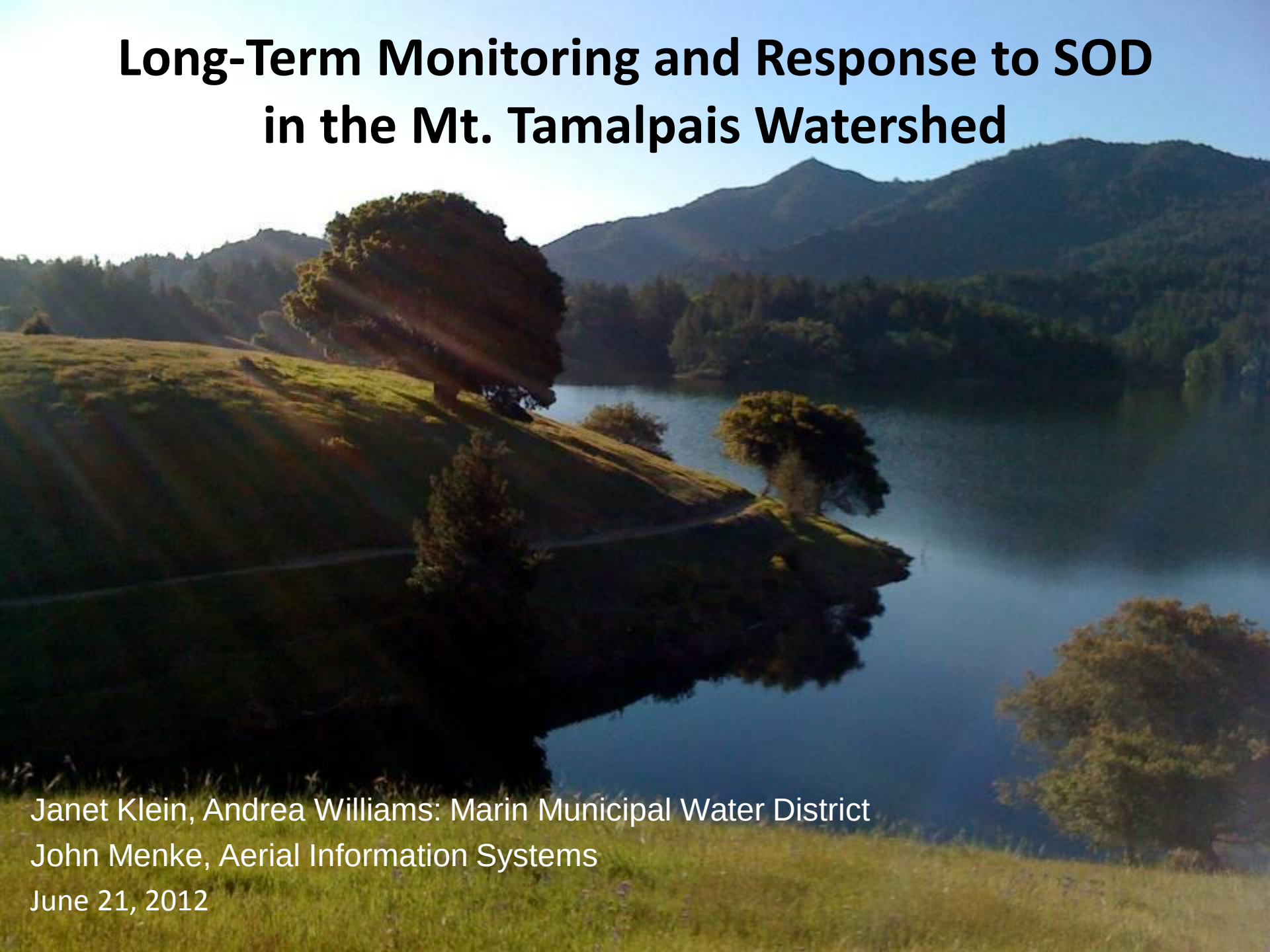
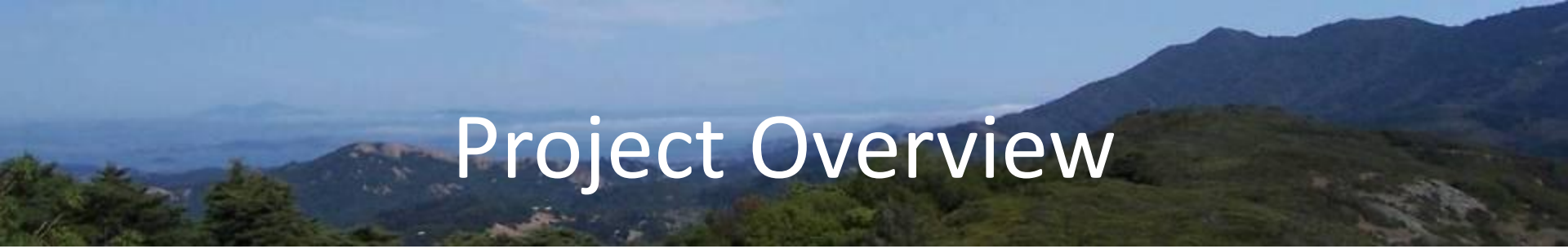
Long-Term Monitoring and Response to SOD in the Mt. Tamalpais Watershed



Janet Klein, Andrea Williams: Marin Municipal Water District
John Menke, Aerial Information Systems
June 21, 2012



Project Overview

- Purpose: To inform the immediate management needs in heavily impacted public wildlands by quantifying the extent and spread of *Phtophthora ramorum*-related tree mortality.
- Funded by the Forest Health Protection Program of the State and Private Forestry Section of the USDA Forest Service.
- Inspired by Managing sudden oak death in California forests and woodlands: before, during, and after *Phytophthora ramorum* invasion (T. J. Swiecki and E.A. Bernhardt Phytosphere Research, 2011)

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MMWD: Founded in 1912
California's oldest municipal water district

MMWD provides Municipal tap water To approximately 250,000 people in southern and eastern Marin County.

Mission: To manage our natural resources in a sustainable manner and to provide our customers with reliable, high-quality water at a reasonable price.

