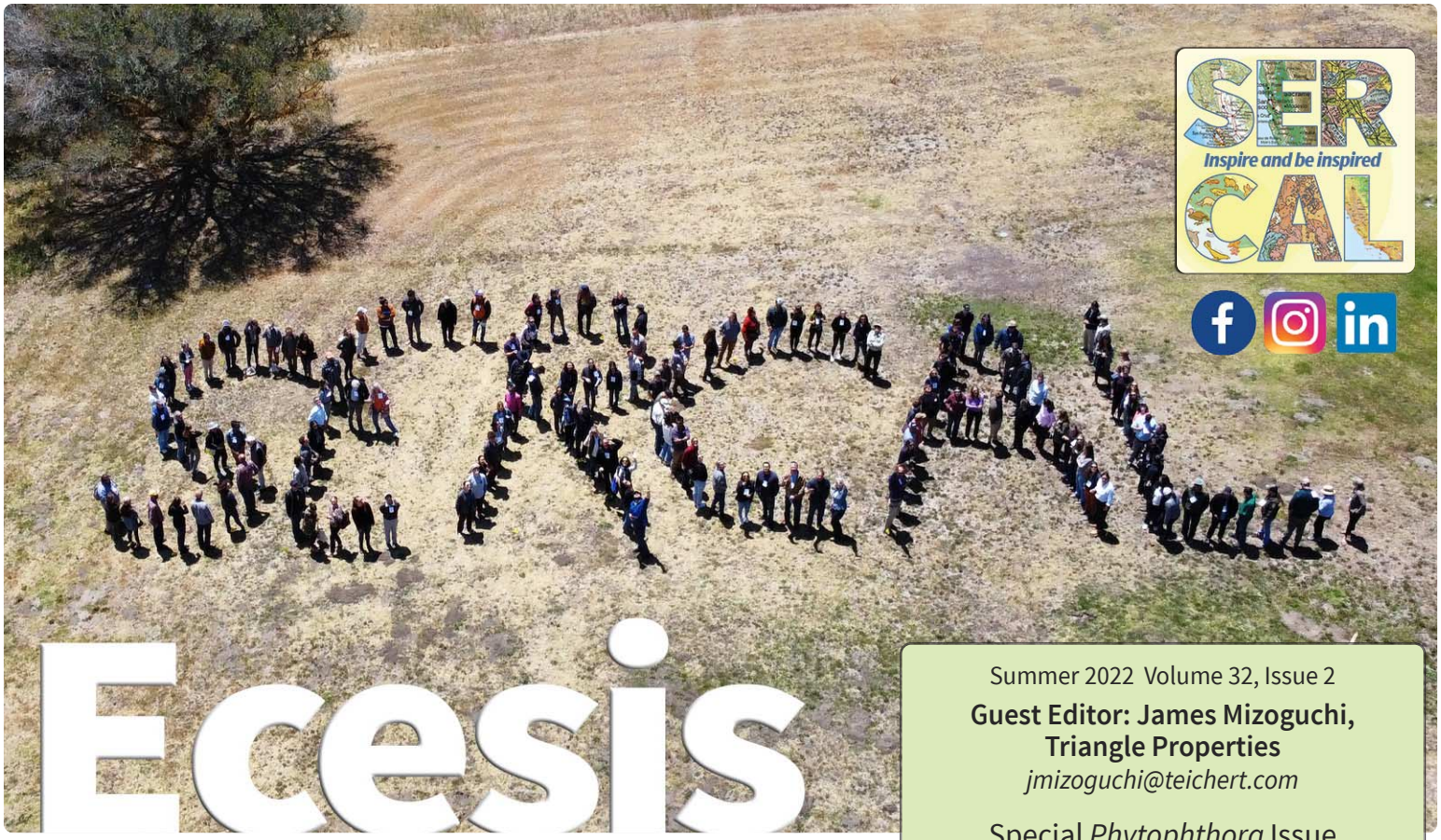

Ecesis

California Society for Ecological Restoration *Quarterly News Journal*

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A View from Restoration's Finest Annual Gathering

What a feat! At last California's restoration community was able to meet again in person… OR virtually. Whatever worked best for the individual.

Huge props go to Conference Chair Thor Anderson for keeping his 2020 vision alive through the two long years of Covid restrictions! Just over 200 people attended in person, and almost 200 people joined us virtually as we livestreamed the track of sessions being held in the main ballroom. The tech team at Central Coast Entertainment made our first foray into a hybrid conference about as stress-free as possible — they were so prepared and also super responsive when the inevitable glitches occurred. And the venue, event planners, and staff at Palo Corona Regional Park were amazing. We highly recommend all of this year's partners.

And… BONUS! For the first time ever, we have recordings to share! We just sent a link to all registrants and have reopened registration — sercal.org/sercal2022 — so there's still time to literally hear and see how your colleagues are *Thinking Big, Starting Small, Restoring Now, and Planting Community in their Projects and Communities.*

We'll be sharing highlights throughout the year, but for now, enjoy this special *Phytophthora* issue that features some presenters from the *California Grown: Updating Nursery Practices* session led by Wolfgang Schweigkofler.

Above: **Success spelled out: One great idea and a whole lotta people making it happen!**

Special *Phytophthora* Issue

Managing Editor: Julie St John
Contributing Editor: James Mizoguchi

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Surface and Irrigation Types Have a Big Impact on Water Splash in Nurseries, Choose Wisely!

by Karen Suslow, Nilwala Abeysekara, Vernon Huffman, and Wolfgang Schweigkofler[1]

In nurseries, plant pathogens can spread via water splash from the ground to container plants growing on benches. We used suspensions of fluorescent microspheres the size of *Phytophthora* spp. propagules to compare the vertical water splash resulting from three irrigation methods on five surface types. Using hand watering, the number of water droplets that splattered to a maximum height of 3′ was significantly higher from concrete than from dry bare soil, weed barrier fabric, gravel, or a mud puddle. Hand watering and impact spray generated limited water splash at heights between 2.5 and 3′. However, spray sprinklers resulted in no water splash above 2.5′. Our results indicate that spread of plant pathogens from the nursery surface to plants placed on raised benches is possible, but unlikely to reach levels needed for successful infection, and that the risk for such transmission can be further reduced by choosing adequate surface types, watering systems and bench heights.

Introduction

Transmission of plant pathogens via water splash is considered a major threat for plant health in nurseries. Many plant pathogens can survive for extended periods of time in nursery soil, on plant debris or in water puddles, and have the potential to infest potted plants placed on benches, either through the root system or aerial plant parts. Rain splash plays an important role in the spread of many plant pathogens, including members of the genus *Phytophthora*. Sporangia produced by *Phytophthora* spp. release motile zoospores that can actively move through water and infest a wide range of host plants. Chlamydospores are resting spores which can survive in the soil or other substrates for many weeks. The invasive pathogen *P. ramorum* has already killed millions of forest trees in the western US and the UK and is still spreading to new areas. *P. ramorum* also causes leaf spots or twig dieback on many other host plants, some of them important ornamentals, such as rhododendron, camellia, and others (Grünwald et al., 2012). Aerial spread of *P. ramorum* and related species in the genus *Phytophthora* in wildlands in California is associated with rainfall and therefore restricted to the rainy season from approximately November to May (Pastalka et al., 2017; Schweigkofler et al., 2021). Plant trade plays a major role in the long distance spread of *P. ramorum*, and several *Phytophthora* species (e.g. *P. tentaculata* and *P. cactorum*) have been detected commonly on nursery stock grown for restoration and revegetation purposes in California (Rooney-Latham et al., 2019). Therefore, a considerable amount of research was conducted over the last twenty years to detect and control *Phytophthora* species in nurseries (Schweigkofler et al., 2014). *Phytophthora ramorum* is listed as a federally regulated quarantine organism in the US for which a regulatory program including treatment options for nurseries was initiated by USDA APHIS in 2002 and later modified (USDA APHIS 2020). Spread of *Phytophthora* propagules from infested nursery surfaces (e.g. concrete, dry bare soil, gravel, weed barrier fabric) to potted plants can be reduced by placing the pots on benches to increase the separation between inoculum and host plant. According to Swiecki et al. (2019), water splash from rainfall-sized droplets in still air can reach a height of about 2′. But to our knowledge, no experimental data on the vertical movement of *Phytophthora* propagules from different surfaces is described in the literature. The aim of this experiment was to investigate the height of water splash off of five commonly used nursery surfaces with three different irrigation types. In order to mimic the movement of *Phytophthora* sporangia and chlamydospores, we used fluorescent microspheres with a diameter of 53–63 microns, similar in size to the microbial propagules.

Material and Methods

Experiments were conducted at the National Ornamentals Research Site at Dominican University of California (NORS-DUC) in San Rafael, California (www.dominican.edu/directory/national-ornamentals-research-site-nors-duc). Five nursery surfaces (i) concrete, (ii) weed barrier fabric, (iii) 3/4″ gravel, (iv) dry bare soil, and (v) mud puddle (= irrigated bare soil), were tested in this experiment. The three watering systems used included (a) hand watering using a hand wand (Dramm Touch N Flow 12804- 30″ length with 'soft touch' 400 water breaker nozzle) attached to a 3/4″ garden hose dispensing 11 gal (~41.6L) per min, (b) spray sprinkler (Toro 570 shrub spray sprinkler) dispensing 4 gal (~15.1L) per min, and (c) an impact spray (Rain bird 2045PJ impact rotor) dispensing 11 gal (~41.6L) per min. Due to the nature of the sprinkler set up at NORS-DUC, the concrete surface was tested only with hand watering. Each surface was tested with a trial area of 3′ (width) x 2′ (depth). Blotter paper (Whatman #1 chromatography paper) cut to 3′ (height) x 1′ (width) was placed at a 90° angle to each of the surfaces (Figure 1). A suspension was made by diluting 0.2g of fluorescent yellow polyethylene microspheres (UVPMS-BY2-1.02; Cospheric LLC) coated with Tween 20 in 200 mL of deionized water.

