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2016 Aerial Survey Results: California

Forest Health Monitoring Program • 1731 Research Park Drive, Davis, CA 95618
www.fs.usda.gov/detail/r5/forest-grasslandhealth

Forest Service
Pacific Southwest Region
R5-PR-034
May 2017

COVER PHOTO
Low elevation mixed conifer forest on the Sequoia National Forest showing the effects of long term exceptional drought conditions. The photo depicts scattered older dead trees and a high level of newer dead conifers, mostly ponderosa pine but also white fir and sugar pine. Many green trees are likely currently infested with bark beetles and will show crown fade in 2017. In the lower left there is a grove of apparently healthy giant sequoia trees.
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USDA Forest Service, Region 5

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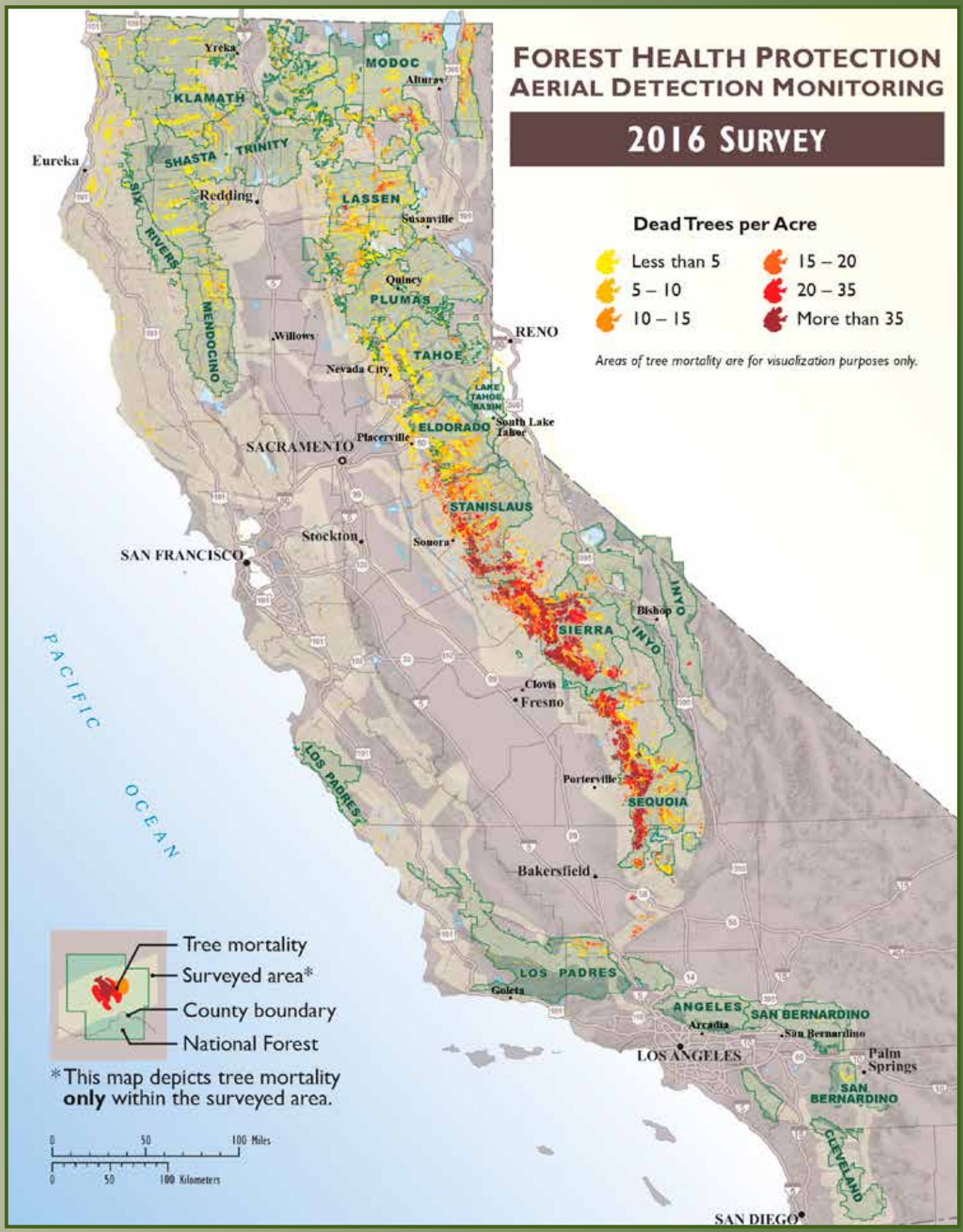
Contents

Service Areas

The geographical breakdown for this report is by the R5 State and Private Forestry, Forest Health Protection, Shared Service Area (SSA) configuration which divides the state of California into four different regions (Northeastern, South Sierra, Southern CA and Northern CA), primarily using National Forest boundaries. Several exceptions exist such as the Humboldt-Toiyabe (admin. By R4) and Inyo (admin. By R5) NFs along with the Lake Tahoe Basin MU (admin. By R5) which straddle the state lines between CA and NV as well the Klamath (admin. By R5) and Rogue River (admin. By R6) NFs which straddle CA and OR. For the purposes of this report the SSA areas were expanded to include all land ownerships in CA, as well as the portions of NV and OR administered by R5.

Statewide Damage Mapped



Overview

Aerial Surveys have been conducted annually in California since 1994 by R5 Forest Health Protection staff to record and map recent tree injury and mortality. Surveys were typically flown on a 3-3.5 mile grid but are now flown on a four mile grid to save flight time and reduce costs. Surveys utilize a small fixed wing aircraft with two observers looking out opposite sides using computer touch tablets to record tree injury such as defoliation, discoloration, dieback or more commonly death.

