BRITISH COLUMBIA
Ministry of Forests

Bark beetle biology and management

BCIT

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Marnie Duthie-Holt, MPM, RPBio

Kootenay Boundary Regional Entomologist

Outline

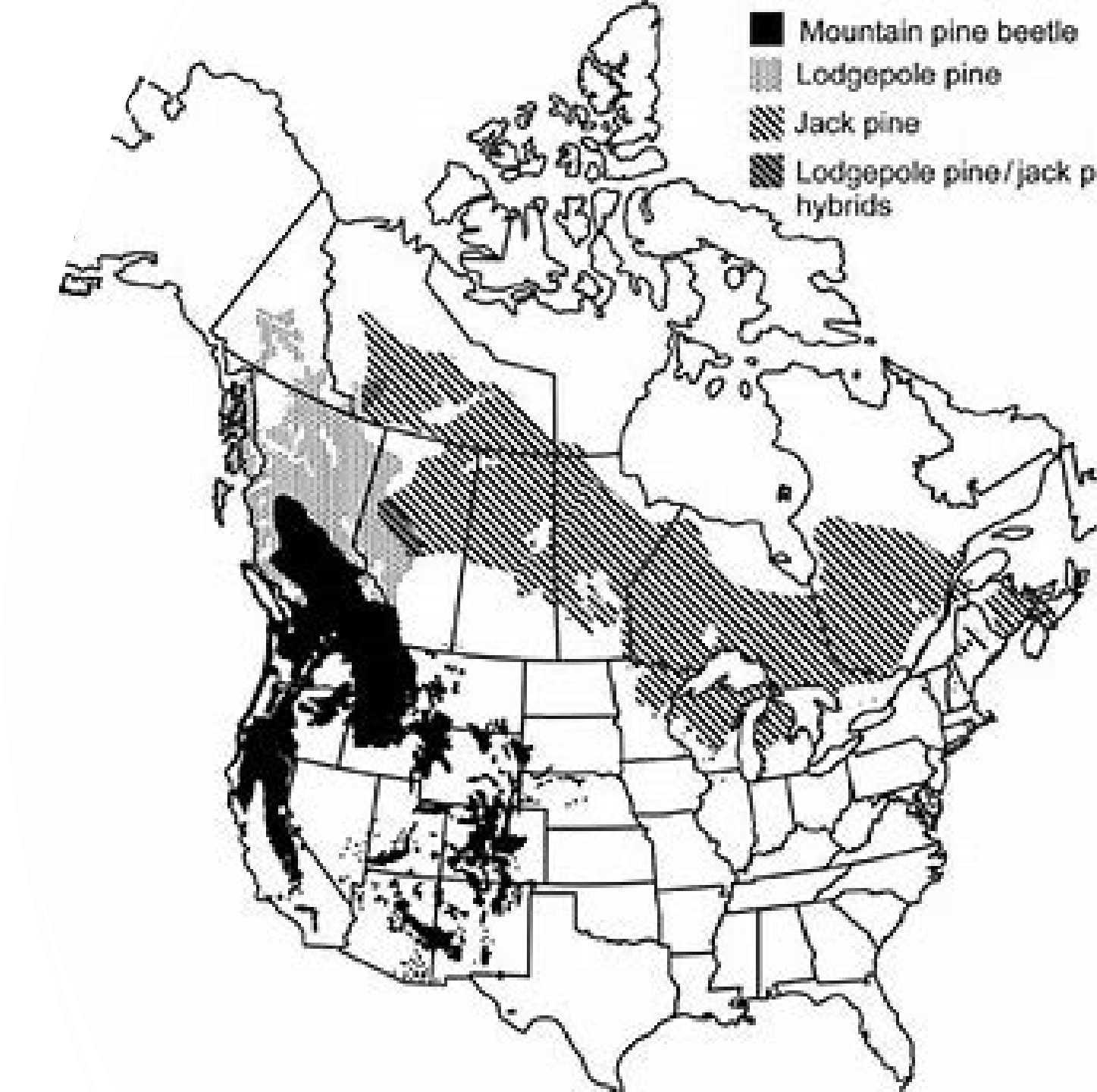
- Biology/ Life cycles
- Natural controls
- Why do populations increase?
- Monitoring techniques
- Control strategies and tactics