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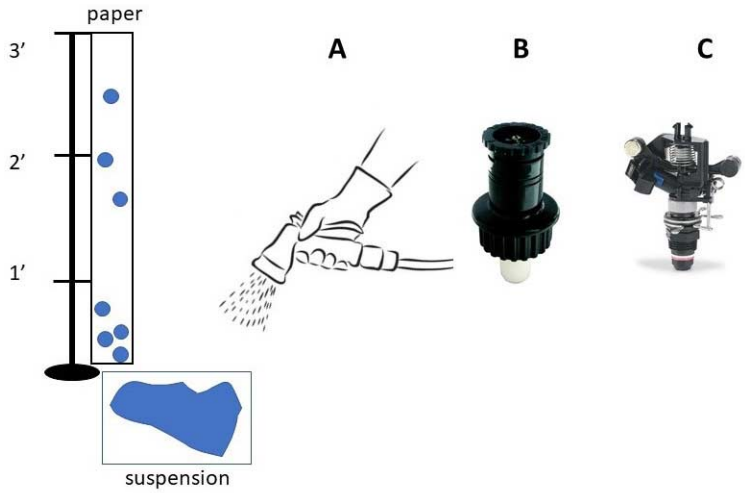

Figure 1. Detection of water splash off of common nursery surfaces with three different irrigation types. Blotter paper was placed at a 90° angle to each surface and 200mL of a fluorescent suspension containing ~2 x106 microspheres were poured onto the surface, 1-1.5′ in front of the blotter paper. Each surface was watered using three different irrigation types, separately (A: Hand wand, B: Spray sprinkler, C: Impact spray).

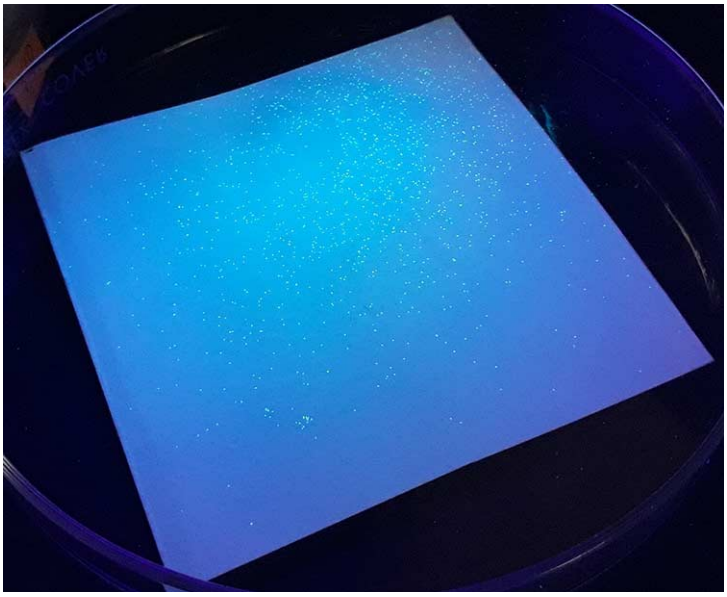

Figure 2. Detection of fluorescent microspheres on filter paper using an UV-lamp.

Surface and Irrigation Types Have a Big Impact on Water Splash in Nurseries *continued*

The suspensions, which contained approximately 2 million microspheres each, were poured onto the trial area at a distance of 1–1.5′ to the blotter paper. The surfaces were watered with each of the irrigation systems separately for 30 seconds at an angle of 45–60°. The hose wand was held at ~2′ above the surfaces. Each experiment was repeated three times. The blotter papers were allowed to dry for three days at room temperature and then scanned with a handheld UV trans-illuminator (UVL 21 Black Ray 115V 60-0.12 Ultraviolet products LLC) for fluorescence (Figure 2). Four parameters (maximum height of fluorescence detection; number of splashes between 1–2′; 2–2.5′; and 2.5–3′) were recorded for each surface. Detection of one fluorescent microsphere was counted as one droplet.

Statistical data analysis was conducted using the SPSS software for Windows ver. 26.0 (IBM, Armonk, NY: IBM Corp). Any statistically significant difference, (i) between the watering types for each substrate and (ii) between the different substrates for each watering type, were determined by conducting separate one-way analysis of variance (ANOVA) tests for each of the four parameters. Tukey's HSD test was run concurrently with the ANOVA test to determine the means that are significantly different from each other at a significance level of $= 0.05$.

Results

Most water droplets (> 95% of all) were detected at the height between 0 and 1′ above the surface for all surface and irrigation types. In this area droplets were so numerous that it was difficult or sometimes impossible to identify single spots under the UV light. Therefore, numbers were only reported for the areas between 1–2′, 2–2.5′ and 2.5–3′ (Figure 3).

The average maximum splash height created by the three watering systems (hand watering, spray sprinkler, and impact spray) on dry bare soil, gravel, mud puddle, and weed barrier fabric reached between 0.63 and 2.81′. More droplets were detected in the area between 1–2′ than in the higher areas (2–2.5′ and 2.5–3′) for all watering/surface combinations. The average number of droplets between 1–2′ ranged from 0.33 (using spray sprinkler on mud puddle) to 26.5 (impact spray on weed barrier fabric).

For the height between 2–2.5′, impact spray on weed barrier fabric resulted in the highest average droplet numbers, but this value was not significantly different from splashes resulting from hand watering or spray sprinkler on weed barrier fabric.

The average number of droplets reaching the highest tested area (2.5–3′) was generally very low, with values mainly between 0 and 1. The use of impact spray on weed barrier fabric resulted in significantly higher number of droplets than any of the other watering/surface combinations. No droplets were observed between 2.5–3′ when the spray sprinkler was used.

Concrete was the surface type with the highest average number of droplets in all three heights (1–2′, 2–2.5′, and 2.5–3′) when tested with hand watering, and the differences were statistically different from dry bare soil, mud puddle, weed barrier fabric, and gravel. The highest average water splash height was also found on concrete (2.69′), but in this case the results were not statistically significant.

continued next page

Surface and Irrigation Types Have a Big Impact on Water Splash in Nurseries *continued*

All surfaces except concrete were also tested with the spray sprinkler and impact spray, and weed barrier fabric was the surface type from which water splashes were detected most commonly.

Conclusions

The extent of vertical water splash (defined as highest average splash and number of droplets at a given height) differs based on surface and watering type. The fluorescent microspheres used in the experiment had a diameter of 53–63 microns, resembling the size of *P. ramorum* propagules (sporangia: 46–65 x 21–28 µm, chlamydospores: 46–60 µm) and acted as surrogates for the spread of waterborne pathogens. Of the five surface types tested, concrete resulted in significantly higher droplet numbers above 2′ when tested with hand watering compared to bare soil, mud puddle, weed barrier fabric, and 3/4" gravel. Only a very small fraction of the microspheres used in the experiment was detected at a height of 2–3′ above surface level using all three irrigation types and no droplets were observed between 2.5–3′ when spray sprinklers were used. The spray sprinklers used in this experiment emitted significantly less water per minute than hand watering and impact spray (4 gal/min vs. 11 gal/min), which could explain some of the observed differences. However, the smaller droplet size released from the spray sprinkler resulted in a 'mist-like' irrigation pattern with decreased physical impact compared to the 'rain-like' irrigation typical for hand watering and impact spray. In laboratory experiments with *P. ramorum*, an

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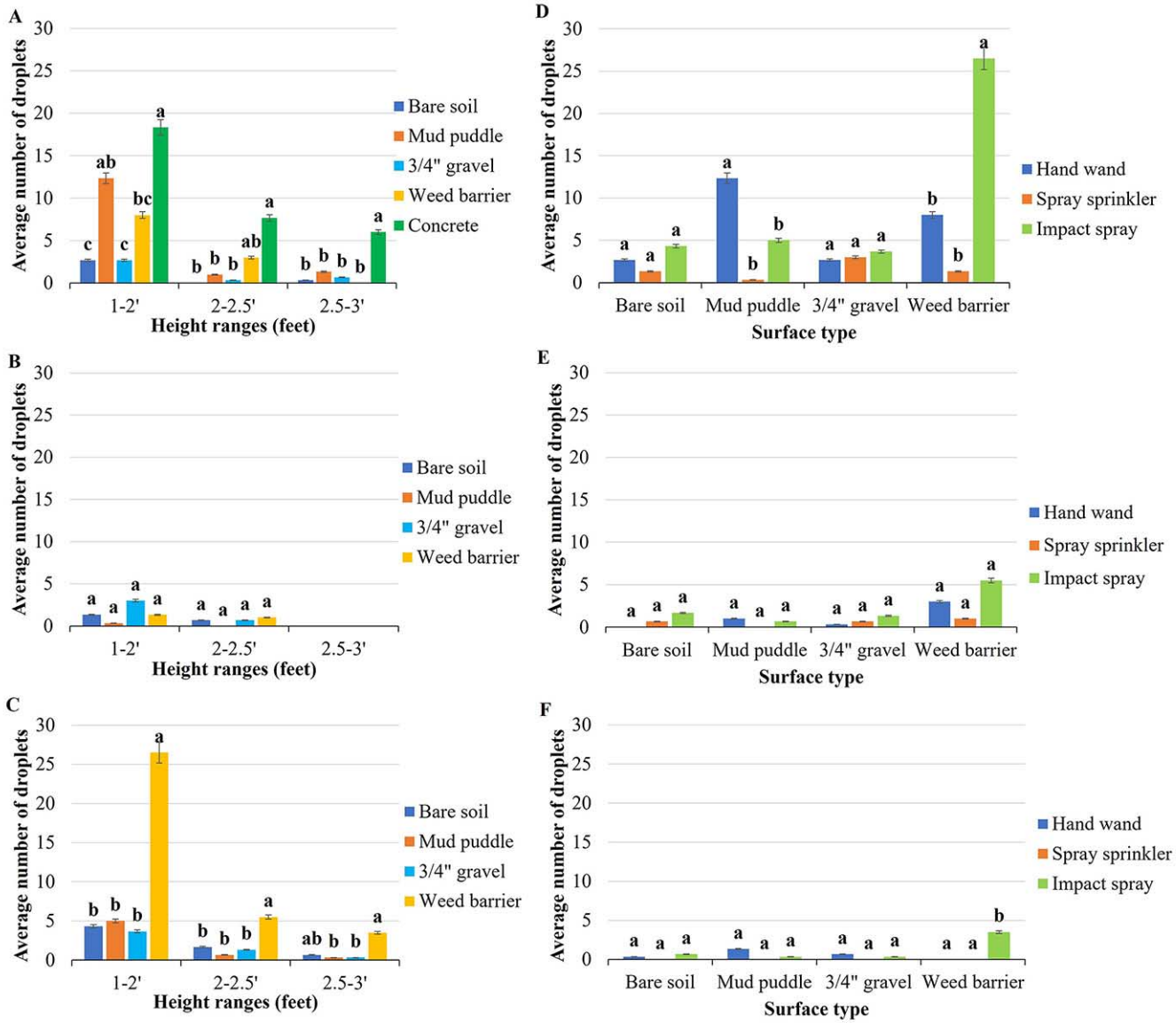