Approximately 47 million acres of California forestlands were surveyed in 2016 including all National Forests, all forested National and State Parks, and most forested private lands. Many isolated forest areas, urban areas, areas of restricted and controlled airspace such as military installations and other sensitive areas, were not surveyed.

After five years of increasingly exceptional drought conditions throughout most of California, mortality again increased significantly in many areas. In 2016, aerial surveys estimated 62 million recently killed trees; more than double 2015 estimates. Since 2010, the onset of this prolonged and exceptional drought event, an estimated 102 million trees have died. Mortality was again predominantly in lower elevation pine and mixed fir forests of the Southern Sierra Nevada Range where the drought has been the most severe and prolonged. However, in 2016 extensive mortality was also observed further north in the Sierra Nevada range and into higher elevations. Elevated levels of scattered mortality was commonplace throughout the Sierra Nevada Range and interspersed with more numerous and larger groups of severe mortality.

A special survey of the Southern Sierra Nevada foothills was conducted in May to obtain an early assessment of the extent and severity of conifer mortality and to evaluate oak woodland health since early leaf drop is a common drought response. It was confirmed that scattered and occasional high levels of deciduous oak mortality has occurred over the past few years, but this survey was not comprehensive and therefore, oak mortality levels and extent is likely greatly under-reported.

Regular survey flights began as usual in July and were mostly completed by the end of August. The exceptions were the Sierra and Sequoia National Forests which were not surveyed until mid-September due to smoke and flight restrictions associated with the Cedar Fire.

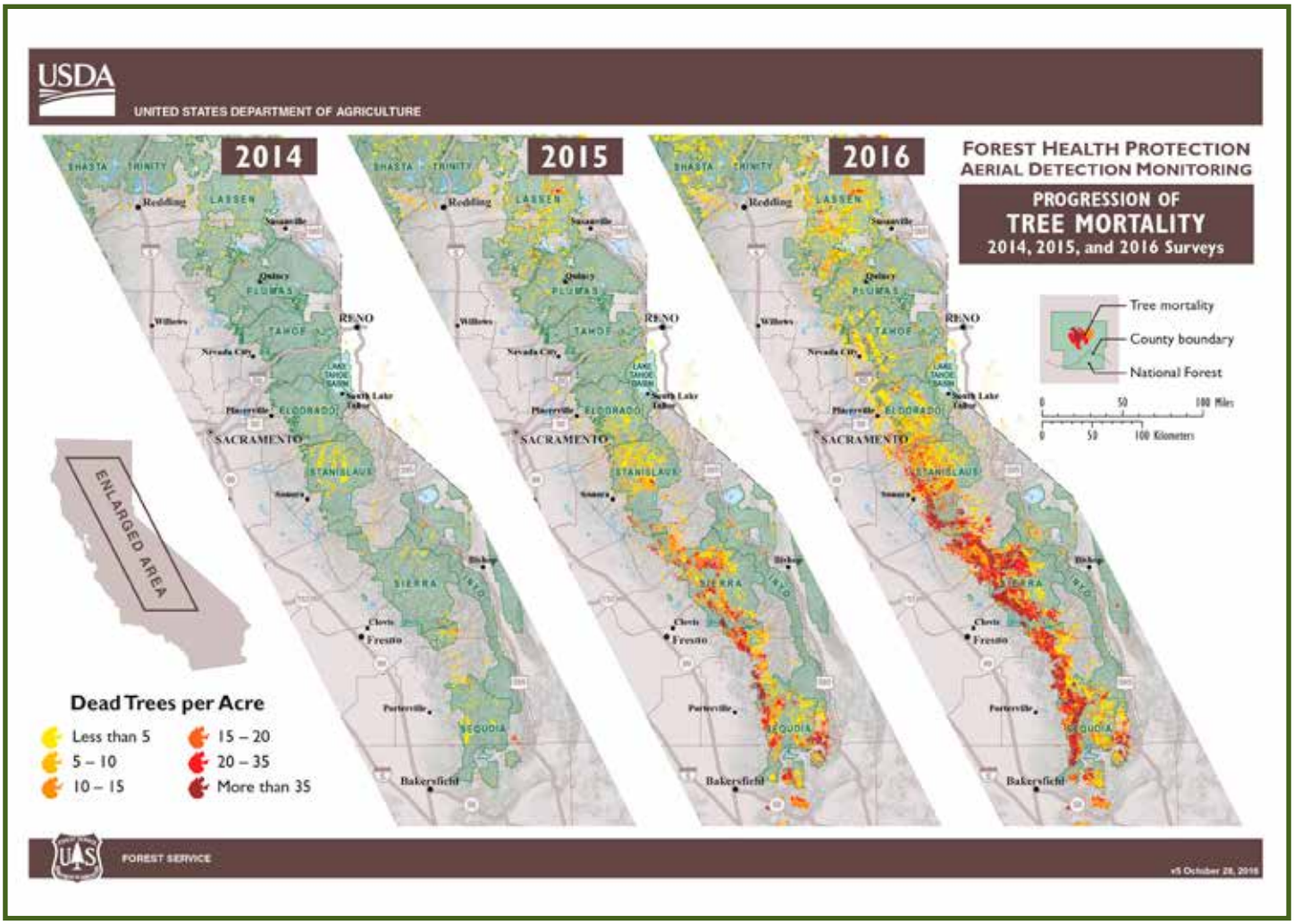
Capturing drought-related mortality was the priority and the extremely high levels of mortality (varied tree species) across landscapes was daunting and difficult to capture with a high level of accuracy. Therefore, it is highly likely that some tree mortality and other types of damage was missed.

Acres reported in this document may be noted in more than one bullet (on subsequent pages) as multiple damage types, damage agents and host tree species often occur in the same location. Additionally, acres reported have some level of mortality, but not all trees are typically killed.

