Ecological Impacts of Using Early Intervention to Control Spruce Budworm

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Service canadien des forêts
Ressources naturelles Canada
Merci!
Merci!
The spruce budworm, *Choristoneura fumiferana*
Early Intervention Strategy

- Btk
- Tebufenozide
Early Intervention Strategy

- Btk
- Tebufenozide

Insecticides specific to Lepidoptera
Must be eaten to have an impact
Why should we care about ecological impacts?

• Impact on insect community
  • Could alter the efficacy on SBW

• Impacts on critical habitats and ecosystem services
  • Could allow prioritization of ecological values in EIS
Why should we care about ecological impacts?

- Impact on insect community
  - Could alter the efficacy on SBW
Eveleigh et al. 2007

Other leps' natural enemies

SBW's natural enemies

Overall

Coleotechnites attupictella
Coleotechnites picenella
Acteris variana
Choristoneura fumiferana
Epinota radicana
Choristoneura rosaceana

BALSAM FIR

Eveleigh et al. 2007
SBW's natural enemies

Eveleigh et al. 2007
Other leps’ natural enemies

SBW’s natural enemies

Eveleigh et al. 2007
Parasitoid diversity depending on SBW density

New Brunswick
Eveleigh et al. 2007
Parasitoid diversity depending on SBW density

New Brunswick
Eveleigh et al. 2007
Lepidoptera community

June

September
Lepidoptera community

June

September
Lepidoptera community
Lepidoptera community

June

September
Lepidoptera community
Lepidoptera community
How can we study that?

- Assessing SBW parasitism rates
- Sampling the lepidoptera community
- Sampling the parasitoid community
Assessing SBW parasitism

Traditional method

- Up to a month
- Need taxonomic expertise
Assessing SBW parasitism

Molecular method

- A few days
- Need molecular equipment
Assessing SBW parasitism
Assessing SBW parasitism

Parasitoids killed with SBW?
Assessing SBW parasitism

Parasitized larvae often eat less...

Parasitoids killed with SBW?
Lepidoptera community

- Branch sampling
- Branch beating
- Visual inspection
Lepidoptera community

- Species?
- Parasitized?
Lepidoptera community

• Species?
• Parasitized?
Lepidoptera community

- Species?
- Parasitized?
Lepidoptera community

- Species?
- Parasitized?

Visual observation

2018

Number of caterpillars

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<tr>
<th>CT</th>
<th>Récolte 1</th>
<th>Récolte 2</th>
<th>Récolte 3</th>
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Récolte 1, Récolte 2, Récolte 3, Récolte 4
Parasitoid community
Parasitoid community
Why should we care about non-target impacts?

• Impact on insect community
  • Could alter the efficacy on SBW

• Results will come in the next few years
• Same sites will be visited 1-yr post-treatment => recovery?
Why should we care about ecological impacts?

• Impact on insect community
  • Could alter the efficacy on SBW

• Impacts on critical habitats and ecosystem services
  • Could allow prioritization of ecological values in EIS
Ecological impacts of using early intervention to control spruce budworm in forest watersheds

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Ecological/ecosystem impacts of insect disturbances

Positive impacts

*Forest insects and diseases:*
- help renew forests by removing old, weakened or otherwise vulnerable trees
- help in soil formation by breaking down dead trees and other plant material and recycling the nutrients
- provide new habitat and food for wildlife
- pollination

Negative impacts

*Forest insects and diseases:*
- cause radial and height growth loss, volume loss, dieback and deformity
- through that damage, can kill individual trees or entire forests
- through widespread killing of existing forests, can result in the displacement of existing tree species
Pest management

**BENEFITS**
- wood supply
- ecosystem services

**RISKS**
- environmental impacts
- non-target effects

risk of no intervention?
Prevention of secondary pests and diseases
Spruce mortality due to 2' pests

Ostaff & MacLean 1989
BENEFITS  RISKS

maintenance of ecosystem services?
Predicted ecosystem impacts of defoliators

→ reduced canopy cover & structure
→ shifts in understory vegetation
→ altered habitat quality & availability
→ changes in food webs
→ effects on ecosystem processes
- hydrological & nutrient cycles
- source of drinking water
- recreational value
Pre-disturbance functioning of cold-water streams

- canopy shading
- interception of precipitation
- hydrologic inputs from catchments
Hydrologic response and potential interaction with biogeochemical & biotic shifts in streams
Impacts on forested catchments / headwaters:

- budworm frass and needle-fall
- changes in soil microclimate
- shifts in nutrient cycling

→ inputs into streams & aquatic foodwebs
Empirical test of the ecological impacts of EIS?

→ Before-After-Control-Impact (BACI) paired design
Ecosystem monitoring over multiple years:

- Baseline

![Ecosystem monitoring graph](image-url)
• sustained progression of outbreak toward southeast in Gaspésie

Source: Healthy Forest Partnership
Selection of experimental watersheds

1. Spatial data acquisition
2. Watershed delineation
3. GIS-based screening
4. On-the-ground screening
5. Bird habitat surveys
6. Site ranking
7. SBW outbreak assessments
8. Site shortlist negotiations
9. Treatment assignments
6. SBW outbreak assessments

• Before-After-Control-Impact (BACI) paired design with defoliation gradient

→ *hybrid approach*
• physical & biogeochemical effects, shift in aquatic basal resources
• effects on aquatic food webs
• cascading impacts on cold-water fish health & habitat

Nutrient inputs may result in C source shift

Organic molecule composition

Benthic community and diet

Microbial fate of organic molecules

Fish community and diet

Stream flow
Carbon sequestration consequences of SBW outbreaks and control in eastern Canadian forests

S Heard, LP Comeau, C Wagg, D Pureswaran, M Stastny

• microbial respiration
• C flux, decomposition
• labile vs. recalcitrant C fractions
• community shifts in ectomycorrhizae
• short- & long-term C dynamics
Responses of bird communities to SBW outbreaks

- Evidence of initial 10-fold increase in abundance for certain species during SBW outbreaks

...but followed by rapid decrease in bird abundance in relation to subsequent habitat loss
Comprehensive quantification of defoliation

→ UAVs, ground surveys, branch sampling, cross-validation of methods

→ integration with sampling & measurements of response variables
Cumulative Defoliation vs. Mortality over time since the start of the budworm outbreak. The graph shows a decline in ecological indicator values with increasing time, indicating defoliation. The baseline (defoliation) is shown as a reference for comparison.
SBW Early Intervention Strategy in forest watersheds?

**BENEFITS**

**RISKS**

maintenance of ecosystem services?

risk of no intervention?

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