

Phytophthora ramorum in Coast Live Oak: Search for Resistance and Mechanisms

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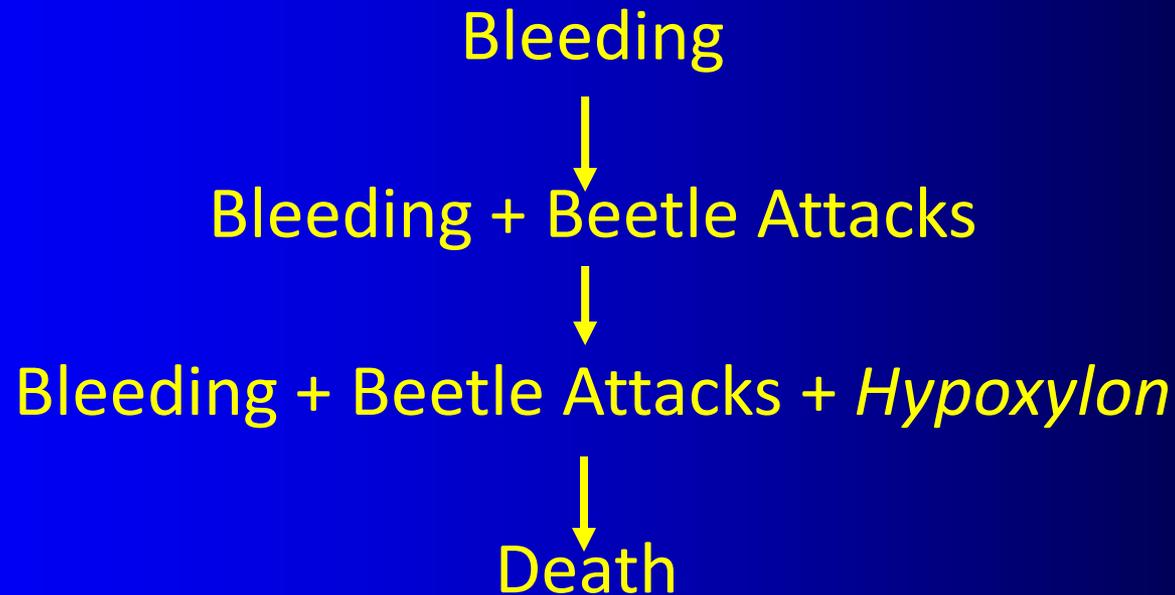
East Bay hills, November 2008. Darker green trees are coast live oaks, lighter green are bay laurels, recently killed coast live oaks are brown, older kills are grey



China Camp State Park 2010 Plot 7: 20% symptomatic & 13% dead in 2000, 5% symptomatic & 56% dead in 2012



Phytophthora ramorum infections follow a predictable sequence in coast live oaks



1) Bleeding: exudation through intact bark, above soil line to about 1.5 meters



2) Beetle attacks on infected part of bark; ambrosia and bark beetles

3) Fungal fruiting bodies (*Annulohypoxylon*) develop on bark after beetle attacks

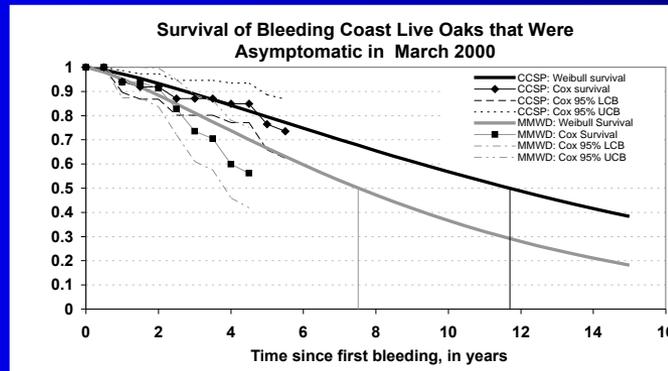
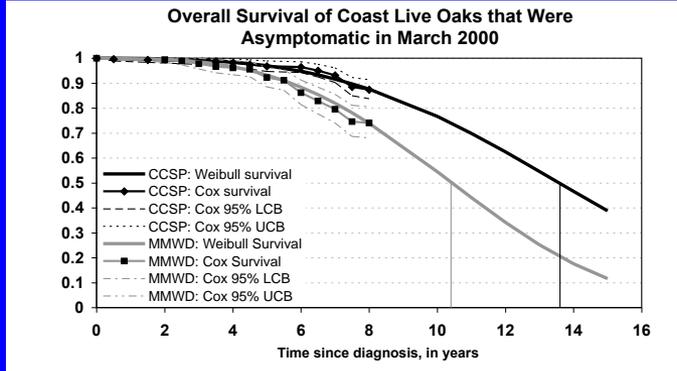




