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PREDICTING POTENTIAL SPREAD OF THE PINE WILT DISEASE: WHICH PROGRESSES AND WHICH FUTURE DIRECTIONS?

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Predicting potential spread of the pine wilt disease (PWD) is very important to anticipate future infestations and optimize surveillance for early detection. Although good progress has been done so far to model potential spread (in Japan, China, Korea, Portugal/Spain - Europe), there is a need : 1) to review available models, 2) to point out their improvements and drawbacks, and 3) to identify future directions.

Spread of an invasive species results from the combination of dispersal in new environment, establishment and population growth processes. For the PWD, processes are more complex since the disease is caused by the invasive pine wood nematode (PWN), *Bursaphelenchus xylophilus*, itself carried and transmitted to pine trees by native longhorn beetles of the genus *Monochamus*. Furthermore, PWN-infested trees show wilting symptoms only under specific conditions, notably high summer temperatures. Spread of the disease thus results from an interaction among at least three actors (PWN, insect vectors and host trees) in specific environmental conditions. Therefore, modelling potential spread of PWD could consider the overall process, or only parts of it. Here, I review the main types of models used to assess the potential spread of the PWD, pointing out the main results, and highlighting future directions to refine the spread predictions. Models used so far to describe potential spread of PWD are mainly: species distribution models, dispersal models (including least-cost path analyses), disease expression models based on thermal conditions, and integrated spread models. The development of (semi-)mechanistical models describing the key processes would allow refining the assessment of the PWD potential spread in various or changing conditions. Despite the knowledge accumulated so far, many unknowns remain even about the biology, the ecology or the behaviour of the PWN and the insect vectors. Collecting such data is important to assess more accurately the PWD potential spread.