Acres with Mortality and Estimated Number of Dead Trees by Land Ownership

Ownership	Acres	Dead Trees
National Forest (Region 5)*	2,571,000	40,111,000
National Park	219,000	6,457,000
Other National Forest**	12,000	58,000
Other Federal	211,000	1,353,000
State	36,000	372,000
Local	5,000	31,000
Private	1,251,000	13,316,000
Totals	**4,305,000**	**61,698,000**

Acre and tree counts throughout this report have been rounded to the nearest thousand
*Includes an additional 2,000 acres and 6,000 trees detected on R5 LTBMU land in Nevada
**Region 4 National Forest areas located in California



This map shows the core area progression of the drought induced mortality event in California over the preceding three years. Although the drought actually started in 2010, it was not yet severe enough to precipitate mass bark beetle caused mortality both because the trees had enough moisture reserves to ward off beetle attacks, and also because bark beetle populations were not yet at outbreak levels. Increasingly over time, this situation changed with the trees having no moisture reserves left and successful beetle attacks successively increasing populations each generation making mass attacks more intense and more successful.

Also it is important to note that the aerial survey cannot detect mortality until the trees have been dead some months and the foliage has dried out and faded from green to a red or yellow color. Thus currently infested trees still look healthy from a distance.

The vast majority of tree mortality has occurred in the Southern Sierra Nevada Mountain Range where the drought has been the most extreme and prolonged in correlation with large scale contiguous mixed conifer forest type. It is evident that conifer mortality has spread both in area and intensity and now forests are increasingly impacted not only further north but also into higher elevations.

Northeastern California Shared Service Area

Headquarters: Lassen National Forest Supervisor's Office, 2550 Riverside Drive, Susanville, CA 96130

Website: http://www.fs.usda.gov/detail/r5/forest-grasslandhealth/?cid=fsbdev3_046723

Entomologist: Danny Cluck (530) 252-6431 dcluck@fs.fed.us

Pathologist: Bill Woodruff (530) 252-6680 wwoodruff@fs.fed.us

National Forests: Modoc, Lassen, Plumas, Tahoe, portions of northwestern Humboldt-Toiyabe (along with R4)

Other Major Forested Areas: Lassen Volcanic National Park, Lava Beds National Monument

Background

The northeast quadrant of the State is the most rural with no major population centers. It includes the Modoc Plateau, Southern Cascade and Northern Sierra Nevada Mountain Ranges, the eastern Klamath and Warner Mountains, as well as portions of the Great Basin near the Nevada border. Privately owned industrial timberlands are common.

This area of the State has had five years of drought and was characterized as having moderate drought conditions in the north to severe conditions in the south. Although, drought conditions were neither as extreme or prolonged as areas further south, mortality was substantially elevated compared to previous years.

Survey Highlights

- Acres with white fir mortality greatly increased and was scattered across the landscape wherever tree densities were high.
- Acres of ponderosa pine mortality also significantly increased and high in localized areas.

Modoc National Forest:

- Tree mortality in the Warner Mtns. was quite expansive but mostly as scattered fir and pine as opposed to concentrated groups.
- Fir and ponderosa pine mortality greatly increased west of Goose lake and in areas surrounding Adin, CA.
- Mortality throughout the Modoc plateau was significantly elevated from recent years.

Lassen National Forest:

- Extensive, and often high levels of fir and yellow pine mortality, was detected around Harvey Mountain.
- Extensive and moderate levels of mortality in mixed conifer was detected southwest of Lake Almanor.
- Extensive scattered to moderate conifer mortality was recorded within and around Lassen Volcanic National Monument.

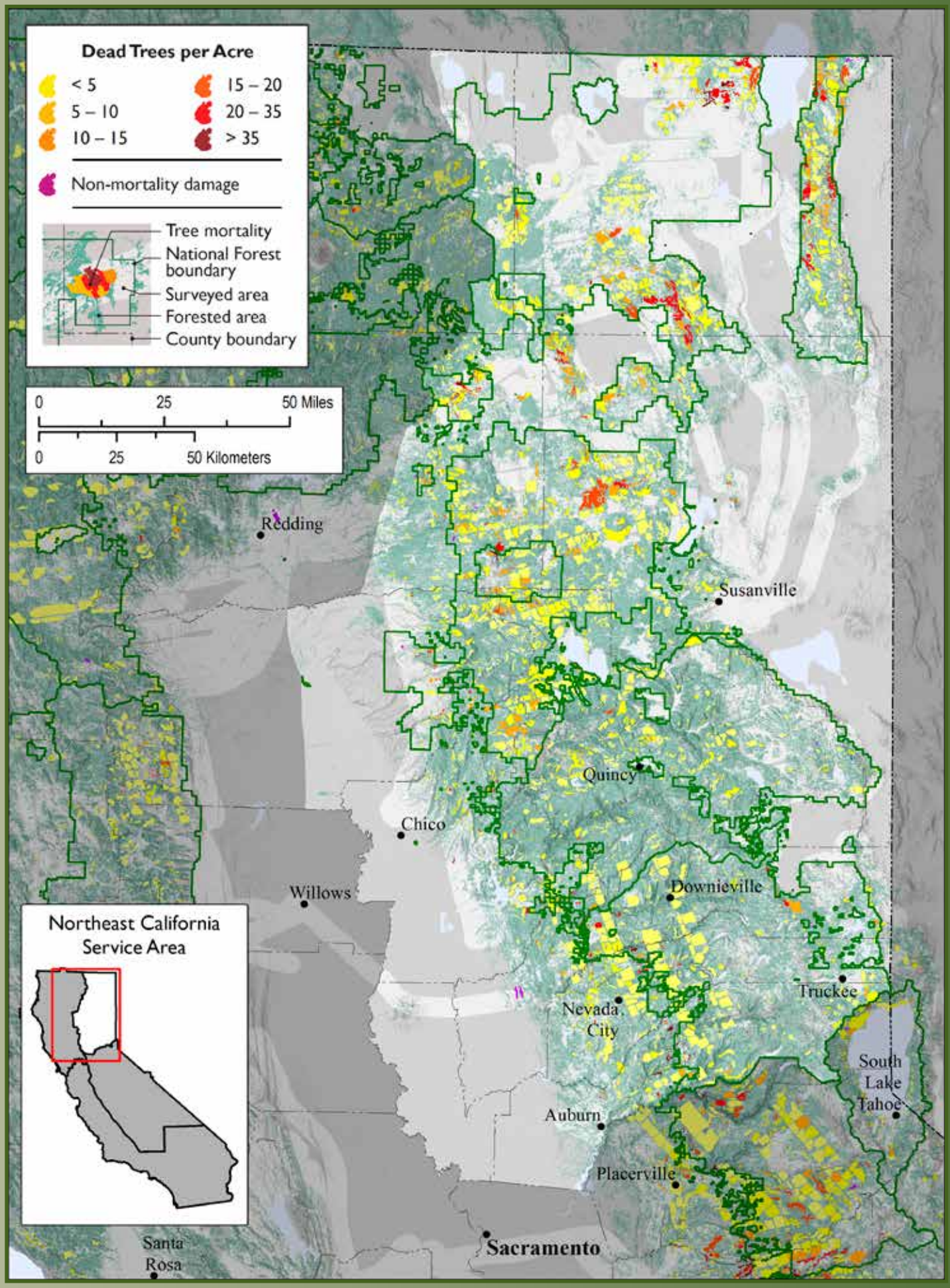
Plumas National Forest:

