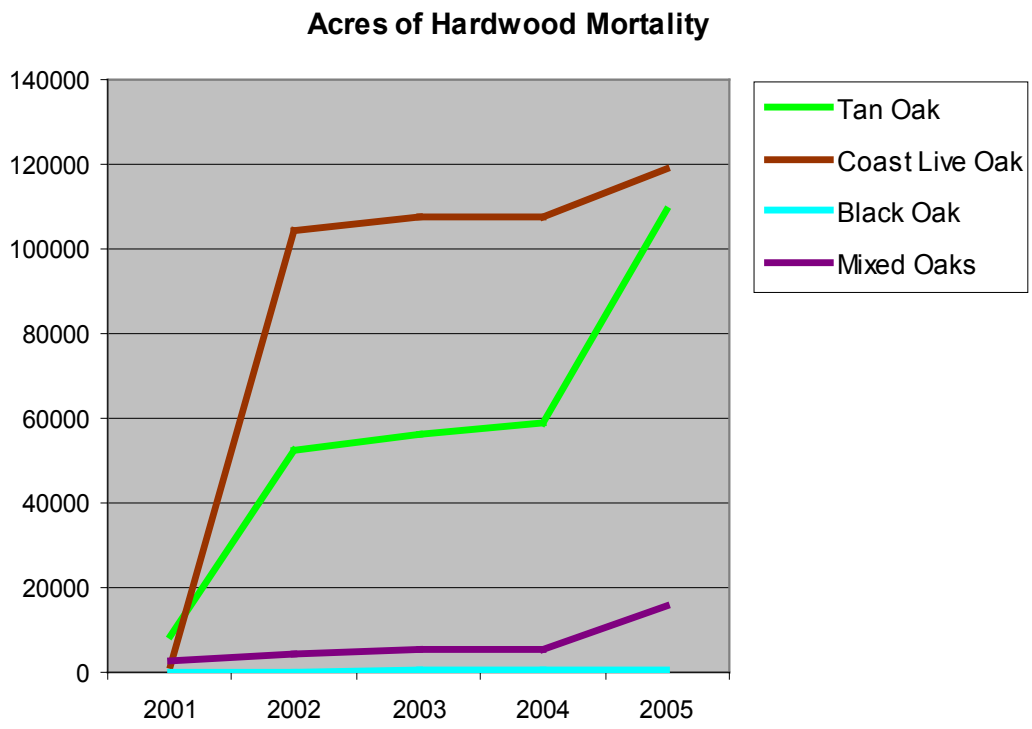

Figure 5. Hardwood mortality acres are added across all years. Host types were determined from aerial observation.

In order to corroborate the host species trends shown in Figure 5, the aerial survey polygons were overlaid onto statewide vegetation data (http://www.fs.fed.us/r5/rsl/projects/mapping/) and the surveyed polygon host type information was compared to vegetation mapped host type. The majority of the surveyed polygons containing oak mortality occurred in areas designated as vegetation classes that typically contain coast live oak or tan oak. A small amount of portions of the surveyed polygons fell in neighboring non-host vegetation classes, such as annual grassland, which could contain coast live oak and/or tan oak. More polygons that were mapped as coast live oak had a greater chance of containing non-host types such as grassland, due to the fact that live oak tends to not form dense stands. Figure 6 below shows this phenomenon.

