CALIFORNIA OAK MORTALITY TASK FORCE REPORT
SEPTEMBER 2018

FRANCE

Where did the *Phytophthora ramorum* outbreak on Japanese larch (*Larix kaempferi*) in France originate from? To search for that answer, two isolates from the infested Saint-Cadou forest in Brittany were genotyped using simple sequence repeat (SSR) markers by Kurt Heungens, Institute for Agricultural and Fisheries Research (ILVO) in Belgium. To date, the outbreak could not be traced back to any previously known infestation. One isolate belonged to the most prevalent EU1 SSR-based genotype in Europe. The other isolate had an EU1 SSR-based genotype with mutations in two markers. One of these mutations was unique, so the isolate was classified in a new genotype. The isolates do not have the "British" mutation, so there is no data that would indicate that the isolates are from the UK.

P. ramorum symptoms were first observed on Japanese larch in the Saint-Cadou forest (Brittany), in the northwestern corner of France, in 2015, but the trees were not sampled. A 2016 survey detected many symptomatic trees, but the pathogen was not recovered. In May 2017, the pathogen was isolated from needles, stems and the litter layer. By May 2018, approximately 80% of the trees were symptomatic or dead in the more infected plots (see photo). The stand (24 ha of 50 year-old pure Japanese larch) was removed in June 2018 with approximately 3,000 m^3 of logs harvested and processed into chips for heating. In June 2017, *P. ramorum* was also confirmed in a mixed forest stand (Japanese larch, oak and sweet chestnut (*Castanea sativa*)) in Hanvec, 15 km from Saint-Cadou. Disease prevalence in this stand was estimated to be very low, and the stand was removed at the end of 2017.

***P. ramorum* infected Japanese larch, Saint-Cadou forest, Brittany**.
Photo: © C. Husson, Département de la Santé des Forêts (DSF).

In France, since 2010, larch stands have been surveyed by the Département de la Santé des Forêts (DSF, France's Forest Health Service). This year the Brittany survey area has increased, and includes the west coast of France. No new outbreaks have been found.

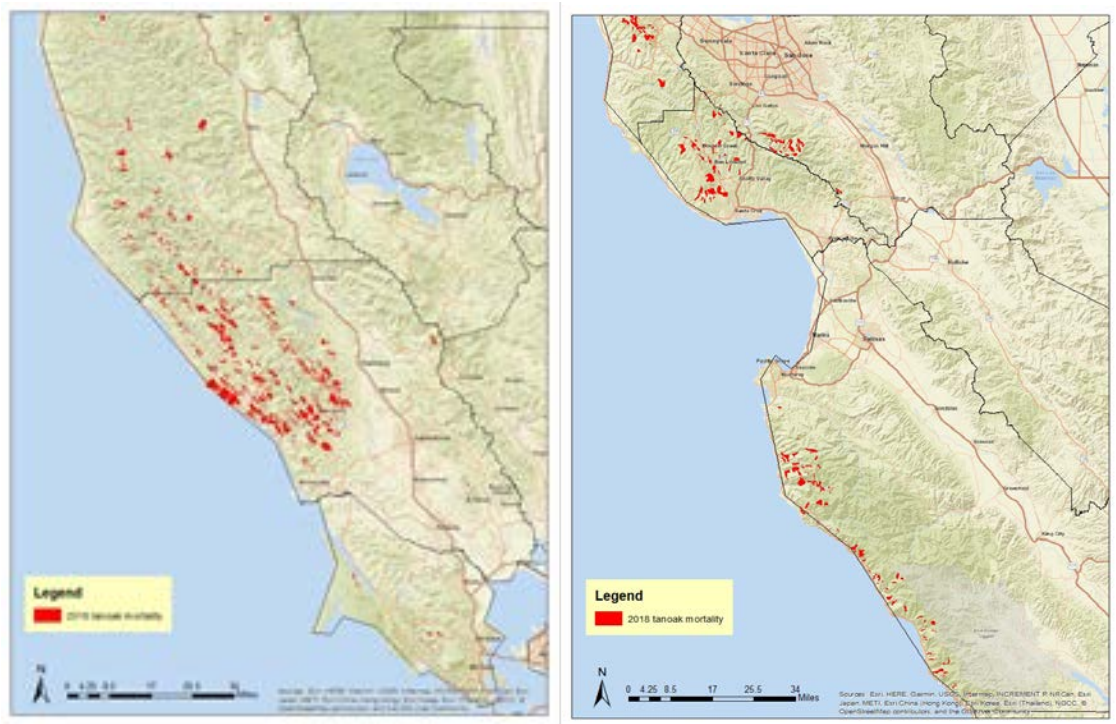
These detections are the first report of *P. ramorum* affecting Japanese larch in France and in mainland Europe. Until now, in France, *P. ramorum* had only been detected in nurseries, green spaces, and in a few cases in the natural environment on understory rhododendron in Normandy and Brittany, but not near the infected larch stands. The presence of this pathogen in the natural environment represents a major threat for larch trees, but also for sweet chestnut and is a concern for both forest and ornamental trees.