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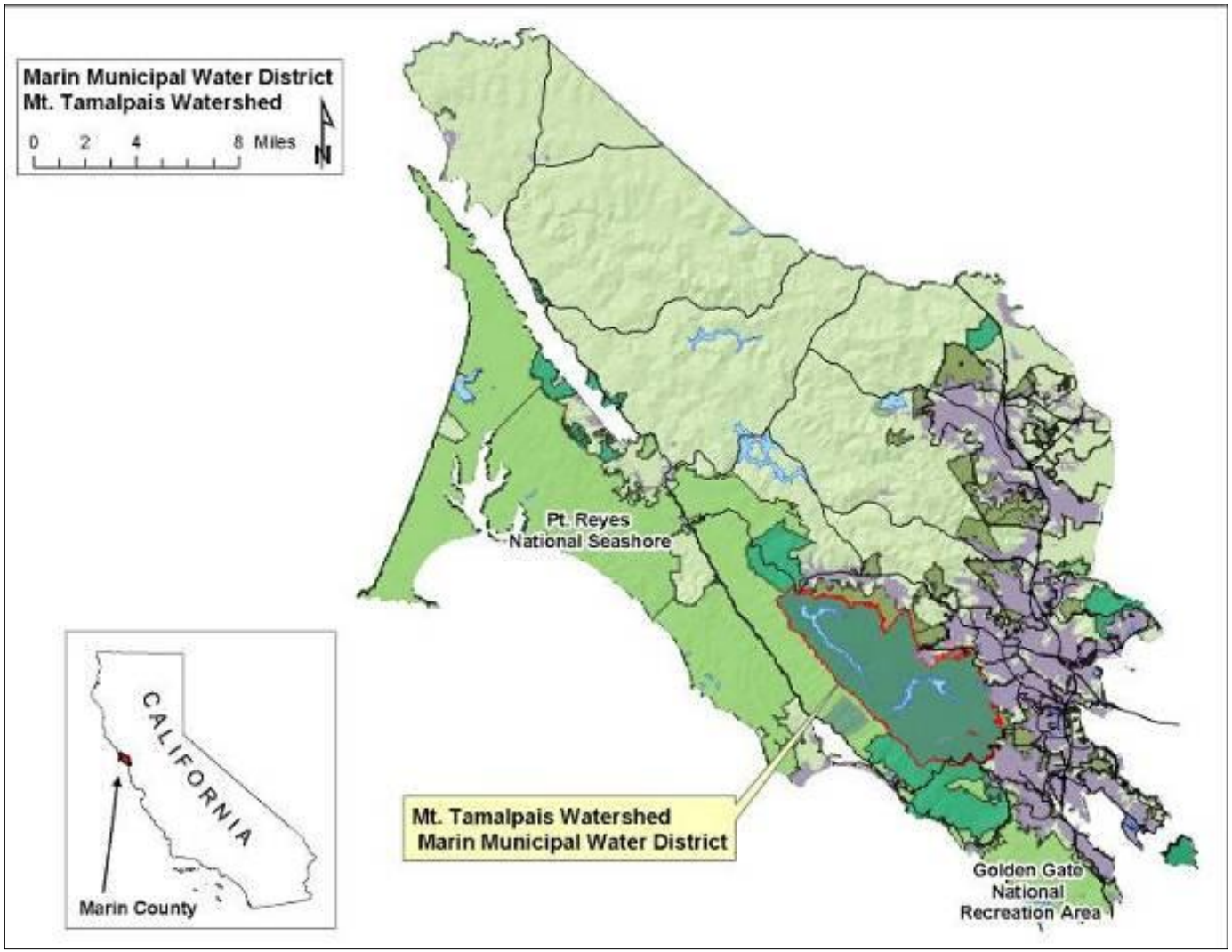
Marin Municipal Water District's Mt Tamalpais Watershed

The 18,500 acre Watershed is part a 300,000 acre complex of protected open space.

It contains over 100 miles of service roads and trails open to the public.



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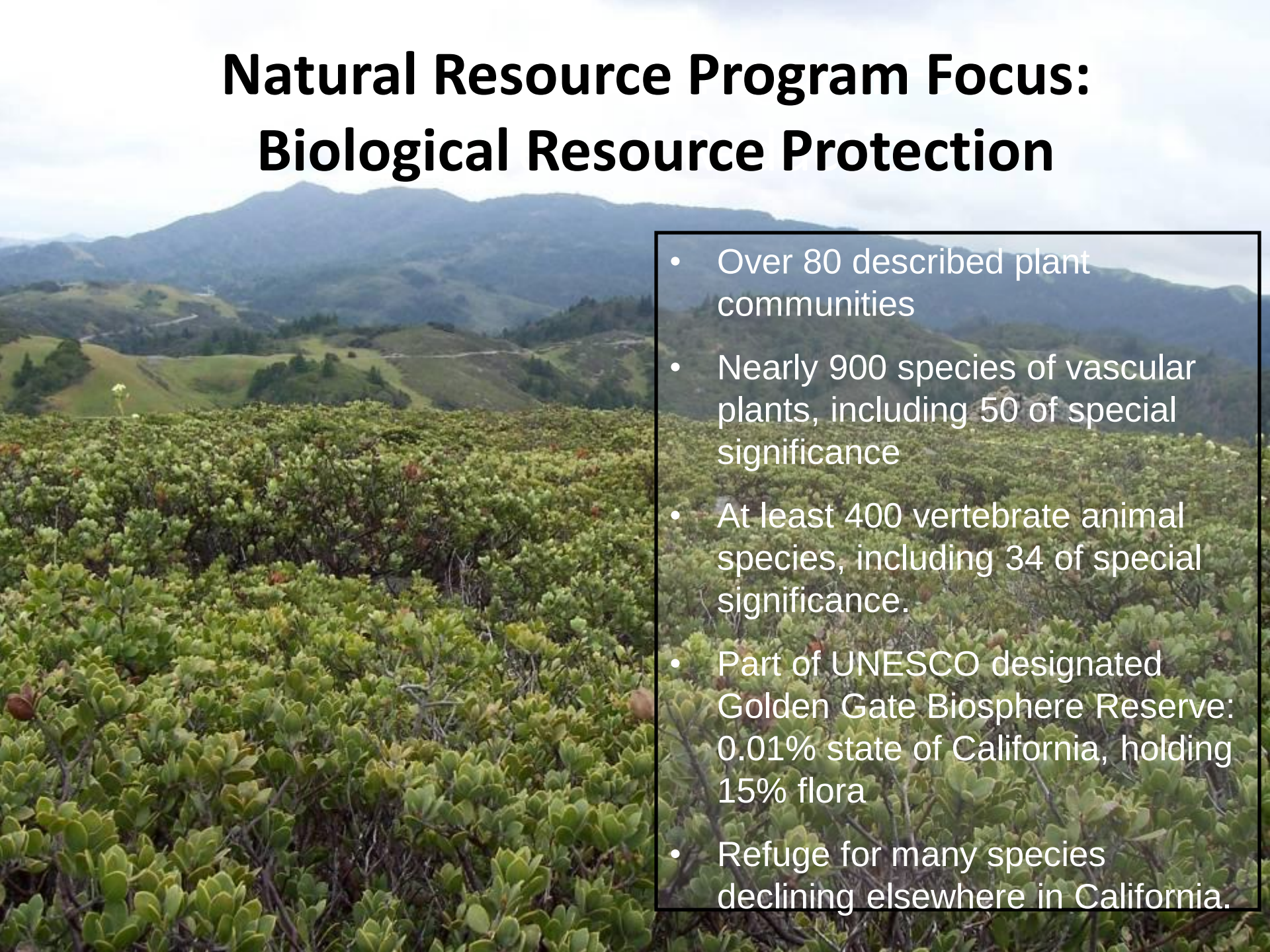
Natural Resource Program Focus: Biological Resource Protection