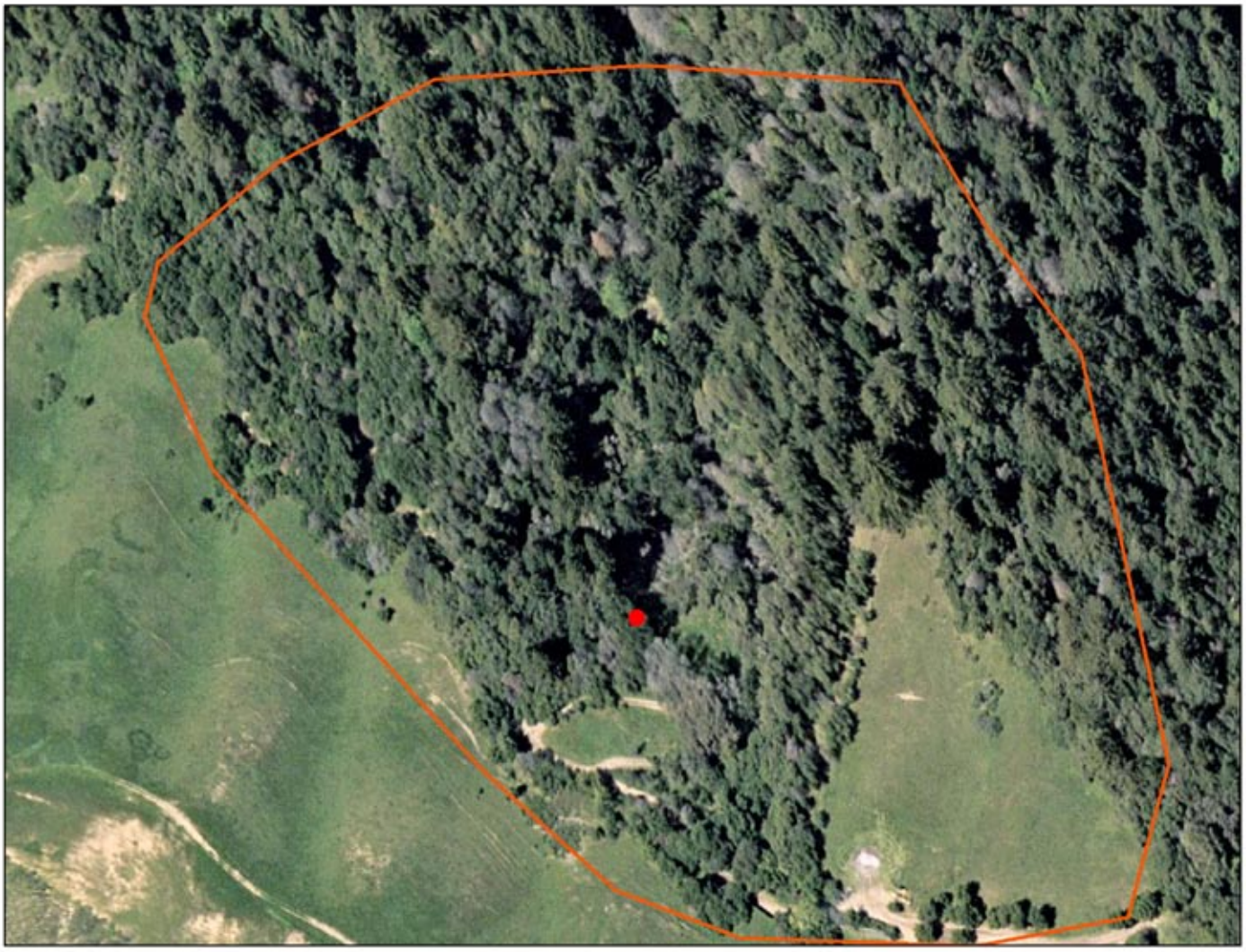

Figure 6. Hardwood mortality in the Big Sur region.

This stand of dead and dying coast live oak and tan oak is shown overlayed with an aerial survey polygon (orange) mapped in 2005 in the Big Sur region. Note that the polygon does contain some non-host habitat (grassland). The red dot represents a sampling site that tested positive for *P. ramorum*.

Figure 7 displays the trend in Marin and Sonoma Counties. In 2001 and 2002 hardwood mortality was observed primarily near urban areas within coast live oak and mixed hardwood host types (predominantly canyon live oak with tan oak, black oak, and coast live oak components). Results from the 2005 survey show that SOD is increasingly impacting the tan oak host type. Figures 8, 9, 10 show very little new mortality in the coast live oak and mixed hardwood host types of coastal counties. These results suggest that SOD is spreading along coastal areas as opposed to spreading inland.

