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Using an evapo-transpiration model to predict the current and future range and severity of pine wilt disease caused by pine wood nematode, *Bursaphelenchus xylophilus* in Europe

Gruffudd H, Evans H F, Jenkins T

Forest Research in Wales, Edward Llwyd Building, Penglais Campus, Aberystwyth, Wales, UK, SY23 3DA

Email: hannah.gruffudd@forestry.gsi.gov.uk, hugh.evans@forestry.gsi.gov.uk, tom.jenkins@forestry.gsi.gov.uk

ABSTRACT

Pine Wilt Disease (PWD) is a xylem restricting disease of pine trees, caused by the Pine Wood Nematode (PWN) *Bursaphelenchus xylophilus.* The nematode is carried from host tree to host tree by vector longhorn beetles in the genus *Monochamus*. The interaction between the nematode and beetle is crucial in the establishment and spread of the disease. PWN, a native of North America where it does not kill pine trees, has spread internationally killing trees in Japan, China, Korea, Taiwan and, from 1999, Portugal. Based on the locations where tree mortality has been recorded, it appears that pine trees growing in hot, dry conditions are more susceptible to the nematode, resulting in pine wilt disease. Results in the literature show that the growth and development of PWN is temperature-dependent and that there is a temperature range, outside which nematode development is restricted. In this paper we describe the ETPN model, an evapo-transpiration model (previously developed by Forest Research), which has been modified to incorporate the presence of PWN inside a tree, to predict the regions of Europe that are likely to succumb to pine wilt disease. ETPN acts independently of the vector; hence we predict the likelihood of PWD, assuming that a tree in a particular region has been infested by the pine wood nematode.

We have run the ETPN model for various locations in Japan, where PWD has been killing pine trees for over a century. The results of the ETPN model are in good agreement with observations in Japan and provide strong validation for the model.

We have also considered different regions in Europe: Portugal; where PWD has been found, France; where we would not currently expect to see PWD, but a region that might become suitable under future climates and Sweden; where we would not expect to see PWD. We demonstrate how the different climates of these three regions give very different results. Finally, we consider various climate change scenarios to demonstrate how PWD is likely to affect different regions in Europe in the future, especially in areas where there might be a shift from nil to low likelihood of PWD to a higher likelihood of tree mortality.

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