- High levels of CA red fir mortality and branch flagging was detected in the Bucks Lake Wilderness.
- High levels of white fir and ponderosa pine mortality was detected around and especially east of Lake Oroville.
- Mortality within eastern portions of the Forest was uncommon.

Tahoe National Forest:

- Scattered widespread mortality in mixed conifer was detected throughout western portions of the Forest.
- Mortality in eastern portions of the Forest was uncommon except for areas around Sierraville and Martis Peak.

Northeastern California Shared Service Area



Northeastern California Shared Service Area

Survey Details

Miles Flown: 3,810 Acres Surveyed: 8.9 million

Acres with Mortality and Estimated Number of Dead Trees by Unit

Forest or Park	Acres	Dead Trees
Lassen NF	249,000	1,325,000
Modoc NF	207,000	1,538,000
Plumas NF	102,000	344,000
Tahoe NF	99,000	358,000
Lassen Volcanic NP	28,000	147,000
Lava Beds NM	0	0

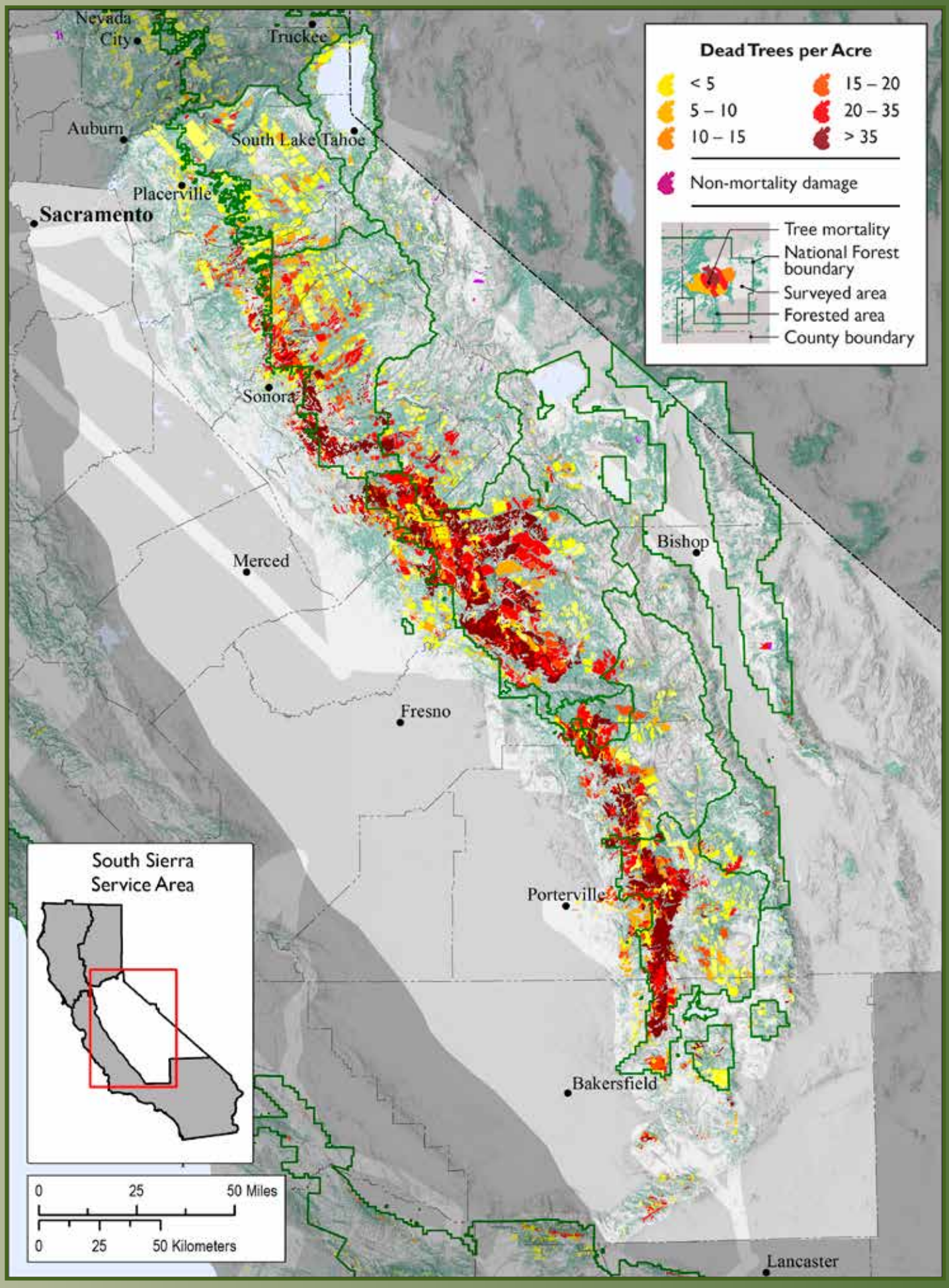
http://www.fs.usda.gov/detail/r5/forest-grasslandhealth/?cid=fsbdev3_046696

