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

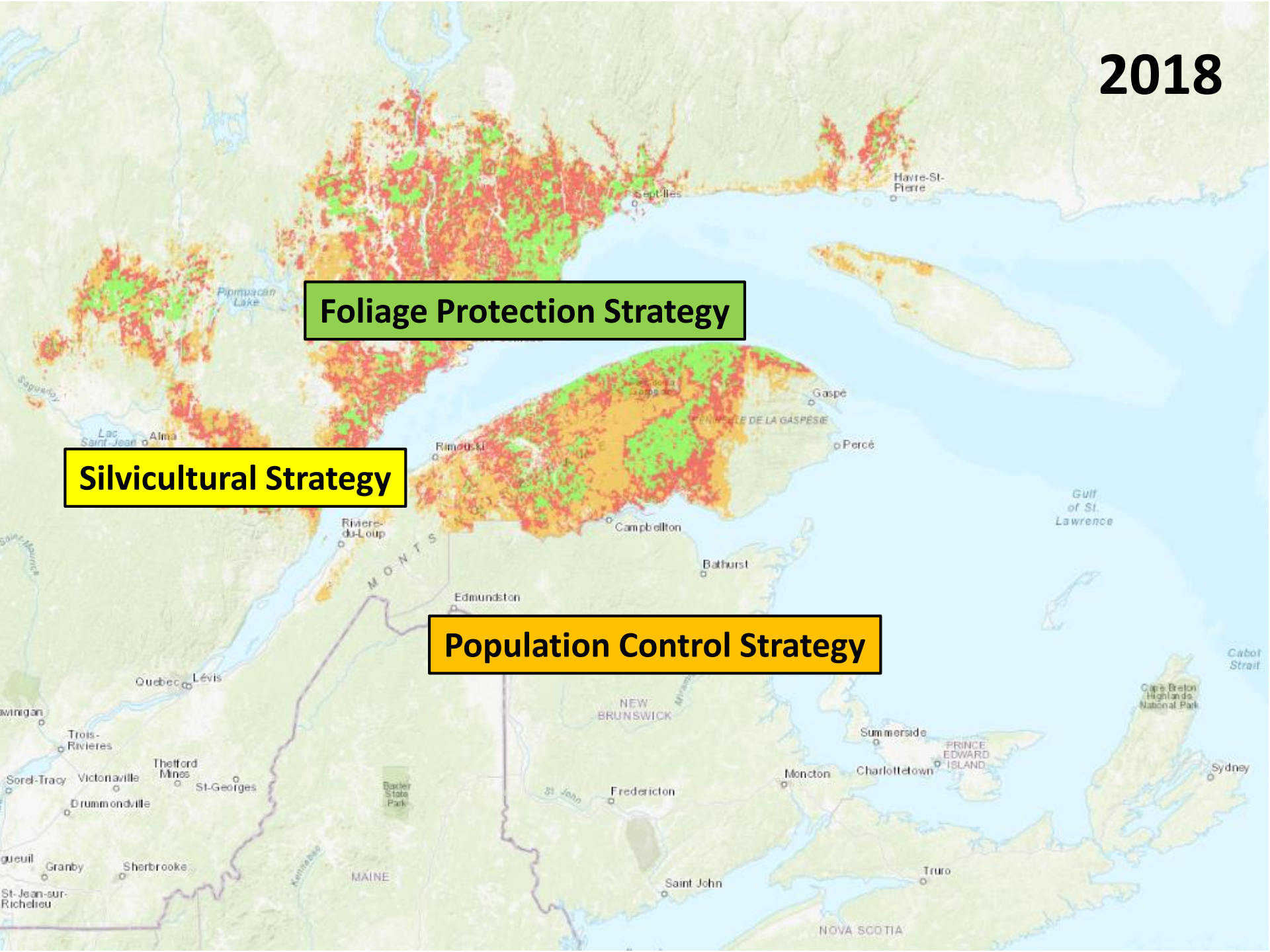
Atlantic Forestry Centre, Canadian Forest Service

Source: NB Woodlot owners webpage

Photo: Michigan State University

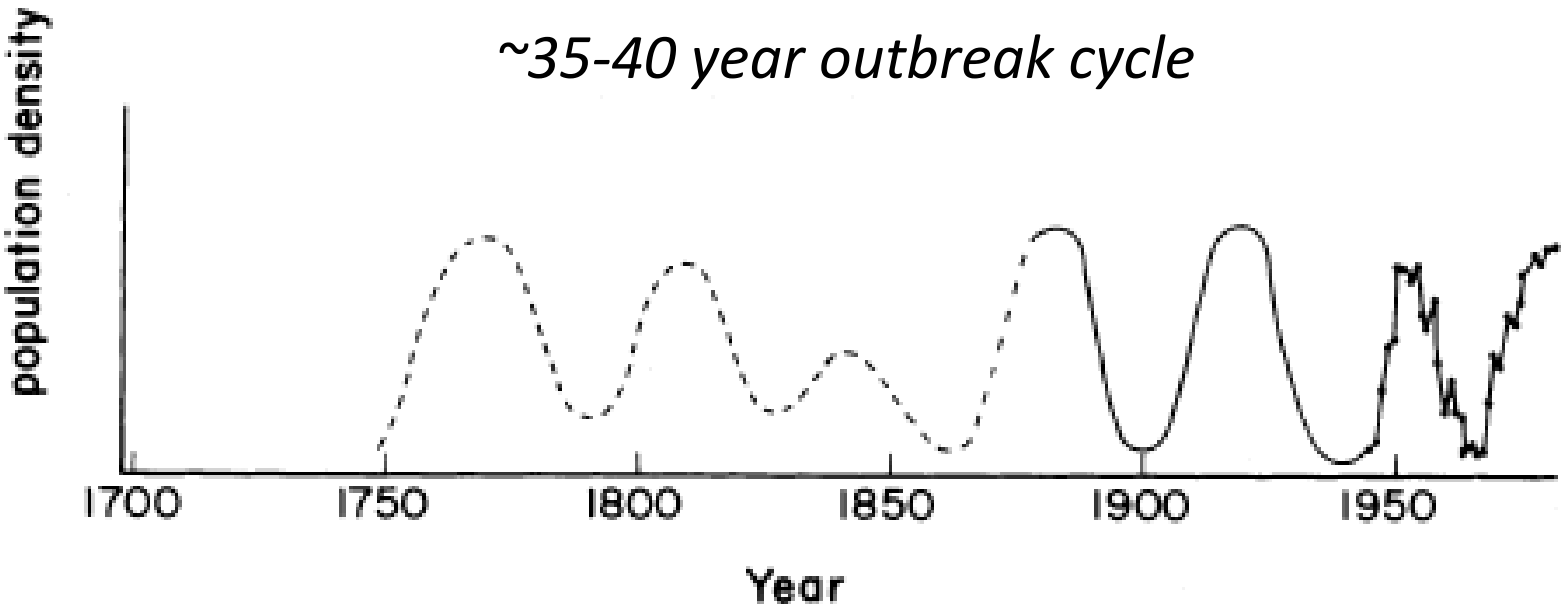
Cape Breton Highlands, 1977

Photo: Ed kettela


2018
Foliage Protection Strategy
Silvicultural Strategy
Population Control Strategy
Havre-St-Pierre
Sept-Îles
Pipmuacan Lake
Saguenay
Lac Saint-Jean
Alma
Rimouski
Gaspé
PENINSULE DE LA GASPÉSIE
Percé
Gulf of St. Lawrence
Rivière-du-Loup
Campbellton
Bathurst
MONTS
Edmundston
Quebec
Lévis
NEW BRUNSWICK
Cape Breton Highlands National Park
Cabot Strait
Trois-Rivières
Thetford Mines
Sorel-Tracy
Victoriaville
St-Georges
Drummondville
Baxter State Park
St. John
Fredericton
Summerside
PRINCE EDWARD ISLAND
Moncton
Charlottetown
Sydney
Granby
Sherbrooke
St-Jean-sur-Richelieu
MAINE
Saint John
Truro
NOVA SCOTIA

