ASSESSING 2001-2003 FOREST MORTALITY IN SOUTHERN CALIFORNIA USING MULTIPLE REMOTE SENSING PRODUCTS COMBINED WITH REMEASURED FOREST INVENTORY PLOTS

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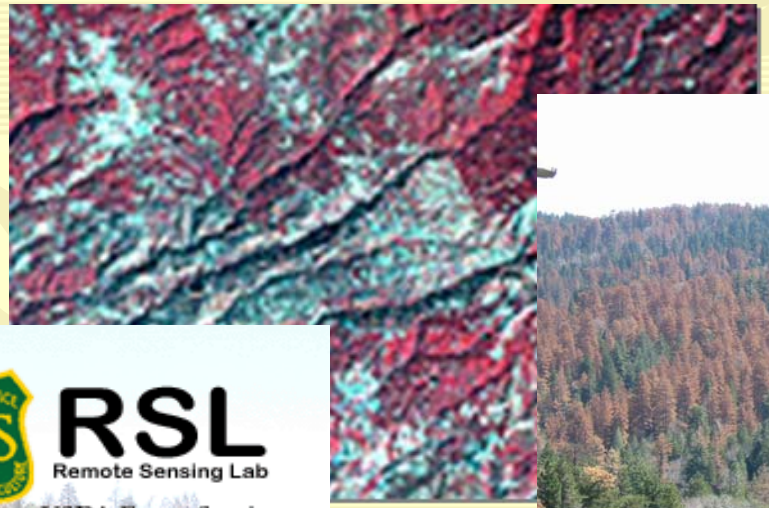
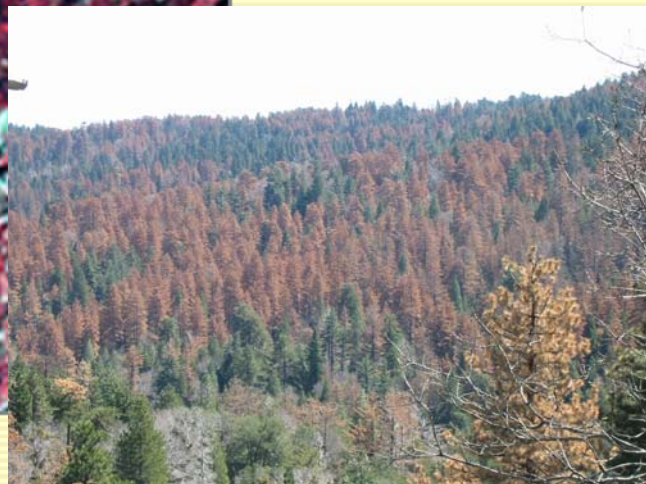
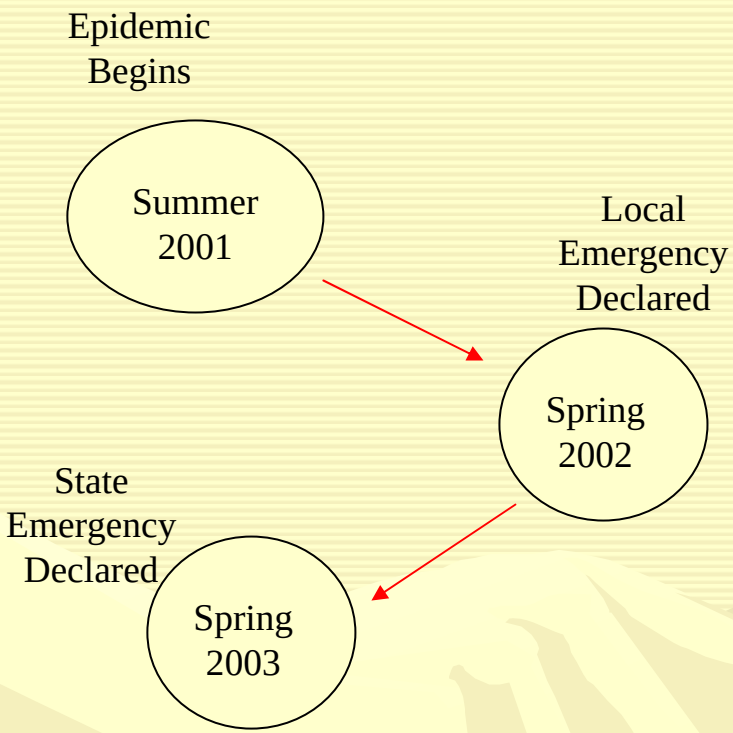




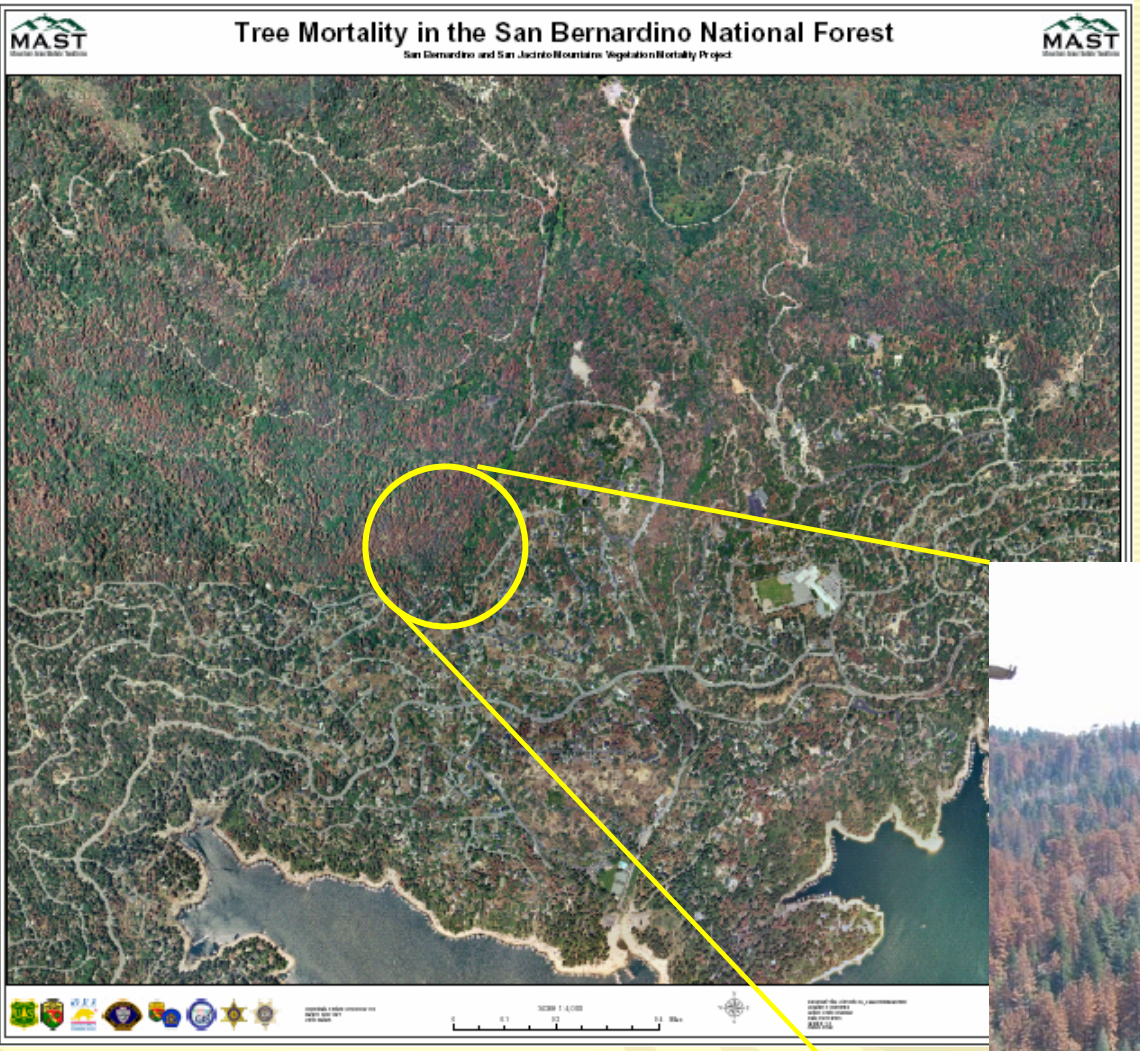
FRAP Fire and Resource Assessment Program, California Department of Forestry and Fire Protection
Forest Health Protection
RSL Remote Sensing Lab
USDA Forest Service