Figure 3: Average number of water droplets from different surfaces using three different irrigation types. Left panel: results arranged by irrigation type (A: Hand wand, B: Spray sprinkler, C: Impact spray); right panel: results arranged by height (D: 1–2′, E: 2–2.5′, F: 2.5–3′). Bars with different letters are statistically significant at $P<0.05$.

Surface and Irrigation Types Have a Big Impact on Water Splash in Nurseries

continued

inoculum threshold of 51 zoospores/mL was reported for infecting detached rhododendron leaves (Rollins et al., 2015). Consequently, smaller droplet sizes and low numbers of droplets reaching 2′ above surface reduce the risk of spreading waterborne pathogens.

Best Management Practices should be used in nurseries to produce healthy plants. We recommend to:

- Place plants on raised benches at a height of 3′ if possible (Figure 4)
- Choose an irrigation type with small water droplet sizes and low pressure, preferably overhead; when watering with a hose, keep the water on the plants soil surface and avoid aiming the hose at the ground to reduce splashing
- Choose a surface type which can be cleaned and drained easily, and from which droplets bounce back at reduced rates.

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Figure 4: The risk of water splash transmitted plant diseases can be reduced by placing plants on a bench above a graveled surface irrigated with spray sprinkler.

Steaming is an Efficient Way to Treat Soil, Potting Mix, Pots, and Other Supplies Infested by Plant Pathogens

by Wolfgang Schweigkofler and Vernon Huffman[1]

Infected nursery plants play an important role for the spread of many plant pathogens, among them *Phytophthora ramorum*, the causal agent of Sudden Oak Death and Ramorum blight. In order to minimize the risk for disease transmission to new areas, nurseries are inspected regularly for *P. ramorum*, and federal regulations require the eradication of infested plants and disinfestations of nursery soil and equipment (USDA APHIS 2020). Heat treatment is a well-established method for the mitigation of plant pathogens. The National Ornamental Research Site at Dominican University of California (NORS-DUC) is a federally funded research nursery that develops and tests methods for managing federally regulated quarantine organisms, including *Phytophthora* species. At NORS-DUC, we use steaming to decontaminate research plots in which experiments with *Phytophthora ramorum* or other quarantine pathogens were conducted. Laboratory trials have shown that heat treatment at a temperature of 50°C for at least 30 minutes inactivates *P. ramorum* (Schweigkofler et al. 2014). Based on research done at NORS-DUC, USDA APHIS accepted steaming as an official treatment for nursery soil infested with *P. ramorum* (USDA APHIS 2020). Steaming is now an established part of the Best Management Practices (BMP) in several nurseries and botanical gardens in California and other states (Elliott et al. 2021). Steaming can be used to mitigate existing soil beds *in situ*, but also potting mixes, pots, and other nursery equipment, and will reduce the risk of establishment and transmission of plant diseases. However, it has to be considered that some plant pathogens, esp. endospore-producing bacteria, but also some fungi, can tolerate much higher temperatures than *P. ramorum* and will survive at 50°C.

Steaming can be achieved using different methods. For the traditional top-down approach, a steam sock made out of a permeable material is placed on top of the area to be steamed, and then the area is covered with a tarp to contain the heat. The time and energy needed to reach the target temperature depends on a number of parameters, among them steamer size, type of treated material, size of treated soil plot, soil moisture and structure (compactness), soil depth, and ambient temperatures. With our commercial steaming unit (SIOUX Steam-Flo SF-20), huge piles of pots can be steamed within two to three hours, but it can take up to 12 or more hours to steam a soil plot to a depth of 20 cm. Top-down steaming can be used successfully for treating potting mix up to 4 cubic yards. However, most native plant nurseries need to steam larger quantities of soil and potting mixes, upwards of 15 cubic yards at a time. Steaming such big quantities requires substantial longer time as well as more fuel to run the steamer, resulting in higher costs.

Figure 1. A manifold developed at NORS-DUC for steaming using 'bottom-up' heat transfer.

NORS-DUC developed a manifold heating system to deliver heat more effectively using a bottom-up approach. Our manifold consists of five cross pipes 10′ across connected at a 90° angle to a central pipe of 12′. All pipes are stainless steel and have a diameter of 1.5″ (Figure 1). Every 18″, a 1/8″ hole was drilled into the bottom side of the cross pipes to limit the chances of clogging the holes with soil. The size specifications of the manifold will vary depending on the specific nurseries soil holding area. The use of stainless steel increases the longevity of the manifold, however cheaper versions using black steel pipe were developed by several nurseries and used successfully. The

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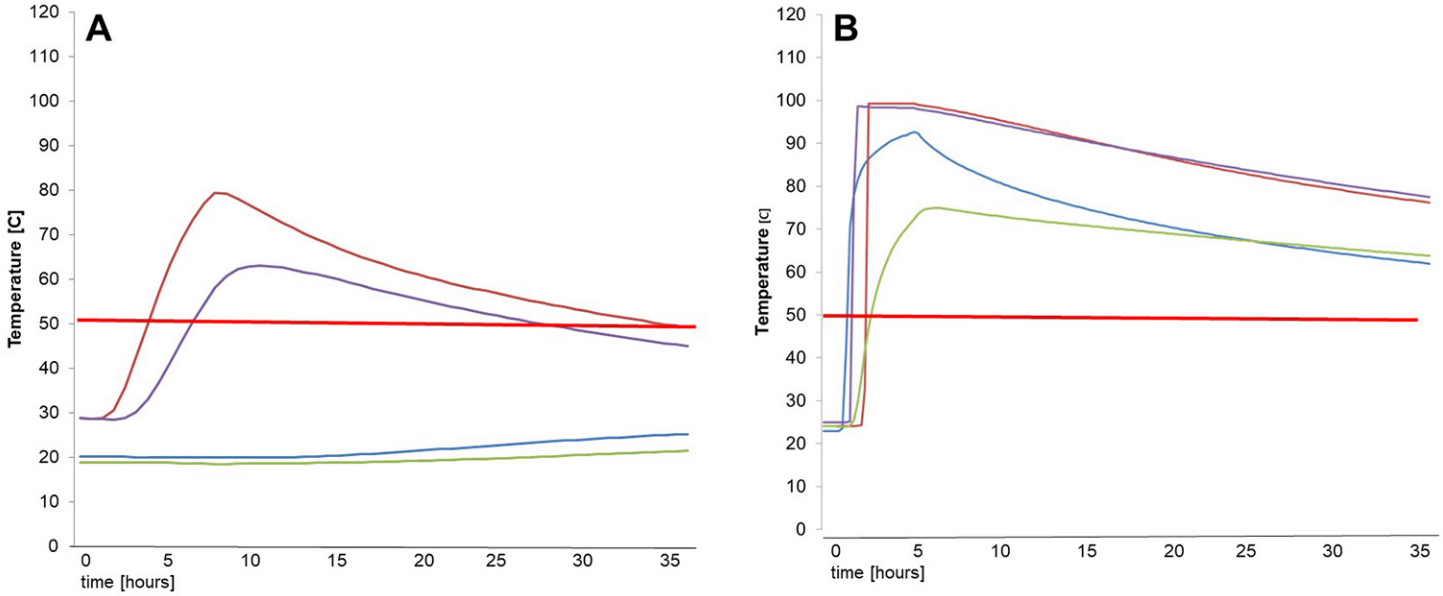

Figure 2. Temperature profile for steaming 7.5 cubic yard pile of potting mix using A) a 'top-down' (without manifold) and B) a 'bottom-up' (with manifold) approach. The target temperature of 50°C is shown as a straight red line. The steamer was switched off after 7 hours (A), and 1.5 hours (B), respectively. Temperatures were measured at the top area of the pile (red and purple lines), and the bottom of the pile (green and blue lines), respectively.

Steaming is an Efficient Way to Treat Soil, Potting Mix, Pots, and Other Supplies Infested by Plant Pathogens *continued*

size of the manifold can be adapted according to the needs of the nursery, however it is important to have the correct number of orifices drilled in the pipes to achieve the needed steam output. The company producing the steamer provides a table for calculating the right number of orifices based on steamer type, steam pressure, length of pipe used, and pipe diameter. Using a manifold changes the direction of the heat transfer and significantly decreases the time needed to reach our target temperature of 50°C.