Current research includes development of improved detection methods, a survey of *P. ramorum* presence in watercourses of Brittany and an assessment of the ability of trees and shrubs of western France forest ecosystems to carry the disease. The *P. ramorum* research program is being coordinated by Benoit Marçais (French National Institute of Agricultural Research, INRA) and Renaud Ioos (French Agency for Food, Environmental and Occupational Health & Safety, ANSES).

The Saint-Cadou find has been published in: Schenck, N.; Saurat, C.; Guinet, C.; Fourrier-Jeandel, C.; and others 2018. First report of *Phytophthora ramorum* causing Japanese larch dieback in France. Plant Disease. First Look. https://doi.org/10.1094/PDIS-02-18-0288-PDN.

MONITORING

The USDA Forest Service, Forest Health Monitoring, Aerial Detection Survey has produced preliminary maps of new tanoak mortality in 2018 throughout the range of sudden oak death except for Humboldt County. A large increase in tanoak mortality compared to the previous few years is apparent in the maps below.



2018 tanoak mortality attributed to *P. ramorum* in Mendocino Co. south through Monterey Co.

These maps are only for general information; the mortality polygons are observed from the air and are preliminary. Areas have not been surveyed on the ground to confirm that *P. ramorum* is the mortality agent. Also, not all mortality present on the ground appears in these polygons, as many mortality areas exist beneath dense conifer canopies and cannot be seen from the air. Nevertheless, these snapshots do follow the expected sudden oak death mortality pattern of increased tanoak mortality two seasons after the very wet and extended 2016-2017 winter season. For more information about this survey, see: https://www.fs.usda.gov/detail/r5/forest-grasslandhealth/?cid=fsbdev3_046696 or contact: Jeff Moore USDA Forest Service, Pacific Southwest Region (R5), Aerial Survey Program Manager, 530-759-1753, jwmoore02@fs.fed.us.

Washington State: *P. ramorum* detected at a botanical garden in Kitsap County, WA. A water bait from a small pond downstream from the mitigated areas at a previously positive botanical garden in Kitsap County was confirmed positive on July 12, 2018. The pond is less than a mile from Puget Sound. In 2015, *P. ramorum* was detected at 15 sites in this botanical garden. Extensive renovations and soil steaming were conducted and the pathogen had not been detected in this managed landscape for approximately 2.5 years.

Quarterly surveys of the Botanical Garden will continue in 2018. Follow-up sampling will focus on vegetation in and around the pond where the positive bait originated. Also, host plants are extensively sampled near previous positive sites and around the perimeter of the garden. The next survey will be in early fall 2018.

The spring certification survey for Washington's only regulated interstate shipper was conducted in May. The results were negative. The nursery has since been released from the requirements of its compliance agreement after completing six consecutive surveys with negative results.

2018 *P. ramorum* Cooperative Forest Survey for the Eastern U.S. Seven Eastern states participated in the 2018 Spring National *P. ramorum* Early Detection Survey of Forests: AL, GA, MS, NC, PA, SC, and TX. Of the 292 samples collected from 48 sites this spring, *P. ramorum* has been detected from three samples from two locations in AL (first detection in 2008 and 2009), two samples from one location in MS (first detection in 2008), and one sample from NC (first detection in 2010). All of the positive samples were collected from streams associated with previously positive nurseries.

Outbreaks of *P. ramorum* on larch in Scotland intensify. Forestry Commission Scotland has released an updated map of "Statutory Plant Health Notices (SPHNs) served for *Phytophthora ramorum* on Larch sites in woodland settings" at: https://scotland.forestry.gov.uk/supporting/forest-industries/tree-health/phytophthora-ramorum?highlight=WyJyYW1vcnVtIiwiJ3JhbW9ydW0iLCIncmFtb3J1bSciXQ. The map shows statutory notices for larch removal have been issued throughout much of Scotland with many detections in 2018 concentrated near Dumfriesshire and Ayrshire, northeast of the heavily infested "*P. ramorum* management zone" designated in 2014. The large number of outbreaks are attributed to favorable, wet conditions in summer and fall 2017 and are so numerous that it will be impossible to fell all of the infected trees this year. Priority for eradication is being given to

those occurring farthest from the '*P. ramorum* Management zone' in SW Scotland. This policy will be reviewed once further aerial surveys are completed in early September 2018.

