

# FREQUENTLY ASKED QUESTIONS

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section 5

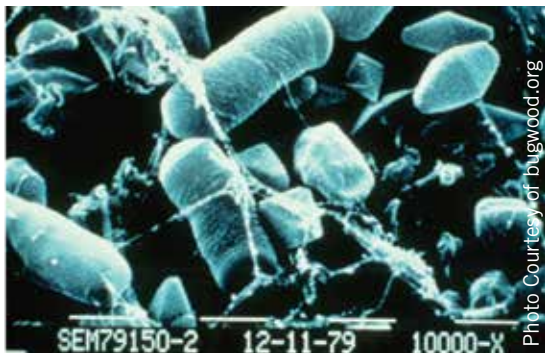






### 5.1 WHAT IS FORAY?

Foray is the brand name of a microbial biorational insecticide produced by Valent BioSciences. It contains the spores and unique crystalline proteins produced by a naturally occurring bacterium, *Bacillus thuringiensis* spp. *kurstaki* (Btk). These biological components are combined with approved ingredients and water to make the final product. Foray is commonly used to protect many forests, woodlots, and forested residential areas from defoliating caterpillar pests.



### 5.2 WHAT IS BACILLUS THURINGIENSIS OR Bt?

*Bacillus thuringiensis* or Bt is a naturally occurring spore forming bacterium that is found throughout most areas of the world. It can be found in soils and on leaves/needles and in other common environmental situations. When growing and reproducing spores, the bacteria also produces unique crystalline proteins. When eaten, these natural proteins are toxic to certain insects, but not to human beings, birds, or other animals.

*Bacillus thuringiensis* was first isolated in silkworm colonies in Japan the early 1900s, but it is named after the town of Thuringia in Germany where it was discovered killing flour moths a few years later. In 1938, the first commercial product was released in France, but commercial interest did not really develop until the late 1950s and early 1960s.

Today, various strains of Bt are produced commercially in several countries and are used to control pests in forestry, agriculture, and public health.

### 5.3 HOW MANY VARIETIES OF Bt ARE THERE?

There are several dozen varieties or subspecies of Bt, and they do not all share the same properties. *Bacillus thuringiensis* spp. *kurstaki* (Btk) is the most widely used, protecting agricultural crops, fruit trees, and rural and urban forests from defoliating lepidopteran larvae.

Other subspecies of Bt developed commercially by Valent BioSciences are subspecies *aizawai*, active against lepidopteran pests, *israelensis*, active against mosquito, gnat and blackfly larvae, *sphaericus*, active against mosquito larvae, and *tenebrionis*, which is active against some leaf eating beetle larvae.

### 5.4 HOW DOES Btk WORK?

Btk must be ingested by the target larvae in order to cause mortality. The ingested bacterium does not kill the larvae immediately, but instead sets a chain of events in motion that causes death of the larvae by multiple modes of action (sepsis and starvation).

Upon ingestion, the protein crystal metabolites (protoxins) produced by the Btk bacterium immediately begin interacting with the highly specific alkaline environment found in the gut of lepidopteran larvae. The gut of the insect is paralyzed and the larva ceases feeding within minutes. Soon after, the midgut wall of its gut becomes compromised: holes are formed in the midgut lining and the Btk spores contained in Foray begin germinating. The ongoing destruction of the midgut wall allows the bacteria to enter the circulatory system of the target insect, causing full-scale infection and death.

This process usually happens within a single day, but may take as long as 3-5 days. It is important to note, however, that the insect stops feeding within minutes of consuming Foray.

### 5.5 DOES Btk OCCUR NATURALLY?

Yes. Soil is the natural environment for Btk. Its ecological niche is infection of lepidopteran larvae, where it completes its life cycle. Various species and strains of Bt were isolated from urban, forest, and agricultural soils long before the material was used in insect control programs. Bt has been detected in soils and other substrates around the world including Canada, the United States, Japan, Germany, France, and Israel. Bt can also be found on the leaves of deciduous and coniferous trees and some varieties of Bt have also been found in grain elevators and grain dust.