We compared the time needed to steam 7.5 cubic yards of soil mix, a pile which was 24 inches high, using the traditional top-down method and the bottom-up manifold method. Using the traditional top-down method, the target temperature was reached within the upper 6 inches of soil mix after seven hours, however the target temperature had not been reached at the bottom of the pile. Using the bottom-up manifold method, all areas reached the target temperature within 1.5 hours (Figure 2).

NORS-DUC offers a 'Steaming-on-the-Go' service for nurseries, and other stakeholders in Northern California, who need to disinfect supplies, potting mixes, or soil plots *in situ*, but lack the needed equipment. We bring our steam unit to the site for a controlled heat treatment, using temperature sensors to ensure the target temperature is reached. The service not only serves to fulfill BMPs and USDA APHIS regulations, but can also help to cut costs and time for the nurseries, who otherwise would need to buy new supplies or use other, more time-consuming cleaning methods. For

continued next page

Figure 3. 'Steaming-on-the-Go' of huge numbers of pots can be achieved in a relatively short time at low costs.

Steaming is an Efficient Way to Treat Soil, Potting Mix, Pots, and Other Supplies Infested by Plant Pathogens *continued*

example, used pots — often still containing plant debris or soil which might be contaminated by plant pathogens — have to be disinfested before they can be reused or replaced with new ones. Recently we steamed 175,000 used pots for a grower which only took three days (Figure 3). At an average price of 50 to 75 cents per pot, the costs for replacing the pots would be approximately $100,000, which is many times higher than the cost for steam cleaning. Steaming is also a relatively ecologically friendly method which can reduce the use of toxic chemicals and plastic waste.

Still, questions remain on the effect of steaming on the microbial biodiversity, such as survival of different microbial groups and re-colonization pattern of the treated potting mix, as well as possible effects on the chemical soil properties. Research at NORS-DUC was initiated in collaboration with Pennsylvania State University to study these changes in soil properties and possible effects on plant growth.

Further information on the 'Steaming-on-the-Go' program can be found on the NORS-DUC website: **https://www.dominican.edu/directory/national-ornamentals-research-site-nors-duc/publications-and-information-nurseries**. For help with designing a manifold please contact Vernon Huffman at **vernon.huffman@dominican.edu**.

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Meet the Contributing Author: **Wolfgang Schweigkofler**

Occupation: I am a Research Associate Professor and Principal Investigator at NORS-DUC, the National Ornamentals Research Site at Dominican University of California, San Rafael, CA.

County of residence or work: Our small university is located in Marin County, but we also work in other counties, mainly in NorCal.

What is your specific discipline (or underlying education)? I am a plant pathologist and environmental microbiologist with a PhD from the University of Natural Resources and Applied Life Sciences, Vienna, Austria.

What services do you provide for restoration in California, or what is your restoration passion? We study invasive plant pathogens, such as Phytophthora ramorum, causal agent of Sudden Oak Death, and try to develop methods to control them. We offer a service, called 'Steaming-on-the-go' for native plant nurseries in NorCal, for heat treatment of potting mixes, and we also have a strong outreach program. The goal of our research is helping nurseries to produce disease-free plants, which can be out planted without introducing new pathogens in native environments.

How did you get into this field? I did research on agricultural crops, such as grapes and apples, back in Europe. When I came to California, I developed an interest in forest pathology and invasive species. Unfortunately, we see many examples of exotic pathogens damaging native environments, and I hope that with my research I can help to reduce the risk of new introductions.

What is your favorite California native species? There are so many. But I really like the yellow-bellied marmot (ok, no plant...) and the coast redwood.

Any advice for others in the field of restoration? Go out for a hike in different areas in California and get inspired by the beauty of the landscape and the amazing biodiversity California has to offer.

Left to right: Sticky monkey-flower (*Diplacus aurantiacus*) and California rose (*Rosa californica*) showing dieback associated with *Phytophthora*.

Sampling and Diagnostic Guide for Soil-borne *Phytophthora* Species on California Native Plants:

Part 1. Selecting Plants to Sample

by Tyler B. Bourret[1] and Susan J. Frankel[2] Revised May 2, 2022. *Photo credits: UC Davis, Department of Plant Pathology.*

Introduction

Over the past several years, *Phytophthora* has emerged as a significant problem on California native plants in nurseries and restoration areas. Here we provide guidance for *Phytophthora* sampling and survey design. The tips may be applied to determine *Phytophthora* incidence in natural ecosystems and restoration sites, and they are presented with the goal of reducing the risk of unintentional introduction of exotic pathogens and improving restoration plant health. In the guide "Part 1. Selecting Plants to Sample" (see box page 9) we provide direction for where and how to sample.

> *Note: To avoid spreading pathogens, good sanitation is required when sampling so this guidance should be used along with instructions for cleaning tools, boots, hands (gloves), and with care to not inadvertently transport incidental debris or soil.*

Additional sections will be forthcoming with instructions for sampling handling, baiting and other procedures. For sample identification, the soil or plant material may be sent to the California Department of Food and Agriculture laboratory for identification.

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Information on fees and how to deliver samples is available at https://www.cdfa.ca.gov/plant/PPD/plantpath.html. For questions, contact Janice Alexander, Phytophthoras in Native Habitats Work Group at jalexander@ucanr.edu.

How to select specific areas to sample

When managing *Phytophthora* in restoration sites, one of the first steps is to determine whether the pathogen is present on the site, both pre- or post-planting. Survey design and sampling is site-specific, but we have assembled a few pointers to help identify the most likely places to find infected plants based on symptoms and site characteristics. Caution is warranted, it is very difficult to prove *Phytophthora* is not present. At times pathogens can be present with no visible symptoms — these microbes don't always express themselves in ways that people can see.

In most cases when sampling a planned or in-progress restoration area, site selection is predetermined by restoration goals. A primary decision revolves around the tradeoffs between sampling width (the number of sites) and depth (the number of samples per site). In contrast, for landscape-level surveys, site selection is critical. Proper site and sample selection maximizes the amount of information gained from each sample. (We use "site" to mean one localized, continuous area.)

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Figure 1. A site experiencing anthropogenic soil movement. Potentially infested soil is being moved in along a closed road via unauthorized off-road vehicle use. The closed road was selected for potential restoration and managers wanted to assess if it was already infested by *Phytophthora*. The sampling focused on the area where the people are standing, since it is closest to the source of the potentially infested soil. *P. crassamura* was later baited from soil along this closed road.

Sampling and Diagnostic Guide for Soil-borne *Phytophthora* Species on California Native Plants *continued*

Although much about the natural distribution of *Phytophthora* is unknown, the distribution of soil-borne *Phytophthora* species on a landscape is not typically continuous, nor is it random. Therefore, surveys should focus sampling on areas with the highest likelihood of finding *Phytophthora*. This not only increases the chances of finding the pathogen but allows for a stronger interpretation of negative results.

Land use history. When embarking on a survey, review the site's previous use. While California has native pathogens, their occurrence is typically rare to uncommon, and it appears that human activities are ultimately responsible for most of the damaging infestations of *Phytophthora*. Many ecosystems are not pristine, having previously been used for agriculture or horticulture, both of which facilitate establishment of *Phytophthora* species. Roads and trails, even those no longer in use, enhance soil movement. Past restoration, or other plantings are possible *Phytophthora* introduction pathways.

Moving with soil. One of the most important ways *Phytophthora* can be spread is by movement of soil, either anthropogenically or naturally (Figure 1). *Phytophthora* moves *through* soil unassisted, but this movement is limited, typically a few meters a year, or less. This movement is much faster downhill than uphill and is greatly facilitated by contact with roots.

Areas that are likely to have had soil moved into them should be prioritized for sampling. When surveying these disturbed sites, consider the source of the soil and target that location for initial sampling. For example, former roads or trails are commonly slated for restoration. When evaluating these project areas, surveys should target the trailhead or road origin, where soil movement is most likely. If *Phytophthora* is detected, then subsequent surveys can focus on assessing the extent of the infestation.

> *Note: A primary consideration during sampling is to make sure proper sanitation is practiced so that soil or pathogens are not unintentionally spread.*

Moving with water. *Phytophthora* species proliferate and spread in water, and *Phytophthora* spores are found in rivers, creeks, lakes, and ponds. (Bodies of water can be baited for *Phytophthora*, for an overview see **https://ucanr.edu/sites/rizzolab/Research_Projects/Stream_Monitoring/**.) Whether outplanted or naturally recruited, vegetation near watercourses, that are even sporadically subject to flooding, are at risk of *Phytophthora* infection (Figure 2). Inundation risk is an important consideration when selecting restoration site locations – sites that are flooded are more likely to yield *Phytophthora* than upland, dry sites. Plants that are more likely to be

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Figure 2. A restoration outplanting within the flood plain of an urban river. The California mugwort being sampled likely encounters many swimming spores during times of flooding. Several *Phytophthora* species were baited from roots and soil, and directly from the river water.

