Frontline

Forestry Research Applications

Canadian Forest Service
Great Lakes Forestry Centre

Technical Note No. 94

GUIDELINES FOR USING SEX PHEROMONE TRAPS TO MONITOR EASTERN SPRUCE BUDWORM POPULATION DENSITIES[1]

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CATEGORY: Pest management
KEY WORDS: Pheromone trap, lure, budworm, monitoring

INTRODUCTION

The eastern spruce budworm (*Choristoneura fumiferana* [Clem.]) remains a serious problem throughout Canada and the northern United States in the management of forests containing balsam fir (*Abies balsamea* (L.) and white spruce (*Picea glauca* [Moench] Voss). Currently the only management options are reactive (i.e., actions taken once an outbreak has occurred), such as protection of the trees by the application of insecticides or salvage harvesting. In future, improved forest inventories coupled with computerized geographic information systems will allow for proactive treatments, such as the adjustment of harvest schedules to ensure a sustained wood supply by integrating inventory data, growth and yield data, and data on budworm impact. A critical factor in the success of such plans will be advanced knowledge of when and where outbreaks of the budworm will occur.

Between outbreaks, populations of eastern spruce budworm sink to extremely low densities, often less than one larva per 1 000 branches. At these levels conventional larval sampling is impractical. However, if changes in density could be monitored at these levels, then it would be possible for the pest manager to determine when larval sampling is again advisable so as to more accurately assess the potential threat of another outbreak.

Sex pheromone traps are ideal for this purpose. They can monitor changes even at the lowest densities. They are also easy to use and relatively cheap. This note provides guidelines for using sex pheromone traps to monitor spruce budworm populations.

MATERIALS

There are three components to an effective pheromone trap: the trap itself, a lure, and a killing or restraining agent. Registration is not required for the use of the trap and lure in either Canada or the United States, but if an insecticide is used inside the trap then registration is required in both countries.

Trap

The trap chosen for the eastern spruce budworm monitoring program is the Multi-pher I® (Sanders 1986, Jobin et al. 1993) (Figs. 1 and 2), manufactured by le Groupe Biocontrôle,

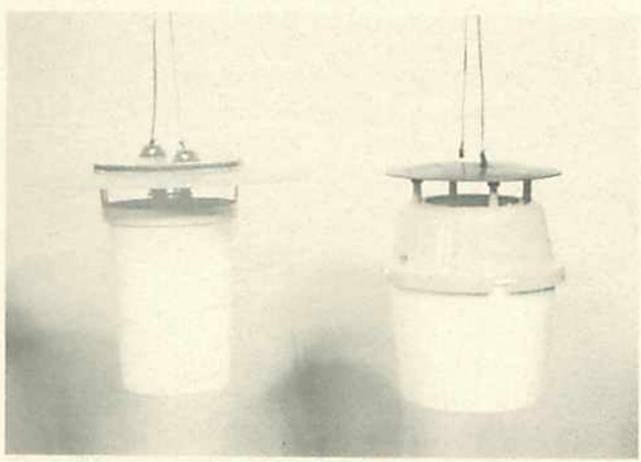

Figure 1. Multi-pher I® trap (left) and Unitrap® (right) recommended for use in the spruce budworm pheromone trapping program.

[1] A 15-minute video tape, demonstrating the use of the traps, is available on request from the author.

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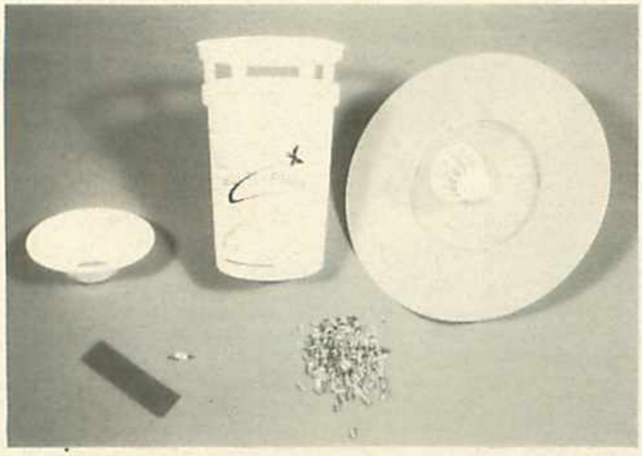

Figure 2. Exploded view of a Multi-pher® trap showing the component parts: the lid (right) with the shuttlecock inserted; the bucket (center); the baffle or funnel (left) that fits inside the bucket; and the Vaportape II® insecticide strip (bottom left).

Ste-Foy, Québec, and available through a number of suppliers. The Unitrap® (International Pheromone Systems, Wirral, United Kingdom) performs equally well and is an acceptable substitute. Both types of trap have the capacity to hold several thousand moths without losing their effectiveness. This makes them suitable for monitoring a wide range of population densities.

