Effectiveness of Western Spruce Budworm Suppression Project at Bridger Bowl Ski Area, 2010

Nancy J. Sturdevant, Ph.D., Forest Entomologist

USDA Forest Service, Northern Region, Missoula MT

Joel Egan, Forest Entomologist

USDA Forest Service, Northern Region, Missoula MT

Chris Hayes, Biological Technician

USDA Forest Service, Northern Region, Missoula MT

Introduction

The Gallatin National Forest, in cooperation with Bridger Bowl ski permittee and Forest Health Protection, Region One, conducted a western spruce budworm, *Choristoneura occidentalis* Freeman, suppression project at Bridger Bowl ski area in 2010. A significant portion of Bridger Bowl ski area is located and operated on Forest Service land. In 2010, approximately 500 acres of forested lands were sprayed with an aerial application of the biological insecticide, *Bacillus thuringiensis* (*B.t.*). *B.t*. is a safe alternative to traditional pesticides and provides between 85-88% foliage protection (Reardon 1984). It is often the treatment of choice in many settings including sensitive areas where other pesticides are restricted. *B.t*. is non-toxic to mammals, birds, fish and humans.

The forests at Bridger Bowl are comprised mainly of pure, mature Douglas-fir stands. Some areas contain mixed and pure lodgepole pine stands. Budworm has been impacting all size and age classes of Douglas-fir and subalpine fir at Bridger Bowl for many years. The impacts from western spruce budworm were especially noticeable prior to treatment following a long-term drought in Montana. Many large trees were almost completely stripped of foliage and in some cases subsequently attacked by Douglas-fir beetle, *Dendroctonus pseudotsugae* Hopkins. Douglas-fir beetle responds to trees that are weakened; or to events such as fire and blow-down where large amounts of weakened host trees become available for beetle colonization.

Figure 1. Defoliation by Budworm at Bridger Bowl, 2010, Pre-spray.

Following a FHP service visit in 2010 (MFO-TR-10-16), the decision was made to spray *B.t.* in areas most affected by budworm. Without treatment, there was a high probability that many trees at Bridger Bowl would be severely impacted by budworm and Douglas-fir beetles. Reducing damage from budworm in 2010 also provided the Forest with the additional time needed to develop a vegetation management plan for Bridger Bowl.

Figure 2. Sampling Larvae to Predict Defoliation Levels

<u>Sampling to Determine the Need to Spray</u>

In early July 2010, FHP and John VanHouten, Bridger Bowl Forest Manager, conducted larval surveys to predict the level of defoliation expected in 2010. Locations for sampling were selected that had significant defoliation and were in two different elevation zones (greater than 6,700 feet; less than 6700 feet).

On July 9, 2 branches were sampled from each of two trees at 4 locations. Most larvae were in the 2nd and 3rd instars and the tree buds were mostly closed. The population threshold for spraying was more than 4 larvae found per branch. This threshold predicts moderate or high levels of defoliation from larval feeding the year of sampling (Twardus 1985; Srivastava & Campbell 1983). We found more than 4 (5-32) larvae per branch in 5 of 6 potential spray areas.   Two spray blocks were assigned to areas that had the most significant damage.

Sampling to Determine Timing of Spraying

Timing of spraying is critical to the success of a budworm spray project especially when using *B.t.* which has a short residual window of effectiveness. Larvae need to have emerged from their overwintering shelters-mostly closed buds, and be actively feeding to maximize the likelihood of ingesting an adequate amount of material. Also, the application of the spray needs to be soon enough to prevent undesirable defoliation (larger larvae also consume more foliage) and before larvae pupate, become adults and lay eggs.

Spray blocks were released for spraying when greater than 50% of larvae were found in the 4th, 5th and 6th larval instars and the majority of buds were expanded at least 1 inch in both the upper and lower spray blocks. Our methods were based on projects conducted by Ripley (2000) and Reardon (1984). The percentage of larvae found in each instar was lowered from 85% to 50% to accommodate the differences in larval development between the upper and lower elevation spray blocks. Both blocks were slated for treatment on the same day.

On July 14, larval development and bud elongation were evaluated at three locations in each of the lower and upper spray blocks to determine timing of spraying. Two branches from each of 12 trees were examined and the instar for each larva found was recorded (figure 3).