“Fab” 4 Bark Beetles in BC

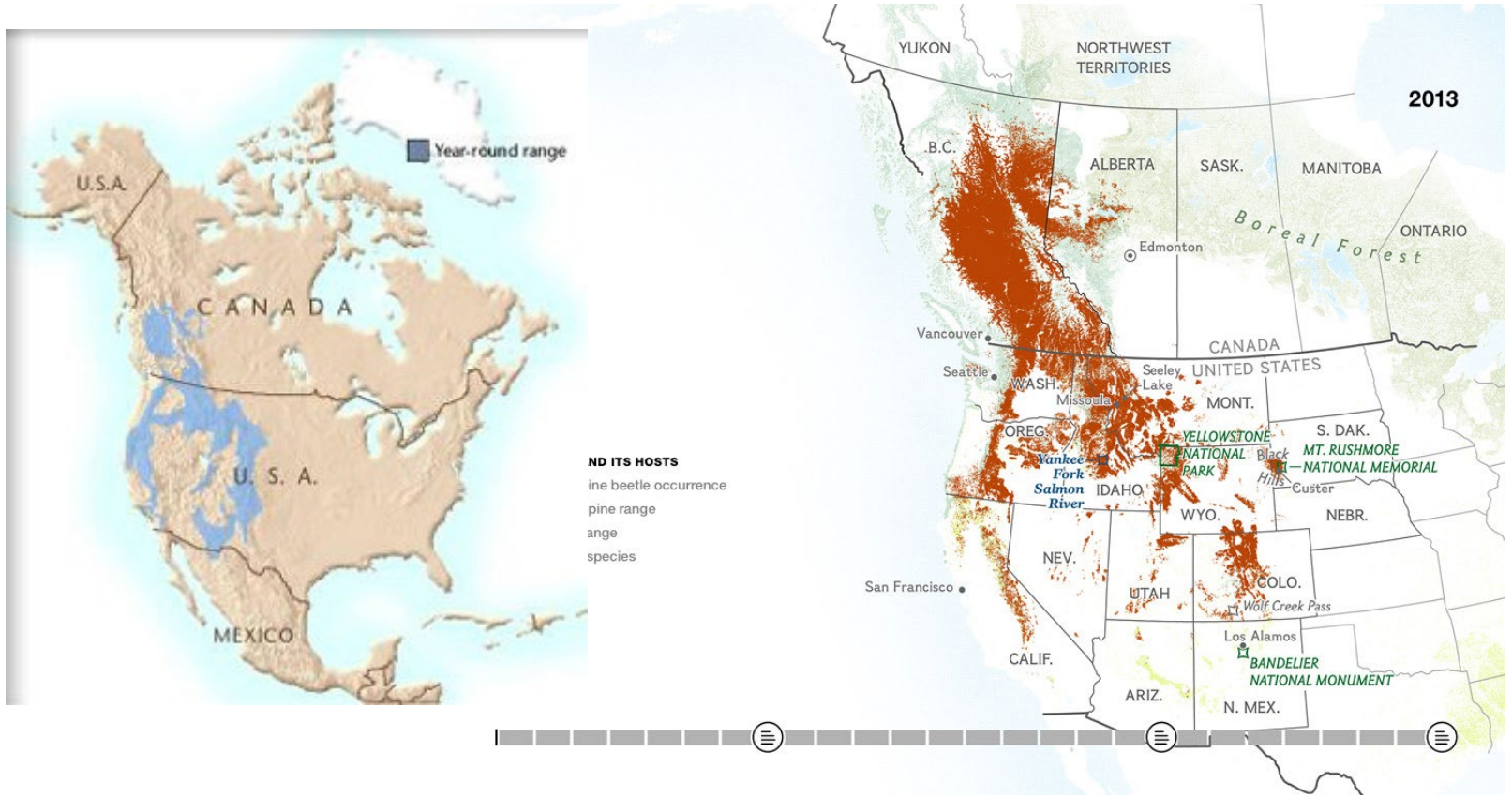
Bark beetle	Code	Hosts
Mountain pine beetle	IBM	Pl, Pp, Pw, Pa, Pf, Pj
Spruce beetle	IBS	Sx, Se, Sw, Ss
Douglas-fir beetle	IBD	Fd (Lx)
Western balsam bark beetle	IBB	Bl (Ba, Sx)

Why do we care?