- Over 80 described plant communities
- Nearly 900 species of vascular plants, including 50 of special significance
- At least 400 vertebrate animal species, including 34 of special significance.
- Part of UNESCO designated Golden Gate Biosphere Reserve: 0.01% state of California, holding 15% flora
- Refuge for many species declining elsewhere in California.

Gratuitous Photos of Cool Biological Resources











Natural Resource Program Focus: Wildfire Risk Reduction

- Over 2000 structures are within 0.5 miles of watershed.

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Not Quite Ground Zero for Tanoak Die-off

Large-scale, rapid die-off of tanoak (*Notholithocarpus densiflorus*) first noted on Mt Tamalpais in 1995.—probably imported by some hippy from Santa Cruz.

Bill Williams Canyon 1995

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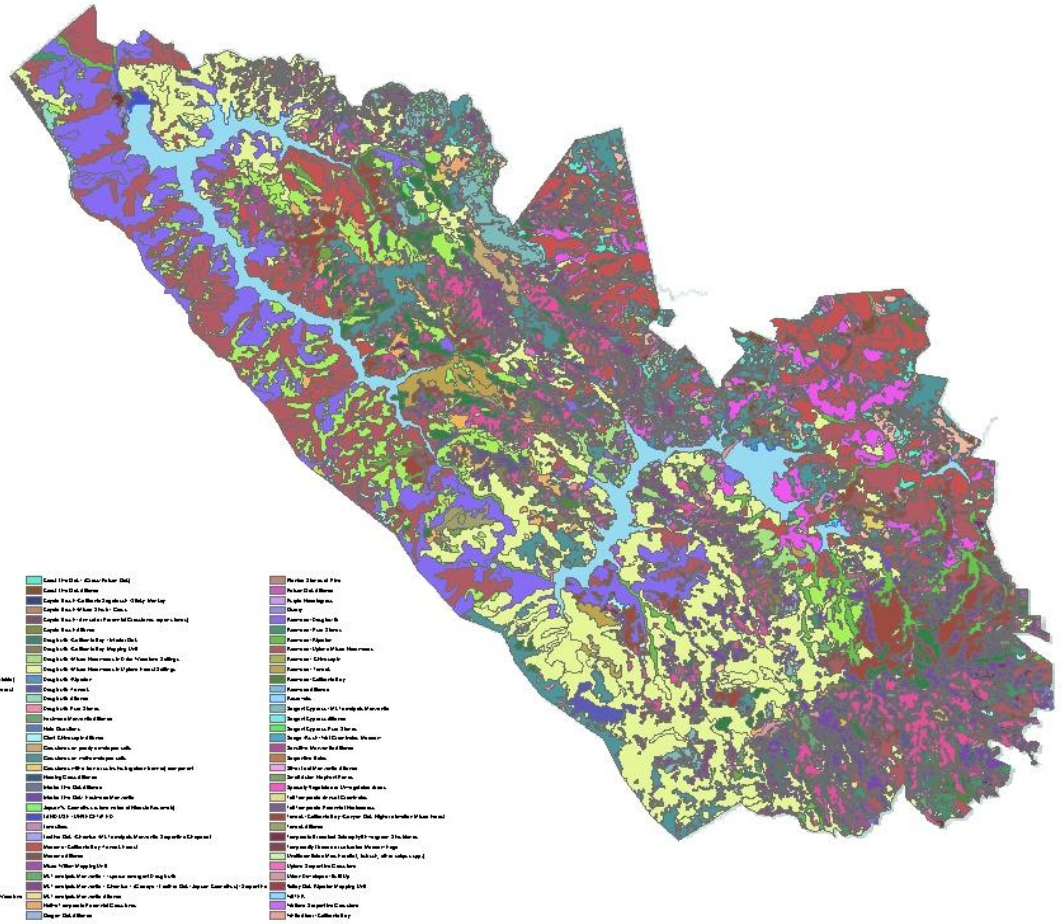
Primary Planning and Analysis Tool: 2004 Vegetation Map of the Watershed

- Fuel break design
- Wildlife habitat modeling
- Special status species detection
- Road and trail assessments
- Weed control strategies
- Environmental impact analyses
- Initial assessment of SOD extent



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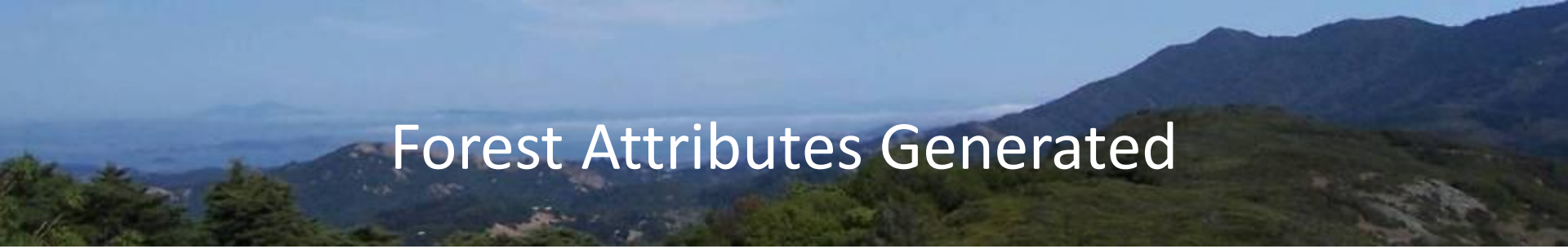

Forest Attributes Generated

Vegetation Alliance: dominate canopy species per National Vegetation Classification Standards. Accuracy > 90%

Vegetation Association: Subdominate or associated species. Accuracy >70%

Completed in 2005

Hardwood and Conifer Density

- 1 = Greater than 60%
- 2 = 40-60%
- 3 = 25-40%
- 4 = 10-25%
- 5 = 2-10%

Canopy Mortality (Standing trees)

