INVESTIGATION INTO THE SPRUCE BUDWORM

IN THE DISTRICT OF LAKELAND

PREPARED BY THE DISTRICT OF LAKELAND

ENVIRONMENTAL ADVISORY COMMITTEE

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SPRUCE BUD WORM IN THE DISTRICT OF LAKELAND

1. INTRODUCTION

The Spruce Budworm is considered the most serious pest of the fir and spruce forests in North America. A substantial outbreak of the Spruce Budworm occurred in Saskatchewan between 1996 and 2005. In 2011 damage was noted to white spruce near Emma Lake and the highest amount of defoliation was sustained in the Murray Point area.

The District of Lakeland Environmental Advisory Committee has prepared this report to assist the District Council as it considers the question of whether or not to implement a spraying program for the Spruce Budworm within the District of Lakeland.

Background

- BioForest Technologies Inc. provided a proposal to the District of Lakeland Council on March 29, 2012 to conduct a 2012 Spruce Budworm Defoliation Monitoring Survey and a 2013 Population Forecast Survey.
- The District of Lakeland Council passed this proposal on to the Environmental Advisory Committee in May of 2012 asking that the committee look into the matter on their behalf and report back to the Council.
- In mid-summer the District of Lakeland Council contracted BioForest Technologies Inc. to conduct a 2012 Spruce Budworm Defoliation Monitoring Survey and a 2013 Population Forecast Survey within the District .(see *Monitoring Spruce Bud Worm in Lakeland)* for more details of the surveys).

2. SASKATCHEWAN'S FORESTS

Forests are an important part of Saskatchewan's economy and environment. Over half of the province is forested, providing many benefits. Saskatchewan forests are also home to many thousands of species of plants and animals within a variety of ecosystems – this biological diversity or 'biodiversity' is often used as an indicator of ecosystem health. Wildfire and insects are the dominant natural agents of change in the boreal forest. They play a significant role in forest composition and structure and shaping the northern landscape. (Saskatchewan Ministry of Environment, 2009)

Current state of the forest within the District of Lakeland

The forest area within the District, like one third of the commercial forest in Saskatchewan, is classified as old or very old. Many of the mature spruce trees within the subdivisions are near or are approaching the end of their natural lives. The older trees are being or have been affected by human activities and by natural processes within nature. As more development has taken place, trees and their roots have been damaged or uncovered making them susceptible to future damage by natural forces or construction activity. New construction has also seen the removal of a good number of trees within the District as land owners have been clear cutting lots to allow for easier construction.

Mature trees within the District also have heart rot or are infested with insects which make them more susceptible to being blown down by strong winds particularly in wet years.

As the forest continues to age and its health deteriorates from natural processes such a weather events and disease such as the Spruce Bud Worm, the District and ratepayers may need to consider costs for the removal of dead or dying trees from lots, buildings, roads, etc. A large defoliation and tree health loss from the Spruce Budworm may potentially increase these costs.

There currently are no commercial logging operations of economic significance within the District subdivisions or the adjacent areas.

The forest canopy will reduce and as the openings increase, new tree and underbrush species will emerge, in effect changing the make-up or composition of the forest landscape. A reduction in the forest canopy and ground cover, particularly from human actions, has the potential to increase and provide for quicker runoff into the lakes and with it more sedimentation which will affect the water quality of our lakes. This we have experienced first-hand on Emma Lake with the reconstruction of the Murray Point road.

Students from the University of Saskatchewan's School of Environment and Sustainability who have been involved a resilience assessment in the Lakeland region, have indicated to us that as the spruce and pine die off, the initial dominant species we will see in the area is the trembling aspen.

Threats to the forest within the District of Lakeland

Wind and weather events: Wind and weather events topple trees and dislodge branches, particularly trees that are aged, infected by insects, have had their roots disturbed by standing water or the loss of trees close to them.
Human activity: Forestry operations and the process of clearing land and leaving a few standing trees also puts these trees at risk. Compacting of the forest floor, root and stem disturbance by any means such as ATV's, can affect drainage and cause permanent damage that will affect the life of a forest.
Insect infestations: Many insects and bark beetles invade trees in the forest and in our communities. Infestations of insects are usually cyclical. In the past we have seen insect eruptions such as tent caterpillars and currently there is the potential for a significant Spruce Budworm outbreak.

