

A photograph of a person in a maroon hoodie and black beanie measuring a tree with a tape measure. The person is standing in a grassy area next to a river. In the background, there are trees and a house. The text "Are Invasive Plant Pathogens Moving into the Puyallup River Watershed?" is overlaid on the image.

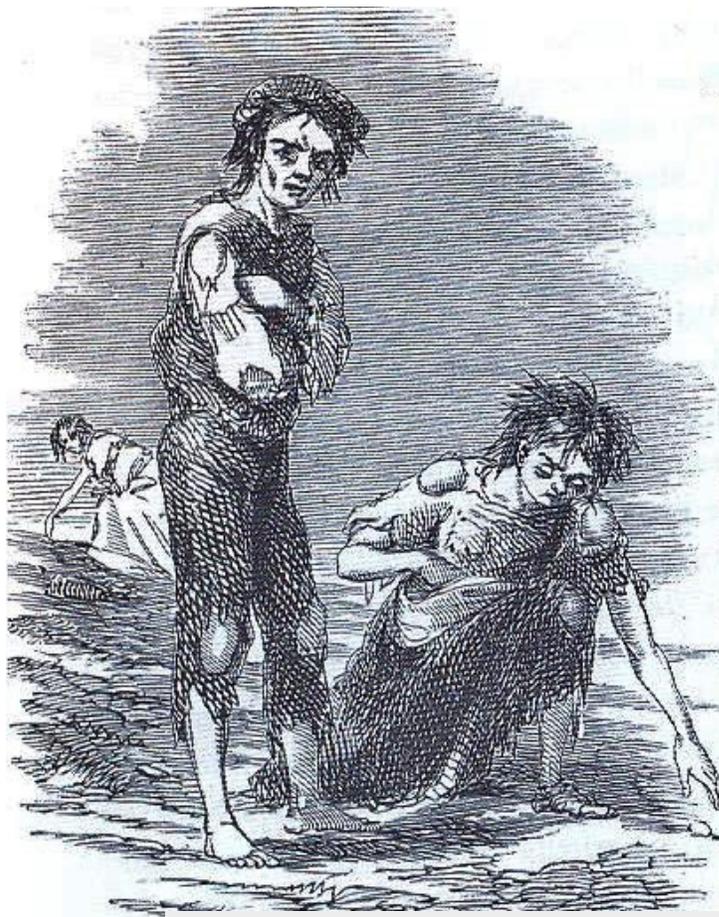
Are Invasive Plant Pathogens Moving into the Puyallup River Watershed?

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Movement of plant diseases



Phytophthora – the plant destroyer



“Perhaps no other single plant disease has resulted in such widespread human suffering and sociological impact.”