### 5.6 HOW IS FORAY MADE?

Foray is produced from Btk using a proprietary, industrial-scale fermentation process developed by Valent BioSciences and conducted at its state-of-the-art manufacturing facility in Osage, IA. This process is similar to the technology used for the production of antibiotics.

The process begins with a small flask of pure Btk inoculum that is introduced into enclosed, sterilized fermentation tanks along with an optimized combination of growth media, water, heat, and aeration (among others). As the bacteria reproduce, all aspects of the fermentation broth are monitored and precisely controlled. Foray is unique in that its best-in-class manufacture includes a step-wise bioassay process to validate its efficacy on live insects all the way through production and final formulation. The fermentation broth containing spores and crystalline proteins is formulated with approved ingredients and water to make the final formulation of Foray.

### 5.7 HOW IS FORAY DIFFERENT FROM CHEMICAL INSECTICIDES?

**Btk is not a chemical insecticide, rather it is a naturally occurring organism.** Chemical pesticides have a single mode of action (making them susceptible to insecticide resistance) and typically kill a wider range of insects, including many beneficial ones. The active ingredient of Foray is a natural bacterium, *Bacillus thuringiensis*, spp. *kurstaki* Strain ABTS-351. This strain of Btk produces a finely balanced profile of four different protoxins specific to the larvae of certain caterpillars.

This means that non-targets (birds, bees, fish, people) are unaffected by Foray. Foray is quickly biodegraded in nature, unlike a number of chemical pesticides that form by-products and residues of environmental concern. Most formulations of Foray are approved in Certified Organic programs.

### 5.8 WHY IS FORAY THE Btk YOU SHOULD USE?

Foray was developed in response to growing concern among the scientific community, policy makers, and the public in the 1960s and 70s over the use of chemical pesticides. At that time, forest managers realized that an alternative to broad spectrum chemical insecticides would be needed if protection against defoliators was to remain a component of future forest management efforts. In order to be successful, the new insecticide would have to be:

- Highly effective when applied in small amounts
- More target-specific than synthetic chemicals
- Formulated such that it can penetrate dense foliage to hit target leaves
- More quickly broken down in the environment than synthetic chemical compounds
- Harmless to non-target organism populations such as bees, birds, fish and mammals
- Comparable to the cost of chemical insecticides



## The Caterpillar Bioassay Laboratory

Expert entomologists in Osage diligently maintain insect colonies to provide a continuous supply of insects for bioassay testing. Insects are maintained at various stages of their life cycles in order to ensure healthy and consistent populations.



## Sustaining the Insect Colony

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## Fermenter

Large-scale fermentation is used to grow microorganisms using a proprietary process that includes sophisticated controls and monitoring. The fermentation process takes multiple days, with production time varying by the product. A proprietary media mix is inoculated with VBC's proprietary organism strains, continually tested for purity. Valves and piping allow for multiple inputs including air and nutrients.



## Fermenter Motor and Drive

Fermentation requires a significant amount of agitation powered by a motor and drive system mounted on top of the tank. The large hatch on the right is called the manway, which gives technicians access to the tank between production runs.

## COMMONLY ASKED QUESTIONS

Btk was not an immediate success in terms of effectiveness and cost, but intensive research and development has resulted in a product that now meets all of these criteria. Foray (first registered in 1986) is now the product of choice in the majority of forest protection programs in North America and western Europe due to its formulation science, unique strain, and superior quality.

This product has gained an unprecedented level of public acceptance and as a result, Foray is the most widely used biological larvicide in the world to protect trees from insect infestations in both rural and urban settings. The foundation of Foray's success is simple and two-fold: it is both highly effective and ecologically friendly. In fact, some formulations of Foray are approved for use in the production of certified organic products, such as maple syrup.

