A conceptual framework for the spruce budworm 'Early Intervention Strategy'

Rob Johns

P. James, V. Martel, D. Pureswaran, J. Regniere, D. MacLean, E. Moise, J. Bowden, M. Stastny, D. Kneeshaw

Atlantic Forestry Centre, Canadian Forest Service

Source: NB Woodlot owners webpage

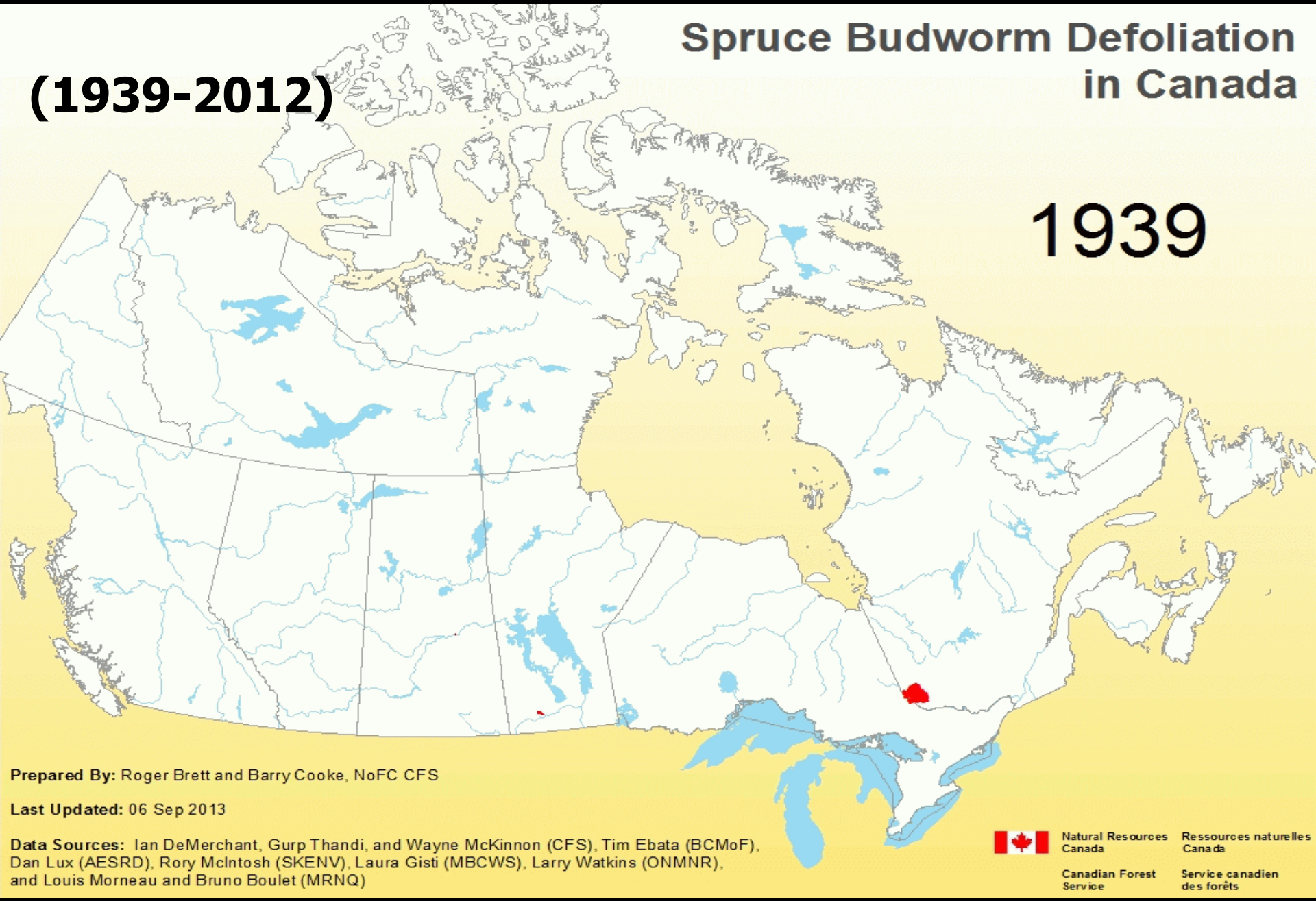
Photo: Michigan State University

Cape Breton Highlands, 1977

Photo: Ed kettela

(1939-2012)

Spruce Budworm Defoliation in Canada



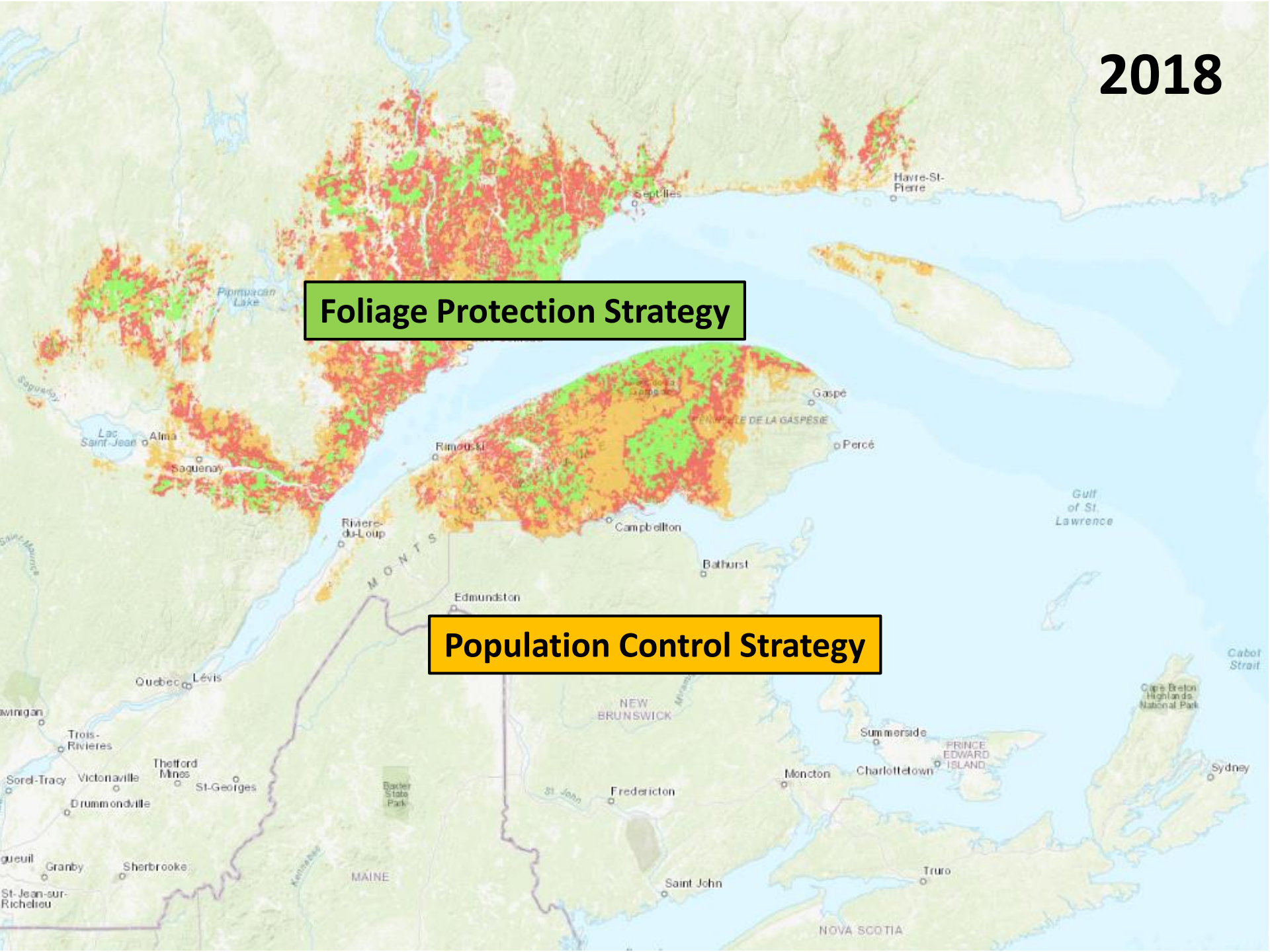
Prepared By: Roger Brett and Barry Cooke, NoFC CFS

Last Updated: 06 Sep 2013

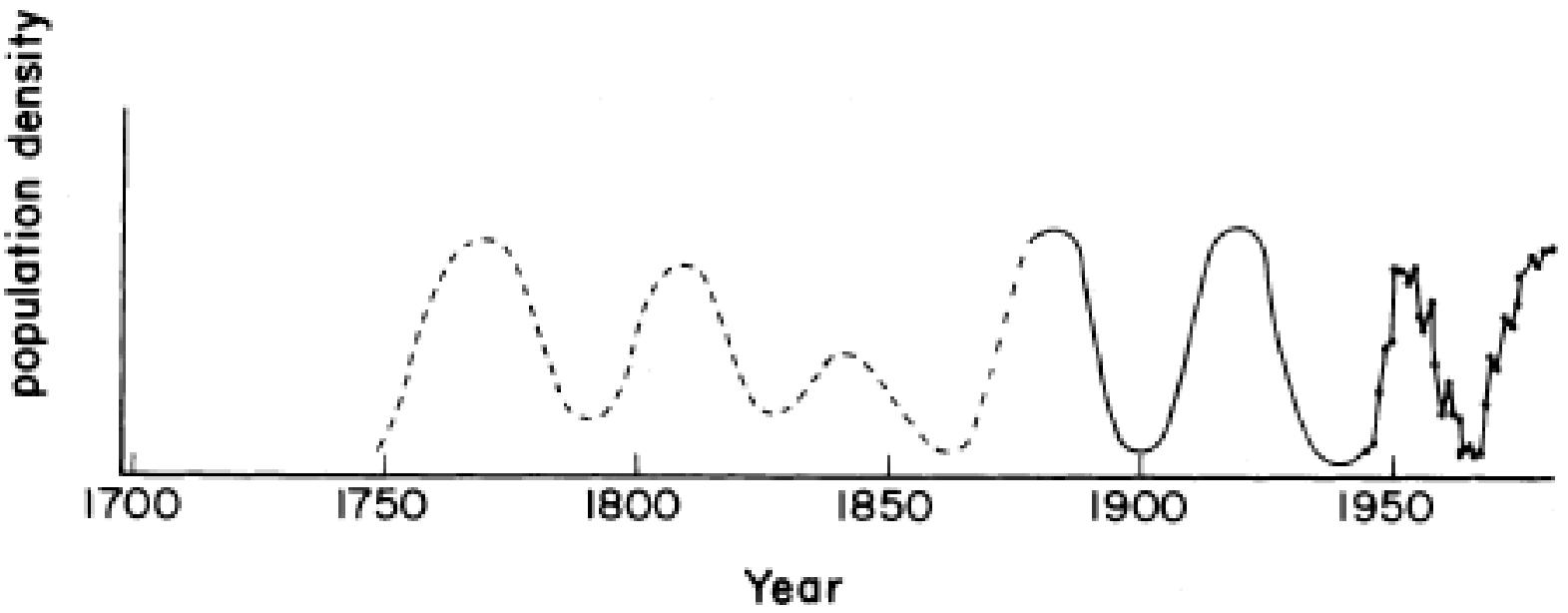
Data Sources: Ian DeMerchant, Gurp Thandi, and Wayne McKinnon (CFS), Tim Ebata (BCMoF), Dan Lux (AESRD), Rory McIntosh (SKENV), Laura Gisti (MBCWS), Larry Watkins (ONMNR), and Louis Morneau and Bruno Boulet (MRNQ)

Natural Resources Canada | Ressources naturelles Canada

Canadian Forest Service | Service canadien des forêts


2018
Foliage Protection Strategy
Population Control Strategy
Havre-St-Pierre
Gaspé
Percé
Alma
Saguenay
Rimouski
Campbellton
Bathurst
Edmundston
Quebec
Lévis
Trois-Rivieres
Thetford Mines
Sorel-Tracy
Victoriaville
St-Georges
Drummondville
Granby
Sherbrooke
St-Jean-sur-Richelieu
Fredericton
Moncton
Summerside
Charlottetown
Sydney
Saint John
Truro
MAINE
NEW BRUNSWICK
PRINCE EDWARD ISLAND
NOVA SCOTIA
Gulf of St. Lawrence

Population dynamics:
The basis of management strategy

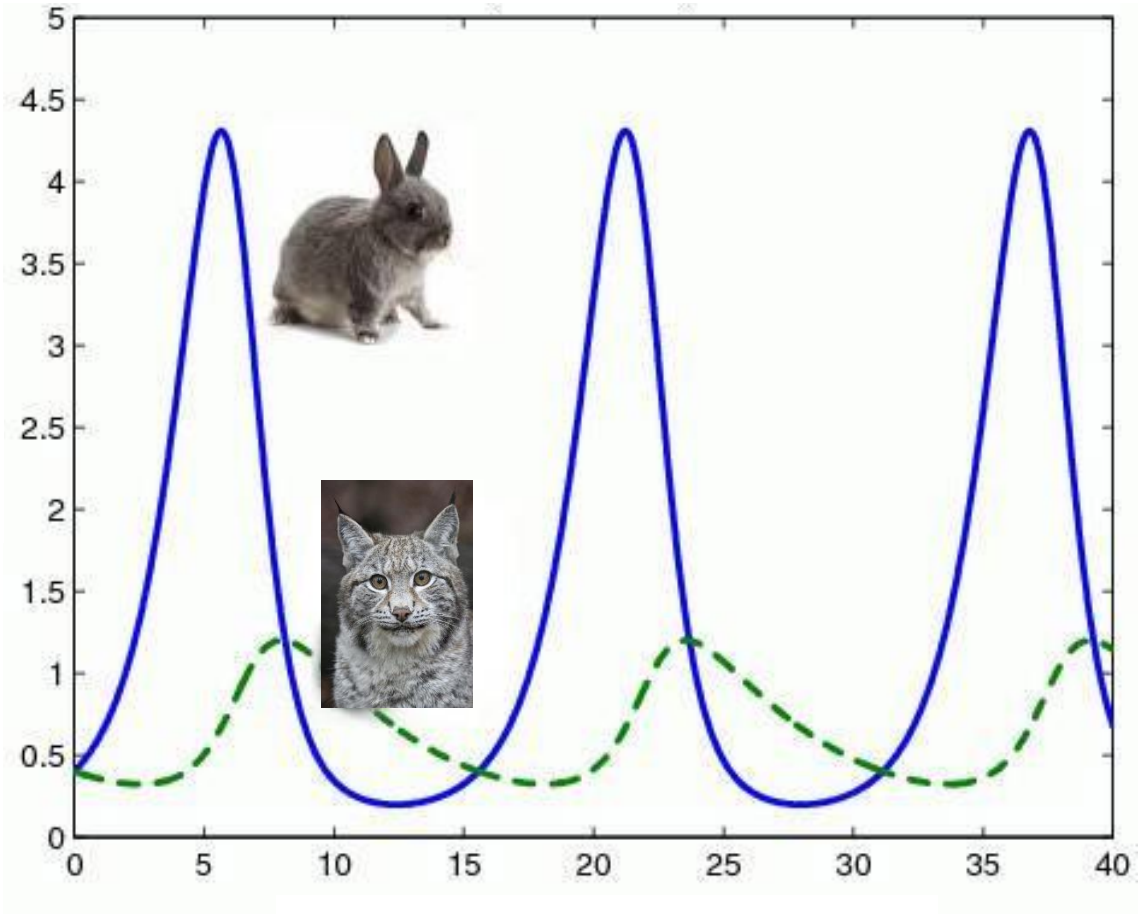


~35-40 year outbreak cycle


What drives spruce budworm outbreak cycles?