Lure

Numerous types of lures are available (Sanders 1981, 1992; Sanders and Meighen 1987). The necessary criteria for an affective lure are protection of the synthetic pheromone from chemical degradation (usually oxidation, which is hastened by exposure to UV radiation) and release of the synthetic pheromone at a predetermined and relatively constant rate throughout the flight period of the spruce budworm.

The release rate selected for the eastern spruce budworm monitoring program is 100 nanograms per hour, slightly higher than the natural release rate of a female moth (Silk et al. 1980, Morse et al. 1982). This is sufficient to catch some males at very low densities, and yet it causes no aberrant behavior in the males, which is a possibility at excessively high release rates. The duration of release is specified to be at least 8 weeks. This spans the flight period (about 3 weeks in any one location) and provides a margin of a few weeks to allow for errors in predicting moth flight. It also permits deployment of the traps during larval sampling, which may occur 3–4 weeks before moth flight.

The lures in current (1996) use are Biolures® (Consep Membranes Inc., Bend, Oregon), with a loading of 2.8 mg of synthetic pheromone per lure. Each Biolure measures approximately 3 cm x 4 cm, and has a sticky patch on one surface so that it can be stuck to the underside of the trap lid. The lures are individually wrapped to reduce the risk of contamination.

Insecticide

In contrast to many of the traps used for the detection and timing of moth flight, the Unitrap and Multi-pher traps contain no sticky surface. Moths entering the buckets are trapped by the funnel-shaped entrance. If they are not immobilized in some way the moths will fly around inside the trap, damaging both themselves and other moths and making identification and counting difficult. The moths are therefore killed by an insecticide, for which registration is required. The insecticide selected for this purpose is the fumigant dichlorvos (DDVP). There are several products on the market with DDVP impregnated in plastic, but only one is registered for use in pheromone traps in Canada: namely Vaportape II® (Hercon Environmental Corp., Emigsville, Pennsylvania; Canadian Registration No. 21222; United States Registration EPA No. 8730-32). Each plastic strip measures 3 cm x 10 cm and is 2 mm in thickness (Fig. 2). They are sold individually wrapped so as to eliminate any danger of exposure in handling. The packet should be opened in the field and dropped into the bucket at the time the trap is deployed.

PROTOCOLS FOR HANDLING AND DEPLOYMENT OF TRAPS

Assembly of Traps

First, if the trap is not already assembled, a wire hanger is attached to the lid through the holes provided. Then a Biolure is removed from its envelope, the paper backing is peeled away, and the lure is stuck to the underside of the lid. The shuttlecock is then snapped into place. This impedes the flying moths and increases the probability that they will fall into the bucket. Next the funnel is fitted securely into the bucket. Care should be taken to ensure that it is fully inserted and that it will not move if the trap is knocked during handling. The bucket is then fastened to the lid, and checked to ensure that it is positioned squarely and that all the fasteners have interlocked. Finally, at the time of deployment, the Vaportape II plastic strip is removed from its wrapper and dropped into the bucket.

Handling of Traps, Lures, and Insecticide

Multi-pher and Unitraps are made of rigid plastic and require no special care in handling. The plastic does however absorb pheromone, which remains active from one year to the next and makes the trap slightly attractive even without a lure. This contamination is not a serious problem, but the pheromone of one species may affect the response of another species. Therefore, individual traps should always be reserved for the same species in successive years.

The pheromone itself has no known toxic affects on humans or other animals, and no safety precautions are needed when handling the lures. However, for individuals handling large numbers of lures, rubber or vinyl gloves should be worn to avoid contamination of the traps. Pheromone lures of any type should be stored in a freezer, and be kept as cool as possible during transit so as to avoid high rates of release and possible contamination of other equipment.

The insecticide DDVP is potentially toxic, and direct contact with the insecticide strip or inhalation of the vapor should be avoided. The Vaportape II strips are packaged in tinfoil, virtually eliminating any leakage of the vapor. As a precaution against such leakage, it is recommended that the strips be kept refrigerated during storage. However, they should not be kept in a refrigerator that is used to store food. For individuals handling large numbers of the insecticide strips, rubber or vinyl gloves are recommended. Exposed strips should never be kept in a confined space, such as the interior of a car, for any length of time. When the traps are collected and dismantled at the end of the season the lures and Vaportape strips should be removed and immediately disposed of in a sanitary landfill.

Selection of Trapping Sites and Deployment of Traps

To ensure that trap catches are representative of budworm populations, certain protocols must be met. Traps should be deployed in mature forest stands (a minimum of 10 ha in area) containing at least 50 percent white spruce and/or balsam fir. Each trap should be hung at eye level on a dead branch at least 50 cm from the stem of the tree. It should also be free from any obstruction that might prevent it from swinging freely. As suggested by Jobin et al. (1993), hinged brackets can be fastened to trees in permanent sample plots. This ensures that the traps are hung in exactly the same position each year. Because trap catches are more variable at the edge of a stand, traps should be positioned at least 40 m from the edge.