- All of the Fab 4 are **native** to western NA, however **range expansion** has occurred due to warmer climates
- Bark beetles are the most destructive group of forest pests in BC and cause widespread mortality to mature forests
- BC experienced the largest IBM outbreak on record which began around 1999 and subsided a decade later (18 M ha Pl)



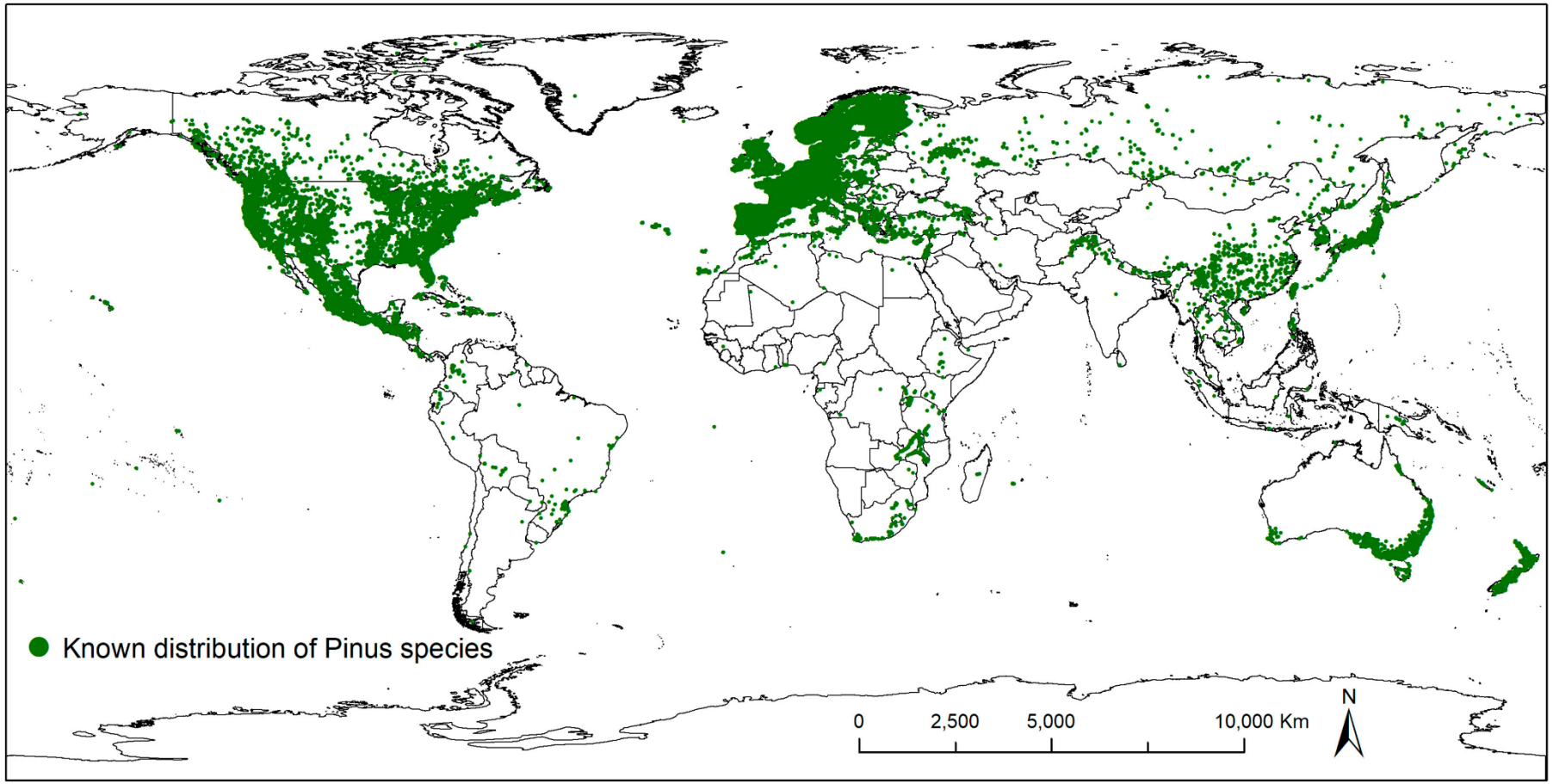
DISTRIBUTION: IBM



IBM

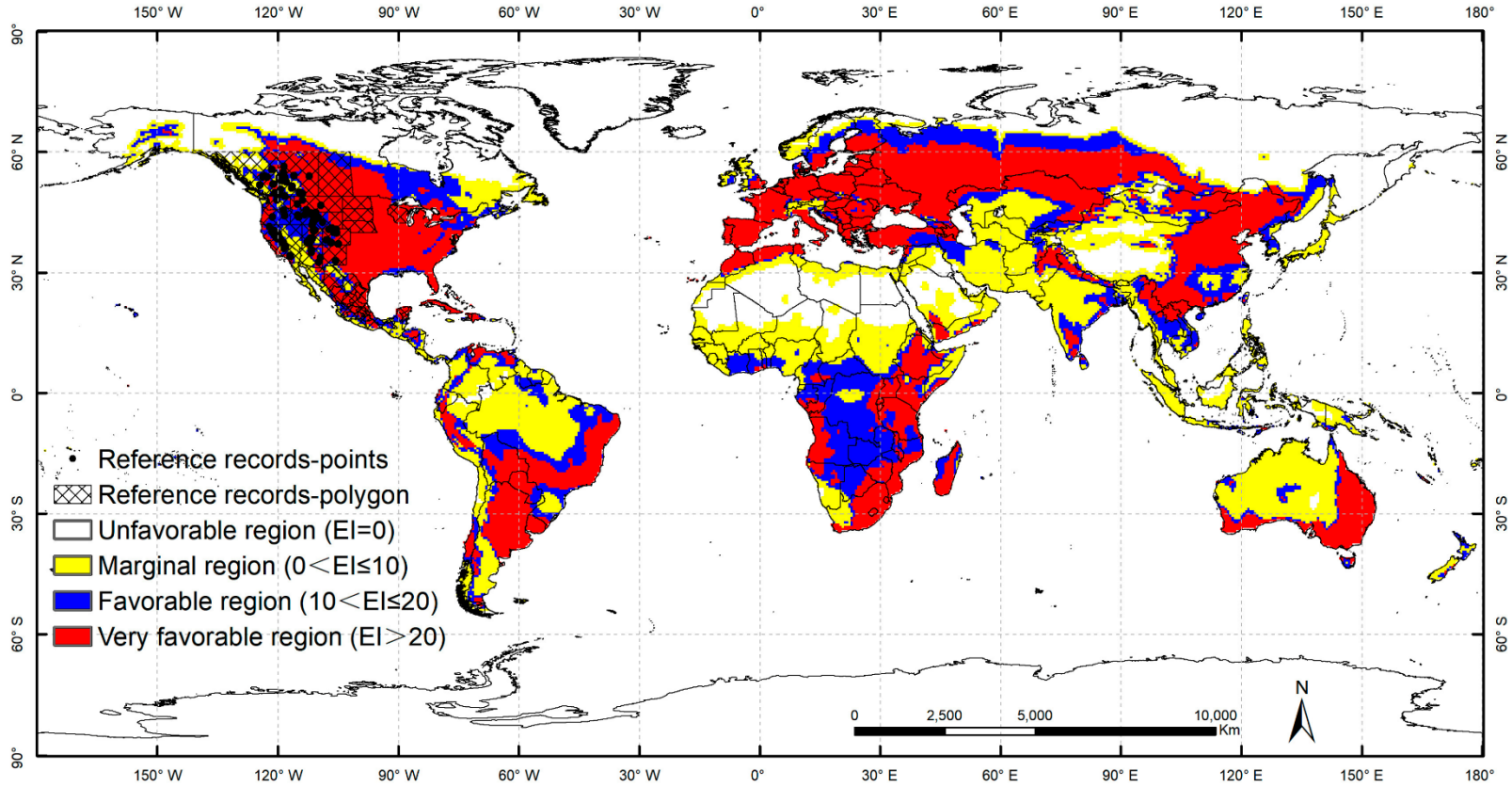
Native to western North America
Range expansion due to warmer climate

Pinus spp. are among the most widely distributed plant species in the world



Climate Change Impacts on the Potential Distribution and Range Shift of *Dendroctonus ponderosae* (Coleoptera: Scolytidae). 2019. Zhou et al. Forests.
https://www.mdpi.com/1999-4907/10/10/860/htm

Predicted potential global distribution under historical climate conditions and the known global occurrence records of IBM (*D. ponderosae*). The unfavorable, marginal, favorable, and very favorable regions were painted in white, yellow, blue, and red, respectively. The known distribution based on published records were filled with black dots and mesh polygons.