More than 100 species identified

P. infestans – responsible for the Irish potato famine in 1845

P. sojae - soybean stem and root rot

Several *Phytophthora* spp. cause disease on cacao

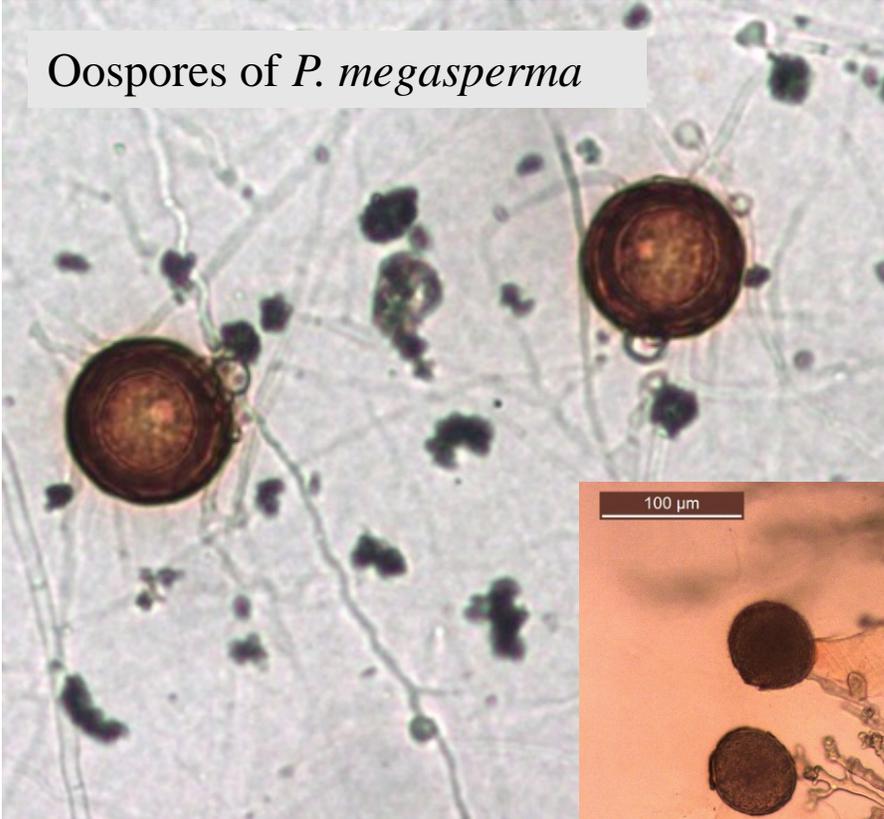
P. cinnamomi – causes damage to forest ecosystems worldwide

P. ramorum – causes Sudden Oak Death (SOD)

[Forest Phytophthoras.org](http://ForestPhytophthoras.org)

Phytophthora

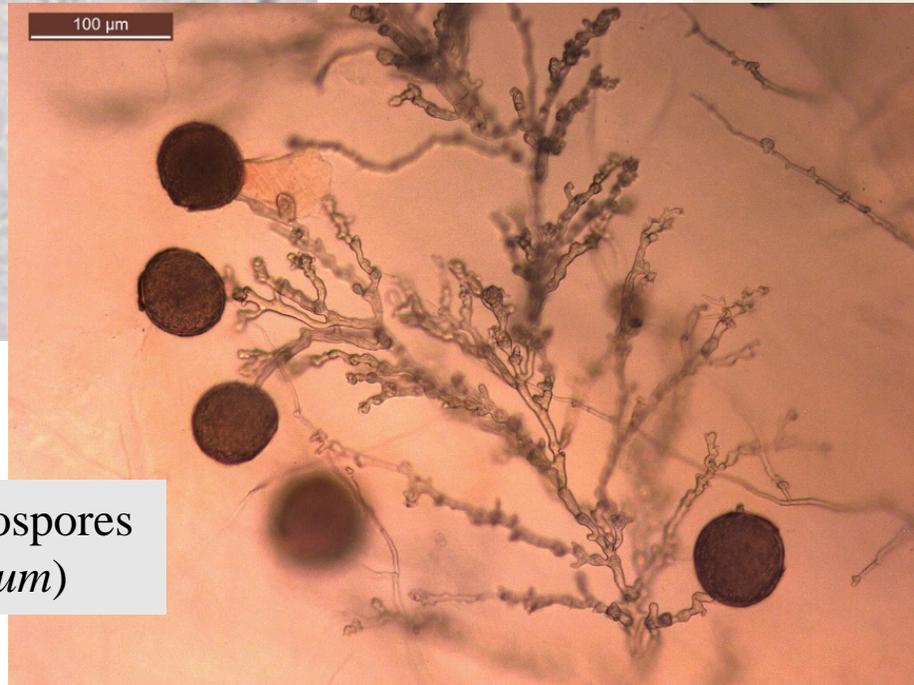
Oospores of *P. megasperma*



Sporangia containing swimming zoospores (*P. ramorum*)



Chlamydospores (*P. ramorum*)



Phytophthora is microscopic and species can be identified by spore stages and/or DNA sequencing

Damage caused by *Phytophthora* spp.