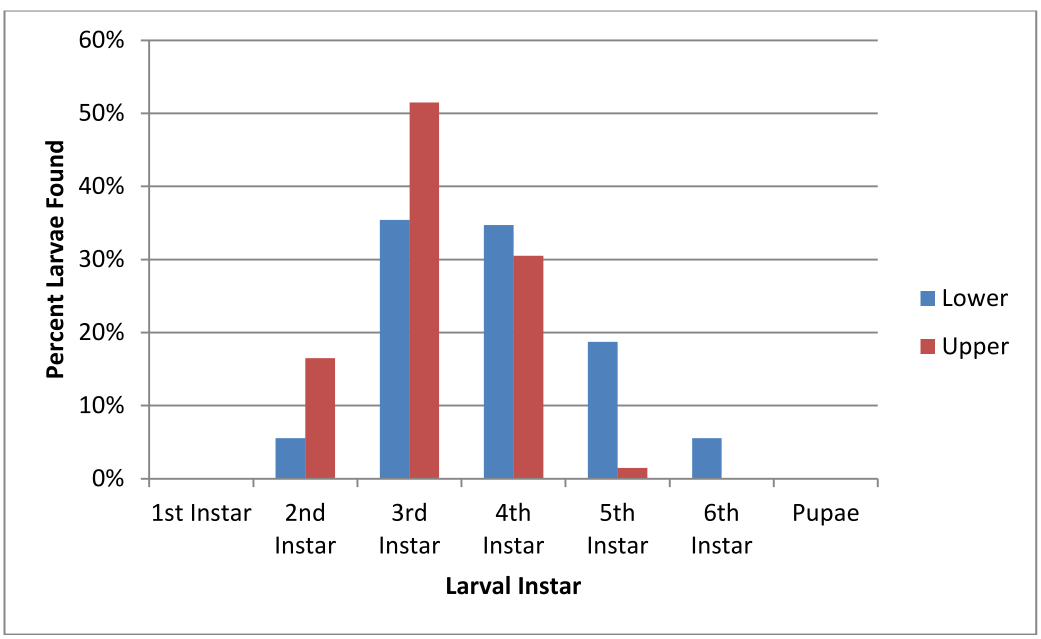

Figure 3. Relative distribution of larval life stage found on July 14, pre-spray

On July 14, an average of 56% of larvae found in the lower spray block were in the 4th or larger larval instar. Only an average of 29% of larvae found in the upper spray block were in the 4th or greater instar of larval development. Based on these results we decided to sample again on July 16. On July 16, 2 branches on each of six trees were sampled to evaluate the progression of larval development. Sixty-seven percent of larvae found in the lower spray block and 26% of larvae found in the upper spray block were in the 4th larval instar or greater. The decision was made to contact the applicator and spray within the next 4 days if possible.