Distribution IBS

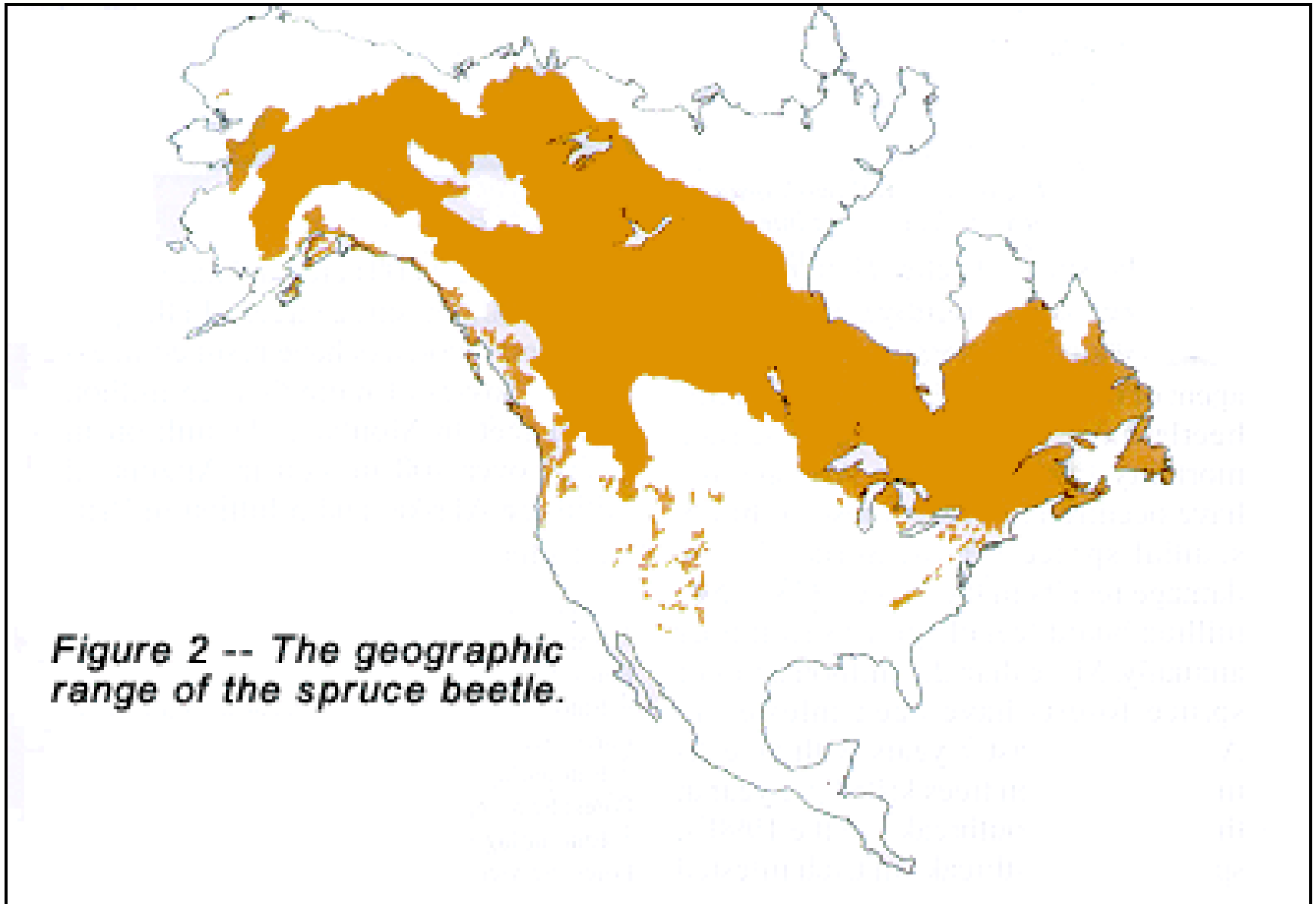
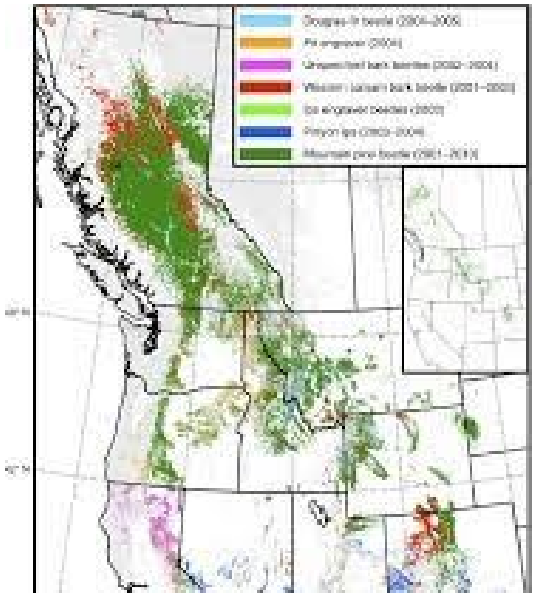
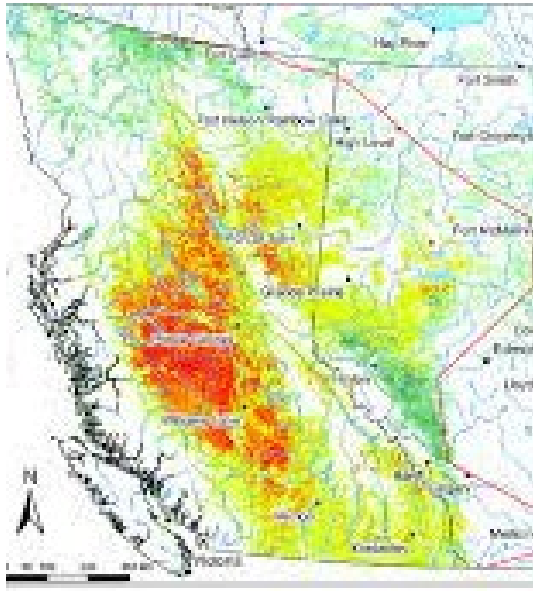