3. THE SPRUCE BUDWORM – WHAT IS IT?

Spruce budworms are a group of closely related insects in the genus Choristoneura. A native species, the spruce budworm is considered the most serious pest of fir and spruce forests in North America. Its range coincides with that of fir, white spruce, and more and more with the range of the black spruce. Caterpillars feed primarily on current year growth but will also feed on old needles and buds until new growth emerges.

Subsequent years of heavy defoliation can cause reduced growth, branch dieback, top kill, and mortality. Infested areas can be identified by silken masses of chewed needles; needle loss; branch and crown dieback. Western spruce budworm populations may occur cyclically with long periods between outbreaks, or populations may be chronically present with only short durations between outbreaks.
(http://dnrc.mt.gov/forestry/Assistance/Pests/WesternSpruceBudworm.asp)

Spruce budworm is a recurring disturbance; outbreaks typically occur on 30 to 35 year cycles. A substantial outbreak of spruce budworm occurred in Saskatchewan between 1996 and 2005. The Ministry of Environment began spraying affected areas with Btk as early as 1992 in hopes of minimizing the area affected. However, area sprayed is relatively small in comparison to the total area under attack. The infestation reached its peak in 2002 and returned to pre-outbreak levels in 2008. (Saskatchewan 2011 State of the Environment Report http://www.environment.gov.sk.ca/soereport2011)

The budworm has messy eating habits. They use their silk webbing to tie two or three shoots together to form a feeding tube. Then they bite the needles off at the base. The needles dry out, leaving masses of silk and dried red-brown needles hanging from the trees.

A single year of defoliation generally has little impact on the tree. However, it does cause weakening of the tree, making it more susceptible to attacks by other insects. Defoliation over a few consecutive years causes tree growth loss. However, if defoliation of current and previous-year shoots continues uninterrupted over several years, some trees will die, while others will continue to gradually decline for several years, even after the end of the infestation. This is the case with fir, the species most vulnerable to Spruce Budworm attacks, which dies after four years of consecutive years of sever defoliation. (Natural Resources Canada)

The budworm also seriously affects regeneration-host trees usually less than 5 feet (1.5 m) tall and 1 to 2 inches (2.5 to 5.0 cm) in diameter. These young trees are especially vulnerable when growing beneath mature trees, since larvae disperse from the overstory and feed on the small trees below. Coniferous seedlings have relatively few needles and shoots and can be seriously deformed or killed by only a few larvae.
(U.S. Department of Agriculture Forest Service, Forest Insect & Disease Leaflet 53)

Spruce budworm induced mortality is slow to occur, and it is usually light even after several years of defoliation. Mortality tends to be concentrated in smaller trees, especially suppressed trees. Overall, average stand mortality seldom exceeds 5 percent, but losses can be much higher in patches following several years of severe defoliation.
http://www.dnr.wa.gov/Publications/rp_fh_wadnrdefoliators.pdf

Growth loss is a function of diminished height and diameter growth, or volume of wood produced. Volume loss can be quite variable.

After 5 years of budworm infestation, stand volume growth reduction can range from 1 percent to 20 percent. Repeated infestations may cause much greater cumulative losses. http://www.dnr.wa.gov/Publications/rp_fh_wadnrdefoliators.pdf

Dead trees, along with the masses of dry needles and silk will provide fuel in the event of a forest fire.

4. SPRUCE BUDWORM CONTROLS

a. Natural Controls

At normal ("endemic") population levels, defoliators are held in check by a combination of predators, parasites, and adverse weather. However, natural population controls can't prevent defoliator outbreaks in extensive out-of-balance forests especially during periods of drought.