P. cinnamomi root disease on *Eucalyptus*

Root disease
Bleeding cankers

Shoot blight
Foliar lesions



P. ramorum foliar and shoot blight on *Vaccinium* at a nursery

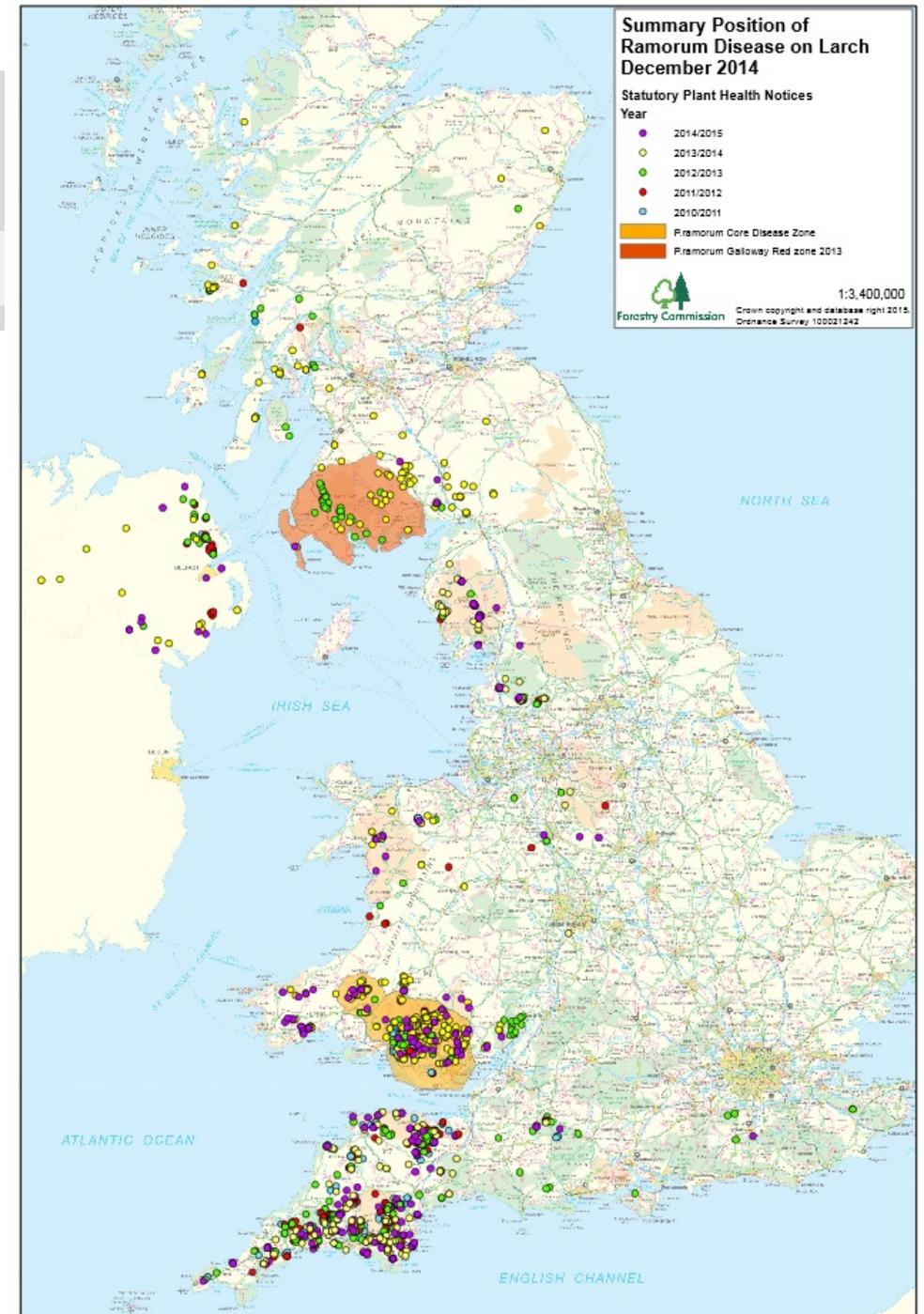
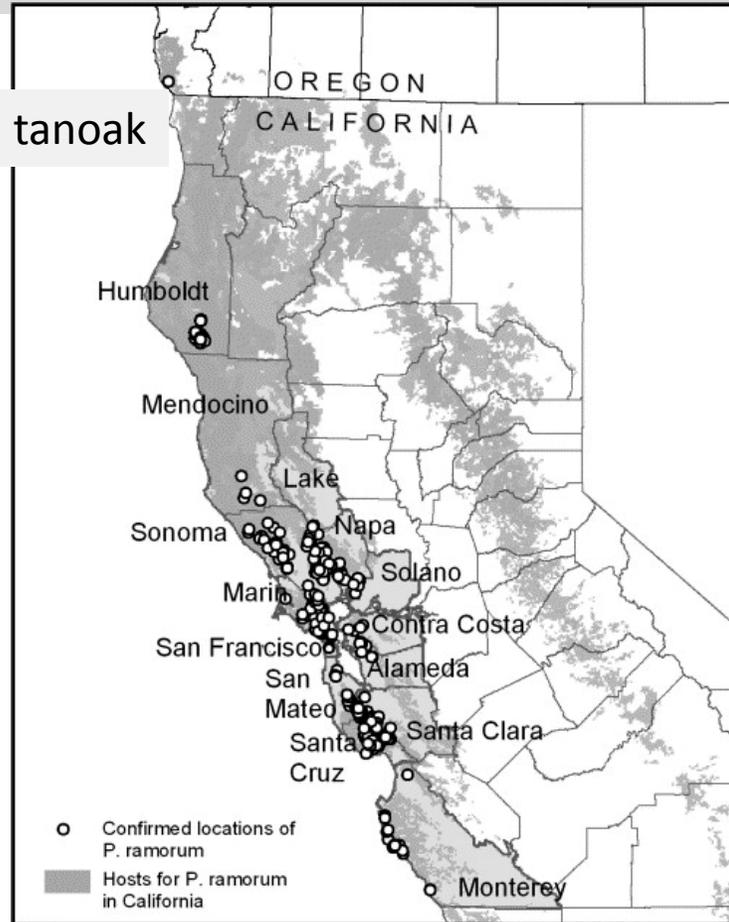


