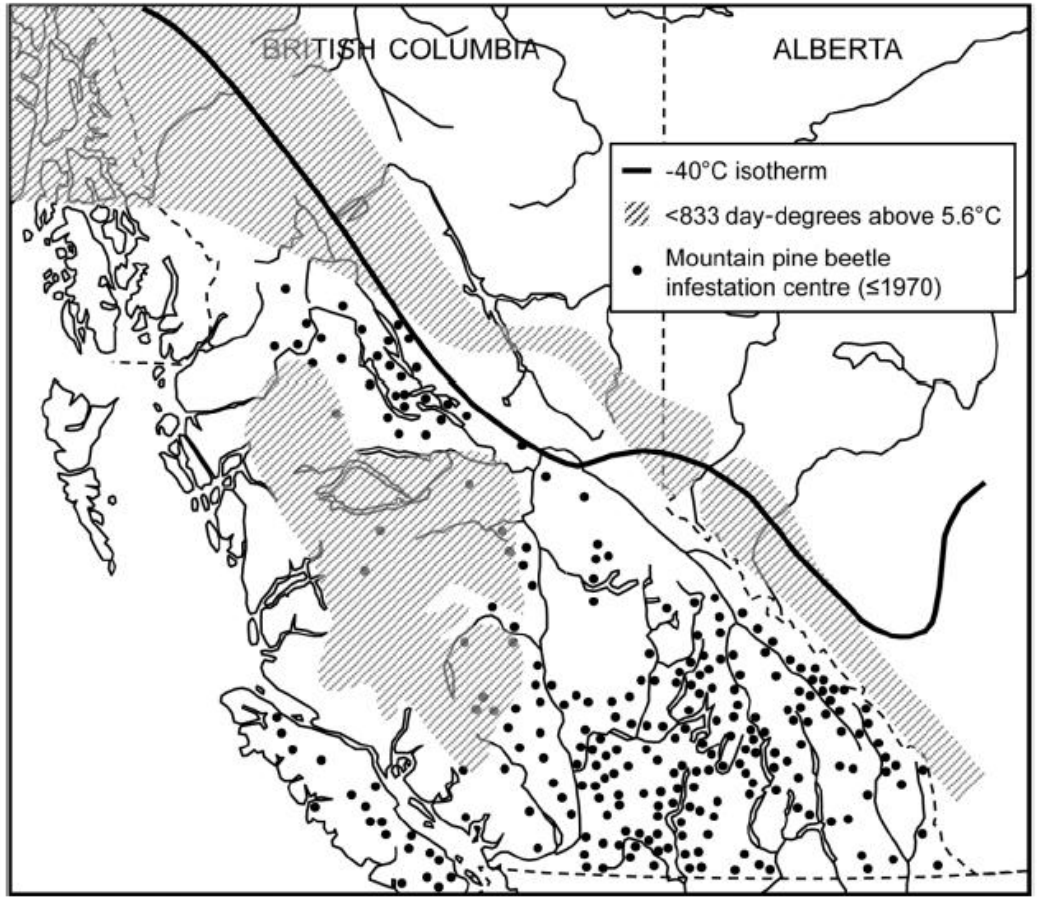
Mountain pine beetle range expansion: The impact of phenology and survival

Kathy Bleiker and Greg Smith
Canadian Forest Service

What limits MPB range?

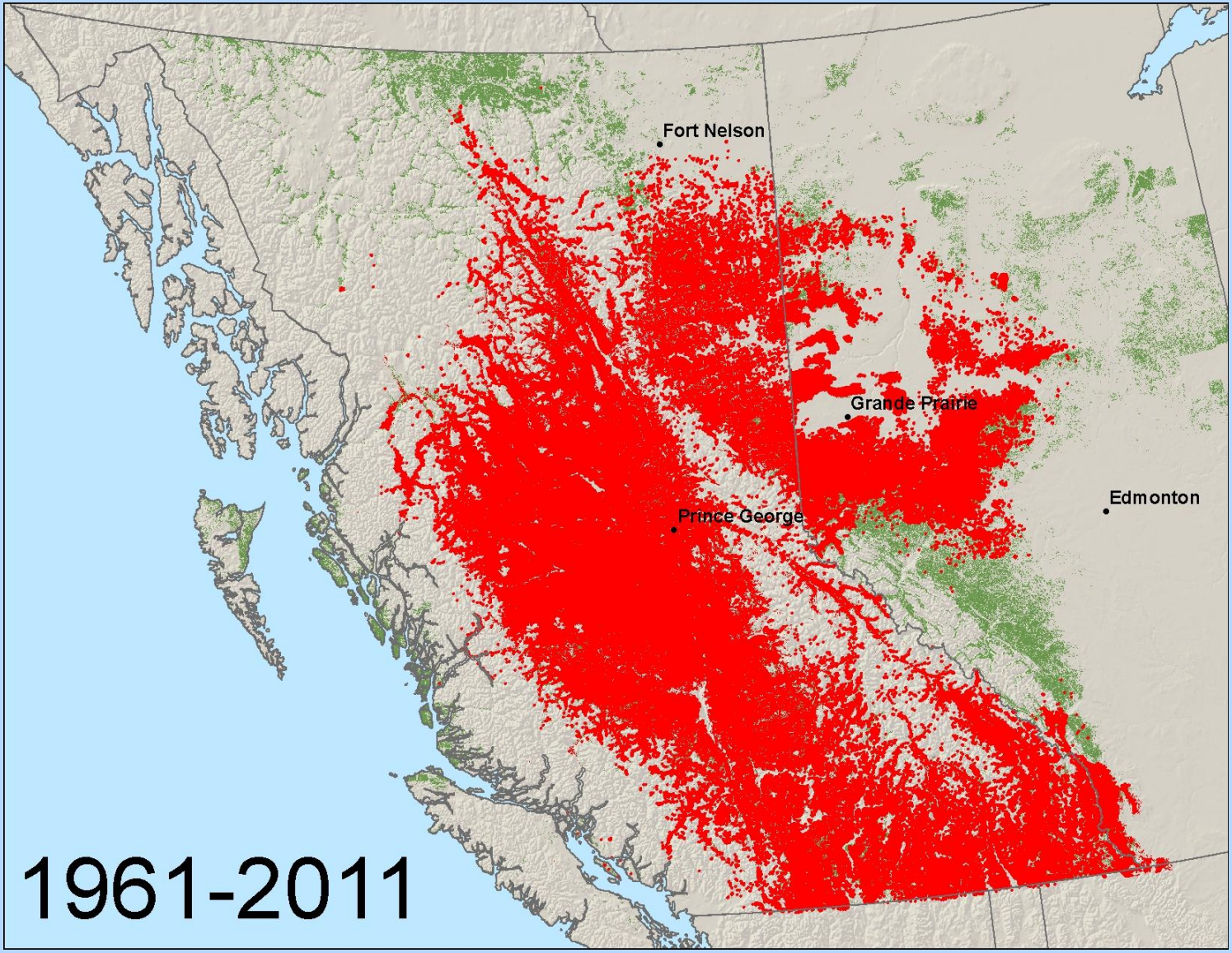
Historic distribution of infestations up to 1970



Safranyik et. al. 1974, 2010

Limits N & E : -40C & DD
Poor areas inside range; good areas outside (n. AB)

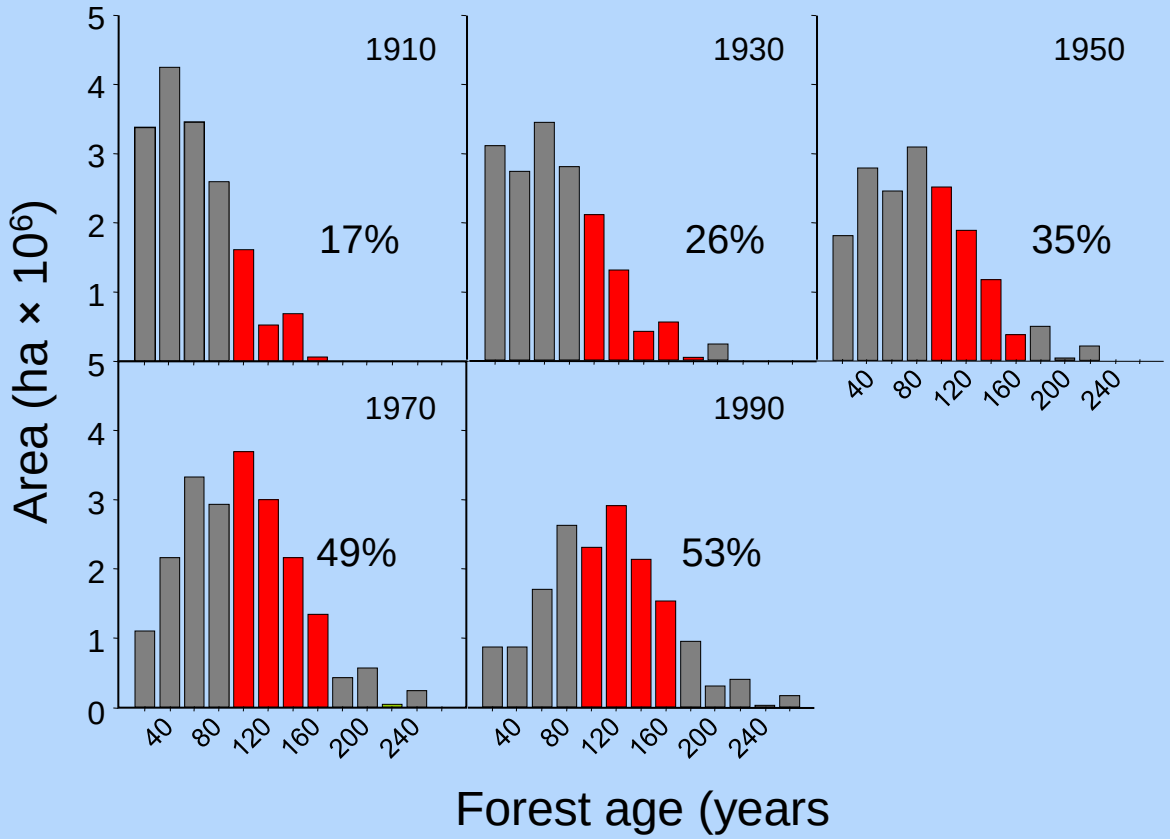
Has MPB expanded its range?