¹Coast live oak median survival by disease stage, in years (se)

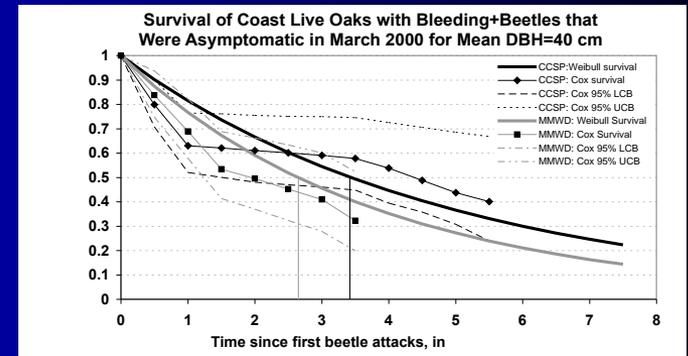
Bold line: China Camp State Park
Grey line: Marin Municipal Water District

Asymptomatic
15.8 (1.5)/11.7 (0.8)



Bleeding
11.7 (2.7)/ 7.5 (1.6)

Bleeding + Beetles
3.3 (0.4)/ 2.0 (0.2)



¹McPherson, Mori, Wood, Kelly, Storer, Svihra, & Standiford. 2010 Forest Ecology & Management 259: 2248-2255.

Inoculations in 5 populations (4 coast live oak, 1 Shreve oak), led to a wide range of responses, characterized by canker size.

2002: Two coast live oak populations in Marin County were inoculated to test efficacy of insecticides to control mortality of infected trees

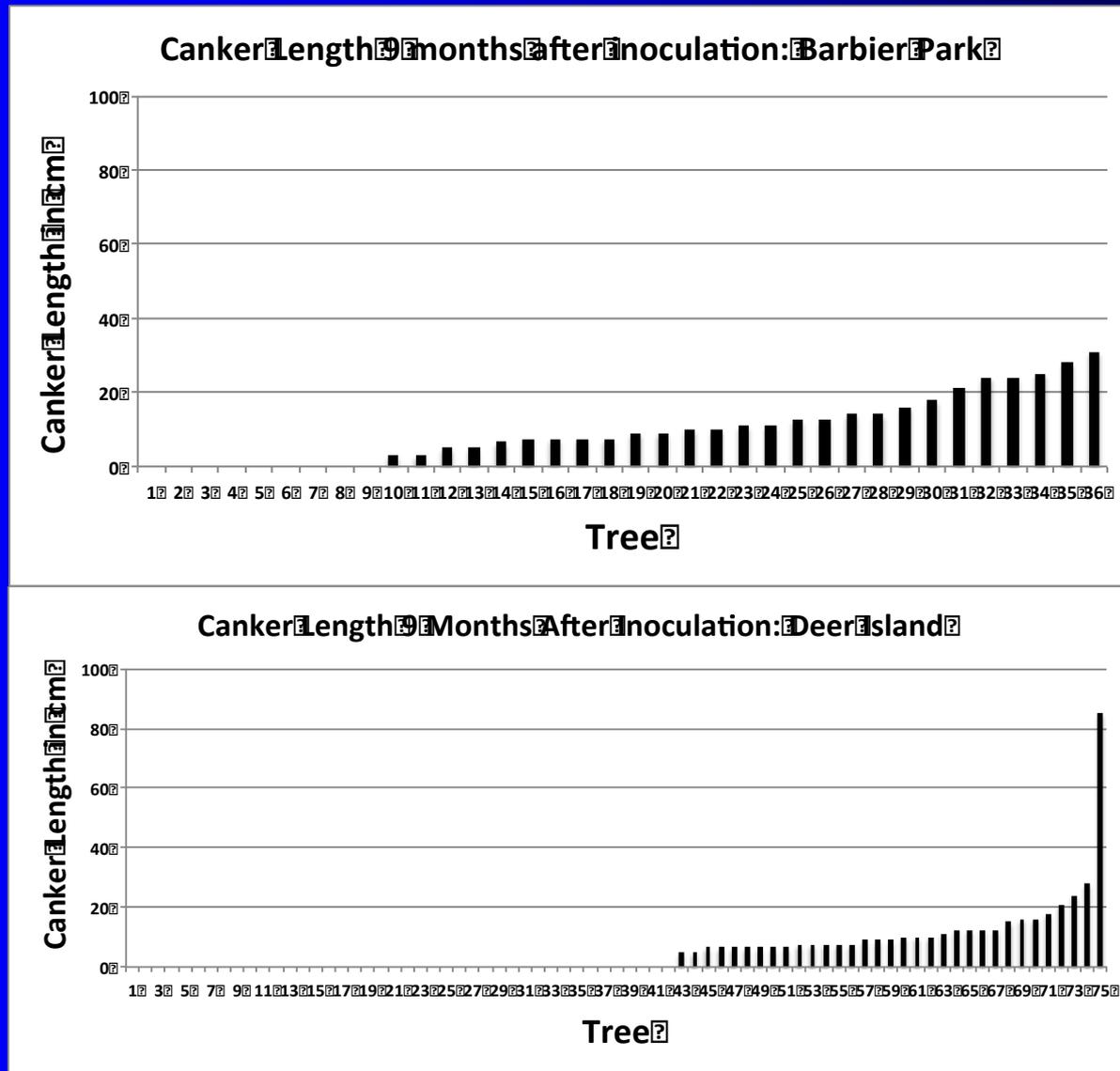
2003: One Shreve oak population in Santa Cruz County was inoculated to test efficacy of insecticides to control mortality of infected trees