Oscillatory hypothesis

Predator-prey cycles drive budworm outbreaks

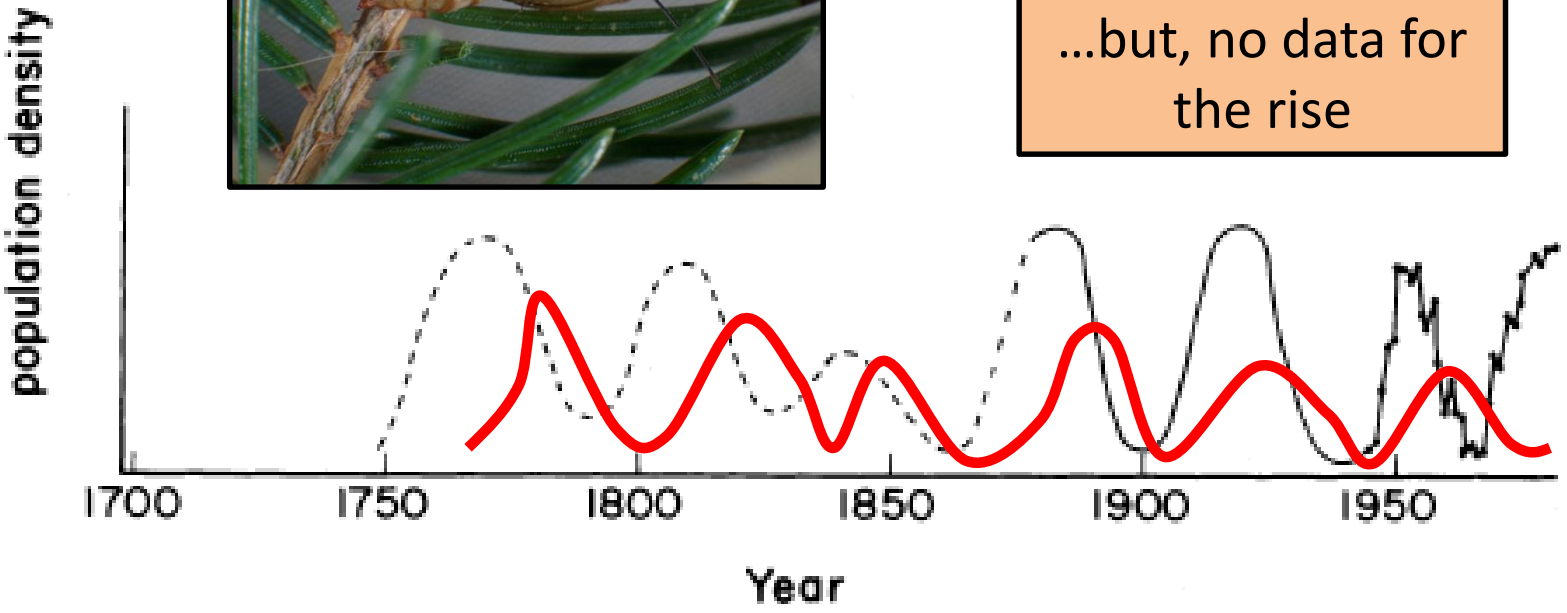


Oscillatory hypothesis

Predator-prey cycles drive budworm outbreaks

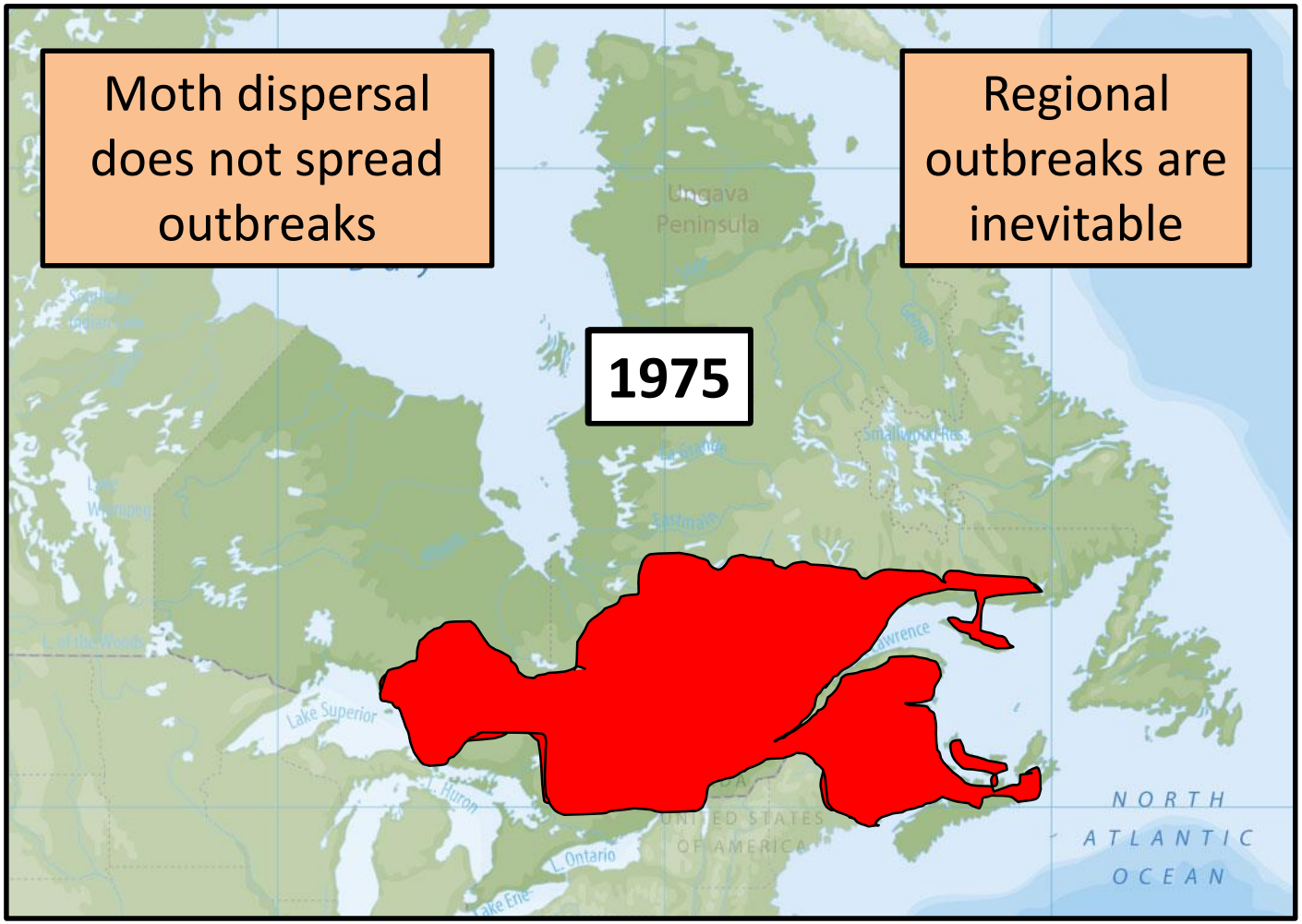
Only data for collapsing populations

…but, no data for the rise



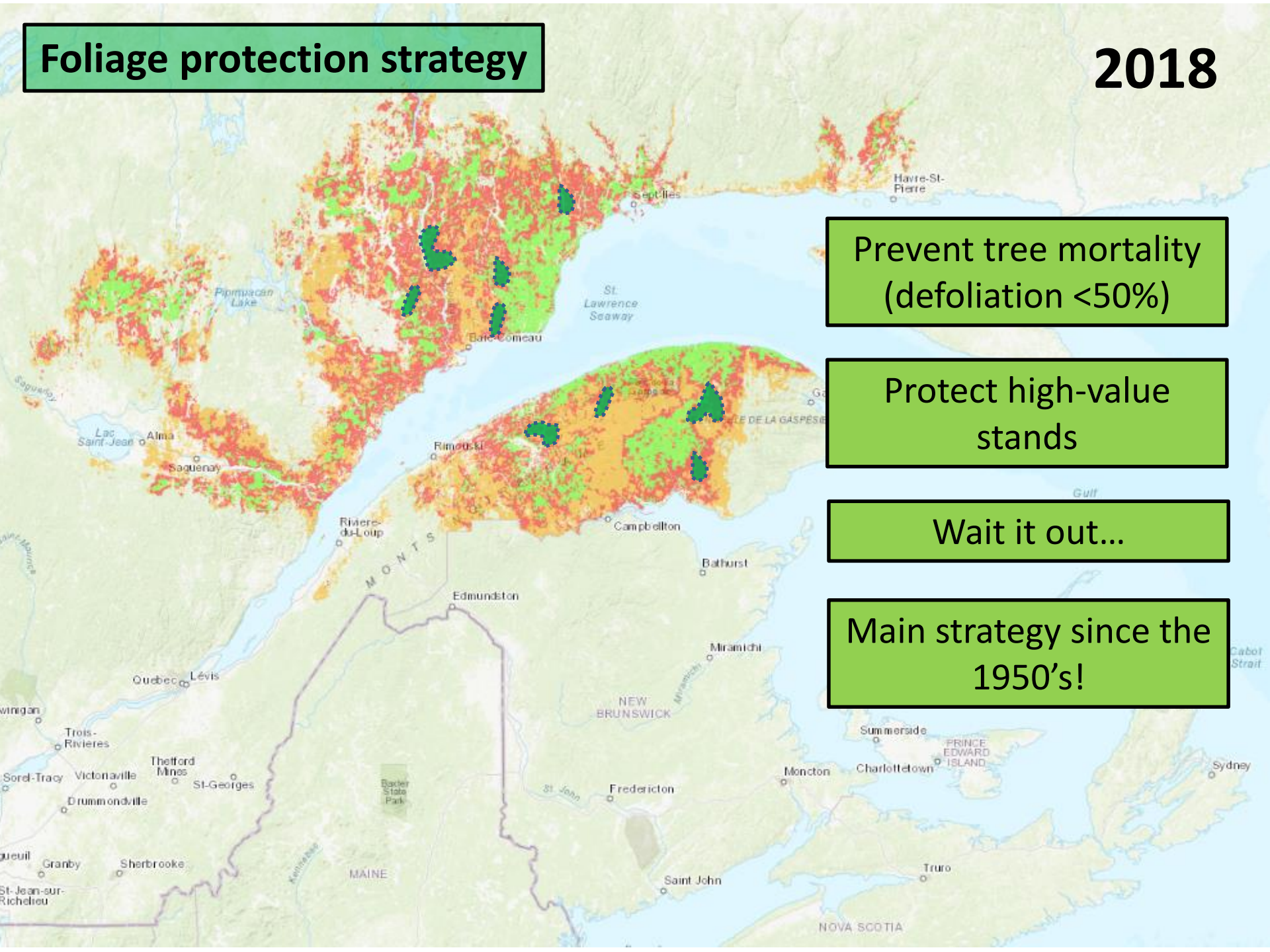
Oscillatory hypothesis

Outbreaks are synchronous across the landscape



Foliage protection strategy

2018



Prevent tree mortality (defoliation <50%)

Protect high-value stands

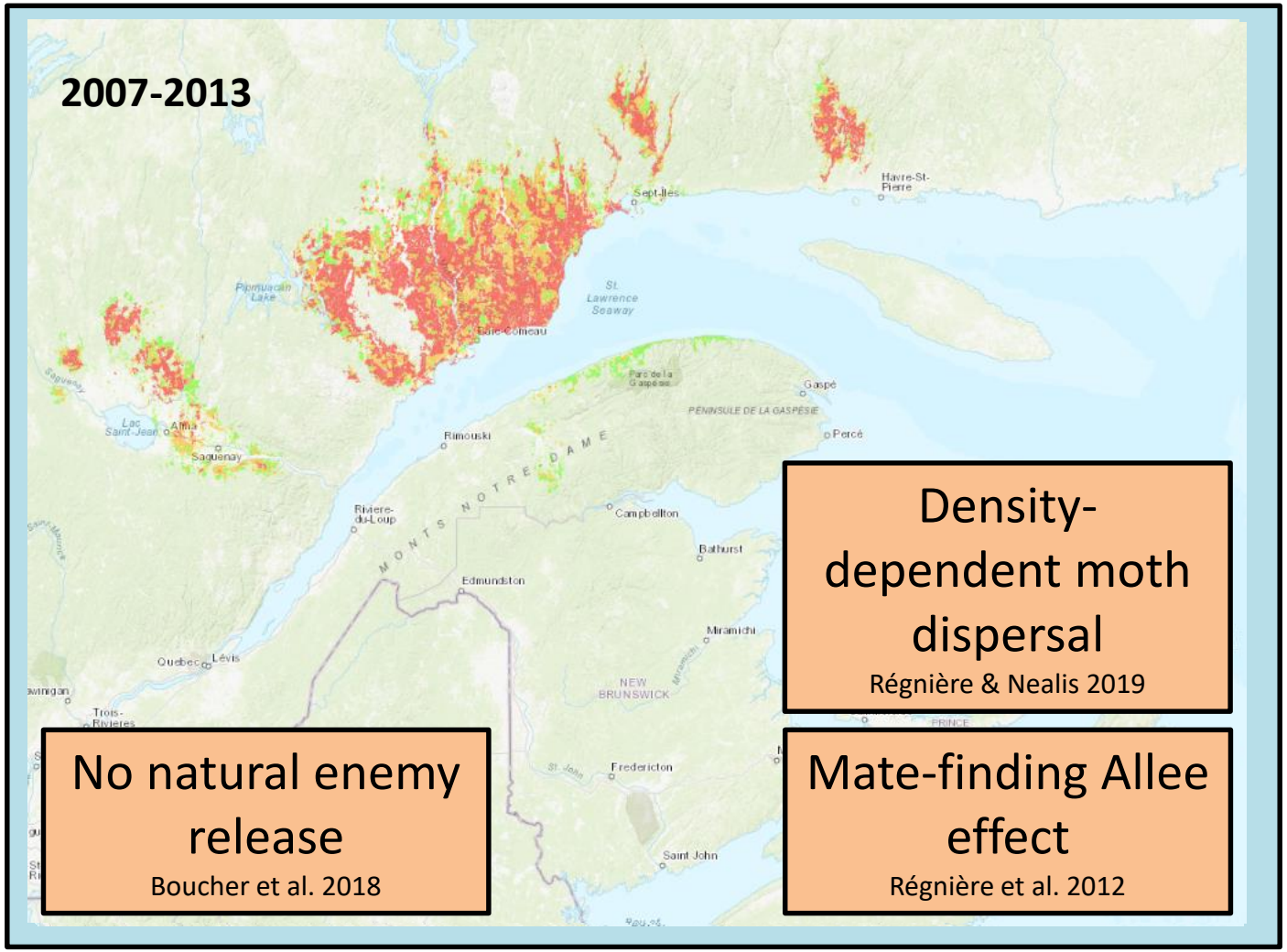
Wait it out…

Main strategy since the 1950's!

Epicentre Hypothesis

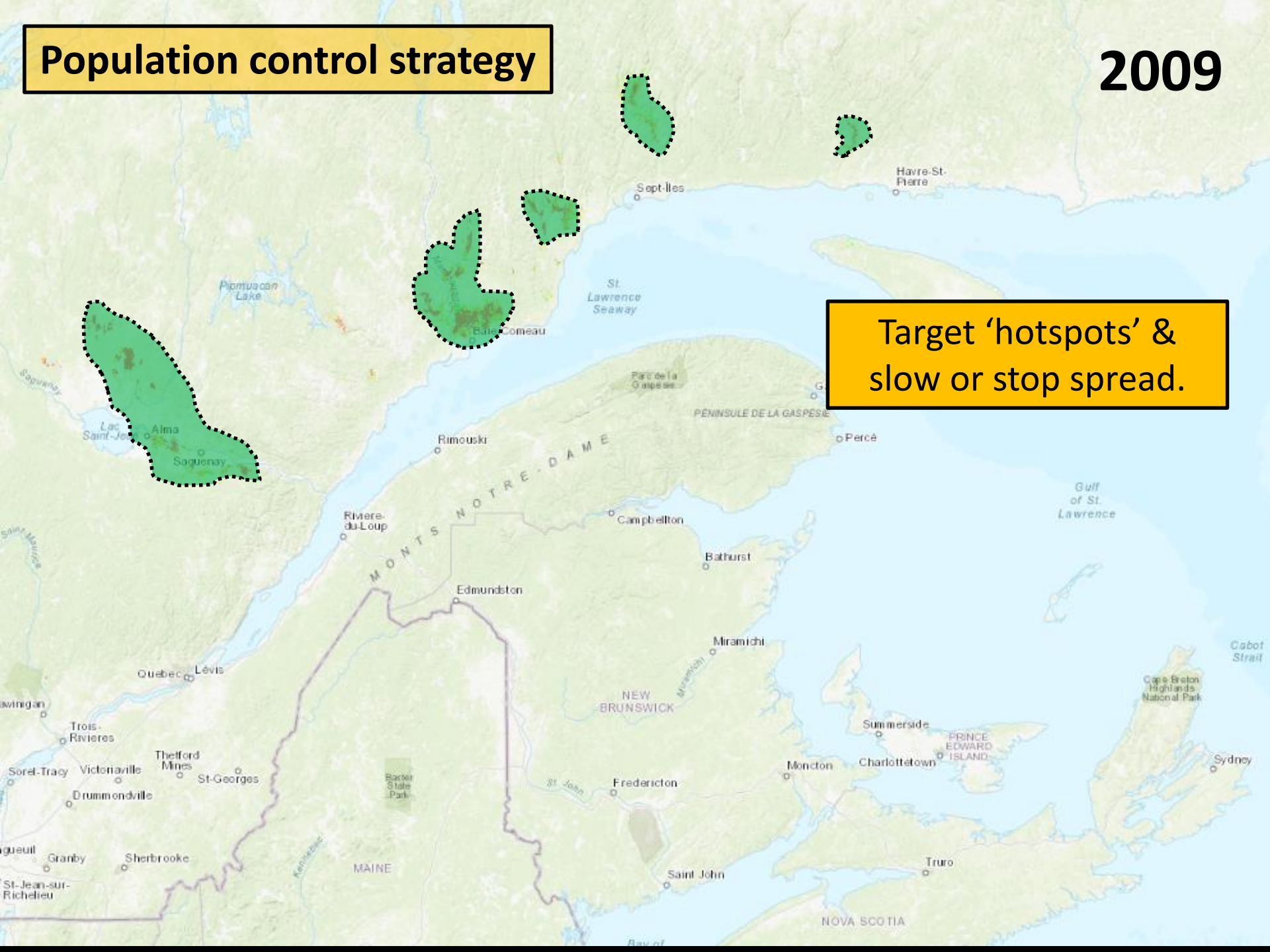
(Double equilibrium hypothesis)

