Effects of an aerial treatment of *Bacillus thuringiensis kurstaki* on non-target Lepidoptera caterpillars in Forest Park, Portland, Oregon

DN Kearns, TE Valente, CS Hedstrom, and JJ Vlach Oregon Department of Agriculture, Salem, OR

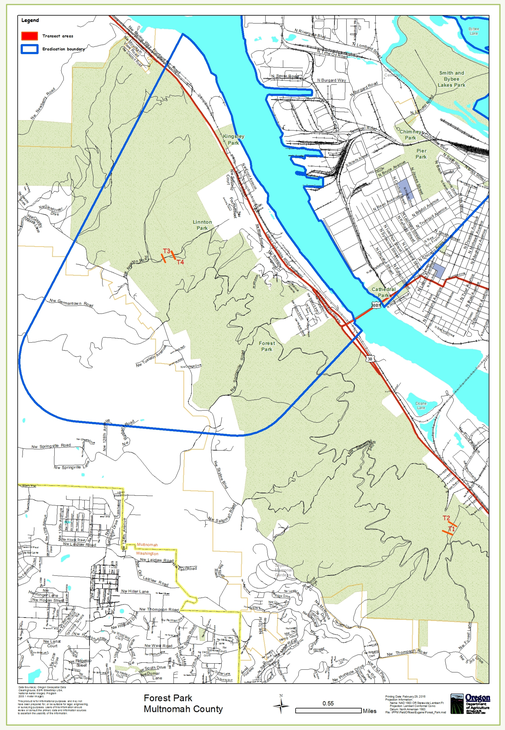
Introduction

Bacillus thuringiensis kurstaki (*Btk*), a naturally occurring soil bacterium, is widely used in aerial treatment programs for the European and Asian Gypsy Moth (*Lymantria dispar* L.). In Spring 2016, the Oregon Department of Agriculture Insect Pest Prevention and Management Program (ODA IPPM) treated approximately 8000 acres in northwest Portland to eradicate an incipient population of the Asian Gypsy moth. Included in the treatment area was Forest Park, a public municipal park that covers over 5100 acres of second-growth and old growth forest.

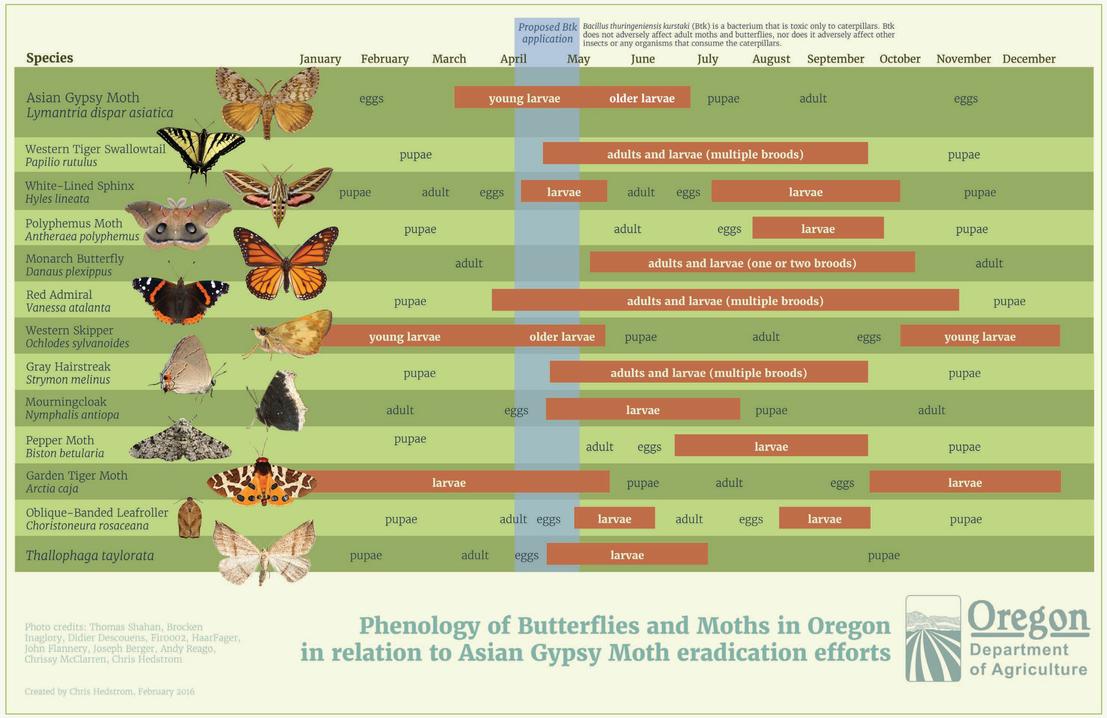
Public concerns about aerial spraying play a major role in planning an eradication program. One focus of concern is the potential for harming non-target species in an aerial application of *Btk*. The bacterium is most effective as a biological insecticide against leaf-feeding caterpillars in early instars, but it is not specific and may reduce populations of native Lepidoptera (Miller 1990).

