Natural Resources Canada | Ressources naturelles Canada

Frontline

Forestry Research Applications

Canadian Forest Service – Great Lakes Forestry Centre

Technical Note No. 115

How many trees need to be sampled to detect emerald ash borer?

INTRODUCTION

The emerald ash borer (EAB), *Agrilus planipennis* Fairmaire (Fig. 1), is a non-native insect pest of Asian origin that is currently infesting large numbers of ash (*Fraxinus* spp.) trees in Ontario and Québec and could soon spread to other provinces. Infestations can be present for many years before they are detected, making this insect particularly difficult to control.

One of the requirements for effective management of EAB is early detection of infestations when densities are still low and before signs and symptoms are obvious.

Fig. 1. Adult emerald ash borer.

Fig. 2. Serpentine galleries made by EAB larvae, found by branch sampling.

GREAT LAKES FORESTRY CENTRE RESEARCH

Emerald ash borer infestations tend to begin in the crown of larger open-grown trees. Great Lakes Forestry Centre scientists developed a branch sampling method that is highly effective at detecting EAB-infested trees before the appearance of visible signs and symptoms of attack, such as thinning tree crowns, epicormic shoots or insect exit holes on tree trunks. Sampling involves removing two branches from the mid-crown of a tree, peeling bark from the base of each branch and closely examining for signs of EAB larvae (Fig. 2). This method is of particular value in urban areas with high-value ash trees (Fig. 3). More details of the method can be found in Ryall et al. (2011b).

Determining sampling intensity

One challenge facing urban foresters is how to determine how many trees must be sampled to provide a high probability of detecting an unknown and asymptomatic EAB infestation. We have developed a sampling simulator model (Legg et al. 2014) that calculates a recommended number of ash trees to sample in areas where EAB has not yet been detected. The recommended sampling intensity is based on the number of ash trees (the inventory), the 'size' of EAB infestation being sampled (i.e., percentage of trees assumed to be infested), and the detection rate for branch sampling.

Urban foresters are often constrained by available resources (time, funding or staff) and thus the amount of sampling that can be conducted is limited. To address this issue, the simulator also provides the probability of detecting an EAB infestation when a specific number of trees has been sampled. Urban foresters can determine how many trees they can sample and then use this information to determine the likelyhood of having detected an infestation when that number of trees has been sampled.

Fig. 3. Healthy-looking ash with no visual symptoms, but determined to be infested with EAB using branch sampling.

How to use the sampling simulator model?

In the scenario provided here, we assume an inventory of 5,000 ash trees infested with very low populations of EAB where the probability of detection in an individual tree using branch sampling is 55%. The model is then run to calculate the sampling effort (number of trees examined until first detection) for a 70, 80 or 90% probability of detection (Table 1). These results should be interpreted as the maximum number of trees to be sampled to detect *at least one infested tree*, given the infestation level and probability of detection desired. For example, it would be necessary to randomly sample up to 165 trees to provide an 80% probability of detecting an infestation where 1% of trees are infested.

It is important to recognize that EAB might not be detected in any of the 165 trees sampled. This could occur because: 1) EAB populations in trees are too low to be detected by branch sampling; 2) the probability of *not* detecting the infestation is 20% and it does not get found; or 3) EAB are not yet present in the area. Alternatively, an infested tree might be detected before all 165 trees have been sampled. At that point, detection survey activities should cease and a follow-up delimitation survey could be initiated.

For further technical details and to run alternate scenarios, see http://w3.uwyo.edu/~dlegg/union.html.

Table 1. Maximum recommended number of ash trees to sample randomly (per 5,000 trees)

Probability of Detection of Infestation	Percentage of Trees Infested			
	0.5	1	1.5	2
70	230	128	86	61
80	312	165	113	83
90	446	230	149	118

Another way to use this model is to first determine the number of trees that can be sampled based on available resources. With this information, model results can be used to estimate the probability of detecting an infestation of a certain size. For example, if available resources limit sampling efforts to a maximum of 150 trees, there would be a 90% probability of detecting an infestation where 1.5% of trees are already infested, or an (almost) 80% probability of detecting a 1% infestation (Table 1).

Caveats

For results generated here, the detection rate for branch sampling of individual trees was assumed to be a conservative 55% (based on results of Ryall et al. 2011a) when gallery density is less than 8/m^2.

Similar recommendations for number of trees to sample are generated by the model for inventories as large as 10,000 ash trees. Larger inventories would need to be subdivided into 10,000-tree groups.

Recycled paper

Aussi disponible en français sous le titre : Frontline Note technique nº 115 : Combien d'arbres doivent être échantillonnés pour pouvoir détecter l'agrile du frêne?

CONCLUSION

Branch sampling is an effective tool for detecting incipient EAB populations, before outward signs and symptoms become apparent. Early detection of EAB populations can provide managers with additional time to identify and implement management options before unacceptable ash decline and mortality occurs. This model can be used by urban foresters to balance the resources they have available for EAB detection against the probability of detecting incipient EAB populations.

Ash tree material can contain live EAB; it must <u>not</u> be moved outside of regulated areas established by the Canadian Food Inspection Agency (CFIA). In non-regulated areas, discovery of EAB galleries or of a live specimen must be reported to the CFIA.

Procedures for **movement and disposal** of ash wood are available at: http://www.inspection.gc.ca/plants/plant-protection/insects/emerald-ash-borer/eng/1337273882117/1337273975030.

CONTACT INFORMATION

Krista Ryall (krista.ryall@nrcan-rncan.gc.ca)
and Jeff Fidgen (jeff.fidgen@nrcan-rncan.gc.ca)
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/glfc
E-mail: GLFCWeb@nrcan.gc.ca

COLLABORATORS

Canadian Food Inspection Agency

Ontario Ministry of Natural Resources and Forestry

We are grateful to the cities of Toronto, Pickering, Oakville and Sault Ste. Marie for permission to sample trees.

LITERATURE CITED

Legg, D.E.; Fidgen, J.G.; Ryall, K.L. 2014. Resampling simulator for the probability of detecting invasive species in large populations. J. Soft. Eng. Appl. 7:498-505.

Ryall, K.L.; Fidgen, J.G.; Lyons, D.B.; Turgeon, J.J. 2011a. Detectability of the emerald ash borer (Coleoptera: Buprestidae) in asymptomatic urban trees by using branch samples. Environ. Entomol. 40:679-688.

Ryall, K.L.; Fidgen, J.G.; Turgeon, J.J. 2011b. Detection of emerald ash borer in urban environments using branch sampling. Natural Resources Canada, Canadian Forest Service, Great Lakes Forestry Centre, Sault Ste. Marie, Ontario. Frontline Technical Note 111. 3pp.

Canadian Forest Service, Great Lakes Forestry Centre
1219 Queen Street East, Sault Ste. Marie ON P6A 2E5
705-949-9461

	Print	Online
ISSN	1717-6980	1717-6980
Cat. No.	Fo123-1/115E	Fo123-1/115E-PDF
ISBN	978-1-100-25857-7	978-1-100-25858-4