Natural Resources Canada | Ressources naturelles Canada

Bulletin 66

FRONTLINE EXPRESS

Canadian Forest Service – Great Lakes Forestry Centre

Improving forest pest risk predictions using financial investment techniques

INTRODUCTION

Influences such as climate change, fire and pest outbreaks introduce uncertainty to predictions of the functioning and health of forest ecosystems. Uncertainty is especially problematic with the entry and introduction of alien invasive species. In recent years, ecological risk models have been used to better assess risks and reduce uncertainties associated with the various biological, economic and social impacts of disturbances in Canadian forests. The use of quantitative models that are based on existing knowledge to predict uncertain events is a useful tool that helps quantify risk and supports environmental and economic decision making. In particular, models have recently been used to estimate risks of new introductions of exotic pests and help determine their potential impacts on the Canadian forest sector. These efforts play an increasingly important role in decisions related to policy development, staff and equipment allocation, and outreach activities.

Models to assess risks and uncertainties of exotic pest invasions

Quantitative models can be used to estimate many aspects of pest invasions, from predicting the arrival of a new invasive pest to its expected pattern of spread over the landscape and resultant social and economic impacts. The models not only predict the pest's spread based on the distribution of potential host trees and suitability of the climate to its survival, they also help determine where an invasive species came from. Models can be used to guide a course of action to stop or slow the spread of an invasive pest as well as to determine the associated costs of eradication or control. They can also help predict consequences if a pest cannot be controlled. In the case of emerald ash borer (EAB) for example, if ash trees cannot be saved, the models can estimate what it would cost to plant replacement trees.

Knowledge about a new invasive species is often limited, so models used to assess risk are rarely precise. Outputs are generally limited to coarse assessments of establishment and impact potential. Often the need to act quickly when an invasive organism is newly detected in a given region does not allow enough time to acquire the empirical data necessary to characterize the local risk well.

Not taking uncertainty into account when developing these models and assessments can have serious implications when the models are used to support decisions on managing or regulating an invasive organism. Uncertainty inevitably changes the interpretation of risk estimates because most decision makers in pest management and regulation are fundamentally risk-averse. This is problematic, as behavioural research indicates that experts tend to underestimate uncertainty by a considerable margin. Government agencies may need to optimize the use of limited budgets and have a legal mandate that obliges them to minimize risk. In this situation, a decision maker's subjective perceptions of risk may result in choosing a solution that appears to be satisfactory, but which may not be the optimal one. In promoting the acceptance and use of models as valuable decision support tools, researchers must educate decision makers about how models and risk assessments incorporate and communicate uncertainty.

GREAT LAKES FORESTRY CENTRE (GLFC) ROLE

Portfolio valuation techniques for ecological risk assessments

Decision-making under severe uncertainty is a common practice in other fields, such as financial asset valuation. Financial analysts work to find the best allocation of financial assets as a trade-off between net expected returns and their volatilities. Applying this concept to pest invasions, the impact of the invasion (or the level of expected damage) can be thought of as analogous to the concept of "net return" and the uncertainty of that estimate to the concept of "volatility" of a financial portfolio investment. The process of assessing and mapping risks of ecological invasions can then be likened to finding an optimal investment strategy, a technique referred to as portfolio valuation. Using these novel analytic techniques, GLFC modelers have developed several new bio-physical and bio-economic models that can be used to help quantify risks and reduce uncertainties about invasive organisms.

Ideally, a decision to manage or eradicate a new invasive organism should be based on a trade-off between the estimate of the impact of invasion and the uncertainty of that estimate. Even though these models rely to a certain extent on imprecise data and thus generate a degree of uncertainty, they are still valuable for decision making, particularly when little concrete information is available and prompt action may be critical.

Assessing risks of human-assisted spread of EAB

GLFC modelers applied this portfolio valuation technique to quantify risks associated with human-assisted movement of EAB. Long-distance dispersal remains the most uncertain and difficult characteristic of invasions to adequately estimate, but has been widely recognized as a key contributor to the expansion of invasive pest populations. In the case of EAB, the majority of long-distance introductions of new populations have been caused by commercial and passenger vehicles moving infested materials, such as logs, firewood or nursery stock via major road corridors.