Outbreaks spread ‘contagiously’



Population control strategy

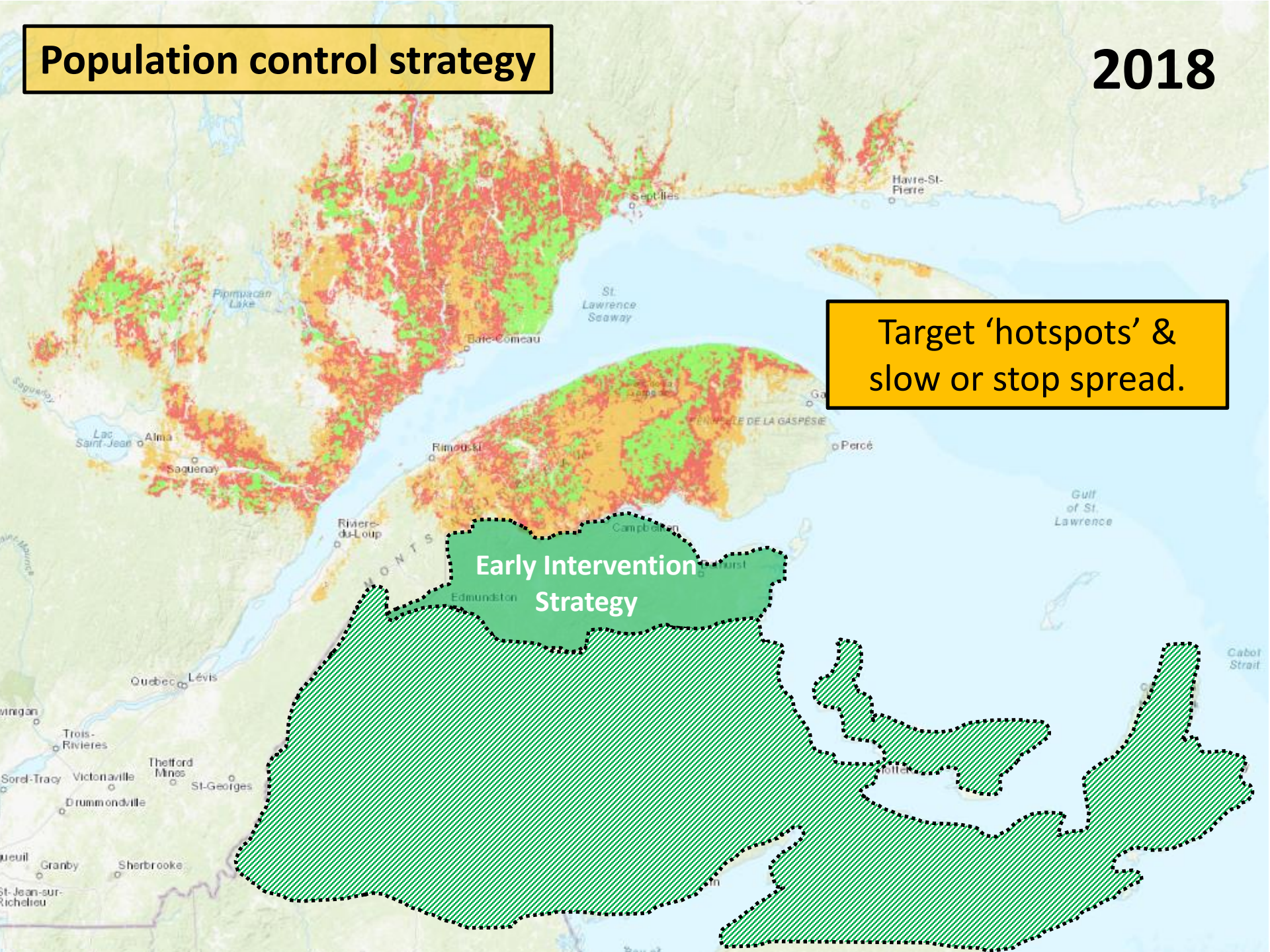
2009



Target ‘hotspots’ & slow or stop spread.

Population control strategy

2018



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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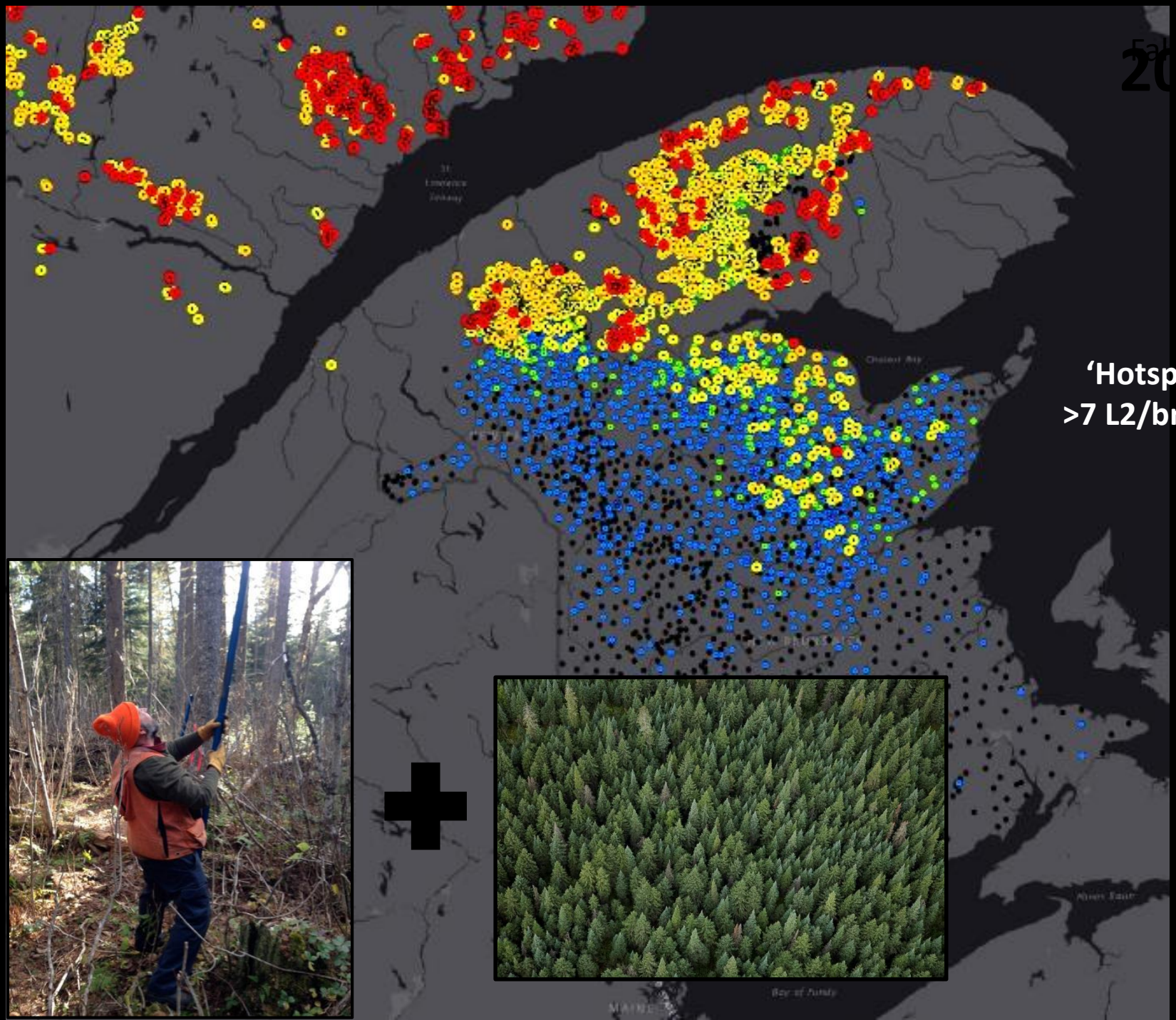
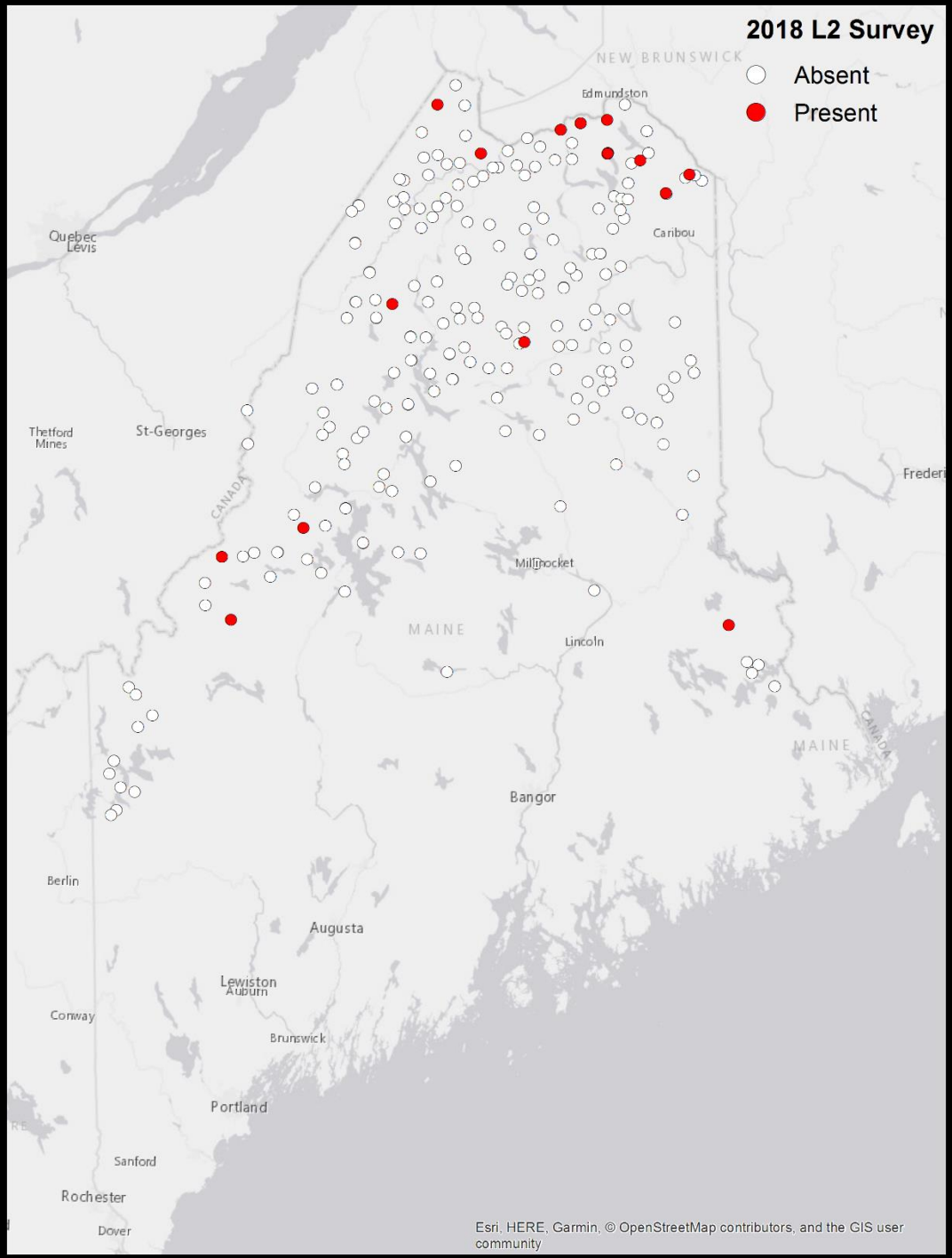

‘Hotspot’
>7 L2/branch


2018 L2 Survey
Absent
Present
NEW BRUNSWICK
Edmundston
Caribou
Quebec
Levis
Thetford
Mines
St-Georges
CANADA
Millinocket
MAINE
Lincoln
MAINE
CANADA
Bangor
Berlin
Augusta
Lewiston
Auburn
Conway
Brunswick
Portland
Sanford
Rochester
Dover
Esri, HERE, Garmin, © OpenStreetMap contributors, and the GIS user community

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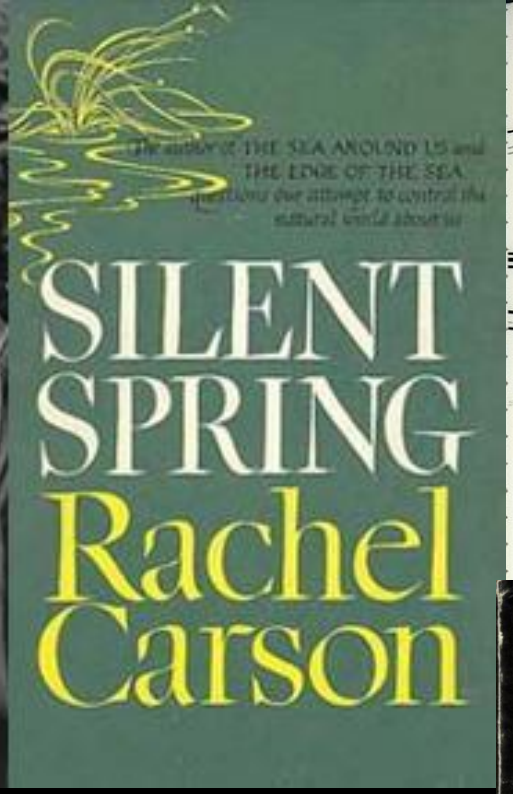
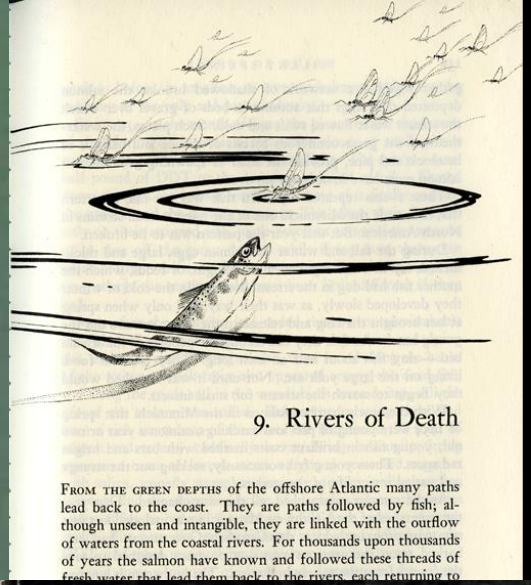
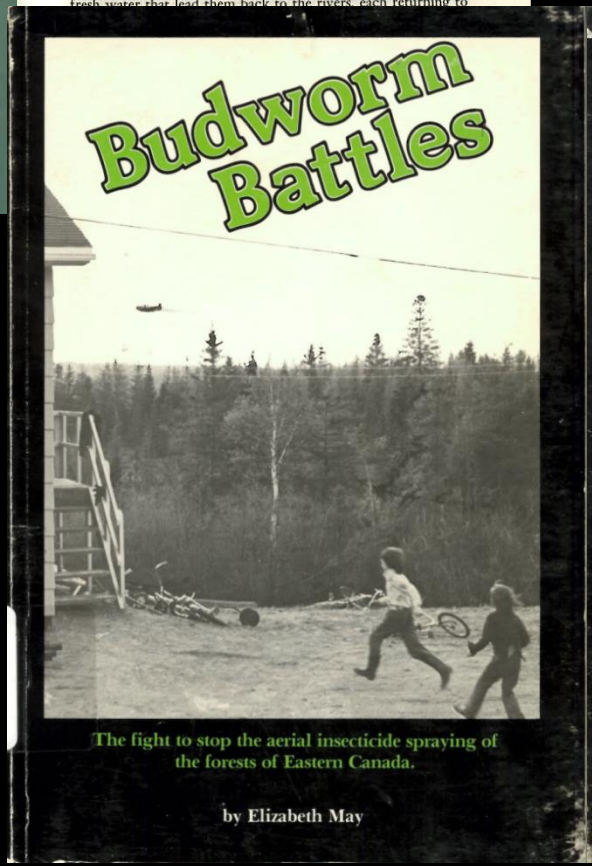
DDT - 1962





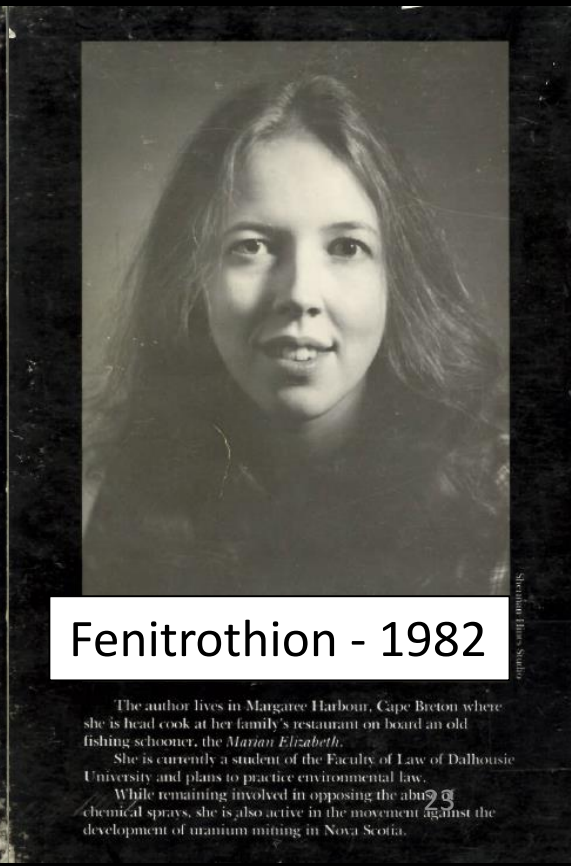
9. Rivers of Death

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



The fight to stop the aerial insecticide spraying of the forests of Eastern Canada.

by Elizabeth May



Fenitrothion - 1982

The author lives in Margaree Harbour, Cape Breton where she is head cook at her family's restaurant on board an old fishing schooner, the *Marian Elizabeth*.