- 0
- 1 = less than 1%
- 2 = 1-5 %
- 3 = 5 -10%
- 4 = more than 10%

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Immediately Moot

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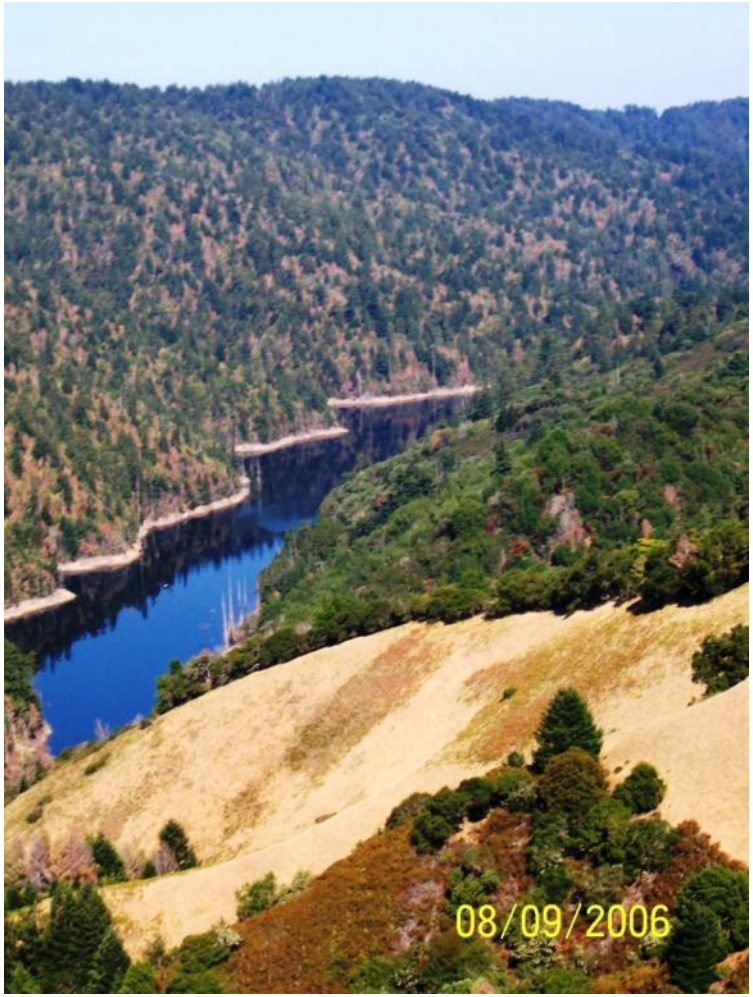
Water District

Bolinas Ridge, Mt Tamalpais
Marin Municipal Water District, 2006



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SOD 5-Year Spread Assessment

Objectives:

1. Establish a cheap, repeatable method for long-term monitoring of disease progression on the watershed.
2. Update forest and woodland portions of 2004 vegetation community map.
3. Quantify SOD-related changes in the canopy and understory.
4. Inform response.

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Landscape-Scale Method: Aerial Photo Interpretation and Classification by Aerial Information Systems, Redlands CA

Repeat of methods used to generate 2004 Vegetation map.

Over 13,000 acres reassessed.

Over 3000 polygons reclassified.

Heads-up digitizing technique based off of 420 ground points collect in 2005.

Minimum mapping unit: 0.5 hectares
Imagery: true color and color infrared, 1:1200 resolution

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Assumption

We presumed that observed die-offs in tanoaks, coast live oak, black oak, shreve's oak, and canyon live oak was due to *Phytophthora ramorum.* Tissue samples were not taken to confirm.

This assumption was made due to the large number of positive tissue samples documented by other studies conducted on Mt Tamalpais.

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Ground Sampling Method: CNPS/CDFG Modified Rapid Assessment for Vegetation Classification

Returned to 60 stands first surveyed in 2005. Repeated sampling protocols.

Original plot locations were not monumented, preventing direct comparisons of 2005 and 2010/2011 data.

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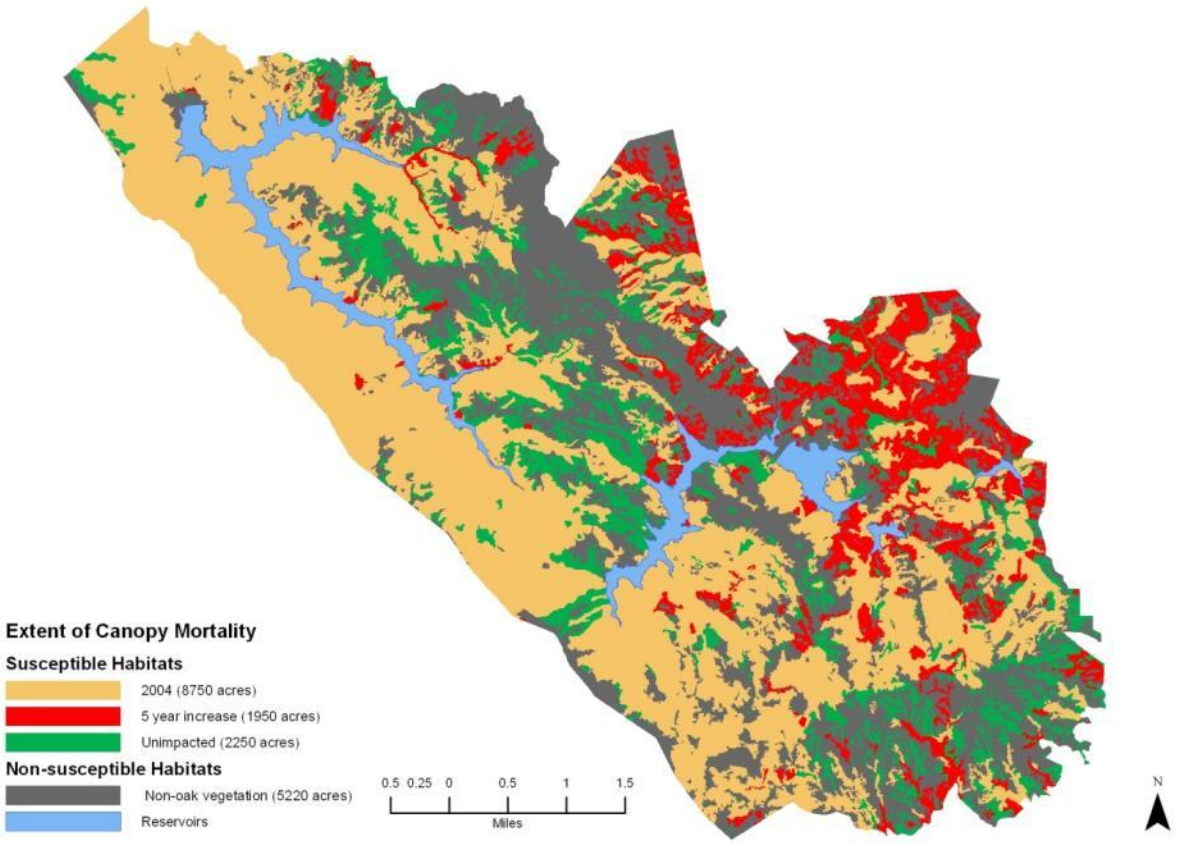
Results
SOD-related canopy die-off expanded

Impacted forests and woodlands increased from 8750 acres to 10,700 acres.

