



# **Plant Pathogens Taking Root: Reframing Stewardship and Habitat Restoration Practices When Confronted with Phytophthora Introductions**

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**San Francisco Public Utilities Commission,**

**Water Enterprise**

**Natural Resources and Lands**

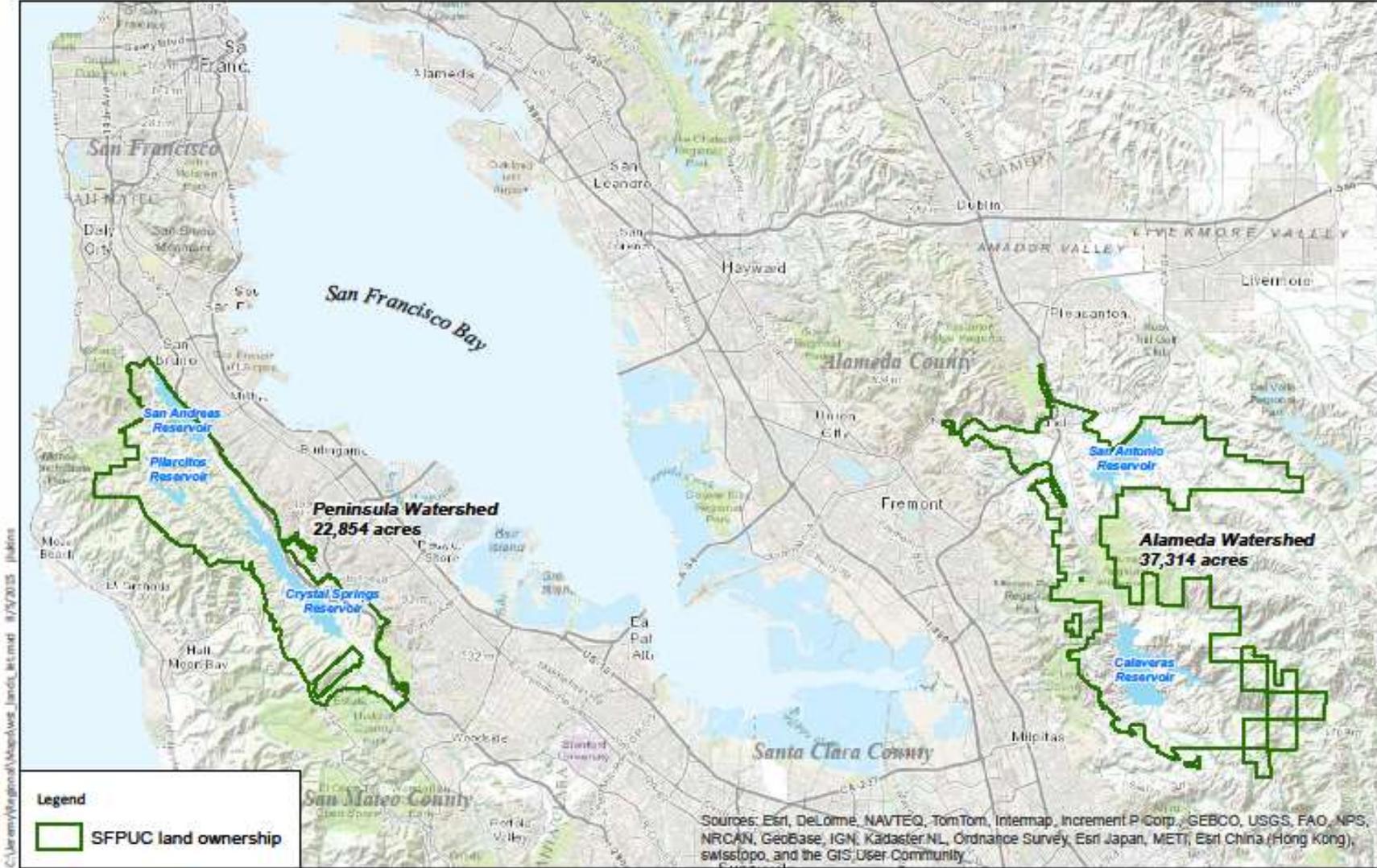
**Management Division**



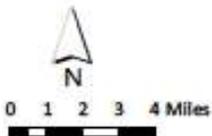
# Hetch Hetchy Regional Water System



Delivering drinking water every day to 2.6 million residents and businesses in Southern Alameda, Northern Santa Clara, San Mateo and San Francisco counties.