She is currently a student of the Faculty of Law of Dalhousie University and plans to practice environmental law.

While remaining involved in opposing the abuse of chemical sprays, she is also active in the movement against the development of uranium mining in Nova Scotia.

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

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2°C
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Véronique Demers
Publié le 09 octobre 2014

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Publié le 09 octobre 2014

«Avec la tordeuse de l'épinette noire, on connaît des cycles d'épidémie de 30 à 40 ans. Depuis 2006, on remarque que des foyers d'infestation commencent à grandir», observe la chercheure et scientifique Véronique Martel. (Photo TC Media – Véronique Demers)

Official site of Canadian Forest Industries and Wood Products magazines

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WOOD PELLET

WPAC AGM 2014
SUSTAINABLE GROWTH

ENEWS SIGN UP FREE

The pending storm

Eastern Canadian foresters brace for spruce budworm.

by Rob Johns & Deepa Pureswaran | Oct 2013

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Breakaway - CBC Radio One

Canadian Forest Service researchers Veronique Martel, Deepa Pureswaran and Louis de Grandpré pose with a giant Budworm model.

HealthyForest PARTNERSHIP

English Français

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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.

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.

Learn More

Ask the Experts

Recent Questions

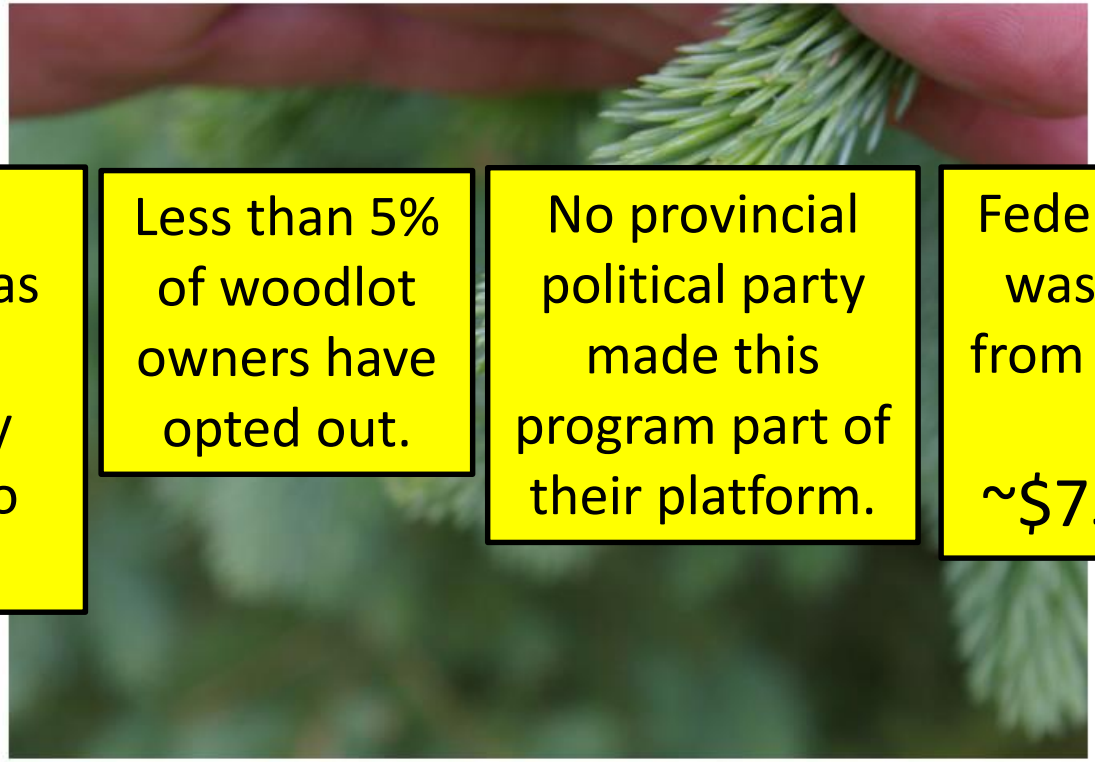
- » What happens to Mimic once it is sprayed?
- » Do all of the spruce trees die during...
- » If you are successful what can we expect...
- » If a spruce budworm infestation occurs how long...
- » What would be the economic impacts if we...
- » How many jobs could be lost if treatments...

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."



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

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

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5) Benefits > costs

Benefits > Costs?

- Uncontrolled budworm outbreak
  = ~$15 billion loss over 30 years.

- Foliage protection protects <4% of outbreak area in Quebec (though it is ~85% 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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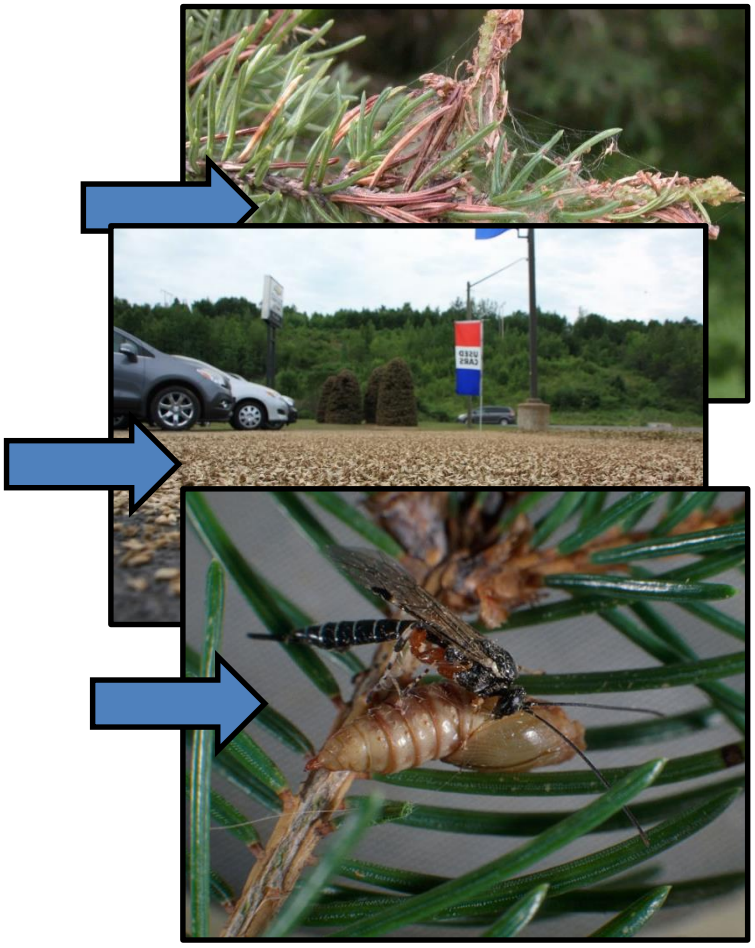
How do we control pest populations?

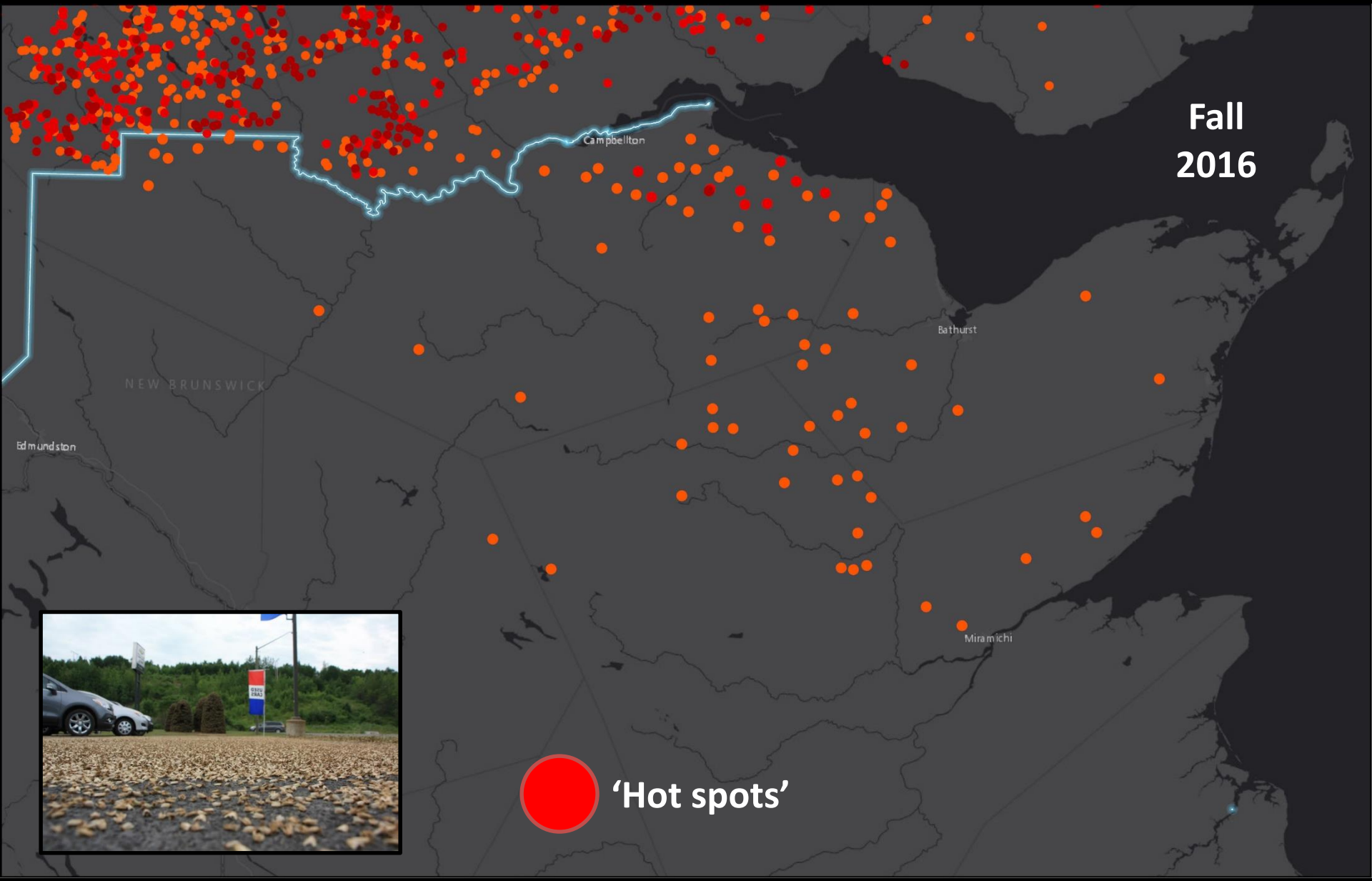
We need to '<u>add</u>' mortality:

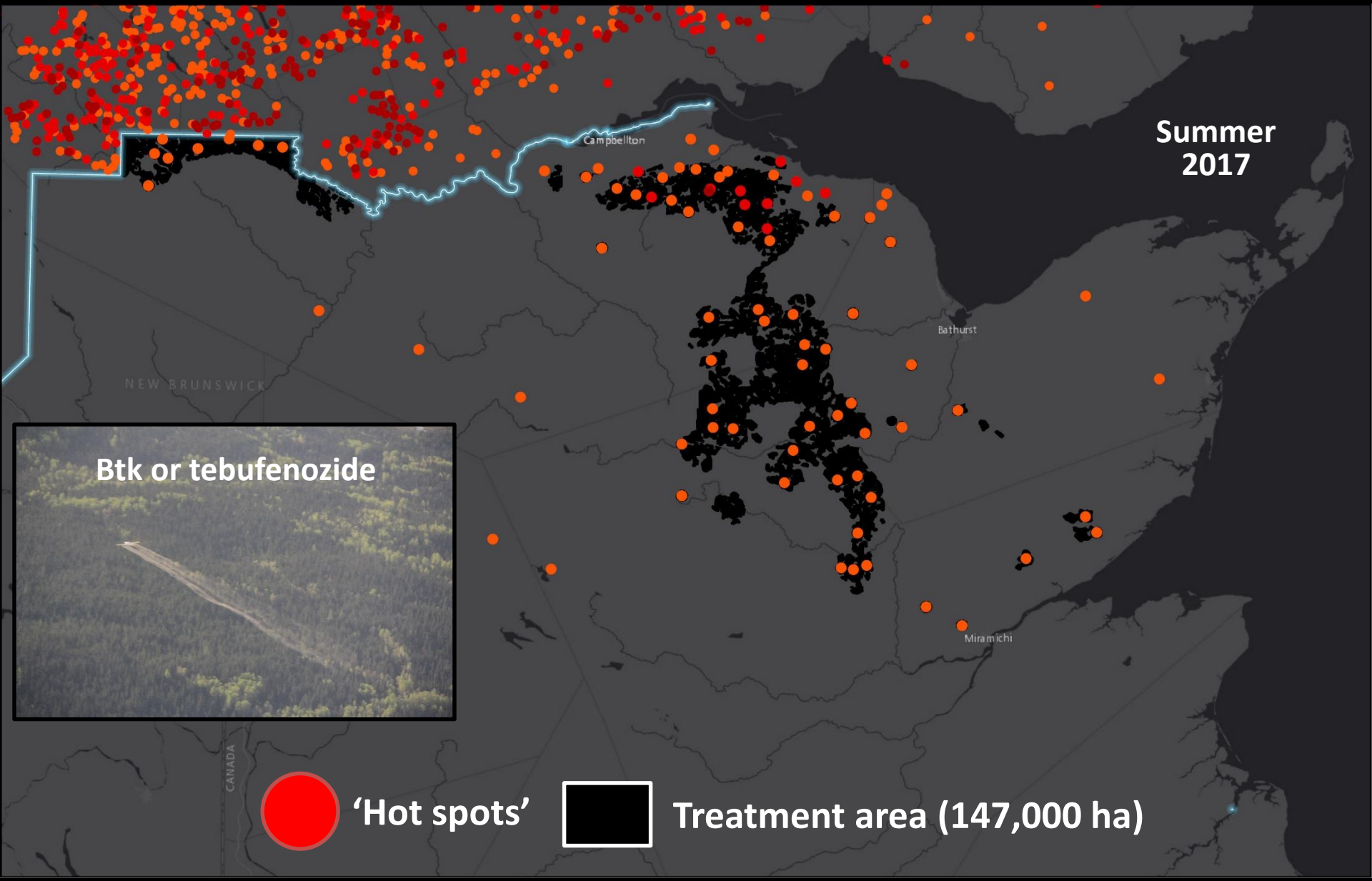
1) Control populations while densities are relatively low.