Management strategy
is built from
Population dynamics

~35-40 year outbreak cycle



Royama 1984

What drives spruce budworm outbreak cycles?
Photo: Ed kettela

Silvicultural hypothesis

Forest regeneration cycles drive budworm outbreaks

BUT…

Tree ring data too short and imprecise

Forest regeneration cycle takes ~70 years

Silvicultural hypothesis 2.0

Forest composition influences outbreak intensity

To an extent…

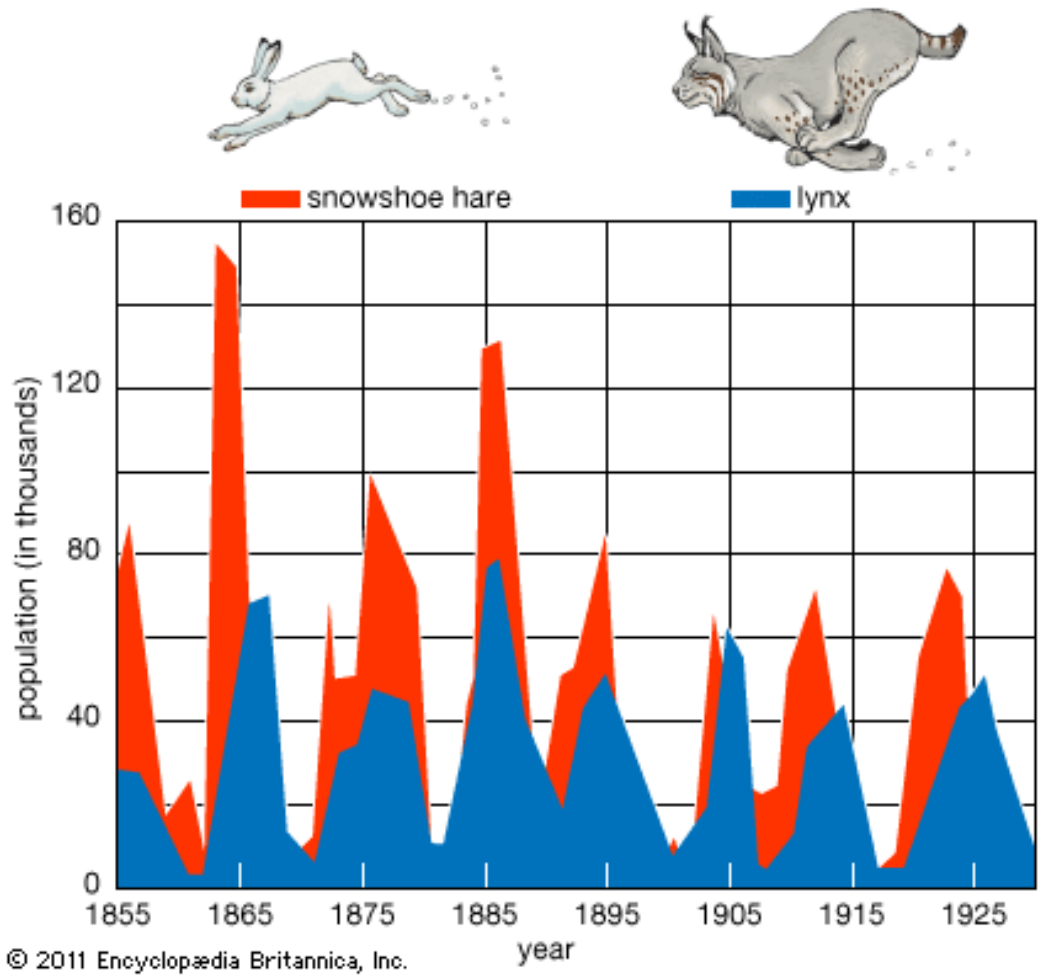
More hardwood content =
Less defoliation & shorter duration
Zhang et al. 2018

Balsam fir:black spruce ratio influences stand susceptibility
Bognounou et al. 2017

Silvicultural strategies?