Specific map/data requests can be directed to the FHP staff listed on page 7.

Left: Tree mortality in far northeastern CA along the Warner Mountains has been ongoing for several years. 2016 mortality mostly consisted of white fir with lesser amounts of ponderosa, Jeffrey and Washoe pine. Some areas were more heavily impacted such as here near Cedar Mountain.

Right: Mortality in northeastern CA was mostly confined to mature, heavily stocked stands and white fir was most impacted. However pine mortality was not uncommon such as this area near Widow Mountain along the border between the Lassen and Modoc NFs.

South Sierra Shared Service Area



South Sierra Shared Service Area

Headquarters: Stanislaus National Forest Supervisor's Office, 19777 Greenley Road, Sonora, CA 95370

Website: http://www.fs.usda.gov/detail/r5/forest-grasslandhealth/?cid=fsbdev3_046697

Entomologist: Beverly Bulaon (209) 532-3671 x323 bbulaon@fs.fed.us

Pathologist: Martin MacKenzie (530) 532-3671 x242 mmackenzie@fs.fed.us

National Forests: Eldorado, Inyo, Sequoia, Sierra, Stanislaus, Lake Tahoe Basin Management Unit, Southern portions of the Humboldt-Toiyabe

Other Major Forested Areas: Lake Tahoe Basin Management Unit, Sequoia-Kings Canyon and Yosemite National Parks and Devil's Postpile National Monument

Background

This area of the State boasts an abundance of natural wonders including the lowest and highest points in North America as well as the oldest living trees, the bristlecone pine, and the largest trees, the giant sequoia. It includes the bulk of the Sierra Nevada and White Mountain Ranges. Densely populated areas are located to the west in the San Joaquin Valley. However, numerous small communities in the foothills that have been greatly impacted by the high levels of pine and oak mortality.

Most of this area has experienced exceptional drought conditions for multiple years.

Survey Highlights

- Tree mortality continued to be widespread and at high levels especially in lower elevations in the southern Sierra Nevada Range, but increasingly further north and into higher elevations.
- Gray and pinyon pine mortality was substantially reduced compared to 2015 and 2014 levels.
- A special survey was conducted in May to capture an early assessment of mortality levels in the low elevation pine and oak woodlands and verified that substantial levels of additional mortality had occurred since the 2015 survey. The timing of this survey was critical for assessing deciduous oak health (after leaf out but before drought-related early leaf drop). Not all oak woodlands were surveyed in this early survey so oak mortality is substantially underrepresented.

Lake Tahoe Basin Management Unit:

- Scattered mortality of fir and pine was common in northern areas of the Basin including significant levels of large diameter sugar, ponderosa and Jeffrey pine.

Eldorado National Forest:

- Scattered, and moderate levels of conifer mortality was widespread especially in western and southern areas of the Forest.
- Higher elevation areas around Kybers and Pyramid Peak also had scattered conifer mortality across expansive areas.

Stanislaus National Forest:

- High levels of mortality across landscapes was common in western lower elevation areas of the Forest.
- More moderate levels of mortality across landscapes was common in western high elevation areas.
- Expansive areas of higher levels of mortality were detected in the south near Coulterville across to Ascension Mountain and into Yosemite NP.

Inyo National Forest:

- Substantial areas of moderate conifer mortality were detected west of Mammoth and in far southwestern portions of the forest.
- Scattered mortality was detected in isolated stands of high elevation five-needle pine.

Sierra National Forest:

- High levels of mortality continued in lower elevations and was also readily observed in higher elevations throughout most of the Forest.
- Mortality was highest in the low elevation pine type along the western edge of the Forest, but many large areas of intense mortality are now occurring at much higher elevations in the Forest interior.
- Scattered mortality was also detected at the highest elevations in numerous small pockets of isolated slow-growing conifers.

South Sierra Shared Service Area

Sequoia National Forest:

- The level of mortality in many areas of remnant low elevation pine actually decreased since most trees previously succumbed to drought and bark beetles; these ponderosa stands have approached 100% mortality.
- Large areas with moderate levels of mortality were detected at higher elevations throughout the Forest.
- Pinyon mortality within the Scodie and Paiute Mtns far to the south significantly decreased compared to levels detected in previous years.