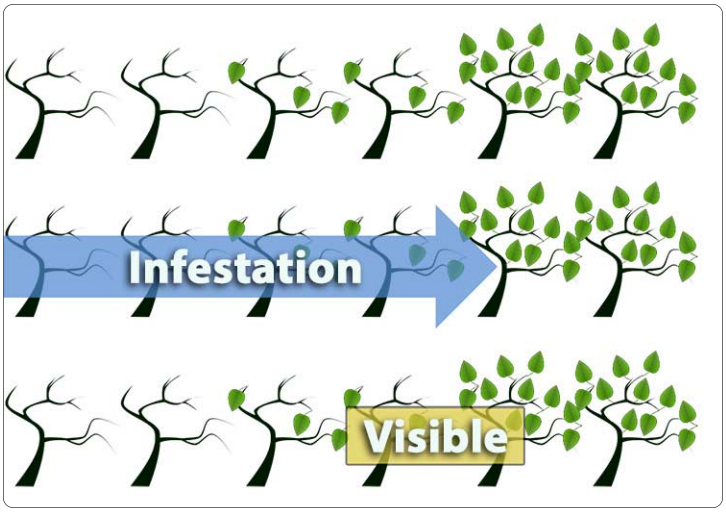

Figure 3. Illustration of a disease front. In this schematic, the infested area grows from left to right, and above-ground symptoms lag behind root infections. If possible, samples should be collected in an area where symptoms first become visible (indicated in yellow), as the pathogen may no longer be present or viable in the areas where plants have died.

Sampling and Diagnostic Guide for Soil-borne *Phytophthora* Species on California Native Plants *continued*

flooded should be prioritized for *Phytophthora* sampling. For previously outplanted sites, knowing which species are in a local waterway can help determine whether plants may have become infected onsite due to exposure to floodwater.

Topography, soil, and local vegetation. Sample in areas with woody plants, in low-lying areas since they hold the most water, and because *Phytophthora* is more common downhill. Consider local soil-type information when selecting sites. *Phytophthora* is more likely to be found in soils with high clay content and low organic matter, and in areas with greater moisture retention.

Although it is not always visible, *Phytophthora* root rot may form a "disease front" or root disease center with a gradation between declining or dead vegetation (Figure 3). As the infestation area expands, plants on the edge become infected and begin to decline then die. If the leading edge can be determined, sampling should be targeted around declining, rather than dead, plants.

Edges, or transitional areas between vegetation types, provide useful areas to sample. Edges pick-up a greater range of physical conditions, and a location with multiple vegetation types provides a greater diversity of potential *Phytophthora* hosts. Edges may represent historical disease fronts, and so sites containing edges may detect the causal agents of previous declines.

Sample selection

Which plants to sample. *Phytophthora* populations are associated with their plant hosts. So, when sampling, collect soil beneath plants and include roots. A good sample choice is often the most symptomatic individual at a particular site. But the most symptomatic toyon at one site might show

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Sampling and Diagnostic Guide for Soil-borne* Phytophthora *species on California Native Plants: Part 1. Selecting Plants to Sample is now available from the Phytophthoras in Native Habitats Work Group. The guide provides tips for *Phytophthora* sampling and survey design for restoration sites or natural ecosystems to target where and how to sample. Although much about the natural distribution of *Phytophthora* is unknown, the distribution of soil-borne *Phytophthora* species on a landscape is typically not continuous, nor is it random. Therefore, surveys should focus sampling on areas with the highest likelihood of finding *Phytophthora*. Photographs and diagrams illustrate general principles to determine sampling strategies to assess whether *Phytophthora* is present on a landscape. If you need more information or have questions contact Janice Alexander, Phytophthoras in Native Habitats Work Group, **jalexander@ucanr.edu**.

Figure 4. At this active restoration site, downhill soil movement from the road and potential flooding from the currently dry creek increase risk of *Phytophthora* exposure.

Figure 5. In this restoration outplanting in a natural ecosystem, plants in low-lying areas were targeted for sampling as the most likely places to yield a *Phytophthora*-positive sample.

Sampling and Diagnostic Guide for Soil-borne *Phytophthora* Species on California Native Plants *continued*

slight stunting or leaf yellowing, while at another, the most symptomatic toyon may exhibit severe branch dieback and wilting. Note that some *Phytophthora* species make resistant spores than can last for long periods of time in dead plant material or soil, allowing them to survive while they are not infecting a plant.

Sample selection is not a precise science, but the following four factors can help target plants for sampling:

1. Check planting basins with weak plants. If a plant was produced in a nursery with poor phytosanitation, the plant may have become infected in the nursery.

2. Look for pronounced symptoms (stunted, off-color, blotchy, thin crown) on live plants. When multiple individuals of a plant species are present, the most symptomatic one is the most likely to test positive. Partially green plants are best, avoid decayed, older-dead plants.

3. Sample areas with flooding potential. Plants in areas that are prone to flooding or standing water should be targeted.

4. Evaluate disturbed areas. Disturbance, such as movement of soil from roads and trails, increases the likelihood of infection (Figure 4).

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Figure 6. A metal spade is a good choice for soil sampling in softer soils. Metal spades have few crevices which makes them easier to sterilize between samples. In this planting basin, the plant had recently died but the soil was tested.

Figure 7. A trenching shovel maybe used for sampling harder soils. Its narrow profile facilitates sampling soil associated with restoration plants without harming too many roots, and it can be applied forcefully.

Figure 8. This blue oak sapling is stunted or declining but still alive, which makes it a good choice for sampling.

Sampling and Diagnostic Guide for Soil-borne *Phytophthora* Species on California Native Plants *continued*

When sampling consider:

Microtopography. Plants growing in areas where water collects should be preferred over those on slopes (Figure 5).

Soil type. Soil with higher clay content has a greater chance of harboring *Phytophthora*.

Plant species. Woody shrubs and trees, with their extensive root systems are considered most susceptible to soil-borne *Phytophthora*. However, rush (*Juncus* spp.) and herbaceous plants can also become infected. Priorities for sampling should match the value of the plant in the landscape and knowledge about species' susceptibility.

When to sample. *Phytophthora* activity syncs with active root growth and is correlated with moisture, making recovery most likely during the growing season and rainy season. In California's Mediterranean climate, in many areas, the growing season and best time to sample extends from the late autumn through winter and into early spring but depends on elevation and latitude. As molecular detection techniques become increasingly available, the need for *Phytophthora* to be viable in the soil sample will be alleviated, but the pathogen will always be easiest to detect during periods when it is actively sporulating. Tools and more guidance are provided in Figures 6–9.

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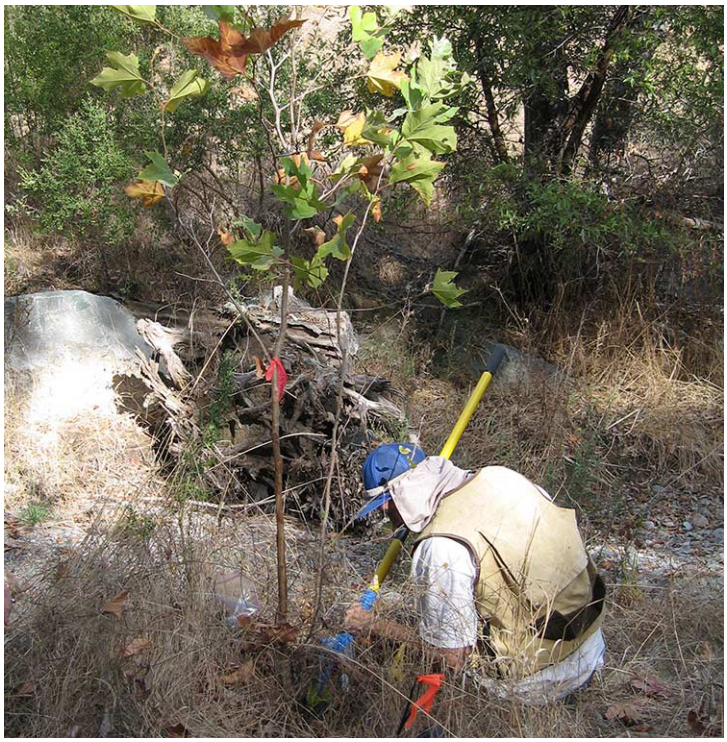

Figure 9. While this tree is still green, it has long internodes and relatively sparse foliage compared to other similar individuals in the site, making it a good choice for sampling.

Appendix: Background

Introduction to *Phytophthora* — *Phytophthora* (ancient Greek: "plant destroyer") is a genus of plant-pathogenic, microscopic organisms that have a long history of killing plants in agriculture (e.g. late blight of potato, *Phytophthora infestans*, cause of the Irish potato famine) and in natural ecosystems (e.g. sudden oak death, caused by *P. ramorum*). In restoration ecology, *Phytophthora* species that encounter plants, either in a nursery or in the field can pose major obstacles to project success. Unintentional introductions of *Phytophthora* into natural ecosystems during restoration activities may turn planting into a means of habitat degradation rather than rehabilitation.

***Phytophthora* & *Pythium*: The "oomycetes"** — *Phytophthora* and its relative *Pythium* are oomycetes that resemble the molds of the Kingdom Fungi, but are actually more closely related to brown algae. Many species of *Phytophthora* and *Pythium* (as well as *Phytopythium*, a group recently split from *Pythium*) have broad host ranges, attacking the roots, stems, or foliage of a wide variety of woody shrubs and trees, and to a lesser extent, herbaceous plants. Their broad host range facilitates the infestation of novel habitats by increasing the chance of encountering susceptible hosts, both in nurseries or restoration sites, and greatly increases the risk of an accidental introduction leading to a disease epidemic in an invaded ecosystem, such as sudden oak death (*P. ramorum*).

Unlike most members of the Kingdom Fungi ("true fungi"), oomycetes usually have swimming spores (zoospores) that enable them to locate and infect plants. This aspect of oomycete biology is exploited in the detection technique known as "baiting" where a sample is flooded with water and living plants or plant parts (the bait) are floated so that it is likely to be encountered by zoospores. The technique can be done without access to a laboratory, and its sensitivity allows for the assessment of larger quantities of soil as compared to other methods. Green (partially ripe) pears are a widely available and common bait, that develop dark and relatively distinctive lesions following infection by *Phytophthora* or *Pythium*.