Epidemic Begins

Chronology

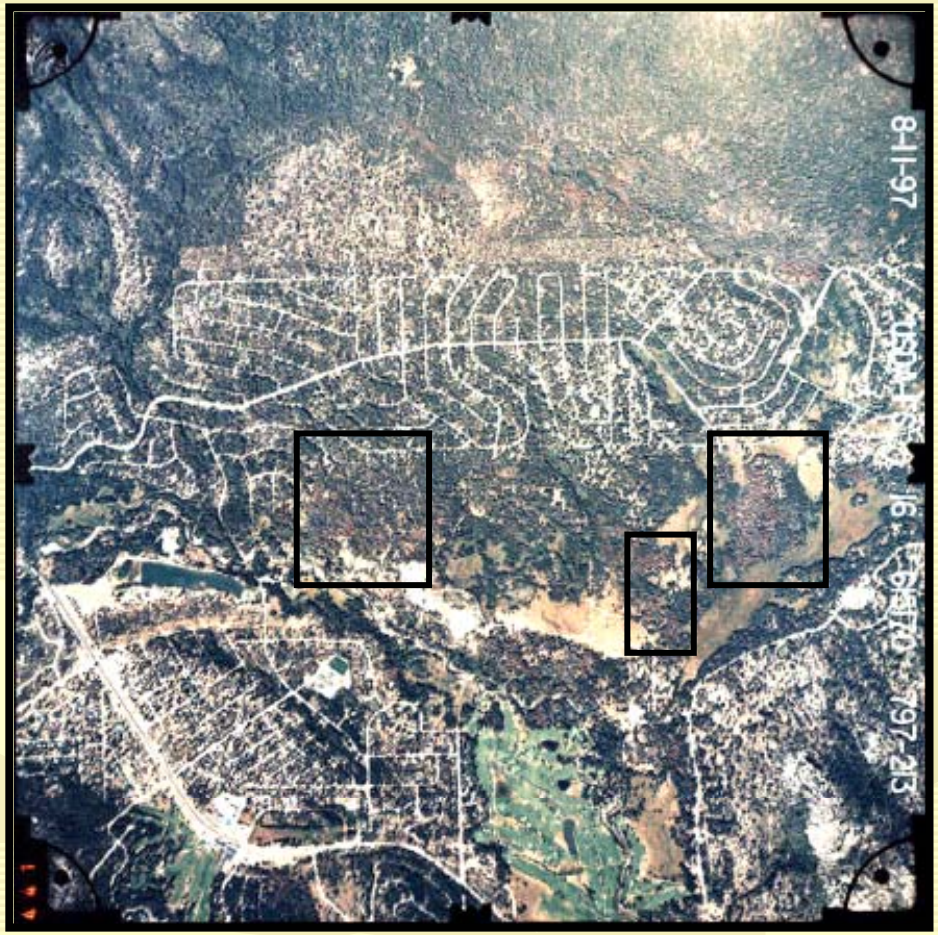


- In 2001 a massive pine bark beetle epidemic became evident
- Drought-induced
- Approximately one million acres have experienced severe tree mortality
- Adjacent to major metropolitan areas in San Diego, Riverside and San Bernardino Counties
- Risks from fire and falling trees pose a major threat to public safety, private property, and ecosystem health



Examples of Tree Mortality as of April 2003

Challenges



- Rapidly evolving forest mortality
- Increasing risk from falling trees and extreme fire events
- Many diverse assets at risk
- Many different entities with responsibilities and liabilities
- Need for operational decision support as well as long term monitoring of forest recovery

Cooperative Strategy

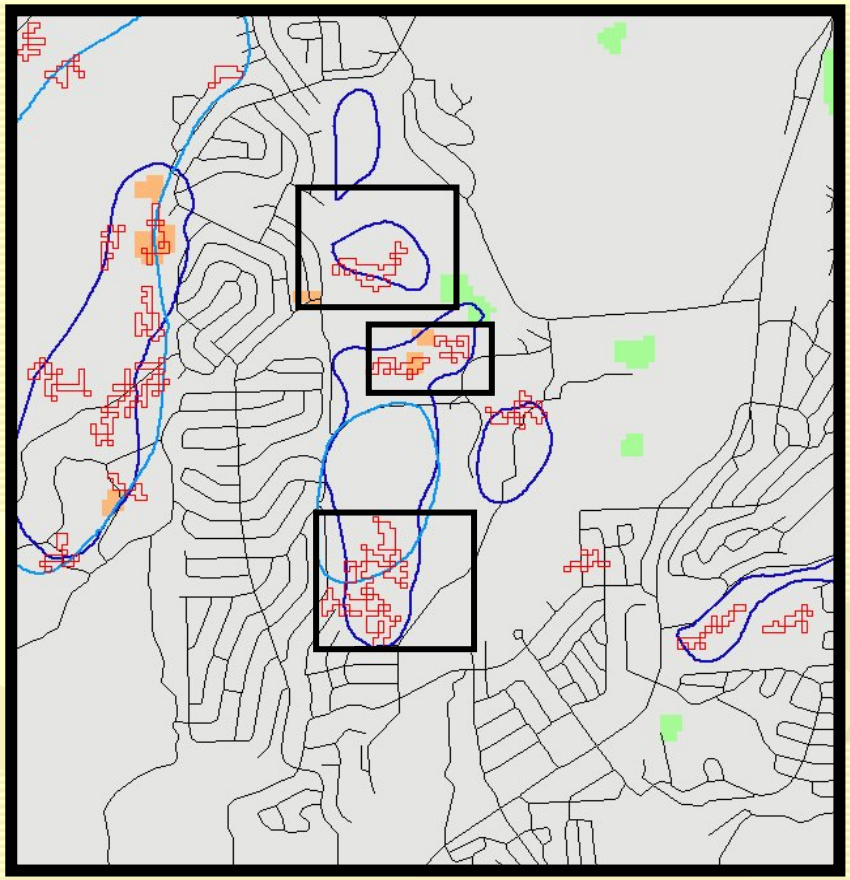
Two main project components

- Develop decision support tools in GIS to provide Operational Support capabilities (tree removal, evacuation planning, treatment priorities)
- Conduct Monitoring activities using aerial survey, remote sensing and FIA inventory
- Leverage existing data and programs
  (FIA, RSL, FHP, FRAP)

FRAP Fire and Resource Assessment Program California Department of Forestry and Fire Protection
Forest Health Protection
RSL Remote Sensing Lab USDA Forest Service

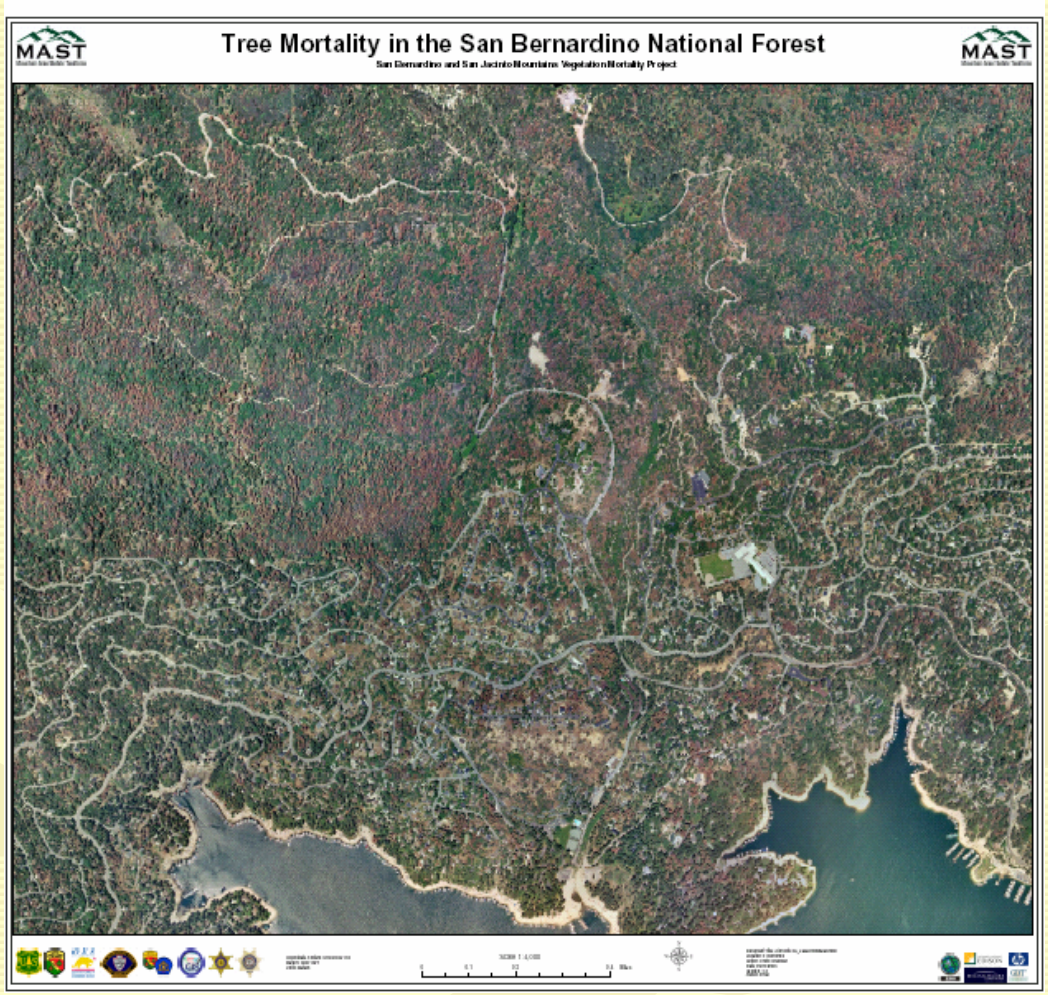
Support Operational Needs

Provide Analysis support to Agencies



- Provide tree mortality estimates using FHP aerial survey, FRAP Mortality data and existing FIA Inventory
- Conduct Wild Life Habitat Assessments
- Model Potential Fire Behavior
- Help Prioritize & Track treatments
- Assess Wood Utilization/Disposal options