Bleeding cankers caused by *P. citricola* on Alder

P. ramorum distribution in forests

UK - larch

Western US – oak, tanoak



Native plants from nurseries

Plants were purchased from nurseries in WA and OR that provide to restoration sites

Sampled for *Phytophthora* species in spring by soil baiting, also isolation from symptomatic material

2016-17– sample dead plants from restoration sites and adjacent forests

Phytophthoras we don't want to find include:

- *P. alni ssp. alni*
- *P. ramorum*
- *P. tentaculata*



Plants in gallon pots are stacked for shipping



Pot sampling results - WA

Nursery #	ACMI	ALRU	ARUV	COSE	LUPO	MAFU	MAHO	MIMU	POGR	THPL	total
1	0%			50%	40%	30%					30%
2			10%			20%	30%				20%
3	0%	30%			20%				20%	30%	20%
4					0%				10%		8%
5		70%				40%	80%			0%	48%
6	10%		60%					0%	10%		20%
7		100%		0%	33%	50%	0%	7%			21%
total	3%	67%	35%	25%	27%	35%	20%	4%	13%	15%	25%

Phytophthora species in WA native plant nurseries

Clade	Species	ACMI	ALRU	ARUV	COSE	LUPO	MAFU	MAHO	MIMU	POGR	THPL
1	<i>P. cactorum</i>		x				x	x		x	
2	<i>P. citricola</i> group		x	x			x	x	x	x	x
2	<i>P. plurivora</i>		x		x	x	x			x	
2	<i>P. pini</i>		x		x	x					x
2	<i>P. occultans</i>	x	x		x			x			
7	<i>P. alni</i> ssp. <i>uniformis</i>		x								
7	<i>P. cambivora</i>						x				
7	<i>P. cinnamomi</i>			x							
8	<i>P. cryptogea</i>			x		x	x				
10	<i>P. gallica</i>				x						
	unidentified		x	x		x	x		x		