### 5.9 HOW EFFECTIVE IS FORAY?

Foray efficacy has been proved to be comparable to chemical applications in controlling many lepidopteran pests when pest population densities are low to moderate. As it is not systemic and requires ingestion, Btk is less likely to be as effective as chemicals when pest populations are extremely high unless multiple applications are conducted.

However, a forest pest control strategy does not have to kill all the target insects in order to be successful. In fact, studies indicate that there are

benefits to maintaining some pest insects in an area to support the population of natural enemies.

Because it can take up to a few days for larvae to die after a Foray application, there is not an immediate reduction in the pest population.

When using Foray, it is important that forest health managers understand that

Lepidoptera feeding cessation occurs within minutes of ingesting Foray, and that death to affected larvae is imminent.

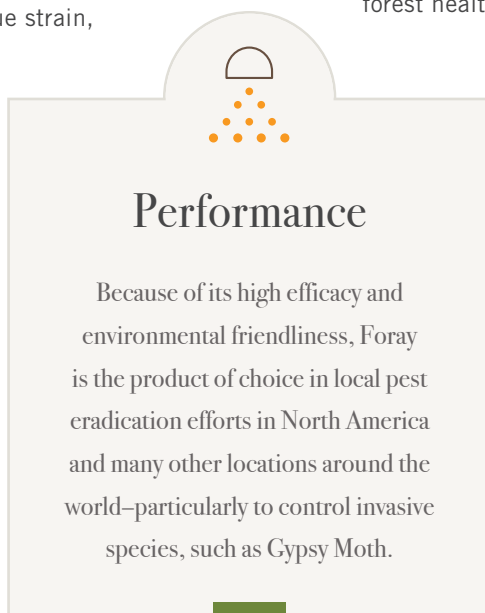
Depending on the life cycle of the pest and climatic conditions, more than one application of Btk may be necessary to achieve the desired level of control.

When eradication is the goal of a control program, a single application of Btk may be somewhat

less effective than some chemical insecticides in reducing the population to zero. However, because of its low impact on non-target organisms, Btk is the product of choice for most forest pest control programs (including eradications) conducted in North America and around the world.