Here, we examine the effects of three aerial applications of *Btk* on native caterpillars in Forest Park.

Dysstroma brunneata reared from flowering currant. The caterpillar was collected outside of the spray area and reared to the adult stage.



Transects within and outside of the spray block. The blue line indicates the spray boundary. Transects (in red) are labelled T1, T2, T3, and T4.



The general phenological development of some native Lepidoptera species that could be affected by an aerial application of *Btk* in April and May is illustrated. It was developed as an educational tool for public meetings prior to the aerial *Btk* treatment. Not all species shown occur within the Forest Park study transects.

Methods

Four 100-m transects for sampling immature Lepidoptera were set up in treated (aerially sprayed with *Btk*) and untreated sites in Forest Park in Spring 2016. Two untreated transects were at an elevation of 129 m, and two treated transects were at an elevation of 283 m. The distance between the transects within the spray block and outside the spray block was approximately 5.2 km.

We conducted the first sampling on April 13, 2016, two days before the first aerial spray with *Btk*. We conducted the second sampling on May 9, 2016, one week after the third (final) aerial treatment was completed.

All sampling was conducted using beating sheets. Two teams of two people sampled along the transects, each going in opposite directions from the midpoint on the transect. Sampling effort consisted of tapping foliage of a chosen plant 12 times (3 times per quadrant) and collecting caterpillars that landed on the beating sheet. The most common host plants were chosen for sampling, but some other plant species were included because overall numbers of caterpillars were low. Common plants included sword fern, Oregon grape, red huckleberry, salmonberry, big leaf maple, vine maple, and hazelnut.

Caterpillars were maintained on their host plant foliage in a sunroom in 16 ounce clear plastic cups. Fresh foliage was placed in a floral pick filled with water and replaced as needed. The intent was to continue rearing the caterpillars to later instars or adults so they could be identified.

Analysis

There was naturally occurring variability outside and inside the treatment block in caterpillar abundance and species diversity. Because sample sizes were relatively low, we used simple Goodness-of-fit tests to examine post-spray effects. Total numbers of caterpillars per transect were compared to the numbers expected based on per-transect proportions of pre-spray collections.

Results

No. caterpillars	Outside (T1 + T2)	Inside (T3 + T4)	Total
Pre-spray	23	17	40
Proportion	0.575	0.425	
Post-spray	46	14	60
Expected value	34.5	25.5	60
X^2	3.833	5.186	9.019

Table 1. Based on a comparison with pre-spray collections, the number of caterpillars within the spray block was significantly reduced after the spray ($X^2c = 6.63$, df = 2-1 = 1, $p < 0.01$).

Literature cited

Miller, J.C. 1990. Field assessment of the effects of a microbial pest control agent on nontarget Lepidoptera. American Entomologist 36:135-139.

No. species	Outside (T1 + T2)	Inside (T3 + T4)	Total
Pre-spray	13	9	22
Proportion	0.591	0.409	
Post-spray	25	11	36
Expected value	(36 * 0.591) = 21.3	(36 * 0.409) = 14.7	36
X^2	0.643	0.931	1.574

Table 2. The number of caterpillar species collected post-spray within the spray block is not significantly different from the number of species expected, based on the relative number collected pre-spray ($X^2c = 3.84$, df = 2-1 = 1, $p > 0.05$)

Discussion

Our analysis indicates that the aerial application of *Btk* was successful in reducing caterpillar abundance within the spray block (Table 1). The goal of the spray program was to eradicate any gypsy moth caterpillars in Forest Park.

Table 2 shows that there is no significant difference in the number of Lepidoptera species before and after the *Btk* application within the spray block. This result indicates that the treatment did not eradicate all native species and suggests that recovery within the spray block may be relatively rapid. For example, we collected a specialist on sword fern, *Thallophaga taylorata*, in the spray block after the spray. Previous studies have shown that native species recovery can occur two years after a *Btk* treatment (Miller 1990).

Post-spray collection: *Cyclophora sp.* (Geometridae) on vine maple inside the spray area.

Post-spray collection: Geometrid species on vine maple inside spray area.

Post-spray collection: Noctuidae on Oregon grape inside spray area (reared to adult *Diarsia rosaria*).

Thallophaga taylorata (Geometridae) collected on sword fern outside spray area.

Orthosia hibisci (Noctuidae) collected on big leaf maple outside spray area.

Acknowledgements

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