2005: Two coast live oak populations in Marin County were inoculated in a study of the involvement of fungi in mortality

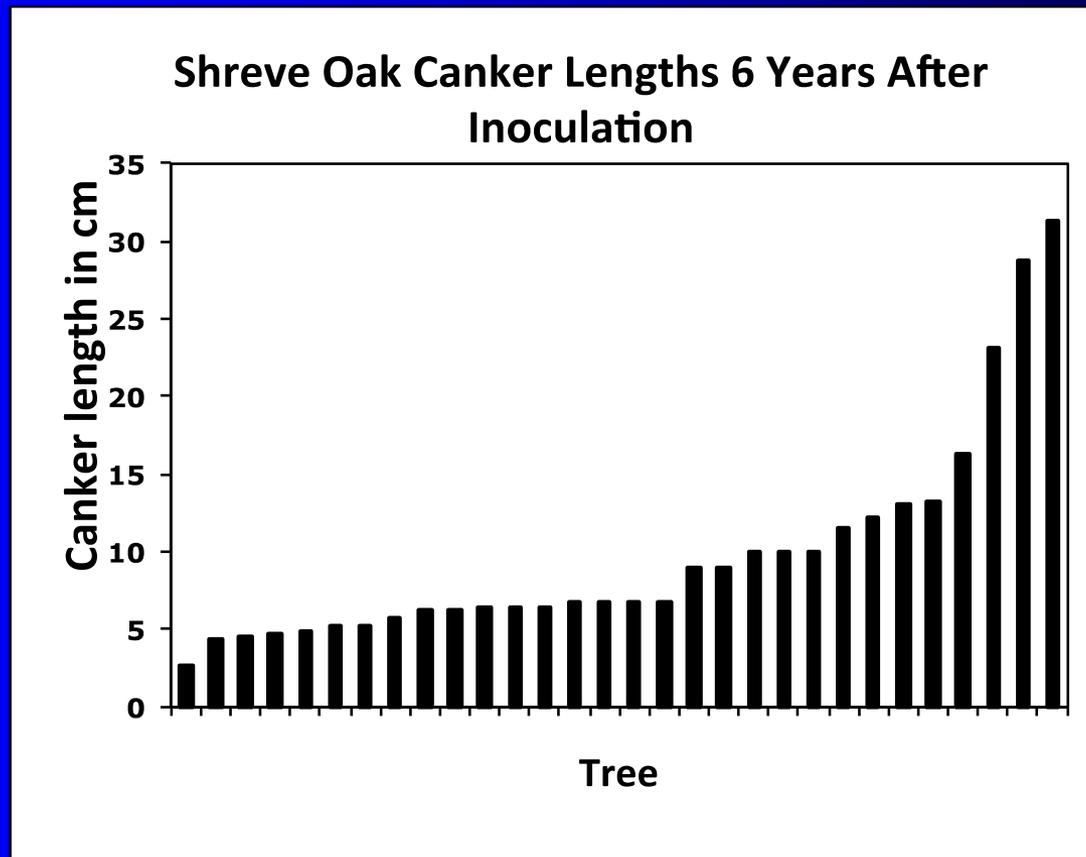
Inoculated coast live oaks show a variety of canker sizes



