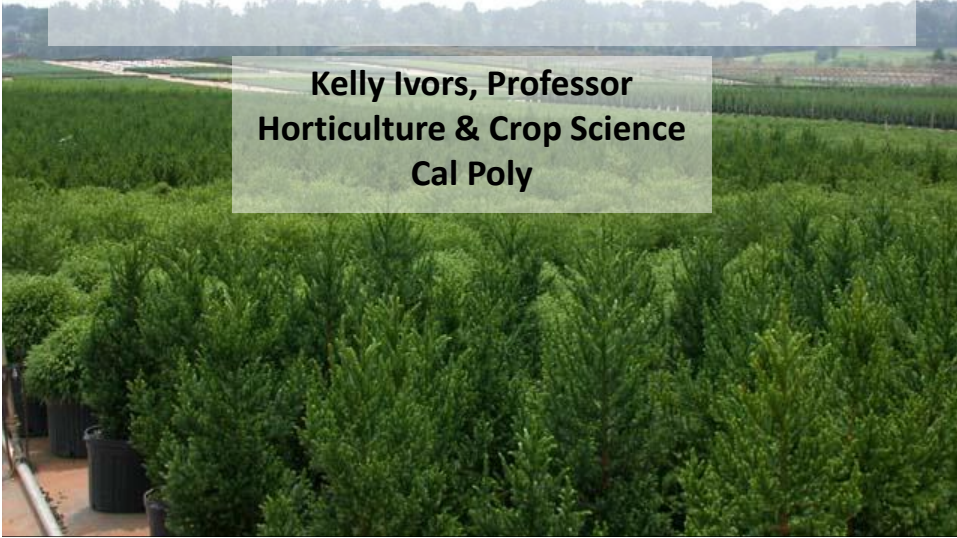


Plant pathogens in irrigation water... What are the risks?

**Kelly Ivors, Professor
Horticulture & Crop Science
Cal Poly**

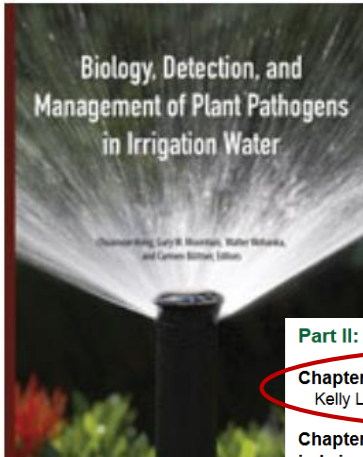


NC STATE Ornamental Pathology

Plant pathogens in irrigation water... What are the risks?

Andrew Loyd, Mike Benson and Kelly Ivors
Department of Plant Pathology, NC State University





Biology, Detection, and Management of Plant Pathogens in Irrigation Water

Part II: Diversity and Biology of Plant Pathogens in Water

Chapter 6: Oomycete Plant Pathogens in Irrigation Water

Kelly L. Ivors and Gary W. Moorman

Chapter 7: *Ralstonia solanacearum*: A Case Study of a Bacterial Pathogen in Irrigation Water

Jason C. Hong, Pingsheng Ji, Timur M. Momol, Steve Olson, Praksash Pradhanang, and Jeffrey Jones

Chapter 8: Fungal Plant Pathogens in Irrigation Water

Robert L. Wick

Chapter 9: Plant-Parasitic Nematodes in Irrigation Water

James A. LaMondia

Chapter 10: Plant Viruses in Irrigation Water

Carmen Büttner and Renate Koenig

Plant Disease volume 98: pages 1213-1220

Phytophthora Populations in Nursery Irrigation Water in Relationship to Pathogenicity and Infection Frequency of *Rhododendron* and *Pieris*

A. L. Loyd, D. M. Benson, and K. L. Ivors, Department of Plant Pathology, North Carolina State University, Raleigh 27607

Abstract

Loyd, A. L., Benson, D. M., and Ivors, K. L. 2014. *Phytophthora* populations in nursery irrigation water in relationship to pathogenicity and infection frequency of *Rhododendron* and *Pieris*. Plant Dis. 98:1213-1220.

