CALIFORNIA OAK MORTALITY TASK FORCE REPORT
FEBRUARY 2021

This issue features *Phytophthora ramorum*/sudden oak death (SOD) status and activity summaries for 2020 with reports from across the US and Great Britain. Many of the listings link to more detailed reports, tables, maps and photos.

2020 CALIFORNIA *P. RAMORUM* IN WILDLANDS SUMMARY

***Phytophthora ramorum* was officially confirmed for the first time in Del Norte Co., on tanoaks** (*Notholithocarpus densiflorus*), triggering regulations for Del Norte Co. and marking the first EU1 lineage detection on vegetation in California. Management activities designed to limit the spread of the new EU1 find in Del Norte Co. have been conducted. All other *P. ramorum* infections in California, including nearby infections in the same county, are of the NA1 lineage. The nearest EU1 infections in forests are approximately 35 miles to the north in the area between the Pistol River and the Rogue River in Curry Co., Oregon.

At the southern extent of California's known *P. ramorum* infestation area, surveys were conducted to locate *P. ramorum*-infected trees in San Luis Obispo and southern Monterey Counties. Helicopter, ground and water surveys did not detect *P. ramorum* on vegetation in San Luis Obispo County. Five streams were monitored for *P. ramorum* near the border between these counties: Santa Rita, Santa Rosa, San Simeon, and San Carpoforo Creeks, and Salmon Creek. Salmon Creek and San Carpoforo Creek were positive for the pathogen. SOD-Blitz citizen scientists collected 130 samples from throughout San Luis Obispo County, none of which tested positive for the pathogen.

Farther north in Monterey County, areas south of Plaskett Creek show severe, advanced SOD mortality. There are many standing dead tanoaks (some older and some recently dead) and accumulating fuels in the understory due to fallen tanoaks. Several areas that were heavily infested by *P. ramorum* burned in 2020, including portions of Big Creek, Devils Creek, Vaciente Creek, and Mill Creek drainages.

Sudden oak death aerial survey was not conducted in California in 2020 due to COVID-19 precautions. More details of *P. ramorum* status in California in 2020 are pending publication in the 2020 California Forest Pest Conditions report. Results from the citizen science SOD Blitz surveys, held under the direction of Matteo Garbelotto, UC Berkeley, are available at https://nature.berkeley.edu/matteolab/?page_id=5438.

P. RAMORUM - OREGON WILDLAND UPDATE

Since 2001, an interagency team continues to slow the spread of *P. ramorum* through a program of early detection and treatment of infected and nearby host plants. Treatments include cutting and burning infected and potentially exposed host material. In late 2020, ODA expanded the Generally Infested Area boundary to encompass areas within the SOD quarantine areas where the infestations were not treated from 2018 and 2019 due to priority rankings (Fig. 1).