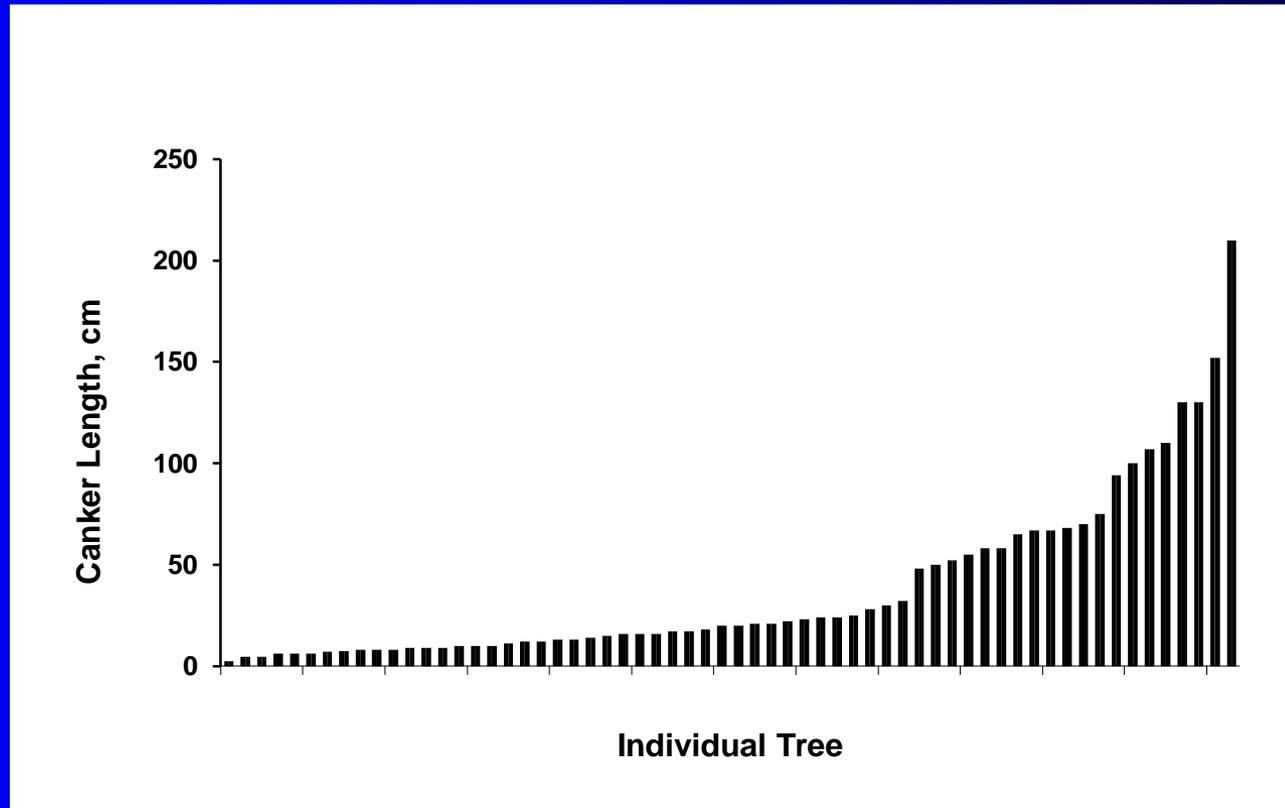
Coast live oaks, external canker lengths, Marin County (2005, infested stands).
 Most trees with large cankers were cut in the experiment.



