A conceptual framework for the spruce budworm ‘Early Intervention Strategy’

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Source: NB Woodlot owners webpage
Cape Breton Highlands, 1977
Population dynamics:  
The basis of management strategy

~35-40 year outbreak cycle
What drives spruce budworm outbreak cycles?
Oscillatory hypothesis

Predator-prey cycles drive budworm outbreaks

Population density (Millions)
Oscillatory hypothesis

Predator-prey cycles drive budworm outbreaks

Only data for collapsing populations

...but, no data for the rise
Oscillatory hypothesis

Outbreaks are synchronous across the landscape

Moth dispersal does not spread outbreaks
Regional outbreaks are inevitable

1975
Foliage protection strategy

- Prevent tree mortality (defoliation <50%)
- Protect high-value stands
- Wait it out...
- Main strategy since the 1950’s!
Epicentre Hypothesis
(Double equilibrium hypothesis)

Outbreaks spread ‘contagiously’

2007-2013

Density-dependent moth dispersal
Régnière & Nealis 2019

No natural enemy release
Boucher et al. 2018

Mate-finding Allee effect
Régnière et al. 2012
Population control strategy

Target ‘hotspots’ & slow or stop spread.
Population control strategy

2018

Target ‘hotspots’ & slow or stop spread.

Early Intervention Strategy
Early Intervention Strategy

Conceptual Framework:

1) Population dynamics

2) Monitoring: Hotspots and treatment areas

3) Efficacy and non-target effects

4) Communication and outreach

5) Benefits > costs
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Silent Spring
Rachel Carson

From the green depths of the offshore Atlantic many paths lead back to the coast. They are paths followed by fish; although unseen and intangible, they are linked with the outflow of waters from the coastal rivers. For thousands upon thousands of years the salmon have known and followed these threads of life in the sea. It is along these paths that we must trace the destruction...
Communications

Strategy:

1) Transparent and proactive engagement
   - public, indigenous communities, foresters, politicians, media, etc.

2) Scientists communicate on the science

3) Directly address issues raised by the public
L’arbre, une ressource précieuse à conserver

Véronique Demers
Publié le 09 octobre 2014

« Avec la tordeuse de l’épième de l’érablière, on connaît des cycles d’épidémie de 30 à 40 ans. D’après 2014, on remarque que des foyers d’infestation commencent à grandir », observe la chercheuse et scientifique Véronique Martel. (Photo TC Media – Véronique Demers)
New Brunswick is a province that shares a deep connection with its forests. We interact with the forest in many ways - whether it's through residence, recreation or employment - our forests are at the heart of who we are and what we do. It is because of that important relationship that the Healthy Forest Partnership was created.

Protecting Our Forests

The North Shore and Gaspe regions of Quebec are currently experiencing a significant infestation from the spruce budworm, which is moving towards the Quebec/New Brunswick border.

What is Spruce Budworm?

A spruce budworm is a small, brown caterpillar with the Latin name Choristoneura fumiferana, found throughout the range of spruce and fir in Canada and the United States. Spruce budworm is native to North America and has evolved together with the spruce and fir trees it feeds on over thousands of years.

Ask the Experts

Recent Questions

» What happens to Mimic once it is sprayed?
» Do all of the spruce trees die during...
» If you are successful what can we expect...
» If a spruce budworm infestation occurs how long...
» What would be the economic impacts if we...
» How many jobs could be lost if treatments...

ASK YOUR QUESTION »
Budworm Tracker: Community science
Bacterium used to fight budworm no threat to humans, says ecologist

“They appear to be approaching this from a very responsible manner.”

Media coverage has been universally positive (to date).
Less than 5% of woodlot owners have opted out.
No provincial political party made this program part of their platform.
Federal funding was renewed from 2018-2021 ~$75 million

A spruce budworm. Rob Johns, a forest insect ecologist at Canadian Forest Service in Fredericton, says that the bacterium used to fight the spread of the destructive pest in Restigouche has no effect on humans even if it gets into the drinking water.

Photo: Natural Resources Canada
Early Intervention Strategy

*Conceptual Framework:*

1) Population dynamics
2) Monitoring: Hotspots and treatment areas
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4) Communication and outreach
5) Benefits > costs
Benefits > Costs?

• Uncontrolled budworm outbreak = \textasciitilde$15 \text{ billion loss over 30 years}.

• Foliage protection protects <4\% of outbreak area in Quebec (though it is \textasciitilde85\% effective).

• Cost depends on the framework efficiency...

• Framework efficiency will vary regionally depending on how well framework needs can be satisfied...
Ok...but does it work?
And, what are the risks?

Dr. Sara Edwards
Forest Protection Ltd.

Source: NB Woodlot owners webpage
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How do we control pest populations?

We need to ‘add’ mortality:

1) Control populations while densities are relatively low.

2) Control over large areas to limit sources of immigration.

3) Avoid impacting natural enemies or other non-target organisms.
Treatment area (147,000 ha)

Summer 2017

'Hot spots'

Btk or tebufenozide

‘Hot spots’  Treatment area (147,000 ha)
Treatment area (147,000 ha)

'Hot spots'

Fall 2017
Fall 2017

'Hot spots'
Treatment area (220,000 ha)

'Hot spots'
Fall 2018

Treatment area (220,000 ha)

'Hot spots'
Fall 2018

‘Hot spots’
Summer 2019

Treatment area (~10,000 ha)

'Hot spots'

90% decline

Sites above treatment threshold (%)

Year

2014 2015 2016 2017 2018

0 2 4 6 8 10 12 14

‘Hot spots’ Treatment area (~10,000 ha)
Meanwhile to the north...
Experiments: Are we adding mortality?
Treatment mortality

![Graph showing treatment mortality over years with comparison between untreated and treated groups.](image)
Population growth

Year

Population growth rate

- Untreated
- Treated
- Late treatment

2017

2018

-5

-4

-3

-2

-1

0

1

2

3

4

5
Is it working?

- Results are encouraging.

- A little ‘added’ mortality goes a long way.

- Is it sustainable? Can we outlast the ongoing outbreak in Quebec?

- What are the potential non-target impacts?
  - (e.g., for other caterpillars and the natural enemies they harbor).
Non-target Impacts: Broader ecosystem
Bioaccumulation - net accumulation of contaminant
Targeted treatments

Btk
(Bacillus thuringensis kurstaki)

Tebufenozide
Btk is a common soil bacteria

• Highly selective with low toxicity
  • No effect on mammals, fish, birds, shellfish, etc.

• How does it work?
Btk toxins are activated in the gut
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Btk spores germinate in the body cavity
Only treat areas with high spruce/fir content
How much ends up in water?
~600 colonies per mL
Conclusions:

• Btk needs to be ingested by caterpillars to be effective

• No bioaccumulation

• Btk is specific to caterpillars due to their unique gut chemistry

• Only trace amounts end up in water – what ends up in water is not harmful to non-caterpillars