Why?

Huge source population

Distribution and abundance of susceptible hosts



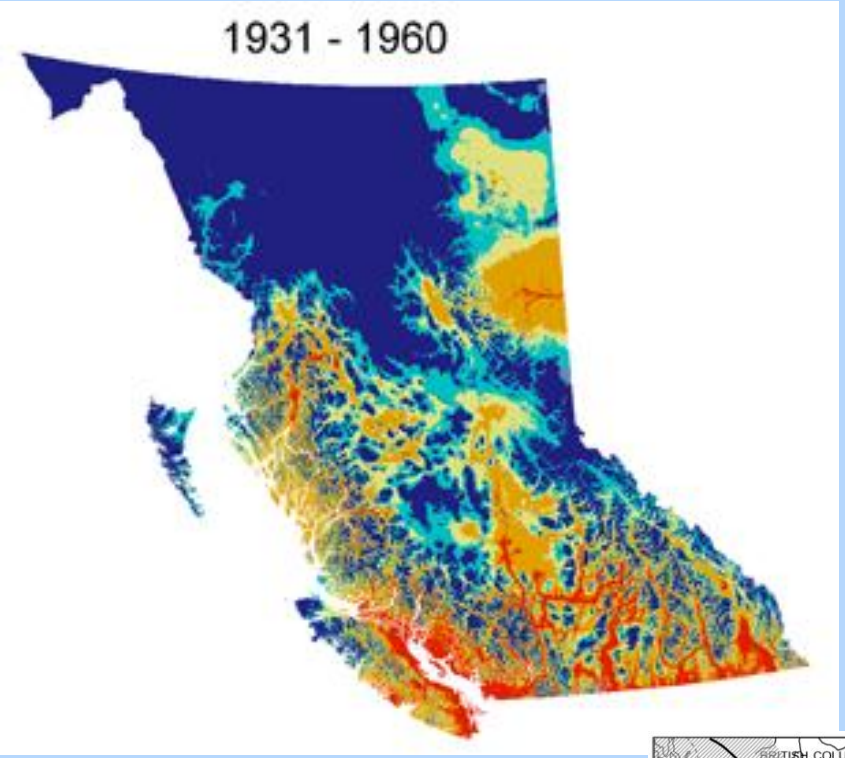
- Reconstructed pine forests based on past disturbances (fire, harvesting, beetles)
- Trees most susceptible to MPB between 80 and 160 years old
- Area of susceptible trees at outbreak start 3 times greater than 1910

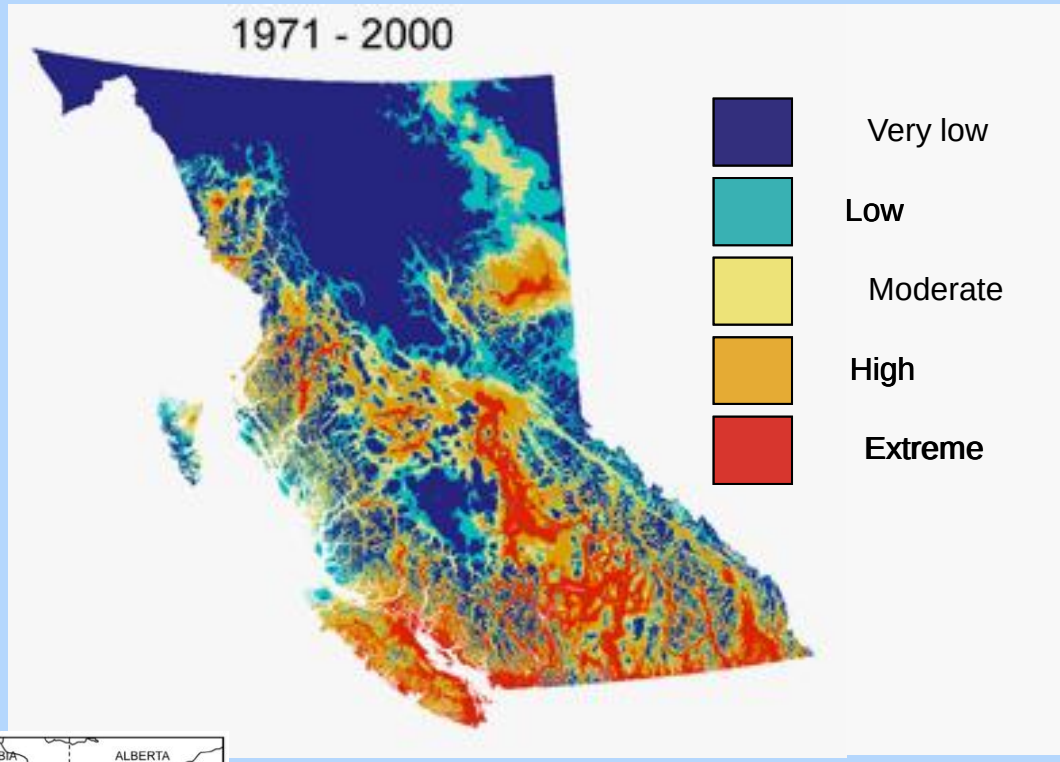
Taylor and Carroll 2004

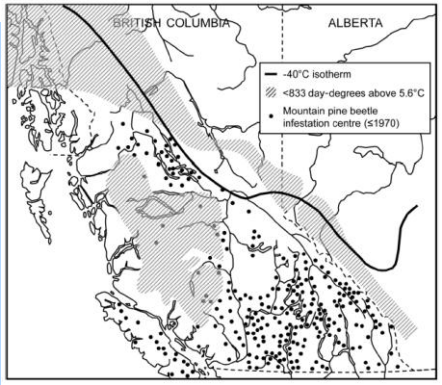
Fires 1880s

Why?