Shreve oaks (*Q. parvula* var. *Shrevei*), Santa Cruz County (2003, infested stand). Cankers measured beneath bark.



Coast live oaks, Marin County (2002, infested stands). External canker lengths, April 2002 (9 months after inoculation). Two populations pooled.



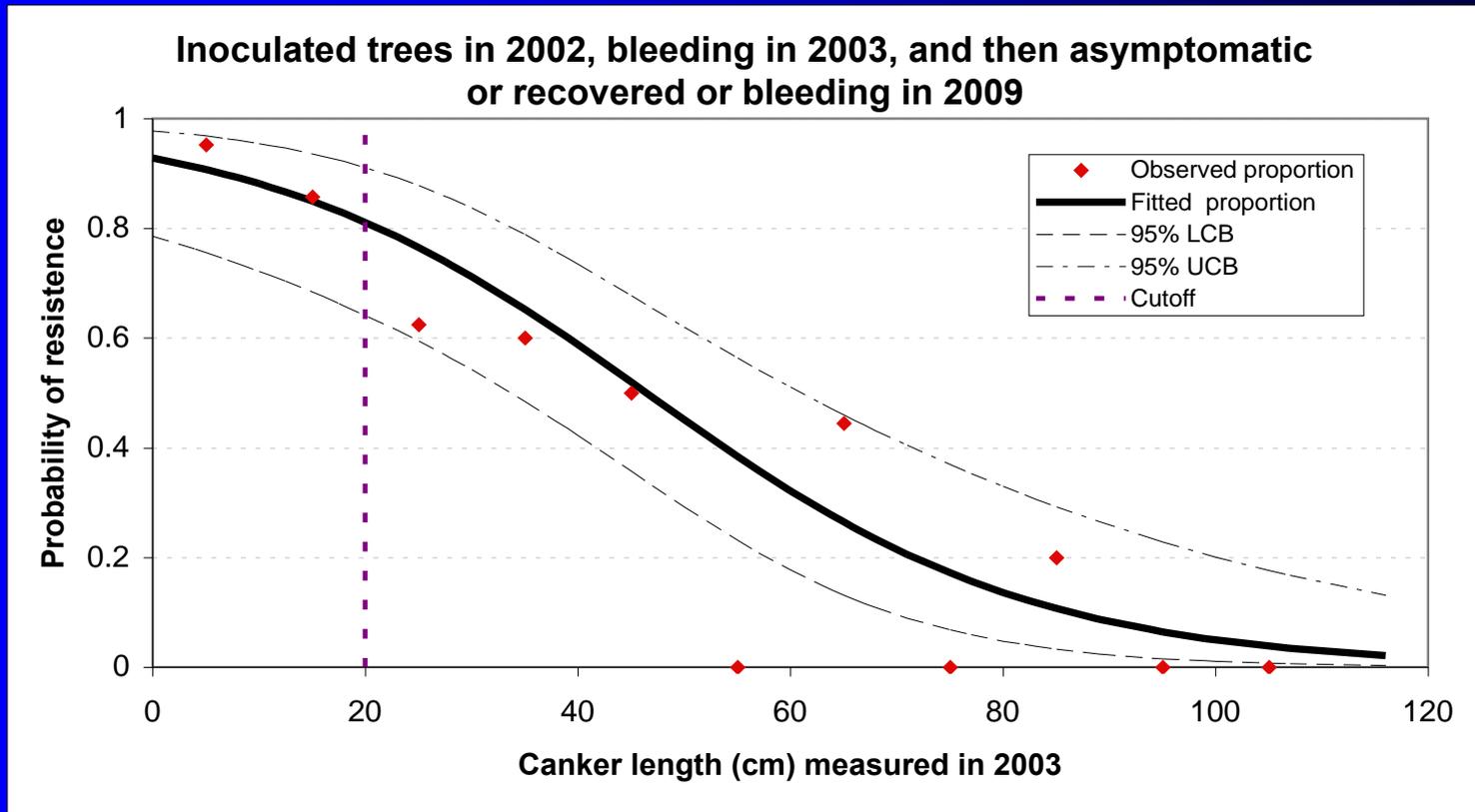
Tree 31, inoculated July 2002, image July 2009