Phytophthora spp. are waterborne plant pathogens that are commonly found in streams, rivers, and reclaimed irrigation water. *Rhododendron* and *Pieris* trap plants at two commercial nurseries were irrigated with water naturally infested with *Phytophthora* spp. during the 2011 and 2012 growing seasons to assess the frequency of disease. *Phytophthora* spp. were consistently recovered from water samples at every collection time but detected on only 2 of the 384 trap plants during the two growing seasons. Pathogenicity assays proved that *Phytophthora* hy-

drophatica and *Phytophthora* taxon PgChlamydo, commonly recovered taxa in irrigation water at the nurseries, were foliar pathogens of *Rhododendron* and *Pieris*; however, neither species was able to cause root rot on these same hosts. Overall, *Phytophthora* spp.-infested irrigation water did not act as a primary source of infection on *Rhododendron* and *Pieris*, even though foliar pathogenic species of *Phytophthora* were present in the water.

Why sanitize irrigation water?

- Pathogen dispersal in nurseries from recycling irrigation water



Capturing / routing run-off



Capturing run-off



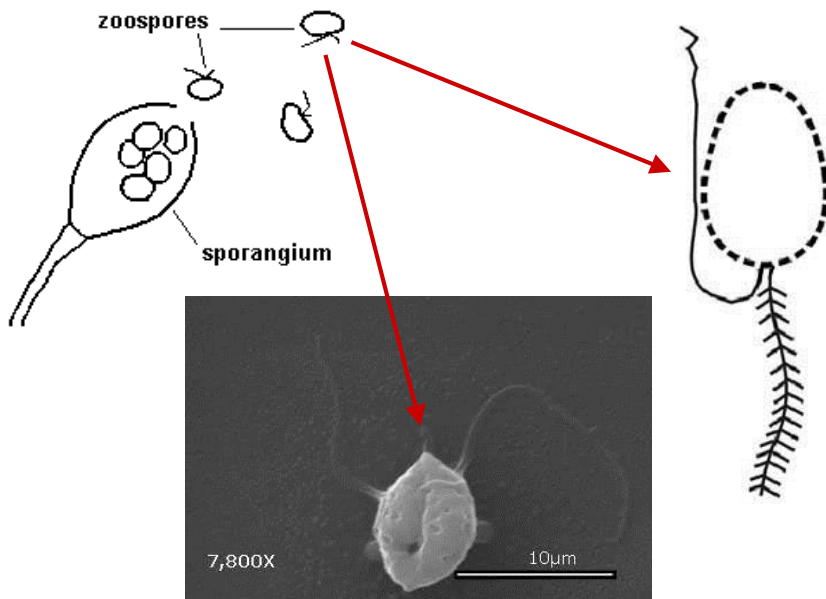
Capturing run-off



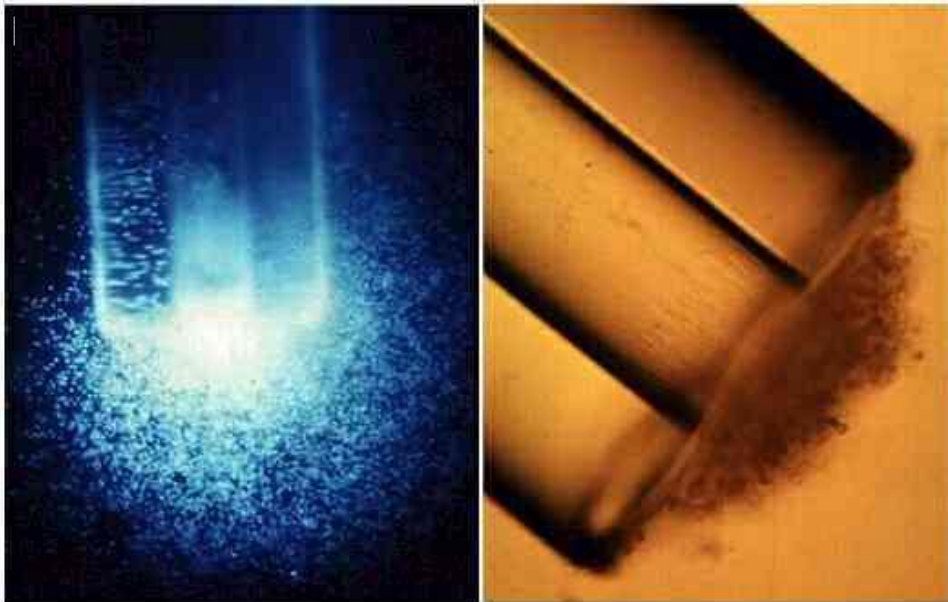
Increased dependence on recycled water has exacerbated crop losses due to waterborne pathogens, i.e. Phytophthora / Pythium