Mapping and Monitoring Activities



Map Tree Mortality through 2003 on 963,000 acres of public and private lands

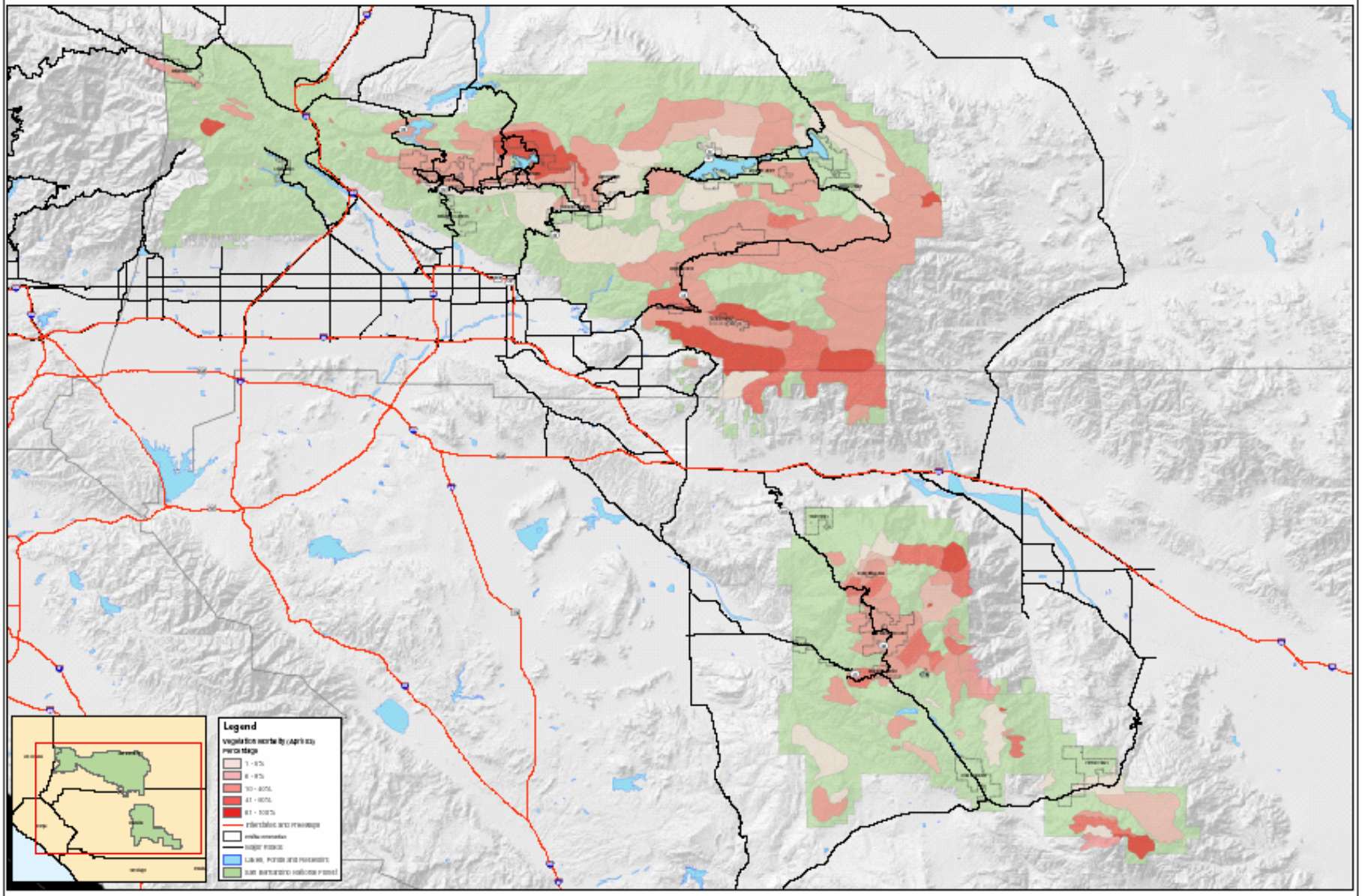
- Update seamless vegetation data across all lands
- Re-Measure approximately 100 FIA plots on public and private lands
- Assess impacts of mortality on key assets including housing, infrastructure and ecological health.
- Generate a report and publish on the World Wide Web.

Southern California 2003 Mortality

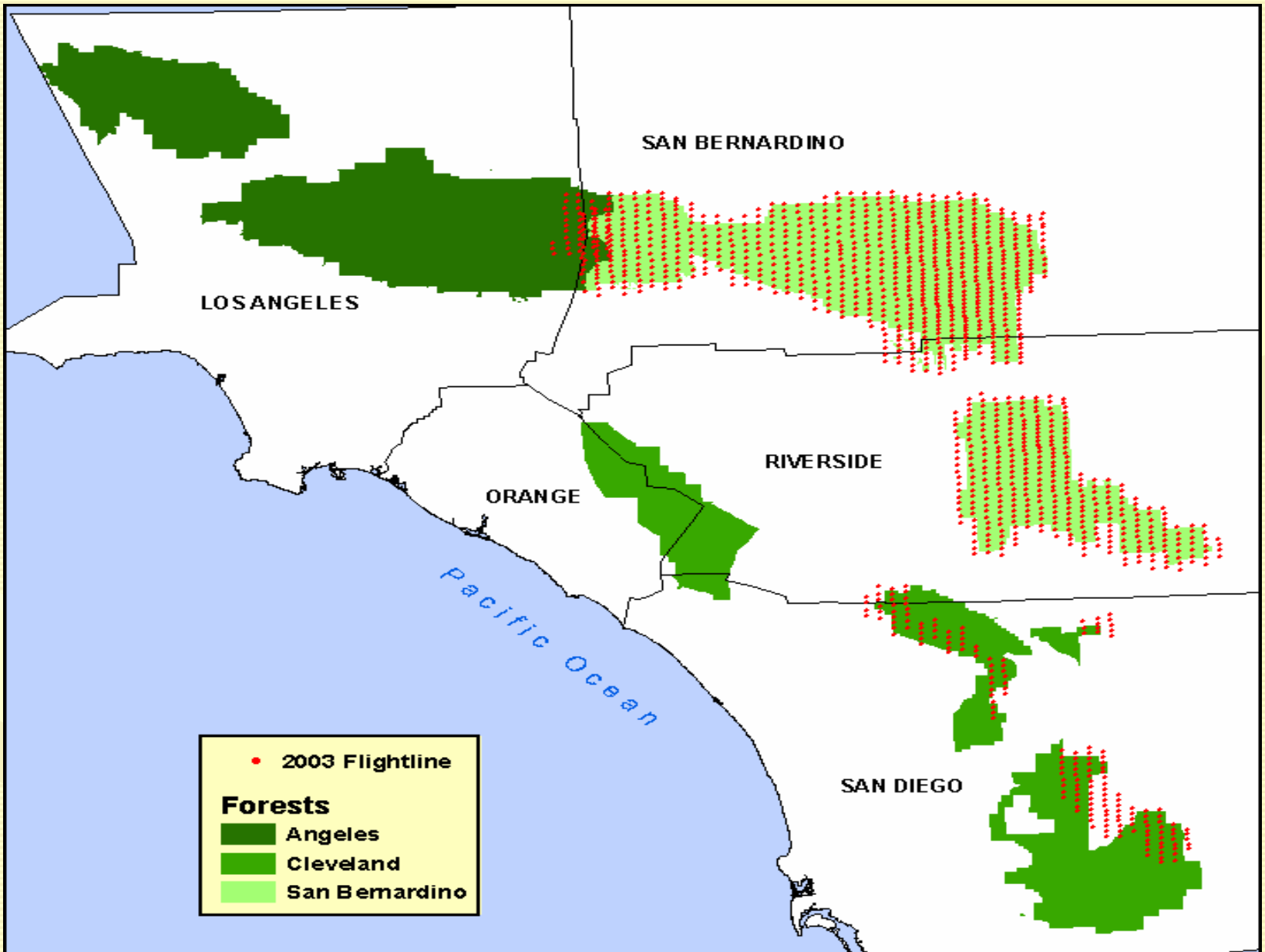
- Major Mortality event 2001-2003
  - Occurred on approximately 963,000 acres
  - The majority of mortality was on National Forest Lands
  - Change detection and aerial sketch mapping was completed and used along with a forest type map to create a mortality strata layer for area estimates
  - FIA plots were re-measured for tree mortality on all lands winter of 2003
  - An estimate of live and dead trees per acre by species, diameter, and associated volumes were developed