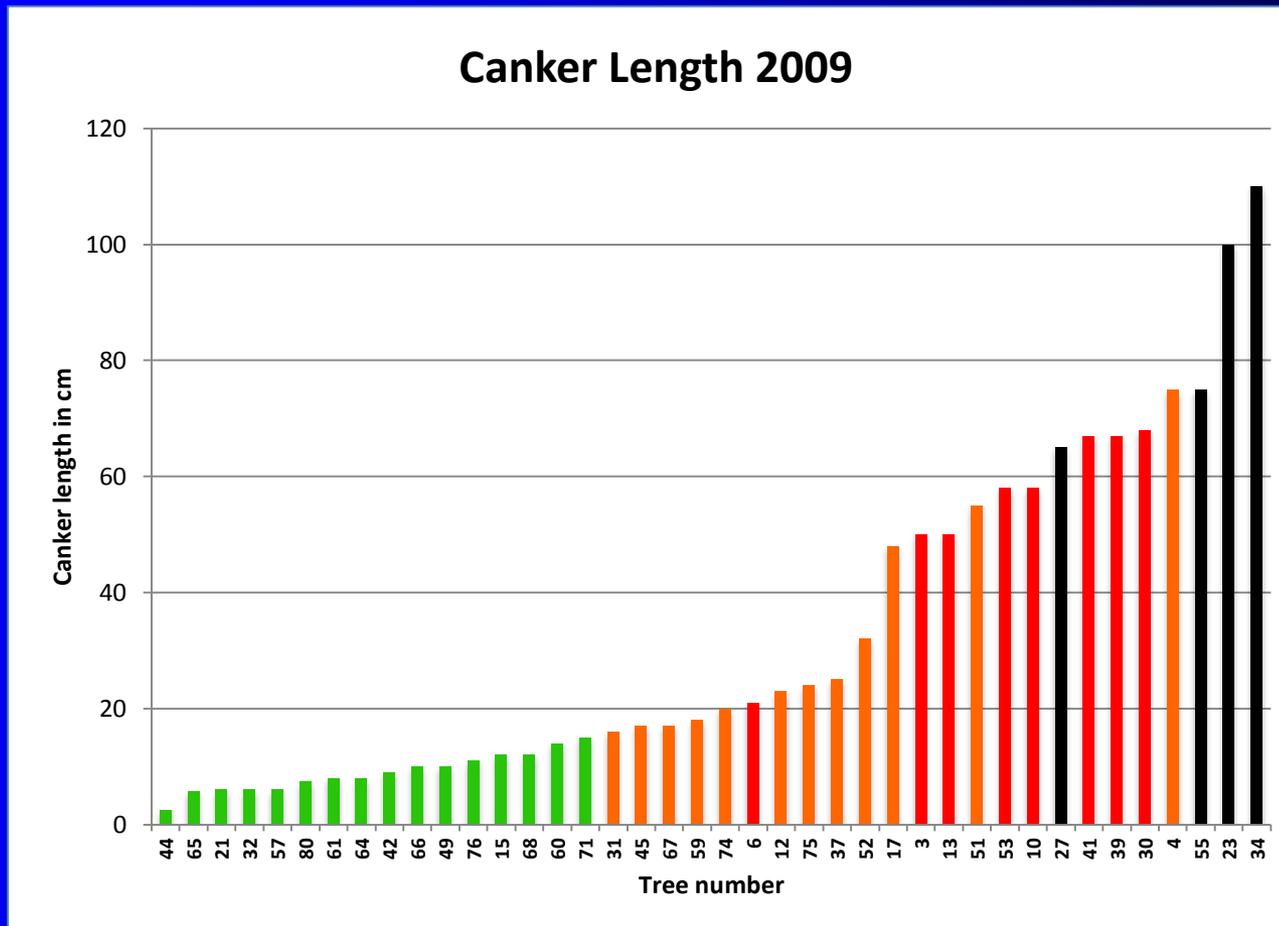
Tree 31, bark removed. Note the evidence of an active wound response (arrows). Central circle represents size of a control wound.



A Logit model regressed on canker length, measured 9 months after inoculation, predicts that an inoculated tree with a canker 20 cm or less has an 80% probability of surviving at least another 6 years.