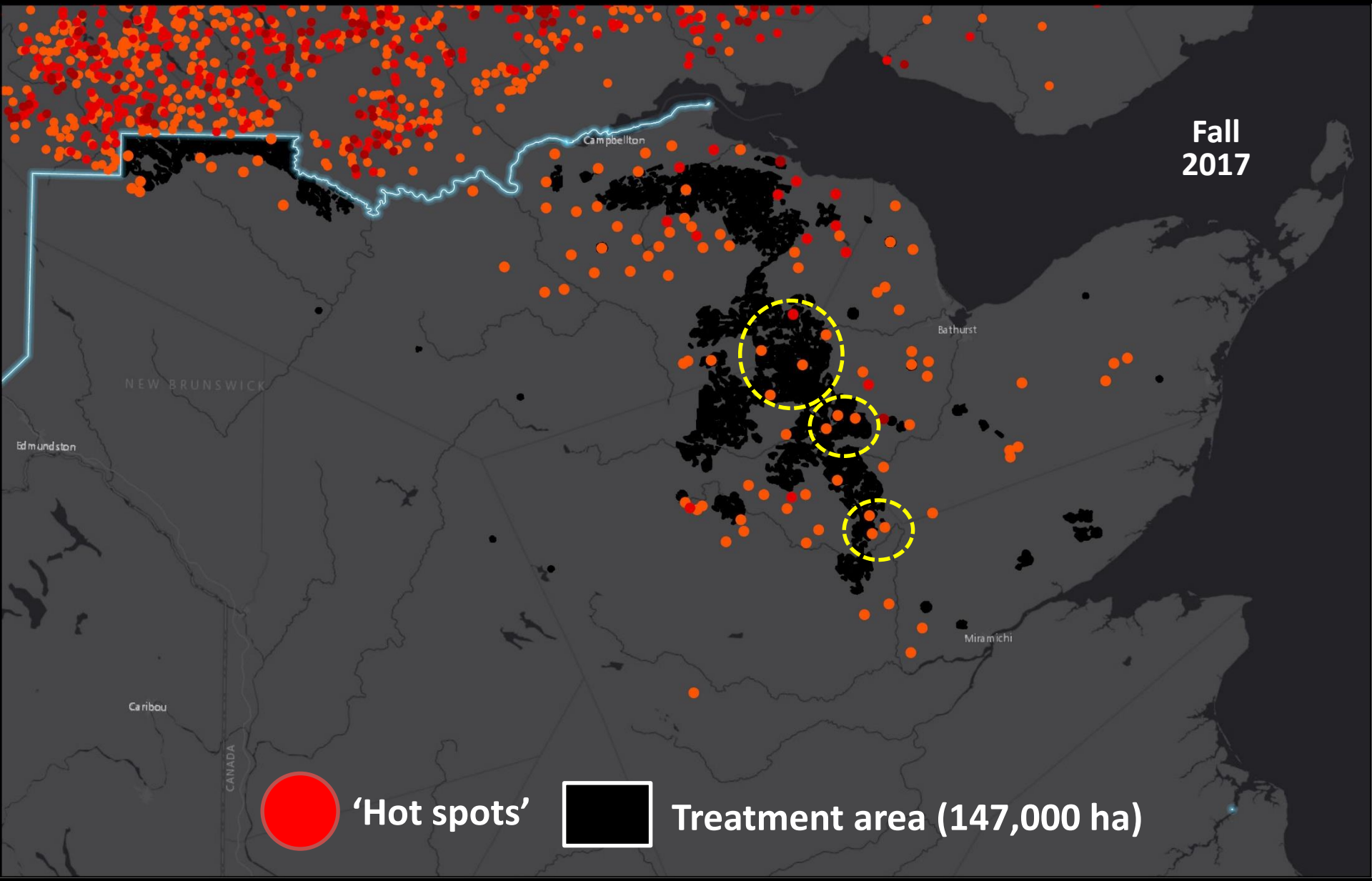
2) Control over large areas to limit sources of immigration.

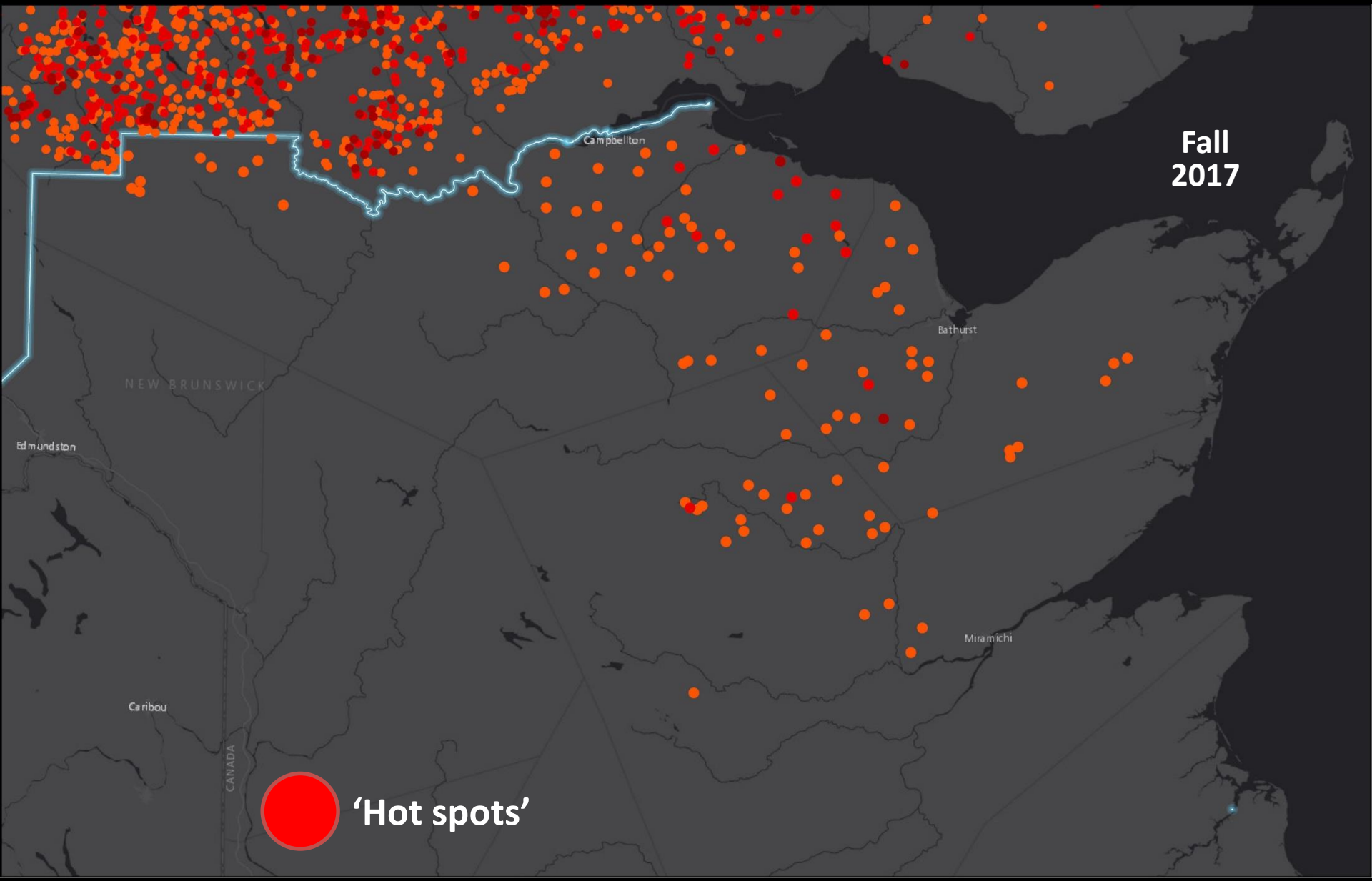
3) Avoid impacting natural enemies or other non-target organisms.

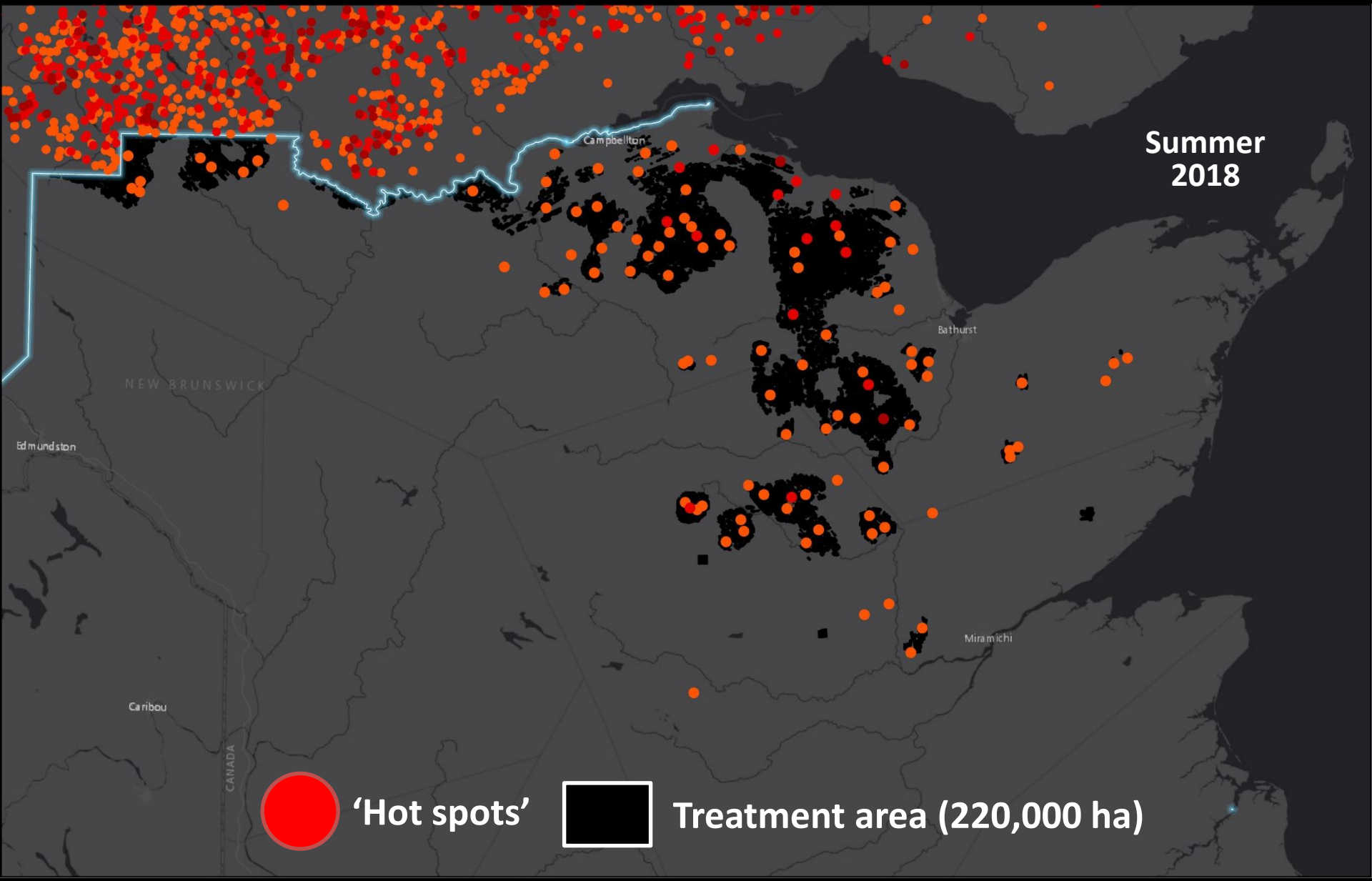


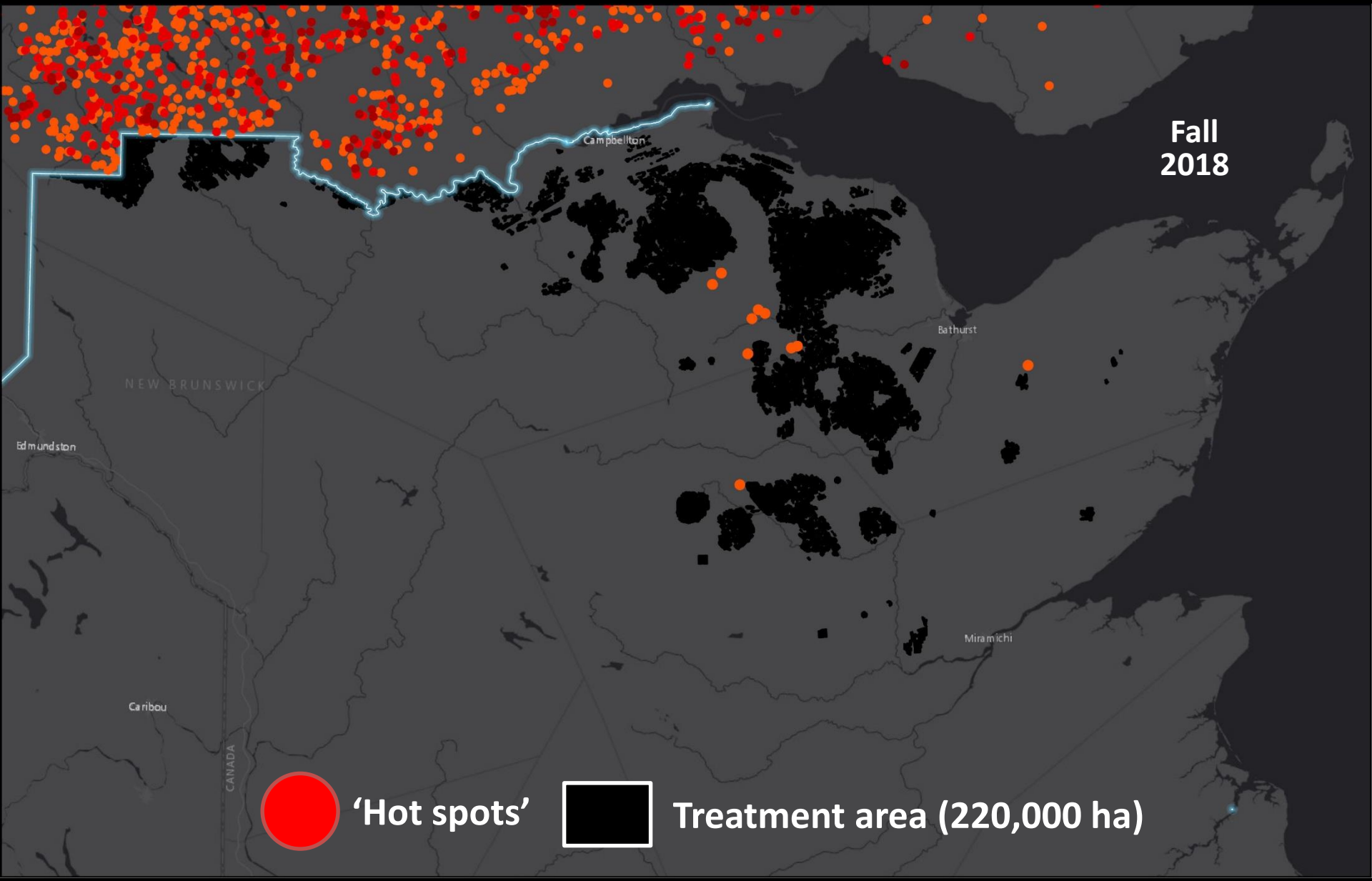

Fall
2016
Campbellton
Bathurst
NEW BRUNSWICK
Edmundston
Miramichi
‘Hot spots’


Summer 2017
Campbellton
Bathurst
Miramichi
NEW BRUNSWICK
CANADA
Btk or tebufenozide
'Hot spots'
Treatment area (147,000 ha)


Fall
2017
Campbellton
Bathurst
NEW BRUNSWICK
Edmundston
Miramichi
Caribou
CANADA
'Hot spots'
Treatment area (147,000 ha)


Campbellton
Bathurst
NEW BRUNSWICK
Edmundston
Miramichi
Caribou
CANADA
Fall
2017
‘Hot spots’


Summer
2018
Campbellton
Bathurst
NEW BRUNSWICK
Edmundston
Miramichi
Caribou
CANADA
‘Hot spots’
Treatment area (220,000 ha)


Fall
2018
Campbellton
Bathurst
NEW BRUNSWICK
Edmundston
Miramichi
Caribou
CANADA
‘Hot spots’
Treatment area (220,000 ha)