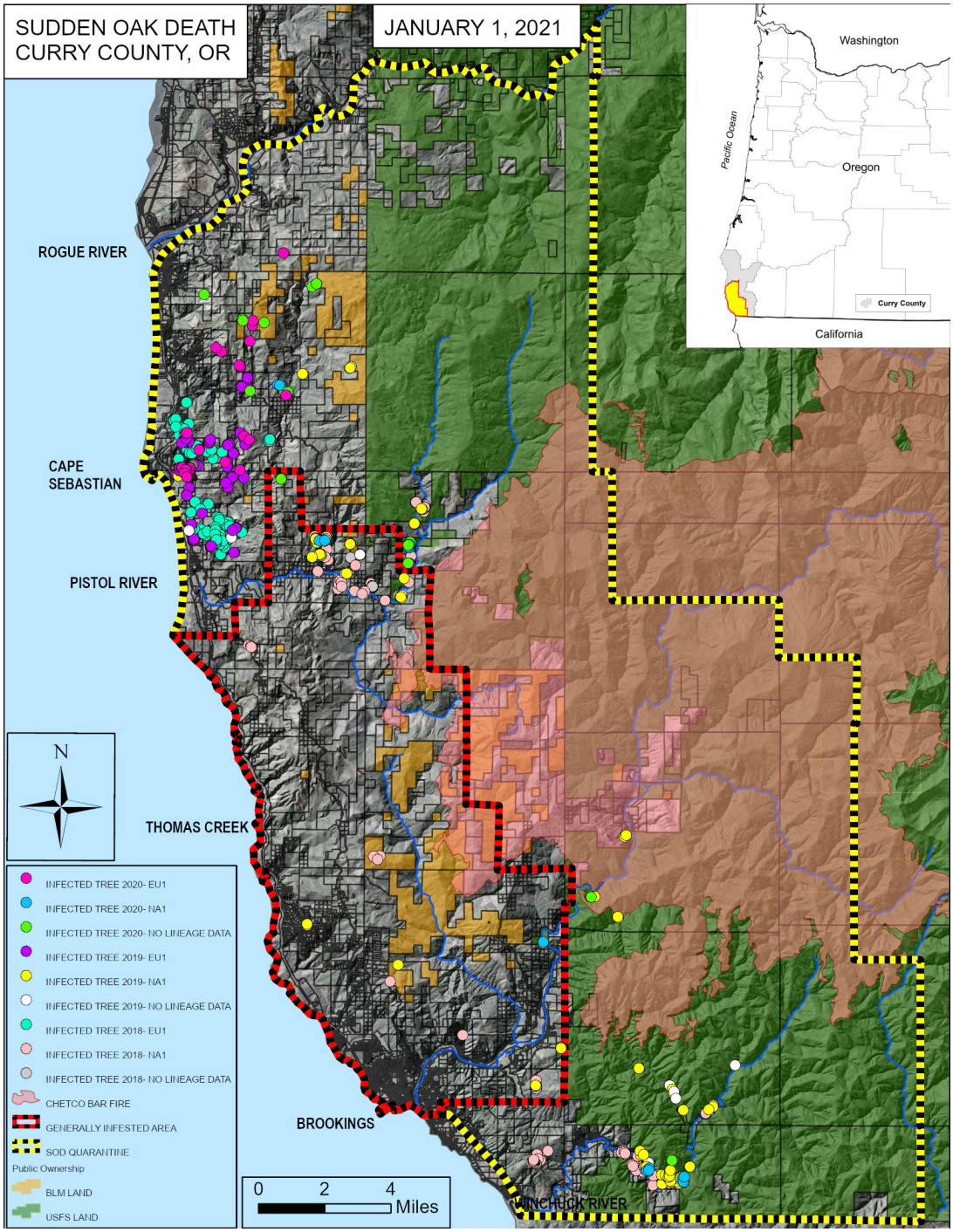

Figure 1. Map of *P. ramorum* detections in Oregon by year. Credit: ODF & USFS.

To monitor disease spread and detect new infestations, Oregon's Sudden Oak Death (SOD) Program relies on multiple survey methods throughout the year, such as aerial, ground-based transects, and stream monitoring. With regional aerial surveys cancelled for 2020 due to COVID-19 safety concerns, SOD foresters at Oregon Department of Forestry (ODF) and US Forest Service (USFS) scanned through 220,000 acres of high-resolution aerial imagery to detect

dead tanoak trees. Over 600 points were identified from the imagery and are currently being ground checked and sampled.

Since 2015, ODF has been aggressively treating all known EU1 infestations with large buffers of 300 - 600 feet. In 2020, ODF, USFS, and Bureau of Land Management completed treatments on 30 acres infested with the EU1 lineage, with over 700 acres awaiting burning of tanoak material. To date since 2002, eradication treatments have been completed on more than 7,400 acres at an estimated cost of over $31 million.

In 2019, ODF, USFS, and Oregon State University (OSU) staff planted several thousand tanoak seedlings grown from acorns collected from the southern Oregon coast marking the first out-planting to monitor for genetic resistance to *P. ramorum* in Oregon. ODF staff collected tanoak acorns in 2016-2018 from tanoak trees both exposed to the disease, within the SOD Generally Infested Area, and from areas free of disease, such as along the Rogue River.

Figure 2. A study evaluating genetic resistance to *P. ramorum* of tanoak seedings in Oregon. Beastie, part of an invasive species awareness campaign from the UK, is present in the foreground. Photo: Casara Nichols, ODF.

