Balancing Pest Disturbances in Forest Management

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Annual total area damaged by major bark beetle and budworm species in British Columbia

- **Area damaged (x 1000 ha)**: 0, 500, 1000, 1500, 2000, 8000, 9000, 10000

Legend:
- **bb**: Black bars
- **def**: Gray bars
Annual area defoliated by western spruce budworm in British Columbia, 1909-2007

Year
1920 1940 1960 1980 2000
Area defoliated (x 1000 ha)
0 200 400 600 800 1000
Figure 7. Areas defoliated by western spruce budworm in BC in 2006.
History of Outbreaks

Tree ring chronology studies

- Increase in frequency of SBW outbreaks due to human caused changes in stand & forest structure

Logging practices + Suppression of forest fires = Increased frequency & duration of western spruce budworm outbreaks

(Swetnam and Lynch 1993;1989; Schmidt et al 1987;Anderson et al 1987; Rellin et al 1983)
Mountain pine beetle damage
Tweedsmuir Park, BC
Removal of infested lodgepole pine and retention of Douglas-fir
Selective removal of lodgepole pine to mitigate MPB damage creates stand-level modification of forest structure and ambient climate.

What will be the impacts on outbreak behavior of western spruce budworm?
**Stand Dynamics**

**Open Stands**
- **Less susceptible** to WSBW (Fauss & Pierce 1969) recover from defoliation better (Williams et al 1971*)
- **defoliation increases** (Williams et al 1971*)
- open diverse habitat there will be more predators (Kemp & Simmons 1979*)
- **Survival of WSBW** for 4-6 instars favored by increased exposure to solar radiation
- support greater number of WSBW due to more normal & adventitious buds
- **Trees recover** better because of greater reserves (Williams et al 1971*)

**Closed Stands**
- **more susceptible** (Brookes et al 1985)
- WSBW defoliation increases with decreasing density (Stoszek & Mika 1983)
- Susceptibility increases with host density while dispersal losses decrease (Carlson 1987)
- defoliation increases as crown closure increases (Wulf & Cates 1985)
- less larval loss during dispersal (Beckwith & Burnell 1982*)
- Trees must compete for resources (Carlson 1987)

**Thinning**
- **decreased defoliation** in thinned stands (Batzer 1967)
- Less def. & increase in mean annual Increment (Carlson et al 1985*)
- No diff. b/w cut and uncut in dispersal of 2nds may be due to dense foliage catching larvae before trap. Larval predators more active in dense stands and on small trees (Carlson et al 1988*)
- Dispersal losses decrease in dense stands and increase in mixed wood and open stands.
- Strip clear cutting –dispersal losses of early instars 1.4m/ha vs 2.9 m/h (Jennings et al 1985*)
- Forests with understory cut are less susceptible to SBW defoliation, more larvae reach the ground (Fellin 1985*)
- More dispersing larvae in partial versus clear cuts, in a recent study found no difference between cut and uncut.

**Maturity**
- Increase in maturity = decrease in WSBW defoliation (Stoszek & Mika 1983)
- Younger & smaller trees have a greater number of bird and ins. predators, decreasing WSBW numbers when populations are already low (Carlson et al 1984*; Torgersen and Campbell 1982*)

**Density**
- Presence of Ponderosa Pine acts as insulation for DF against WSBW (Fauss and Pierce 1983)

**Tree species**
- Non-host species decrease stand susceptibility to WSBW (Brookes et al 1987)
- Presence of Ponderosa Pine acts as insulation for DF against WSBW (Fauss and Pierce 1983)
How has risk changed?

Are more eggs laid on isolated trees?

Do new microclimatic conditions make trees more or less suitable?

Is the impact of natural enemies altered?

Are co-dominant trees more vulnerable to damage?

Are intermediate and juvenile trees more susceptible?
Our design consisted of 10 sites each with an open (partial harvest) and an adjacent closed (no harvest) plot.

Measures in each plot in 2006 and 2007:
1) Eggs, overwintering, dispersing early- and late-feeding stages of spruce budworm.
2) Natural mortality agents (parasitoids and diseases)
3) Damage
4) Stand characteristics
Annual defoliation by western spruce budworm in open and closed, paired plots at 10 IDF sites in BC

Slightly less defoliation, on average, in open vs. closed plots
Despite small differences in damage between open and closed sites, key processes governing spruce budworm population dynamics were different in open and closed plots.

- More eggs laid in open plots
- But greater dispersal losses in open plots

= More feeding larvae in closed stands

- But greater disease-caused mortality in closed stands

= Equivalent damage in open and closed stands
Conclusions

• Selective clearing of lodgepole pine and retention of Douglas-fir did not result in large differences in damage to western spruce budworm.

• These structural changes did, however, alter key population processes; opening stands increased dispersal losses but closed stands harbored more natural enemies.

• The effect of these processes were compensatory.

• These results are robust and could be exploited to develop stand-level modifications to decrease risk of damage from western spruce budworm.