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(164) Modelling of potential spread of Pine Wood Nematode by natural means in Slovenia at present climate conditions and in light of predicted climate changes

Gerič Stare B, Knapič M, Ogrica N, Širca S, Urek G

Agricultutral Institute of Slovenia [Hacquetova ulica 17, SI-1000 Ljubljana, Slovenia]
Email: matej.knapic@kis.si

ABSTRACT

Pine wood nematode (PWN), *Bursaphelenchus xylophilus*, threatens economy and biodiversity of Slovenian forest. A model was developed to simulate natural means of spread of PWN from three (3) potential entry points to Slovenia. The stochastic model of natural spread was developed on a 1 × 1 km grid. The model is based on real data, such as host tree density, susceptibility of each conifer species to PWN infestation, suitable temperature for PWN development, and appearance of the drought stress. Modelling is performed on the assumption that *Monochamus* spp. vectors are present in all Pine tree growing areas and that their maximum annual spread is 3 km. Simulation results show that if no containment measures are applied, at present climate conditions PWN would be spread almost over the entire Pine forest-covered and temperature appropriate territory of Slovenia in average of approximately 200 years. The extent and speed of PWN spread differ depending on entry point and climate conditions. The modeling was simulated also using a medium scenario of predicted climate changes for two periods: 2021–2050 and 2061–2090. At present environmental conditions, 8.954.000 m^3 of *Pinus* spp. growing stock is endangered. The model clearly demonstrated that the spreading of PWN is relatively slow by the natural means. The human factor is the most critical for rapid PWN spreading.

INTRODUCTION

PWN represents a serious threat to susceptible conifer trees by causing Pine wilt disease. By natural means the PWN is transmitted by vectors – beetles of genus *Monochamus*. The maximum annual distance of beetle movement is up to 3.3 km (Kobayashi *et al.*, 1984). On long distance PWN is dispersed by human activity which increases the speed

of spread considerably. On the other hand it is difficult to predict such long distance jumps (Robinet *et al.* 2011). We modelled the spread of PWN in Slovenia by natural means only, considering different influencing factors, such as host tree density, susceptibility of each conifer species to PWN infestation, suitable temperature for PWN development, and appearance of the drought stress. International trade is the most likely pathway of PWN potential introduction so modelling was done for 3 different entry points: sea port, airport and a saw-mill.

MATERIAL AND METHODS

Spread of PWN was modeled in 1 x 1 km grid with cellular automata using rule of extended Moor's neighborhood. Probability for establishment of PWN in the cell was defined with temperature and drought stress while speed of dispersal was determined with maximal annual distance of beetle movement (3 km) and host tree density and susceptibility. Each factor was classified and their influence in the rule of PWN spread was defined. The drought stress in the model was defined as a point in time, when soil moisture decreases below 50% of plant available water and last at least for two consecutive months. The climate changes were simulated with general circulation models (Bergant 2007). The modelling simulations were performed in 300 replicates.

RESULTS AND DISCUSSION

Spread of PWN by natural means is relatively slow. The modeling results show that appropriate space for PWN would be infested in 200 years at present climate condition. The modeling was also simulated using a medium scenario of predicted climate changes (Bergant, 2007) for two periods, 2021–2050 and 2061–2090. At present environmental conditions, 8.954.000 m^3 of *Pinus* spp. growing stock is endangered. With climate changes endangered quantities of growing stock would increase to 14.464.000 and 18.577.000 m^3 for periods of 2021–2050 and 2061–2090, respectively.

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