San Bernardino National Forest - Vegetation Mortality

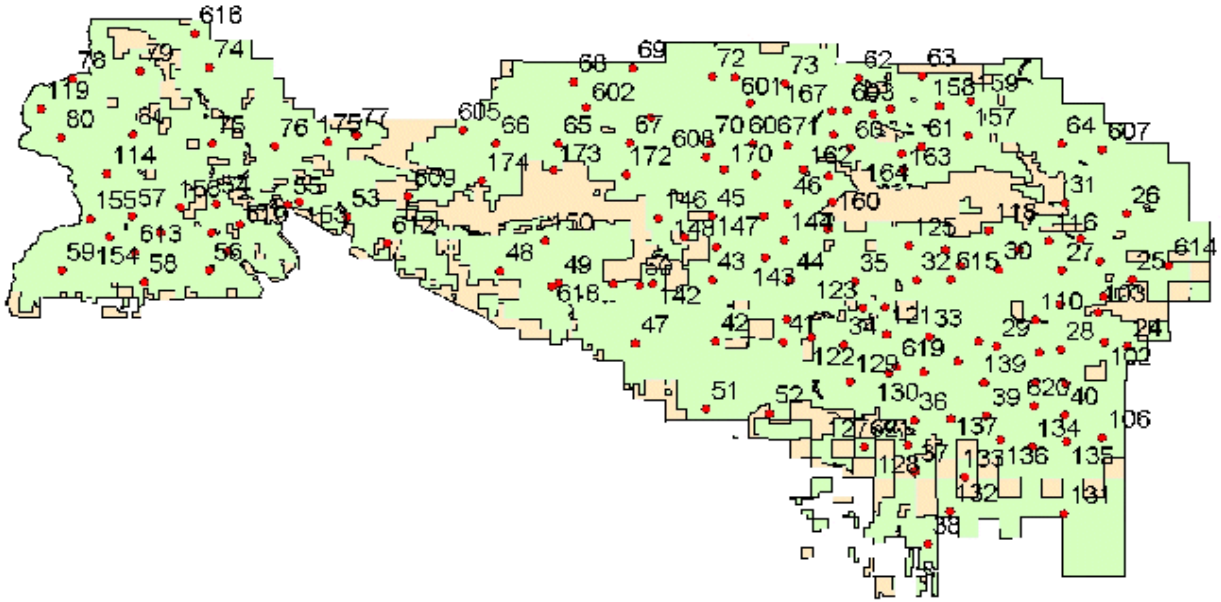
San Bernardino and San Jacinto Mountains Vegetation Mortality Project