The acorns were sorted by family and grown at the USFS Dorena Genetic Resource Center until ready for field testing and OSU lab testing. Monitoring of the outplanting continued in 2020; visual observations indicated about 10% mortality of tanoak seedlings throughout the planting and visible SOD symptoms on about 20% of the seedlings (Fig. 2). Oregon's SOD Program is interested in hunting down potentially resistant tanoak trees in SOD infested areas and encourages local landowners to identify those trees using the TreeSnap App. For more information contact Sarah Navarro, Sarah.Navarro@usda.gov.

P. RAMORUM UPDATES FROM ENGLAND, SCOTLAND AND WALES

England. After several years of a decreasing disease trend, *P. ramorum* expanded into new geographical areas in England in 2020, due to conducive weather conditions in 2019 (Fig. 3). In total, 2020 surveillance identified 274 woodland sites with infection present or suspected. Statutory Plant Health Notices (SPHNs) are being issued; these are requiring affected owners to fell 1,070 ha (2,644 ac) of larch - the greatest area since 2010 (1,178 ha/2,911 ac). As has always been the case, EU1 was the only lineage identified from English samples. For more details, photos and maps READ MORE.

Figure 3. High levels of larch mortality in Derbyshire, East Midlands, UK. Photo: Mick Biddle, UK Forestry Commission

Scotland. Findings from aerial and ground surveillance in 2020 have identified concerning areas of new *P. ramorum* infection on larch in areas of the south and west of Scotland where the climate is known to be suitable to disease and infections have been detected in previous years. Large scale spread of the disease has also been detected in areas of Kintyre, Argyll, Mull, Cowal, Arran and the western Scottish Borders, areas that have had only limited infections historically. For a more detailed report READ MORE**.**

Wales. In 2020, a highly significant increase of *P. ramorum* infections was detected in mid and north Wales. The infestations are notable for their number, area affected, and intensity of symptoms/dieback caused, with sub-compartments with up to 50 to 80% dieback observed. The location and intensity of some of these new sites is concerning, as is the overall area affected for the year (1,463 ha/3615 ac) compared to last year (804 ha/1986 ac). For maps and a more detailed report READ MORE.

MONITORING

Southeastern US stream survey. For the last three years (2018-2020), seven southeastern states have participated in the yearly US Forest Service, Cooperative Sudden Oak Death (SOD) Early Detection Stream Survey (Table 1). The SOD pathogen has been detected from six streams in three states: four streams in Alabama (AL), one stream in Mississippi (MS), one stream in North Carolina (NC, Table 2). The pathogen has been consistently present in these streams for at least the last ten years. In 2020, a total of 41 streams in seven states (AL, FL, GA, MS, NC, SC, and TX) were surveyed. Due to COVID-related travel restrictions, the number of streams surveyed and samples collected was less than previous years. Of 400 baited samples from these streams, diagnosis had been completed for 220 samples to date. The pathogen has not been detected. All positive streams detected in 2018 and 2019 were associated with previously *P. ramorum* positive nurseries, streams in close proximity to these nurseries, that may contain run-off water.

Table 1. Number of streams surveyed in southeastern states for US Forest Service Sudden Oak Death Early Detection Stream Survey from 2018 to 2020.

Year	AL	FL	GA	MS	NC	SC	TX	Total
2018	9	0	14	5	5	7	3	**43**
2019	9	3	14	5	5	7	5	**48**
2020	9	3	10	5	2	7	5	**41**

Table 2. Streams in southeastern states positive for the sudden oak death pathogen from US Forest Service Sudden Oak Death Early Detection Stream Survey from 2018 to 2020.

Stream	AL-a	AL-b	AL-c	AL-d	MS	NC	Total
2018	+	+	+	+	+	+	**6**
2019	+	+	+	+	+	+	**6**
2020*	-	-	-	-	-	-	**0***

*Survey samples collected in late fall of 2020 (n=180) had not been diagnosed at the time of this report. Results are pending.

Midwestern and Eastern US stream survey. In 2019, the USDA Animal and Plant Health Inspection Service (APHIS) confirmed *P. ramorum*-positive plants in retail stores or nurseries in nine states covered by the USDA Forest Service, Eastern Region Forest Health Protection, Region 9: Illinois, Indiana, Iowa, Maryland, Michigan, Missouri, Ohio, Pennsylvania and Wisconsin.