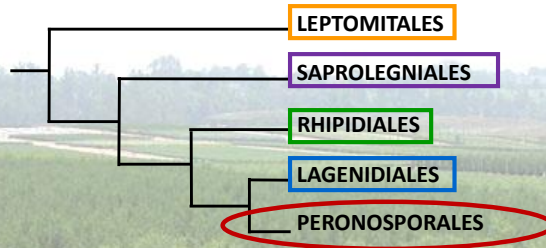
***Phytophthora* ZOOSPORES**



Zoospore chemotaxis



Oomycete (water mold) Evolution



Leptomitales: Aquatic saprobes

Saprolegniales: Aquatic parasites

Rhipidiales: Aquatic ...

Lagenidiales: Aquatic parasites, biocontrol organisms

Ornamentals commonly diagnosed with *Phytophthora* root rot

P. cinnamomi
P. nicotianae
P. drechsleri
P. cryptogea
P. citricola
P. citrophthora
P. cactorum
P. cambivora
P. gonapodyides
P. heveae
P. hydropathica
P. ramorum
P. tropicalis

- *Abies* (esp. Fraser fir)
- Arborvitae
- Azalea
- Boxwood
- Camellia
- Chamaecyparis
- Dogwood
- Forsythia
- Gardenia
- Hemlock
- Holly (*Ilex* spp)
- Juniper
- Lavender
- Pieris
- Rhododendron
- Taxus
- American chestnut...

- Begonia
- Blue daze
- Calibrachoa
- Dusty miller
- Easter lily
- Euphorbia
- Fuchsia
- Gerber daisy
- Ivy (*Hedera* spp)
- Million bells
- Nandina
- Petunia
- Verbena

Phytophthora root rot

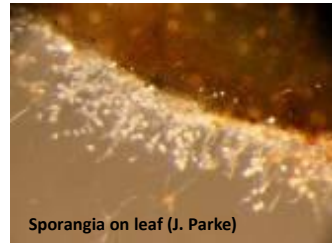


Phytophthora dieback (foliar)



How does *Phytophthora* spread?

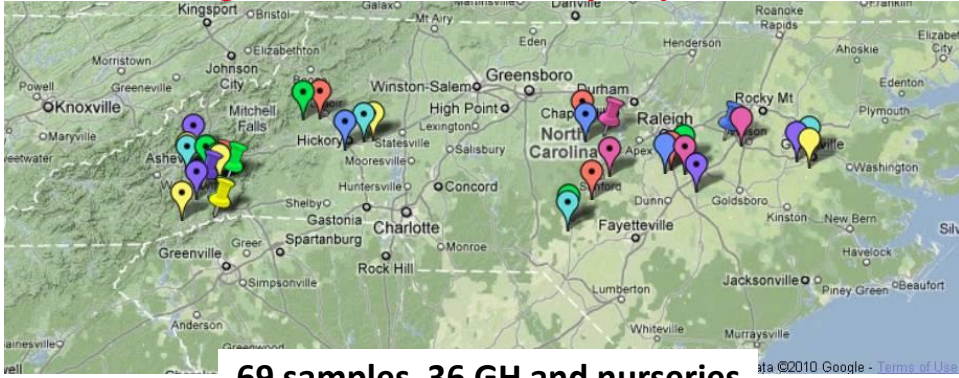
- Movement of infested plants (ornamental trade)
- Splash dispersal from infected plants / soil / debris
- Contaminated media / pots
- Irrigation water or flood events