One trap will provide almost as reliable an estimate as will a group of traps spaced >40 m apart. However, a layout of three traps, arranged in an equilateral triangle with 40 m between traps, is recommended. This compensates for traps vandalized or damaged by wildlife. To ensure continuity from year to year, it is recommended that both the trail and the trees from which the traps are hung be permanently marked.

Timing

Traps should be deployed several days in advance of the expected start of the moth flight period. Because the lures have an effective life of at least 8 weeks, this allows for flexibility in the time of deployment.

Collection of Traps

Traps should be collected when the moth flight is over, but a little extra time should be allowed in case there is an influx of moths from an area where insect development has been slower. If there are only a few moths they can be counted at the site. If this is not convenient, the moths can be emptied into a paper bag for counting later. These bags can be stored in a cold, dry location for several weeks if necessary before counting, but care should be taken to ensure that they are kept cool and dry and that rodents, especially mice, cannot reach them.

Counting should be done in a fumehood or in a well ventilated area so as to avoid the inhalation of moth scales, which can cause allergic reactions. A face mask should be used to provide additional protection. Several techniques are available to speed up the counting of large numbers of moths. First the moths should be spread out, and large insects other than budworm should be removed. Then one or more subsamples can be counted and either weighed or measured volumetrically. By dividing the weight or volume into that of the whole catch, the total count can be estimated.

INTERPRETATION OF CATCHES

Since 1986, traps have been deployed in approximately 700 sites throughout the range of the spruce budworm from Alberta to Newfoundland and across six states of the northern United States. Results from these surveys are now being processed to analyze changes in population density. These analyses are the subject of separate publications (*see* Lyons et al.[2]). The subject of this note is the use of traps for predicting subsequent larval population densities.

To achieve this, sampling of overwintering second instar (L_2) larvae was also carried out at a number of the trapping sites over a wide range of budworm densities in north central Ontario during the period 1989 through 1993. Each year the potency of the new batch of lures was calibrated against the previous batch and correction factors were applied where necessary.[3] The resulting regression for the combined data is shown in Figure 3. In Québec, the Ministère des Ressources

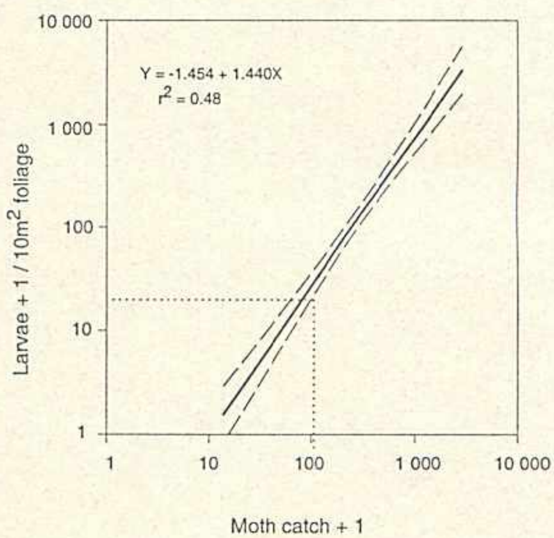

Figure 3. Relationship between moth catch and subsequent overwintering second instar larval populations (solid line). The dashed lines denotes the 95 percent confidence interval. The dotted line indicates that a catch of 100 moths corresponds to a larval density of 25/10 m² of branch surface area.

[2]Lyons, D.B.; Pierce, B.; Sanders, C. Data management system for the spruce budworm trapping network: User's guide. Nat. Resour. Can., Canadian Forest Service, Great Lakes Forestry Centre, Sault Ste. Marie, ON. (In press)

[3]Sanders, C.J. Pheromone traps for detecting incipient eastern spruce budworm outbreaks. Nat. Resour. Can., Canadian Forest Service, Great Lakes Forestry Centre, Sault Ste. Marie, ON. (In press)

naturelles uses a different approach. There, correlations between L_2 and trap catch are used for annual calibrations (Boulet 1992).

The regression in Figure 3 indicates that a catch of 100 moths corresponds to a density of 25 L_2/10 m^2 branch surface area, or about three larvae per branch, in the subsequent generation. This is approximately the threshold density at which L_2 sampling becomes practical. Therefore, a trap catch of 100 moths can be used as a trigger to initiate more intensive larval sampling.

Note that these data are for mature mixedwood stands in north central Ontario (the area between Lake Nipigon and the Québec border), and are representative of boreal mixedwood stands in Ontario and western Québec. Because trap catch is a reflection of the number of insects per unit area of forest, the relationship between L_2 densities and moth catch will change in different forest types. Given the same densities of larvae per branch, pure stands of mature white spruce in river bottoms in Alberta or balsam fir in the Maritimes will carry far higher populations of eastern spruce budworm per hectare than will a mixedwood stand with only 50 percent spruce and fir. Therefore, relationships between larval density and trap catch will have to be established in each region for the major stand types involved.

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The preparation of this note was funded under the Northern Ontario Development Agreement's Northern Forestry Program.

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Catalogue No. Fo 29-29/94E
ISBN 0-662-24907-0
ISSN 1183-2762

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