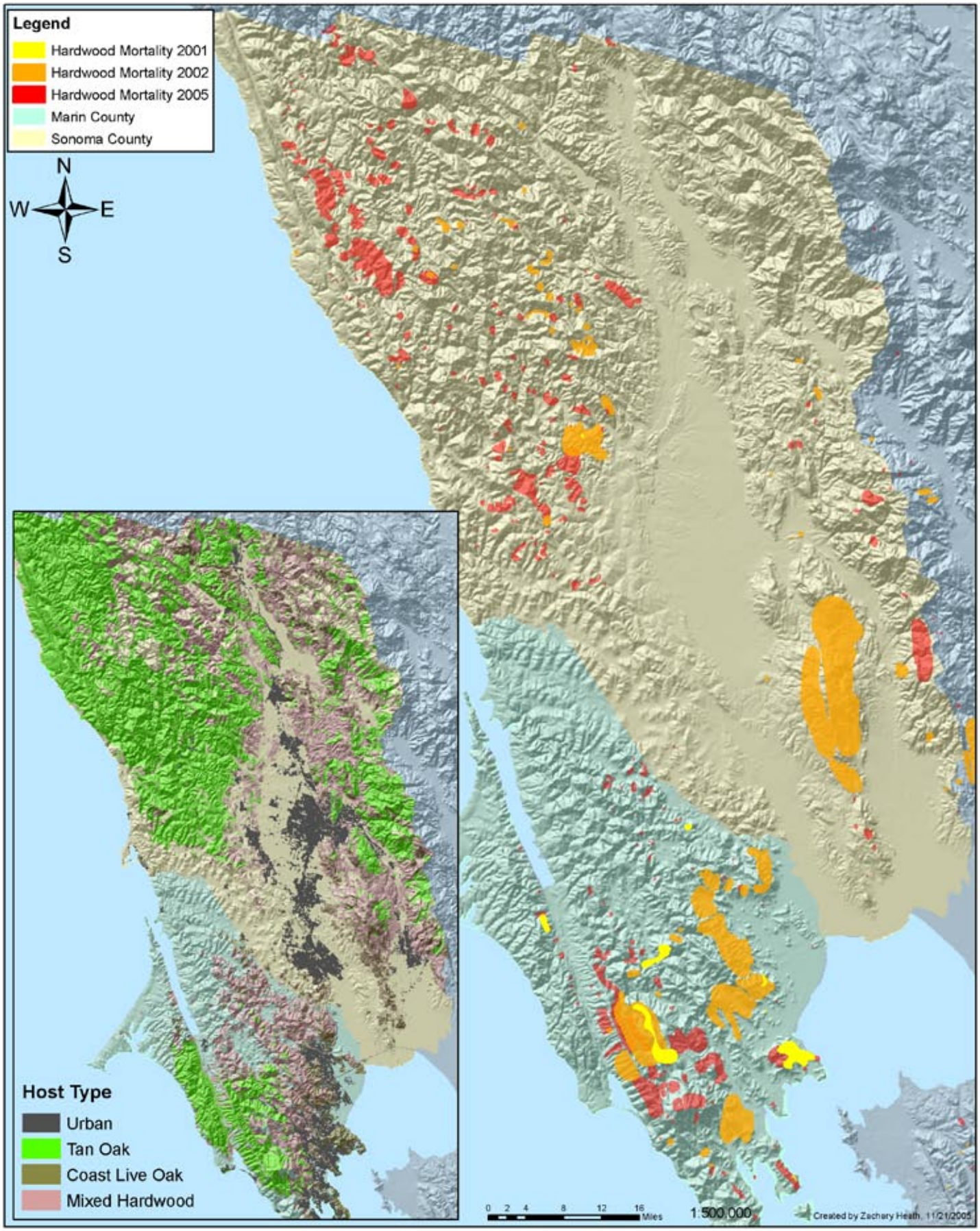

Figure 7. Hardwood mortality in Marin and Sonoma Counties.