Irrigation water tour July-Sept 2009



Irrigation water tour July-Sept 2009

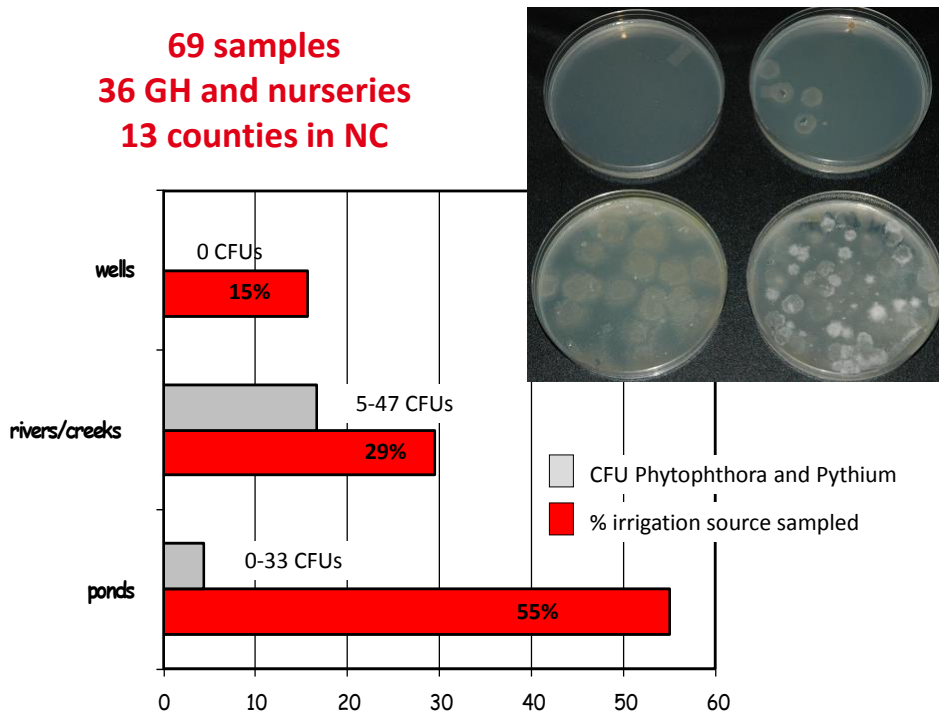


69 samples, 36 GH and nurseries
13 counties in NC



A large range in how water was treated (if treated at all)



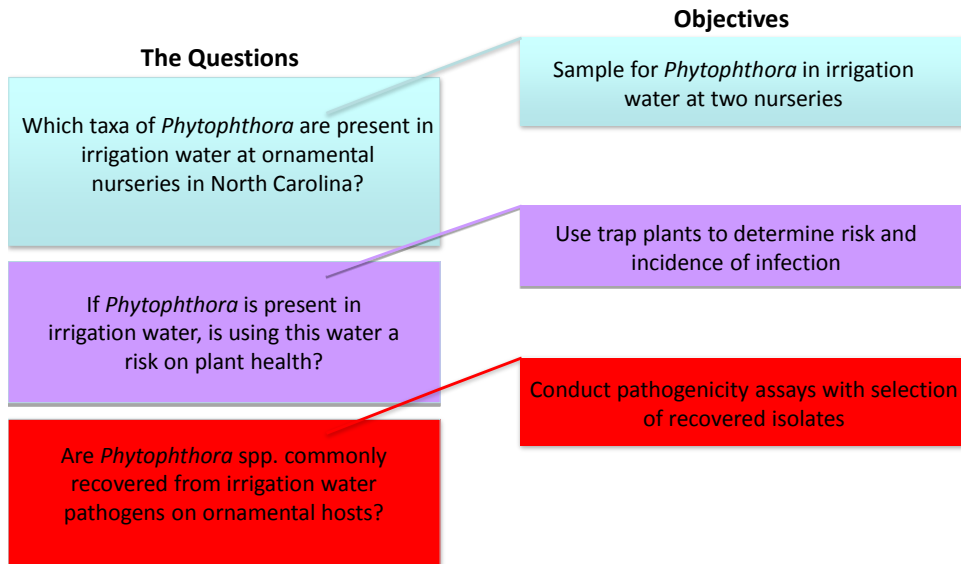


Irrigation water tour July-Sept 2009

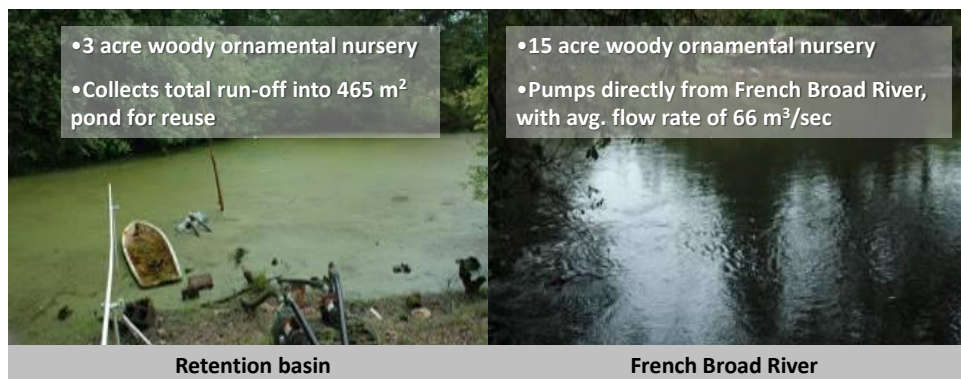
- *Phytophthora* not found in wells
- *Phytophthora* counts correlated with the amount of water recycling
- Higher *Phytophthora* counts found in natural water sources than in pond water, although most of these *Phytophthora* are yet to be described...
- New *Phytophthora* species found in both ponds and natural sources