Services of the San Francisco Public Utilities Commission  
Natural Resources Division Author: JGL Date: 8-5-15



**SFPUC Watershed Lands**  
**San Francisco Bay Area**



# Large Infrastructure Projects



# Calaveras Dam Replacement Project



# San Antonio Creek





2008



2012

## SOD in tanoaks on the Peninsula



2013



2016



# What is Phytophthora?



- Name Phytophthora means “plant destroyer”
- Genus of plant-damaging Oomycetes (water molds)
- Resemble fungi but actually belong to a different major eukaryotic group called the stramenopiles
- Commonly called “water molds”, they produce swimming spores, called zoospores, and thrive under wet environmental conditions
- *P. infestans* caused potato late blight and led to the Irish potato famine of the 1840s

# Pathogen Risk Minimization Measures

- Contract specifications required pest and pathogen free work product and sterilization for equipment *exceeding industry standards*
- Equipment steam, pressure, and/or chemically disinfected
- Brand new pumps, boats, etc.
- Nurseries and contractors inspected
- Seed mixes screened
- Root wads and logs heat treated





# Land Management Response



# Solarization of Infected Planting Basins





08/22/2014 10:03





# SFPUC Sampling Documented Phytophthora Hosts



## 2014

- *Arbutus menziesii*
- *Baccharis glutinosa*
- *Carex barbarae*
- *Euthamia occidentalis*
- *Frangula californica*
- *Heteromeles arbutifolia*
- *Hordeum brachyantherum*
- *Juncus baliticus*
- *Juncus effusus*
- *Juncus patens*
- *Diplacus aurantiacus*

- *Platanus racemosa*
- *Pseudotsuga menziesii*
- *Quercus agrifolia*
- *Scrophularia californica*

## 2015-Present

- *Acer macrophyllum*
- *Artemisia douglasiana*
- *Eriogonum nudum*
- *Quercus douglasii*
- *Quercus lobata*
- *Umbellularia californica*



# Sunol Long-Term Improvements Project



## PLANTING PALETTE

### Trees

AC	<i>Aesculus californica</i>
AM	<i>Acer macrophyllum</i>
CO	<i>Cercis occidentalis</i>
CSS	<i>Cornus sessilis</i> var. <i>sessilis</i>
HA	<i>Heteromeles arbutifolia</i>
PR	<i>Platanus racemosa</i>
PS	<i>Pinus sabiniana</i>
PVD	<i>Prunus virginiana</i> demissa
QA	<i>Quercus agrifolia</i>
QB	<i>Quercus berberidifolia</i>
QD	<i>Quercus douglasii</i>
QL	<i>Quercus lobata</i>
QW	<i>Quercus wislizenii</i>
SLA	<i>Salix lasiolepis</i>
SNC	<i>Sambucus nigra</i> ssp. <i>caerulea</i>

### Entry Road Groundcovers

E1	<i>Arctostaphylos cruzensis</i>
E2	<i>Arctostaphylos</i> 'John Dourley'
E3	<i>Arctostaphylos Hookeri</i> Franciscana
E4	<i>Arctostaphylos</i> 'Pacific Mist'
E5	<i>Baccharis pilularis</i> 'Pigeon Point'
E6	<i>Ceanothus thymisiflorus</i> griseus 'Yankee Point'
E7	<i>Agrostis pallens</i> / <i>Carex praegracilis</i> / <i>Bouteloua gracilis</i>

### Native Meadow

M1	<i>Achillea millefolium</i>
M2	<i>Sisyrinchium bellum</i>
M3	<i>Agrostis pallens</i>
M4	<i>Artemisia douglasiana</i>
M5	<i>Epilobium canum</i> subsp. <i>Canum</i>
M6	<i>Solidago elongata</i>
M7	<i>Ranunculus californicus</i> var. <i>californicus</i>
M8	<i>Leymus triticoides</i>
M9	<i>Koeleria macrantha</i>
R3	<i>Rhamnus californica</i>
R9	<i>Juncus effusus</i> subsp. <i>pacificus</i>

