Summary of Brown Spruce Longhorn Beetle Research Projects

Natural Resources Canada - Canadian Forest Service

November 2009 - May 2006 - 2003/2004

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Assessing Risk Mitigation Techniques

NRCan-CFS studies have determined that the risk of the BSLB surviving and being moved is extremely low in bark stripped from infested trees, and that a secondary treatment of chipping bark in "hog" machines reduces this risk even further. These results supported the CFIA's decision to ease previously imposed restrictions on movement of bark and hog fuel in areas where the BSLB has been found.

Analysing Risk

Researchers have developed a risk analysis framework, and are using it to assess the risks associated with the BSLB infestation in Nova Scotia. This tool has greatly improved the deployment of a pheromone trapping system in Nova Scotia, by identifying areas where the risk of presence for BSLB is highest. At the same time, it makes for a more efficient use of resources. As part of this area of research, NRCan-CFS researchers have investigated the impact of BSLB on the red spruce resource with the establishment of long-term plots to monitor change in mortality over time in areas outside the current containment zone (where BSLB populations are of low density) and within the containment zone (where BSLB populations are of higher density). A snapshot in time for BSLB impact on spruce trees within the containment zone shows that while recent mortality is very patchy, it ranges from zero percent to as high as 78%. The plots will continue to be monitored and assessed for the risks associated with this alien species.

Determining Natural Dispersal

In laboratory tests, the BSLB has shown to be capable of flying more than 10 km in 24 hrs, however the average life-time distance flown is about 2 km. Movement in the field is likely much shorter due to response to nearby host odours and pheromones, time spent mating and laying eggs, etc. Mark-release-capture studies conducted in 2009 and planned for 2010 may shed more light on the insect's natural dispersal in the forest.

Examining Natural Controls

Two native species of wasps attack an average of 10-20% of the BSLB population. Woodpeckers and native checkered beetles have also been found to prey on the BSLB. Field studies begun in 2008 will determine the impact of natural enemies on BSLB survival on healthy and stressed trees; results should be known in the spring of 2010.

Examining Pheromone Mediated Controls

In 2006, NRCan scientists discovered and synthesized a BSLB pheromone (chemical substance released by the insect that influences the behavior of other members of the same species) called "fuscumol". A mixture of fuscumol and spruce odour has been used in trapping surveys by the Canadian Food Inspection Agency (CFIA) and Nova Scotia Department of Natural Resources since 2007, and has greatly increased the ability to detect the presence of the BSLB.

NRCan-CFS and its partners are taking the use of the pheromone fuscomol one step further by experimentally testing and evaluating its efficacy in mass trapping and mating disruption.

Initial results from a mass trapping experiment have demonstrated that by placing a high density of traps baited with fuscumol and spruce odours (100 traps per hectare), BSLB populations can be significantly reduced in plots in forested stands with relatively low numbers of the beetle, but the method has no effect in plots in forested stands with relatively higher population numbers. Trials were repeated in 2009 to further examine this suppression technique and results will be available in early 2010.

In 2008 NRCan-CFS and its partners tested the ground application of fuscomol (employing Hercon® Disrupt Micro-flake® technology) to disrupt mating and suppress local BSLB populations. Results from 2008 were inconclusive, due in part to technical and logistical challenges. Trials were repeated in 2009 using aerial applications of Hercon® Bioflakes (a biodegradable formulation) and results are anticipated in early 2010.

Understanding the Behaviour of BSLB in Canadian Forests

NRCan-CFS researchers have discovered that the BSLB does not behave in Canada like it does in its native Europe. In Europe, the BSLB infests Norway spruce trees that appear unhealthy with thinned, sparse crowns that have been previously weakened by root rots or other agents. In Nova Scotia, the BSLB infests native spruce trees that appear healthy with full green crowns, but that are growing at a slower rate than their non-infested counterparts. Once colonized by the BSLB, a tree is re-infested until it dies, usually in 1 to 5 years.