Seven years after inoculation: **Green** = Putatively Resistant, **Orange** = In Remission, **Red** = Susceptible, **Black** = Dead.
 Cankers measured beneath bark.

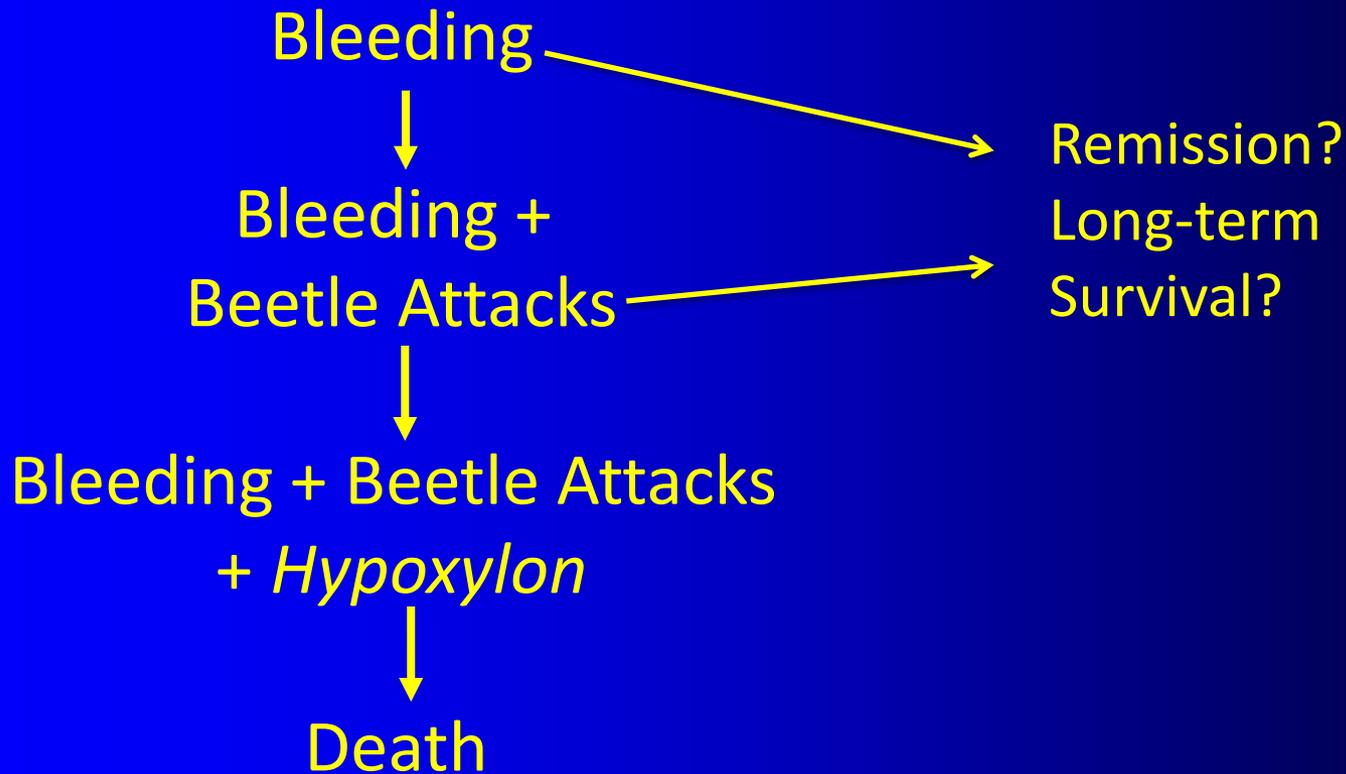


The continuous size distribution of induced cankers among the several inoculated oak populations is consistent with quantitative, multi-gene, and potentially durable resistance to *Phytophthora ramorum*

China Camp State Park, bleeding in 2002, asymptomatic since 2007



Maybe the sequence is not so predictable?



Our working hypothesis:

Trees with a history of exposure to *P. ramorum* are likely to have been pre-screened for susceptibility/resistance. Naïve trees will give a better estimate of true resistance.

Solution:

Select a location where the pathogen is present, but has not yet become widespread.

Briones Regional Park in Contra Costa County is infested, but the present distribution of Sudden Oak Death is still limited to a relatively few sites. Anna Conrad will report on this work.

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