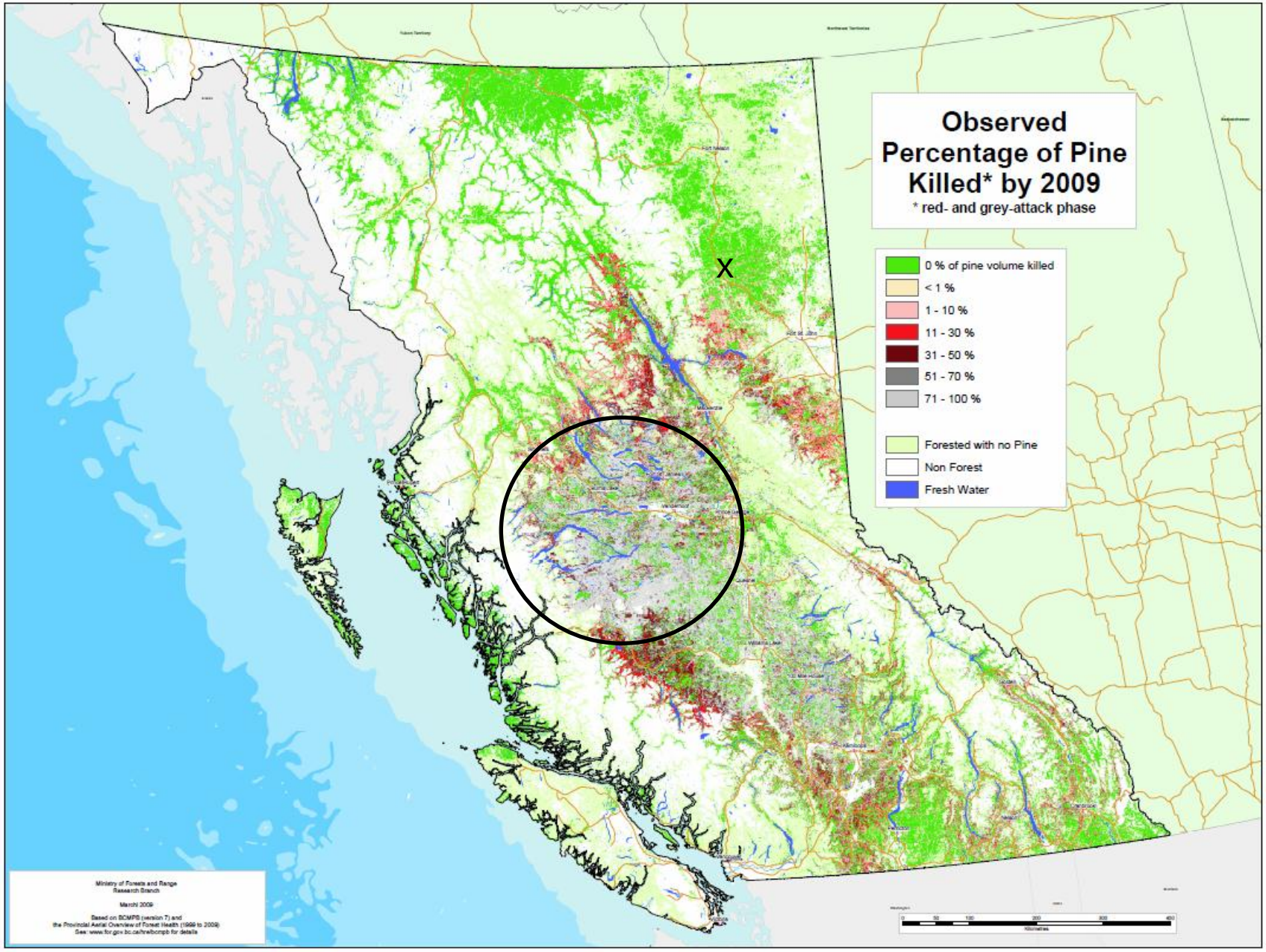
Climate Change: Increase in "extremely suitable" habitat







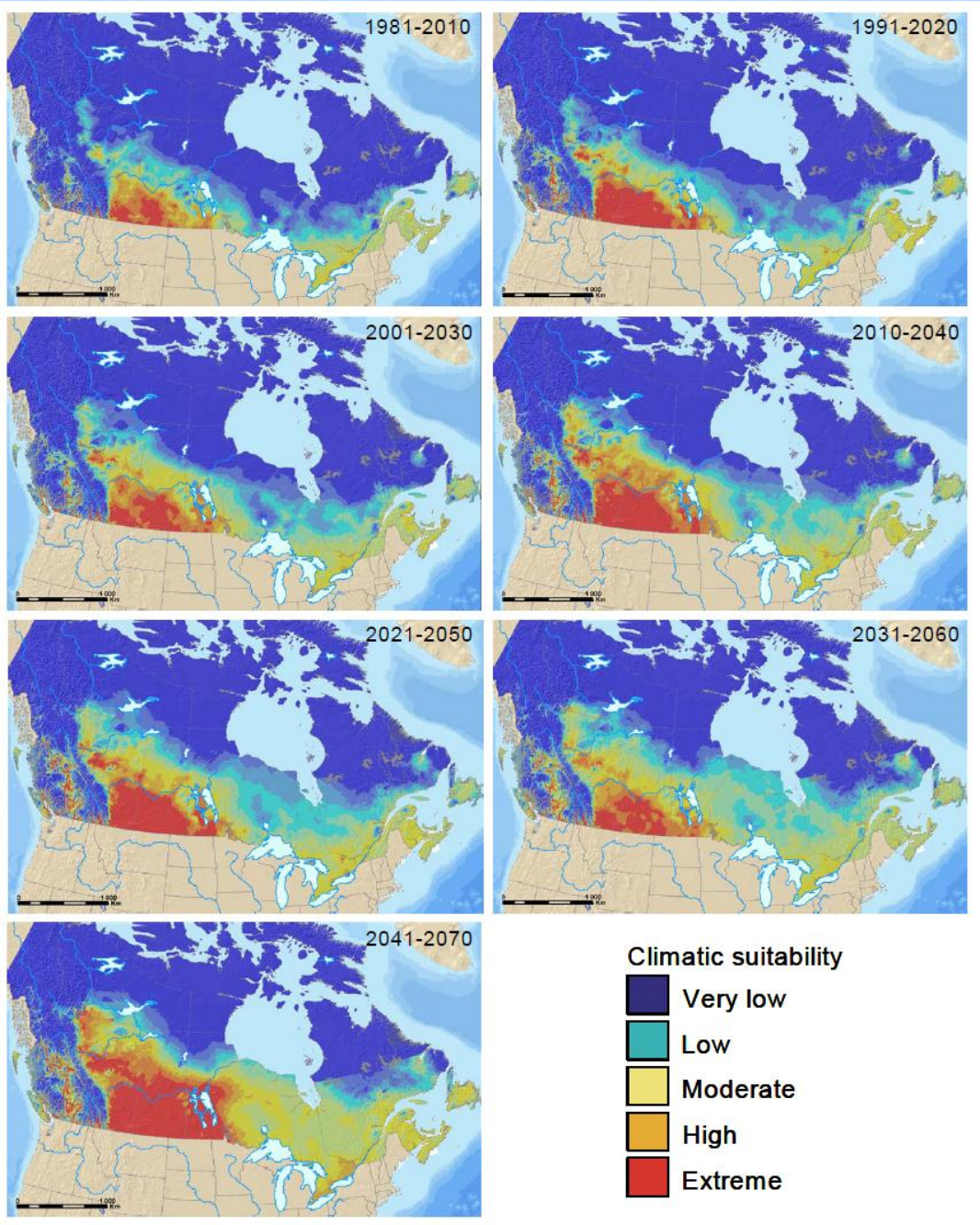
Carroll et al. 2006


Observed Percentage of Pine Killed* by 2009
* red- and grey-attack phase
0 % of pine volume killed
< 1 %
1 - 10 %
11 - 30 %
31 - 50 %
51 - 70 %
71 - 100 %
Forested with no Pine
Non Forest
Fresh Water
X
Ministry of Forests and Range
Research Branch
March 2009
Based on BCMPB (version 7) and
the Provincial Aerial Overview of Forest Health (1999 to 2009)
See: www.for.gov.bc.ca/hre/bcmpb for details

Will MPB spread?

Is pine in the boreal forest at risk?

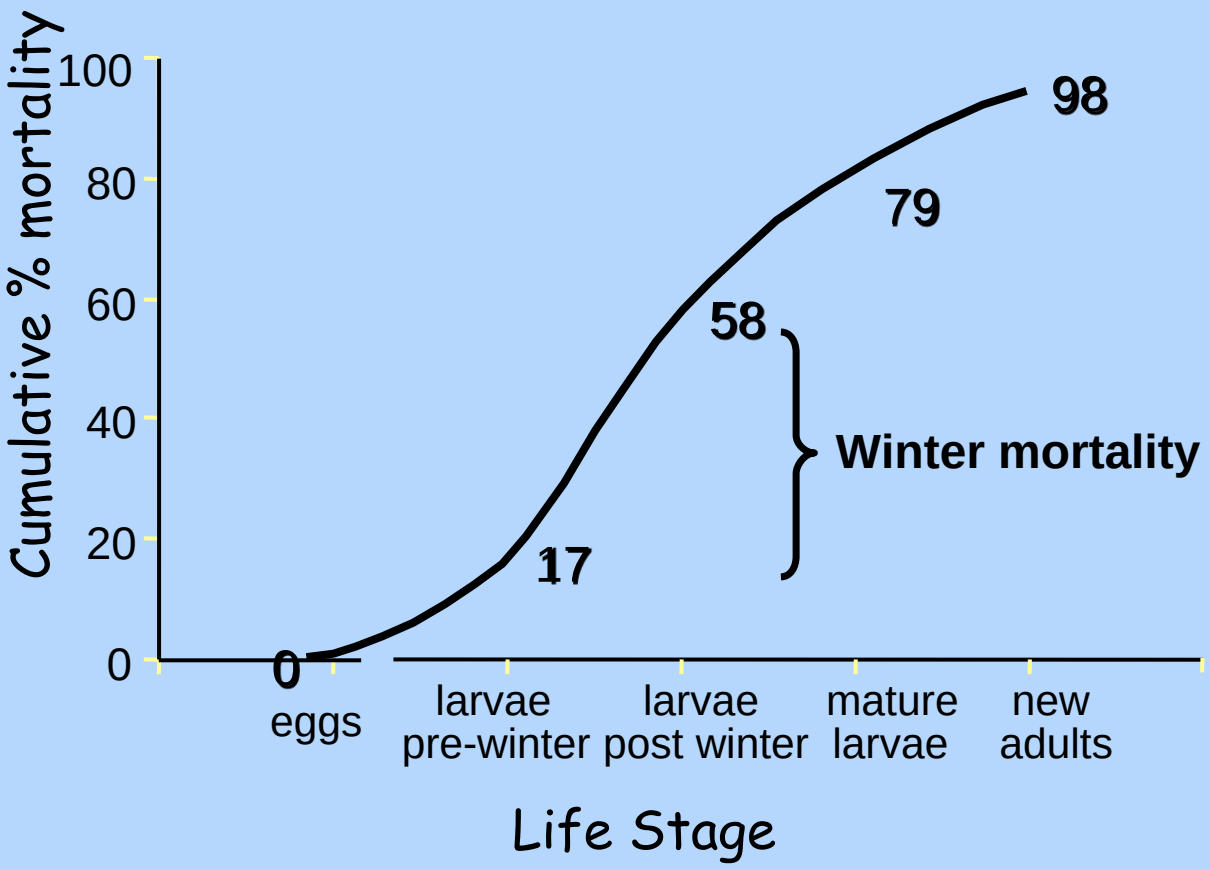
Climate/weather
Distribution and abundance of susceptible hosts
Dispersal abilities
Interactions with other species