In both Europe and Canada, BSLB infestation is most common in older, large diameter spruce and has not been found in trees less than 9 cm in diameter. The BSLB also appears to behave more aggressively in Canada than the North American longhorn beetle, *Tetropium cinnamopterum,* which infests weakened or dying spruce trees with sparse crowns.

From NRCan-CFS' experiments, we have learned that the BSLB can successfully colonize healthy red spruce trees, and that when exposed to natural enemies, its survival in healthy trees is greater than in stressed or felled trees.

For more information about the BSLB please visit:

- Exotic Pest Advisory - Brown Spruce Longhorn Beetle
- Top 10 Science Facts on the BSLB
- Brown Spruce Longhorn Beetle (Chronology)
- Battling the Brown Spruce Longhorn Beetle
- Early Detection of Invasive Alien Species
- Using Lures and Traps to Detect the Brown Spruce Longhorn Beetle
- Using scents to trap forest insect pests

May 2006

Detection of the BSLB with host volatile-baited traps

The objective of this study is to develop an attractant lure and determine the most effective trap design for detection of the brown spruce longhorn beetle (BSLB). In collaboration with CFS colleagues at the Great Lakes Forest Centre in Sault Ste. Marie, ON, we collected host volatiles from

BSLB-attacked red spruce trees in Point Pleasant Park in May 2001 and analyzed them in the lab to determine the chemical composition. We then synthesized an attractant lure composed of the most common and abundant monoterpenes found in the red spruce volatiles (which we termed “spruce blend”) tested it in different trap designs in 2001 and 2002, in both Halifax and Europe. The spruce blend was significantly attractive to the BSLB by itself, but the addition of an ethanol lure boosted attraction significantly.

In 2003, we found the average trap catch of BSLB in Halifax and Poland was increased 2-7 times by baiting traps with high release rate lures of spruce blend and ethanol. In Poland, the BSLB lures also attract Tetropium castaneum (L.) and Spondylus buprestoides (L.) neither of which is present in North America to our knowledge, so the BSLB lure could be used for detection of these species as well as the BSLB in areas of North America at risk of accidental introduction. A large, cross-vane “Colossus” trap developed by Simon Fraser University and PheroTech Inc., baited with high release rate lures of spruce blend and ethanol had the highest average catch of BSLB and has been used operationally in trapping surveys for the BSLB in Halifax since 2004. Details of this research can be found in the following publications:

Sweeney, J., J. Gutowski, J. Price and P. de Groot. 2006. Effect of semiochemical release rate, killing agent, and trap design on capture of *Tetropium fuscum* (F.), and other longhorn beetles (Coleoptera: Cerambycidae). Environmental Entomology. 35: 645-654.

Sweeney, J., de Groot, P., MacDonald, L., Smith, S., Cocquempot, C., Kenis, M., and Gutowski, J. 2004. Host volatile attractants and traps for detection of *Tetropium fuscum* (F.), *Tetropium castaneum* (L.), and other longhorned beetles (Coleoptera: Cerambycidae). Environmental Entomology 33: 844-854.

Research is now underway to determine whether the BSLB uses sex- or aggregation pheromones for long-distance attraction, and cuticular hydrocarbons as contact pheromones. Identification and synthesis of the former compounds may lead to a more sensitive detection tool than host-volatile attractants; identification and synthesis of the latter might lead to mating disruption applications.

Assessing control of *Tetropium fuscum* using entomopathogenic fungi

In 2003, in collaboration with colleagues at CFS-LFC and CFS-PFC and Maritime Microbiologicals, we began laboratory studies to test the susceptibility of the BSLB to the entomopathogenic fungus, Beauveria bassiana. Adult beetles were susceptible to infection by B. bassiana isolates from both Halifax and Quebec. Field trials were conducted in 2004 and 2005 to test the efficacy of B. bassiana for suppression of BSLB in the field using two different strategies: 1) direct application of fungal spores to spruce bait log decks, and 2) *B. bassiana*-impregnated polyester quilt bands wrapped around live spruce trees. The fungal application did not suppress BSLB infestation of the bait logs. However, an average of 66% of BSLB adults were infected on fungal-treated tree bands compared to 14% on untreated control bands. Laboratory screening of additional isolates is planned in an effort to find a more infective fungal isolate.