### 5.10 IS FORAY HARMFUL TO HUMANS AND ANIMALS?

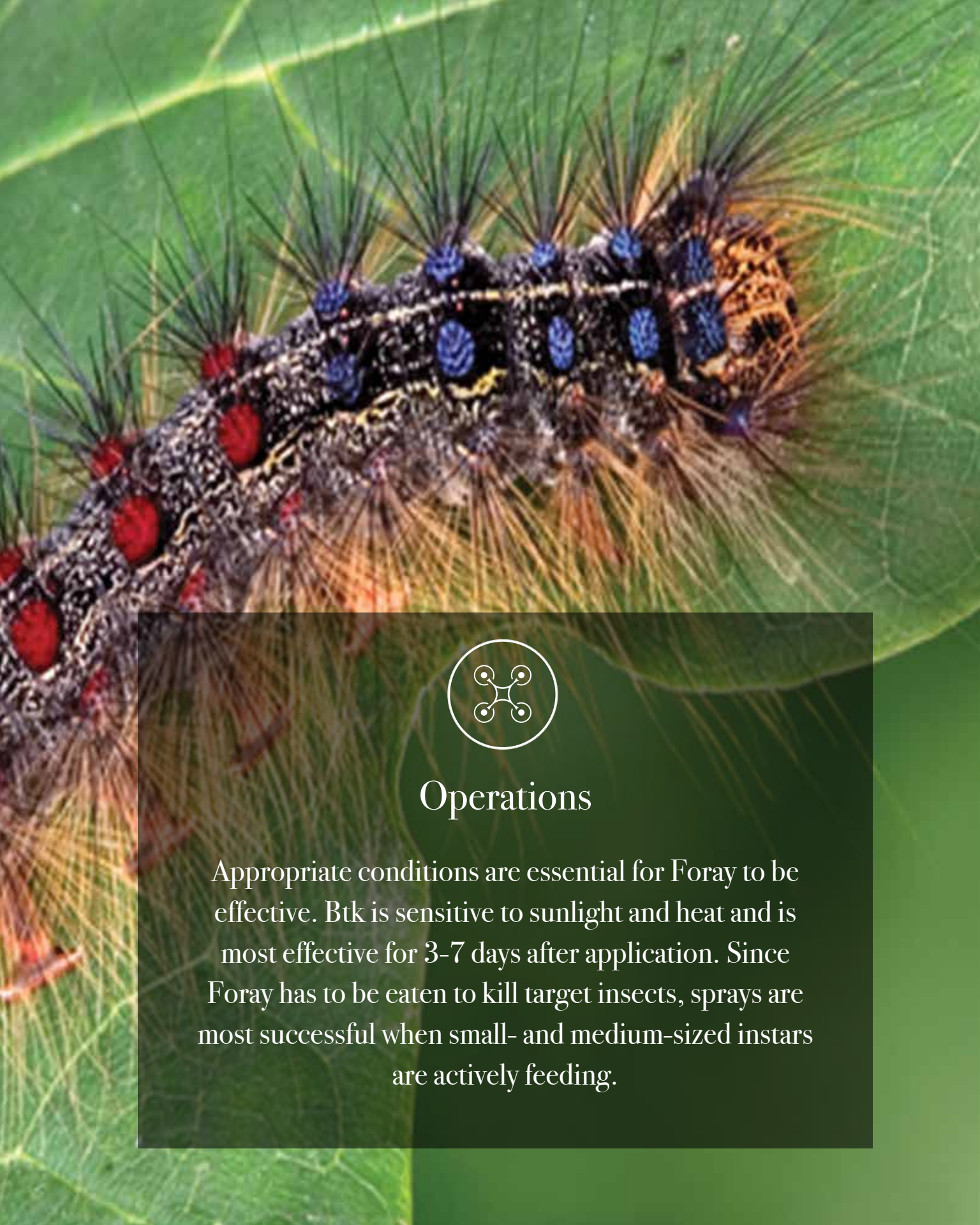
As required by the United States Environmental Protection Agency (EPA) and the Pest Management Regulatory Agency (PMRA) of Health Canada, extensive oral and intravenous animal studies have been conducted with



## Performance

Because of its high efficacy and environmental friendliness, Foray is the product of choice in local pest eradication efforts in North America and many other locations around the world—particularly to control invasive species, such as Gypsy Moth.





## Operations

Appropriate conditions are essential for Foray to be effective. Btk is sensitive to sunlight and heat and is most effective for 3-7 days after application. Since Foray has to be eaten to kill target insects, sprays are most successful when small- and medium-sized instars are actively feeding.

## COMMONLY ASKED QUESTIONS

Foray. No evidence of any poisonous, infectious or disease-causing effects were found. In inhalation tests with Btk, there were no mortalities and Btk was shown to have a low pathogenic potential.

Feeding, skin, breathing, and eye irritation animal studies were also carried out with Foray. No toxic effects were seen when significant quantities of Foray were fed or inhaled. Very mild, temporary skin irritation and moderate, temporary eye irritation was observed in the tests when Foray were applied directly to the skin and into the eyes. These effects were totally reversible.

In addition, EPA and PMRA have determined that Foray is exempt from residue tolerance. Due to this exemption, there is no required interval before re-entering a sprayed area during government-sponsored pest control programs.

Finally, Btk has been used extensively in commercial urban and rural forest pest management for over 40 years. A solid record of safety and health has been amassed over this time.

### **5.11 WHAT EFFECT WILL Btk HAVE ON PEOPLE, ESPECIALLY THOSE WITH IMMUNODEFICIENCY, ASTHMA OR ALLERGIES?**

Bt is a common bacterium found in soils throughout the world. People are exposed to Bt and many other microbes every day. Many of the microbes we

encounter, including Btk, do not produce any toxins which affect humans. 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. As with many other microbes naturally present in the environment, it can be detected as an insignificant contaminating organism among infection-causing organisms isolated from patient samples.