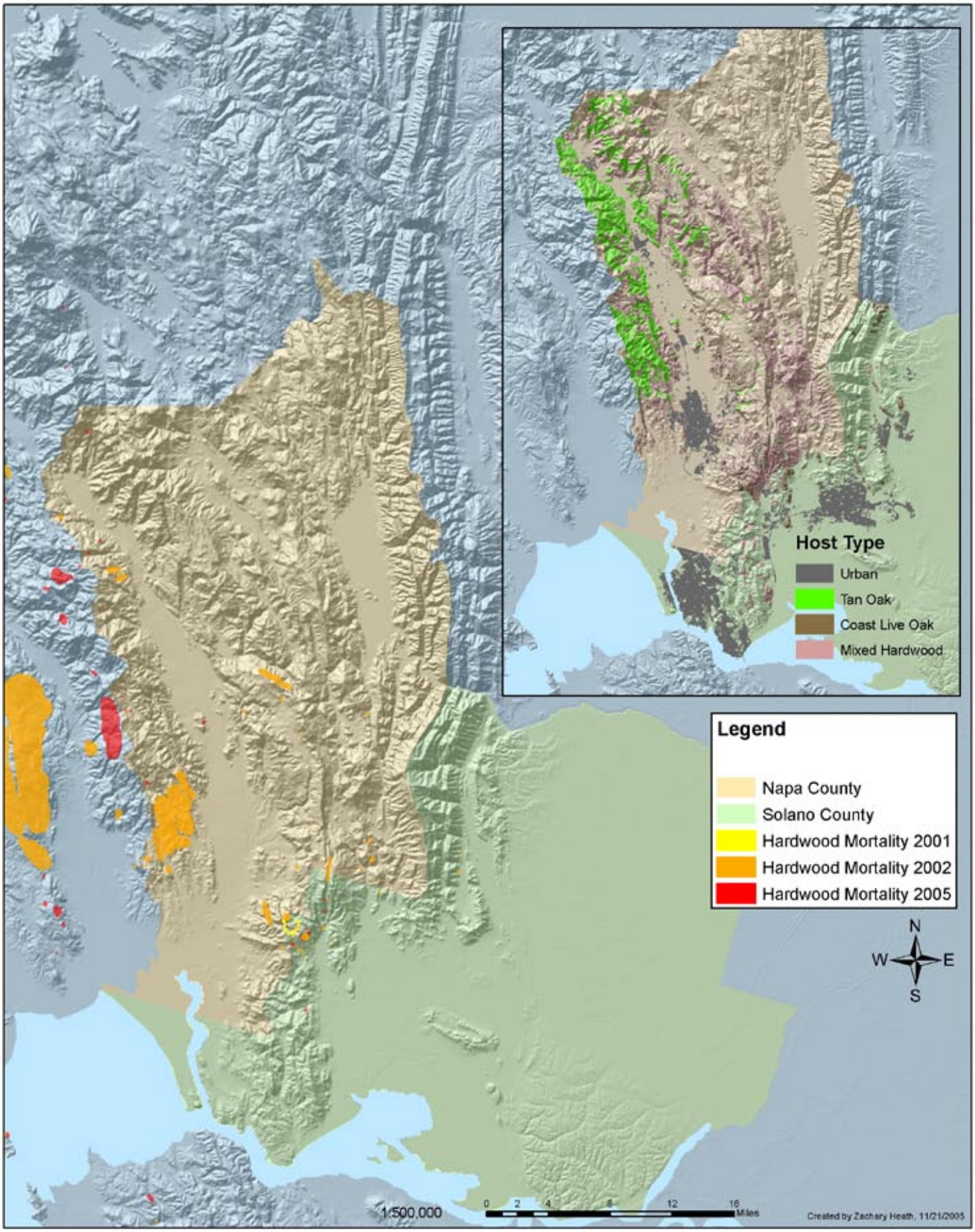

Figure 8. Hardwood mortality in Napa and Solano Counties.