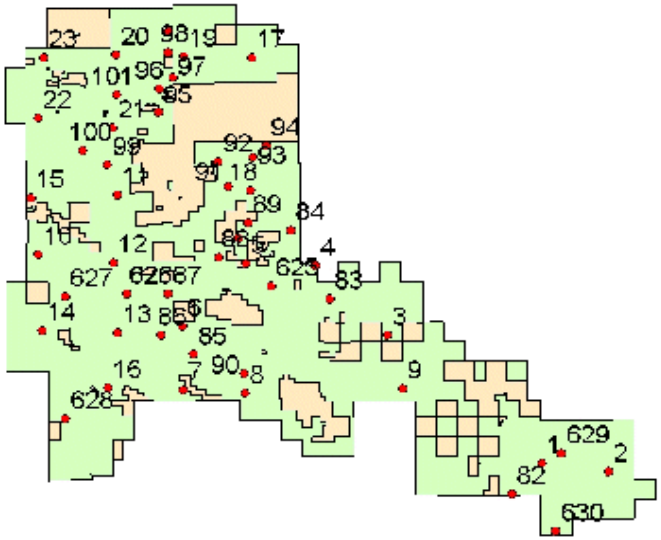
Special Aerial Photo Flight



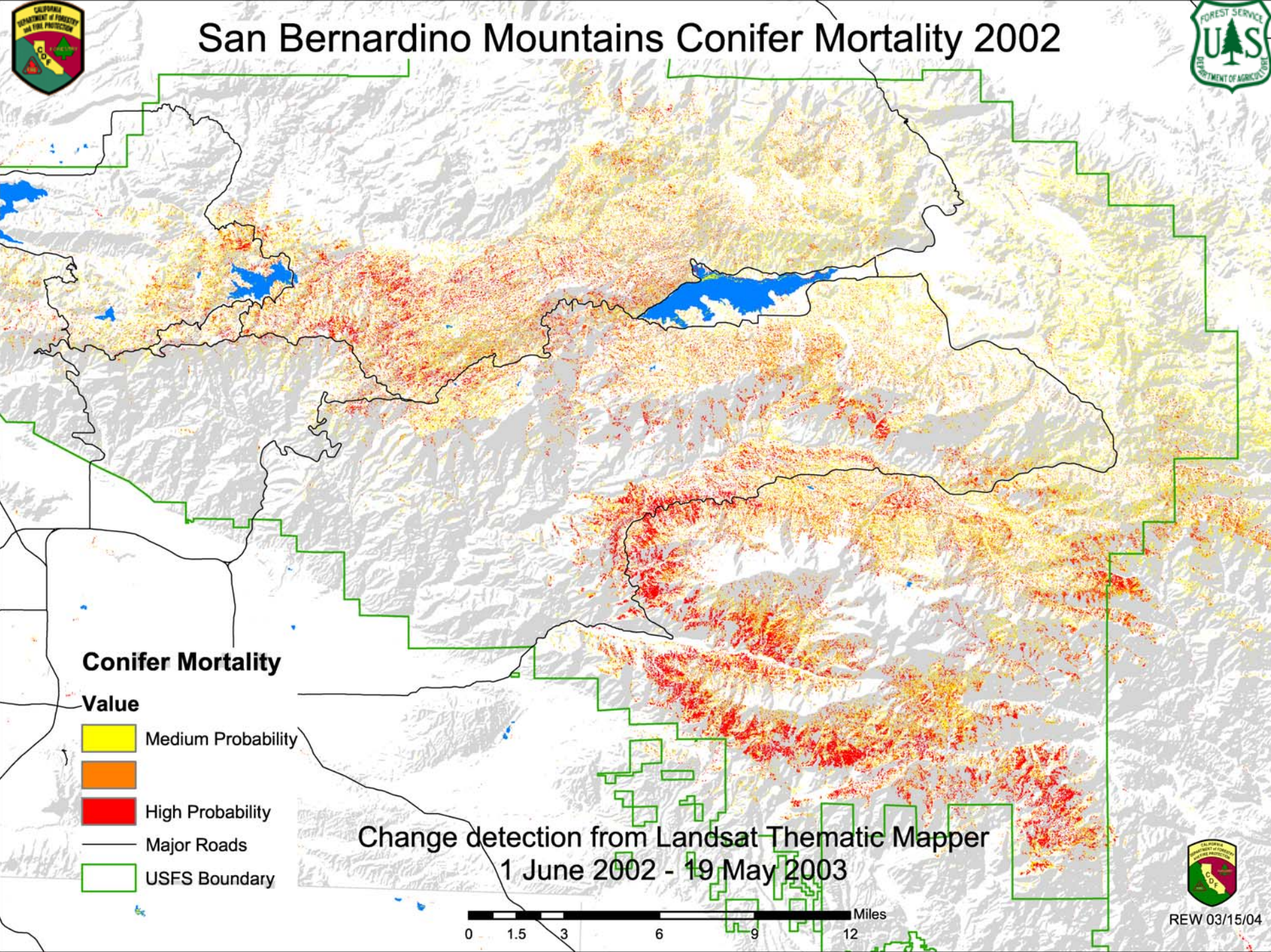
1.7 Mile Grid Plots on Forested Lands

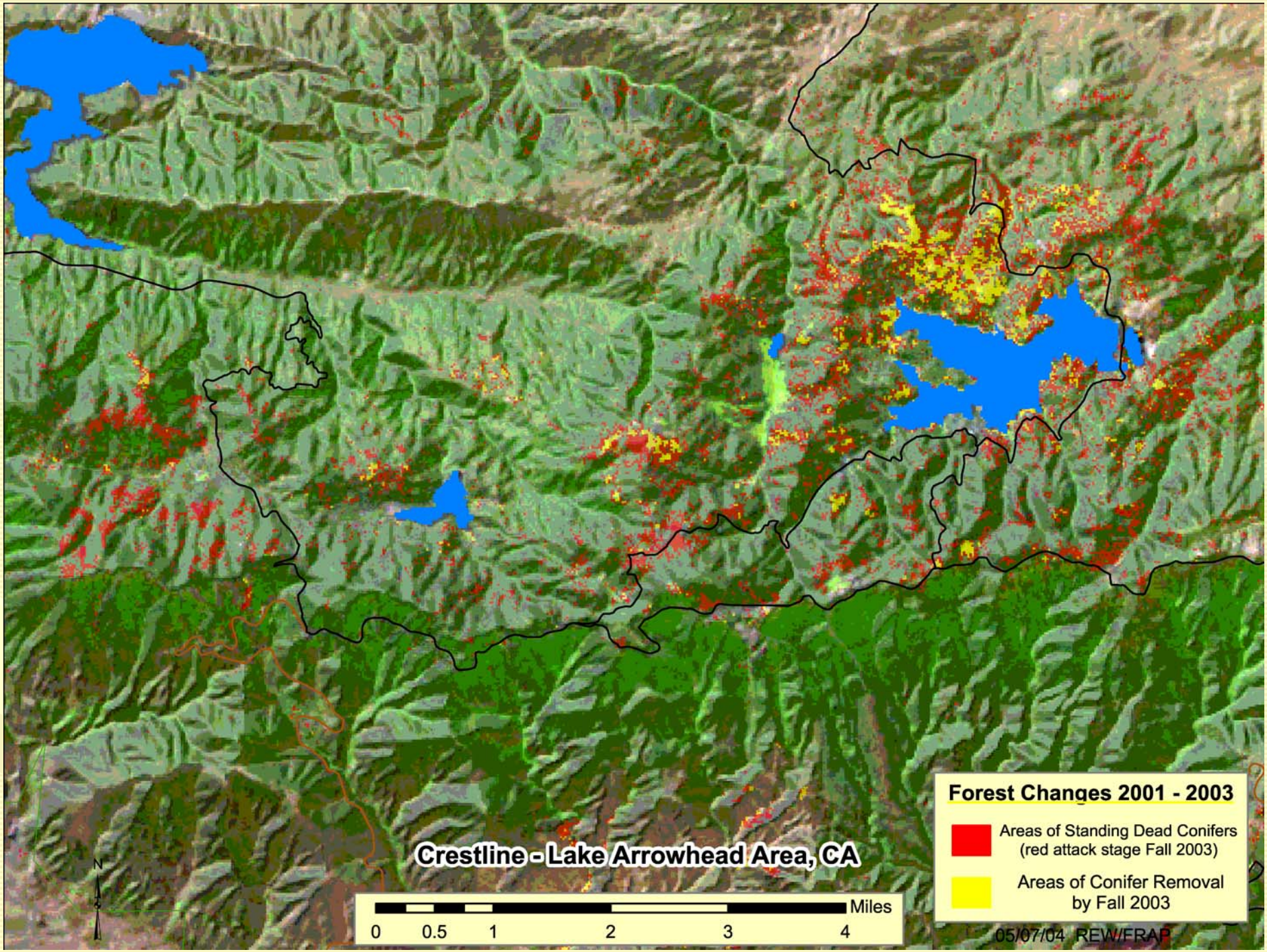


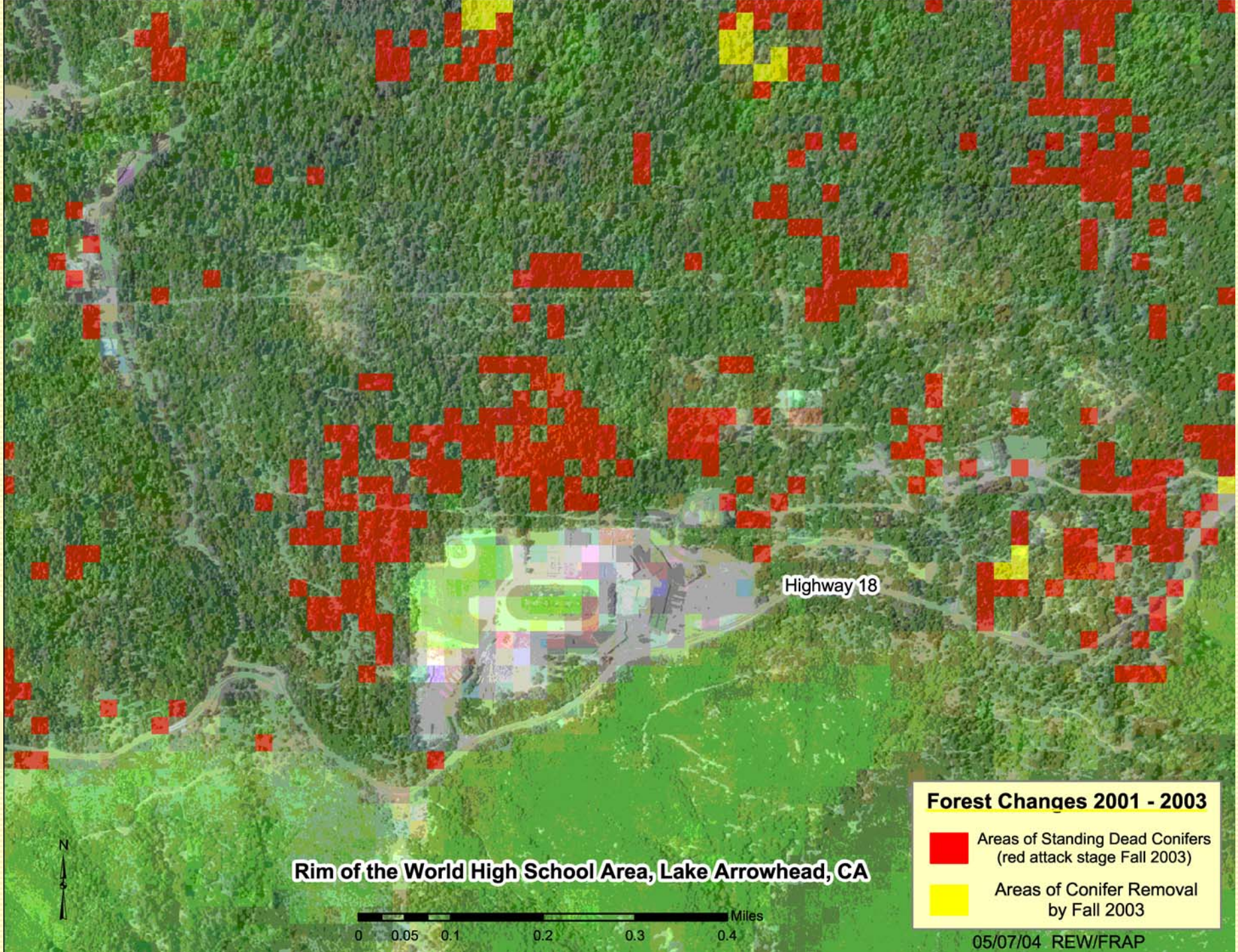
San Bernardino National Forest
GRID Inventory Plots 2000



San Bernardino Mountains Conifer Mortality 2002



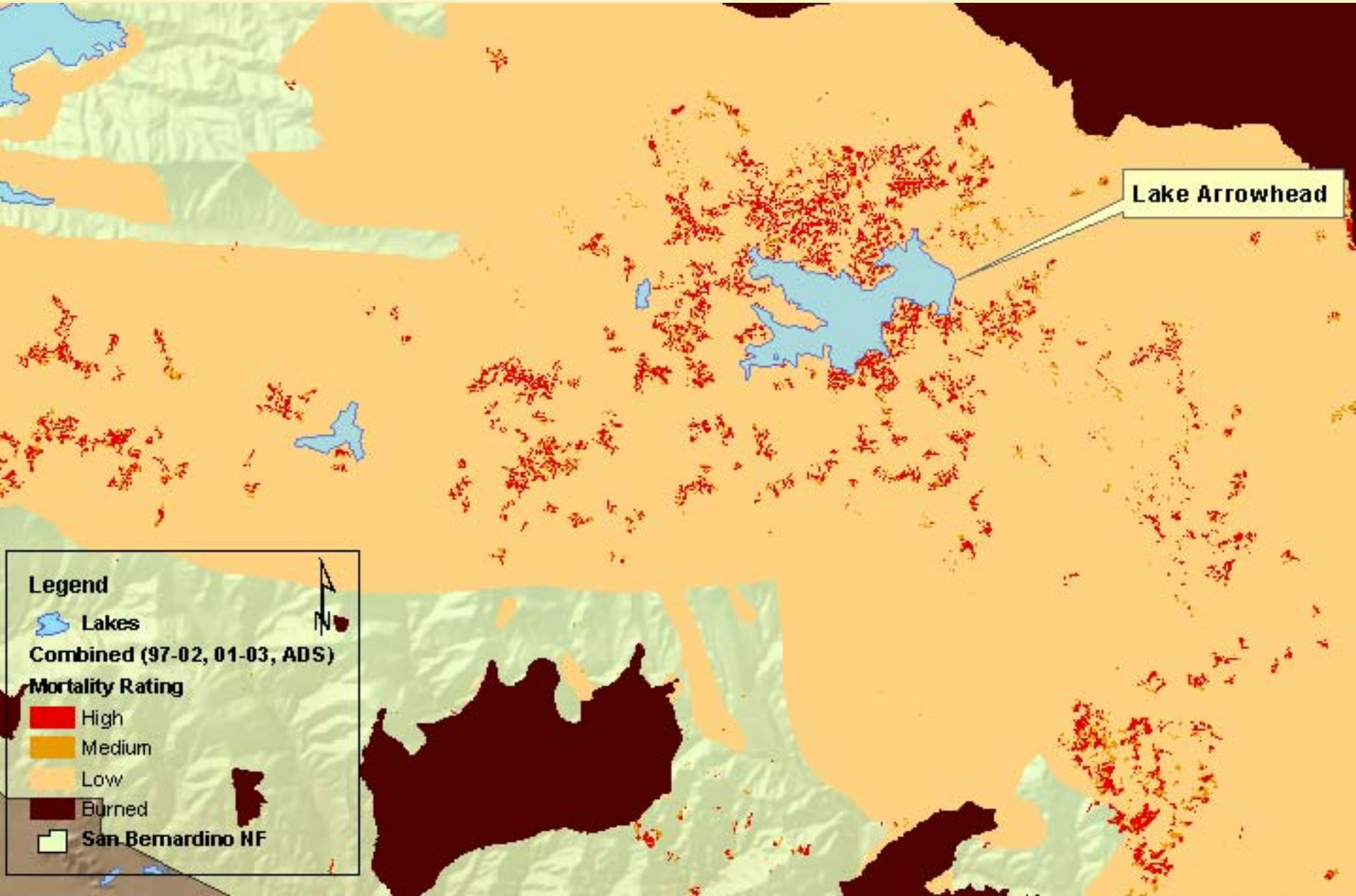

Crestline - Lake Arrowhead Area, CA
Forest Changes 2001 - 2003
Areas of Standing Dead Conifers (red attack stage Fall 2003)
Areas of Conifer Removal by Fall 2003
Miles
0
0.5
1
2
3
4
N
05/07/04 REW/FRAP