Figure 2 -- The geographic range of the spruce beetle.

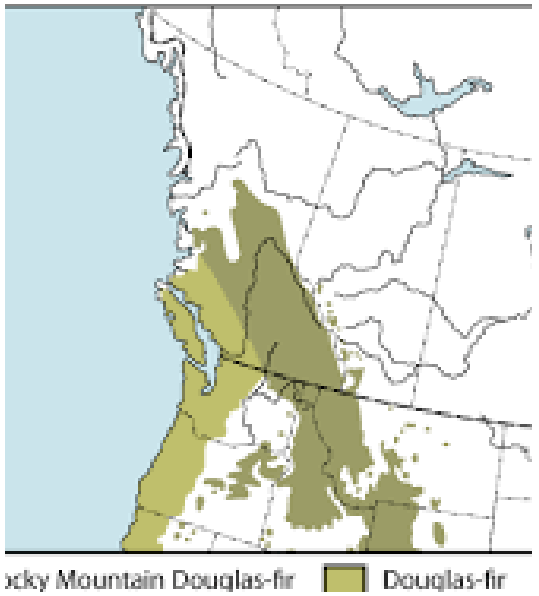
Distribution IBD



Combined



IBM



IBD

IBS

Bark Beetles

Fab 4: Bark Beetles

- Bark beetles are integral components in forest ecosystems.
- As natural forest disturbance factors, bark beetle outbreaks can result in
  - Increased ecosystem diversity and resilience but can also

  - impact forest values such as
  - carbon sequestration,
  - recreation,
  - fish and wildlife,
  - watershed management,
  - range,
  - landscape values and aesthetics,
  - cultural heritage,
  - old growth forest ecosystems, and
  - timber production.