Natural controls help dampen increasing defoliator populations. For example:

- Birds may consume over 80 percent of budworm larvae at normal population levels. Birds eat defoliator eggs and destroy pupae, too. Birds known to feed on the budworm include grosbeaks, warblers, thrushes, sparrows, fly-catchers, tanagers, siskins, and wax-wings. Protecting and maintaining bird habitat helps support bird populations. An abundance of soft snags is especially beneficial. Without the birds, outbreaks would be much more frequent and more severe (Parks Canada, Spruce Budworm Fact sheet, Update August 3, 2002)

- Ants, spiders, and other insects are efficient predators on larvae infesting smaller understory trees. Certain small wasps and flies parasitize eggs. There are more than 40 species of insect parasites (small wasps and flies) of the western spruce budworm of which four or five species are most common. Western spruce budworm larvae, pupae, and adults are parasitized and preyed upon by several groups of insects and other arthropods, small mammals, and birds. Spiders, ants, snakeflies, true bugs, and larvae of certain beetles feed on the budworm, as do chipmunks and squirrels. Disrupting ant colonies and down-log ant habitat during logging and thinning should be avoided.

- Late spring frosts may kill large numbers of larvae. Cool, wet weather slows larvae development making them vulnerable to predators for a longer period. Climatic conditions may adversely affect the budworm in several ways. Small larvae may be blown from the host tree to the ground when windy conditions exist at the time larvae are hatching or dispersing from their overwintering sites. Cool summer weather retards feeding and development, increasing the time larvae are vulnerable to parasites and predators. Occasionally, larvae have not emerged from eggs before the first freezing temperatures in the fall.

Western spruce budworm larvae established in hibernacula are not affected by extremely low temperatures. A 7-day cold wave, -43° F to -53° F (-42° C to -47° C) in Montana between November 11 and 17, 1959, had little to no effect on overwintering larvae. However, unseasonably low temperatures in the late spring or early summer can kill larvae directly by freezing or indirectly by starvation when their food supply - buds and foliage - is destroyed. (U.S Department of Agriculture Forest Service, Forest Insect & Disease Leaflet http://www.na.fs.fed.us/spfo/pubs/fidls/westbw/fidl-wbw.htm

- Defoliator outbreaks naturally subside for several reasons including:
  - Lack of food. Larvae starve once all available foliage is consumed.
  - Lethal viruses and diseases may infect larvae. http://www.dnr.wa.gov/Publications/rp_fh_wadnrdefoliators.pdf

b. Forest Management

These practices are directed at maintaining appropriate diversity within stands and across forest landscapes. Preventing outbreaks by treating forest condition is the best way to manage defoliators. Forest composition, structure, and stocking are the basic factors that influence susceptibility and vulnerability to all forest pests. These basic factors must be considered when planning silvicultural activities to maintain and improve long-term stand and forest resistance to insect outbreaks.

Composition: Limit the fir component to less than 50 percent.

Structure: Shift stand structure toward evenness especially in host species dominated stands**.** Evenly structured stands (a single crown layer) of host species tend to be less vulnerable to defoliator damage than are unevenly structured stands (multiple canopy layers). When properly spaced, evenly structured stands are less vulnerable to wildfire, too. Perfect structural evenness is not necessary, nor is it desirable.

Stocking: Maintain proper stocking for site conditions with carefully applied thinning. Healthy trees with large food reserves are better able to recover from partial defoliation compared to stressed trees in unthinned stands. Thinning reduces competition for soil moisture and nutrients. Tree stress can be further reduced by minimizing soil damage during thinning and harvesting.

c. Pest Control Programs

Btk (Bacillus thuringiensis var. kustaki) is a naturally occurring bacterium that can kill larvae (caterpillars) of some lepidopteran insects (butterflies and moths), including the gypsy moth, spruce budworm, and hemlock looper. Btk is commercially available as a biological insecticide and it is used in pest control programs in forestry, agricultural, and urban settings around the world. (Department of Natural Resources, Government of Newfoundland and Labrador)

All caterpillars, at the immature stage of butterflies and moths, are potentially susceptible to Btk. For example Tiger Swallowtails, Mourning Cloaks, Hoary Comas, Fritillaries and other moths and butterflies that live in our area, may be collateral damage of Btk. The effects of Btk have not been tested on every species of butterfly. Btk does not harm the adult butterflies, their eggs or the chrysalis stage (an immobile stage, when the caterpillar turns into a butterfly within a silken case).