Individuals with an immuno-deficient 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, and Bt is not considered an opportunistic pathogen.

Exposure to a Btk spray program is not likely to result in the development of new allergies, asthma or other hypersensitive reactions. 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 effects. Note that in studies conducted by public health agencies in Canada and in New Zealand, there was no increased incidence of asthma in children living within a treatment area compared to children living outside of the treatment area.



### **Sustainability**

Foray is based on the ubiquitous, naturally-occurring soil dwelling bacterium, *Bacillus thuringiensis* spp. *kurstaki* (Btk). While highly effective against various species of Lepidoptera, Btk has little to no impact on non-target species and the surrounding environment. In fact, Btk and other common microbes are frequently found in blood, urine, and other samples from healthy people.



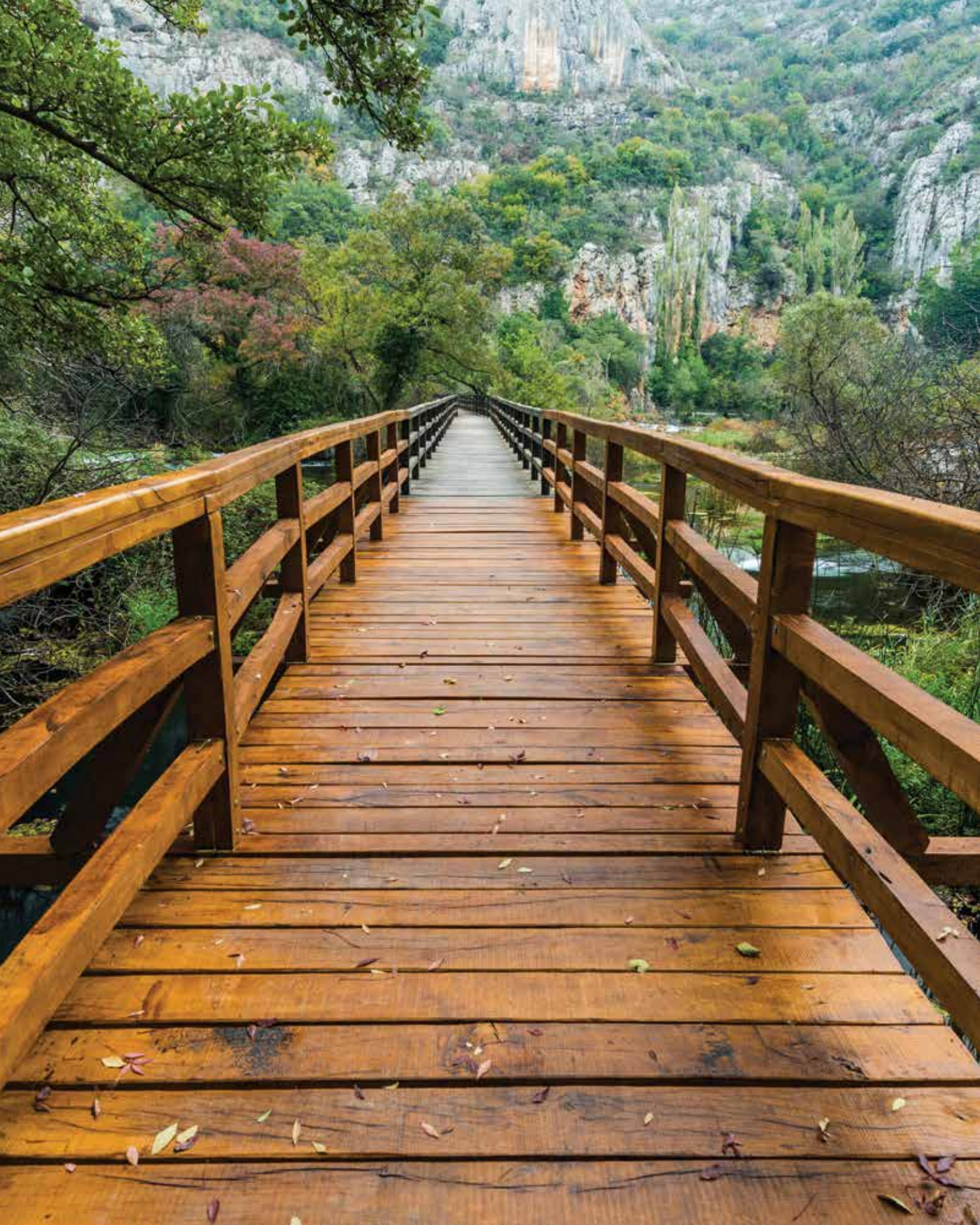






Photo Courtesy of U.S. Forest Service

It is wise for Forest Health managers and applicators to make proactive communication with the public part of their application strategy.

The exposure level to Btk from an aerial spray program is very low in comparison to the levels applied in safety and health related testing. Btk has been shown to be of low risk to residents of forested residential areas when aerially applied to control forest defoliators. That safety record has been confirmed in over 40 years of use in urban and rural applications.

While it may be true that applications of Foray do not pose risks to human health, it is wise for Forest Health managers and applicators to make proactive communication with the public part of their application strategy. Individuals with any of the particular medical conditions described above should consider seeking the advice of their physician prior to the start of the spraying program. Furthermore, residents of the treatment areas may wish to remain indoors during the

actual time of treatment to allow the fine droplets to deposit on the foliage.

**5.12 WILL FORAY INJURE PLANTS?**

Foray has been sprayed on millions of acres of trees and other plants. There have been no reports of any plant damage. Foray and other Bt products produced by Valent BioSciences are commonly used in commercial agriculture, market gardens and in greenhouses.