In spring and early fall 2020, six states from Region 9 participated in the Sudden Oak Death Stream Survey for detecting the presence of *P. ramorum* in targeted streams and other bodies of water, particularly those near retail stores involved in the 2019 confirmations.

A total of 42 streams or waterways were tested using the bottle of bait (BOB) technique with healthy rhododendron or camellia leaf baits. Five waterways were sampled in Illinois, five in Maryland, eight in Ohio, four in Pennsylvania, eighteen in Wisconsin, and two sites in West Virginia. Polymerase chain reaction (PCR) test results from submitted plant materials during the 2020 spring-summer and fall samplings did not detect *P. ramorum*. Results from samples collected during November-early December 2020 will be available shortly. For more information contact, Angel Saavedra, angel.saavedra@usda.gov.

California *P. ramorum* stream monitoring results. In 2020, 44 streams were monitored for *P. ramorum* across northern and central coastal California, by collaborators from multiple institutions, then analyzed by the Rizzo Laboratory, UC Davis. Baiting sites were selected so as to maximize detection of *P. ramorum* spread into high-risk and high-value forests, particularly at the boundaries of the pathogen's known range in northern Humboldt Co. and throughout Del Norte Co. *P. ramorum* was not detected in Del Norte Co. streams. In Humboldt Co., Upper Yager Creek, first detected positive in 2019, tested positive again in two of the first three sampling periods in 2020. Chadd Creek was positive again in 2020, it was first detected positive in 2018 but was not sampled in 2019. Stanley Creek, monitored for the first time in 2020 by the Mattole Restoration Council, was positive during the first of three bait deployments. Near the border between San Luis Obispo and Monterey Counties, San Carpoforo Creek and Salmon Creek were positive. For a more complete report with several tables and maps READ MORE.

REGULATIONS - 2020 USDA APHIS, PLANT PROTECTION AND QUARANTINE, *P. RAMORUM* SUMMARY

In 2020, the USDA APHIS Plant Protection and Quarantine *P. ramorum* Program supported compliance activities, diagnostics and surveys in 30 states. Confirmed positive samples were collected at interstate shipping nurseries, an intrastate shipping nursery, a large managed landscape, commercial landscapes, residences and in the environment (Table 3).

Table 3. Summary of Facilities within the U.S. with APHIS Confirmed Positive Detections of *P. ramorum* in 2020

Type of Facility/Location	Total Positive	# Facilities/Locations Positive for the First Time	# Facilities/Locations Previously Positive
Interstate shipping nursery	12	5	7
Intrastate shipping nursery	1	1	0
Residential/Managed Landscape	5	4	1
Environmental	1	1	0
Total	**19**	**11**	**8**

At the national APHIS laboratory, *P. ramorum* was detected in 177 samples in 2020. The most common sample types confirmed positive for *P. ramorum,* in descending order of frequency, were tissue samples from *Rhododendron* plants (49.4%), tissue samples from *Camellia* plants (15%), water (11%), soil (8%) and tissue samples from *Pieris* plants (7%). No samples were confirmed positive from the other genera considered high-risk, *Viburnum* or *Kalmia*. For more 2020 program summary statistics, tables and figures READ MORE.

NURSERIES

Oregon Department of Agriculture (ODA) *P. ramorum* program update. In 2020, the Oregon Department of Agriculture (ODA) *Phytophthora ramorum* Nursery Program worked with nine interstate shippers under federal compliance agreements (7 CFR 301.92).The ODA also holds compliance agreements with four intrastate shippers, which are regulated under Oregon state quarantine requirements (7 CFR 301.92 and OAR 603-052-1230). One intrastate shipper nursery was confirmed positive in 2020. ODA steam-treated soil in previously confirmed nurseries and collected 4,321 foliar samples during various inspections; 75 samples tested positive (Figs. 4, 5, 6). For more details and photos of ODA's 2020 activities READ MORE**.**

Figures 4 & 5. Confirmed positive rhododendrons. Photos: Melissa Lujan, ODA

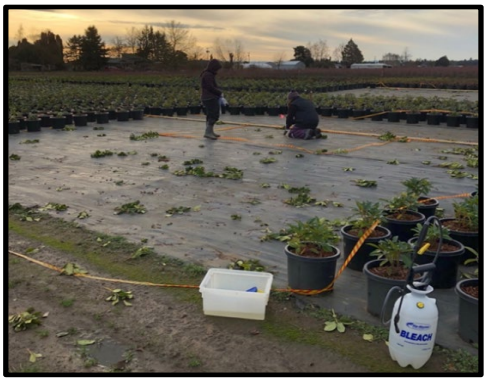

Figure 6. Collecting soil samples during Confirmed Nursery Protocol (CNP) survey.