Plant pathogens in irrigation water...

What are the risks?



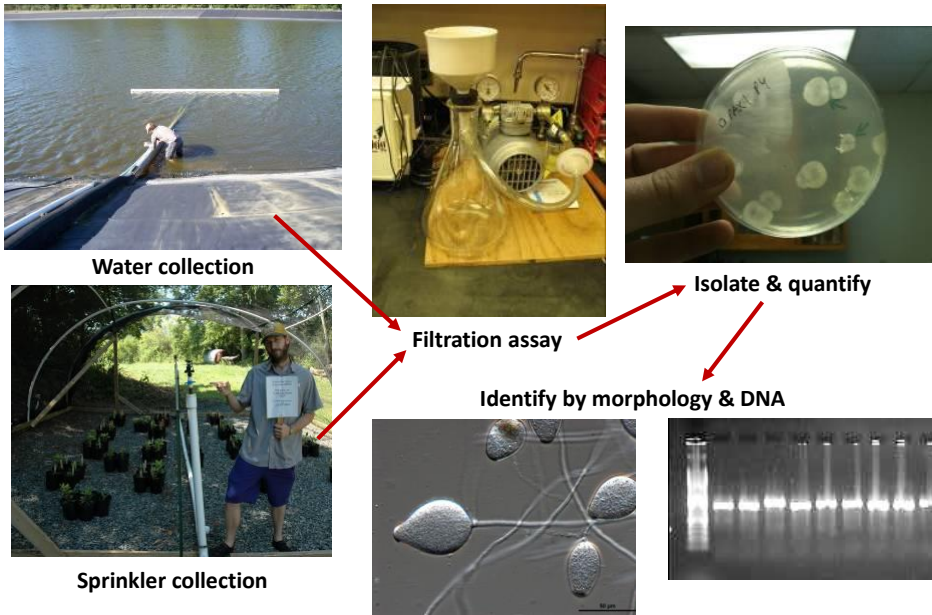
Sample for *Phytophthora* in irrigation water at two nurseries



Nursery I

Nursery II

Water sampling



Sample for *Phytophthora* in irrigation water at two nurseries

- *Phytophthora* consistently detected in water sources for two subsequent summers (every collection time, both nurseries)
- Seven unique taxa identified based on DNA sequence
 - Some known species; some undescribed species
- Nursery II (river water) had more diversity than Nursery I (pond water)
- Dilution of spores occurred from source to sprinkler



**Use trap plants to
determine risk and
incidence of infection**

A. *Pieris japonica*
'Mountain Fire' (2011 & 2012)



B. *Rhododendron* sp.
'Nova Zembla' (2011)
'English Roseum' (2012)

**Use trap plants to
determine risk and
incidence of infection**

In situ detection assay



Sampling the plants



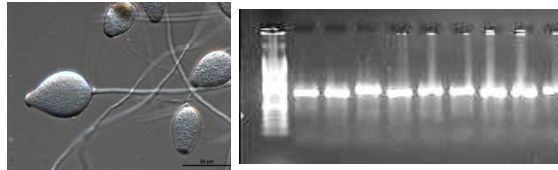
Sample roots with
soil probe

+



Infected foliage
plated on media

Identify



Use trap plants to
determine risk and
incidence of infection

- *Phytophthora* infections detected on 2 of 384 'trap' plants (<1%) over both growing seasons
 - PgChlamydo and *P. hydrophatica*
- Baiting and flooding trap plants yielded no detection of latent infections

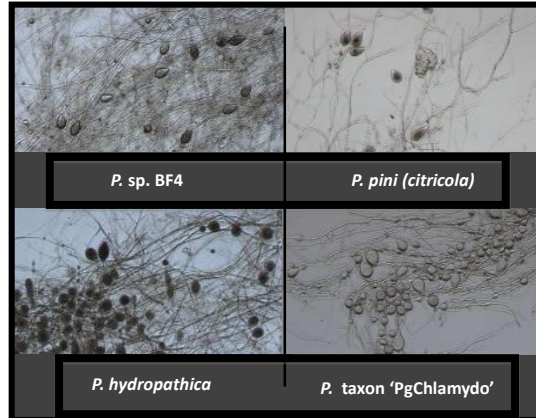
Are they pathogens?