Survey Details

Miles Flown: 6,200 Acres Surveyed: 13.3 million

Acres with Mortality and Estimated Number of Dead Trees by Unit

	Within Region 5		Outside Region 5	
Forest or Park	**Acres**	**Dead Trees**	**Acres**	**Dead Trees**
Eldorado NF	157,000	1,028,000	0	0
Inyo NF	54,000	492,000	0	0
Sequoia NF	391,000	10,147,000	0	0
Sierra NF	557,000	18,563,000	0	0
Stanislaus NF	234,000	4,896,000	0	0
Lake Tahoe Basin MU	12,000	72,000	2,000	6,000
Sequoia-Kings Canyon NP	48,000	3,855,000	0	0
Yosemite NP	131,000	2,430,000	0	0

http://www.fs.usda.gov/detail/r5/forest-grasslandhealth/?cid=fsbdev3_046696

Specific map/data requests can be directed to the FHP staff listed on page 11.

Left: Area west of Kernville and north of Lake Isabella, bordering the early season Erskine fire which burned extremely hot in June 2016 destroying hundreds of homes in the far southern Sierra Nevada Range. Notice the recent, intense mostly ponderosa pine mortality though some older mortality is apparent. Conifers have now been mostly removed from these low elevation areas and likely converted to oak woodlands.

Right: Farther north and in higher elevations such as this on the Sierra National Forest near Huntington Lake, mortality is less intense but very widespread and is affecting mostly fir and Jeffrey pine but also other tree species.

Southern California Shared Service Area

Headquarters: San Bernardino National Forest Supervisor's Office, 602 S. Tippecanoe Ave., San Bernardino, CA 92408-3430

Website: http://www.fs.usda.gov/detail/r5/forest-grasslandhealth/?cid=stelprdb5331503

Entomologist: Andrea Hefty (909) 382-2871 ahefty@fs.fed.us

Entomologist: Stacy Hishinuma (818) 624-8021 shishinuma@fs.fed.us

Pathologist: Melody Lardner (909) 382-2725 mlardner@fs.fed.us

National Forests: Los Padres, Angeles, San Bernardino, Cleveland

Other Major Forested Areas: Channel Islands National Park, Santa Monica Mountains NRA, Pinnacles National Park, San Gabriel and Sand to Snow National Monuments, numerous State and county parks

Background

Forests in Southern CA have many unique qualities such as numerous endemic tree species with unique wind, fire and drought adaptations. Climate is highly varied with strong marine influences near the coast and desert influences further inland. Isolated mountain forested islands separated by vast expanses of treeless terrain are typical. This service area includes all the southern NFs as well as the Coastal and Transvers Mountain Ranges stretching as far north as San Francisco Bay.

These southern forests are in close proximity to large population centers where the bulk of California residents reside in large urban centers and expanding suburban areas. Invasive forest pests are also of particular concern and include tree diseases such as sudden oak death, and insects such as goldspotted oak borer and polyphagous/Kuroshio shot hole borers.

The drought situation in southern California in 2016 was among the worst statewide and categorized mostly in the exceptional drought category with the most severe and prolonged drought conditions along the central coast from Big Sur south to Santa Barbara and east into the Transverse ranges.

Survey Highlights

- Tanoak mortality attributed to Sudden Oak Death (SOD; caused by *Phytophthora ramorum*) was again quite low as drought conditions are not conducive to the spread of this disease.
- Oak mortality was elevated overall, but in known goldspotted oak borer (GSOB) infested areas of San Diego Co., mortality was down somewhat compared to 2015 levels and it is unknown if oak mortality detected outside of known GSOB infestation areas is due to GSOB or drought.
- Oak and conifer mortality along the Tehachapi Range was again elevated in 2016; cumulative mortality levels are high in some areas.
- Even though the drought situation is exceptional (US Drought Monitor) in the inland valley oak woodlands, oak mortality was quite low and gray pine mortality levels were only moderate.

Los Padres National Forest:

- Cumulative levels of mortality around Mt. Pinos are high; low elevation pine host has been depleted in some areas. Ongoing mortality in higher elevation areas of white fir and mixed conifer forests was commonly observed.
- Pinyon pine mortality levels were markedly reduced compared to previous years.
- Pine and fir mortality along the ridgeline of the Sespe Wilderness was markedly elevated.

Angeles National Forest:

- High levels of pine and fir mortality were detected along the north slope of Burnt Peak.

