Aerial spraying of *Bacillus thuringiensis* in areas of human population

A brief overview – draft 5/8/07

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I've pulled together some information on *Bt* and presented it in outline form, below; I am happy to try to answer any questions about this information. Briefly, as I see it, there are 2 key considerations to keep in mind regarding use of this microbial pesticide:

1. RESISTANCE of spruce budworm to *Bt* has been described: after spraying, residual spruce budworm is likely to be resistant to this pesticide. Thus, while it may be sensible to spray an area one year, it would not be good practice to spray that area with this treatment year after year.
2. SAFETY CONSIDERATIONS. NOTIFY YOUR NEIGHBORS if you are going to spray. Studies have shown that *Bt* can be quite widespread outside of aerial spray zones and can be a concern for certain groups of individuals (see below). Because of the potential for infection of humans and other organisms, it is reasonable to inform your neighbors so that they can stay inside or evacuate to town for a period of time around the spraying.

The organism *Bacillus thuringiensis (Bt)*

- Gram positive, aerobic, spore-forming rods
- Naturally occurring soil organism as is typical of genus
- Importance of plasmids and genetic exchange
- Related to two other organisms that cause human disease: *Bacillus anthracis* (cutaneous, pulmonary, systemic infections; anthrax) and *Bacillus cereus* (gastroenteritis)

Pesticide action

- Life cycle of spruce budworm (SBW) (see Wikipedia article)
- *Bt* mode of action: ingestion by insect larval forms as they feed, formation of crystal (*cry)* proteins with sporulation in the gut, insects stop feeding and die
- Resistance of SBW to *Bt* has already been observed and may arise through decreased binding to insect gut epithelium or increased ability of gut proteases to digest the toxic proteins
- At least six toxin (*cry*) types are described; this fact was expected to decrease the probability of resistance, but multitoxin resistance has already appeared.

Specificity of *Bt* for spruce budworm

- *Bt* is known to infect other moths, butterflies, and other insects.
- In spraying programs, the *Bt* subspecies chosen depends upon the insect target, but specificity may not be absolute.

Pathogenicity of *Bt* for humans

- Opportunistic pathogen (not a common human pathogen, but it may be able to infect under certain circumstances)
- Infections reported of eye, wounds, gut in humans; pneumonia in immunocompromised mice

- Human infection has been documented, though apparently is not common, after spraying.
- Studies show that human carriage (in the nose) is increased after aerial spraying.
- Studies to date have evaluated short-term, but not long-term, effects of spraying on human populations.
- Monitoring programs (some states, CDC). *Bt* has been used as an insecticide for about thirty years (under regulation by the EPA), however real attempts to monitor human effects are much more recent and cannot be considered thorough.
- Concerns for those with compromised defenses against infection: infants, elderly, those on chemotherapy, those on cortisol or methyltrexate (e.g., for arthritis)

Pets, Wildlife

- Risks probably similar to those for humans

Spruce budworm control considerations

- Options: do nothing, remove affected trees, spray bacterial pesticide, spray chemical pesticide, pheromone traps, alternate pesticides, other
- There is no question that there are concerns with chemical pesticides and that doing nothing could increase the fire potential of our forested areas.
- Because of the potential for SBW to develop resistance to *Bt*, it does not make sense to spray year after year with the microbial pesticide.
- If we chose *Bt*, what is the efficacy of the control effort? In aerial spraying for gypsy moth control around Victoria, BC, there were virtually no target insects observed in the spray zone the following year (this too argues against repeated annual spraying efforts).
- Property should be evaluated on a case-by-case basis; our home is in an open area containing four Engleman spruce. Because of the potential risks of pesticide spraying, we monitor and apply malathion directly to new growth when needed.
- Aerial spraying of pesticides should be executed with the proper expertise, oversight, and monitoring.
- Those involved in spraying have a responsibility to notify neighbors; an expert can say what this means. However, in the Victoria, BC study, spread of microbial pesticide was quite extensive into nonspray areas.
- Consider dose of pesticide, range of spraying, winds, temperatures, time of day, droplet size (the smaller the droplets, the longer the aerosol hangs in the air and the greater the risk of inhaling the organism far into the lung), resistance, expertise of spraying personnel (they need to know enough to protect themselves from occupational infections!), monitoring, and evaluation of success or failure of the year's control effort.