Conduct pathogenicity assays with selection of recovered isolates

The hosts used



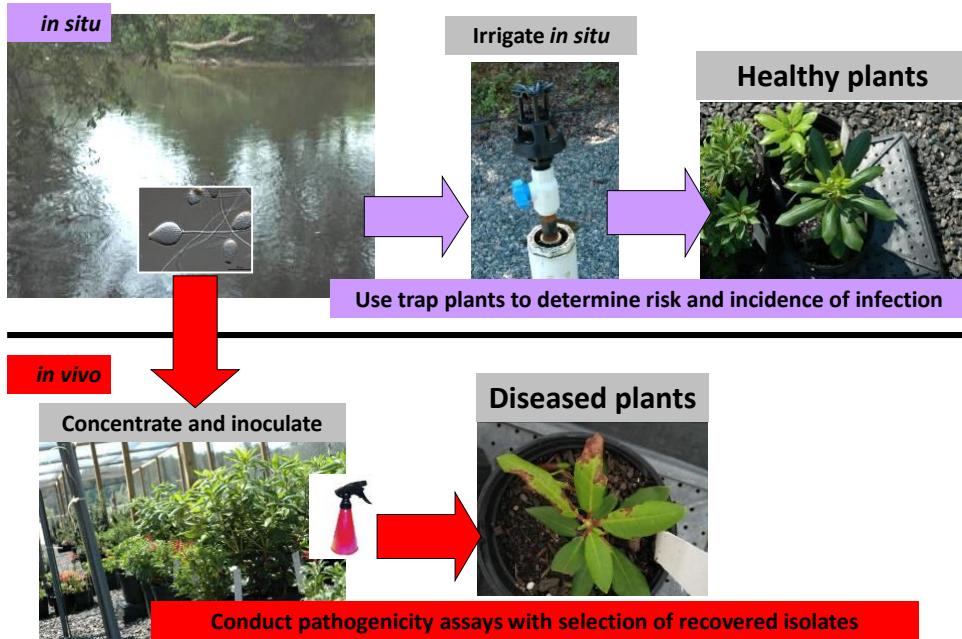
Taxa tested



Are they pathogens?



What IS GOING ON???



**IT'S
A
NUMBERS
GAME**

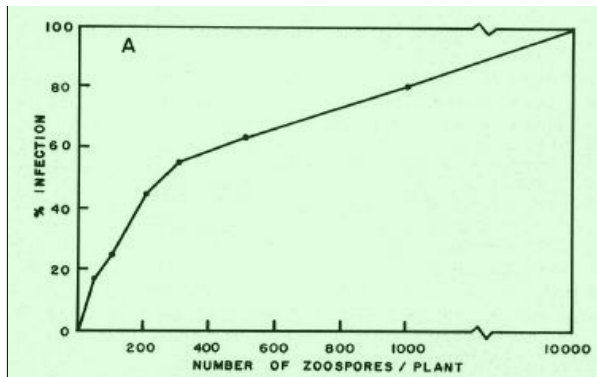


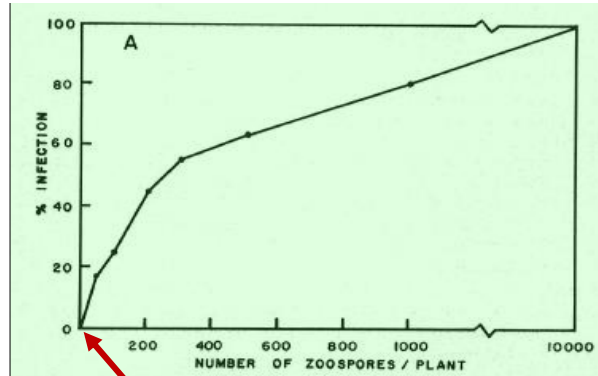
TABLE 1. The effect of concentrations of zoospores of *Phytophthora cryptogea* on percentages of infection and mortality of watercress plants 7 and 21 days, respectively, after inoculation

Zoospores/plant ^a	Infection (%)	Mortality (%)
10 ³	83	30
10 ⁴	100	51
10 ⁵	100	67
10 ⁶	100	81

Mitchell *et al.* 1978

^aThirty plants inoculated with each zoospore concentration.