Carroll et al. 2006

Focus on winter mortality/survival

Winter is tough – even in the "historic" range



Safranyik et al.

Lethal (cold) temperature varies by life stage

- eggs: -18°C
- pupae: -23/34°C
- 1st instars: -23/29°C
- 2nd instars: -23/34°C
- 3rd & 4th instars: -29/40°C

(Reid and Gates 1970; Logan et al. 1995)

Development over the summer determines the stage that enters the winter

→ Effect of phenology

Lethal temps. – range and work to do on it

How will climate and MPB phenology interact in the "new" habitat?
…and affect population success?

Objectives

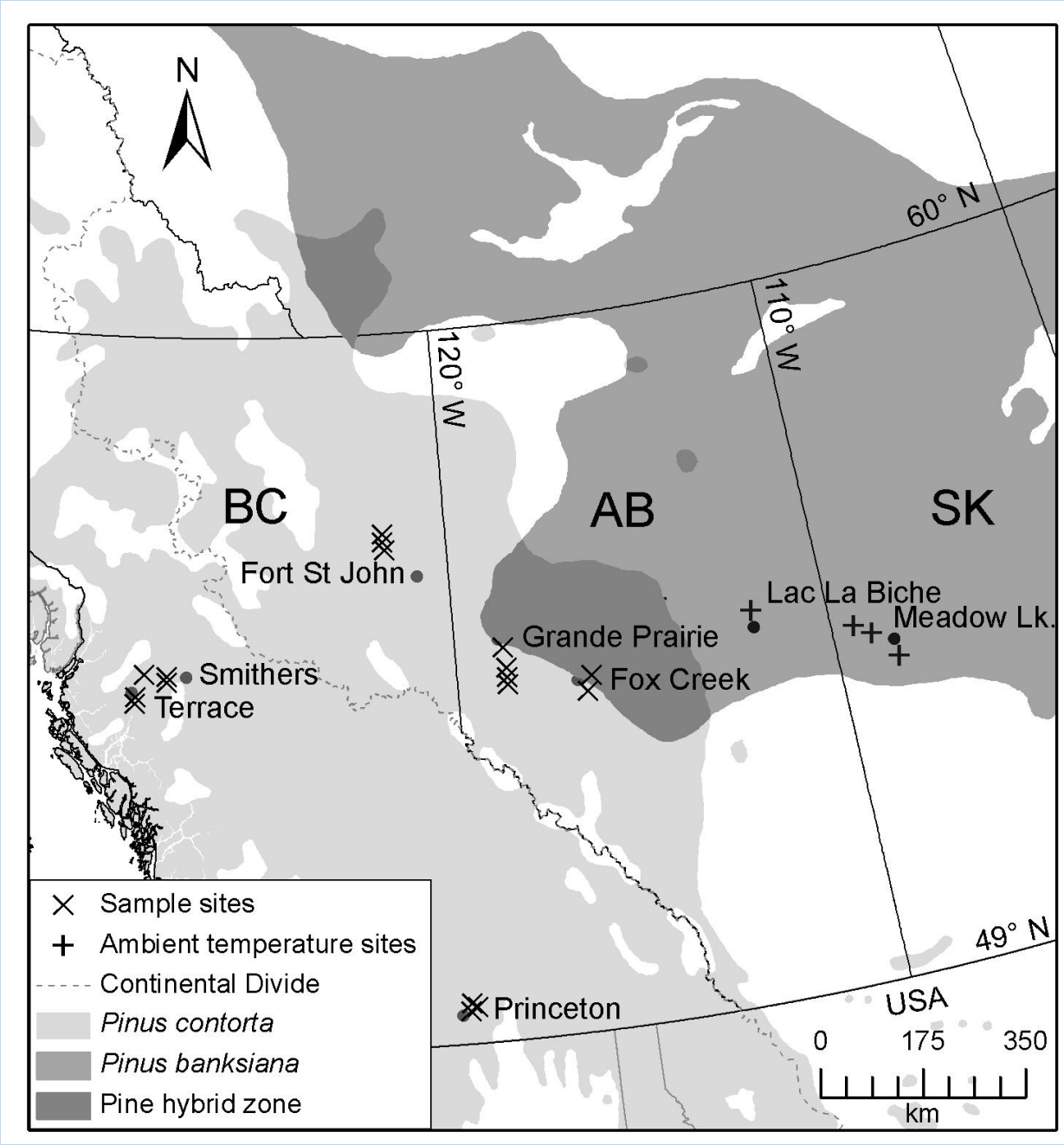
i) Quantify variation in MPB development and survival as it relates to temperature (fine resolution);

ii) Examine MPB reproductive success and attack characteristics (T & GV); and

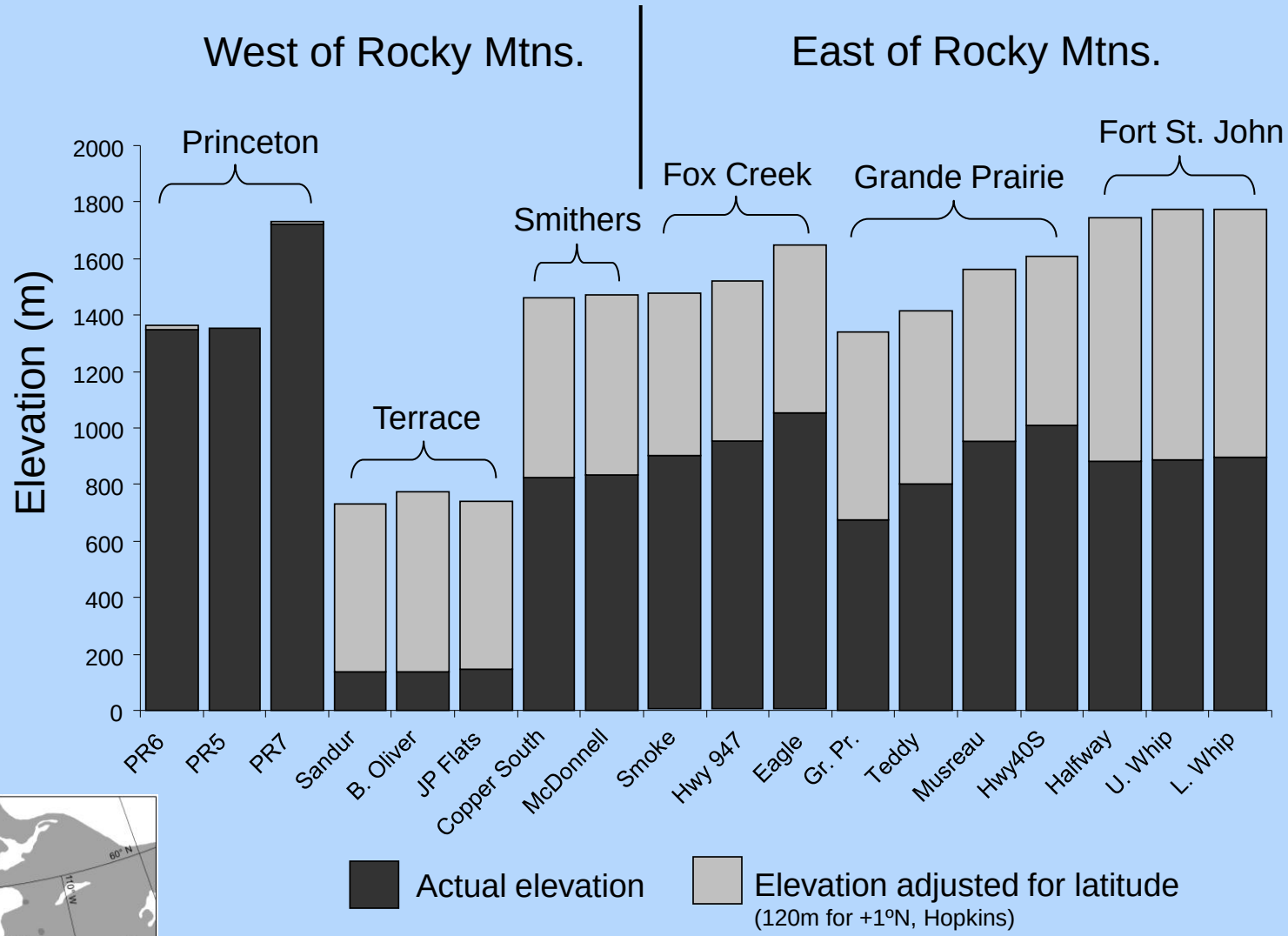
iii) Provide empirical data necessary to parameterize MPB model for AB (Cooke and Régnière).