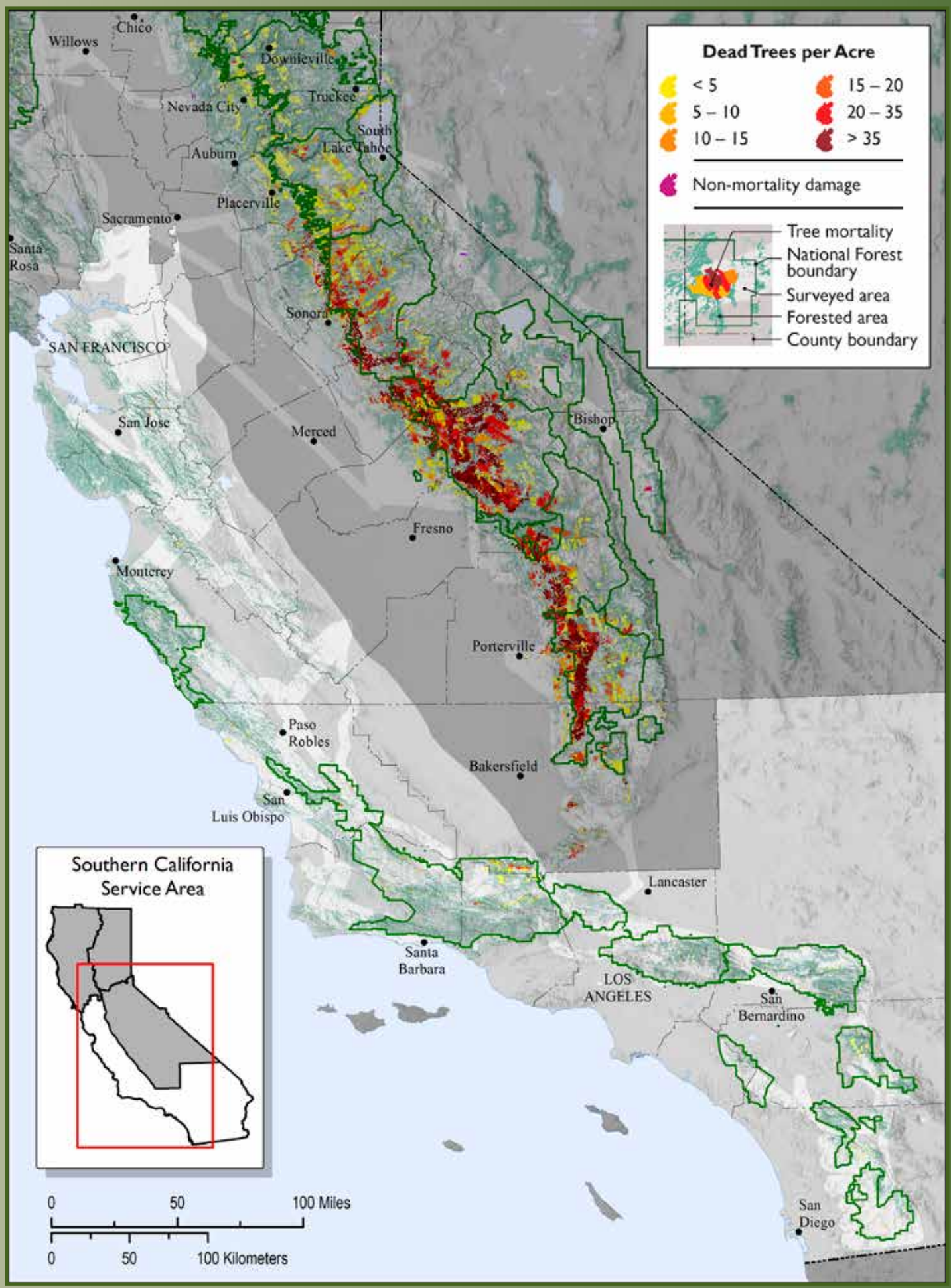
San Bernardino National Forest:

- Moderate levels of pine and fir mortality occurred in the San Jacinto Peaks area.
- Localized moderate levels of Jeffrey pine mortality occurred south of Lake Hemet on the San Jacinto Ranger District.

Cleveland National Forest:

- Moderate levels of oak mortality were common especially around Mesa Grande on the Palomar Ranger District and to the east.
- Jeffrey pine mortality continued around Mt Laguna where high levels of mortality were first detected in 2014. This host type is now severely depleted.

Southern California Shared Service Area



Southern California Shared Service Area

Survey Details

Miles Flown: 4,430 Acres Surveyed: 9.7 million

Acres with Mortality and Estimated Number of Dead Trees by Unit

Forest or Park	Acres	Dead Trees
Angeles NF	3,000	27,000
Cleveland NF	3,000	3,000
Los Padres NF	38,000	260,000
San Bernardino NF	9,000	15,000
Pinnacles NP	0	0

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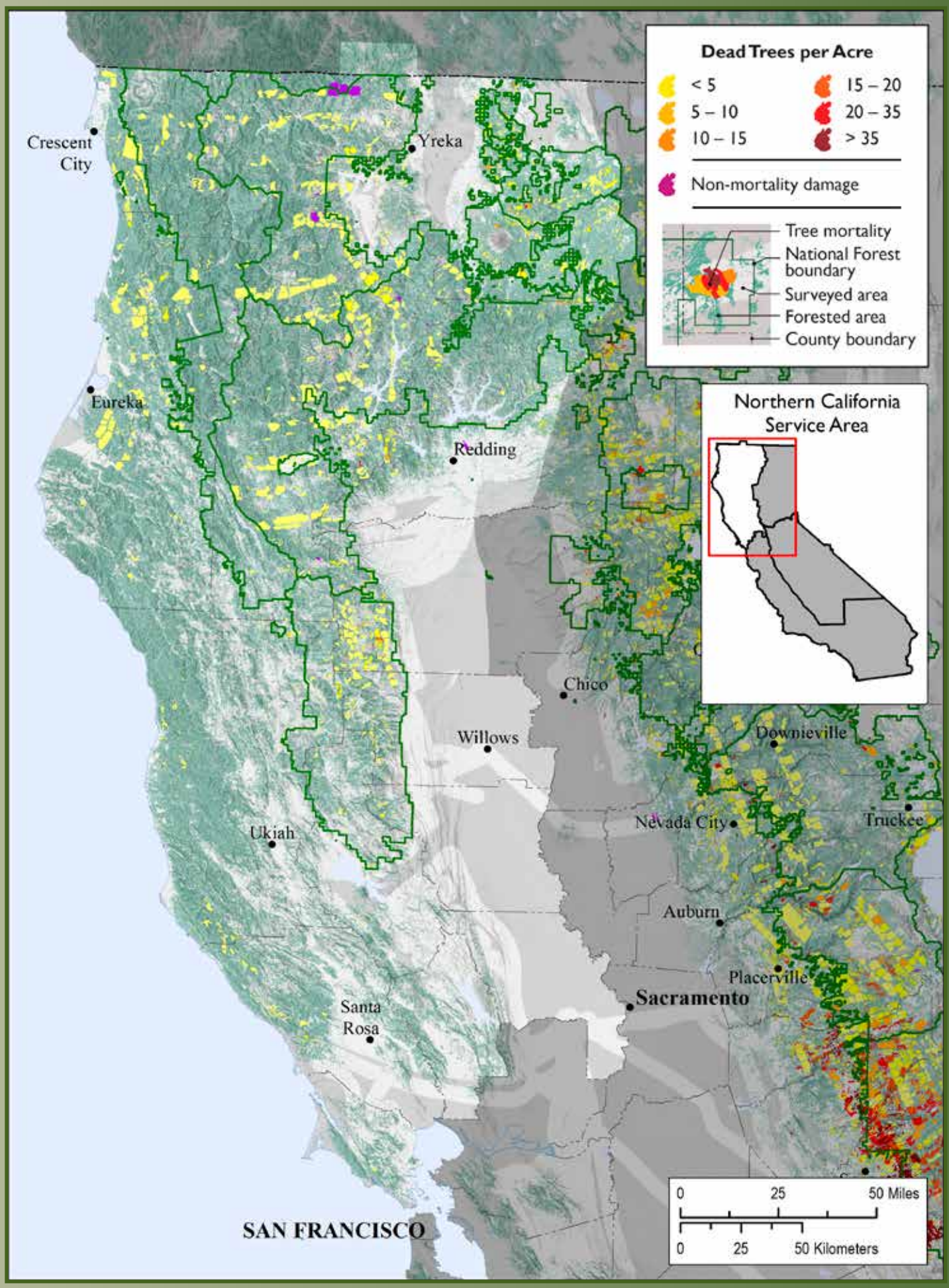
Specific map/data requests can be directed to the FHP staff listed on page 13.