IT'S A NUMBERS GAME



Average # of zoospores deposited into container daily

	Nursery I	Nursery II
2011	2	6
2012	1	3

Sprinkler collection

The Risks...

- **We found little risk over two growing season from our *in situ* detection assay**
 - Although... *P. hydropathica* and *P. pini* were commonly found at Nursery I (retention basin) and Nursery II (river water), respectively.
- **Dependent on a number of factors...**
 - inoculum concentration
 - which *Phytophthora* species are present
 - recycled/surface water vs. 'natural' water sources
 - relative host susceptibility to *Phytophthora*

CRITICAL CONTROL POINT II: Ground



Pot placement on ground

Section I Pest Prevention/Management

d Cleaning & Sanitation/Plant Debris Handling & Disposal



21 BMP

INSERT A BARRIER (E.G. RAISED BENCHES, GRAVEL LAYER) BETWEEN NATIVE SOIL AND CONTAINERS TO PREVENT SPLASH DISPERSAL OF PATHOGEN FROM POTENTIALLY INFECTED GROUND.

CRITICAL CONTROL POINT II: Ground

Limit splash dispersal

- Rhododendrons on bare ground
 - Lesions 2 feet above ground
- Rhododendrons on gravel base
 - No lesions



Data: Mike Benson, NCSU



CRITICAL CONTROL POINT II: Ground

Grow in areas that have good drainage



CRITICAL CONTROL POINT III: Pots



Sanitize pots

Pest Prevention/Management **Section I**
Cleaning & Sanitation/Plant Debris Handling & Disposal **d**



USE NEW OR CLEAN AND PROPERLY DISINFESTED POTS FOR HR PLANT PRODUCTION. REFERENCE USDA LIST OF APPROVED DISINFECTANT OPTIONS²



CRITICAL CONTROL POINT IV: Plants

Exclusion: purchase disease free plants

Section I Pest Prevention/Management

a Exclusion of Pathogen



1 **BMP** CONFIRM NURSERY STOCK IS PROPAGATED FROM MATERIALS OBTAINED ON SITE, OR THAT THE BUY-INS ARE RECEIVED FROM NURSERIES THAT ARE LICENSED AND/OR CERTIFIED ACCORDING TO ALL APPLICABLE PHYTOSANITARY LAWS AND REGULATIONS.

<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
TED	ERY	N/A

source: Nursery Industry BMPs P. ramorum, CA

CRITICAL CONTROL POINT IV: Plants

Exclusion: inspect buy-ins

Section I Pest Prevention/Management

f Inspection

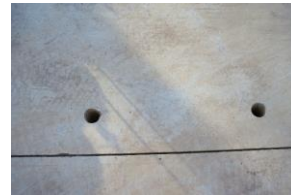


27 **BMP** ROUTINELY MONITOR INCOMING HAP (BUY-INS, RETURNS, TRANSFERS) FOR SYMPTOMS OF *P. RAMORUM*.

source: Nursery Industry BMPs P. ramorum, CA

Do I need to treat my irrigation water?

- Depends on your nursery and your practices...
- Have you had a history of Phytophthora?
 Don't fix something that isn't broken
- What are your risk factors?
 - History of *P. ramorum*?
 - Flood floors?
 - Do your areas flood / experience flood waters?



Water treatment options...

- Physical barriers (pond design)
- Chlorination (gas, tablets, or liquid bleach)
- Slow sand filtration
- Commercial Peroxidases
- Copper ionization
- Ozone
- UV



***Phytophthora* management**

- Do not over-water; use well drained mix and pots
- Irrigation / water management
- Disinfectants for surfaces and equipment between crops
- Sanitize pots if you reuse them
- Grow on benches or use an impermeable protective barrier
- Try your hardest to EXCLUDE the introduction of Phytophthora into your nursery
- Preventative fungicides - drenches & sprays

This research was funded by...