Fall
2018

Campbellton

Bathurst

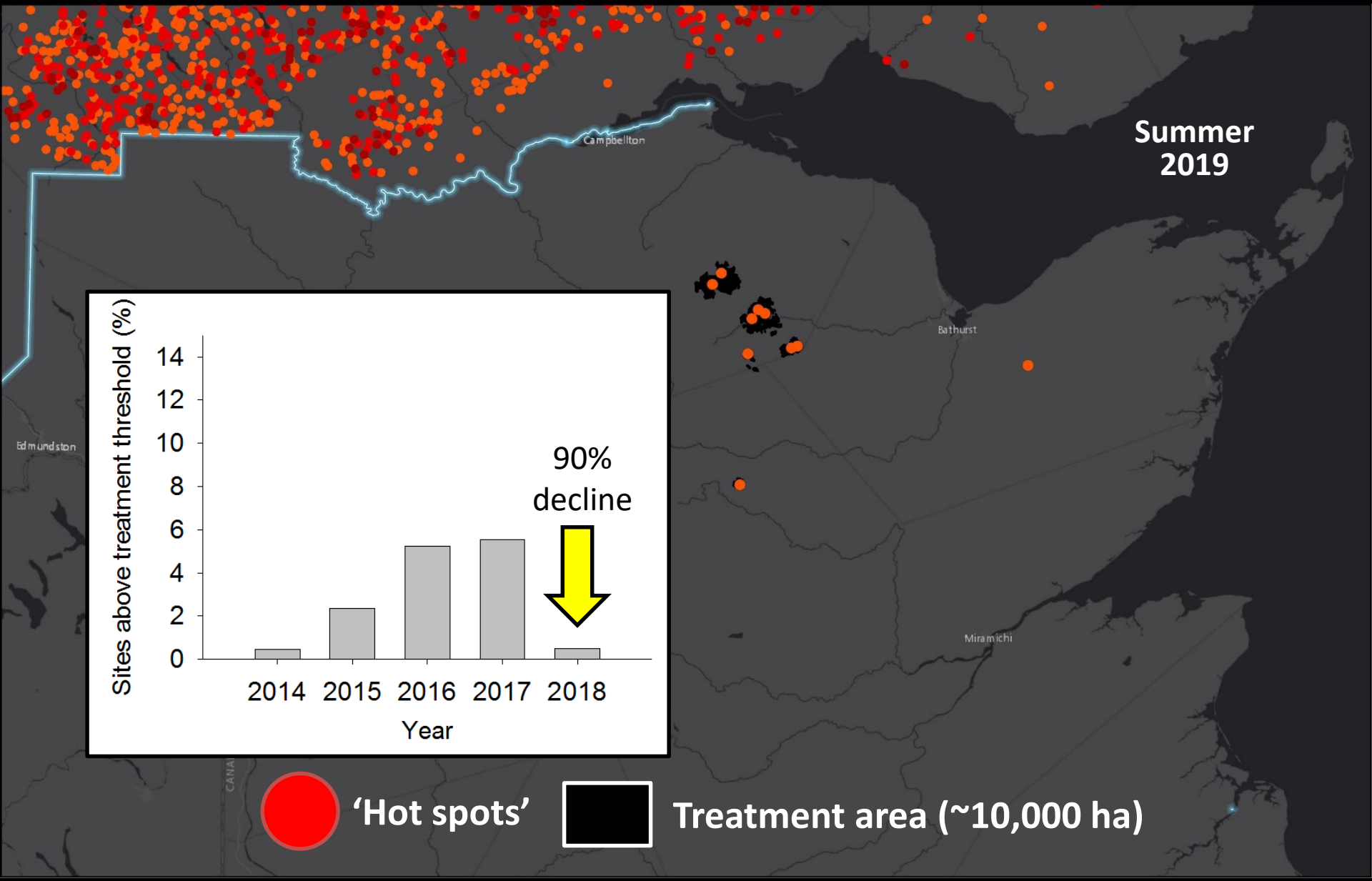
Edmundston

Miramichi

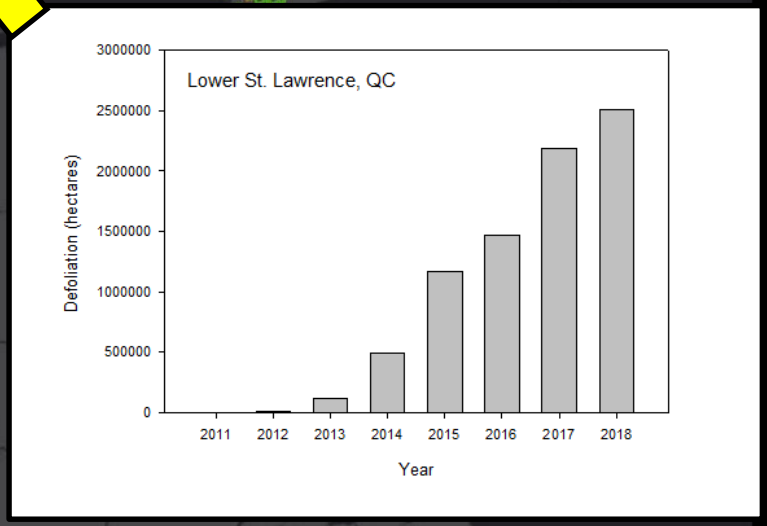
Caribou

CANADA

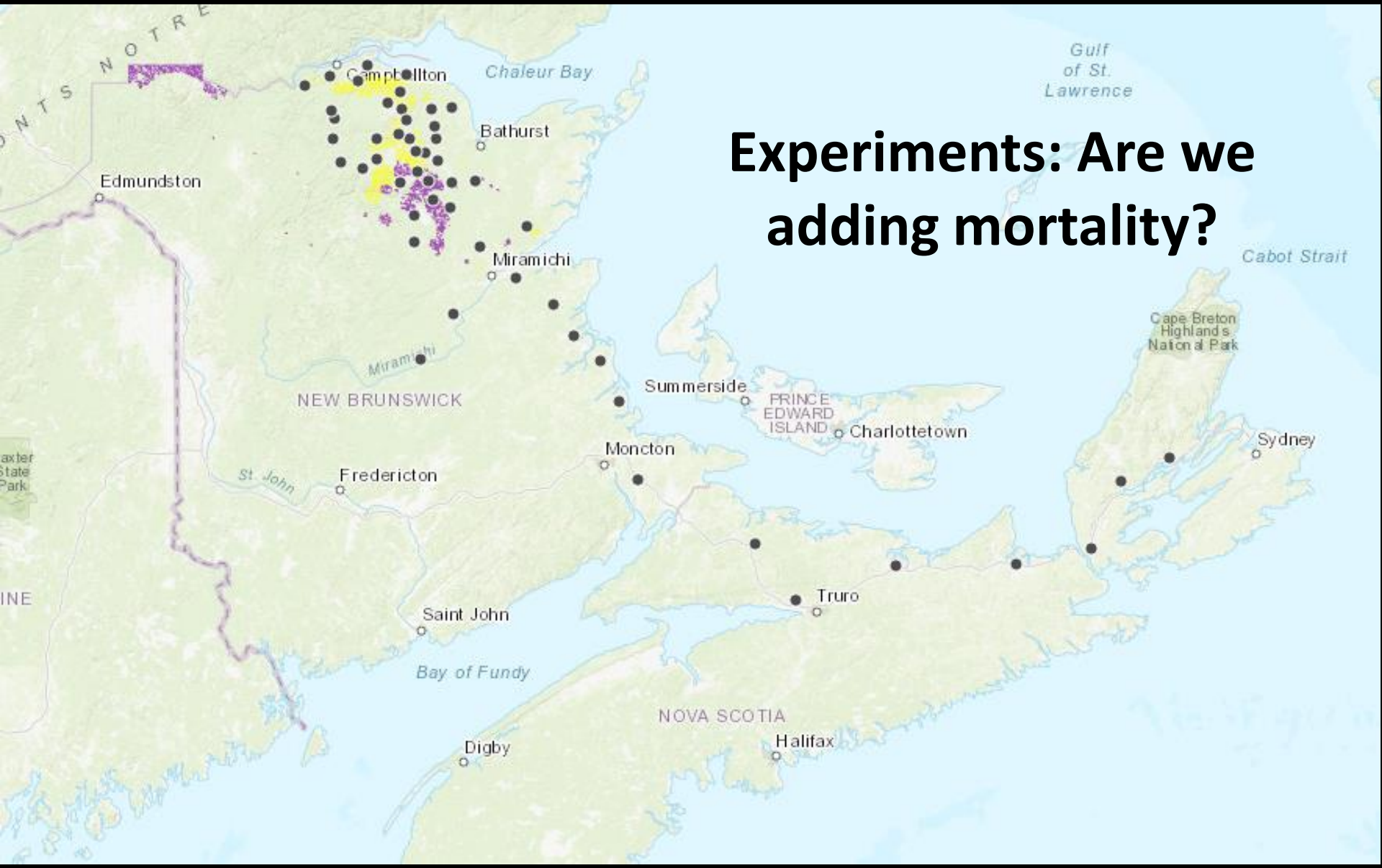
‘Hot spots’


Summer
2019
Campbellton
Bathurst
Edmundston
Miramichi
Sites above treatment threshold (%)
14
12
10
8
6
4
2
0
90%
decline
2014
2015
2016
2017
2018
Year
'Hot spots'
Treatment area (~10,000 ha)

Meanwhile to the north…

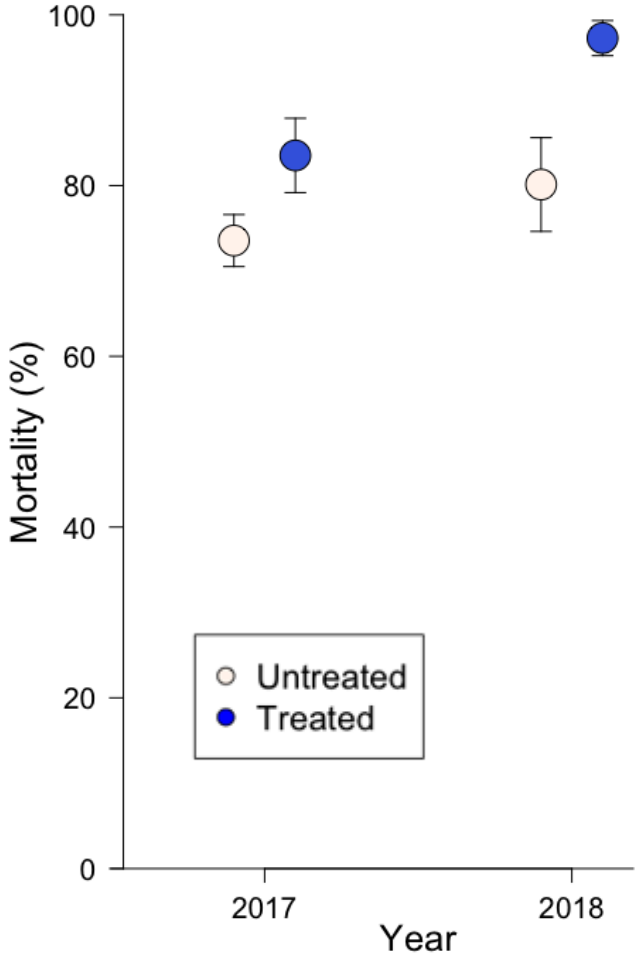


Baie-Comeau
Gaspé
St. Lawrence Seaway
Rimouski
Percé
Campbellton
NEW BRUNSWICK
Edmundston
Miramichi
Caribou

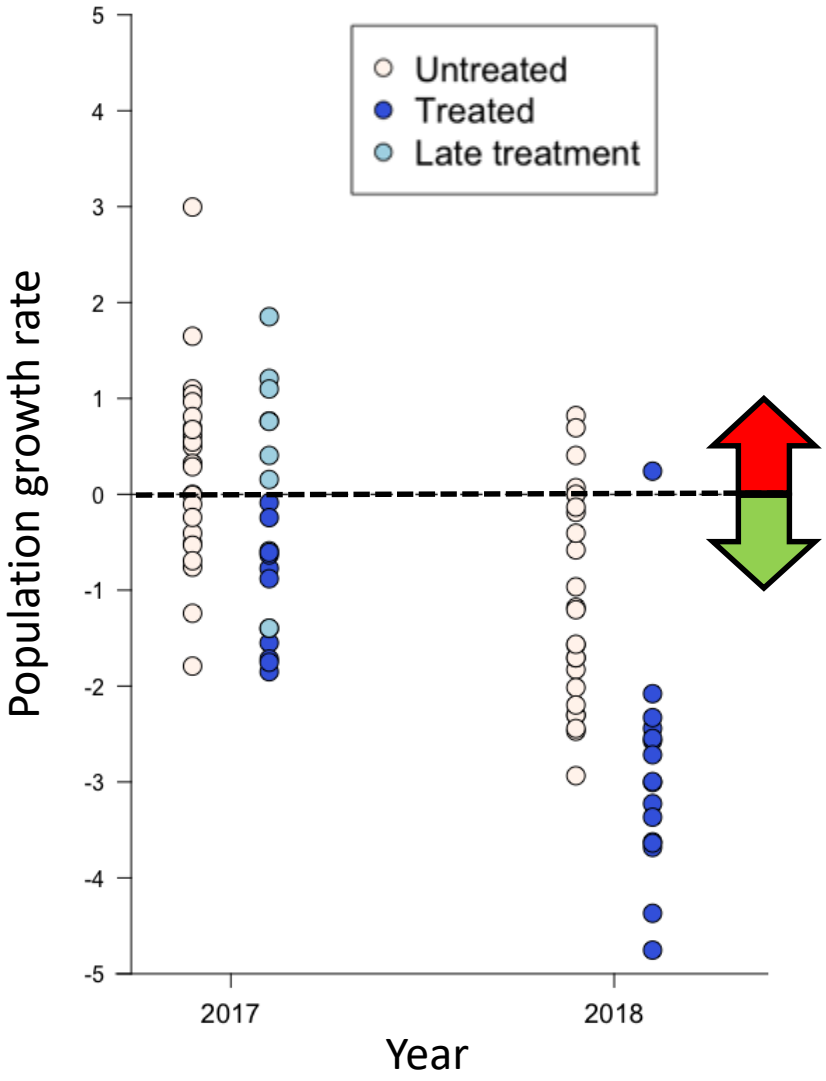


Experiments: Are we adding mortality?

Treatment mortality



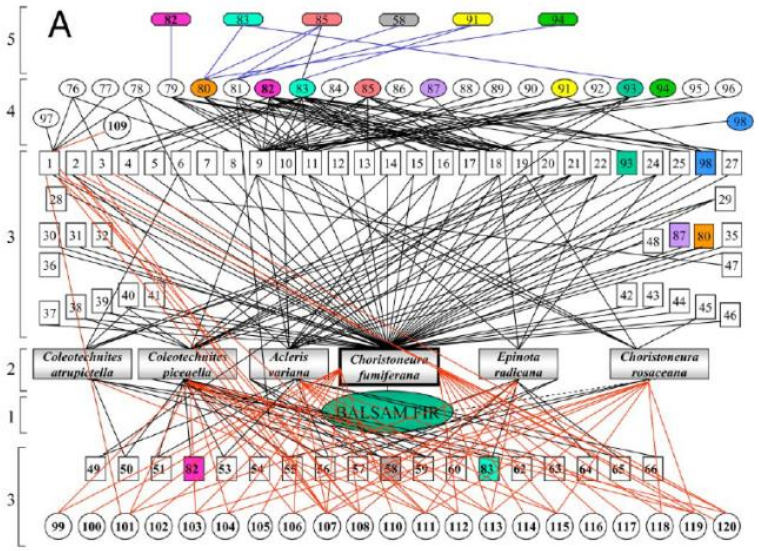
Population growth



Is it working?

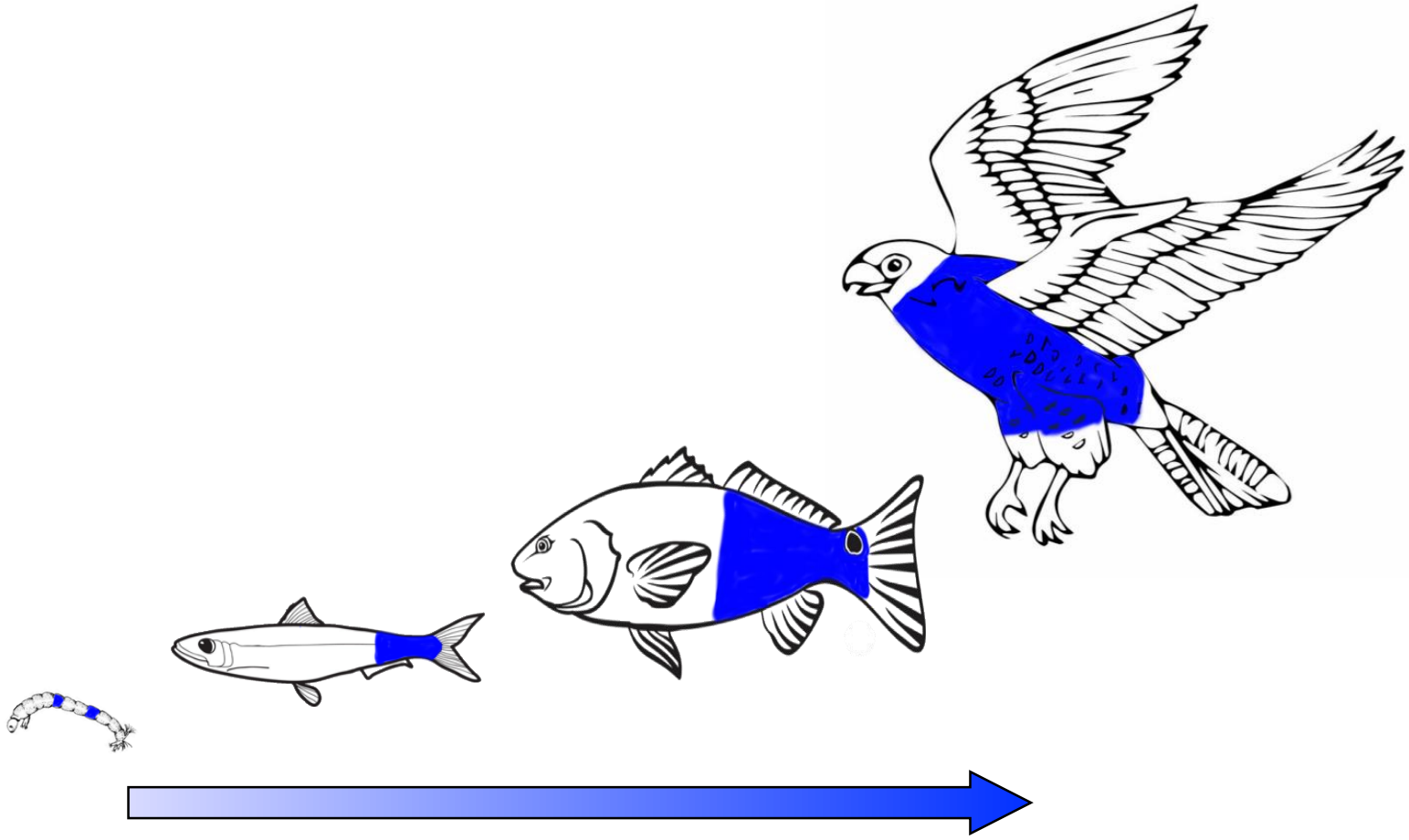
- Results are encouraging.
- A little ‘added’ mortality goes a long way.
- Is it sustainable? Can we outlast the ongoing outbreak in Quebec?
- What are the potential non-target impacts?
  - (e.g., for other caterpillars and the natural enemies they harbor).