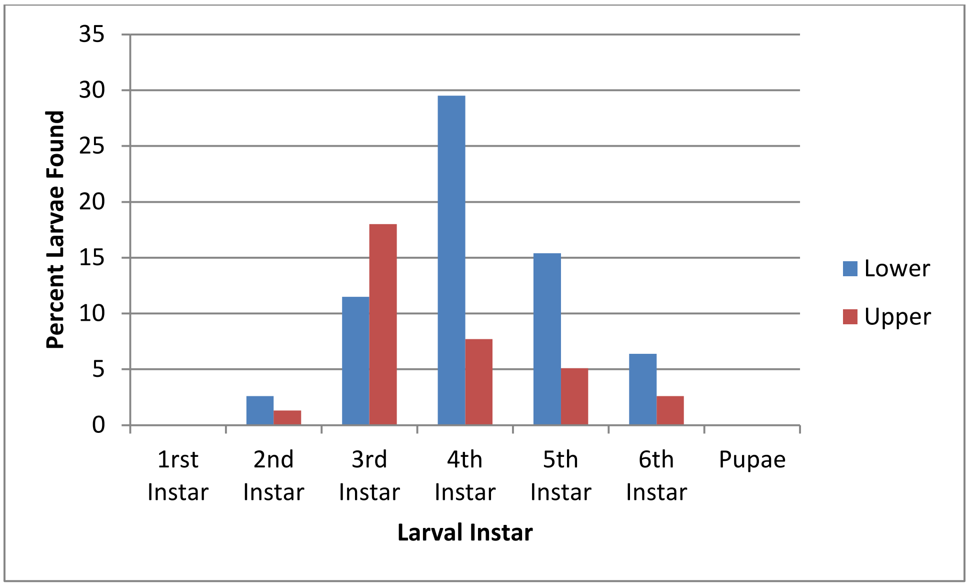

Figure 4. Relative distribution of larval life stage found on July 16, pre-spray

Approximately 500 acres of both Forest Service and private lands were sprayed on July 19, 2010 to reduce damage and tree mortality caused by western spruce budworm. Forty-eight BIU of *B.t.* was sprayed on foliage using a fixed-winged aircraft. Spraying for budworm is often conducted earlier in the year; however, it was delayed due to a wet, cool spring in 2010.

In September 2011, we collected defoliation data at Bridger Bowl, both inside and adjacent to areas sprayed with *B.t.* in 2010. Foliage sampling was very labor intensive and was limited to the lower mid-crown. Therefore, we also included ocular estimates for each tree sampled. Whole tree ocular estimates of defoliation were recorded on 46 trees in each of the sprayed and nearby unsprayed areas (N = 92). From 32 of these trees (16 in each the sprayed and unsprayed areas) two, 18 in long branches were cut from different sides of the lower mid-crown and buds were examined. For each branch sample, budworm presence (defoliation and webbing) or absence was recorded.

CONCLUSIONS
Several hours following the spraying, John observed that many larvae on sprayed foliage appeared to be dead and dying. On July 26, we returned to Bridger Bowl to conduct primarily a visual inspection and found that most of the larvae were dead and very few pupae were found. We sampled a few branches in the treated areas and found that the number of larvae found was reduced from an average of 16.7 to 1.7 following spraying. Many live larvae and pupae were found in untreated areas just outside of treatment blocks. During this time we also observed that defoliation appeared to be less in spayed blocks versus unsprayed blocks.

On September 12-13, 2011 we returned to Bridger Bowl to evaluate the effectiveness of the *B.t.* treatment. Ocular defoliation estimates showed that trees that had been sprayed had significantly lower percentage of their foliage consumed by budworm. There was approximately a 1/3 reduction in defoliation for the treated trees when compared to trees in the nearby untreated area. Percentage of buds with evidence and damage from budworm was also significantly lower in the treated trees compared to nearby untreated trees.

Table 1. 2011 Defoliation in areas sprayed and not sprayed in 2010 at Bridger Bowl ski area.

Defoliation Estimation Technique	Sprayed	Unsprayed	p-value
Whole-tree Ocular	13.4 ± 0.9	21.5 ± 1.3	<0.001
% Buds Defoliated	27.8 ± 3.4	36.1 ± 4.6	0.04

There was significantly less budworm-caused damage found the year following the spray project. A *B.t.* suppression project is considered a success if budworm returns to endemic levels for two years following treatment (Ragenovich 1983). This allows time for trees to recover from the impacts of consecutive years of heavy defoliation. The reduction in defoliation met the objectives established by the Forest and ski area.

The Forest in conjunction with ski area has completed a vegetation management plan for Bridger Bowl. The Forest and ski area owners have moved towards implementing the plan by salvaging dead and dying trees and planting young trees in areas that are suitable to establish a younger size class. In addition, they are thinning in both Douglas-fir and lodgepole pine stands to reduce stand susceptibility to bark beetles and western spruce budworm.

The establishment of a younger size class in both pine and fir-dominated stands is critical to the success of forest resiliency over time. Currently, most of the forests at Bridger Bowl are mature and over-mature stands of pine and fir that are not sustainable over the long-term.

Although western spruce budworm is a native insect that has co-evolved with western spruce-fir forests, extensive damage and mortality from budworm can occur especially during drought periods and in areas where fire has been suppressed. Suppression actions such as spraying *B.t.* at Bridger Bowl may become necessary again if defoliation from budworm is severe and occurs over multiple years. Protecting foliage with *B.t.* is a temporary solution to reducing defoliation, growth loss, deformation, and tree mortality. Silvicultural treatments that reduce stocking density, number of canopy layers, and increase individual tree vigor and species composition are the only long-term solution to budworm management. The need for spraying in the future should be greatly reduced if silvicultural treatments continue to be implemented at Bridger Bowl.

LITERATURE CITED

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