Evaluation of Tree Injections with Systemic Insecticides Using Systemic Tree Injection Tube for BSLB

The potential of injecting trees with systemic chemicals such as neem seed extracts (containing azadirachtin), imidacloprid, and emamectin benzoate for prophylactic control of the BSLB was tested in field experiments in 2001 and 2002. Of the three chemicals, imidacloprid was most promising, but the rate of uptake of insecticides in the phloem (the target tissue in which BSLB larvae feed) of injected trees was very slow and variable, and there was little or difference in BSLB survival between bait logs cut from treated and untreated trees. In 2006, field trials were initiated in Halifax to test new formulations of imidacloprid for protection of live spruce trees from BSLB infestation. Results will be known in the winter of 2006/2007.

2003/2004

Heat as a phytosanitary treatment for wood infested with BSLB (Collaborative project with CFS, led by the University of New Brunswick, Wood Science & Technology Centre (WSTC))

A heat treatment formula that assures that wood products are free of living BSLB is of vital interest to Canada and our trading partners. In the short term, it would directly benefit individuals who wish to move wood or wood products out of the Ministerial Order zone surrounding HRM. UNB-WSTC carried out studies to determine the lethal temperatures for different BSLB life-stages in spruce. The beetles were exposed to different temperatures for various time periods in lumber of low and high moisture content. Larvae were harder to kill using heat treatment than pupae or adults of BSLB but died at lower temperature/time durations than those required to kill pinewood nematode. Results demonstrate that heat treatment is an efficient phytosanitary method to insure that wood does not contain any live *Tetropium*. Results have been published:

Mushrow et al. 2004. Heat as a phytosanitary treatment for the brown spruce longhorn beetle. The Forestry Chronicle 80: 224-228 .

Parasitoids of *Tetropium fuscum*: Feasibility of a classical biological control strategy

If eradication of the BSLB is unsuccessful, long term management methods may be needed. The BSLB is exploited by many parasitoids and predators in its native habitat. Our goal is to determine the incidence, species, and origin (exotic vs. native) of parasitoids affecting the BSLB population in Halifax, Nova Scotia. To date, we have found only two species of wasps parasitizing larvae of the BSLB. Both are native species and both also parasitize the native longhorn species, *Tetropium cinnamopterum*, that also infests spruce trees). Further work will attempt to quantify the impact of parasitoids on survival of BSLB in the Halifax area, and compare results with those observed in Europe.

Susceptibility of Native Conifers to Attack by the BSLB

Our goals are to determine the susceptibility of selected North American conifer species to oviposition and successful infestation by *Tetropium fuscum*. Results to date indicate that all conifer species are susceptible to egg lay by the BSLB. However, given a choice, female BSLB clearly prefer to lay eggs on red spruce than on balsam fir, red pine, white pine, larch, or white or black spruce. In no-choice lab bioassays, BSLB successfully developed from egg to adult in balsam fir, white pine and red pine in addition to spruce. In field experiments and surveys, however, BSLB has not been recorded in non-spruce species in the Halifax area.

Identity of *Ophiostoma* associated with BSLB in Halifax.

A European species of *Ophiostoma, O. tetropii* has been found to be consistently associated with the brown spruce longhorn beetle (*Tetropium fuscum* or BSLB) in the Halifax area of Nova Scotia. The fungus is known to be associated with species of *Tetropium* in Europe. The fungus has been isolated from BSLB-infested trees and from dead trees previously infested with BSLB in and around the Halifax area. The presence of *O. tetropii* indicates if BSLB is likely to be present in outlying areas.

The results have been published in the following peer reviewed journal article:
Jacobs, Karin, Seifert, Keith A., Harrison, Ken J. and Kirisits, Thomas. 2003. Identity and phylogenetic relationships of *ophiostomatoid* fungi associated with invasive and native *Tetropium* species (*Coleoptera:Cerambycidae*) in Atlantic Canada. Can. J. Bot. 81(4): 316-329. April 2003.

