

# MPBSpread

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*October 26, 2016*

## Overview

My notes on the MPBSpread model presented at the fRI MPB Workshop held in Edmonton, AB on October 26, 2016.

This workshop was live streamed at [youtube.com/watch?v=ChdU\\_\\_\\_G21Cs](https://youtube.com/watch?v=ChdU___G21Cs).

**Presenter:** Clive [something]

- MPBSpread is a spatially explicit model on a forest landscape
- 10-20 year horizon
- uses 400 m x 400 m (16 ha) cells
- stochasticity
- no life history; only dispersal (with mortality) within and among stands
- univoltine dynamics

Barry's summary:

logistic stochastic cellular automaton at 16 ha resolution, driven by numerous environmental variables known to have nonlinear influence on probability of establishment.

## Model construction

The model calculates the probability of successful colonization of unoccupied cell  $i$  at time  $t$ :

$$P_{i,t} = HQ_i \sum_{j=1}^n BEF_{j,t} G_{j,t} W_{i,j}$$

- $HQ_i$  is habitat quality scaled from 0 to 1;
  - $HQ_i = PADL$
  - $P$  is the percentage of susceptible pine (data source??)
  - $A$  is age [of cell??]
  - $D$  is density [of pine??]
  - $L$  is a location factor [??]
- $BEF_{j,t}$  is a 'beetle export factor', which is an index of dispersal from occupied cell, scaled from 0 to 1;
  - linear increase then exponential decline
- $G_{j,t}$  is a directional scaler for wind, between 0 and 1;
  - circular frequency distribution of wind directions (biased eastward)
- $W_{i,j}$  is a weighting factor for distance from unoccupied to occupied cells, between 0 and 1.
  - approx. exponential decline, but it's modified to be non-monotonic (flat-tailed distribution) that declines from weight 1 at distance 0 km to near 0 at 10 km.

Cumulative probability of occurrence follows a logistic curve, with two different curves defined for:

1. 'experienced' pine, which has an evolutionary history of MPB outbreak (*i.e.*, BC);
2. 'naive' pine, which doesn't have this history (*i.e.*, AB)

Experienced pine has a lower curve than naive pine (MPB less likely to occur in a cell).

## Model summary

- captures short-distance “diffusive” dispersal as well as larger-distance “jumps” [unclear how...]
- model accounts for:
  - infested trees at stand and landscape levels
  - stand susceptibility
  - [beetle] mortality
  - MPB reproductive output (including climate effects)
  - habitat connectivity
  - [beetle] dispersal
  - beetle control

## Implementing control

- level 1:
  - cells where infestation detected  $\leq 2$  years of establishment
  - a proportion of green attack trees is removed
- level 2:
  - cells with infestation  $\geq 3$  years and  $\leq 7$  km from a road; else no treatment
  - all trees removed

## Application control

- “leading edge focused”
- begin with cell at easternmost longitude and highest latitude
- proceed sequentially by longitude to southernmost cell, then onto northernmost cell to the west
- continue until all cells sampled or total area allocated for control in that year is reached s each infested cell has probability of being detected ( $P_{detect} = 0.90$ ) and subsequent probability of successful eradication ( $P_{eradicate} = 0.65$ )

## Model validation

MPBSpread validated using BC survey data 1999 for the Burns Lake – Quesnel – etc. region.

- 10 model runs to account for stochasticity
- get means and 95% confidence intervals for two metrics:
  1. total area infested
  2. total pine killed
- spread projections were compared to data

## Model application

MPBSpread applied to AB region using 2008-2015 data from Alberta Agriculture and Forestry.

- used ‘naive’ pine curve for thresholds

- used 2008 data to set initial conditions
- two scenarios considered:
  1. ‘do nothing’
  2. ‘business as usual’
    - level 1 control: 10,000 ha
    - level 2 control: 1,500 ha in 2008 increasing to 3,000 ha in 2017
    - $P_{detect} = 0.90$
    - $P_{eradicate} = 0.65$

## Conclusions

1. survey data match reasonably well;
2. control does make a difference;
3. control efficacy is not immediately apparent – it takes time to manifest.

## Other model applications

Also explored different combinations of ‘do nothing’ and ‘business as usual’ for different amounts of level 1 and level 2 control.