**5.13 IS FORAY HARMFUL TO NON-TARGET ANIMALS, BIRDS AND BENEFICIAL INSECT POPULATIONS?**

No. Foray has been tested against mammals, birds and other insects. In all cases, when Foray was tested at doses far in excess of the levels to which these organisms would be exposed during a routine





forestry or urban tree spray program, no harmful effects were observed.

#### **5.14 IS FORAY HARMFUL TO AQUATIC ORGANISMS?**

Foray has shown no adverse effects in aquatic environments. Btk has been tested against freshwater fish and aquatic invertebrate. After extended exposure tests, there were no adverse effects observed.

#### **5.15 CAN Btk GROW AND REPLICATE IN THE ENVIRONMENT?**

Btk is a naturally occurring bacterium but it requires alkaline conditions to complete its life cycle. The vegetative form of Btk is generally not well adapted to soil, and it requires the specialized habitat of vulnerable insects to persist. However, Btk endospores can survive in some soils for at least

four months. Foliage, water, and acidic soils are not suitable environments for Btk growth and replication. In these environments, Btk will degrade quite rapidly.

#### **5.16 WON'T TARGET INSECTS BUILD UP A RESISTANCE TO Btk?**

It is very unlikely that forest pests will build up a resistance to Btk. For an insect species to develop resistance to a pesticide, it must produce several generations per year and must be exposed to multiple applications of the pesticide over a relatively short period of time. Moreover, the 1:1 active ingredient-to-receptor-site dynamic between chemical insecticides and target pests is fundamental to the onset of resistance. With its multiple modes of action and a multiple protoxin profile, resistance to Foray has never been observed in the field. As a result of the combined effect of all these factors, resistance to Btk in forestry applications is highly unlikely to develop.

It should be noted that more intensive spray programs are used to control agricultural pests, and there are a few recorded incidents of Bt resistance after repetitive (10-20 applications/season) applications of Btk to control diamondback moth. In forestry, only a very small area of the total forest is sprayed, and that area will likely not receive more than two or three treatments over the entire lifespan of the trees. The pest population exposure to Btk remains, therefore, extremely low.