Only 17% all habitat with a principal component of tan oak, coast live oak, black oak, canyon live oak or Shreve's oak exhibited no canopy mortality.

The largest unimpacted patch is 150 acres.



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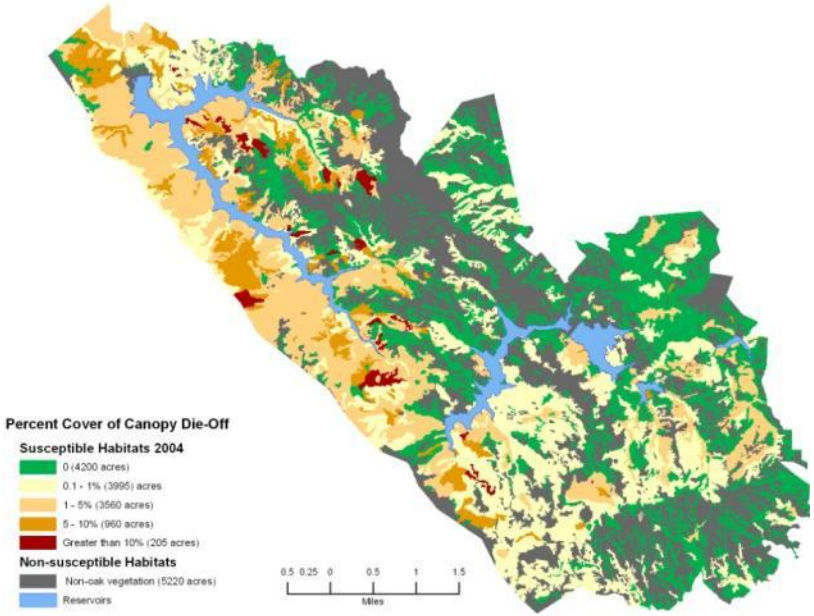
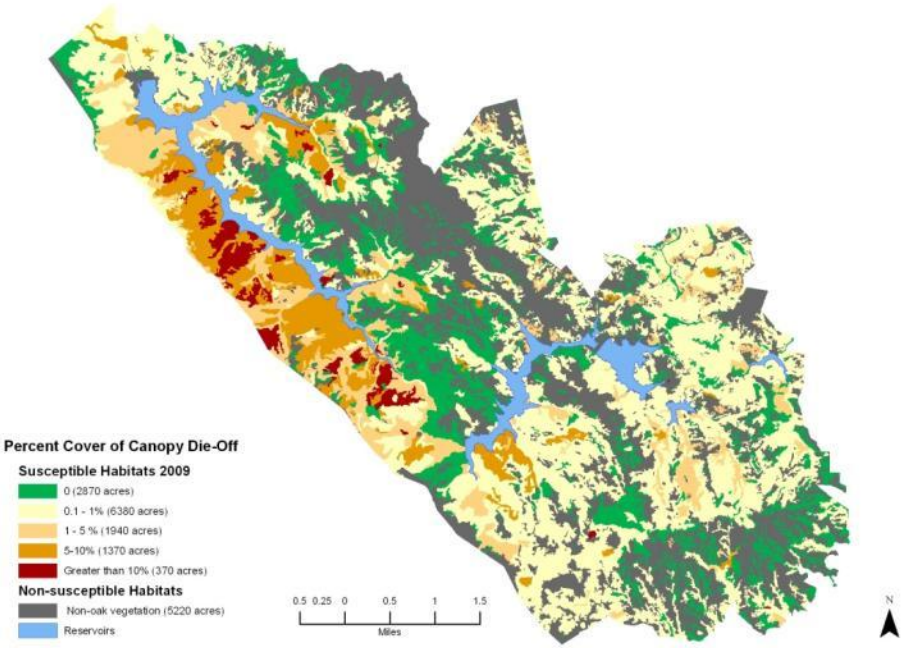
Results: Much of the expansion is due to increased disease incidence in coast live oak dominated woodlands