Non-target Impacts: Broader ecosystem




CROSS COUNTRY
insect spray
CONTAINING 50% DDT
destroys many common insects
USE ON
POTATOES,
PEAS, CORN,
FRUITS and
ORNAMENTALS
No. 1365
NET CONTENTS 1 LB.

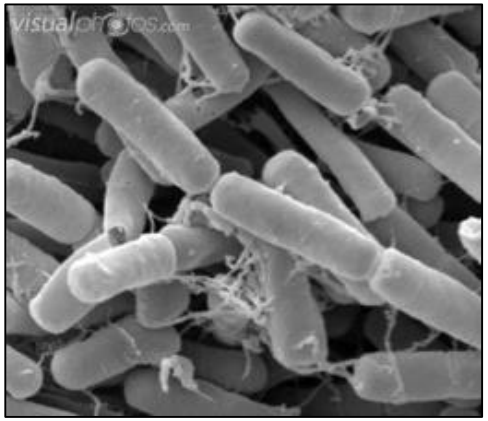
Bioaccumulation - net accumulation of contaminant



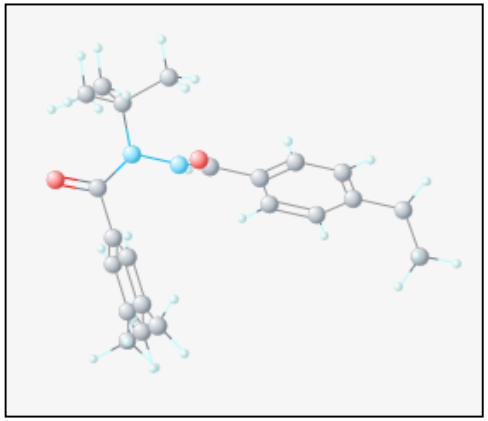
Targeted treatments

Btk

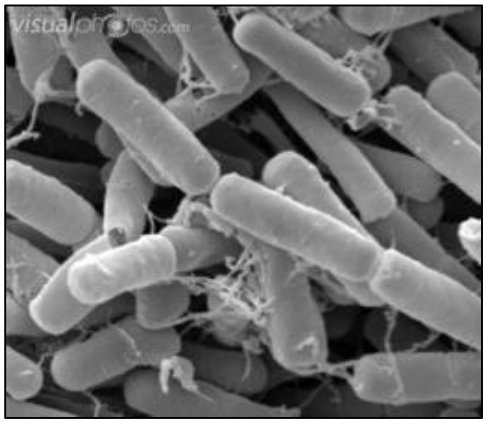
(*Bacillus thuringensis kurstaki*)



Tebufenozide



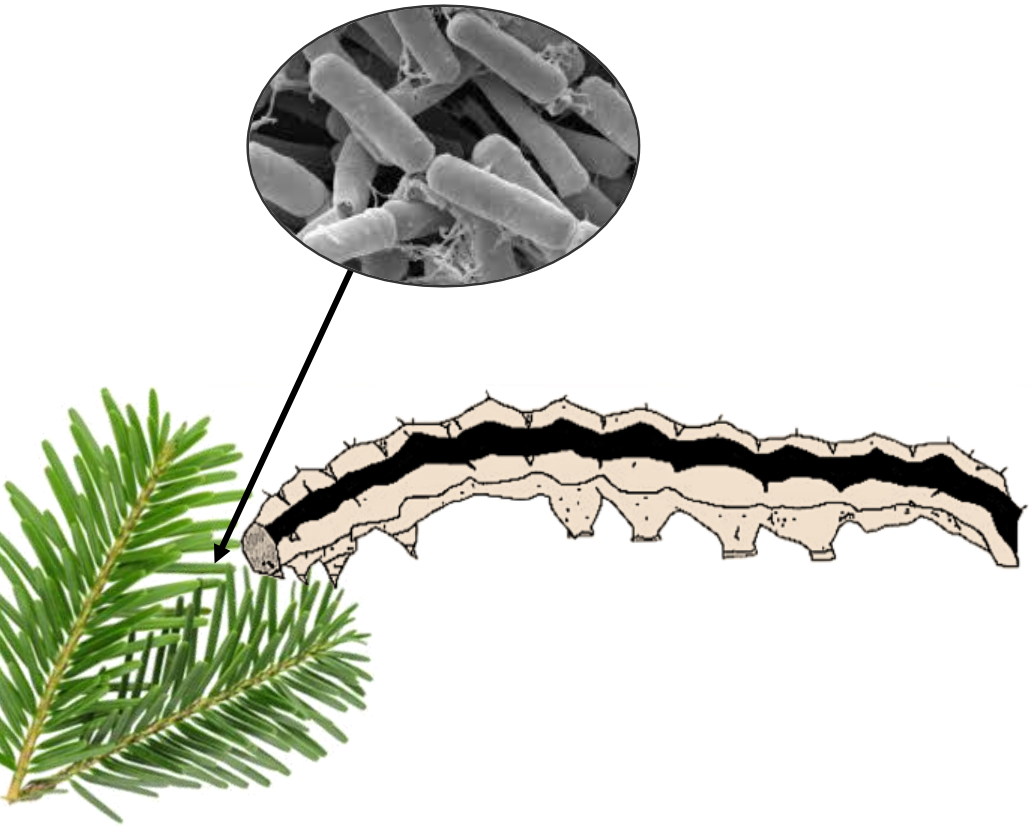
Btk is a common soil bacteria



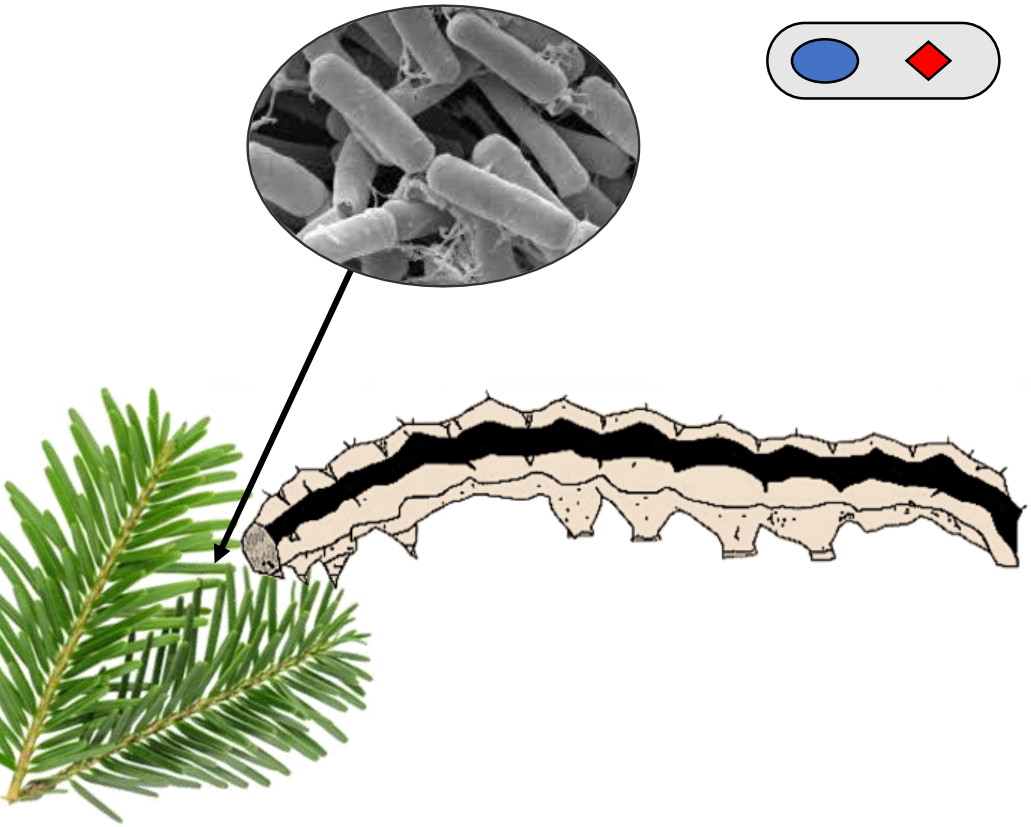
- Highly selective with low toxicity
  - No effect on mammals, fish, birds, shellfish, etc.

- How does it work?