Left: Coulter, Jeffrey and ponderosa pine have been heavily impacted throughout Southern California. This area near Burnt Peak along the Tehachapi Mtn. Range shows considerable mortality within an isolated stand of ponderosa pine. Notice the gray pine on the far side of the road appear healthy.

Right: Coulter pine, which grows in isolated pockets along the southern coastal ranges, have been severely impacted by the drought, including this area near Cypress Peak. Notice the various oaks and other hardwoods appear quite healthy.

Northern California Shared Service Area



Northern California Shared Service Area

Headquarters: Shasta-Trinity National Forests Supervisor's Office, 3644 Avtech Parkway, Redding, CA 96002

Website: http://www.fs.usda.gov/detail/r5/forest-grasslandhealth/?cid=stelprdb5327569

Entomologist: Cynthia Snyder (530) 226-2437 clsnyder@fs.fed.us

Pathologist: Pete Angwin (530) 226-2436 pangwin@fs.fed.us

National Forests: Klamath, Mendocino, Shasta-Trinity and Six-Rivers along with minor portions of Rogue River - Siskiyou

Other Major Forested Areas: Redwood National Park, Golden Gate, Smith River and Wiskeytown NRAs, Berryessa Snow Mountain and Muir Woods National Monuments, Hoopa and Round Valley Indian Reservations, King Range NRCA, Point Reyes National Seashore and several State Parks

Background

The Northern California Shared Service area stretches from the San Francisco Bay area north to the Oregon border and east to the Modoc Plateau. Forests along the north coast of CA are the most productive and diverse ecosystems in the Region ranging from dwarf forests on serpentine soils, to the tallest trees on earth, to expansive oak woodlands in the interior. Forests near the coast are often wet and lush while eastern lowlands are more open and dry. Most of the area is of lower elevation with the exception of the Trinity Alps and Mount Shasta which stretch up past the alpine ecotone.

Except for the Bay area, many areas are remote, sparsely populated and often roadless. Highly productive industrial timber production land is common near the coast. This area has been least affected by the drought and drought conditions were mild along the coast to moderate further inland. Correspondingly, drought-related tree mortality was minimal except for the eastern most areas.

Survey Highlights

- New mortality attributable to Sudden Oak Death (SOD) was again reduced since drought conditions are not conducive to the spread of this disease.
- Overall mortality, not attributed to damage caused by bear feeding in young plantations, was minimal along the coast.
- Levels of oak and gray pine mortality in the interior were also minimal.

Klamath National Forest:

- Scattered pine and fir mortality was common with the extent, frequency and level of mortality increasing somewhat from west to east and from north to south.
- Tree mortality was readily observed in areas north of Ball Mountain and east of Bonita Butte on the Goosenest Ranger District.

Shasta-Trinity National Forest:

- Sizeable areas of low intensity mortality in fir and pine were common.
- Mortality and *Cytospora* sp.-caused flagging in CA red fir was markedly increased, especially along the crest of the Trinity Alps Wilderness.

Six Rivers National Forest:

- Tree mortality was uncommon Forest-wide.

Mendocino National Forest:

- Scattered mortality in pine and fir was particularly common in the northeastern quadrant of the Forest.
- There were high levels (at times extensive) of primarily ponderosa pine mortality around Ball Mountain on the Grindstone Ranger District.

Northern California Shared Service Area

Survey Details

Miles Flown: 6,400 Acres Surveyed: 14.7 million

Acres with Mortality and Estimated Number of Dead Trees by Unit

Forest or Park	Acres	Dead Trees
Klamath NF	175,000	407,000
Mendocino NF	67,000	184,000
Shasta-Trinity NF	175,000	370,000
Six Rivers NF	37,000	73,000
Golden Gate NRA	0	0
Muir Woods NM	0	0
Point Reyes NS	0	0
Redwood NP	10,000	18,000
Whiskeytown NRA	1,000	7,000

http://www.fs.usda.gov/detail/r5/forest-grasslandhealth/?cid=fsbdev3_046696

Specific map/data requests can be directed to the FHP staff listed on page 17.

Left: Trough Ridge in the far northeast corner of the Mendocino NF had numerous pockets of intense ponderosa pine mortality along with scattered white fir mortality. Elevated levels of knobcone pine mortality were also seen in this area and Forest wide.

Right: Conditions typical of the eastern extent of the service area. Notice the almost ubiquitous widely scattered combined with concentrated pockets of mostly ponderosa pine mortality.