5. CONTROL OF SPRUCE BUDWORM WITH Btk

Why is Btk (Foray) used?
It is the industry standard pesticide used to control Spruce Budworm, it is approved by Health Canada for use in forestry, crop and residential situations, and it is a naturally occurring element found in the soil, water and on plants around the world. There are other pesticides that would control Spruce Budworm but they are not as selective and would therefore kill other species, and they created from naturally occurring bacterium the way that Btk is. (Parks Canada)

Very little of this product is required to be effective. Only two to three litres is required to treat a hectare of forest. However, two applications may be necessary to give the best control because the caterpillars may hatch at different times.
(Department of Natural Resources, Government of Newfoundland and Labrador)

How does Btk work?
Btk is most commonly used to control defoliating caterpillar pests. After being sprayed Btk has to be eaten by the insect to be effective, and therefore must be sprayed when the insects are feeding most actively and when they are most susceptible to the insecticide.

Why are aircraft used to spray?
Aircraft are used to spray as they are a very efficient, fast and safe method to apply spray to a forest. They can cover areas that may be remote or have difficult access due to varied terrain. As this application method is fast, favorable weather conditions can be taken advantage of to complete an operation.

How effective is Btk?
Btk is less likely to be as effective as chemicals when pest populations are extremely high unless multiple applications are conducted. Because it can take several days for Btk to kill larvae, there is not an immediate reduction in the pest population as is the case when some chemical insecticides are used. This has created the erroneous perception that Btk does not work. Btk does work, but it takes a little longer to see the results. Depending on the life cycle of the pest and climatic conditions, more than one application of Foray may be necessary to achieve the desired level of control.
(Valent BioSciences Corporation)

As Btk is sensitive to sunlight, it breaks down quickly in the environment. Several days of sunlight or heavy rain cause Btk spray to become non-effective. (Department of Natural Resources, Government of Newfoundland and Labrador)

6. AREA SPRUCE BUDWORM MANAGEMENT PROGRAMS

Provincial Spruce Budworm Management Program has been operating since 1992. Defoliation in areas treated with Btk has been reduced by as much as 60 per cent when compared to areas that have not been sprayed.
http://www.environment.gov.sk.ca/Default.aspx?DN=d5101919-4f16-449c-b076-9f116df1136e

Emma and Anglin Lake Recreation |Areas:
The Ministry of Parks, Culture and Sport carried out an aerial spraying program for the Spruce Budworm using Btk on June 6 and during the week of June 11, 2012, over the Emma and Anglin Lake recreation sites. A survey of the area will be carried out by BioForest Technologies between the spraying program and the spring of 2013. A further spraying application is scheduled for 2013. The Ministry did not spray any District of Lakeland land during this program. Information pamphlets on this program were posted within the Murray Lake campground and in the Christopher Lake SERM office. An email with this information was sent to the Environmental Advisory Committee Chair.

Resort Village of Candle Lake:
A BioForest website posting on June 16, 2011 indicates that a spraying program was carried out over 20,000 ha near Hudson Bay and a 700 ha were treated at the Resort Village of Candle Lake and Candle Lake Provincial Park. The Resort Village of Candle Lake website indicates that the Council approved the 2011 spraying program based upon a BioForest Technologies study. The program was carried out at a quoted cost of $85,507 and the cost was shared by the Resort Village of Candle Lake and the Ministry of Tourism, Parks, Culture and Sports. The Resort Village followed the BioForest Technologies report that no spraying program be carried out in 2012 and they contracted them to carry out a 2012 population survey.

Waskesiu Townsite:
A Spruce Budworm aerial spraying program has been carried out within the Waskesiu town site. After much study, presentations, heated debate and negotiation, the Waskesiu Community Council and Parks Canada agreed on a spraying program over 310 ha of the town site for Spruce Budworm.

Aerial spraying using Btk was carried out twice each spring in 2003, 2004 and 2005 over 310 ha of the town. Parks Canada on their website indicates that this spraying reduced the Spruce Budworm numbers but did not eliminate them. Spruce trees are monitored within the town site on an annual basis and reviewed each autumn by Parks Canada and the Council. Due to defoliation concerns within the town site, the Waskesiu Seasonal Residents Association commissioned BioForest Technologies in the fall of 2010 to conduct an overwintering budworm larval survey. This survey forecasted a severe 2011 defoliation and the Association requested a spring 2011 spraying program be carried out. Parks Canada and the Waskesiu Community Council agreed to carry out an aerial spraying program over 310 ha of the core town site twice in the spring of 2012 and 2013 using Btk.