### Valley Needlegrass

G1	<i>Nassella pulchra</i>
G2	<i>Lupinus formosus</i> var. <i>formosus</i>
G3	<i>Penstemon heterophyllus</i> var. <i>purdyi</i>
G4	<i>Eriogonum fasciculatum</i> polifolium
G5	<i>Sidalcea malviflora</i> subsp. <i>Laciniata</i>
G6	<i>Lupinus albitrions</i>
G7	<i>Eriophyllum confertiflorum</i> var. <i>confertiflorum</i>
G8	<i>Chlorogalum pomeridianum</i> var. <i>divaricatum</i>

### Riparian

R1	<i>Carex nudata</i>
R2	<i>Rosa californica</i>
R3	<i>Rhamnus californica</i>
R4	<i>Stachys rigida</i> var. <i>quercetorum</i>
R5	<i>Mimulus cardinalis</i>
R6	<i>Mimulus guttatus</i>
R7	<i>Lonicera hispidula</i>
R8	<i>Symphoricarpos albus</i> var. <i>laevigatus</i>
R9	<i>Juncus effusus</i> subsp. <i>pacificus</i>
CCS	<i>Cornus sericea</i> subsp. <i>sericea</i>

### Diablan Sage Scrub

SS1	<i>Artemisia californica</i>
SS2	<i>Salvia mellifera</i>
SS3	<i>Erodicyton californicum</i>
SS4	<i>Mimulus aurantiacus</i>
SS5	<i>Eriogonum fasciculatum</i> var. <i>polifolium</i>
SS6	<i>Salvia apiana</i>
G3	<i>Penstemon heterophyllum</i> var. <i>purdyi</i>
G6	<i>Lupinus albitrions</i> var. <i>albitrions</i>
G7	<i>Eriophyllum confertiflorum</i> var. <i>confertiflorum</i>

### Chaparral

C1	<i>Erysimum capitatum</i> var. <i>capitatum</i>
C2	<i>Melica torreyana</i>
C3	<i>Monardella villosa</i> ssp. <i>villosa</i>
C4	<i>Penstemon centranthifolius</i>
C5	<i>Silene laciniata</i> subsp. <i>Californica</i>
C6	<i>Adenostoma fasciculatum</i> var. <i>fasciculatum</i>
C7	<i>Arctostaphylos glauca</i>
C8	<i>Cercocarpus betuloides</i> var. <i>betuloides</i>
C9	<i>Rhamnus californica</i> ssp. <i>tomentella</i>
C10	<i>Lonicera subspicata</i>
C11	<i>Prunus ilicifolia</i>
C12	<i>Rhamnus ilicifolia</i>
C13	<i>Solanum umbelliferum</i>
G3	<i>Penstemon heterophyllus</i> var. <i>purdyi</i>
G7	<i>Eriophyllum confertiflorum</i> var. <i>confertiflorum</i>
SS4	<i>Mimulus aurantiacus</i>

### Oak Savannah

C2	<i>Melica torreyana</i>
C7	<i>Arctostaphylos glauca</i>
C10	<i>Lonicera subspicata</i>
C11	<i>Prunus ilicifolia</i>
C12	<i>Rhamnus ilicifolia</i>
C13	<i>Solanum umbelliferum</i>
G1	<i>Nassella pulchra</i>
G3	<i>Penstemon heterophyllus</i> var. <i>purdyi</i>
OS1	<i>Bromus carinatus</i> var. <i>carinatus</i>
SS4	<i>Mimulus aurantiacus</i>

### Mixed Evergreen Forest

EF1	<i>Aquilegia formosa</i>
EF2	<i>Satureja douglasii</i>
EF3	<i>Stachys rigida</i> var. <i>quercetorum</i>
EF4	<i>Thalictrum fendleri</i> var. <i>polycarpum</i>
EF5	<i>Physocarpus capitatus</i>
EF6	<i>Ribes sanguineum</i> var. <i>glutinosum</i>
C12	<i>Rhamnus ilicifolia</i>
R3	<i>Rhamnus californica</i>
R7	<i>Lonicera hispidula</i>
R8	<i>Symphoricarpos albus</i> var. <i>laevigatus</i>