Highway 18
Forest Changes 2001 - 2003
Areas of Standing Dead Conifers (red attack stage Fall 2003)
Areas of Conifer Removal by Fall 2003
Rim of the World High School Area, Lake Arrowhead, CA
N
Miles
0 0.05 0.1 0.2 0.3 0.4
05/07/04 REW/FRAP

Regionalizing Mortality Information

- **Existing Mid Level Vegetation Map**
  - **2.5 acre MMU**
  - **1:24,000 scale**
  - **National Standards – Anderson 1 and Physiognomic Order, Class, and Subclass**
  - **Dominant Vegetation Types**
- **Regionalized change detection pixels into 5 meter vegetation map segments**
- **Generalized change pixel counts by segment into mortality classes**

Segmentation and Regionalization



Combining Forest Types

- Four Pine Dominance Types were aggregated into a Pine Group
- Four Fir Dominance Types were aggregated into a Fir Group
- All Hardwood Dominance Types were aggregated into a Hardwood Group
- Sub Alpine and Pinyon Juniper types were not aggregated due to low number of plots

Creating Mortality Classes

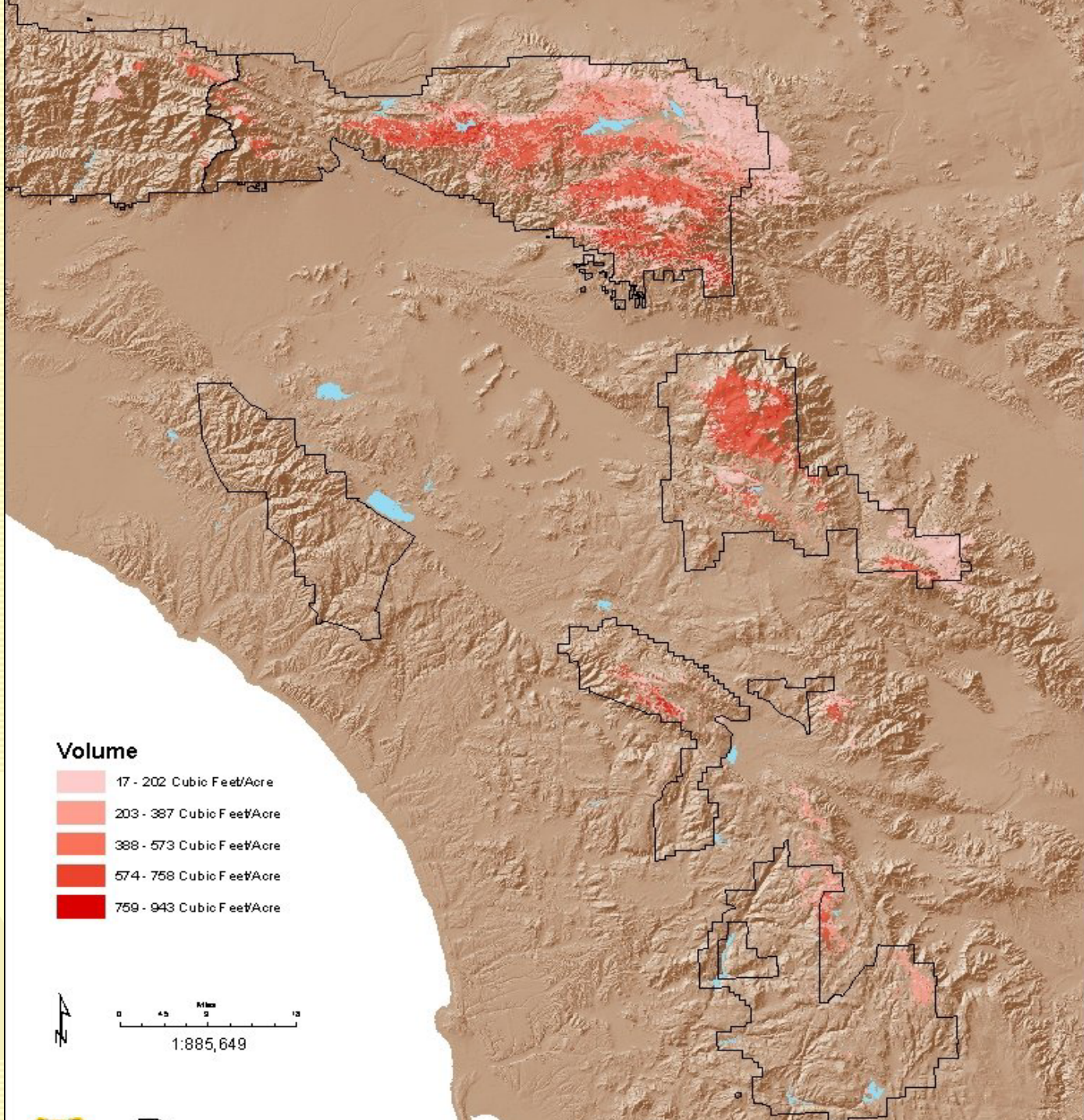
Mortality Class	Canopy Loss Range	Mid-point value
Little or no change	0-15%	8%
Low mortality	16-40%	28%
Medium mortality	41-70%	56%
High mortality	>70%	86%

Stratifying FIA Plots

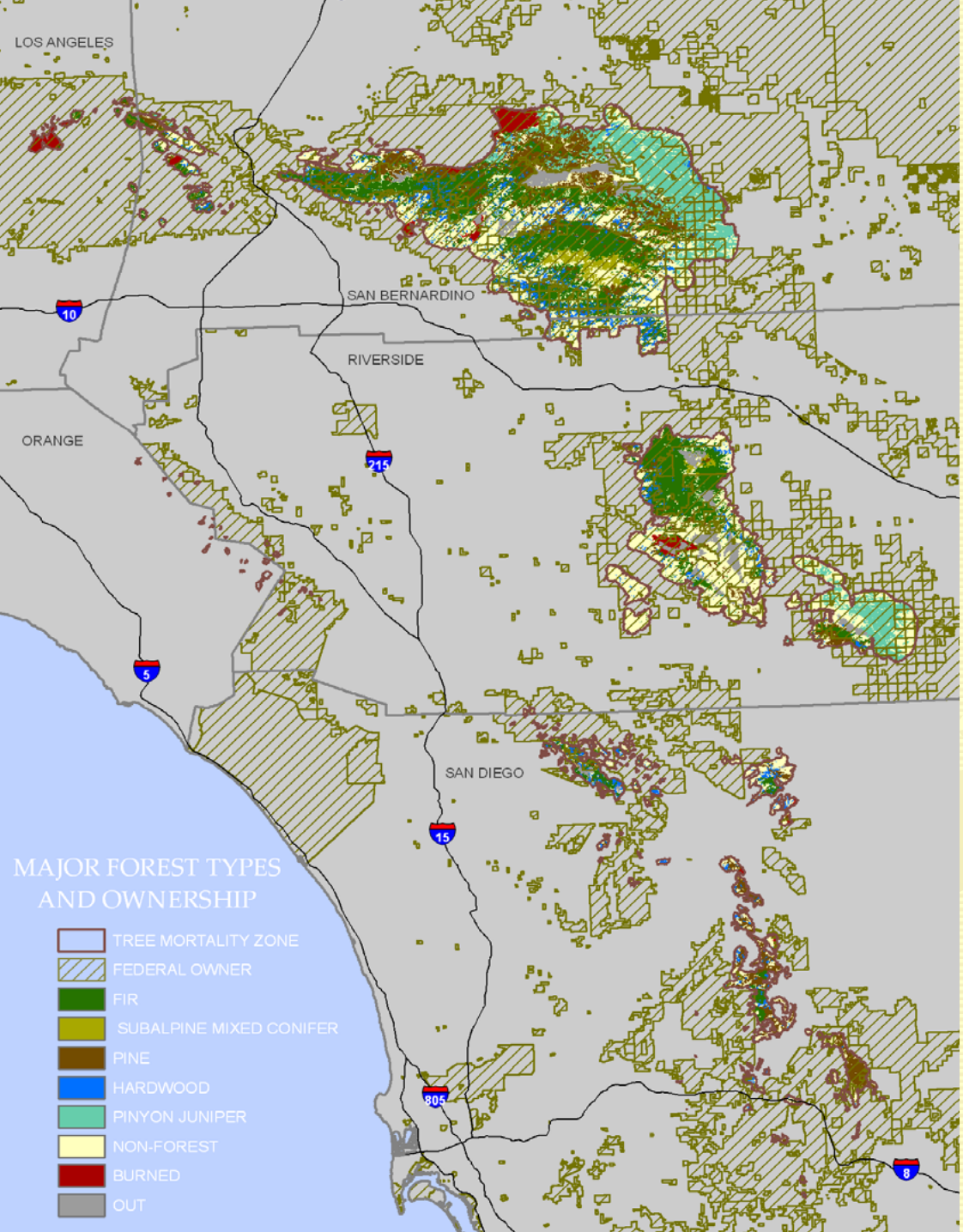
Number of Plots and Basal Area Mortality			
Mortality Class	**Pine**	**Fir**	**Hardwood** combined
Low mortality	27 plots 11.7 BA/Ac	36 plots 28.6 BA/Ac	9 plots 4.1 BA/Ac
Medium mortality	4 plots 13.1 BA/Ac	17 plots 29.8 BA/Ac	5 plots 17.4 BA/Ac
High mortality	3 plots 36.4 BA/Ac	5 plots 43.7 BA/Ac	2 plots 0 BA/Ac