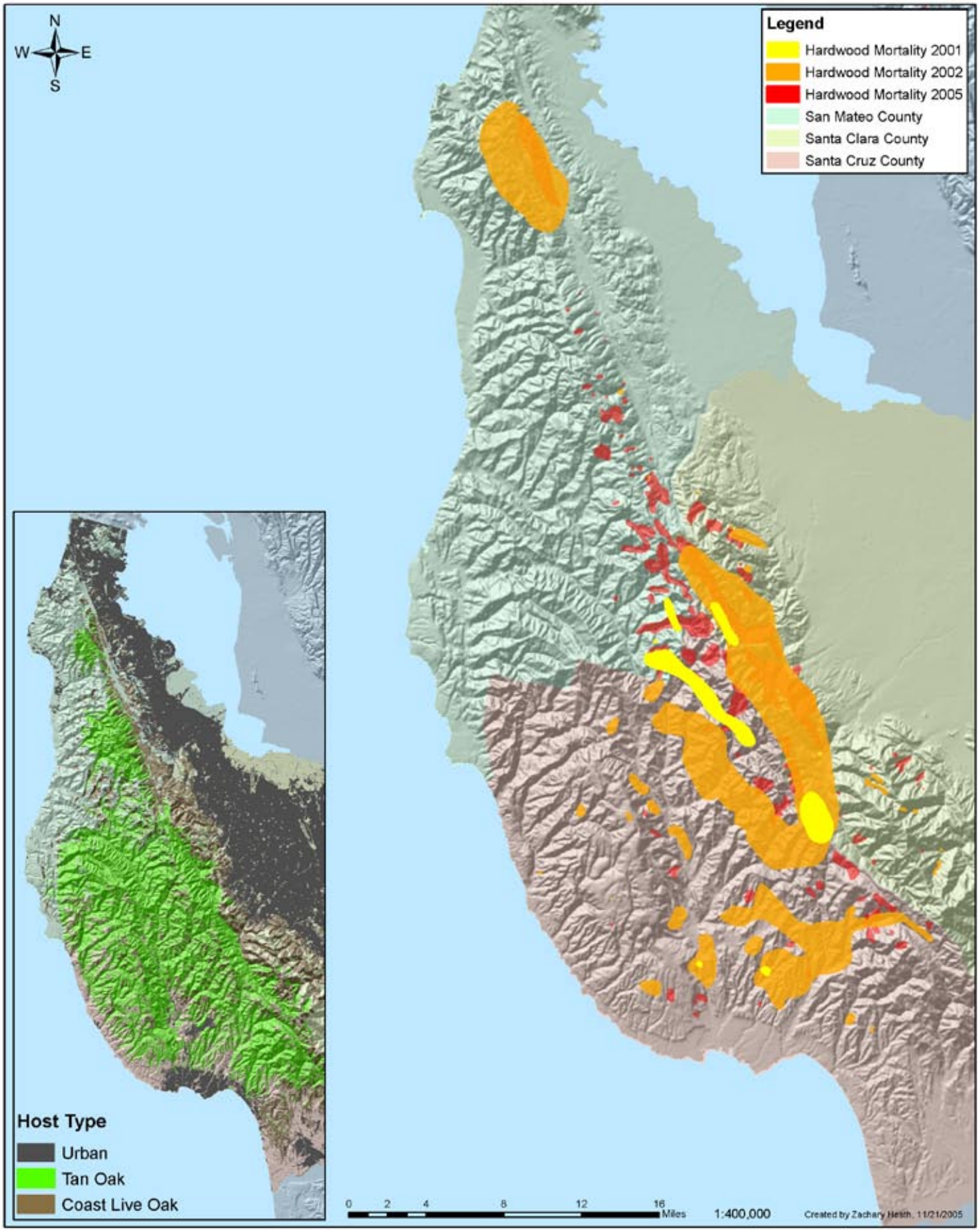

Figure 9. Hardwood mortality in San Mateo, Santa Clara, and Santa Cruz Counties.