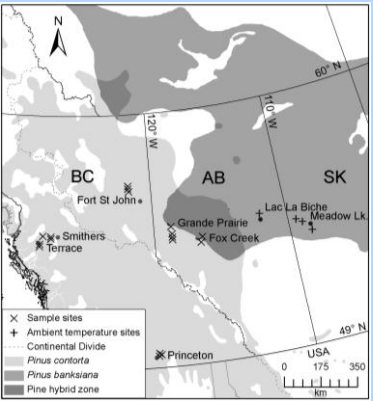
Yr 1 – Phenology up and running; Yr 2 – added mortality (≠ R) and (ii)

Research sites established in 2010



Ambient only
FSJ – gone in 2011
TR
Nothing central


West of Rocky Mtns.
East of Rocky Mtns.
Princeton
Terrace
Smithers
Fox Creek
Grande Prairie
Fort St. John
Elevation (m)
2000
1800
1600
1400
1200
1000
800
600
400
200
0
PR6
PR5
PR7
Sandur
B. Oliver
JP Flats
Copper South
McDonnell
Smoke
Hwy 947
Eagle
Gr. Pr.
Teddy
Musreau
Hwy40S
Halfway
U. Whip
L. Whip
Actual elevation
Elevation adjusted for latitude
(120m for +1ºN, Hopkins)


N
60° N
120° W
110° W
BC
AB
SK
Fort St John
Grande Prairie
Lac La Biche
Meadow Lk
Fox Creek
Smithers
Terrace
Princeton
49° N
USA
0
175
350
km
Sample sites
Ambient temperature sites
Continental Divide
Pinus contorta
Pinus banksiana
Pine hybrid zone

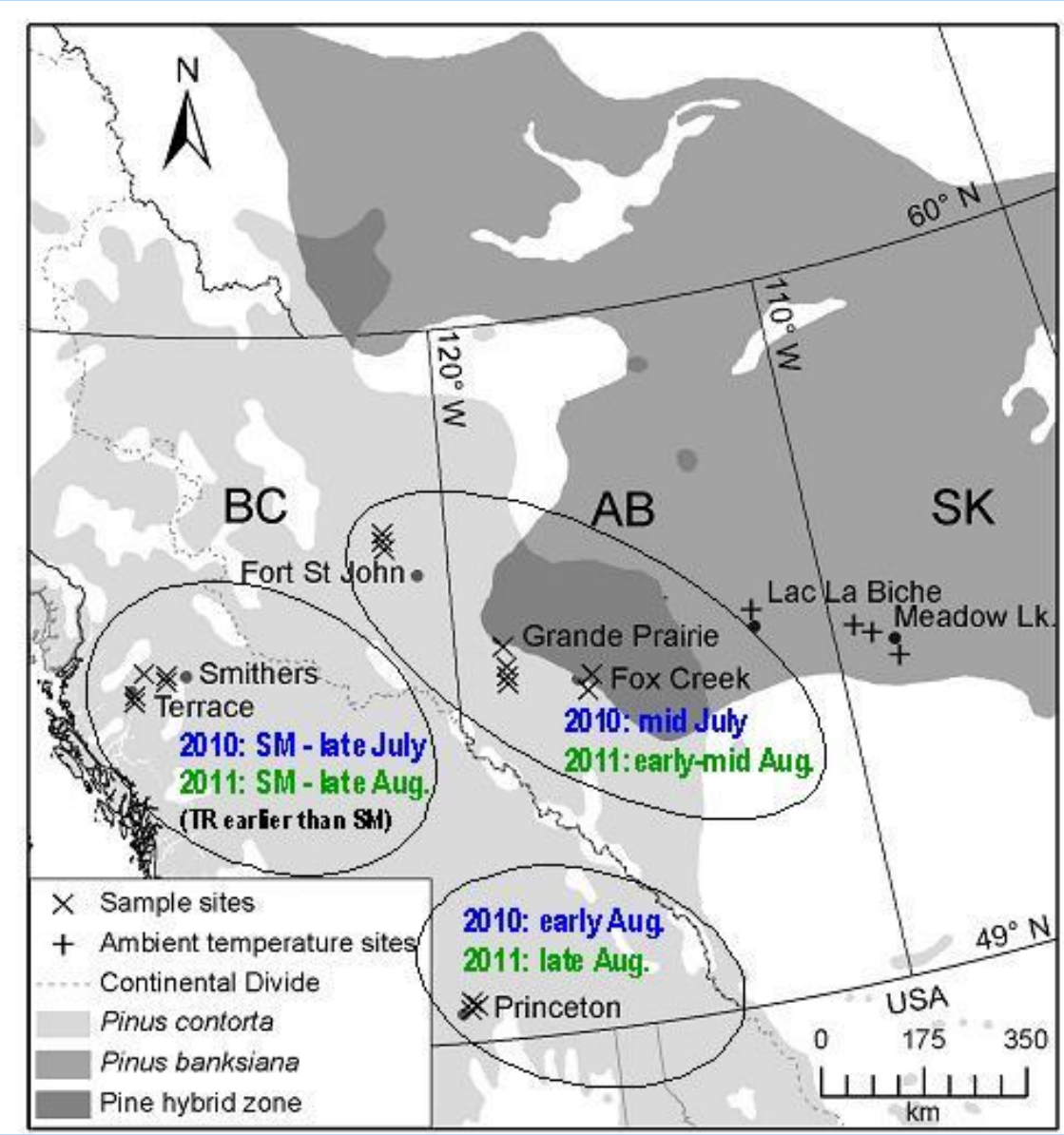
Identify *(really)* new attacks




Monitored dev., estimate peak flight in each region

Insert temperature probes

Sample insect development, attack characteristics, reproductive success



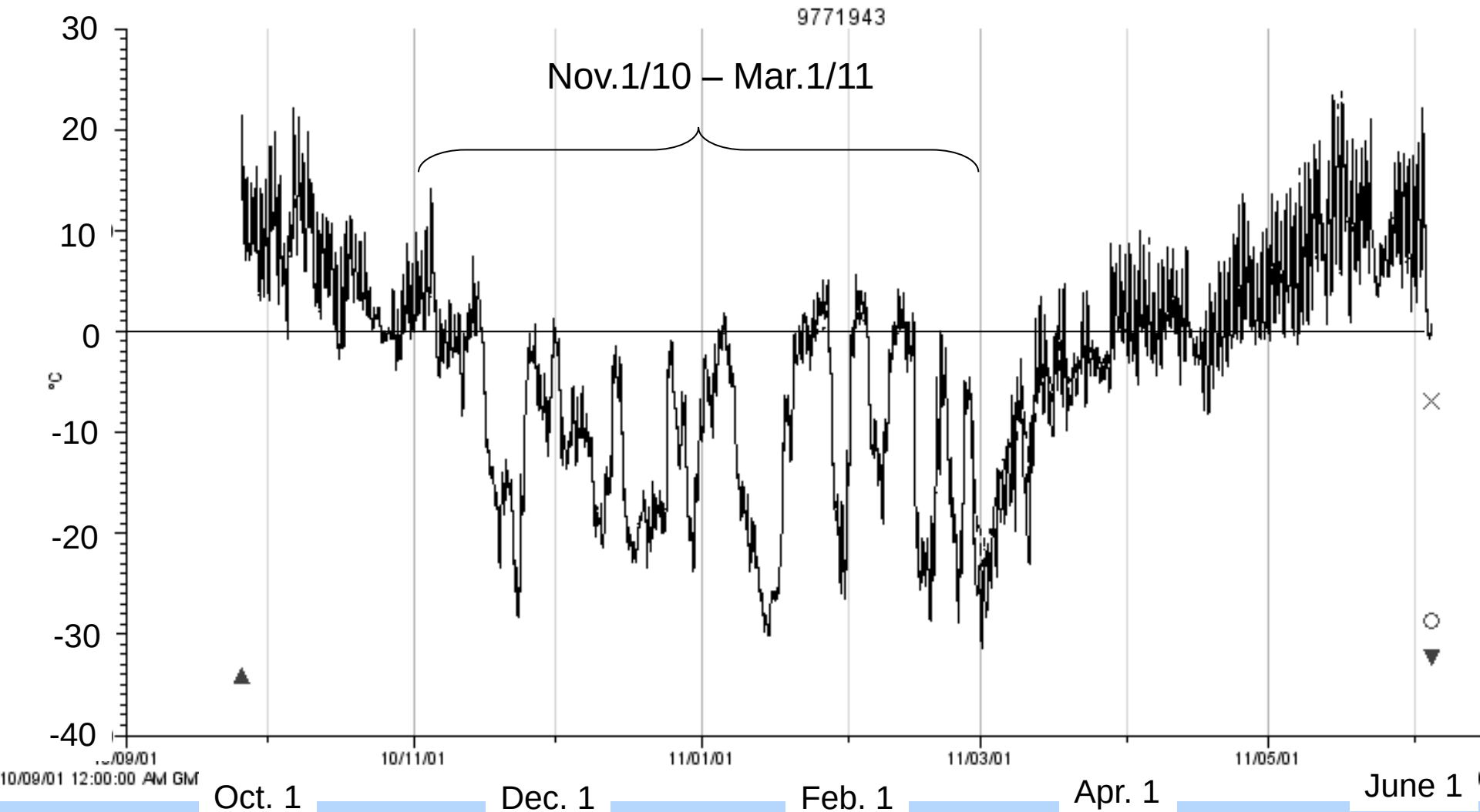
2010
2011 – delayed 3-4 wks everywhere, AB still ahead