California Department of Food and Agriculture (CDFA) *P. ramorum* program 2020 Summary. The California Department of Food and Agriculture (CDFA) receives funding from the USDA to administer the cooperative *P. ramorum* program. The CDFA assists and reimburses the county

agricultural commissioners as they enforce Federal Domestic Quarantine 7 CFR 301.92 and California Code of Regulations 3700 regulations at the 292 establishments regulated for *P. ramorum* in California. Program funding allocated to the CDFA for the *P. ramorum* program increased for fiscal year 20-21 to $1,505,591.

Approximately 8,200 *P. ramorum* program regulatory samples were submitted to the CDFA Plant Pest Diagnostics Laboratory for processing in 2020. A total of 49 samples were determined to be positive for *P. ramorum*. For more information, READ MORE.

Washington State Department of Agriculture (WSDA) *P. ramorum* program - 2020 in review. WSDA assisted in the required certification sampling for Washington's only interstate shipping nursery under a Federal compliance agreement for *P. ramorum*. Spring and fall surveys were conducted at the nursery. All foliar samples were negative in 2020. WSDA inspected seven of the nine 'opt-out' nurseries in 2020. These are nurseries that 'opted-out' of the USDA DA-2014-2 regulations and can no longer ship interstate. Host material appeared free of symptoms and no samples were collected. WSDA confirmed the nine 'opt-out' nurseries are not shipping interstate. For trace-forward activity and survey results from a Kitsap County botanical garden see the complete report here.

RESEARCH (ABBREVIATED ABSTRACTS)

Dun, H.; Mackay, J.; Green, S. 2020. *Phytophthora ramorum* in larch: from epidemiology to host resistance. In, Nelson, C.D.; Koch, J.L.; Sniezko, R.A., eds. 2020. Proceedings of the Sixth International Workshop on the Genetics of Host-Parasite Interactions in Forestry—Tree Resistance to Insects and Diseases: Putting Promise into Practice. GTR-SRS-252. Asheville, NC: U.S. Department of Agriculture Forest Service, Southern Research Station. 170 p.

A better understanding of the epidemiology of sudden larch death is needed to inform management decisions and maintain larch as a commercial timber species. Survivor trees within high mortality stands in the Galloway Forest [Scotland] suggest the possibility of natural resistance within the Japanese larch (*Larix kaempferi*) population. Understanding how the pathogen spreads within and between individuals will help to predict if survivor trees have escaped infection by chance or may actually be resistant.

In order to understand disease spread, 21 individual larch trees in each of 21 plots located in larch stands of varying ages were surveyed for disease symptoms each May and September from 2016 to 2018. In addition to recording symptoms on needles, shoots, branches, and main stem, samples of lesion material were taken from central trees in each plot for pathogen isolation by selective media and qPCR to confirm infection by *P. ramorum*. Read the complete extended abstract at https://www.srs.fs.usda.gov/pubs/gtr/gtr_srs252.pdf#page=146.

Garbelotto, M.; Dovana, F.; Schmidt, D.; Chee, C.; Lee, C.; Fieland, V.; Grünwald, N.J. and Valachovic, Y. 2021. First reports of *Phytophthora ramorum* clonal lineages NA1 and EU1 causing Sudden Oak Death on tanoaks in Del Norte County, California. Plant Disease. Early View.