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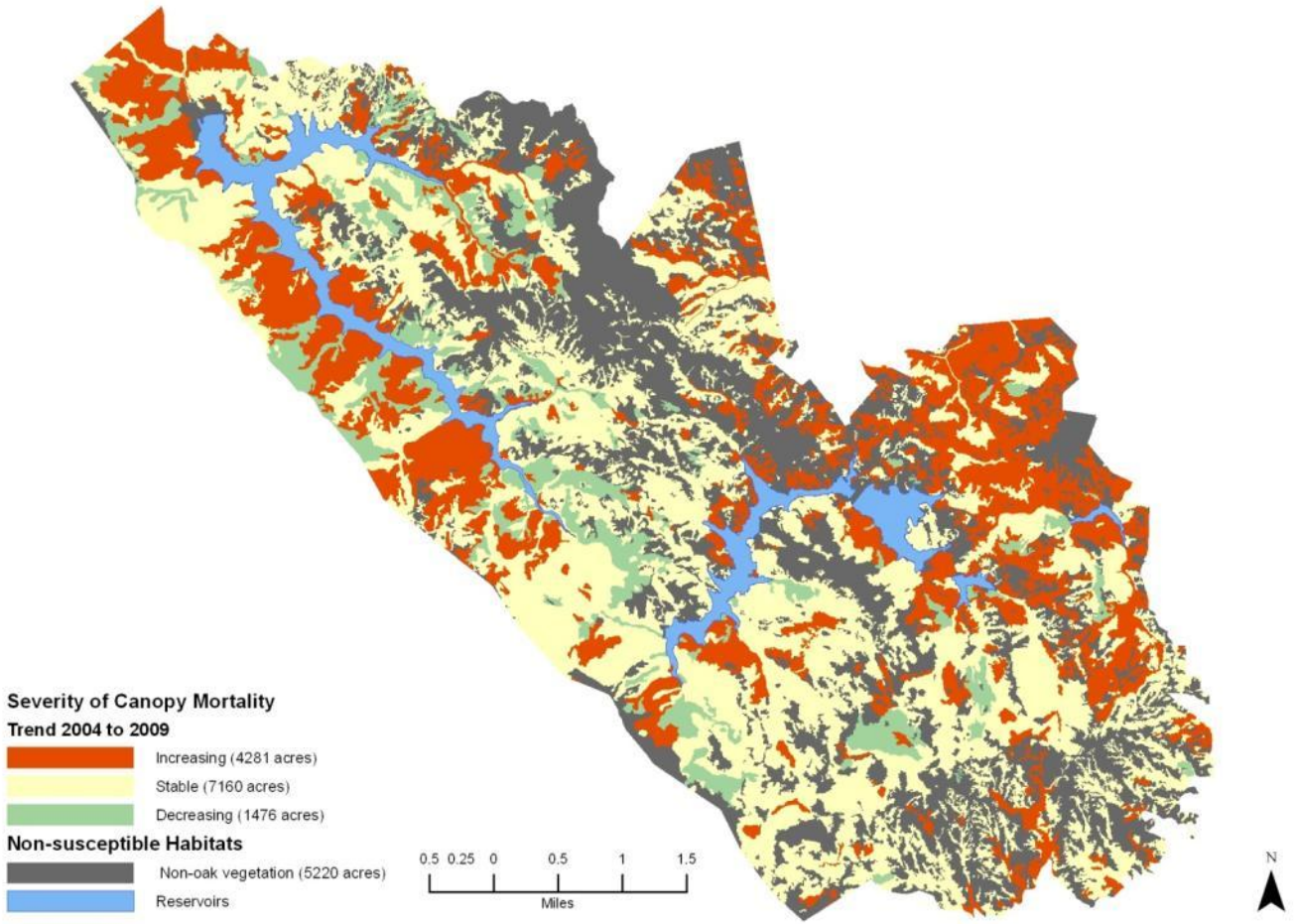
Results: Changes in canopy are not uni-directional



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Results: Gratuitous Slide with Too Much Information to Read

Type-conversion detected in 10 vegetation associations

2078 acres converted from tanoak dominated associations to others in 5 year period.

Type conversions not yet evident in coast live oak dominated stands.

2004 Vegetation Associations	Acres		2009 Vegetation Associations	Acres
California Bay -Tanoak	593.0		California Bay - Madrone	30.0
			California Bay Alliance	324.7
			California Bay -Canyon Oak	7.8
			California Bay Pure Stands	170.3
			Redwood /California Bay	49.8
			Redwood -Upland Mixed Hardwoods	10.4
Canyon Oak Alliance	6.8		California Bay -Canyon Oak	6.8
Douglas-fir -Mixed Hardwoods in Upland Forest Settings	12.5		Douglas-fir -California Bay Mapping Unit	12.5
Madrone Alliance	0.2		Douglas-fir -Mixed Hardwoods in Upland Forest Settings	0.2
Madrone -California Bay -Tanoak Forest	615.4		California Bay - Madrone	445.0
			California Bay Alliance	138.5
			California Bay -Coast Live Oak	2.0
			California Bay -Interior Oak	4.4
			California Bay Pure Stands	24.7
			Madrone Alliance	0.9
Redwood / Tanoak	138.4		Redwood /California Bay	98.4
			Redwood -Douglas-fir	37.7
			Redwood -Pure Stands	0.1
			Redwood -Upland Mixed Hardwoods	2.1
Redwood -Douglas-fir	38.4		Redwood /California Bay	38.4
Redwood -Upland Mixed Hardwoods	261.3		Redwood /California Bay	242.2
			Redwood Alliance	19.1
Tanoak Alliance	53.5		California Bay Alliance	44.2
			Redwood /California Bay	9.3
Tanoak -California Bay -Canyon Oak Higher elevations	356.9		California Bay - Madrone	153.6
			California Bay Alliance	106.7
			California Bay -Canyon Oak	85.1
			California Bay Pure Stands	6.3
			Coast Live Oak - Madrone Lower elevation Mixed Broadleaf	0.4
			Douglas-fir -Mixed Hardwoods in Upland Forest Settings	3.7
			Redwood -Douglas-fir	1.0
Grand Total	2076.3			2076.3

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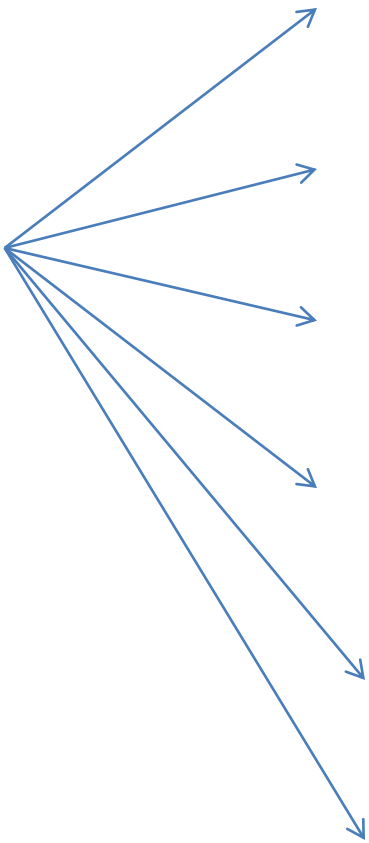
Results: Tan oak is no longer a canopy dominate

California Bay –Tanoak (593 acres)



California Bay - Madrone
(30 acres)

California Bay Alliance
(325 acres)

California Bay -Canyon Oak
(8 acres)

California Bay Pure Stands
(170 acres)

Redwood /California Bay
(50 acres)

Redwood -Upland Mixed Hardwoods
(10 acres)

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Results: Ground Floristics

- No notable recruitment of replacement species
- No notable recruitment of in-stand seedlings/saplings other than Douglas-fir
- Existing canopy-level Douglas-fir, redwood, and California bay gradually filling canopy gaps
- Both shrub and herbaceous cover increased in impacted stands but it is unclear if this is due to changes in the canopy or multiple years of above average rainfall.
- Invasive species coverage, primarily French broom, increased by over 400%--unclear if this is related to changes in canopy coverage or decreased control efforts

Impacts

- 10% of vegetation management budget now goes to hazard tree removal.
- Road and trial access significantly impaired.
- Wildfire risk increase in the short term but decrease as downed trees break down.

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Impacts: Wildlife

Thus far, most monitored bird species are stable or increasing in number. Long-term concerns are focused on acorn-dependent species and northern spotted owls.