2010: Extended attack times
2011: One peak (late)

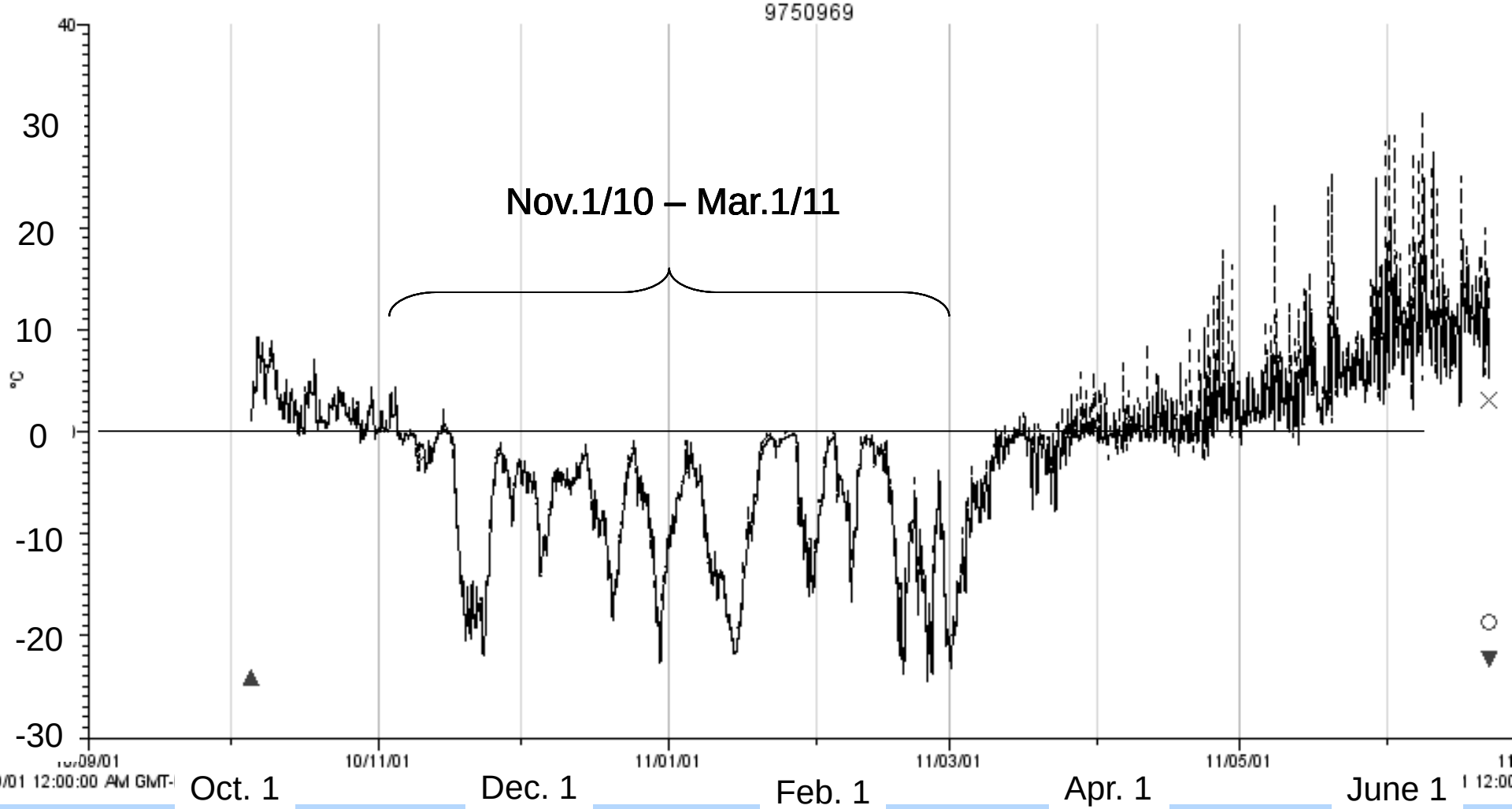
2010 Early-attack

2010 Late-attack

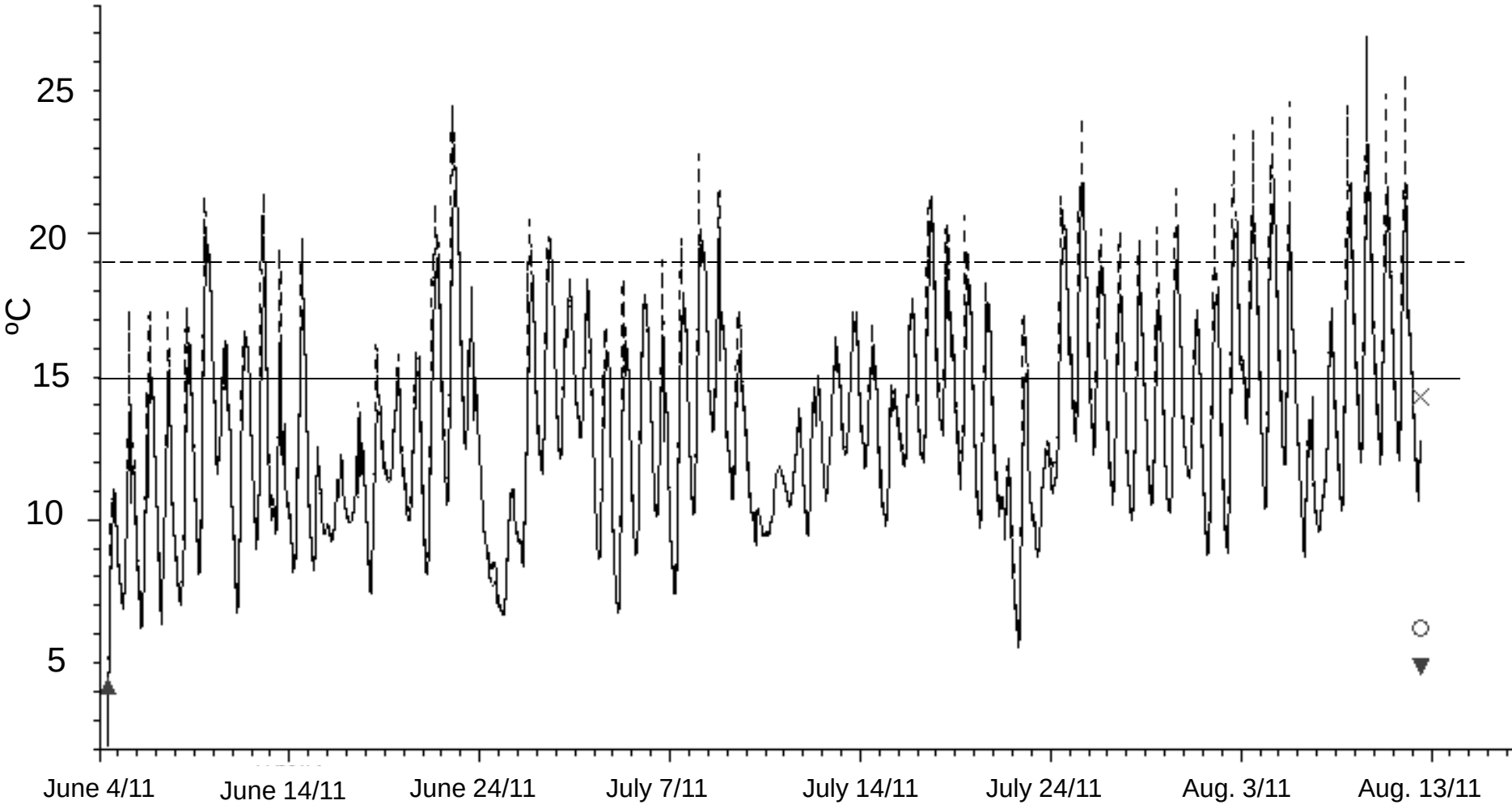
E.g., Winter 2010/2011 - Musreau Lake (south of Grande Prairie)