False negatives vs. false positives — An important consideration when interpreting the results of a *Phytophthora* survey, is the likelihood of false negative results — failing to detect *Phytophthora* that is actually present. If isolates baited from samples are morphologically analyzed by a diagnostician, or genetic (DNA) sequences are obtained from isolates, the likelihood of a false positive (detection of a species of *Phytophthora* when it actually was not present) is low. However, in general, the risk of a false negative for any given sample or survey is significant for a variety of reasons. In this guide we provide only general pointers.

Sampling and Diagnostic Guide for Soil-borne *Phytophthora* Species on California Native Plants *continued*

Acknowledgements

Financial support from the San Francisco Public Utilities Commission (SFPUC) is greatly appreciated. Thanks also to Ted Swiecki and Elizabeth Bernhardt, Phytosphere Research, for their guidance and numerous contributions to sustain plant health.

For more information:

Best management practices for restoration and field work, nurseries, and other guidance: Phytophthoras in Native Habitats Work Group via https://www.suddenoakdeath.org/welcome-to-calphytos-org-phytophthoras-in-native-habitats/resources/.

California Oak Mortality Task Force: www.suddenoakdeath.org.

Instructions for using green pears to bait for *Phytophthora* in soil/root samples: http://phytosphere.com/soilphytophthora/pearbaitingPhytophthora.htm.

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Figure 1. A. Leaf necrosis of Bay laurel (*Umbellularia californica*) infected with *P. cinnamomi*. B. Wilting and die back of Coyote mint (*Monardella villosa*) infected with *P. cactorum*. C. Leaf and branch necrosis of Maritime Ceanothus (*Ceanothus maritimus*) infected with *P. nicotianae*. D. *Ceanothus* sp. root rot caused by *P. niderhauseri*. E. Asymptomatic and symptomatic (plant collapse) of Coastal strawberry (*Fragaria chiloensis*) infected with *P. cactorum*.

Overcoming Challenges in *Phytophthora* Diagnosis for Restoration Plant Health

by Dr. Johanna Del Castillo Múnera[1]

A recurrent challenge for preventing *Phytophthora* outbreaks and introductions into trade and wildlands, is that infected plants may initially be asymptomatic (not show symptoms), so they can pass as healthy plants, and leave nurseries undetected. Symptoms may develop after transplanting, or in response to stress like heat, or low water availability. This is one of the reasons why it is important to do regular *Phytophthora* testing— implementing the leachate baiting method— in the nursery even if plants appear healthy. Joining efforts with the Phytophthoras in Native Habitats Work Group (PWG) — a coalition of restoration nurseries, land management agencies, researchers and non-profit organizations — we are evaluating *Phytophthora* testing protocols to inform design of an accreditation program for restoration nurseries. We're comparing the efficacy of currently available detection methods — the leachate baiting method, immunostrips, and direct isolation from root tissue — on sets of California native plants artificially inoculated with *P. cactorum*, a species frequently recovered from California native plant nurseries. Our experimental assays will expand to compare these three detection methods on other *Phytophthora* species and native hosts. The findings from our work will support monitoring protocols used in the Accreditation to Improve Restoration (AIR) program for restoration nurseries developed by the PWG.

Continual monitoring for symptomatic plants, is a nursery best practice essential to sustain plant health. But, diagnosing

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Overcoming Challenges in Phytophthora Diagnosis for Restoration Plant Health

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Phytophthora diseases can be challenging, as other factors including nutrient deficiency, sunburn, lack of water and other pathogens can cause similar symptoms. It is also important to consider the plant life cycle at the time you are scouting for disease symptoms, as certain native plant species go dormant at different times of the year, and dormancy stages can be confused with symptomatic plants. In the nursery, periodically monitor for the presence of symptoms like wilting, leaf necrosis (browning), chlorosis (leaf yellowing), dieback, and sudden plant collapse (Figure 1). If symptomatic plants are identified, examine the plant parts affected in detail. For example, if plants look wilted, start by checking the roots. Wilting can be a consequence of root rot expressed as the plant's inability to transport water and nutrients when infected by *Phytophthora.* Examine and record the presence of root rot (brown discoloration), total root ball size and condition (infected plants tend to have fewer roots than a healthy one), and any other symptoms. Next, monitor the plants surrounding the symptomatic plants, and keep a record of the environmental conditions and cultural practices for the symptomatic lot. Set weak plants aside, in a quarantine area, away from the healthy plant stock. You can submit samples to the greenhouse pathology lab at UC Davis (**https://greenhousepathology.faculty.ucdavis.edu/**) and/or do leachate testing (**http://phytosphere.com/BMPsnursery/test3_4bench.htm**) in your facility, and submit the pear baits to the CDFA for further *Phytophthora* identification. In order to determine if your plant stock is infected with *Phytophthora*, symptomatic plants and baits should be analyzed in a plant disease laboratory.

Currently, a final *Phytophthora* diagnosis in the laboratory can take up to three weeks. Plant tissue from samples or baits are placed onto a *Phytophthora* selective medium, then five days later, checked for oomycete growth. If present, cultures are obtained and purified (after another five to eight days) and morphological and molecular identification are conducted. This time frame, in which nurseries wait for a final report confirming a *Phytophthora* infection, can be devastating, as during these three weeks, the pathogen may spread in the facility. The development of a faster and more specific detection technique that could be implemented in the field is needed in order to determine in a rapid fashion if plants are infested with *Phytophthora.*

In our laboratory at UC Davis, we're evaluating if a Recombinase Polymerase Amplification (RPA, TwistDx Ltd, Cambridge, UK) method that has been used to diagnose plant pathogens in a quick and simple manner, can be implemented for *Phytophthora* identification from infected nursery plant material. The RPA technology can be implemented in the field. It only requires a kit where suspected infected plant tissue is placed in a small tube, and after 20 minutes it will turn color if the pathogen being assayed for is present. For *Phytophthora*, Miles et al. (2015) developed specific markers that anneal to the *atp9-nad9* mitochondrial gene. We are currently validating these markers with *Phytophthora* cultures in the laboratory, and with artificially inoculated plant tissue. We expect to validate and confirm that these markers can be used to rapidly diagnose *Phytophthora* from infected plant tissue in a nursery. The development of these tools will complement the current practices the PWG is recommending to improve *Phytophthora* management in native plant nurseries, and will be shared as soon as the evaluation has been completed.

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Miles, T.D., F.N. Martin, and M.D. Coffey. 2015. Development of rapid isothermal amplification assays for detection of *Phytophthora* spp. in plant tissue. *Phytopathology* 105(2): 265–278.

Phytophthoras, Restoration and Native Plants: *Recent research findings*

by Susan J. Frankel[1] and Christopher Lee[2]

Sims, L.L., and M. Garbelotto. 2021. *Phytophthora* species repeatedly introduced in Northern California through restoration projects can spread into adjacent sites. *Biological Invasions* 23: 2173–2190. https://doi.org/10.1007/s10530-021-02496-6.

This is the first controlled survey linking the presence of *Phytophthora* species to failing restoration projects and to the plant production facilities that provide plant stock for restoration, while showing that *Phytophthora* species are absent in neighboring undisturbed sites. The study was conducted on six plant species at five locations in San Mateo, Marin, and San Francisco counties. Statistical analyses confirmed that the percentage of positive *Phytophthora* isolations was significantly higher in restoration sites and adjoining disturbed sites than in undisturbed control sites. The authors conclude, "This study further proves that these pathogens are spreading from restoration sites through disturbance pathways."

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Bourret, T.B., S.N. Fajardo, C.P. Engert, and D.M. Rizzo. 2022. A barcode-based phylogenetic characterization of *Phytophthora cactorum* identifies two cosmopolitan lineages with distinct host affinities and the first report of *Phytophthora pseudotsugae* in California. *Journal of Fungi* 8(3): 303. https://doi.org/10.3390/jof8030303.

Of note: "According to our results, there are lineages within both *Phytophthora* species [*P. cactorum* and *P. pseudotsugae*] that are not currently present in California and, therefore, theoretically pose risks to native plants if they were to be introduced. Our evidence also suggests that at least one genotype of *P. cactorum* is being locally spread via restoration activities. …It appears that the *P. cactorum* California restoration lineage is, at the moment, only moving locally through restoration nurseries, while [an] apple–oak lineage is moving locally and worldwide through horticulture."

Dale, A.L., N. Feau, J.A. Berube, J. Ponchart, G.J. Bilodeau, and R.C. Hamelin. 2022. Urban environments harbor greater oomycete and *Phytophthora* diversity, creating a bridgehead for potential new pathogens to natural ecosystems. *Environmental DNA*. https://onlinelibrary.wiley.com/doi/pdf/10.1002/edn3.300.

Dale and collaborators used environmental DNA techniques to investigate the presence of Phytophthoras in urban areas and their surroundings in British Columbia, Canada. They state that the genus *Phytophthora* is clearly advantaged by human activity. "… the observation of higher levels of *Phytophthora* infestation in planted versus natural or seed-generated forests, and the high frequency of nursery-associated *Phytophthora* species suggest that plants-for-planting is an important pathway in the movement of plant pathogens." They conclude, "Our study serves as a warning that some *Phytophthora* species introduced from nurseries or spread by human movement could pose a threat to natural ecosystems. Shifting patterns in oomycete communities could interfere with natural ecosystem processes and result in increases in disease and ecosystem declines."

Swiecki, T.J., E.A. Bernhardt, S.J. Frankel, D. Benner, and J. Hillman. 2021. An accreditation program to produce native plant nursery stock free of *Phytophthora* for use in habitat restoration. *Plant Health Progress* 22(3): 348–354. https://doi.org/10.1094/PHP-02-21-0025-FI.