Summary

- *Phytophthora* is everywhere
- Not all *Phytophthora* is created equal – it is important to know what species are present
- Soilborne *Phytophthoras* that form oospores (homothallic) are generally a bigger threat than waterborne species
- Movement of *Phytophthora* in potted plants is a key pathway for introduction into ecosystems



www.plantheroes.org

Research goals:

1. Are *Phytophthora* spp. moving from nursery plants into natural ecosystems?
2. Baseline survey of local *Phytophthora* species
3. Biology of *Phytophthora* spp.

WSU Ornamental Plant Pathology researchers worked with local schools and volunteer groups to expand sample collecting and processing, increase public awareness of the issue, and provide students with research experiences.



Pierce College



Master Gardeners



Puyallup High School



UW Tacoma

Many Different Projects



2017-2018 – *Phytophthora* in habitat restoration sites

Does *Phytophthora* survive outplanting?

Woodland Creek

Clarks Creek



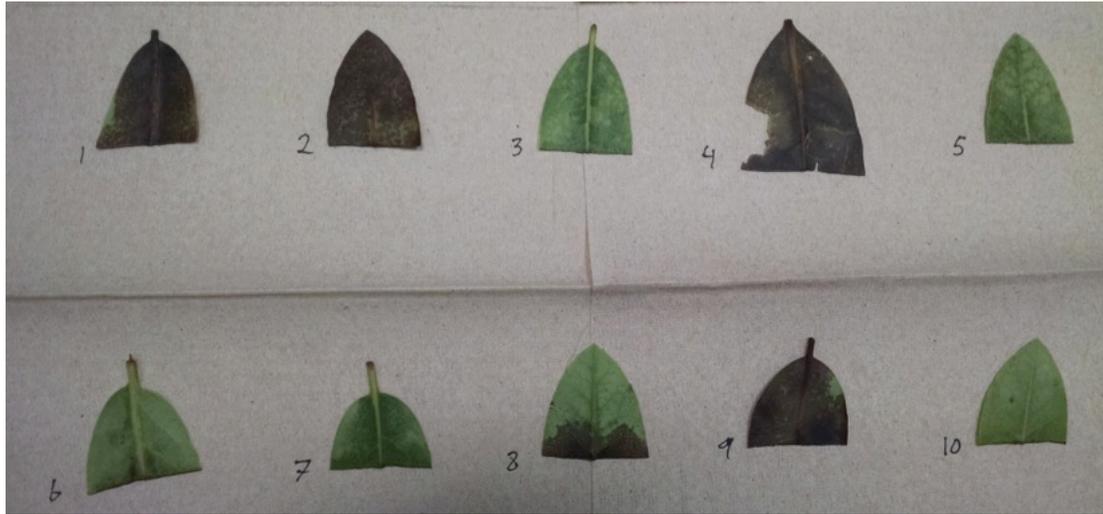