7. MONITORING SPRUCE BUDWORM IN LAKELAND

In July 2012, the District of Lakeland Council contracted BioForest Technologies Inc. to conduct a 2012 Spruce Budworm Defoliation Monitoring Survey and a 2013 Population Forecast Survey within the District.

BioForest Technologies Inc. is a forestry consulting company specializing in forest health surveys and the coordination of forest insect control programs. They have offices in Prince Albert, SK and Sault Ste. Marie, ON and have been in operation since 1996. They have completed more than 300 projects for a full range of clients across Canada and the United States.

BioForest Technologies Inc. completed a ground defoliation survey of the Lakeland area during the summer and on August 3, 2012 they presented a map of these survey results to the District Administrator Dave Dmytruk and Environmental Advisory Committee member Wayne Hyde.

The second half of the spruce budworm survey contract awarded to BioForest Technologies, an overwintering survey, was scheduled to occur in the first week of December 2012. Senior Forest Health Technician with BioForest Technologies Inc. will present an analysis of the results of the initial survey to the District Council. Brian Poniatowski noted in an email that: "*Using the results of the survey combined with our knowledge of 2012 damage we will still be able to determine the areas with and without high budworm numbers and have a really good idea about the distribution of defoliation likely to occur next summer."*

During the summer of 2012, a number of Emma Lake residents expressed concern over the potential loss of and damage to the spruce trees on their lots and in the District due to the spruce budworm.

8. IMPORTANT ISSUES FOR CONSIDERATION

As the District of Lakeland considers the question of whether or not to implement a spraying program for the Spruce Budworm, the following points should be considered.

1. What is the ultimate purpose of a Spruce Bud Worm Control Program?
    - Forest management: *to prolong the life of a renewing forest at the end of its life cycle*
    - Aesthetics
    - Fire Fuel Prevention: *fire fuel is more common from naturally dying old trees and wind damage*
    - Other

2. What are the alternatives to Btk spraying?
    - let the infestation run its natural course
    - investigate forest management alternatives such as removal of damaged and dead trees and encouraging planting of species less prone to disease and insect infestations
    - a combination of programs

3. Cost vs. Benefit Analysis:
    - What will be the short term and long term costs of an infestation? As the area under consideration for spraying is relatively small, will the budworm move back in from areas outside a targeted spray zone?
    - A spraying program will be a potentially long one with considerable costs associated with it that must be justified to the ratepayers.
    - Final outcome of spraying vs. not spraying.
    - Ministry of Parks, Culture and Sports staff indicated there may be a possible partnering arrangement with the District for a 2013 spraying program.

4. Is there enough survey information available or should another year be devoted to gathering additional field data and effectiveness of other local programs?

5. What liability does the District assume if there is health issues believed to be related to the spraying?

6. Public consultation/notification
    - Will there be public input prior to any spraying decision?
    - What is the strategy if there is opposition to the spray as the PANP incurred?
    - If a spraying program is planned how will it be communicated to the District residents?

7. What permits are required to carry out a spraying program?

8. What are the Occupational Health & Safety issues of a spraying program and how are they managed?

    “The spruce budworm is a natural part of our forest, but we need to take steps to keep its numbers under control," says Ministry of Environment entomologist Dr. Rory McIntosh. "A large spruce budworm population can pose a threat to valuable timber resources. Managing heavy infestations in selected areas while allowing the insect to play its natural role in the ecosystem is part of the way we keep our forest healthy. Fire is nature's way of renewing forest," says McIntosh. "However, the build-up of fuel caused by the budworm and the greater chance of wildfire means that we have to use other tools to reduce this hazard. For example, carefully planned logging allows us to harvest trees before they are killed by spruce budworm."
    http://www.environment.gov.sk.ca/Default.aspx?DN=d5101919-4f16-449c-b076-9f116df1136e

9. SUMMARY

The District of Lakeland can decide on one of the following or a combination of the following strategies to manage the Spruce Budworm infestation: do nothing, remove damaged and dead trees and encourage the planting of species less prone to disease and insect infestations or implement a spraying program.

The 'let nature take its course' approach during a serious Spruce Budworm outbreak will have little effect on the area from an economic or aesthetic perspective. When not in a serious infestation, it is hard to imagine the worst effects. Additional deadfall, added to what already exists within the District from natural causes and a series of recent windstorms, could potentially increase the hazard for anyone working or living in the area. This type of hazard is also a high concern should a fire or other emergency arise in the area. However, these conditions are inherent to living in an old growth forest and may need to be addressed regardless.