Nursery *Phytophthora* Best Management Practices (BMPs) designed to exclude *Phytophthora* from nursery plants were developed to address the need for clean planting stock in restoration projects. A pilot program to implement the systematic use of the

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Phytophthoras, Restoration and Native Plants *continued*

BMPs, "Accreditation to Improve Restoration" (AIR), was developed and started in 2018. In 564 tests conducted over 4 years with a sensitive leachate baiting protocol, no *Phytophthora* was detected from over 20,000 nursery plants produced in compliance with the BMPs.

Hamelin, R., G. Bilodeau, R. Heinzelmann, K. Hrywkiw, A. Capron, E. Dort, A. Dale, E. Giroux, N. Carleson, N. Grünwald, and N. Feau. (Pre-print). Genomic biosurveillance detects a sexual hybrid in the sudden oak death pathogen. *Research Square.* DOI: 10.21203/rs.3.rs-699860/v1.

Hamelin et al. report the discovery, in a plant nursery, of novel variants of *P. ramorum* that are the result of hybridization via sexual recombination between European (EU1) and North American (NA2) clonal lineages. The research shows that these hybrids are viable, can infect plants and produce spores for long-term survival and propagation. The *P. ramorum* samples, from infected rhododendron plants, were obtained during regulatory nursery inspections by the Canadian Food Inspection Agency (CFIA). To date, the *P. ramorum* EU1 x NA2 hybrid has only been found in a single nursery in British Columbia; the pathogen has not spread to natural forests. The pathogen is considered eradicated in that nursery, thereby preventing further reproduction of the hybrid.

This is the first report of a viable *P. ramorum* hybrid between clonal lineages being recovered from a live plant. Previously, hybridization has been demonstrated in laboratory crosses between the EU1 (mating type A1) and NA1 (mating type A2) lineages, but the progeny displayed aberrant genotypic and phenotypic variation. This discovery is disconcerting since, as the authors note, "Hybridization provides a source of new genetic variation upon which natural selection can act to modify traits such as pathogenicity and transmission."

Tsykun, R., S. Prospero, C.N. Schoebel, A. Rea, and T. Burgess. 2022. Global invasion history of the emerging plant pathogen *Phytophthora multivora. BMC Genomics* 23: 153. https://doi.org/10.1186/s12864-022-08363-5.

Complementing the other recent studies of *Phytophthora* movement from urban centers and nurseries to wildlands, Tsykun et al. provide a new example that illuminates the movement of these pathogens around the world and their arrival in receiving cities. Using microsatellite markers, the authors show that *P. multivora* — a *Phytophthora* species of known virulence on many hosts that has been found in California and Oregon — most likely originated in South Africa, where it causes little damage on native hosts. It was then moved to Australia and New Zealand, which served as springboards for the subsequent introduction of the pathogen to Europe and North America.

Figure 1. Toyon infected with *Phytophthora cactorum* in a restoration area in San Mateo County. *Photo: Phytosphere Research.*

Donald, F., B.V. Purse, and S. Green. 2021. Investigating the role of restoration plantings in introducing disease—a case study using *Phytophthora. Forests* 12(6): 764. https://doi.org/10.3390/f12060764.

The authors use European common juniper, a species susceptible in the UK, to mortality caused by the non-native pathogen *Phytophthora austrocedri,* to highlight the risks attendant on widescale, relatively unmonitored programs of native plant cultivation and outplanting undertaken by a wide variety of conservations groups. They examined juniper planting projects since 1990 in the UK, finding that the projects continue to increase every year in number and scope and also that of the known *P. austrocedri* outbreaks, a fifth occurred within 2 km of one of these restoration outplantings. Their findings underline the need for increased coordination and standardization of restoration practices between conservations groups.

Personal Perspective: *Sonya Vargas*

Hi SERCAL!

I'm Sonya Vargas—a Senior Biologist at Environmental Science Associates (ESA). I recently accepted an invitation to be an affiliate for SERCAL and serve as co-chair of the diversity committee. I feel privileged to share my personal perspective with you. I hope to spark inspiration and contribute toward building this wonderful community of environmental professionals.

I am a first-generation high school and college graduate, born and raised in San Diego by two loving parents. They came to the U.S. separately with a similar goal in mind—an opportunity to make a better life for themselves and their families. Because of this, my parents instilled in my brother and me the importance of opportunity. I grew up with a sense of duty and responsibility—to do well in school and seize the opportunities my parents could not. While they never pushed us to do things outside of school, my parents supported our choices and interests.

I know that I will always be a mentee and a mentor at the same time because the mutual learning and growing never stops.

In high school, I was accepted into the Cardinals Interact Program and the Ocean Discovery Institute. These two incredibly unique and special non-profit organizations provided me with an unwavering support system and a life-long community. These programs and clubs not only kept me busy and engaged, but also encouraged me to grow and become a mentor for my peers. I went on to earn my Bachelor of Science in Zoology from UC Santa Barbra. I was awarded several scholarships and was fortunate enough to qualify for financial aid. This allowed me to focus on school and pursue volunteer opportunities in research labs and summer internships and fellowships that would help prepare me for a career. Getting ready for graduation, I still felt unsure about my future and career—I had so many questions like what are my next steps? Where can I apply for work? Am I qualified for this position? Do I have enough experience to apply to a well-paying job? How do I launch from my support system? I struggled to find direction, but quickly realized that I wasn't alone—I was part of a community. All I had to do was reach out to those in my community and be open to opportunities.

Thanks to a conversation with a mentor, I learned of a paid opportunity as a Conservation Land Management Intern with the Bureau of Land Management in Redding. Though I was nervous about moving, I seized it! I drove from San Diego to Redding and had a wonderful 6-month experience. I learned from everyone there about biological surveys, plant seed collections, restoration, and other regularly performed land management work. Upon returning to San Diego, my mentors at Ocean Discovery Institute offered me a paid summer internship with RECON Environmental. Shortly after completing my internship, I knew a career in science and conservation was just within my reach. I decided to join RECON as a marketing/administrative coordinator. Though this felt like a detour, I chose to see it as an opportunity that could lead to a career in environmental consulting. In no time, I transitioned into the restoration team.

I became a restoration biologist and worked alongside our biologists and field team that installed and maintained all restoration projects. I was excited to learn that our field team spoke Spanish and that we could communicate with each other in our native language. They all had years of experience and loved the work they did. They reminded me of my parents and the way they made the most of every opportunity. One day a woman joined the field team to work alongside the men implementing and maintaining the restoration sites. She approached me to ask about what I did as a restoration biologist – she was hoping to do the same one day. It felt good to be able to share my experience and feel like I could be a resource for others. After almost 5 years with RECON, I learned about ESA and decided to take the leap to continue growing in my career.

Now, as a senior biologist with ESA, I work alongside yet another group of inspiring biologists who share their knowledge every day. I am especially inspired by all the successful women who come from all backgrounds working in fields they love. As I continue to grow in my field, I am reminded of the importance of

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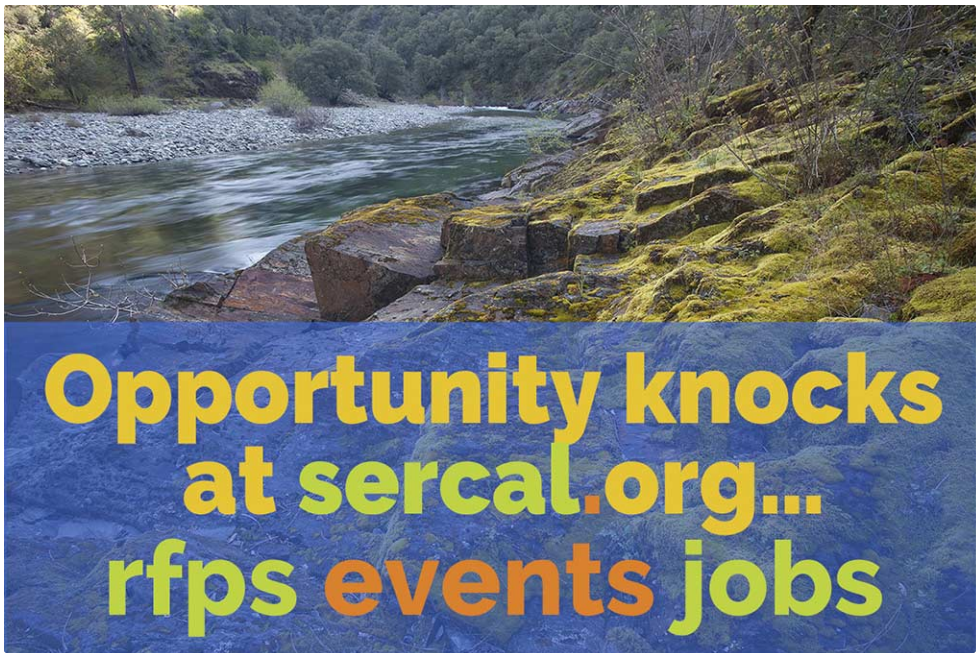
Personal Perspective: *Sonya Vargas* *continued*

representation in different careers, leadership positions, and mentoring roles. At the time, I didn't realize how impactful each experience, opportunity, and mentor were in my personal and professional growth and in transforming my perspective. I realized that somewhere along the way, I was transformed from shy, quiet, and tentative to outgoing, confident, and ready to tackle whatever came next. Every time I feel like an impostor, like I do not have what it takes to be successful in a science and conservation career, I look around and remember that I am surrounded by a community of mentors who have been there and done that. I push myself to continue to seize every opportunity, no matter how unsure or unqualified I may feel at times – whether it is a new complex project I am asked to manage, a new type of report I need to write, or being a mentor for someone else. I am currently serving as a mentor for my peer as part of ESA's Professional Pathways Program, as well as a supervisor for our summer intern who recently graduated from SDSU. Just like I was guided by mentors along my journey and empowered by those who shared their experiences and knowledge with me, I feel a sense of responsibility to be a mentor and a resource for those who need to feel supported and represented in their fields so they can see their goals as obtainable. I know that I will always be a mentee and a mentor at the same time because the mutual learning and growing never stops.