Southern California 2003 Mortality

Cubic Feet Volume of recent dead trees 5 inches DBH and greater



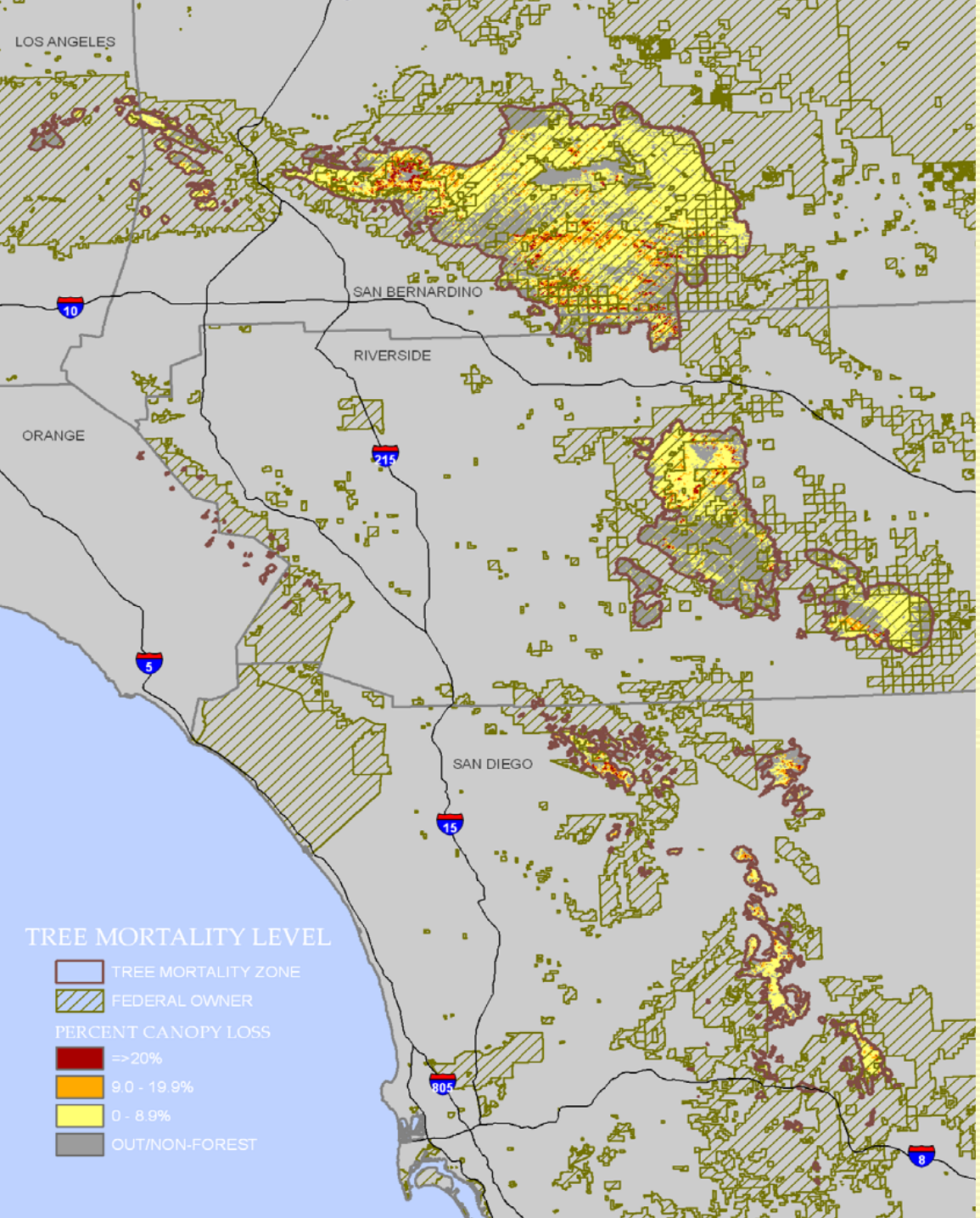
Mortality by Major Forest Type



Mortality Level By Major Forest Type

Major Forest type	≥ 20 % mortality	> 8-19 % mortality	0-8 % mortality	Total
Fir	15,198	33,095	102,637	150,930
Pine	4,616	11,182	69,087	84,885
Hardwood			47,904	47,904
Pinyon juniper			81,271	81,271
Subalpine mixed			9,715	9,715
Total	19,814	44,277	310,614	374,705