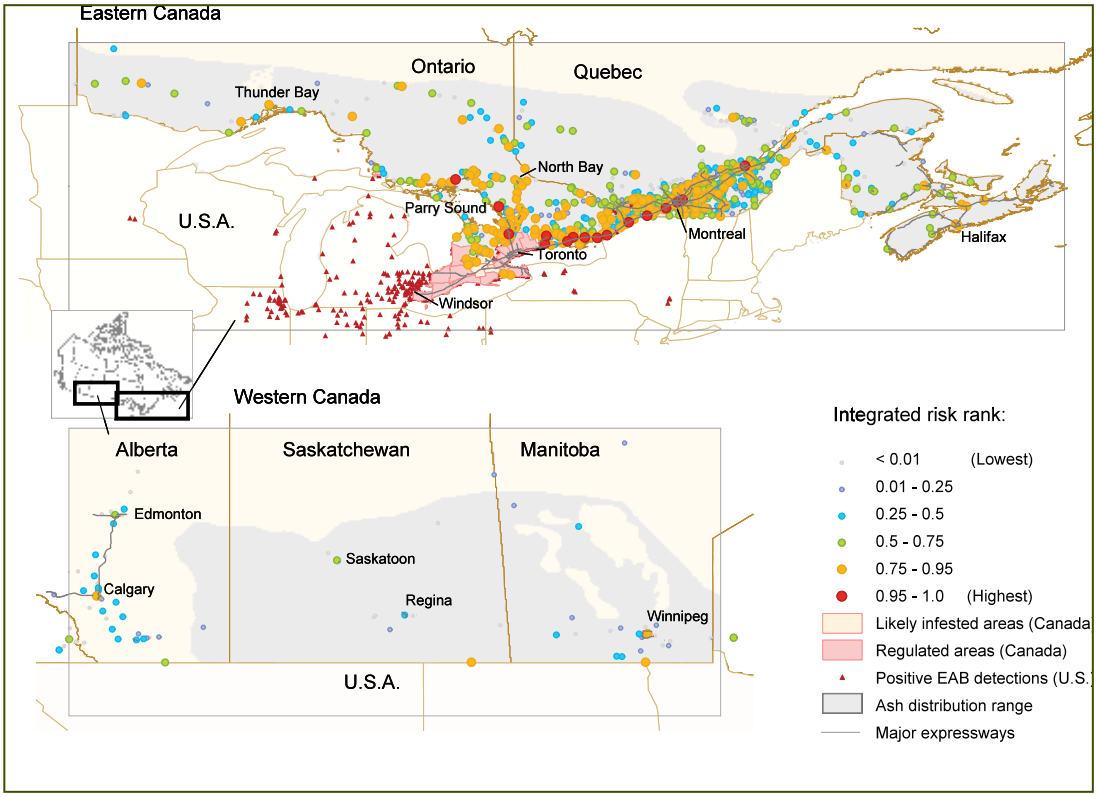

Figure 1. Risk assessments of EAB long-distance spread via commercial freight transportation for major Canadian municipalities (based on the portfolio valuation technique)

The model was designed to predict the movement of commodities commonly associated with the pest and estimate the likely spread of EAB across eastern North America. The study used a pathway-based model of EAB spread by commercial freight transport through a nationwide road network. The distributions of plausible scenarios of EAB expansion were then synthesized into risk-averse assessments.

The approach confirmed that transportation expressways are a major vector of human-mediated spread of EAB in Ontario and Quebec and allowed for the delineation of major geographical areas of concern in a user-friendly map format (see Figure 1). This type of modelling exercise provides managers with more lead time to make decisions because it allows for detections of the pest beyond the main invasion front. Overall, this assessment technique appears to have good potential for prioritizing risks of invasive species introductions under severe uncertainty.

CONCLUSION

Models that take uncertainty into account can be valuable decision support tools in the assessment of ecological risks. The EAB spread model that takes into account the pest's potential movement along transportation corridors has become a useful tool for analyzing the predicted spread of EAB in Canada. The portfolio-based approach represents a major step forward in modelling ecological risks because it provides a simple way to incorporate and communicate both risk and uncertainty in a single decision support product.

PRINCIPAL COLLABORATORS:

United States Department of Agriculture, Animal and Plant Health Inspection Service (USDA APHIS), Plant Protection and Quarantine Division, Center for Plant Health Science and Technology

USDA Forest Service, Southern Research Station, Eastern Forest Environmental Threat Assessment Center

Michigan State University, Centre for Global Change and Earth Observations

University of New Hampshire

CONTACT INFORMATION

Denys Yemshanov
Great Lakes Forestry Centre
1219 Queen Street East
Sault Ste. Marie, Ontario, Canada
P6A 2E5
Phone: 705-949-9461
Fax: 705-541-5700
http://cfs.nrcan.gc.ca/centres/read/glfc
E-mail: GLFCWeb@nrcan.gc.ca

ISSN 1496-7847