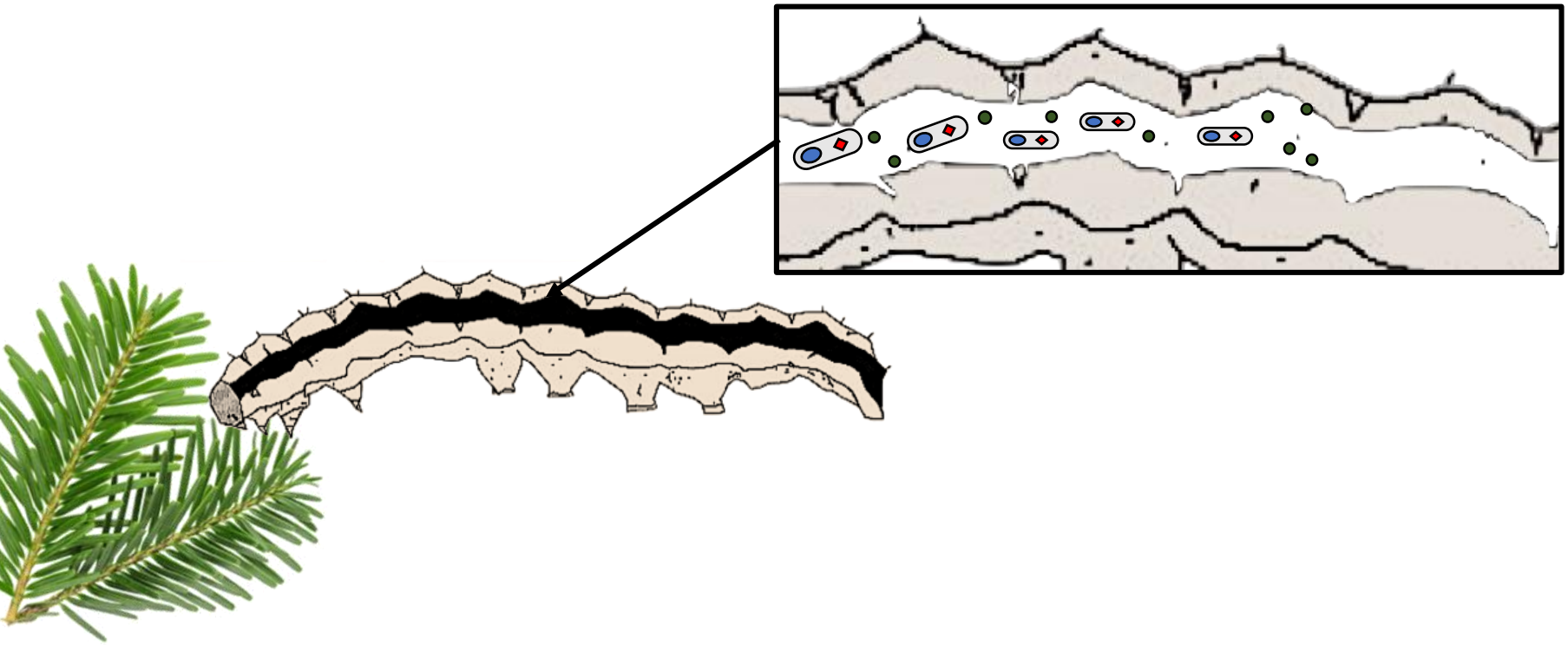
Btk toxins are activated in the gut



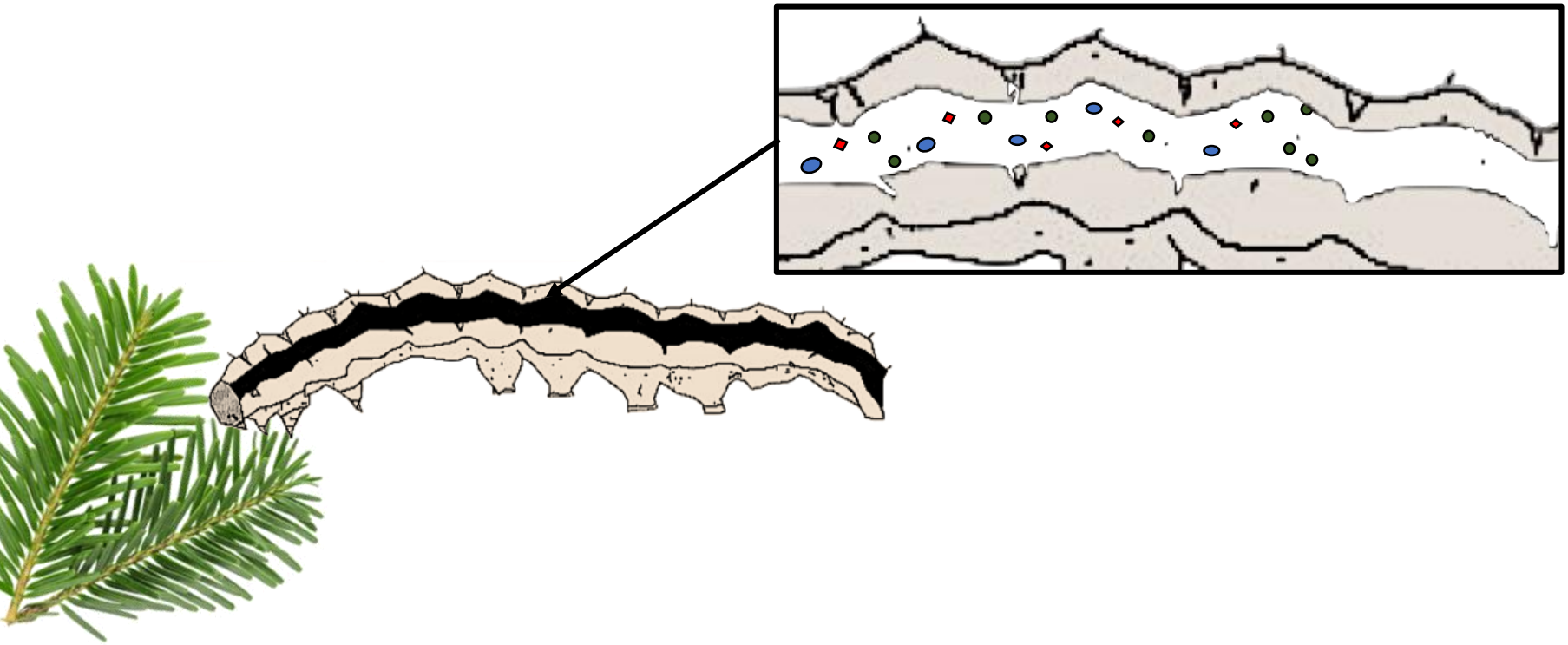
Btk toxins are activated in the gut



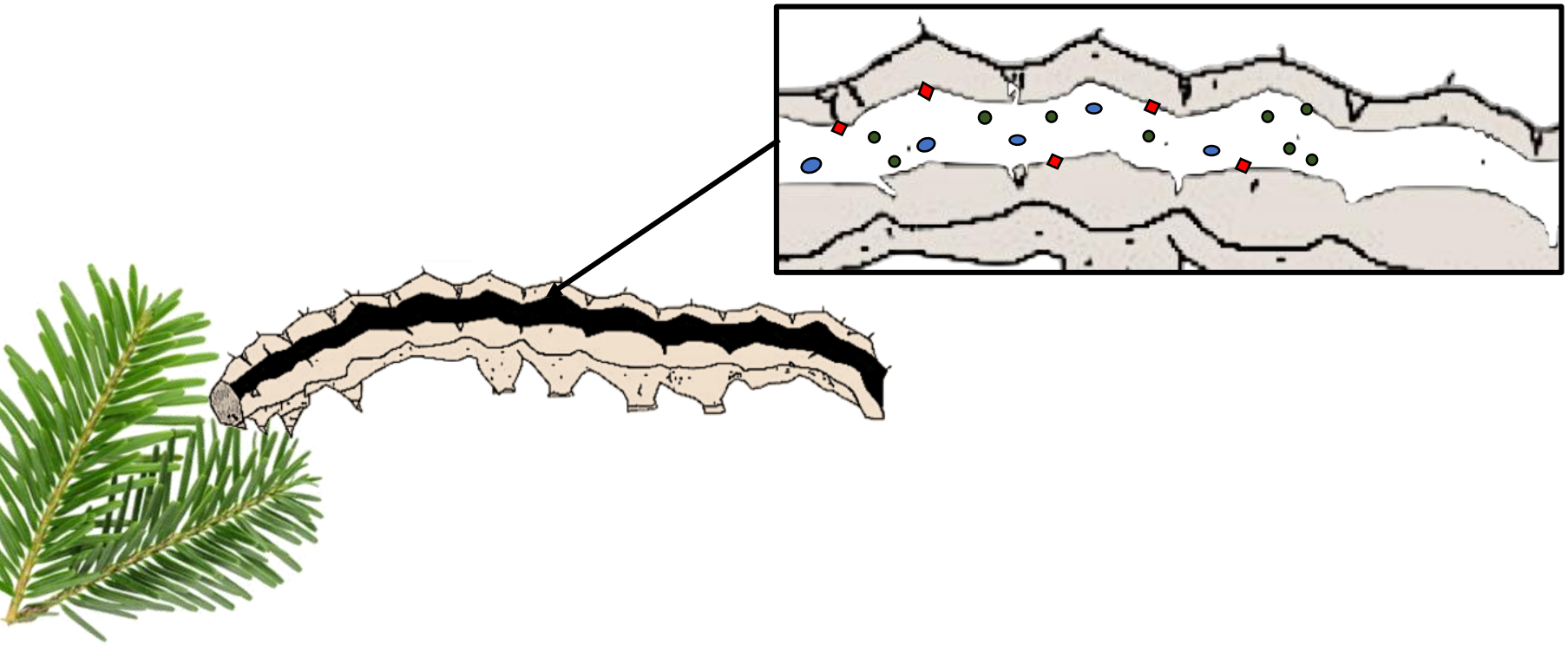
Btk toxins are activated in the gut



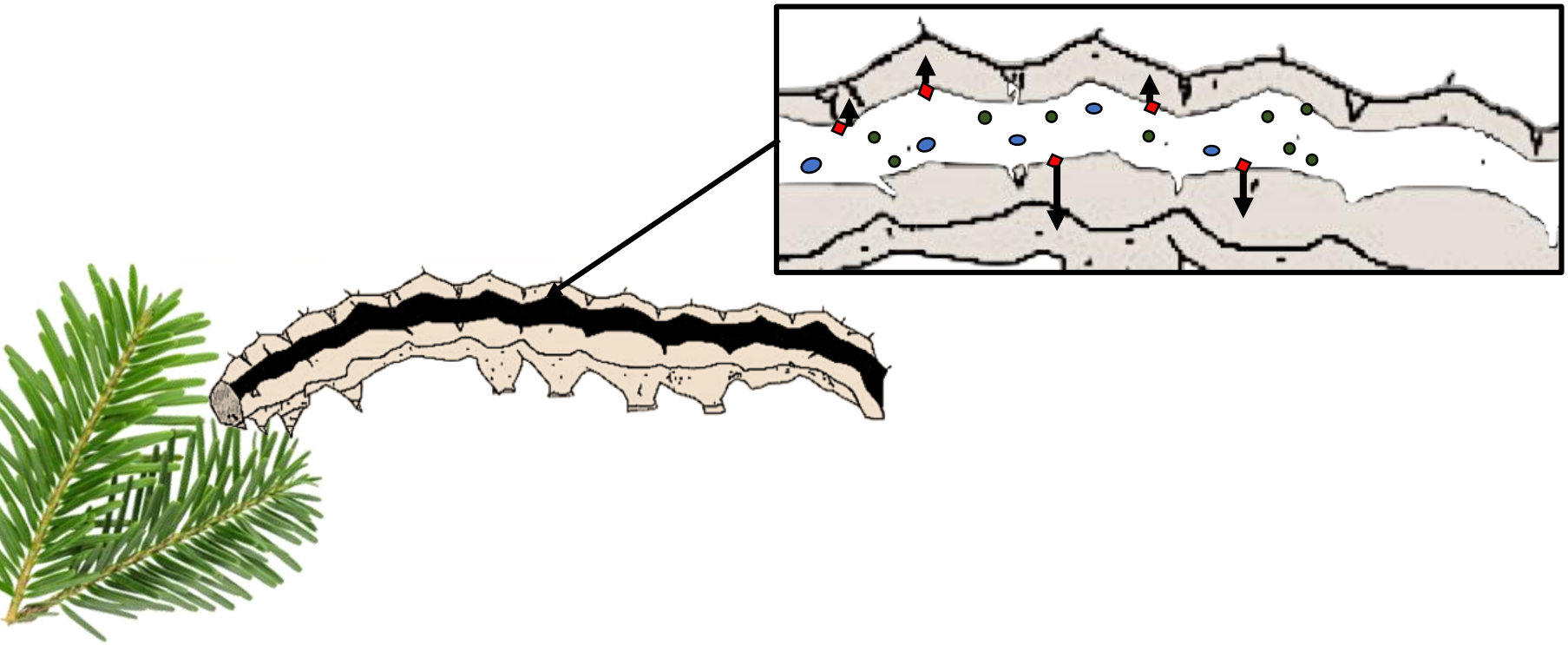
Btk toxins are activated in the gut



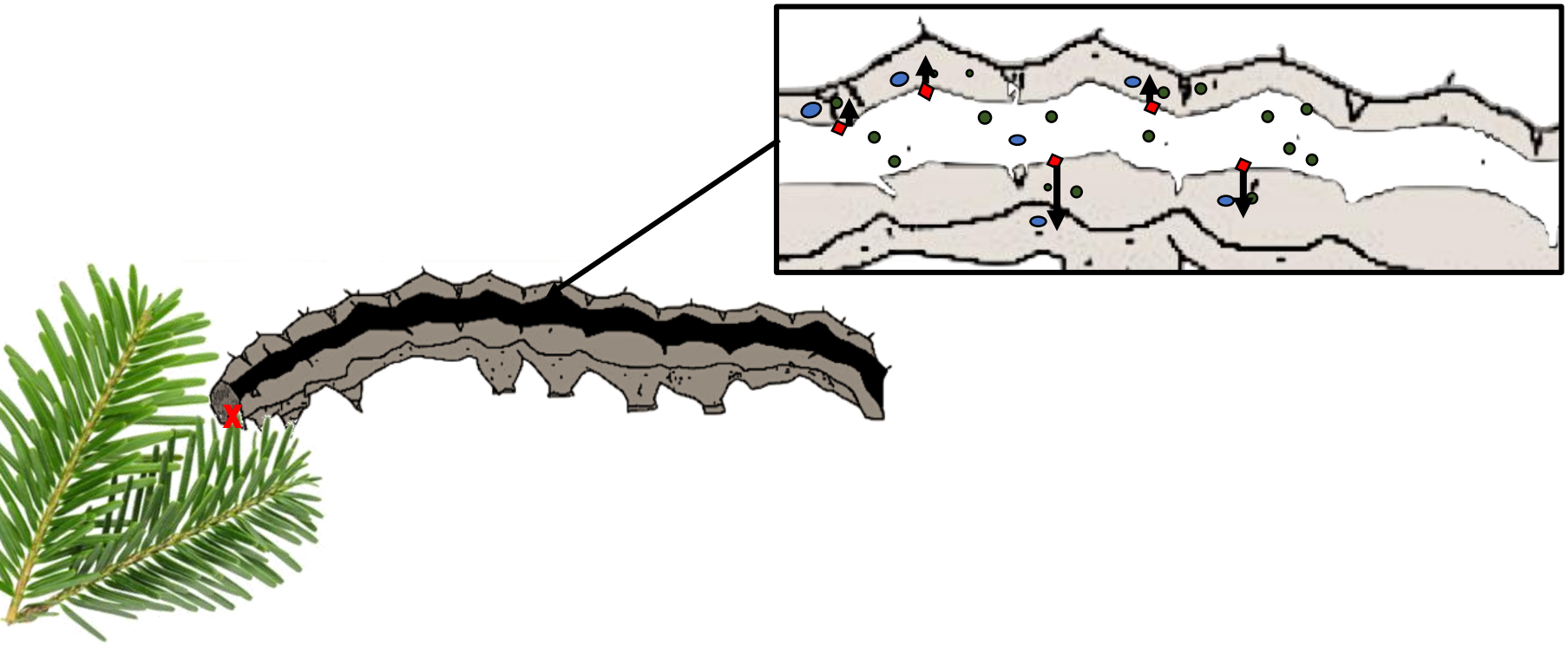
Btk toxins are activated in the gut



Btk toxins are activated in the gut



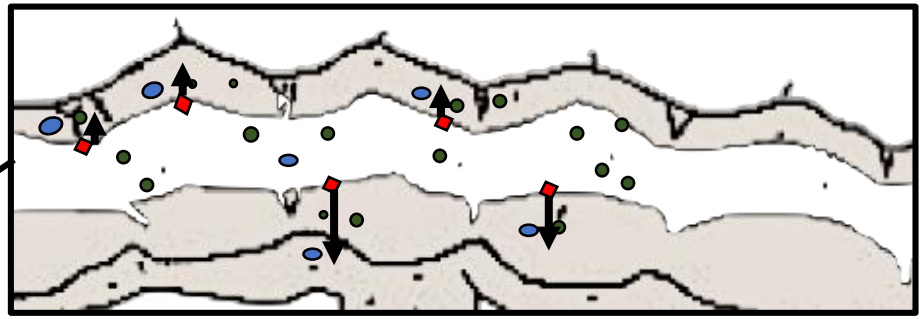
Btk spores germinate in the body cavity

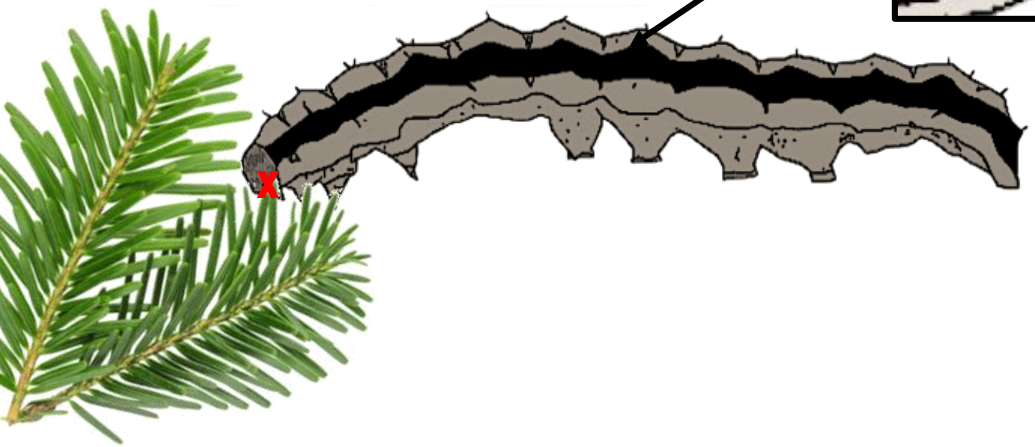


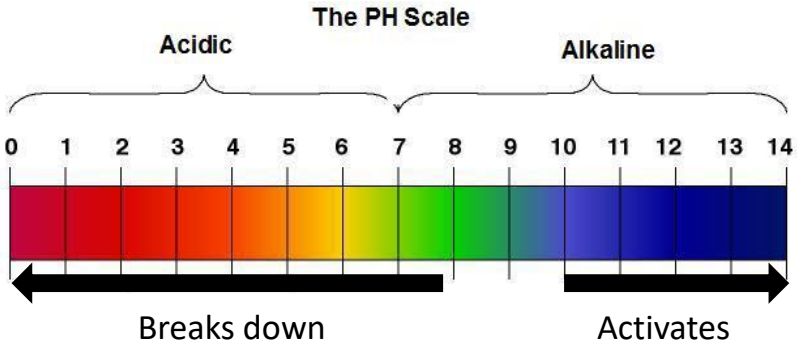
48h post ingestion (dead)

24h post ingestion

Healthy

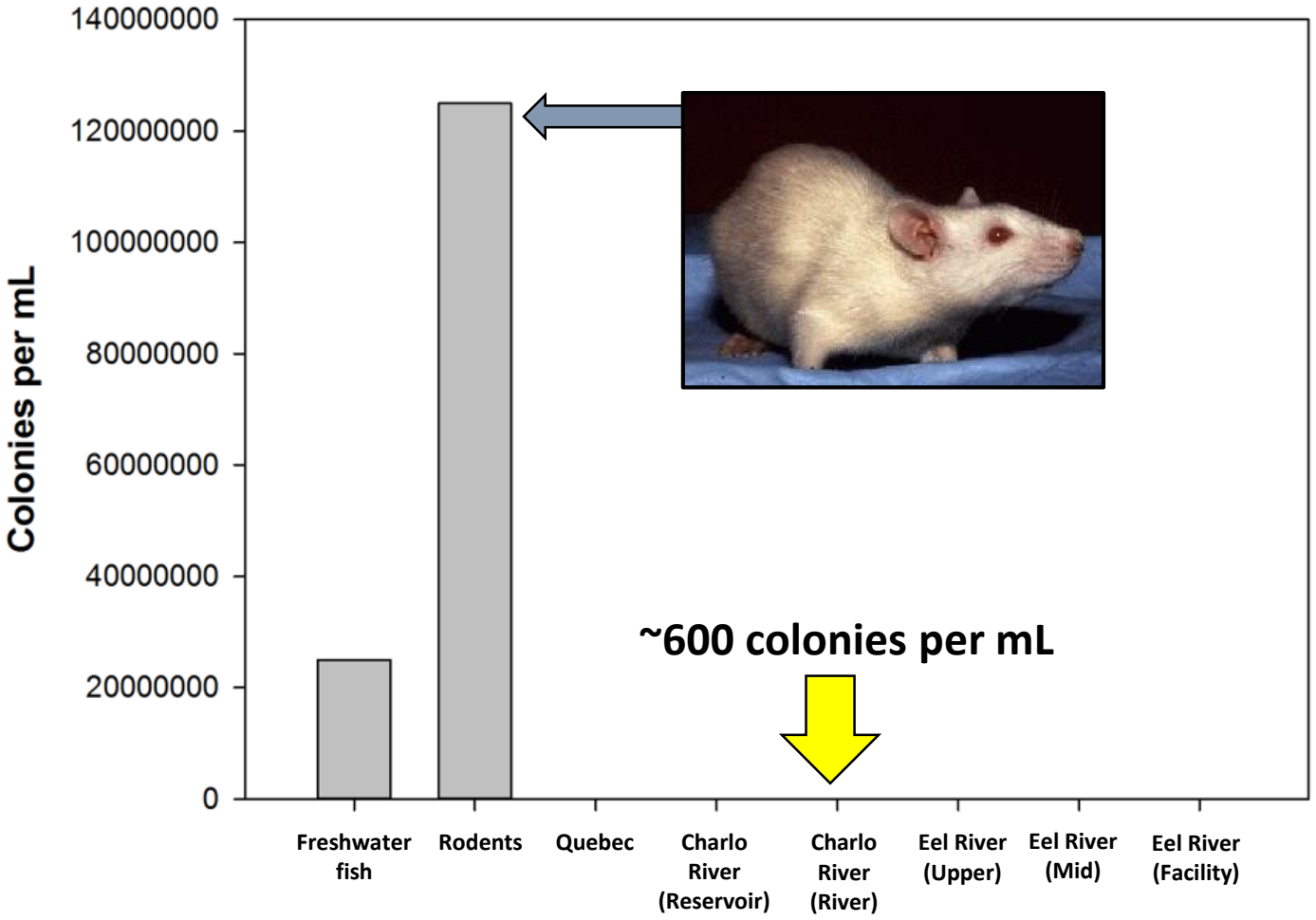






Only treat areas with high spruce/fir content

How much ends up in water?


140000000
120000000
100000000
80000000
60000000
40000000
20000000
0
Colonies per mL
~600 colonies per mL
Freshwater fish
Rodents
Quebec
Charlo River (Reservoir)
Charlo River (River)
Eel River (Upper)
Eel River (Mid)
Eel River (Facility)


2004
1 CENT
2005
CANADA

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

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ISO 14001:2004 certified

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