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Assessment of Management Options: Prevention: Agri-Fos

Cost, high disease incidence, and institutional pesticide ban on the watershed make this option implausible.

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Eradication/Containment: The Curry County Option

Cost, expansive disease incidence, local public opinion, and institutional pesticide ban on the watershed make this option implausible.

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Possible Response: Revegetation

Suitable Replacement species not self-evident.

Disease cycle has not run its course yet.

Expanse of impacted areas well exceeds District's capacity.

Climate change a confounding factor.

This option is likely premature.

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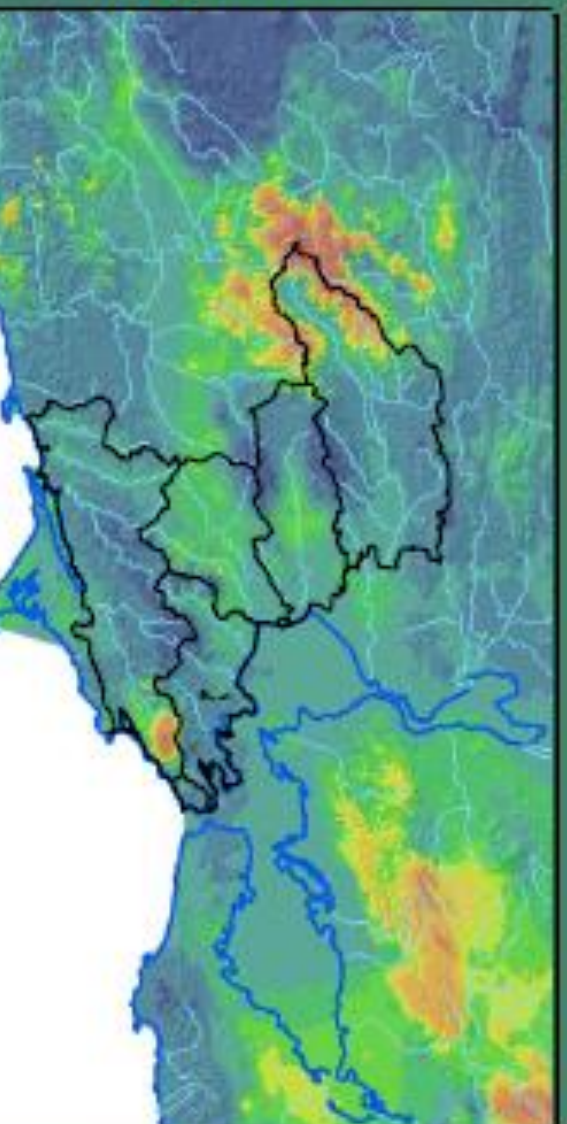
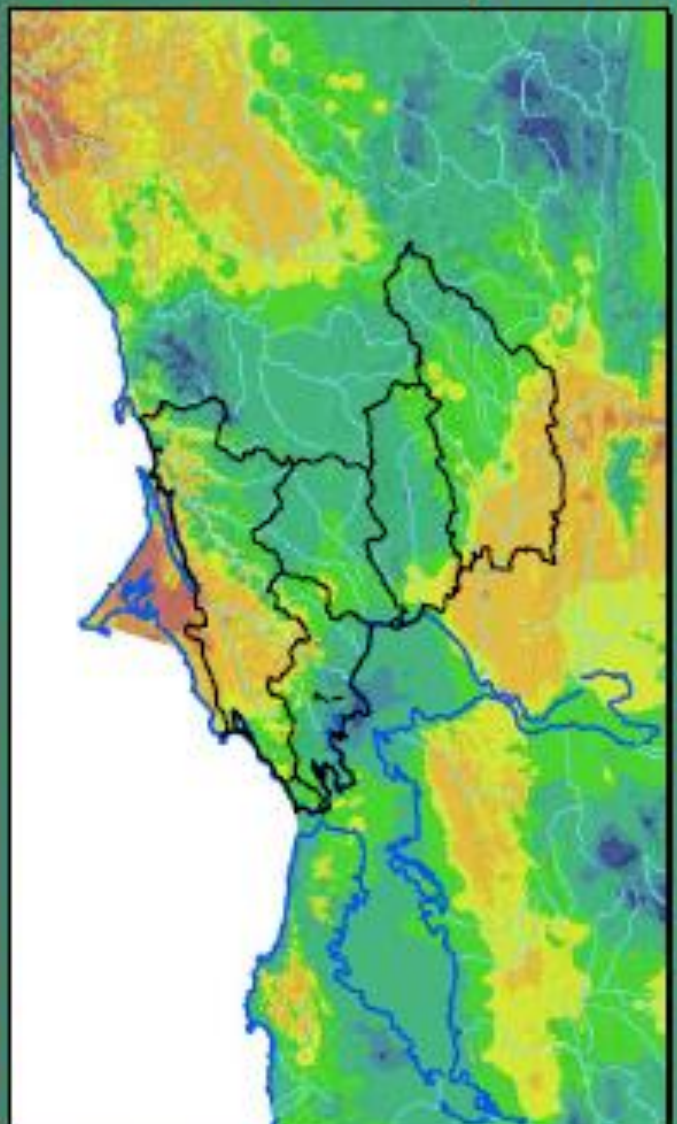
Changes in Annual Climate from 1970-2007

