Hemlock Woolly Adelgid

Adelges tsugae Annand
Hemiptera: Adelgidae

Fidgen, J. G.; Legg, D. E.; Salom, S. M. 2006. Binomial sequential sampling plan for hemlock woolly adelgid (Hemiptera: Adelgidae) sistens infesting individual eastern hemlock trees. Journal of Economic Entomology 99: 1500-1508.

Objective: To develop an efficient, cost-effective sampling method for determining the infestation level of *A. tsugae* on individual, high-value eastern hemlock trees.

Abstract: Hemlock woolly adelgid, *Adelges tsugae* (Annand), is a severe pest of eastern hemlock [*Tsuga canadensis* (L.) Carr.] and Carolina hemlock (*Tsuga caroliniana* Engelm.) on the east coast of the U.S. and Canada. Infestation by *A. tsugae* results in reduced production of new foliage, premature needle drop, branch dieback, thinning of the crown, and a general decline resulting in the death of the tree. Two parthenogenetic generations of *A. tsugae*, the sistentes and progredientes, occur each year. Eggs of both generations hatch into a mobile crawler stage that settles at the base of a needle to feed and mature. Sistentes are found on hemlock from mid-summer into spring. Progredientes occur for a brief period during late spring and early summer, giving rise to the next generation of sistentes that aestivates over the summer months and resumes feeding in the fall. Infestations may spread quickly, and *A. tsugae* is expected to spread throughout the range of eastern and Carolina hemlock.

A binomial sequential sampling plan was developed that samples the presence of sistentes on new shoots in a non-destructive manner. Sistentes are present on the tree for a longer period of time and are more easily observable than the progredientes. The plan requires examination of 20 to 80 new shoots on each tree to classify the tree as having a low, high, or indeterminate infestation level. Sampling took <2 min for each tree.

Sampling Procedure: Select eastern hemlocks that are in good health and exhibiting few symptoms of decline. Sample sistentes between October and May. *Choose a threshold level appropriate for the objective:* a 10% level is appropriate for maintaining aesthetics while a 30% level is appropriate if the goal is to maintain tree health.

Randomly select four branches in the lower crown of the tree. Branches do not need to be cut from the tree, but use pole pruners to reach the lower third of the crown if no live branches are available in the lower crown. There should be at least 20 new shoots on each branch sampled. Tally the number of the first five shoots on each branch that have at least one adelgid. Sum the number of infested shoots across all four branches (number of infested shoots out of 80 shoots sampled).

Check Table 1 for the upper and lower stop values associated with the threshold level chosen for your objective. Classify the tree as a low infestation if the tally of

infested shoots is less than the lower stop value. Classify the tree as a high infestation if the tally of infested shoots is greater than the upper stop value.

If the tally falls between the lower and upper stop values, continue sampling the tree. Examine the next set of five shoots on each branch and tally the number of shoots with at least one adelgid on them. Add this cumulative tally to the first tally and refer to Table 1 again. If the cumulative tally for 40 samples is less than the lower stop value, classify the tree as a low infestation. If the cumulative tally for 40 samples is greater than the upper stop value, classify the tree as a high infestation. If the tally falls between the lower and upper stop values listed for 40 samples, count the number of infested shoots within the third set of five shoots on each branch. Continue in this manner until the tree is classified as either a low or high infestation or a total of 80 shoot samples have been examined. If the tree cannot be classified as a low or high infestation after examining a total of 80 shoot samples, then classify the tree as indeterminate. Trees classified as low or indeterminate using this plan may not require a pest management action.

Notes: Densities of *A. tsugae* on new shoots did not differ between the lower crown and the middle crown of infested trees in this study. This sampling plan is appropriate for building populations of *A. tsugae* but before infested trees are in decline. Sampling trees already in decline or sampling the progredientes stage has not been validated statistically and will likely produce inconsistent results.

Table

Table 1. Stop boundaries for binomial sequential sampling of *A. tsugae* infesting eastern hemlock at the 10 and 30% of new shoots infested with at least one sistens thresholds

Threshold (%)	Sample no.	Stop boundaries				
			Lower stop value		Upper stop value	
10	20	Low infestation	-	Continue sampling	6	High infestation
	40		1		8	
	60		2		12	
	80		3		15	
30	20		3		11	
	40		7		19	
	60		12		37	
	80		16		34	

Table 1 reproduced with permission from the Journal of Economic Entomology, granted April 2, 2009.