E.g., Winter 2010/2011 - Smithers (nw BC)



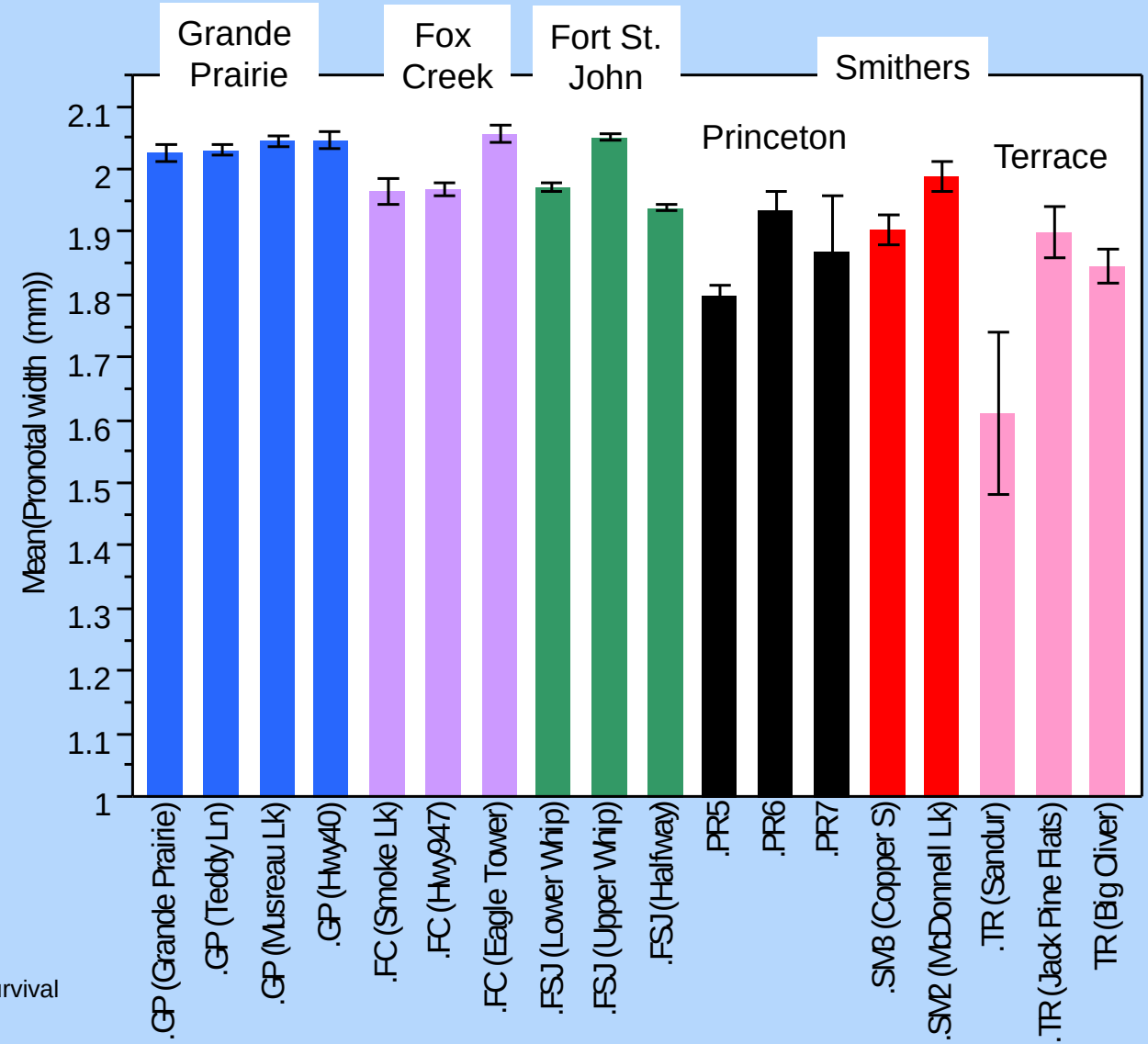
E.g., Summer 2011 - Musreau Lake (south of Grande Prairie)



While we're on the topic of delayed emergence

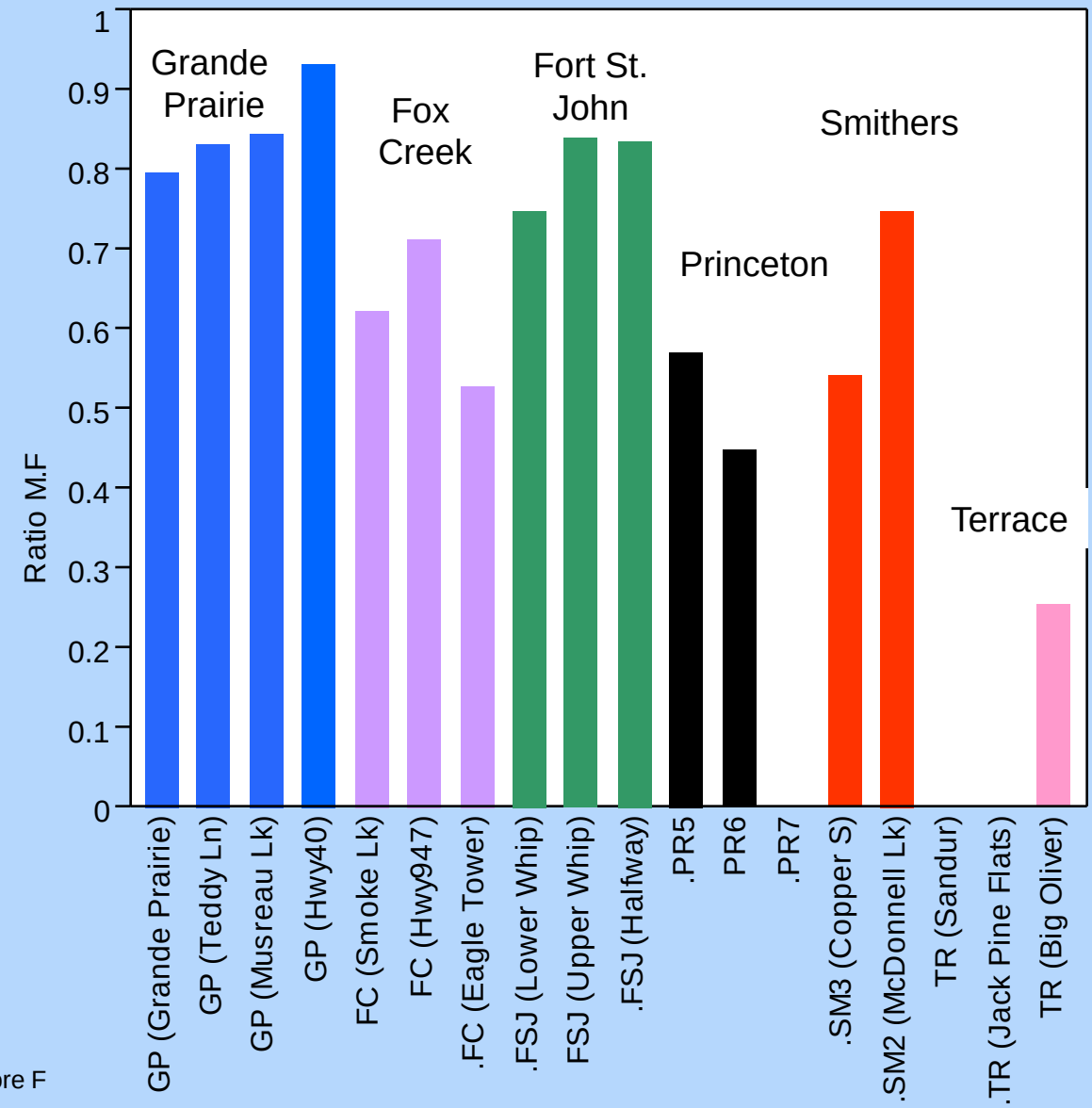
Emergence trap data (Field)

Mean pronotal width (mm)