The techniques of implanting Btk genes into cotton and food crops have been shown to lead to the development of resistance in the species that feed on the plants. However, these genes do not express the full profile of protoxins present in Foray nor do those particular insect pests cause infestations on tree species. It is also highly unlikely that Btk genetic material will ever be implanted into forest tree species.

**5.17 WHAT ELSE IS IN FORAY BESIDES BTK? WILL THESE OTHER INGREDIENTS HARM THE ENVIRONMENT?**

Foray is a biological insecticide which contain spores and crystal-shaped proteins produced by the naturally occurring bacterium *Bacillus thuringiensis* spp. *kurstaki*, or Btk. Foray is a very selective insecticide and is not designed as a broad-spectrum control.

All of VBC's industry-leading Bt products, including Foray, are produced in a similar fashion. Btk is grown in large enclosed fermentation tanks. Foray is produced using ingredients and a technology that is similar to those which are used to make many pharmaceuticals, beer, or spirits. During fermentation, the bacteria (Btk) reproduce in a pre-sterilized growth medium containing basic food sources, such as corn, potatoes, grains, etc. After the fermentation is complete and the bacteria are grown, the fermentation material, including Btk, is collected. This material becomes the basic ingredient of Foray.

This basic ingredient is composed of Btk, which is the active ingredient, and the residual fermentation growth material and water. The water and residual fermentation growth material are referred to as "inerts" or inactive, because they are not "active" against insects. Several other inerts are added to this fermentation material, Btk, and water to make up the final formulations of Foray. These other

ingredients comprise a small proportion of the total formulation.

For example, nearly 90% of Foray 48B is composed of water, the residual fermentation growth material, and Btk. The one other inert is a food-approved carbohydrate.

The other inert ingredients are added to maintain the quality of the Foray formulation: to make it easier to handle and apply, and to protect the activity of the Btk. Some of these ingredients help

ensure the microbial quality and purity of the Foray formulation by acting to control the level of possible contaminating natural microorganisms. These ingredients, added in very minor amounts to control contaminating bacteria and molds, are also used in many foods in Canada and the US. for the same purpose. All components in Foray formulations are EPA- and PMRA-approved, and many are used in food or in the

production of food. Most formulations of Foray are approved in Certified Organic programs.



**Sustainability**

All inert ingredients in Foray formulations are included in 40 CFR 180.1001. This list has been designated by the US EPA as "exempt from the requirements of a residue tolerance on raw agricultural commodities."

**5.18 HOW CAN WE PROVE THAT BTK IS NOT A HARMFUL PRODUCT?**

One can't prove a negative. In the case of Foray and other VBC Bt-based insecticides, we can only cite decades-worth of empirical data and demonstrate that when Btk is applied following the label instructions, that the risk to nontarget organism populations, whether they are birds or humans, is acceptably low.



As a society, we must set standards and we do not permit the sale of commercial products until they have met the safety standards set forth by the scientific community and policy makers. Foray meets or exceeds the safety standards set in the US, Canada, and in all other countries. It should be noted that Canada has some of the toughest regulatory standards in the world. Most formulations of Foray are approved in Certified Organic programs.

#### **5.19 WILL FORAY CAUSE DAMAGE TO CAR FINISHES?**

No. There is nothing in Foray that will cause damage to automobile finishes. Foray

products are formulated to stick to the surface of leaves when dry. Therefore, it is easiest to remove the spray deposit from any surface while it is still wet. To remove dried Foray deposits from any surface, simply soak the dried droplets with water and then sponge or wipe with a soft cloth. As with many other foreign substances such as frass, bird droppings, or pulverized insect residue, a cleaning product normally labeled for car washing may be needed if the dried spray has been on the surface for several days. The sooner the surface is cleaned, the easier it will be to remove the spray droplets.