Methods: Collecting Samples

Collecting and Baiting
Soil Samples

Setting and Collecting
the "Baits" in Streams

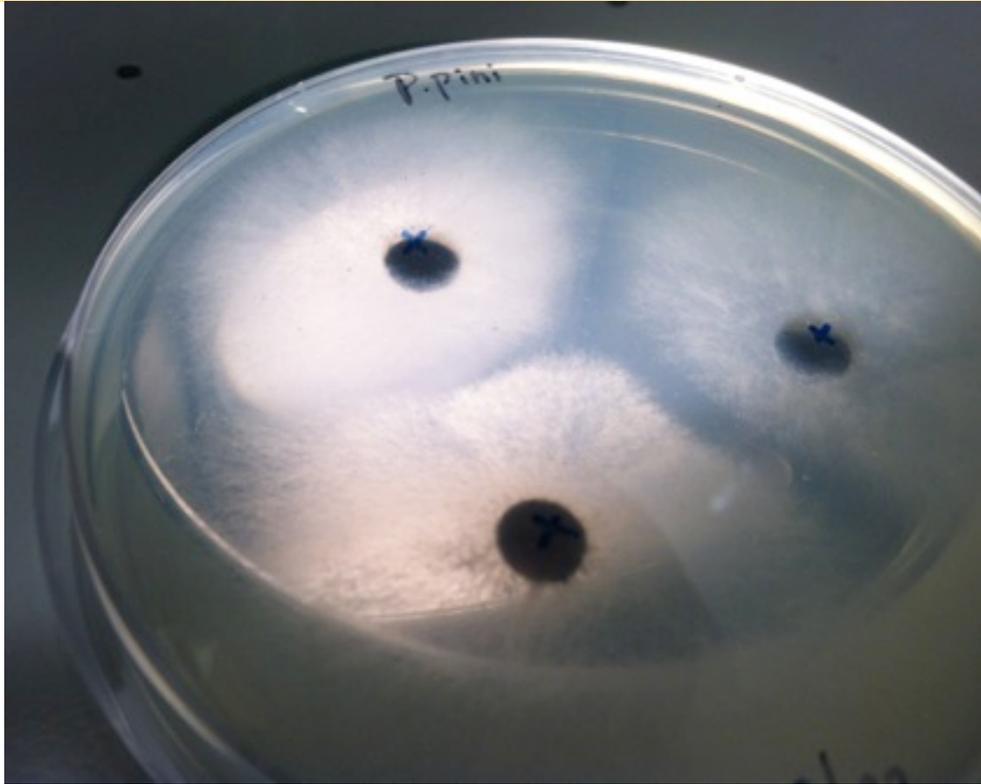


Methods: Culturing and Isolating *Phytophthora*



Students cutting out pieces of infected leaves and putting onto media that selects for *Phytophthora*

Methods: Culturing and Isolating *Phytophthora*



After hyphae grow from the infected leaves, one section is moved onto its own plate to make a pure culture

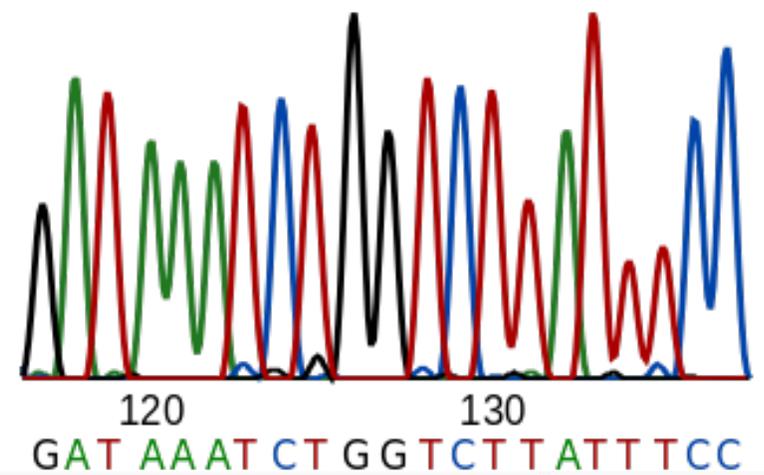


Methods: Preparing for DNA Sequencing and Analysis



Students prepping and amplifying the ITS region of DNA from a pure culture. This is sent off for DNA sequencing.

DNA Sequences are Compared to a Gene Library to Determine Species



← → ↻ 🏠 https://blast.ncbi.nlm.nih.gov/Blast.cgi#alnHdr_62766701 📄 ⋮ 📌 ☆

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Descriptions

Sequences producing significant alignments:
Select: [All](#) [None](#) Selected:0

📄 Alignments 📄 Download ▾ [GenBank](#) [Graphics](#) [Distance tree of results](#) ⚙️