Oscillatory hypothesis

Predator-prey cycles drive budworm outbreaks

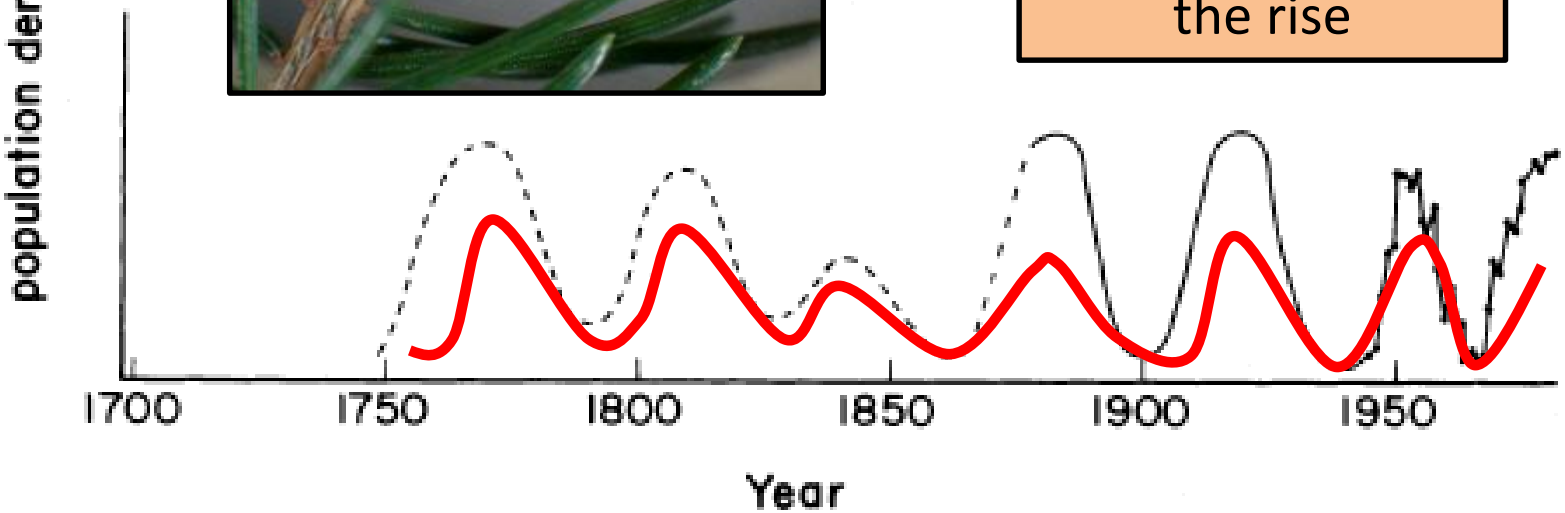


Oscillatory hypothesis

Predator-prey cycles drive budworm outbreaks

Only data for collapsing populations

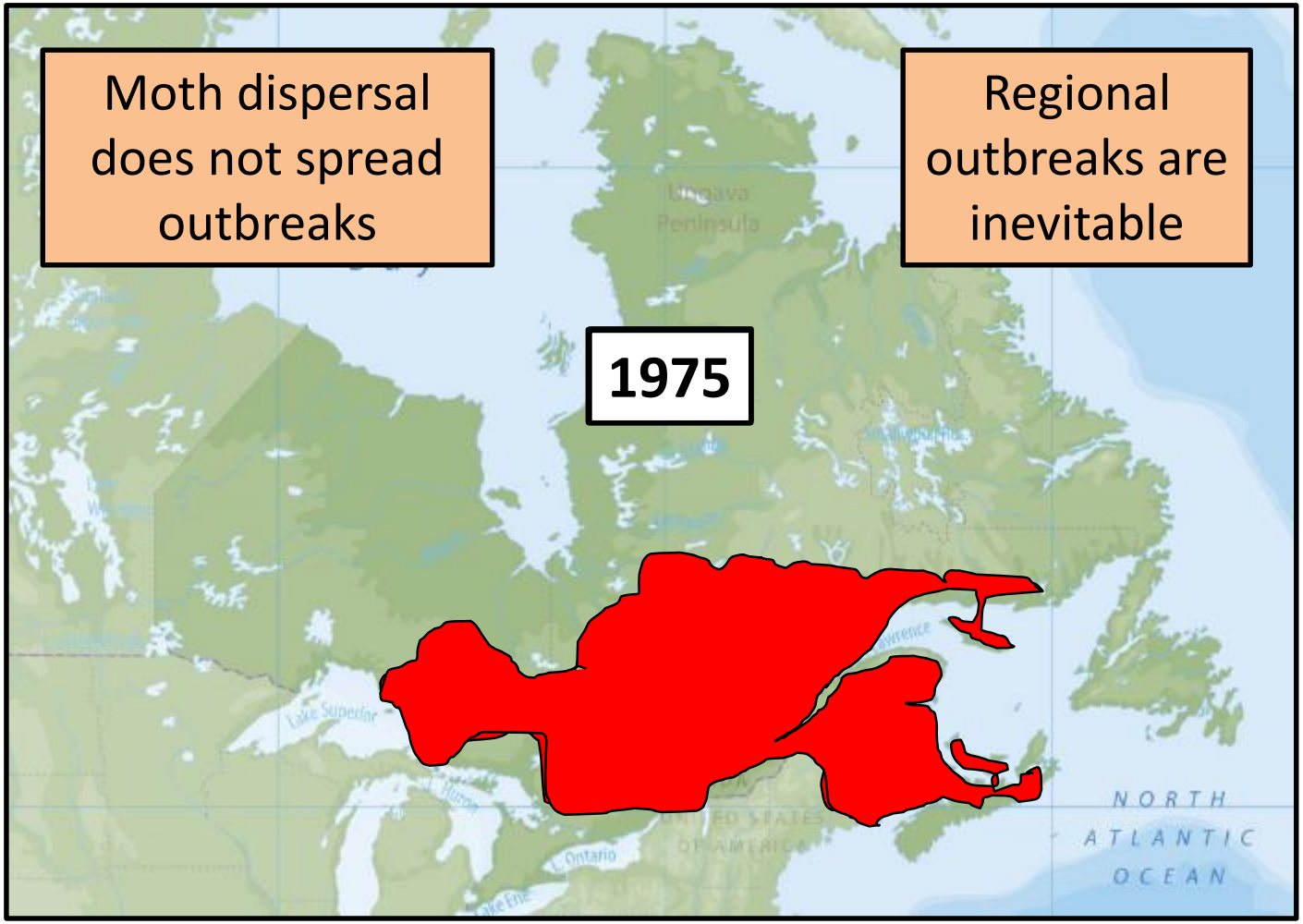
…but, no data for the rise



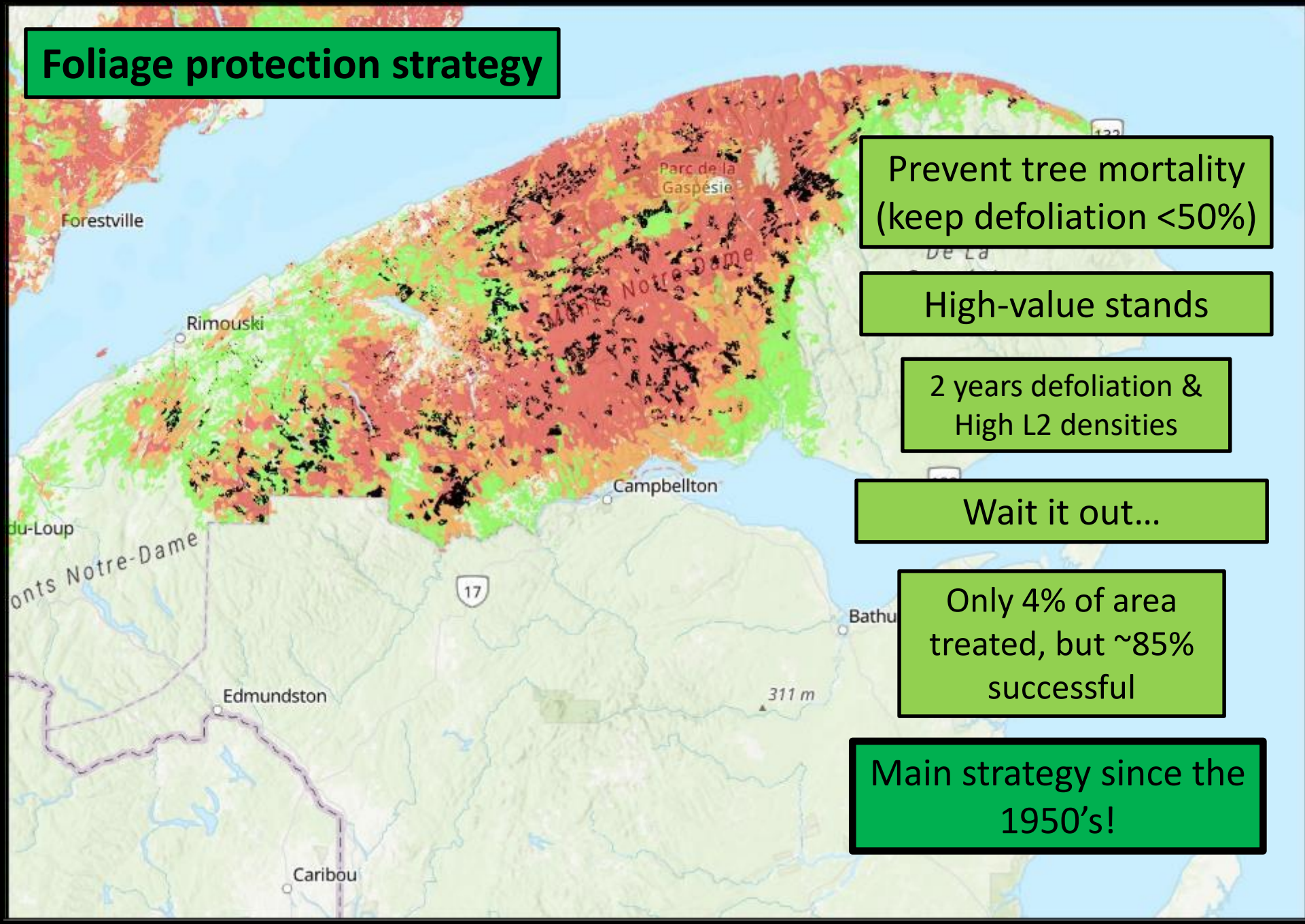
Royama 1984

Oscillatory hypothesis

Outbreaks are synchronous across the landscape



Foliage protection strategy



Prevent tree mortality (keep defoliation <50%)