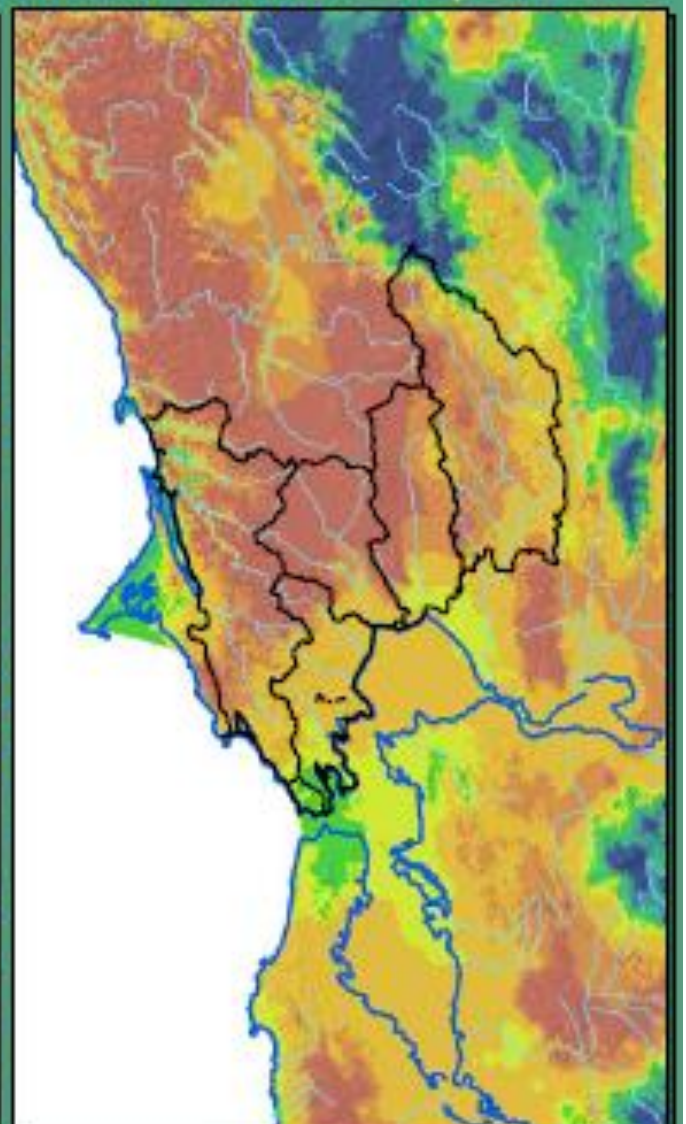
Precipitation

Maximum Air Temperature

Minimum Air Temperature







Strategically Chosen Fuels Manipulation

Price Tag is $1000 – $10,000 per acre depending on conditions

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What Can We Do?

- Scale back the Fuel break system to defensible space around structures and emergency access routes.

- Weed detection and eradiation in high-priority zones along roads and trails;

- Hazard tree removal along access corridors and around facilities.

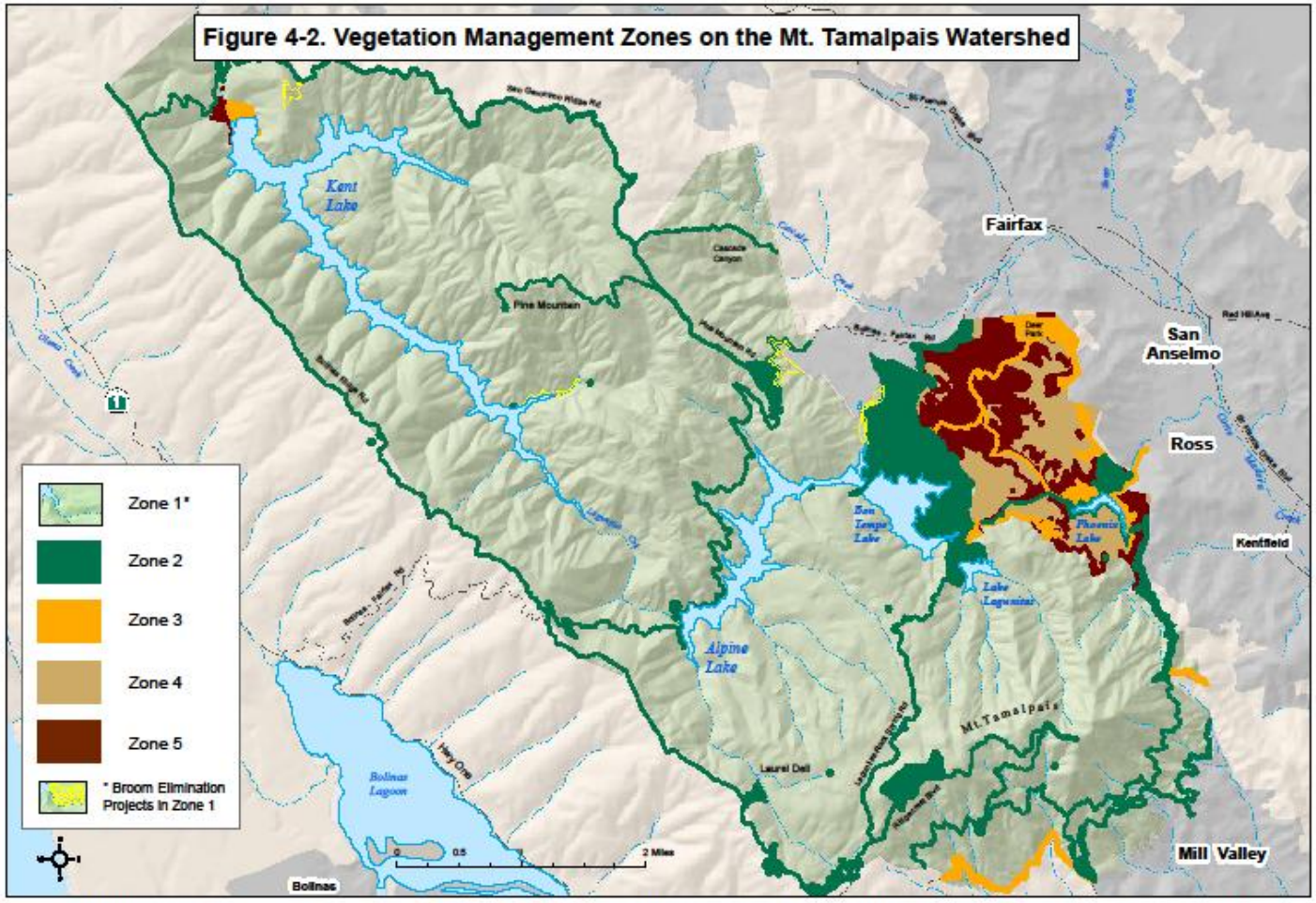

Figure 4-2. Vegetation management objectives prioritize weed elimination, Early Detection/Rapid Response (EDRR), and habitat restoration in Zones 1 and 2. Vegetation management objectives in Zone 3 focus on fuelbreak maintenance. Vegetation management in Zone 4 and Zone 5 is limited to EDRR and highly localized habitat restoration. See Section 6.6 for more information.

And.. What the Hell… Replacement Species Pilot Pine Point Climate Adaptation Test Zone

Step 1: Pile and burn tanoak and coast live oak debris.

Step 2: Control invasives

Step 3: Revegetate with coast live oak ***PLUS*** alternate oak species: Oregon white.

Step 4: Monitor

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Conclusions

- The vegetation situation is bad and getting worse.
- Management options are extremely limited.

HOWEVER

- Aerial photo interpretation combined with CNPS/CDFG vegetation classification rapid assessment protocols is an efficient means of monitoring landscape-scale change over time and yields produces analytic tools that meet multiple management tools.

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These Data are Available!

- Email Jklein@marinwater.org

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  - Nevin Cullen
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