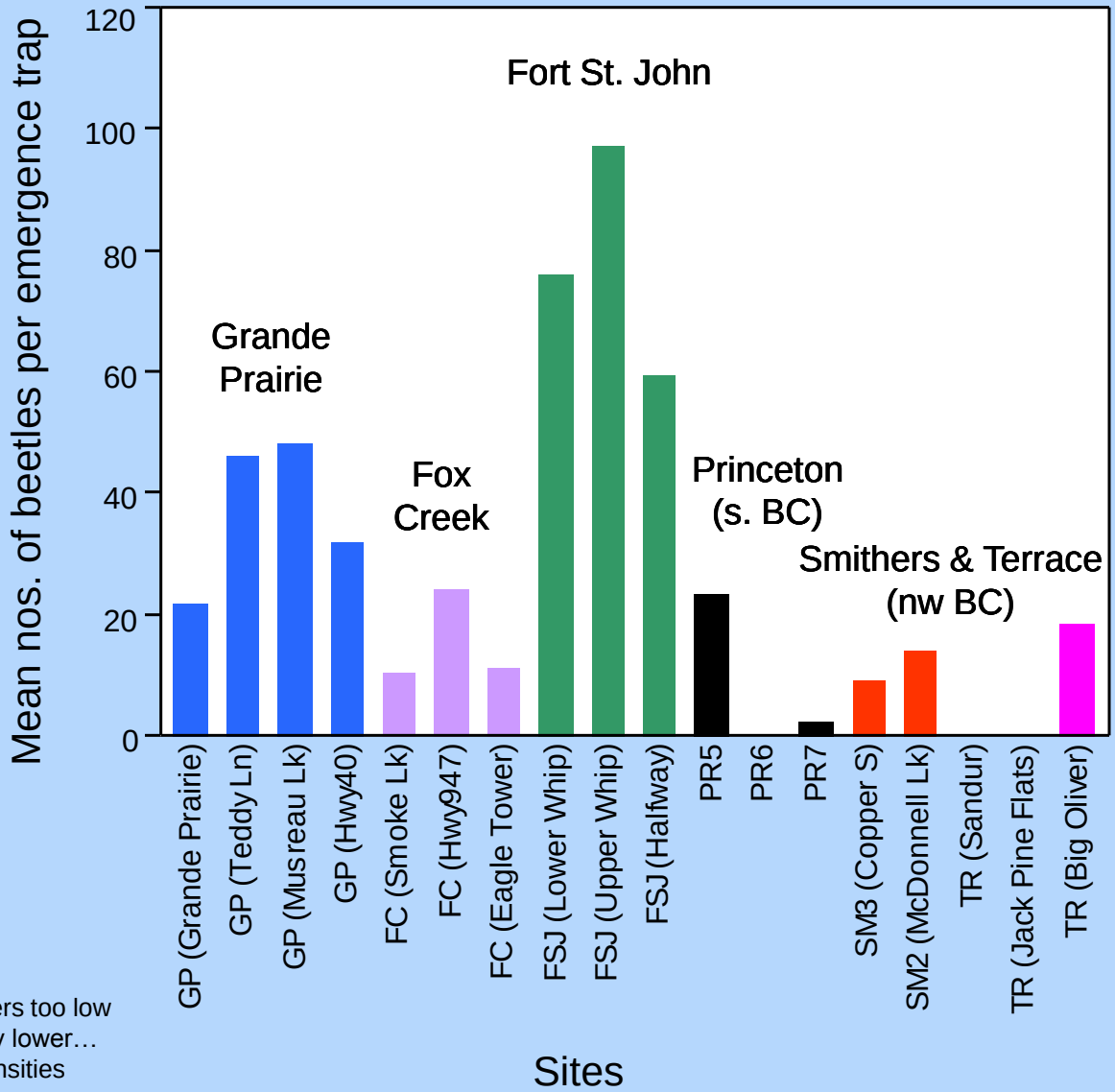
Rel. size-fecundity/survival
Confounding factors

Ratio M:F (lower nos. = more F)



Stressful times, invest in more F

Mean nos. of beetles per emergence trap



Missing – trap numbers too low
Low numbers actually lower…
Need to do actual densities

Future research?

- Overwintering survival
- Cold tolerance – e.g., parameters around cold acclimation; population differences; trade offs; genetics

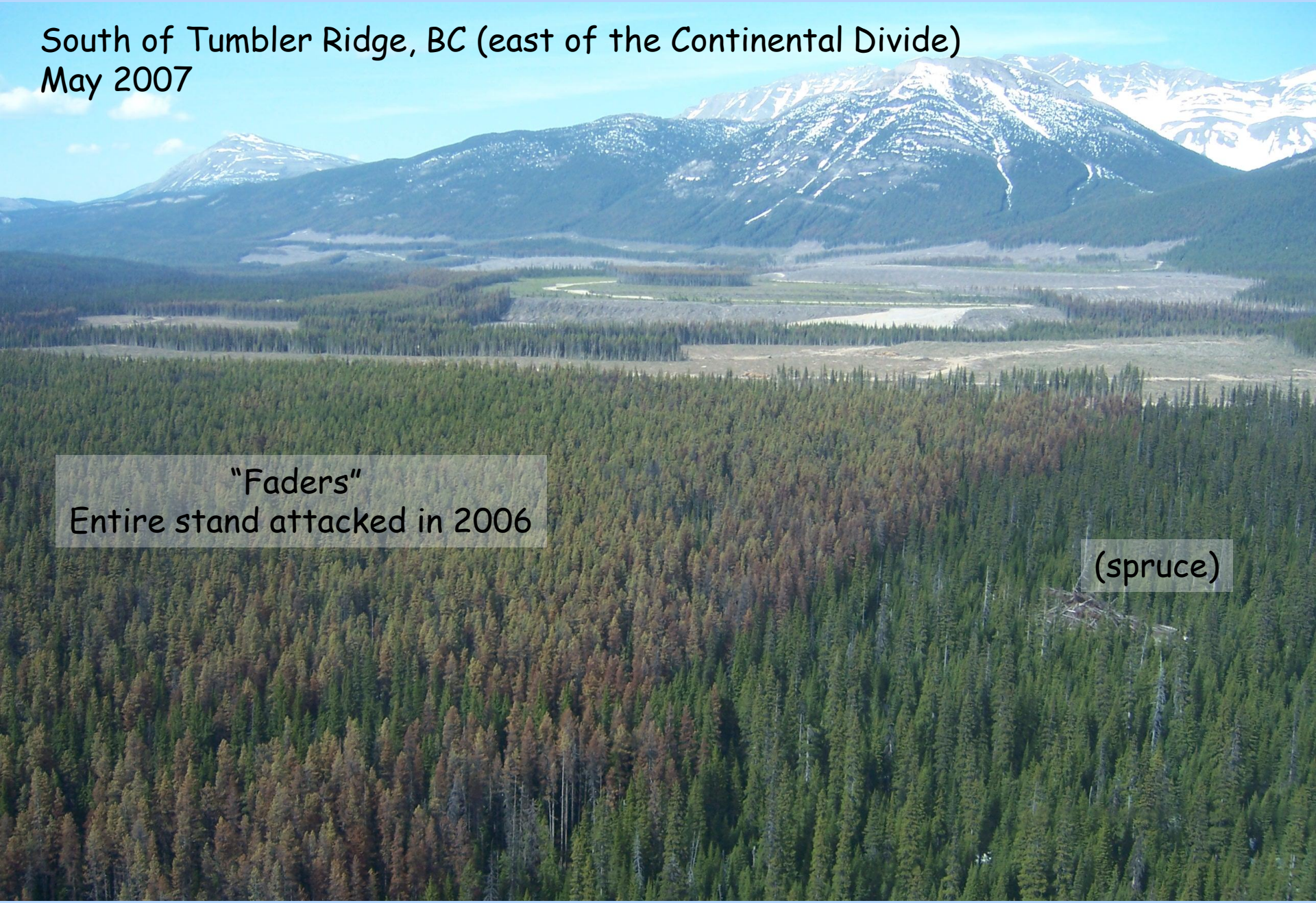
...

Acknowledgements

- L. Safranyik
- *Students:* V. Francis, C. Kay, A. Kletchko, R. Heron, E. Braithwaite, L. Ward
- *CFS-PFC*: V. Waring, D. Lejour, J. Vallentgoed, G. Dalrymple, M. Noseworthy, K. Pellow, N. Humphreys, K. Hogg, J. Simpson, N. Condor, G. Thandi
- *CFS-NFC*: B. Cooke, J. Weber, B. Tomm
- *BC MFR*: K. White, E. Havard, B., Borrett, S. Haight, A. Benterud
- *AB SRD*: A. Hundsdoerfer
- *Companies*: Weyerhauser, Blue Ridge, and Western Millar Forest Products

Funding in yrs 1 and 2 provided by:

Foothills Research Institute, AB SRD, SK MoE, MB CON, OMNR, SERG-I, Forest Protection Limited, NRCan


South of Tumbler Ridge, BC (east of the Continental Divide)
May 2007
"Faders"
Entire stand attacked in 2006
(spruce)