High-value stands

2 years defoliation & High L2 densities

Wait it out…

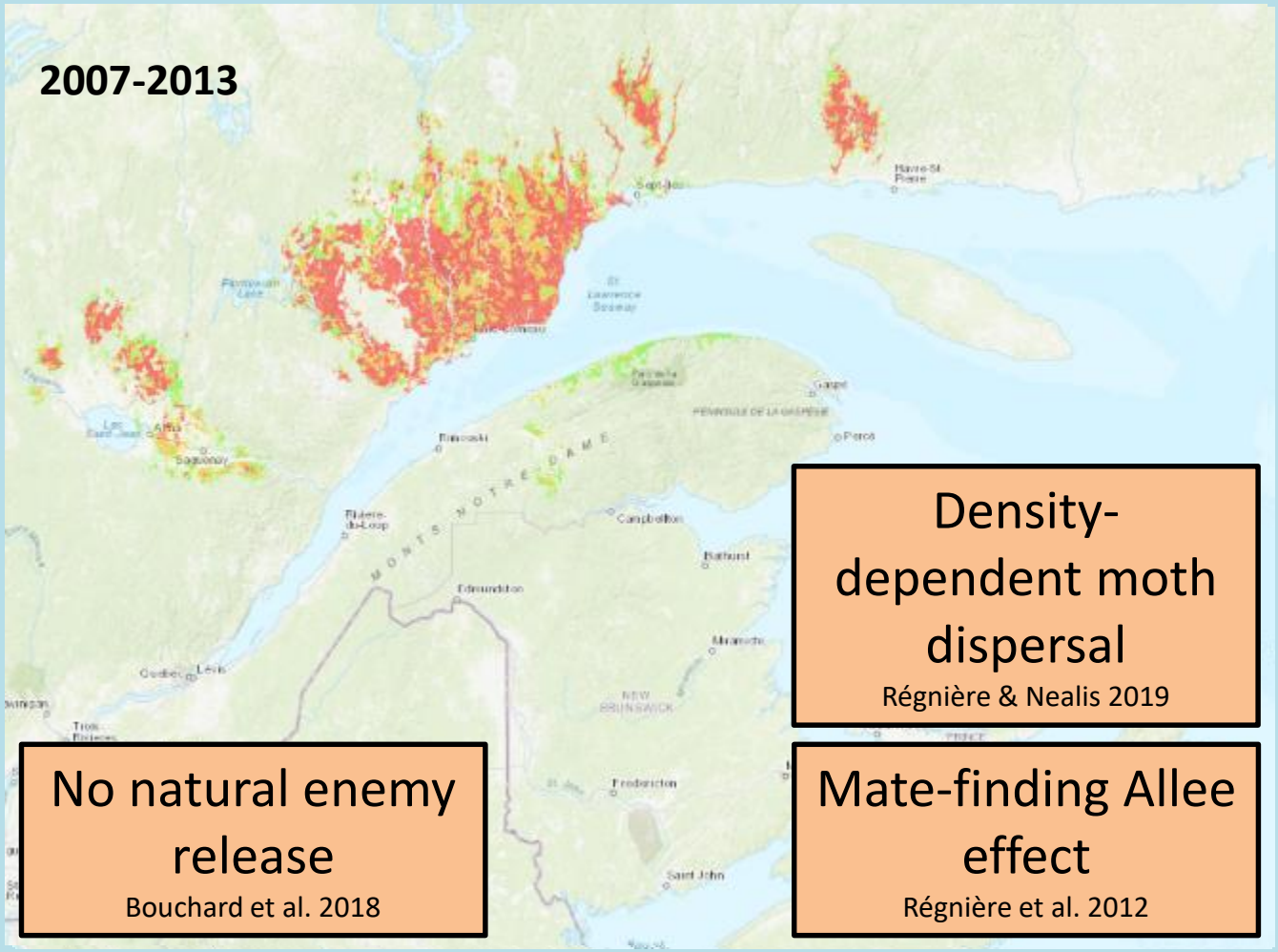
Only 4% of area treated, but ~85% successful

Main strategy since the 1950's!

Epicentre Hypothesis

(Double equilibrium hypothesis)

Outbreaks spread ‘contagiously’