The use of the presence of *Ophiostoma tetropii* as a detection tool for BSLB is discussed in the following recently published article: Harrison, K.J., Smith, G.A., Hurley, J.E. and MacKay, A.W. 2004.Ophiostoma tetropii as a detection tool for the brown spruce longhorn beetle, *Tetropium fuscum* (Fabr.), in Halifax, Nova Scotia. Canadian Plant Disease Survey, Volume 84:125-126. Recent volumes of the Canadian Plant Disease Survey are available online from the Canadian Phytopathological Society website at: http://www.cps-scp.ca/cpds.htm

Pathogenicity of Ophiostoma tetropii associated with *Tetropium fuscum* from Halifax to some coniferous species.

The fungus *Ophiostoma tetropii* was introduced into spruce trees in Point Pleasant Park, Halifax, NS along with an invasion of the brown spruce longhorn beetle, *T. fuscum*. Since species in this genus are known to be pathogenic to trees and virulence can range from severe to non-pathogenic, it is essential to assess the pathogenicity of isolates in order to assess the risk of tree mortality from this fungus. Four sets of lab bioassays with 7 isolates of *Ophiostoma tetropii* made from T. fuscum infested trees in the Halifax Regional Municipality have been completed with one year-old seedlings of 5 conifer species: white, red, black, Norway spruces and white pine. A small scale field trial with 18 spruce trees and 3 isolates of *O. tetropii* was also done in Apr. 2002. The results obtained suggest that this fungus acts like a typical wound pathogen with low virulence to living trees. Our results show that pathogenicity of this imported fungus is comparable to the indigenous wound pathogen, *O. piceae,* which is of little significance to tree health.

Trap logs for Containment of the BSLB

Field trials in 2000, 2001, and 2002 demonstrated that a six-log deck of freshly cut red spruce logs (either 1.2 or 2.4 m long) was attractive to egg-laying BSLB females. In combination with the removal of BSLB-infested trees, deployment of trap log decks reduces the total number of eggs laid on living trees. Trap logs were are also being tested used as a means of detecting the presence of BSLBwithin the Halifax area in 2002 and 2003. With recent improvements in the host volatile-baited traps, the operational use of trap logs to detect the BSLB has been reduced, and replaced with traps.

Molecular Marker for Detection and Monitoring of BSLB

The objective of this study is to develop specific DNA markers for rapid diagnosis of life stages other than adults of BSLB suspects. This technology has the potential to improve our ability to detect and monitor BSLB year round at all its life stages. To date, tentative (not yet validated) molecular markers utilizing three genes have been developed for 10 of the 20+ *Tetropium* species known worldwide.

Slab Chipping as a Phytosanitary Treatment for Woodboring Beetles

Results suggest that chipping BSLB-infested logs with specific chipper types during the dormant period (mid-October to the end of March) is an effective method of killing BSLB.

Light traps were not effective for detecting BSLB

Traps fitted with an ultraviolet (UV) light source were tested as a means of detecting BSLB in 2001 and 2002. Although adult BSLB responded positively to light in laboratory trials, field trials suggested that UV light traps were not attractive and not unsuitable for BSLB detection. This study has been discontinued.

Tree Health and Susceptibility to *Tetropium fuscum* infestion

Tree ring analysis was conducted to compare the radial growth rate of 18 pairs of red spruce trees that were diagnosed as either infested with the BSLB (in 2000) or not. We found that average radial growth rates peaked in 1956 and declined steadily for the last four decades in both infested and uninfested spruce. However, trees that were infested with BSLB grew significantly more slowly than uninfested trees for seven of nine five-year periods from 1956 to 2000, i.e., long before attack by the beetle. Our data indicate that red spruce with reduced growth rates and low vigor were more susceptible to infestation by *T. fuscum* than faster growing, more vigorous trees.

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