A year of forest health surveys has led to the first detection of *Phytophthora ramorum* in Del Norte County followed by the first wildland detection of the EU1 clonal lineage of this pathogen

in California. In July 2019, leaves were sampled from two tanoaks (*Notholithocarpus densiflorus*) and 16 California bay laurels (*Umbellularia californica*) in Jedediah Smith State Park in Del Norte County, the northernmost coastal County of California. Leaves displayed lesions normally associated with Sudden Oak Death (SOD) caused by *P. ramorum* and were discovered during the citizen science-based survey known as SOD Blitz. Samples were surface sterilized using 75% ethanol and plated on PARPH-V8 agar. After plating, DNA was extracted and amplified using two *P. ramorum*-specific assays. Leaves from two tanoaks exhibiting twig dieback had typical lesions along the midvein, gave positive PCR results and yielded cultures with colony morphology, sporangia and chlamydospores typical of the NA1 lineage of *P. ramorum* originally isolated in California from tanoaks and coast live oaks (*Quercus agrifolia*). The two Del Norte MLGs were identical to one another and most similar to MLG c1, with a single repeat difference at a single locus. SSR results suggest the inoculum source may not be from Humboldt County, neighboring to the south, but from a yet unidentified outbreak, possibly associated with ornamental plants. Jedediah Smith State Park was surveyed for 12 months following the initial detection, however the pathogen has yet to be re-isolated in that location. In July 2020, symptomatic leaves from two tanoak trees exhibiting twig cankers were collected 8 km north of Jedediah Smith State Park, where three additional tanoak trees displayed rapidly browned dead canopies consistent with late stage SOD. Colonies from these samples produced chlamydospores and sporangia typical of *P. ramorum* on PARPH-V8 agar, but displayed a growth rate faster than that of NA1 genotypes and were characterized by aerial hyphae, overall resembling the morphology of EU1 lineage colonies. The EU1 lineage was confirmed by the perfect match of the sequence of a portion of the Cox-1 gene (GB MW349116-7) with the Cox-1 sequence of EU1 genotypes (GB EU124926). The EU1 clonal lineage has been previously isolated from tanoaks in Oregon forests, approximately 55 km to the north, but this is the first report for California wildlands and will require containment and government regulations.

Haller, D.J. and Wimberly, M.C. 2020. Estimating the potential for forest degradation in the eastern United States woodlands from an introduction of sudden dak death. Forests. 11(12): 1334.

This research identified areas of the eastern United States forests that may be at particular risk from Sudden Oak Death (SOD) if it becomes established in the region. The highest suitability for SOD occurs where there are both species at risk of serious infection and species that could spread SOD to new hosts. The present project expanded on previous efforts by examining both the possibility and potential consequences of *P. ramorum* establishment based on the presence of suitable hosts.We developed a map of the potential severity of tree loss that could result from a *P. ramorum* establishment in the eastern United States as well as a habitat suitability index based on the density of *P. ramorum* susceptible and spreader host species. We also implemented a connectivity analysis method for determining patches important to the spread of *P. ramorum* in the Great Smoky Mountains National Park. Results: The Ozarks and Appalachians both had a high potential severity of infection due to their high percentage of susceptible species, but the Appalachians had a higher overall level of risk due to the presence of more spreader tree species in the area. Connectivity analysis in the Great Smoky Mountains National Park identified patches likely to be particularly important to *P. ramorum* spread. Analysis of the presence of potential *P. ramorum* hosts in the eastern United States identified suitable conditions for SOD establishment there, particularly in the Appalachians. Techniques developed in this research can identify critical areas for SOD spread at both landscape and regional scales.

RELATED RESEARCH

Barwell, L.J.; Perez-Sierra, A.; Henricot, B.; Harris, A.; Burgess, T.I.; Hardy, G. and others. 2020. Evolutionary trait-based approaches for predicting future global impacts of plant pathogens in the genus *Phytophthora*. Journal of Applied Ecology. https://doi.org/10.1111/1365-2664.13820 (Early View).

Gyeltshen, J.; Dunstan, W.A.; Shaw, C.; Howard, K.; Grigg, A.H.; Hardy, G.E.S.J. and Burgess, T.I. 2021. Metabarcoding shows multiple *Phytophthora* species associated with individual plant species: implications for restoration. European Journal of Plant Pathology. 159: 359–369. https://doi.org/10.1007/s10658-020-02167-7

RESOURCES

Scanu, B., ed. 2020. Proceedings of the 9th Meeting of the International Union of Forest Research Organizations IUFRO Working Party 7.02.09, *Phytophthora* in Forests and Natural Ecosystems. La Maddalena - Sardinia, Italy. 149 pgs. http://forestphytophthoras.org/proceedings.

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