Density-dependent moth dispersal

Régnière & Nealis 2019

No natural enemy release

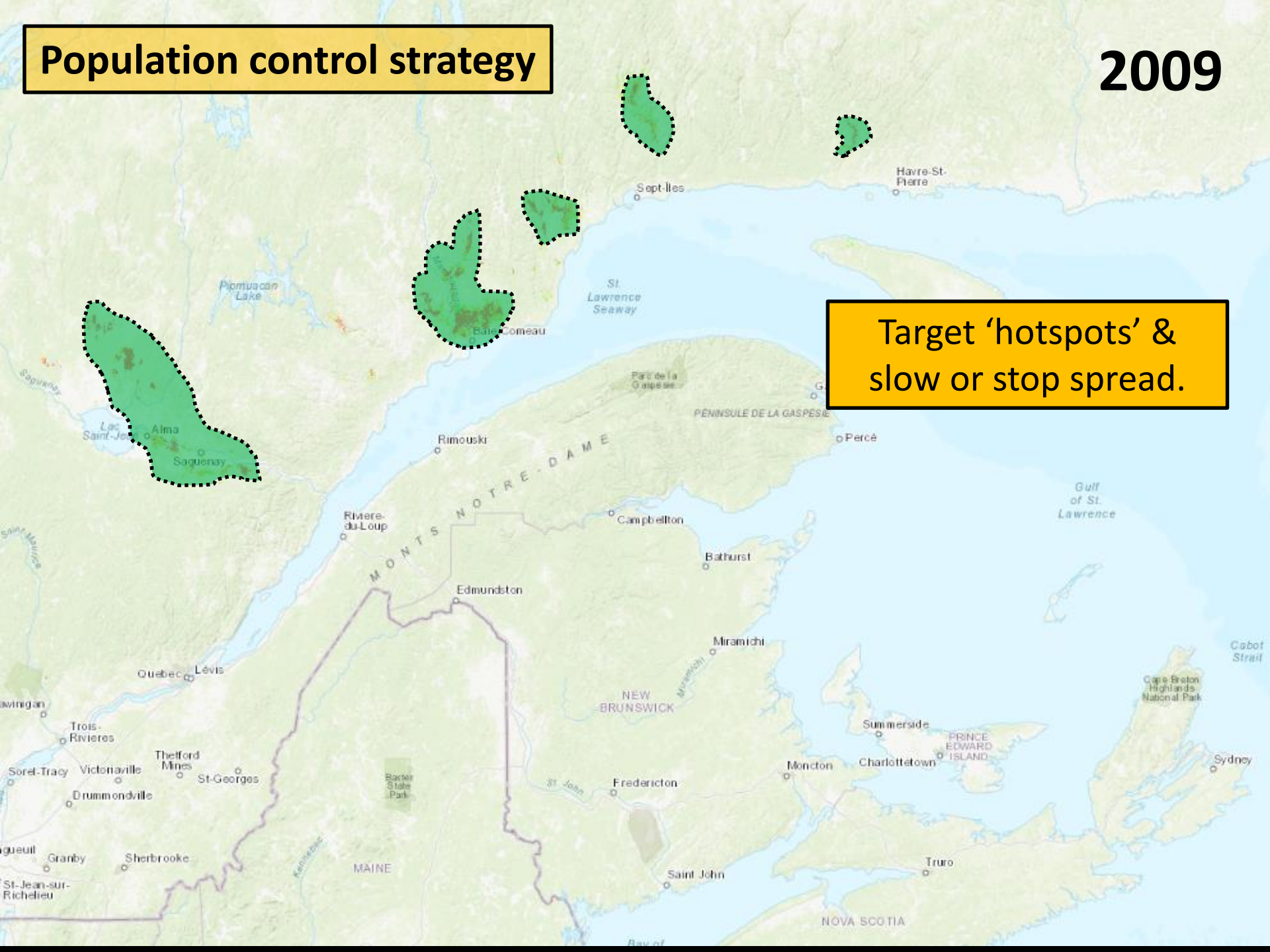
Bouchard et al. 2018

Mate-finding Allee effect

Régnière et al. 2012

Population control strategy

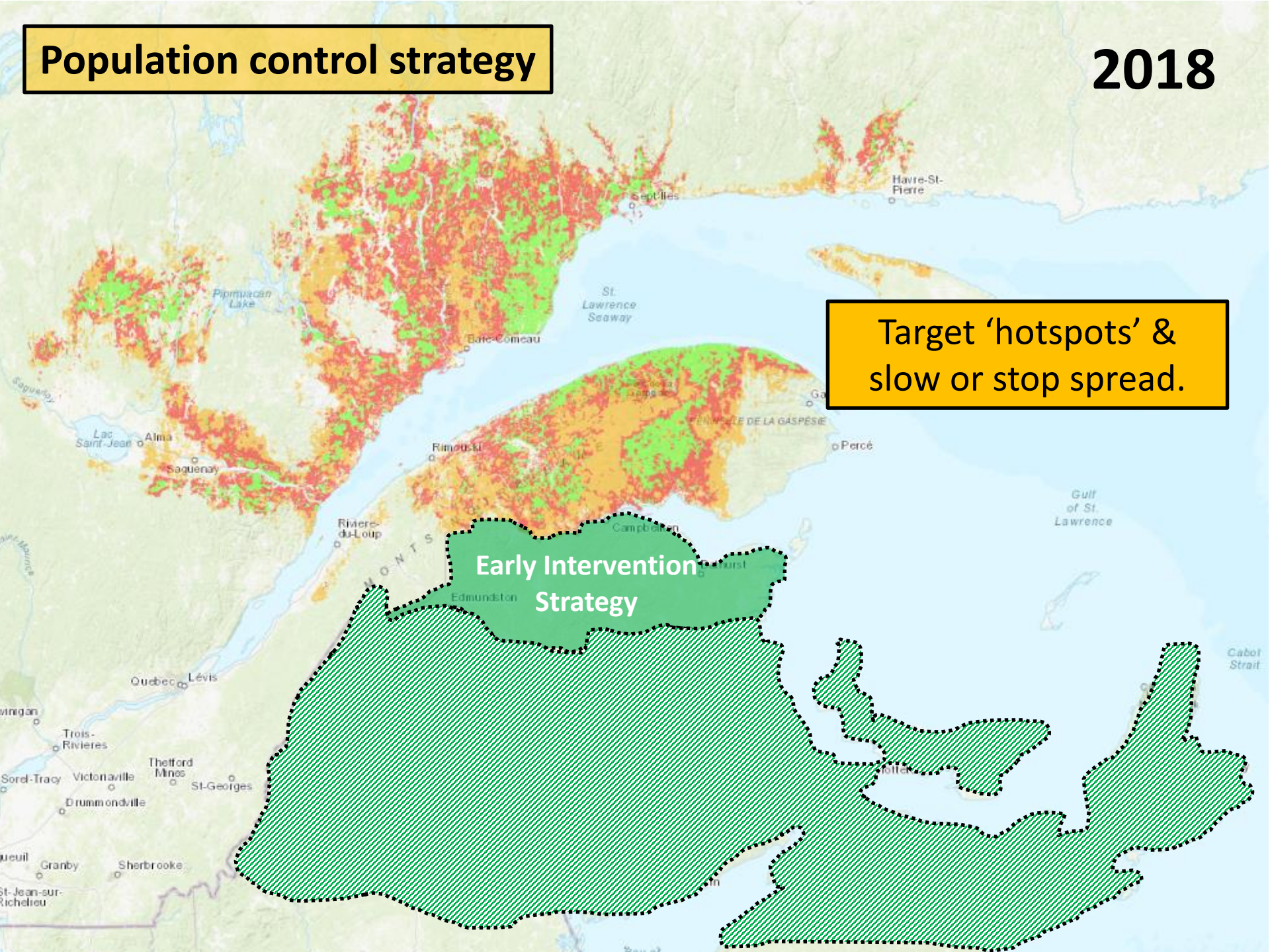
2009



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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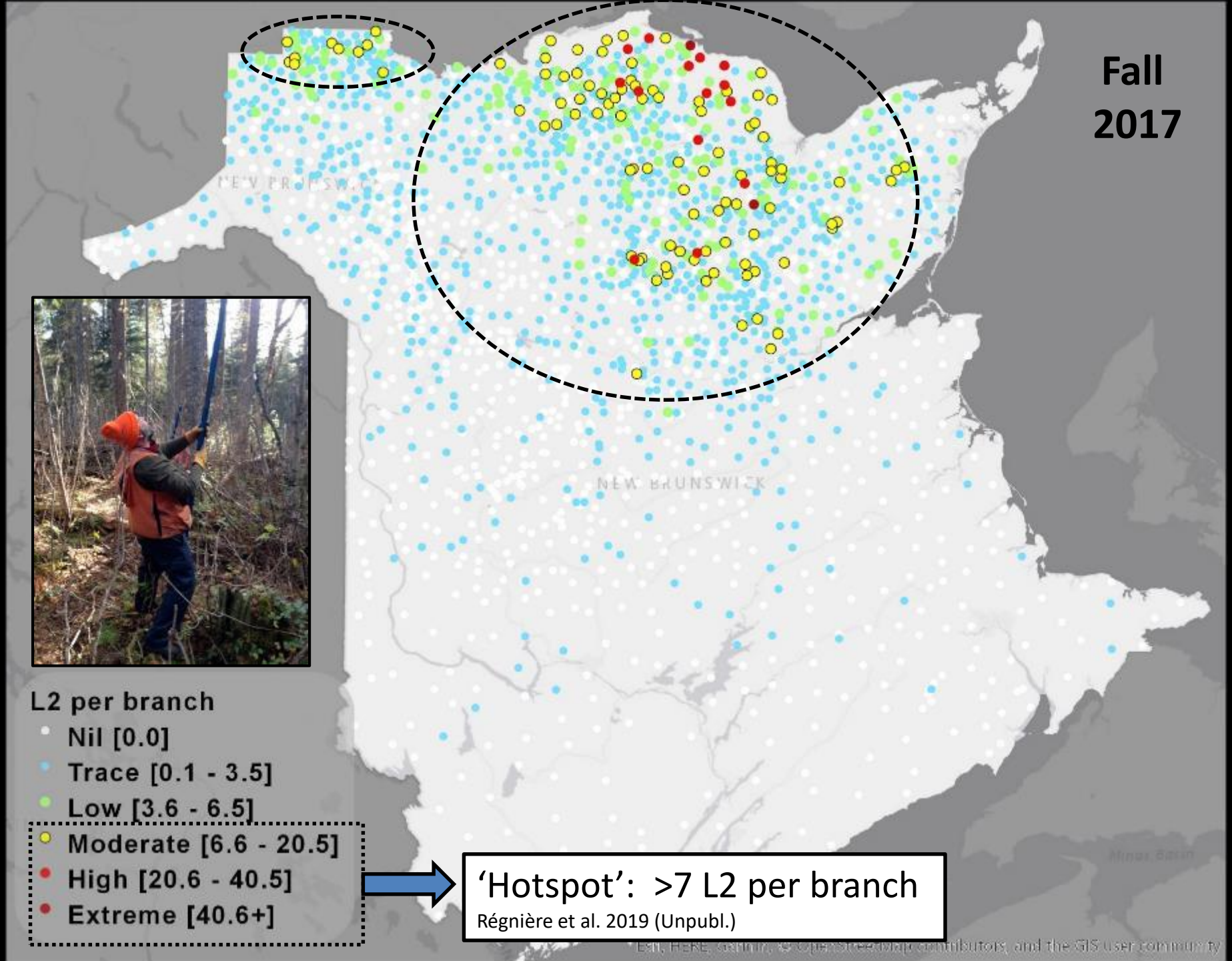
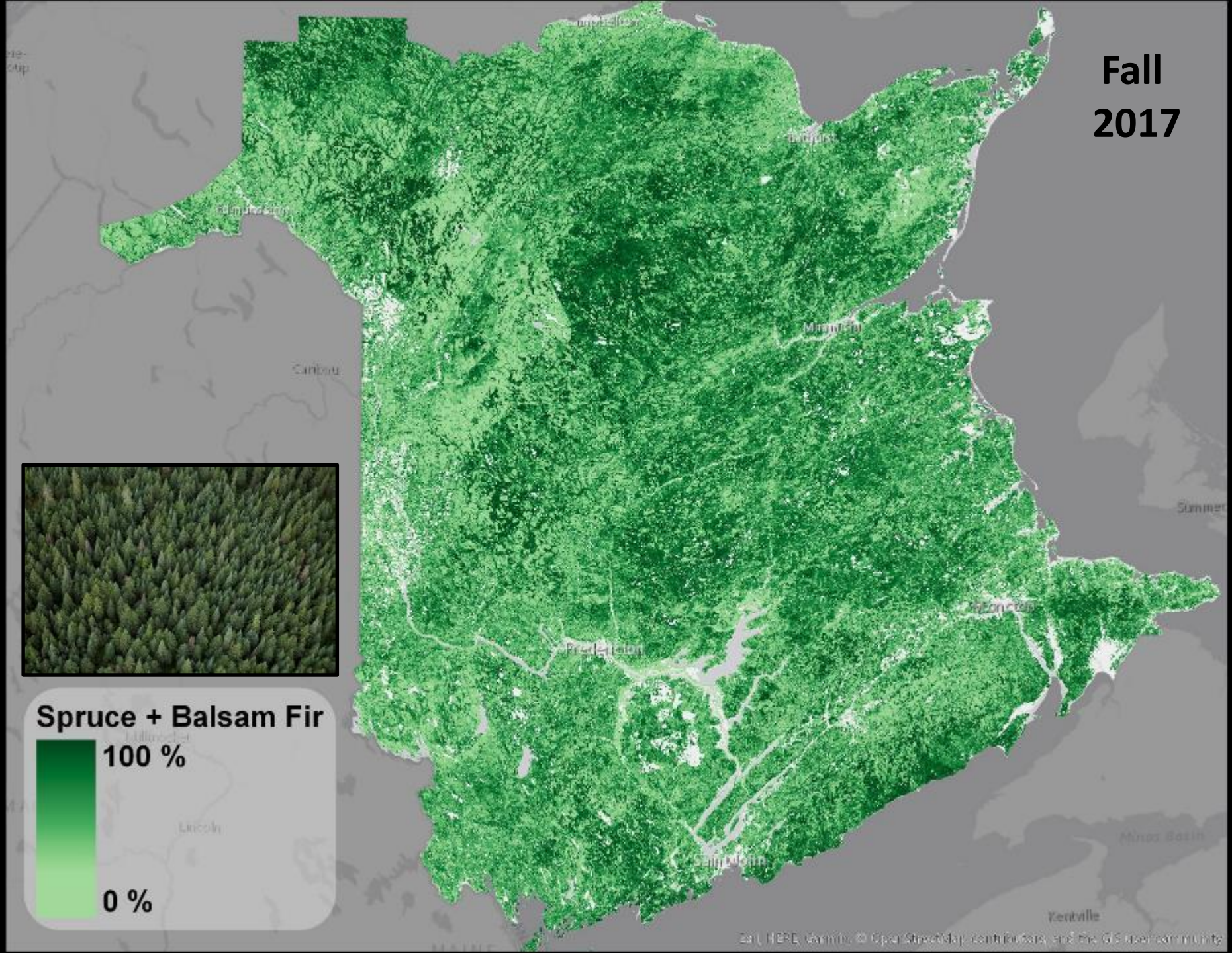
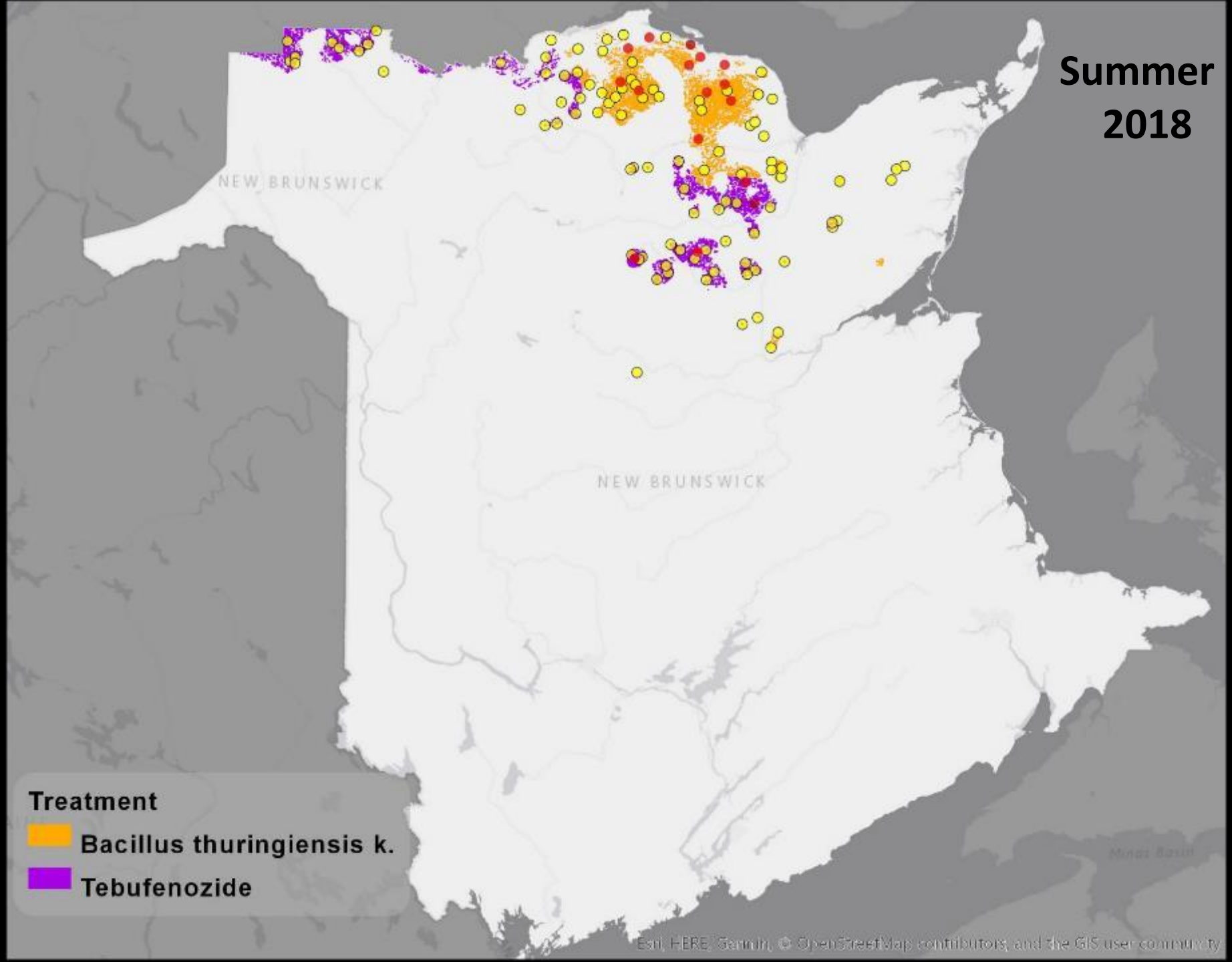