If I could share some last comments to fellow young professionals, I would say don't hesitate to put yourself out there and take on leadership positions. Seize the opportunities that excite you because you never know where they will lead you, who you will meet, or how they will mold you.

I am extremely grateful to everyone that has come into my life and shared their knowledge and provided support; I will always see them as part of my community. If I could share some last comments to fellow young professionals, I would say don't hesitate to put yourself out there and take on leadership positions. Seize the opportunities that excite you because you never know where they will lead you, who you will meet, or how they will mold you. Get involved in things that interest you, become a mentor, join a local Rotaract Club (clubs made up of young professionals that operate under the motto of service above self). Volunteer with organizations like Ocean Discovery Institute, where they have opportunities for you to speak with students about your path and help inspire the next generation. Do these things for your personal growth, but also because we know that showing up, being involved, and being a leader makes a difference to those around us, especially those who may relate to our unique backgrounds and paths.

We want to amplify BIPOC voices — please consider writing your personal perspective.



Carrying the Torch of Mentorship to the SERCAL 2022 Conference and Beyond

by Gregory Andrew, SERCAL Affiliate & Past President

SERCAL connected mentees and mentors at the 2022 conference during the second year of our Mentorship Program. Our goal is to make mentorship a year-round program.

The SERCAL mentorship program connects mentors and mentees to share knowledge and experience and facilitate growth opportunities and professional advancement for students, emerging professionals, youth, and historically underrepresented groups. The goals of the program include:

- Providing a platform which facilitates individual growth opportunities for Mentees in environmental and STEM fields; and
- Ensuring equity in educational opportunities and professional advancement.

SERCAL is looking to identify mentors and mentees among our membership and we will work to arrange for periodic and ongoing meetings between participants in the program.

The 2022 conference was SERCAL's first hybrid conference, which allowed for in-person and virtual attendance and so our Mentorship Program reached a wider audience. Sixty-eight people participated in the program — consisting of 24 Mentors and 44 Mentees — with 21 Mentors and 18 Mentees attending the conference in person, and 3 Mentors and 26 Mentees attending virtually. Participants filled out a questionnaire during conference registration and the SERCAL mentorship committee members matched Mentors with Mentees (each Mentor was matched with one to three Mentees) based on in-person vs. virtual attendance, location, and professional interests. The matches were made about two weeks before the conference to allow time for Mentors and Mentees to reach out to each other and connect before the conference. We asked mentors and virtual mentees to arrange an online meeting or phone call before and after the conference.

During the lunch break on the first day of the conference, SERCAL highlighted mentorship by hosting both in-person and virtual Career Panel meetings. I hosted the virtual meeting with fellow panelists Kari Dupler, Nick Deyo, and Brian Bartell — *Thank you Kari, Nick, and Brian.* We discussed our career paths, offering Mentees perspectives on the private, public agency, and academic career sectors for restoration work. The in-person Career Panel was hosted by Will Spangler with panelists Trina Ming, Cara Clark, Rob Hobbs, Diana Benner, Mary Paul, and Joanna Tang. A takeaway was how there is a broad range of technical and interpersonal skills that are valuable within the field of habitat restoration, including but not limited to plant and wildlife ecology, GIS mapping abilities, statistical analysis, research acumen, irrigation design, mechanical equipment operation, teaching skills and outreach tools, nursery plant growing, and even business administration. Also, at the in-person conference, the Discovery Center room was set up for Mentors and Mentees to meet up for conversation.

In continuing the Mentorship Program across conferences and year-round, SERCAL is looking to identify mentors and mentees among our membership and we will work to arrange for periodic and ongoing meetings between participants in the program.

For anyone who has developed a career in ecological restoration, in almost every case you had a mentor or mentors who gave you support and helped you find your way. As we each entered this field, we were hungry for answers to how this could all work for us. That is as true today as ever, especially if we are going to expand access to opportunities in habitat restoration to a wider range of people.

As a mentor, simply telling your own story, with the trials and tribulations you went through, can give insights to a mentee. You can highlight the current trends in the field, describe the realities of working in restoration, and likely have innumerable pointers and advice you can give.

If there is one consistent message that I have heard mentors express to mentees time and again, it is to encourage a mentee to pursue their passion and assure them that things will fall into place.

SERCAL would like to thank all our mentors — past, present, and future — for your willingness to offer your time and attention to individuals seeking guidance to develop the skills and understanding that will help them pursue their interests and bring their passion to the field of habitat restoration in California.

Visit SERCAL's Mentorship Program page for current information on the program: **https://sercal.org/mentorship-program-for-sercal-2022**.

Also, please share job opportunities and follow the SERCAL jobs board: **https://sercal.org/job-openings**.

SER
CAL

Above: Patrick Espinosa, Dante Khan, Lynzy Louyuh Neal, Paula Crews, and Shaun Pestell.

Right: Stephanie Ma Lucero, Joanna Tang, and Erika Garig.

Below: Stephanie and Joanna with Nina Omomo.

Above: Michael Biedebach with Conference Chair Thor Anderson from Burleson Consulting, a Terracon Company.

Below: Katya Hernandez-Pol.

Not pictured: Peter Nguyen, Eric Medina-Can, and Keaton Sandeman

HIRE THESE PEOPLE! ;-)

Thank you **Terracon Foundation** for making it possible for SERCAL to award its first conference stipends to The Next Generation! And what a glorious first co-hort we had joining us this year. Make note: These young people are shining examples of what the future holds in store!

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Papaver californicum

You are crucial to the resilience of California's native habitats

Just like our floral first responders, SERCAL members make California's ecological systems healthy and whole again. In the three decades since SERCAL was founded (let alone, the last two years) so much — almost everything — has changed. Yet one thing remains constant: *The exceptional power we have when we work together.* We are grateful for all our members and want to recognize these individuals and businesses for their generous support in 2022:

Sustaining Individuals:

Philip Brownsey Environmental Science Associates *Sacramento* ❊ **Gina Darin** California Dept of Water Resources *Sacramento* ❊ **Robert Mazalewski** Consulting Horticulturist *La Mesa* ❊ **Cassie Pinnell** Vollmar Natural Lands Consulting *Sacramento* ❊ **Ross N. Taylor** Ross Taylor & Associates *McKinleyville* ❊ **Karen Verpeet** San Francisco Estuary Institute *Richmond*

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Diana Benner **The Watershed Nursery** *Richmond* ❊ Vic Claassen **Soil Scientist** *Davis* ❊ Robert Freese **Irvine Ranch Conservancy** *Irvine* ❊ Travis Gramberg **Koheid** *Costa Mesa* ❊ Denise Knapp **Santa Barbara Botanic Garden** *Santa Barbara* ❊ Patrick Riparetti **Big Sur Land Trust** *Monterey* ❊ Isaiah Thalmayer **Point Blue** *Petaluma*

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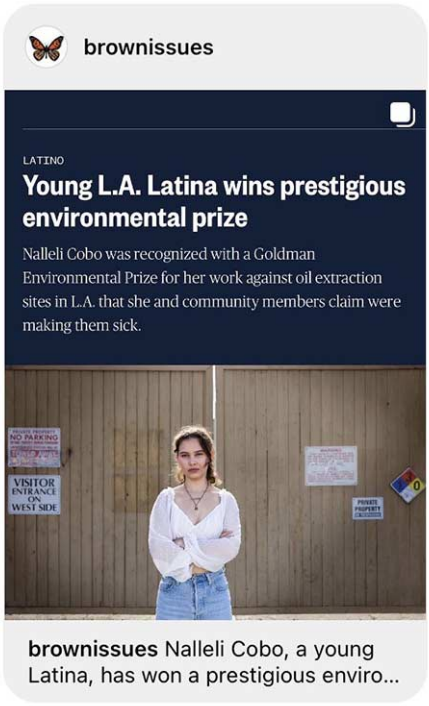
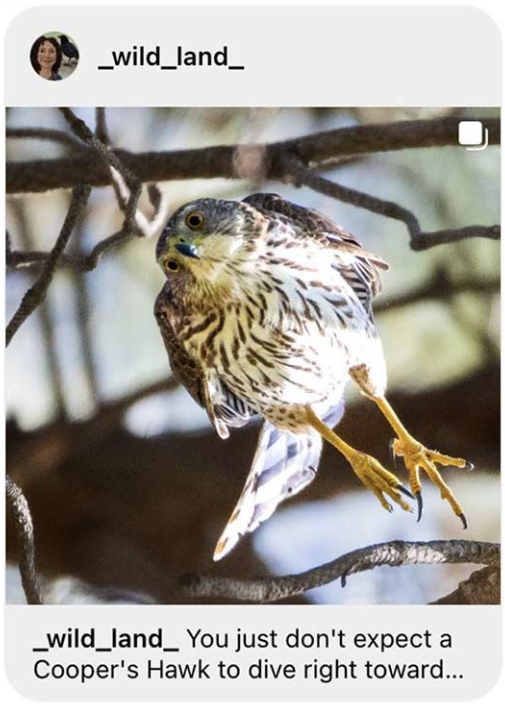
Time to turn up the volume! Who do YOU follow?

Better yet, take over **sercal_restoration** on Instagram and amplify new voices to our community!*

Podcast amplifying voices of environmentalists from marginalized communities — Disabled, Queer, Trans, Black, Indigenous, Latinx and POC.



Cultivating the next generation of Brown Leaders through civic engagement, healing, and narrative change.



Black/Scottish birder, astro, and scientist.

*Contact **julie.sercal@gmail.com** for details!