Multiple Seed and Cone Insects

Barbara colfaxiana (Kearfott), Lepidoptera: Tortricidae
Contarinia oregonensis Foote, Diptera: Cecidomyiidae
Dioryctria abietivorella (Grote), Lepidoptera: Pyralidae
Lepesoma lecontei (Casey), Coleoptera: Curculionidae
Megastimus spermotrophus (Wachtl), Hymenoptera: Torymidae

Dombrosky, S. A.; Schowalter, T. D. 1988. Inventory monitoring for estimating impact of insects on seed production in a Douglas-fir seed orchard in western Oregon. Journal of Economic Entomology 81: 281-285.

Objective: To develop a fixed precision enumerative sampling plan that estimates infestation levels of multiple species of seed and cone insects attacking cones and seeds of coastal Douglas-fir.

Abstract: Genetically improved Douglas-fir, *Pseudotsuga menziesii* (Mirb.) Franco, is commonly grown in orchards in the Pacific Northwest to aid reforestation efforts in the coastal region. The value of harvested seed ranged from $650-2,200/kg in the 1980's, and any damaged seed is considered an economic loss. A number of important insect pests have been reported from Douglas-fir cones, feeding on the cone and developing seeds within the cone.

A study conducted in western Oregon examined the distribution of Douglas-fir cones and insects attacking the cones, as stratified within crowns and among trees in a seed orchard. The number of trees and the number of cones per tree or the number of cones per crown level (bottom, mid, and upper) was determined for sampling multiple cone pests at the 0.10 and 0.20 standard errors (SE) of the mean. In general, 12 cones collected randomly throughout the canopies of each of 100 trees should be adequate to estimate seed losses due to biotic or abiotic factors with a standard error of the mean of 0.20, but stratified sampling among crown levels is recommended for more precise estimates of potential cone and seed yields. Sampling large numbers of trees is necessary due to the high level of variation among trees. Orchard managers should select a sampling plan that balances the desired level of precision with an acceptable cost of sampling.

Sampling Procedure: For non-stratified sampling of biotic and abiotic factors contributing to cone and seed losses, collect 12 cones randomly throughout the canopy of each of 100 trees selected at random in a seed orchard. This should be sufficient to estimate seed losses at the 0.20 standard error level of precision. Examine cones and seeds to determine mortality, total seeds per cone, the number of healthy seeds, and seed loss due to insects, frost, unexplained failure to develop, etc.

Sample immature cones at the flowering stage in April or the pendant stage in June for the flightless weevil *Lepesoma lecontei* (Casey) (Coleoptera: Curculionidae). To sample *L. lecontei* at the 0.10 standard error of the mean, examine 584 cones throughout the crown from each of 781 trees (Table 4). Alternatively, partition the

live crown of each of the 781 trees into thirds by counting the number of whorls present on each tree and dividing by three (Miller 1986a, b). Sample 92 cones from the bottom crown, 390 cones from the mid-crown, or 1,111 cones from the top crown of each tree.

To sample *L. lecontei* at the 0.20 standard error of the mean, examine 146 cones throughout the crown from each of 195 trees (Table 4). Alternatively, partition the live crown of each of the 195 trees into thirds by counting the number of whorls present on each tree and dividing by three (Miller 1986a, b). Sample 23 cones from the bottom crown, 98 cones from the mid-crown, or 278 cones from the top crown of each tree.

Sample mature cones in early September for the following insects that damage seeds:

Douglas-fir cone gall midge	*Contarinia oregonensis* Foote	Diptera: Cecidomyiidae
Douglas-fir cone moth	*Barbara colfaxiana* (Kearfott)	Lepidoptera: Tortricidae
Douglas-fir seed chalcid	*Megastimus spermotrophus* (Wachtl)	Hymenoptera: Torymidae
Fir coneworm	*Dioryctria abietivorella* (Grotè)	Lepidoptera: Pyralidae

Use Table 4 to determine how many trees, cones per tree, or cones per crown level should be sampled for each of these pests. For example, to sample *M. spermotrophus* at the 0.10 standard error of the mean, examine 49 cones throughout the crown from each of 620 trees. Alternatively, partition the live crown of each tree into thirds by counting the number of whorls present on each tree and dividing by three (Miller 1986a, b). Sample 15 cones from either the bottom or mid-crown of each tree, or 25 cones from the top crown of each tree. To sample *M. spermotrophus* at the 0.20 standard error of the mean, examine 12 cones throughout the crown from each of 158 trees. Alternatively, partition the live crown of each tree into thirds by counting the number of whorls present on each tree and dividing by three (Miller 1986a, b). Sample 4 cones from either the bottom or mid-crown of each tree, or 6 cones from the top crown of each tree.

Examine each cone for characteristic damage produced by insects attacking seeds and determine the percentage of healthy seeds or seeds damaged by each insect pest. When sampling *M. spermotrophus*, dissect each cone to remove the scales. X-ray the seeds that appear healthy to detect infestation by *M. spermotrophus* or other internal damage.

Notes: Table 4 was generated from a sample of ten trees at one site in one year. This information should be used with caution until additional data can be collected to verify or adjust the numbers. Additional data collected from other seed orchards throughout the Pacific Northwest will greatly improve the predictive ability of this inventory monitoring system.

References:

* Miller, G.E. 1986a. Distribution of *Contarinia oregonensis* Foote (Diptera: Cecidomyiidae) eggs in Douglas-fir seed orchards and a method for estimating egg density. Canadian Entomologist 118: 1291-1295.

* Miller, G.E. 1986b. Damage prediction for *Contarinia oregonensis* Foote (Diptera: Cecidomyiidae) in Douglas-fir seed orchards. Canadian Entomologist 118: 1297-1306.

Table

Table 4. Minimum number of trees and cones required for seed loss estimates within a predetermined standard error (SE), based on data from 10 study trees at the Beaver Creek Seed Orchard, 1984.

Factor	Trees (*n*)	Cones/tree (*n*)	Cones/tree level		
			Bottom (*n*)	Middle (*n*)	Top (*n*)
SE = 0.10					
Healthy seeds	565	52	15	22	25
Undeveloped seeds	73	2	1	1	2
Gall midge	312	51	59	13	19
Seed chalcid	620	49	15	15	25
Cone moth	605	895	52	945	627
Coneworm	1,020	706	368	468	523
Other	207	148	33	124	75
Weevil	781	584	92	390	1,111
Other cone mortality	379	157	133	198	758
SE = 0.20					
Healthy seeds	144	13	4	6	6
Undeveloped seeds	21	0.5	0.25	0.25	0.5
Gall midge	79	13	15	3	5
Seed chalcid	158	12	4	4	6
Cone moth	151	224	13	236	157
Coneworm	255	177	92	117	131
Other	52	37	8	31	19
Weevil	195	146	23	98	278
Other cone mortality	95	39	33	50	190