HOST SELECTION

Mountain Pine Beetle

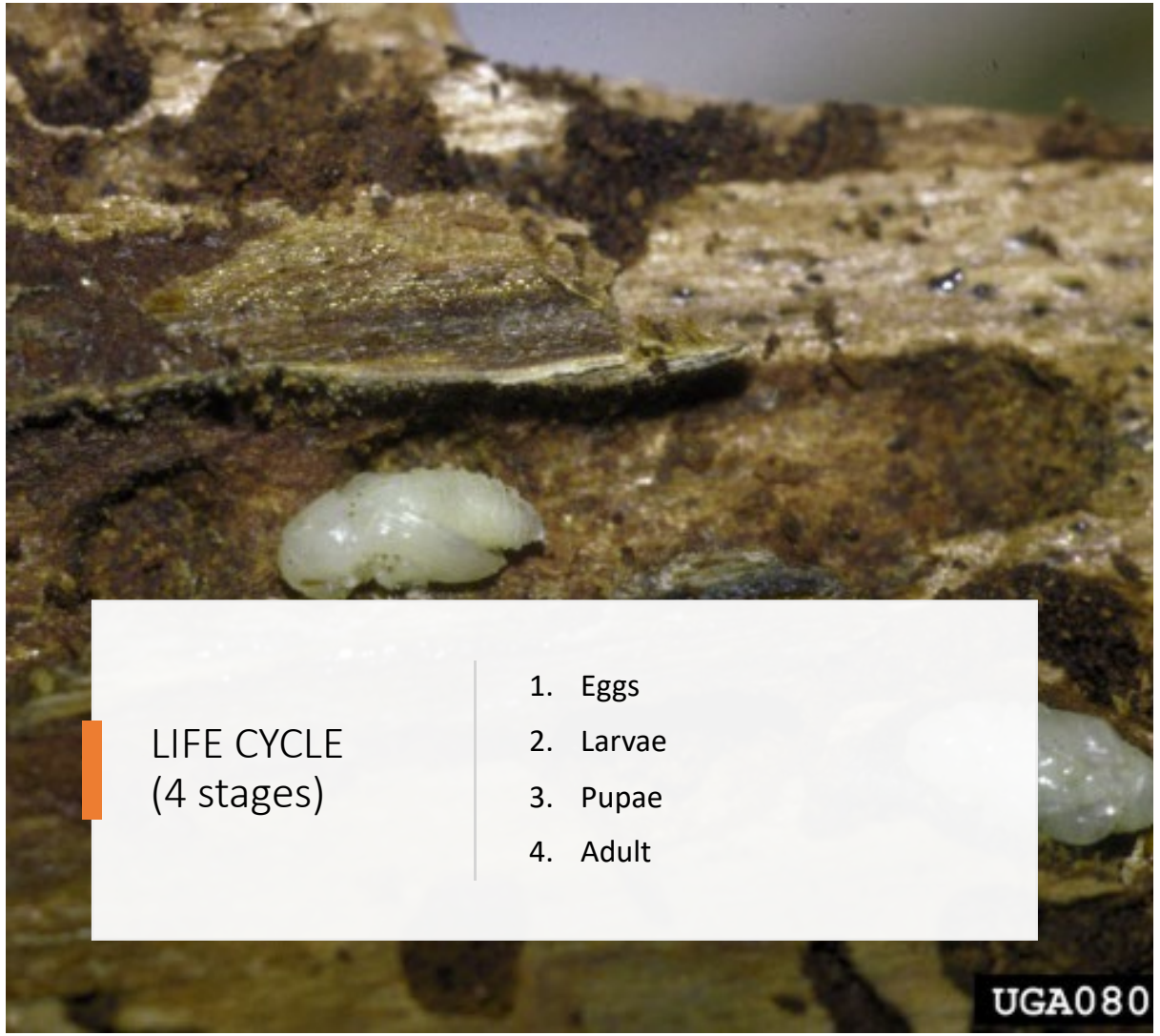
- IBM
  - Prefers standing healthy trees

Douglas-fir/ Spruce Beetle, Western Balsam BB

- IBD/ IBS/ IBB
  - Prefers freshly felled/ stressed trees;
    - Windthrow
    - Drought stressed
    - Snow snapped
    - Fire scarred
  - Will kill healthy standing trees if populations increase

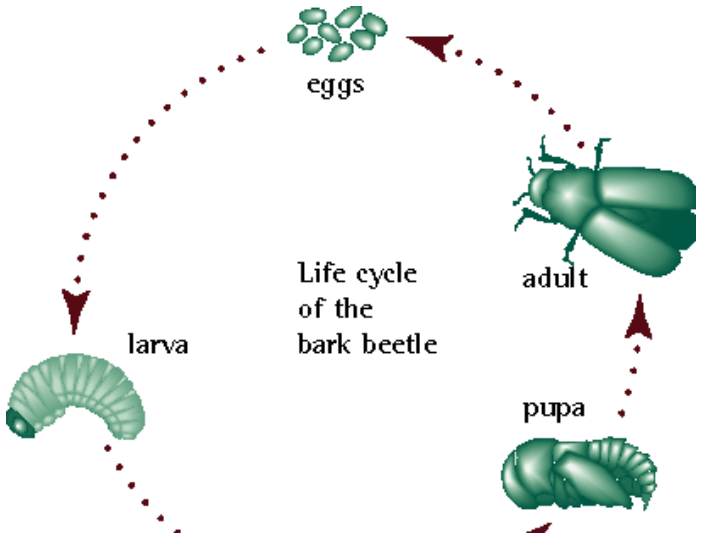
Bark beetle strategy

Mass Attack	To overcome healthy trees must mass attack – large numbers stop sap flow
Synchronize	Synchronize flight, over come tree defenses
Tree Wins	If attacked tree is not killed, beetle's eggs and larvae will not survive to adult stage