The District of Lakeland may consider formulating a Vegetation Management Plan similar to what has been implemented in Waskesiu town site. This plan outlines a transition from a mature spruce dominated forest to a mixed species forest that is less prone to disease and insects. It encourages a community co-operative approach in planting trees and removing hazardous ones and managing spruce budworm defoliation.

The choice to spray is one that will not completely eliminate the Spruce Budworm but reduce the defoliation rates in the areas that are sprayed. In 1998, the Province of Saskatchewan adopted the objective of foliage protection, a shift from an earlier objective of Spruce Budworm suppression. The province has reported that they have achieved reduced defoliation rates in sprayed areas, especially in areas that were sprayed for two consecutive years.

Chemical insecticides such as Malathion, carbaryl, and acephate can substantially reduce budworm. Microbial insecticides such as the bacterium *Bacillus thuringiensis*, a naturally occurring, host-specific pathogen that affects only the larvae of lepidopterous insects is environmentally safe to use in sensitive areas such as campgrounds or along rivers or streams where it may not be desirable to use chemical insecticides. (http://en.wikipedia.org/wiki/Spruce_Budworm)

Budworm populations are usually regulated by combinations of several natural factors such as insect parasites, vertebrate and invertebrate predators, and adverse weather conditions. However, the combined effect of natural agents does not prevent or reduce population resurgences when climatic and forest stand conditions are favorable for an increase in budworm populations. During prolonged outbreaks when stands become heavily defoliated, budworm starvation can be an important mortality factor in regulating populations.

A Spruce Budworm Spray Program is an expensive undertaking with many advantages and disadvantages and diverse opinions on its effectiveness and ecological integrity. This will potentially be a very big undertaking in cost and duration and thus the goal and the benefits of such a program must be carefully considered and communicated to all stakeholders in the District of Lakeland

10. Q&A's ABOUT SPRUCE BUDWORM CONTROL PROGRAMS

Q: Has Btk been approved by Health Canada for use near and over residential areas?
A: Health Canada's Pest Management Regulatory Agency (PMRA) is responsible for ensuring the human health and environmental safety of all pest control products prior to their approval for use in Canada. Only products that are scientifically reviewed and found to be effective and safe for use with minimal risk to human health and the environment are registered by the PMRA.

In Canada, the PMRA has classified all Btk products registered for use in forests, woodlands and residential areas as "restricted." Restricted class products require special permits or licensing from the regulatory authority in the province/territory for purchase. In the case of Btk, provincial/territorial regulatory authorities are consulted before any application takes place, and they must issue permits for the product's use. In addition, only applicators that have passed a provincial certification exam may use Btk products. (Health Canada http://www.hc-sc.gc.ca/cps-spc/pubs/pest/_fact-fiche/btk/index-eng.php)

Q: Is Btk harmful to humans, especially seniors and children?
A: Btk is a common bacterium found in soils throughout the world. People are exposed to Btk and many other microbes every day. Btk and other common microbes are frequently found in blood, urine and other samples from healthy people. It has been shown that the presence of Btk in patient specimen samples is not indicative of pathological or toxic effects.

Individuals with an immunodeficient condition are somewhat more likely to be affected by microbes that are normally controlled by a healthy immune system. Such microbes are referred to as opportunistic pathogens. Btk is not considered an opportunistic pathogen.

Individuals with pre-existing allergies, asthma or hypersensitive individuals, especially those sensitive to normal exposure to soil or smoke and pollutants, could feel some temporary effect. (Valent BioSciences Corporation)

Btk poses little threat to human health either through handling products directly or through indirect exposure such as during a spray program. For Btk toxins to be activated, alkaline conditions that exist only in certain insects' digestive systems must be present. The acidic stomachs of humans and animals do not activate Btk toxins. There have been no documented cases involving toxicity or endocrine disruption potential to humans or other mammals over the many years of use in Canada and around the world.

Studies have shown that even if Btk spores are ingested or inhaled, they are eliminated without any adverse health effects.