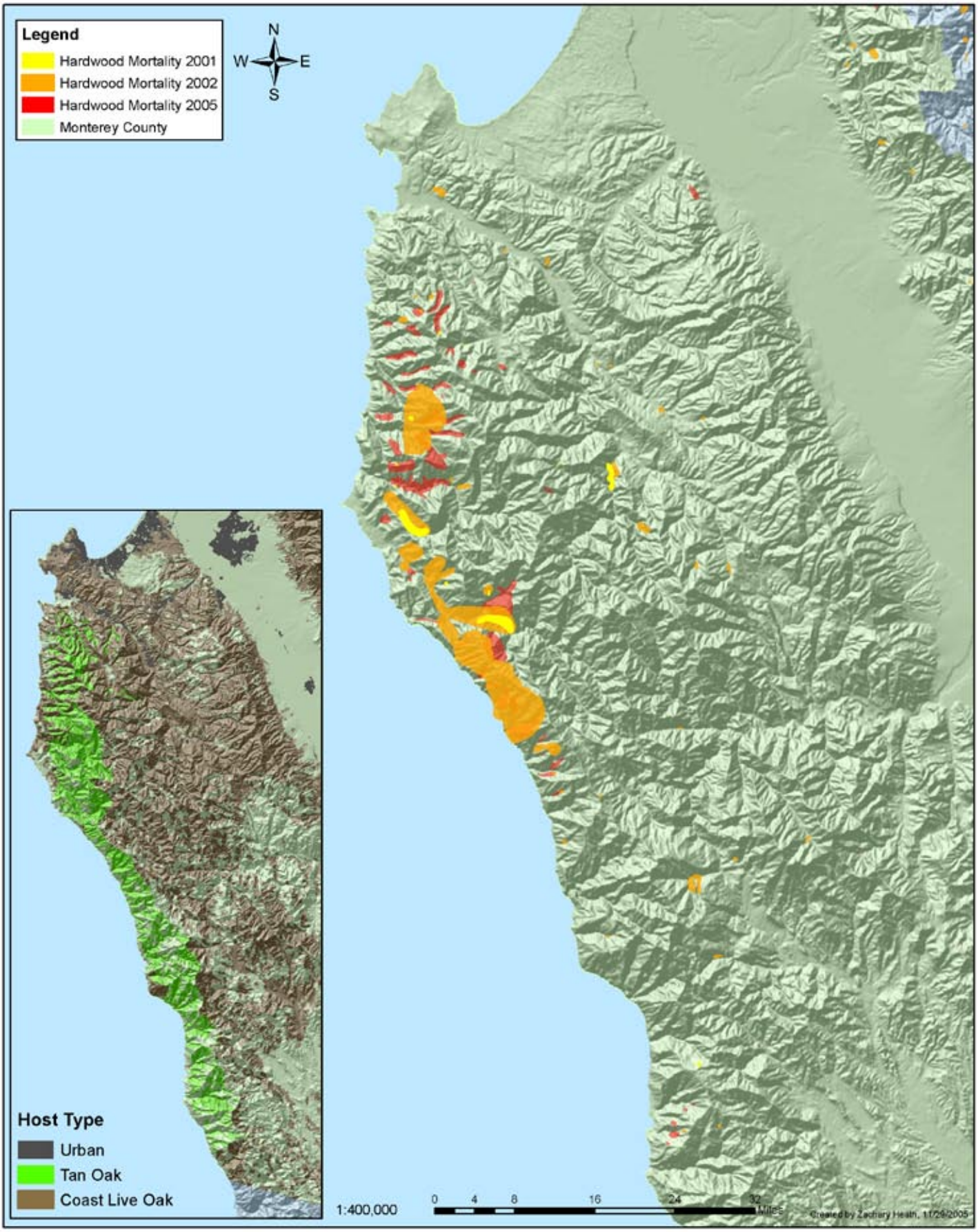

Figure 10. Hardwood mortality in Monterey County.

Surveys conducted in 2005 covered 23 counties in California and mapped approximately 81,000 acres of hardwood mortality. Targeted ground surveys covered seven California counties with four new findings in Humboldt county expanding the known infested area into two watersheds. SOD remains undetected in Del Norte and San Luis Obispo counties. Also of interest is the trend in host type affected. Over recent years, vegetation types containing coast live oak have less mortality and fewer confirmations of SOD while those with a tan oak component appear to be increasing both in terms of mortality area and new confirmations. A more collaborative approach will be emphasized in 2006 by increasing efforts to coordinate our aerial and ground surveys with other monitoring and detection efforts.