More on the status of *P. ramorum* in the UK (England, Wales, Scotland and Northern Ireland) can be found in a situation report posted by Forestry Commission England earlier this summer: https://www.forestry.gov.uk/pdf/PRamorumSituationReport30June2018.pdf/$FILE/PRamorumSituationReport30June2018.pdf

RESEARCH

Harris, A.R.; Mullett, M.S.; Webber, J.F. 2018. Changes in the population structure and sporulation behaviour of *Phytophthora ramorum* associated with the epidemic on *Larix* (larch) in Britain. Biological Invasions. 20(9): 2313–2328.

During a decade of invasion, the exotic pathogen *Phytophthora ramorum* has undergone an unexpected change in behaviour during spread into the woodlands and forests of Great Britain. From 2002 to 2008 most outbreaks centred on nurseries and managed gardens with affected hosts almost exclusively broadleaf shrubs and trees. However 2009 saw a major shift as larch tree plantations (*Larix*) were affected by widespread infection and mortality incited by *P. ramorum*. To understand the processes underlying the host jump to larch, isolates of the EU1 lineage of *P. ramorum* collected from 2002 to 2012 were investigated using seven polymorphic microsatellite markers. Analysis of 347 isolates resolved 51 multilocus genotypes (MLGs) which partitioned into two distinct clusters. One comprised MLGs unique to Britain and unknown elsewhere in Europe, the other cluster was primarily of MLGs already known in other European countries but dominated by one genotype, EU1MG1. Pre-2009 isolates were predominantly of the unique British cluster with only a few typical of the European cluster. This reversed after 2009 with European MLGs, especially EU1MG1, becoming increasingly common as the larch epidemic expanded. We hypothesise that the growing dominance of EU1MLG1 has been an important driver in the emergence of the epidemic on larch, aided by its ability to sporulate more abundantly compared with the dominant unique British MLG. European MLGs appear closely associated with the distribution of larch along the west coast of Britain whereas unique British MLGs tend to be concentrated in south west England. The two population clusters suggest at least two separate introductions of the EU1 lineage into Britain with subsequent diversification.

Simler, A.B.; Metz, M.R.; Frangioso, K.M.; Meentemeyer, R. K.; Rizzo, D.M. *In press*. Novel disturbance interactions between fire and an emerging disease impact survival and growth of resprouting trees. Ecology.
https://esajournals.onlinelibrary.wiley.com/doi/abs/10.1002/ecy.2493

Human-altered ecological disturbances may challenge system resilience and disrupt biological legacies maintaining ecosystem recovery. Yet, the extent to which novel regimes challenge these legacies varies. This may be partially explained by differences in the vulnerability of life history strategies to disturbance characteristics. In the fire-prone, resprouter-dominated coast redwood forests of California, the introduced disease sudden oak death (SOD) alters fuel profiles, fire behavior, and aboveground tree mortality; however, this system is dominated by resprouting trees that are well-adapted to aboveground damage, and belowground survival of individuals may represent the principal biological legacy connecting pre- and post-fire communities. Much

of the research exploring altered disturbances and forest recovery has focused on legacies determined by seed dispersal and aboveground survival of adults. In this work, we use pre- and post-fire data from a long-term monitoring network to assess the impacts of novel disturbance interactions between wildfire and SOD on the belowground survival and vegetative reproduction of resprouters. We found that increasing accumulation of coarse woody fuels from SOD-killed hosts decreased the likelihood of belowground survival for resprouting tanoak trees, but not for redwood. Tanoaks' belowground survival was negatively related to substrate burn severity, which increased with volume of surface fuels from hosts, suggesting heat damage as a possible mechanism influencing altered patterns of resprouter mortality. These impacts increased with decreasing tree size. By contrast, redwood and tanoak trees that survived both disturbances resprouted more vigorously, regardless of post-fire infection by *P. ramorum*, and generated similar recruitment at the stand-level. Our results demonstrate that disease-fire interactions can narrow recruitment filters for resprouters, which could impact long-term population and demographic structure; yet, compounded disturbance may also reduce stand density and disease pressure, allowing competitive release of survivors. Resprouters displayed vulnerabilities to altered disturbance, but our research suggests that legacies maintained by resprouting may be more resilient to certain compounded disturbances, compared to seed-obligate species, because of high rates of individual survival under increasingly severe events. These trends have important implications for conservation of declining tree species in SOD-impacted forests, as well as predictions of human impacts in other disturbance-prone systems where resprouters are present.