Prior to being permitted for sale, use or import into Canada, all formulations are evaluated according to internationally-accepted scientific protocols for their potential to cause skin or eye irritation/sensitization, and acute toxic effects. These tests are designed to show if the product has the ability to produce health effects or trigger allergic-type reactions.
(Health Canada http://www.hc-sc.gc.ca/cps-spc/pubs/pest/_fact-fiche/btk/index-eng.php)

Q: How long will Btk stay in the environment?
A: Btk is naturally occurring and can be found in the soil, water and on plants around the world. Btk has been extensively studied; in over 25 years of safe use, no significant environmental problems have been observed. The insecticidal toxin biodegrades quickly in the environment through exposure to sunlight and microorganisms. This takes between 1 - 4 days on foliage. There are no groundwater contamination concerns as Btk does not percolate through the soil beyond 25 cm.
(Health Canada http://www.hc-sc.gc.ca/cps-spc/pubs/pest/_fact-fiche/btk/index-eng.php)

Q: Will Btk harm birds, insects, fish, and amphibians?
A: Btk has no impact when eaten by fish, earthworms, amphibians, birds, mammals or humans; none of these organisms have the alkaline gut necessary to activate Btk.

Several bird species specialize on Spruce Budworm. These include: cape-may warblers, bay-breasted warblers, Tennessee warblers and evening grosbeaks. Many other bird species will also feed on budworm when they are available. The numbers of bird species targeting budworm have risen in response to the rise in the budworm population. Birds can't eliminate budworm populations but they can keep numbers in check. At a point, budworm populations may saturate even the bird population. Without the birds, outbreaks would be much more frequent and more severe. (Parks Canada, Spruce Budworm Fact sheet, Update August 3, 2002)

Generally, only the younger caterpillars of susceptible species are killed by the product and even they must eat a sufficient dose of BT to be affected. To be effective on pest caterpillars, sprays must be timed to coincide with the most susceptible age of insect because Btk only lasts for a short time in the environment. Unless butterfly caterpillars are in the same place at the same time as the target caterpillars, they would not be at risk of being infected. (British Columbia Ministry of Environment)
http://www.env.gov.bc.ca/epd/ipmp/publications/fact_sheets/bt.htm

Q: Will Btk affect soils?
A: Repeated applications of insecticides containing Btk do not appear to increase levels of Btk activity in the soil. Btk applied to leaves for control of foliage feeding pests will become diluted well below insecticidal levels when it reaches the soil.

The degradation rate in the soil would probably exceed the rate of acquisition from repeated foliar sprays, so populations of applied Btk reaching the soil should decline over time to a fluctuating natural level. Researchers have found that Btk does not move much in soil. This was determined by spraying two types of Btk in close vicinity. No cross-contamination of types was observed (BC MOH 1992).

Changes in soil productivity and fertility due to Btk are not likely because of the natural occurrence of Btk in soil, lack of accumulation, and relatively short persistence of activity in soil (USDA 1995).

Q: How does Btk affect water?
A: Btk may enter water through direct application to surface water, runoff, or through the faeces of animals who have ingested Btk. Following aerial application of Btk (Thuricide 16B) for control of a tortricid pest in eastern Canadian forests, Btk was recovered from rivers up to 13 days after spraying (Menon and de Mestral 1985), presumably as a result of continual leaching into the water.

Field studies indicate that Btk may persist for several months in water. A Nova Scotia study found that 50% of Btk endospores remained viable in fresh lake water for 70 days at 20^{o}C before being inactivated by other micro-organisms in the water (Menon and De Mestral 1985).

It is unlikely that Btk could enter groundwater, as studies have shown that it does not leach out of soil. (BC MOH 1992) (New Zealand Government Environmental Impact Assessment of Aerial Spraying Btk in NZ for painted apple moth - February 2003)

Q: How effective is Btk
A: Btk is less likely to be as effective as chemicals when pest populations are extremely high unless multiple applications are conducted. Because it can take several days for Btk to kill larvae, there is not an immediate reduction in the pest population as is the case when some chemical insecticides are used. This has created the erroneous perception that Btk does not work. Btk does work, but it takes a little longer to see the results. Depending on the life cycle of the pest and climatic conditions, more than one application of Foray may be necessary to achieve the desired level of control. (Valent BioSciences Corporation)