# Phytophthoras in Native Habitats Work Group



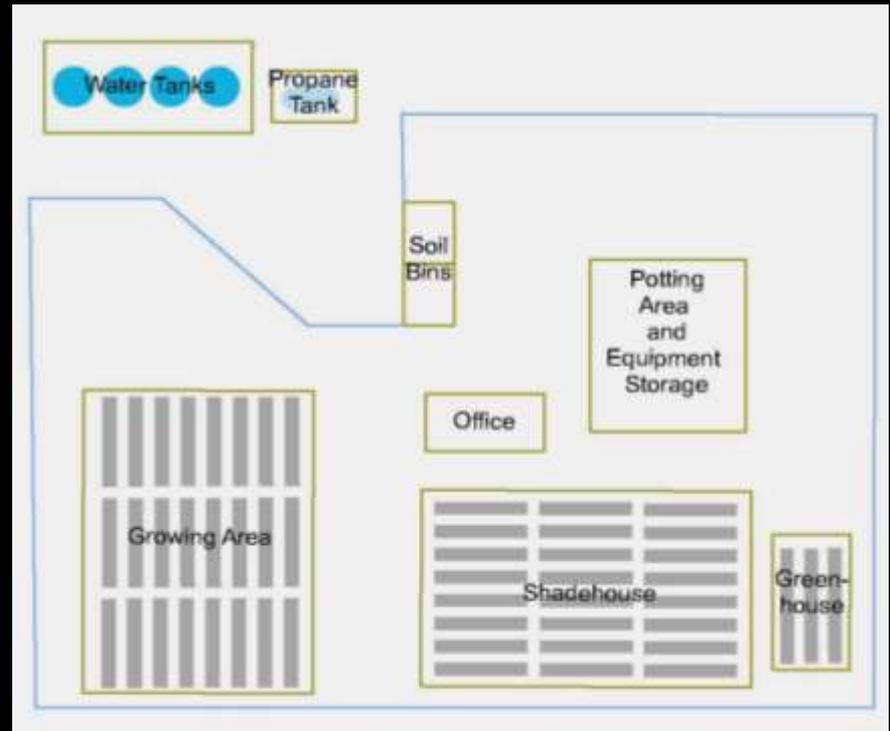
## Nursery Management Resources

- [Guidelines to Minimize \*Phytophthora\* Pathogens in Restoration Nurseries](#)
- [Buying healthy plants: What to look for at a nursery](#) [Understanding results from the CDFA lab](#) [a handout for nurseries](#)

## Guidelines for Restoration Activities

- [Restoration guidance](#)
- [Guidance for contaminated or sensitive sites](#)
- [Holding nursery guidance](#)
- [Guidance to reduce the risk of \*Phytophthora\* and other plant pathogen introductions to mitigation sites](#)

# Sunol Native Plant Nursery





# USDA Forest Service Research Partnership



- Matteo Garbelotto, UC Berkeley, Director, Forest Pathology and Mycology Laboratory;
  - Detector dogs – Lab support
  - Sporulation potential test of five *Phytophthora* species on host plants
  - Selective removal of SOD “refugial bays”
- Matt Quinn, H.T. Harvey and Associates
  - Ecological scent dog training for *Phytophthora* detection
- David Rizzo, UC Davis
  - Delimitation and naming of *Phytophthoras* in SFPUC restoration areas. UC-Davis, Post-doc, Tyler Bourret, David Rizzo, P.I.
- Valerie Eviner, UC Davis
  - The influence of soil conditions on the effectiveness of restoration practices in wetlands and riparian areas.
- Ted Swiecki and Elizabeth Bernhardt; Phytosphere Research
  - Fine-tune effluent baiting protocol.
  - Training related to BMP implementation for the development of the SFPUC nursery.
  - Continue to evaluate the use of California bay removal to protect a stand of coast live oak

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# Questions?



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