Fall
2017
NEW BRUNSWICK
L2 per branch
Nil [0.0]
Trace [0.1 - 3.5]
Low [3.6 - 6.5]
Moderate [6.6 - 20.5]
High [20.6 - 40.5]
Extreme [40.6+]
'Hotspot': >7 L2 per branch
Régnière et al. 2019 (Unpubl.)


Fall
2017
Spruce + Balsam Fir
100 %
0 %
Caribou
Fredericton
Lincoln
Summer
Kentville


Summer 2018
NEW BRUNSWICK
NEW BRUNSWICK
Treatment
Bacillus thuringiensis k.
Tebufenozide
Esri, HERE, Garmin, © OpenStreetMap contributors, and the GIS user community

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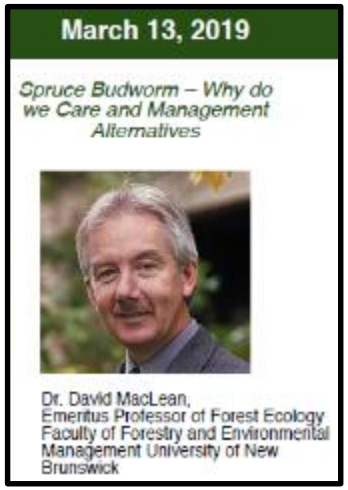

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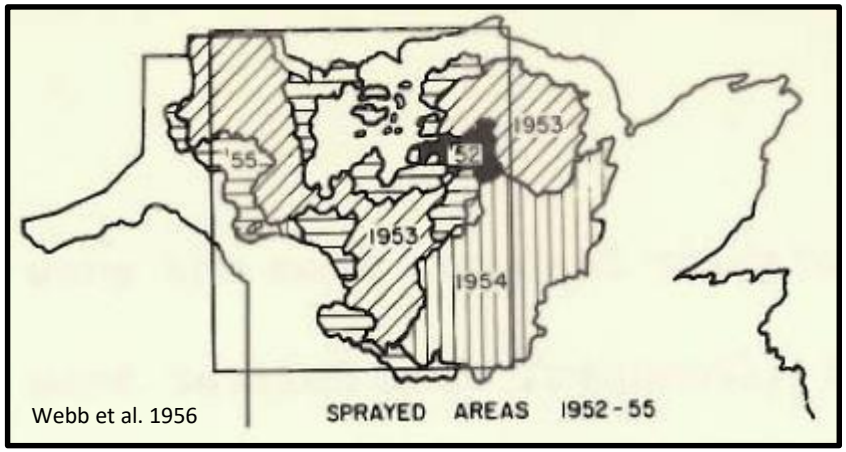
Population Control: Green River Project



Webb et al. 1956

FPL

Population Control Trials

- ~4.2 million ha of DDT
- ~99% budworm mortality!