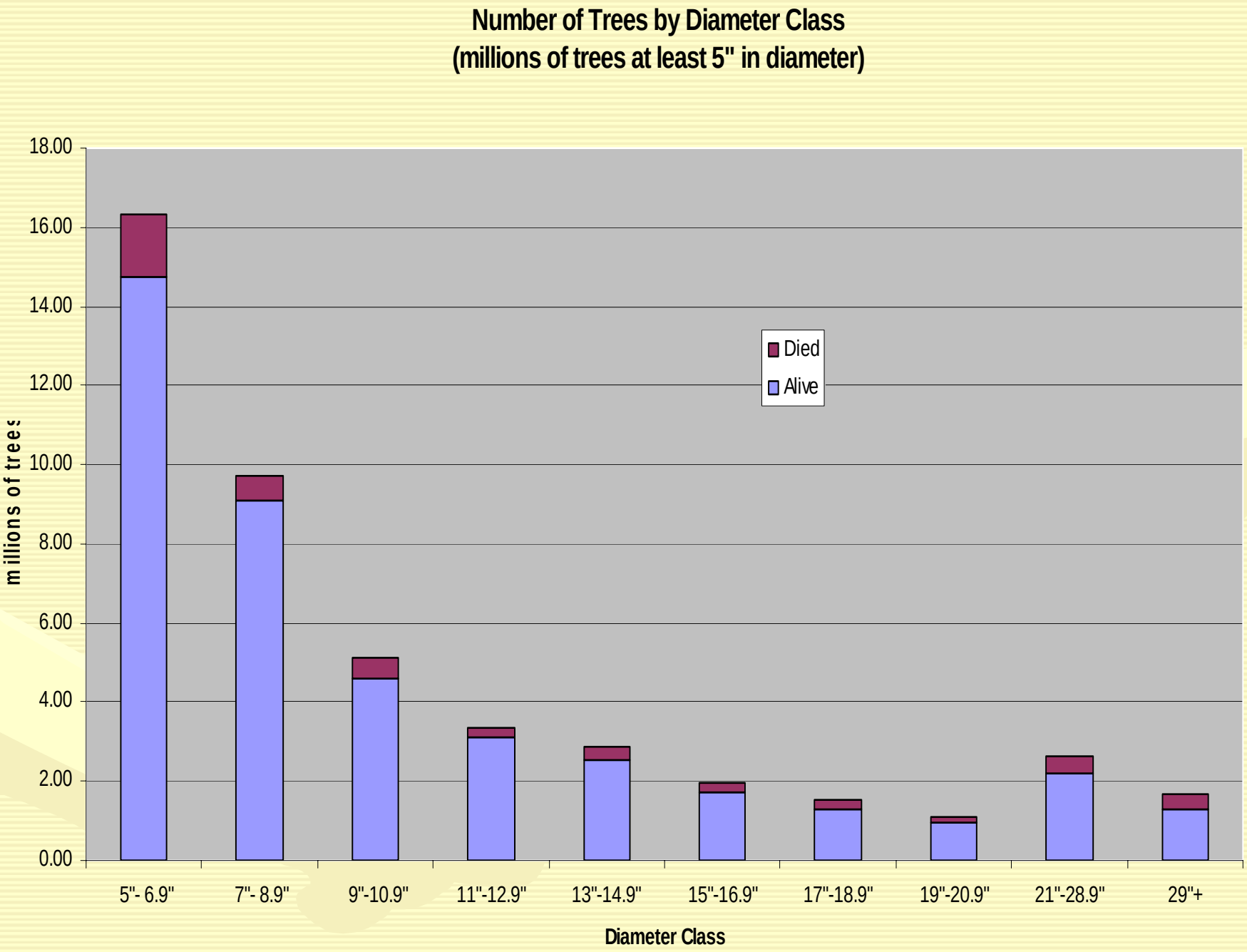
Mortality Level by Ownership

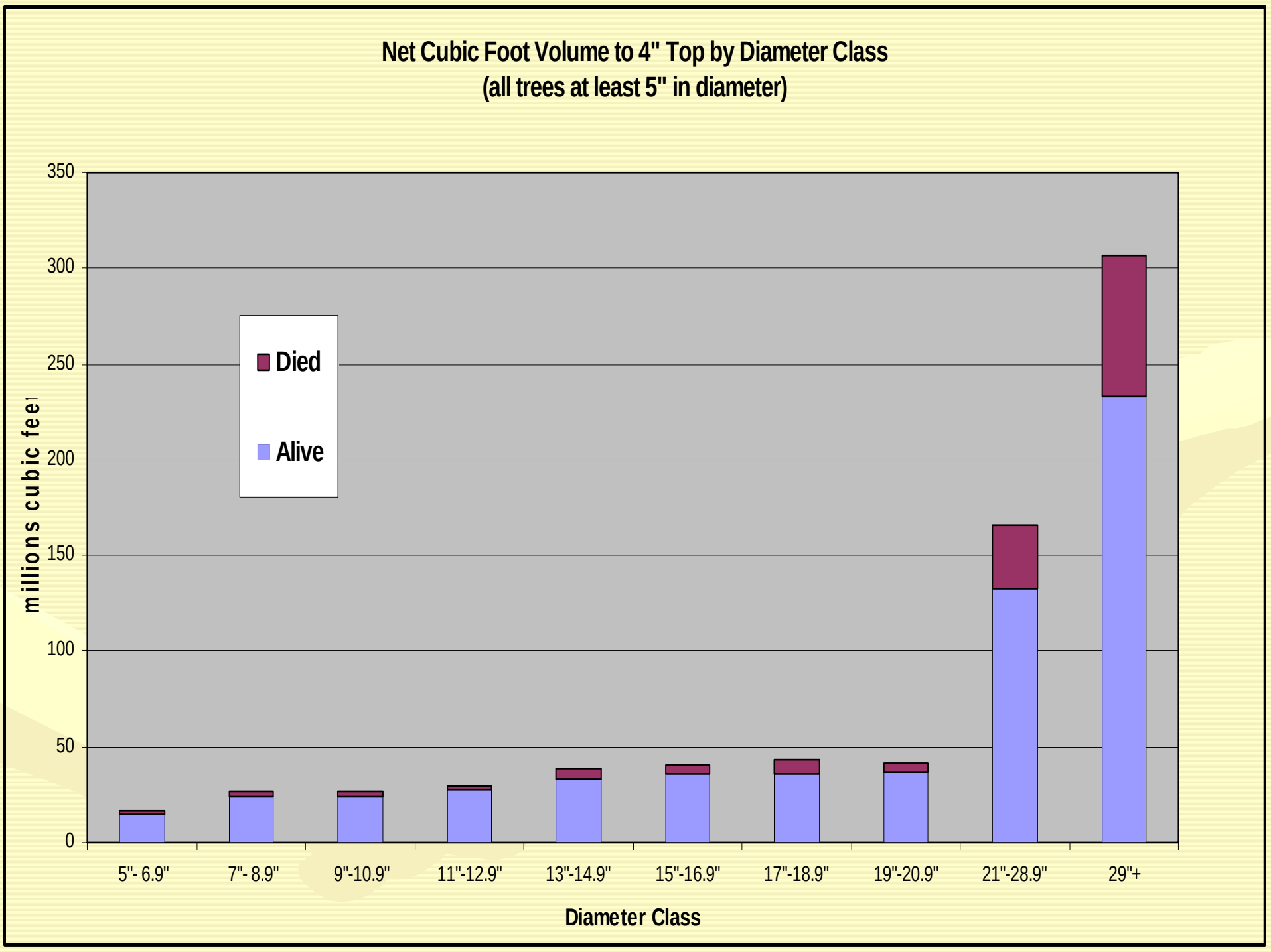


Area and Volume by Owner

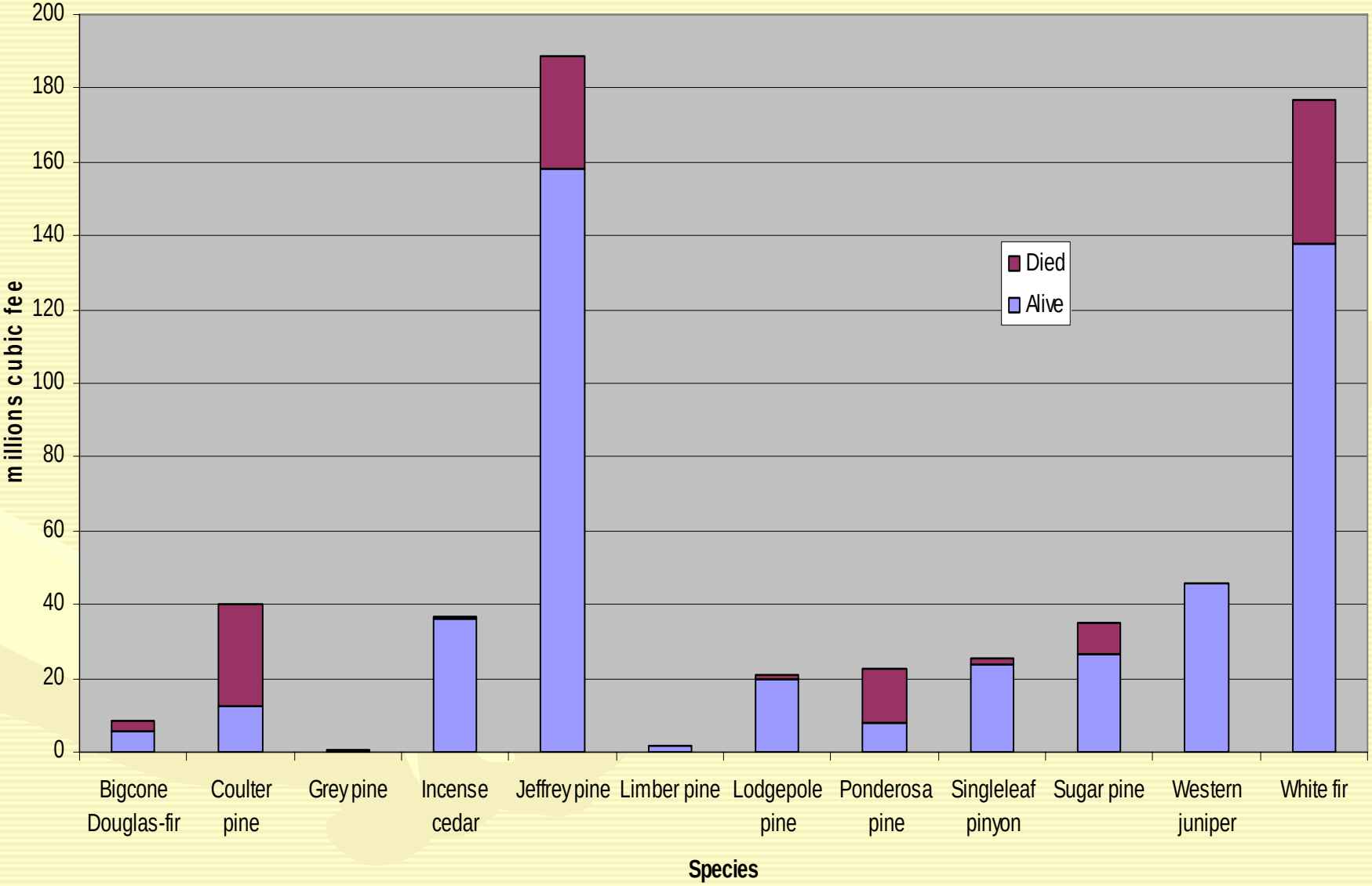
Owner	≥ 20 % mortality	> 8-19 % mortality	0-8 % mortality	Grand Total
Federal	12,005	31,800	242,801	286,606
Non Federal	7,809	12,477	67,813	88,099
Grand Total	19,814	44,277	310,614	374,705

Owner	*Acres	Cubic feet	Trees	Tons
Federal	286,606	103,455,146	3,438,154	2,109,523
Non Federal	88,099	33,394,018	1,186,292	688,135
Grand Total	374,705	136,849,164	4,624,446	2,797,658


Number of Trees by Diameter Class
(millions of trees at least 5" in diameter)
18.00
16.00
14.00
12.00
10.00
8.00
6.00
4.00
2.00
0.00
millions of trees
Died
Alive
5"- 6.9"
7"- 8.9"
9"-10.9"
11"-12.9"
13"-14.9"
15"-16.9"
17"-18.9"
19"-20.9"
21"-28.9"
29"+
Diameter Class


Net Cubic Foot Volume to 4" Top by Diameter Class
(all trees at least 5" in diameter)
350
300
250
200
150
100
50
0
millions cubic feet
Died
Alive
5"- 6.9"
7"- 8.9"
9"-10.9"
11"-12.9"
13"-14.9"
15"-16.9"
17"-18.9"
19"-20.9"
21"-28.9"
29"+
Diameter Class

Net Cubic Foot Volume to a 4" Top by Conifer Species
(millions of cubic feet -- trees at least 5" in diameter)



Implications for the Future…

- **Need for quick initial assessments of current conditions**
- **Increasing demand for frequent updates to core data sets that describe natural conditions as well as key assets**
- **Require an ability to integrate various kinds of data sets to support a wide range of activities from operational to long term monitoring**
- **Need for various kinds of support tools for a large and varied client base with highly variable skill levels**
- **Need for ongoing processes to provide data and reports that are timely and applicable to current issues**

Old Fire Sunday, October 28, 2003

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