	Description	Max score	Total score	Query cover	E value	Ident	Accession
<input type="checkbox"/>	Phytophthora megasperma isolate P93 (B9A) 18S ribosomal RNA gene, partial sequence; internal transcribed spacer 1, 5.8S ribosomal RNA gene, and internal transcribed spacer	1417	1417	97%	0.0	99%	AY995407.1
<input type="checkbox"/>	Phytophthora megasperma isolate P46 18S ribosomal RNA gene, partial sequence; internal transcribed spacer 1, 5.8S ribosomal RNA gene, and internal transcribed spacer 2, cor	1417	1417	97%	0.0	99%	AY995370.1
<input type="checkbox"/>	Phytophthora megasperma isolate 77-214 18S ribosomal RNA gene, partial sequence; internal transcribed spacer 1, 5.8S ribosomal RNA gene, and internal transcribed spacer 2,	1415	1415	97%	0.0	99%	EF213591.1
<input type="checkbox"/>	Phytophthora megasperma isolate P92(BO11B) 18S ribosomal RNA gene, partial sequence; internal transcribed spacer 1, 5.8S ribosomal RNA gene, and internal transcribed spac	1415	1415	97%	0.0	99%	AY995406.1
<input type="checkbox"/>	Phytophthora megasperma isolate P80 (BO-5) 18S ribosomal RNA gene, partial sequence; internal transcribed spacer 1, 5.8S ribosomal RNA gene, and internal transcribed spac	1415	1415	97%	0.0	99%	AY995396.1
<input type="checkbox"/>	Phytophthora megasperma isolate P77 (BO-7) 18S ribosomal RNA gene, partial sequence; internal transcribed spacer 1, 5.8S ribosomal RNA gene, and internal transcribed spac	1415	1415	97%	0.0	99%	AY995393.1
<input type="checkbox"/>	Phytophthora megasperma isolate WA4.5.R5 18S ribosomal RNA gene, partial sequence; internal transcribed spacer 1, 5.8S ribosomal RNA gene, and internal transcribed spacer	1411	1411	97%	0.0	99%	KU053273.1
<input type="checkbox"/>	Phytophthora megasperma isolate WA4.5.R1 18S ribosomal RNA gene, partial sequence; internal transcribed spacer 1, 5.8S ribosomal RNA gene, and internal transcribed spacer	1411	1411	97%	0.0	99%	KU053272.1

Clarks Creek Results

Year	Site	Phytophthoras
2010	1001	<i>P. gonapodyides</i> , <i>P. lacustris</i> , <i>P. taxon Raspberry</i>
2011	1102	<i>P. gonapodyides</i> , <i>P. lacustris</i> , <i>P. megasperma</i> , <i>P. siskiyouensis</i> , <i>P. chlamydospora</i> , <i>P. bilorbang</i>
2017	WC1	<i>P. gonapodyides</i> , <i>P. lacustris</i> , <i>P. chlamydospora</i>
2017	WC2	<i>P. lacustris</i> , <i>P. chlamydospora</i>
2017	WC3	<i>P. gonapodyides</i> , <i>P. lacustris</i> , <i>P. chlamydospora</i> , <i>P. gregata</i>
2017	WC4	<i>P. lacustris</i> , <i>P. chlamydospora</i>
2018	CC6	<i>P. gonapodyides</i> , <i>P. lacustris</i> , <i>P. chlamydospora</i>
2010	1007	<i>P. gonapodyides</i> , <i>P. cambivora</i> (possibly <i>P. uniformis</i> *)
2011	1103	<i>P. gonapodyides</i> , <i>P. siskiyouensis</i>

Endemic root nibblers

Plant pathogens

*possibly invasive



Future Work:

Survey more sites:

Restoration sites – before and after planting



Future Work:

Survey more sites: Storm water ponds, runoff, etc., for movement from ornamental plantings into the environment



Future Work: Monitor Same Sites Over Time



Phytophthora cinnamomi infecting Pacific madrone in California

It is possible that *Phytophthora* species that were on the nursery plants are still in the soil but not sporulating because of our warmer soils when compared to California. Early detection of invasive pathogens may help stop its spread.

Thanks to Marianne Elliott and WSU Great Opportunity for Students