But…

- Populations quickly rebounded
- 25% of sites retreated annually.
- Decimation of parasitoids and prey (and therefore also predators).
- Insecticide resistance.

<u>Conclusion</u>: "Let's recalibrate for Foliage Protection!"

How do we control pest populations?

Populations can compensate for some culling (or harvest)…

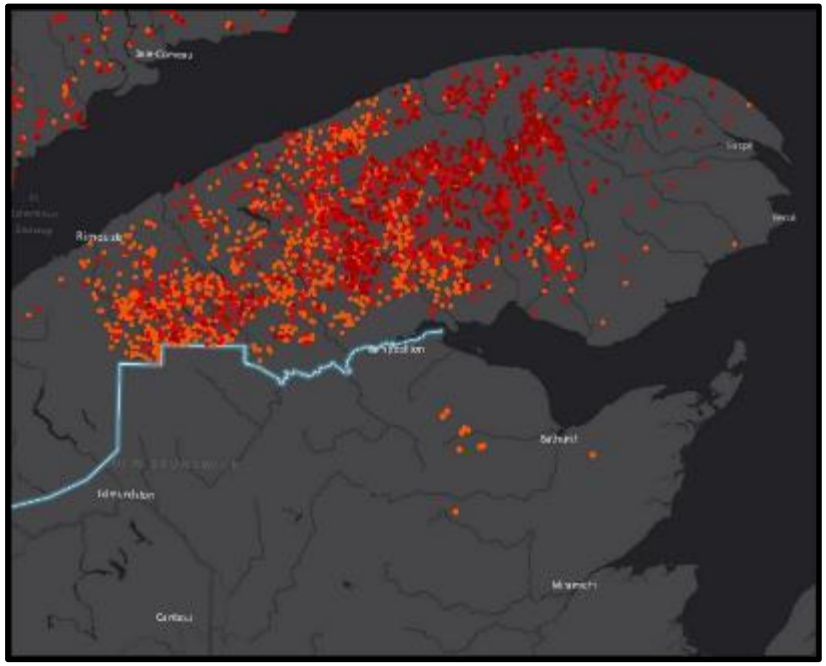
Avoid provoking compensatory responses and thereby “add” mortality

How do we control pest populations?

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

1) Control populations while densities are relatively low.

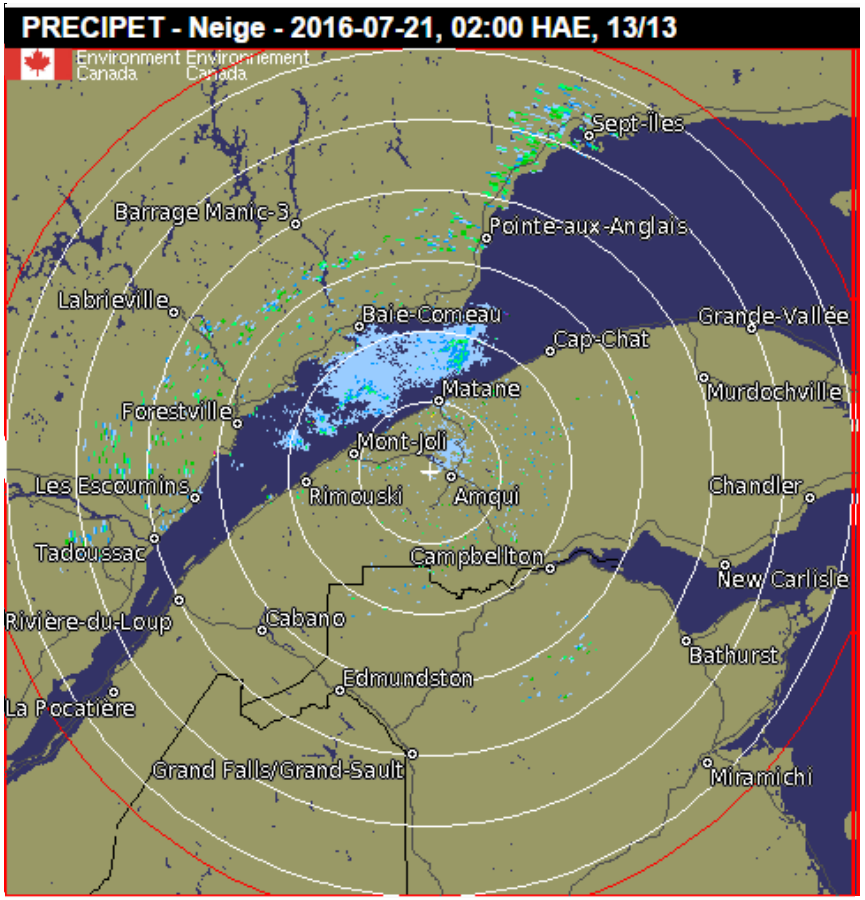
Photo: Michigan State University



How do we control pest populations?

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

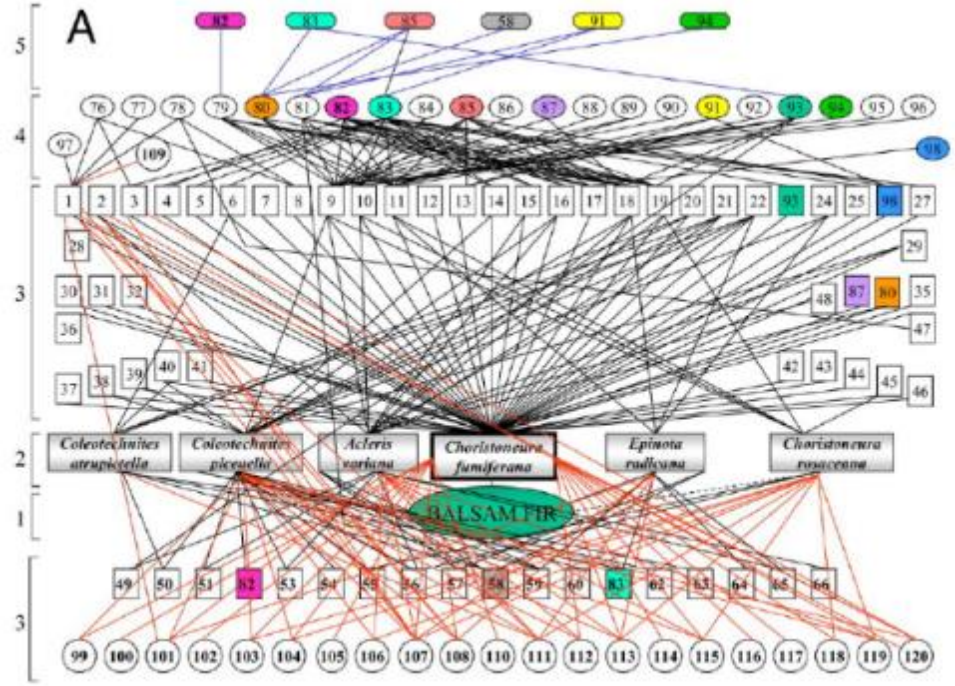
2) Control over large areas to limit sources of immigration.



How do we control pest populations?