Tonini, F.; Jones, C.; Miranda, B. R.;Cobb, R. C.; Sturtevant, B. R.; Meentemeyer, R. K. 2018. Modeling epidemiological disturbances in LANDIS-II. Ecography. Early View. https://onlinelibrary.wiley.com/doi/abs/10.1111/ecog.03539.

Forest landscape simulation models (FLSMs) – often used to understand and project forest dynamics over space and time in response to environmental disturbance – have rarely included realistic epidemiological processes of plant disease transmission and impacts. Landscape epidemiological models, by contrast, frequently treat forest ecosystems as static or make simple assumptions regarding ecosystem change following disease. Here we present the Base Epidemiological Disturbance Agent (EDA) extension that allows users of the LANDIS-II FLSM to simulate forest pathogen spread and host mortality within a spatially explicit forest simulation. EDA enables users to investigate forest pathogen spread and impacts over large landscapes ($> 10^5$ ha) and long time periods. We evaluate the model extension using *Phytophthora ramorum* as a case study of an invasive plant pathogen causing emerging infectious disease and considerable tree mortality in California. EDA will advance the utility of LANDIS-II and forest disease modeling in general.

Xie, B.; Cao, C.; Chen, W.; Yu, B. 2018. Prediction and analysis of the potential risk of sudden oak death in China. Journal of Forestry Research. https://doi.org/10.1007/s11676-018-0755-x

Sudden oak death (SOD) is one of the most rapid and destructive forest pathogens, which has caused the death of many host plants in Europe and America. There are currently no cases in China where there are more host plants and a more suitable climate for this pathogen to survive. Therefore, it is vital to discern the potential suitable habitat, quantify the risk levels, and monitor the potential high-risk areas. In this study, we modelled the potential invasion range and risk level of this pathogen at present and in future scenarios in China, using the least correlated components of all the environmental factors based on the Genetic Algorithm for Ruleset Production niche model and GIS analysis. The results indicate that most areas in China are free from a potential SOD risk, and the majority of potential occurrence areas are concentrated in Southern China (Yunnan, Sichuan, Guizhou, Chongqing, Hunan, Fujian). The area of high and extremely high risk in 2050 (RCP26, RCP45, RCP60, and RCP85) is larger than that at present. The most susceptible area is Yunnan province with 80% of the area prone to SOD at extremely high risk in present and future scenarios. The results will be important for monitoring potential high-risk areas in the currently uninfected parts of China.

RELATED RESEARCH

Addesso, K.; Baysal-Gurel, F.; Oliver, J.; Ranger, C.; O'Neal P. 2018. Interaction of a Preventative Fungicide Treatment and Root Rot Pathogen on Ambrosia Beetle Attacks during a Simulated Flood Event. Insects. 9(3) doi: 10.3390/insects9030083.

Redondo, M.A.; Boberg, J.; Stenlid, J.; Oliva, J. 2018. Contrasting distribution patterns between aquatic and terrestrial *Phytophthora* species along a climatic gradient are linked to functional traits. The ISME journal. August 2. https://www.nature.com/articles/s41396-018-0229-3.

Sims, L.; Tjosvold, S.; Chambers, D.; Garbelotto, M. ***In press*****.** ***Phytophthora*** **species in** plant stock for habitat restoration can be controlled through best management practices. Plant Pathology. Early view. https://onlinelibrary.wiley.com/doi/abs/10.1111/ppa.12933.

MEETINGS

Save the date. The Sudden Oak Death Seventh Science and Management Symposium (SOD7) **is** planned for June 25-27, 2019 in the Presidio, San Francisco. The SOD7 will cover research and field activities for *Phytophthora ramorum* around the world as well as progress to address Phytophthoras in native habitats, restoration areas and native California plants. More details will be available shortly.

CALENDAR OF EVENTS

10/21 – 24 – 2018. 9th International Oak Society Conference 2018 at UC Davis.
A session on oak pests has been organized by the California Oak Mortality Task Force. More information is available at http://www.internationaloaksociety.org/content/9th-international-oak-society-conference-2018.

11/13 - 14– 2018 California Forest Pest Council Annual Meeting at UC Davis. More information will be forthcoming soon.

06/25 - 27– 2019 Sudden Oak Death Seventh Science and Management Symposium. Golden Gate Club, The Presidio, San Francisco. More information will be forthcoming soon.