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

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



Eveleigh et al. 2006

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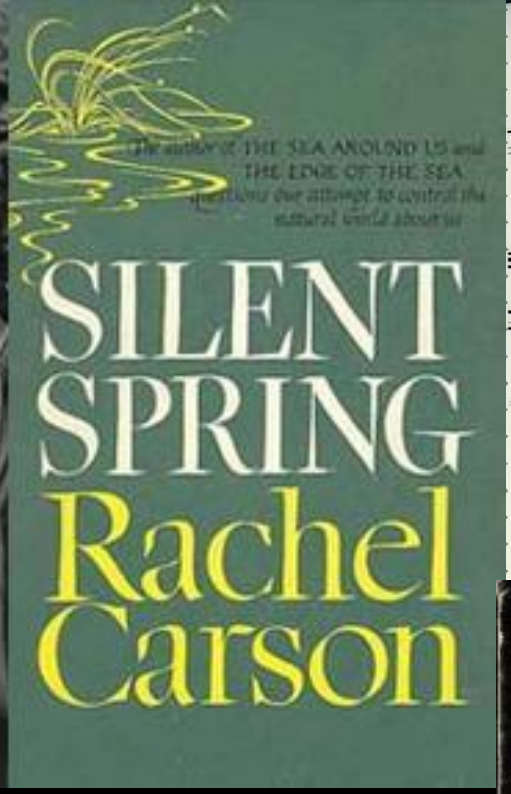
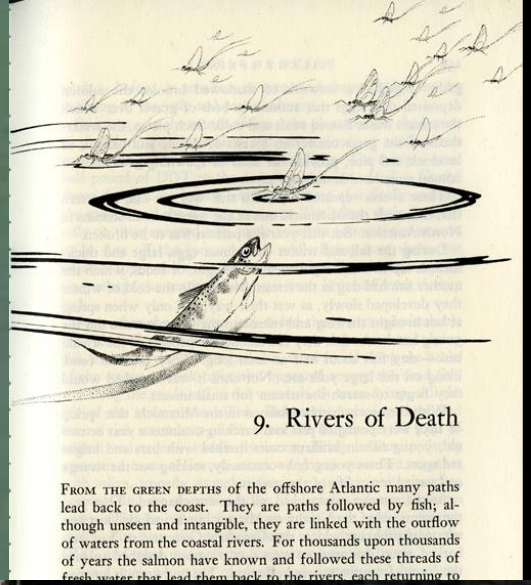
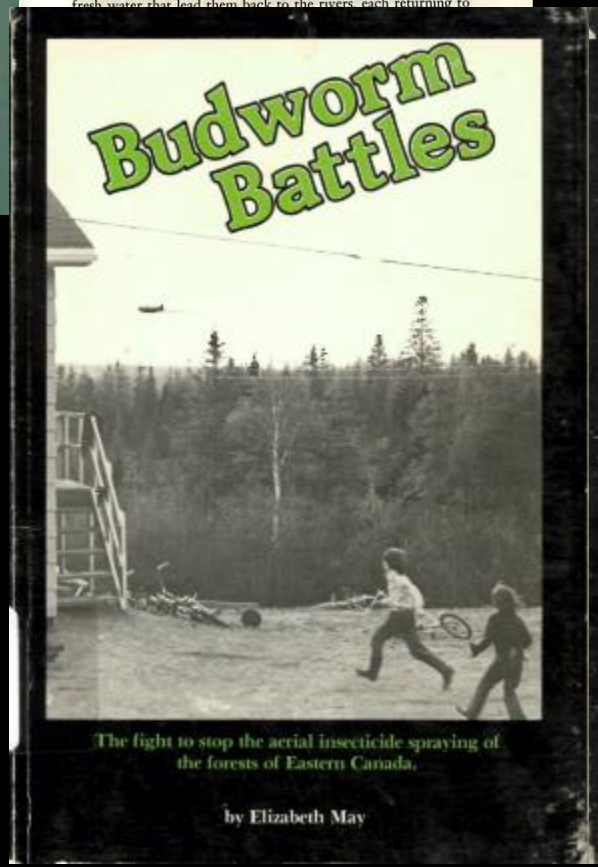


DDT - 1962



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 fresh water that lead them back to the rivers, each returning to



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 *Marion 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 aerial chemical sprays, she is also active in the movement against the development of uranium mining in Nova Scotia.

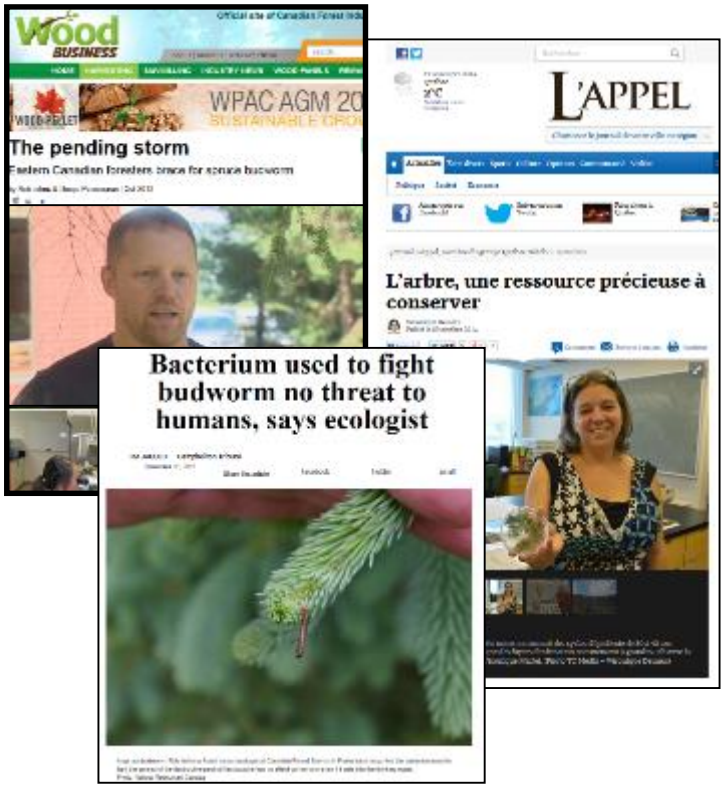
Communications Strategy

(1) To be a credible primary source of information and education → Scientists and experts lead the discussion sharing accurate information

(2) Share our research program with Atlantic Canadians → Public awareness of the situation and what is being done to address it

(3) Engage stakeholders to inform them with updates on our efforts → Stakeholder communications & outreach
Responsive and accurate information

HealthyForest
PARTNERSHIP



Communications

Strategy:

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

2) Scientists communicate on the science

3) Directly address issues raised by the public

Early Intervention Strategy

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Benefits > Costs?

- Uncontrolled budworm outbreak = *~$15 billion loss over 30 years*.
- Research that increases efficacy of components makes EIS more cost-effective:

  Population dynamics, moth dispersal modelling, genomics, radar work, satellite, community science, DSS, climate change, etc.
- Cost-benefit balance will likely vary regionally.
- In some cases, 'Foliage Protection' may be more cost-effective.

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Acknowledgements

Maps by: **Luke Amos-Binks, DERD**

***Foliage protection thresholds*: Nicolas Girard, SOPFIM**

March 13, 2019

Spruce Budworm – Why do we Care and Management Alternatives

Dr. David MacLean,
Emeritus Professor of Forest Ecology
Faculty of Forestry and Environmental Management University of New Brunswick

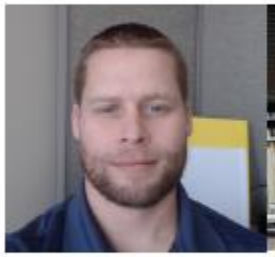
March 20, 2019

A Conceptual Framework for the Spruce Budworm Early Intervention Strategy

Dr. Rob Johns
Research Scientist
Canadian Forest Service
Atlantic Forestry Centre

March 27, 2019

Operational Requirements for a Successful Early Intervention Strategy



Drew Carleton
Manager of Forest Health
New Brunswick
Department of Energy and Resource Development

Luke Amos-Binks
Forester
New Brunswick
Department of Energy and Resource Development

Andrew Morrison
Operations Manager
Forest Protection Limited

April 3, 3019

Communications and Outreach – Important Pillars for a Successful Program

Chris Norfolk
Director, Forest Planning and Stewardship
New Brunswick
Department of Energy and Resource Development

Emily Owens
Citizen Science Coordinator
Canadian Forest Service
Atlantic Forestry Centre

April 10, 2019

Ecological Impacts of Using Early Intervention to Control Spruce Budworm

Dr. Michael Stastny
Research Scientist
Canadian Forest Service
Atlantic Forestry Centre

Dr. Véronique Martel
Research Scientist
Canadian Forest Service
Laurentian Forestry Centre

April 17, 2019

Early Intervention Strategy for Spruce Budworm: Does it Work? Can we do it More Efficiently?

Dr. Sara Edwards
Postdoctoral Fellow
Forest Protection Limited

E-Lectures are on Wednesdays

from: 1:30 p.m. - 2:30 p.m. EST / 2:30 p.m. - 3:30 p.m. AST / 10:30 a.m. - 11:30 a.m. PST