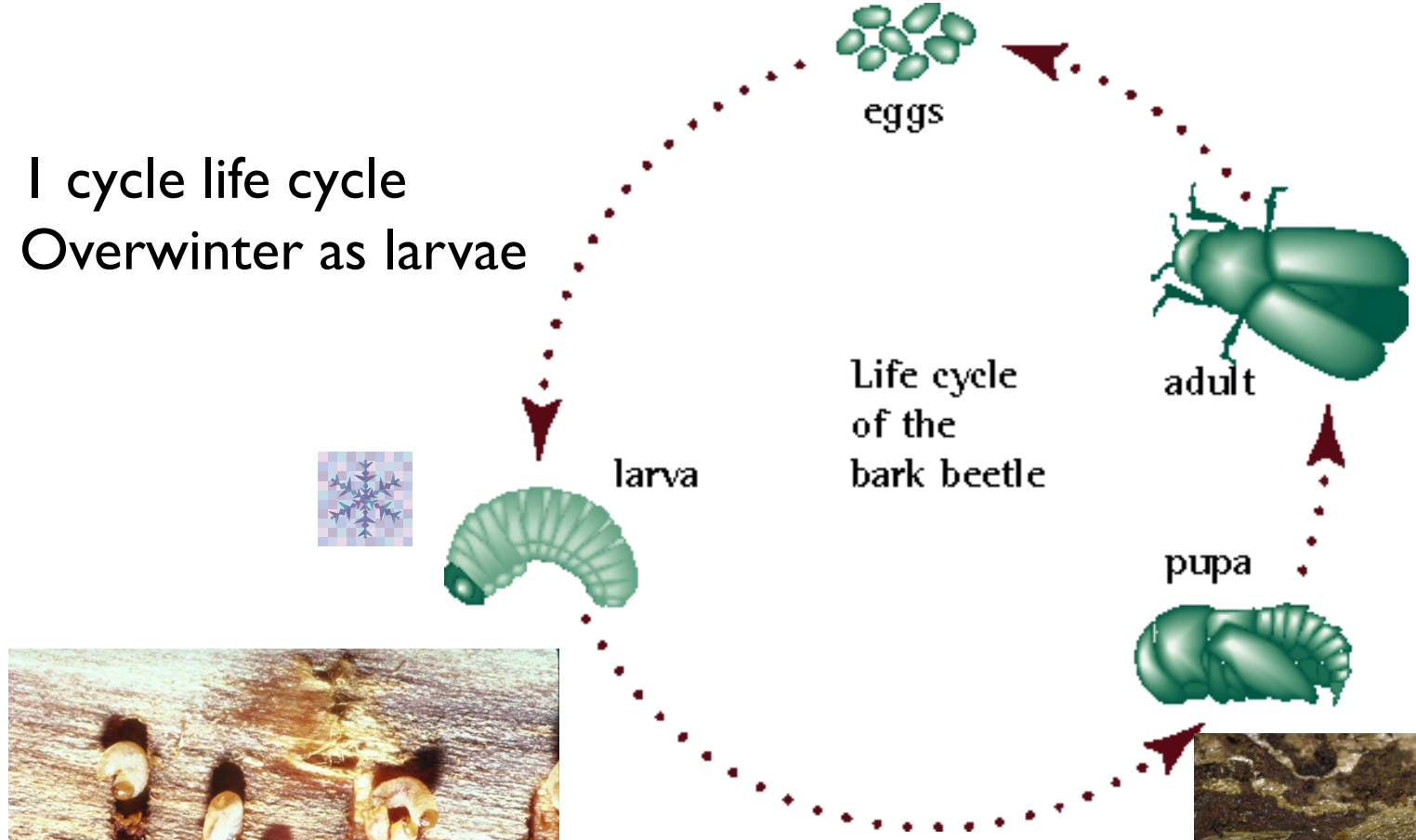
LIFE CYCLE (4 stages)

1. Eggs
2. Larvae
3. Pupae
4. Adult

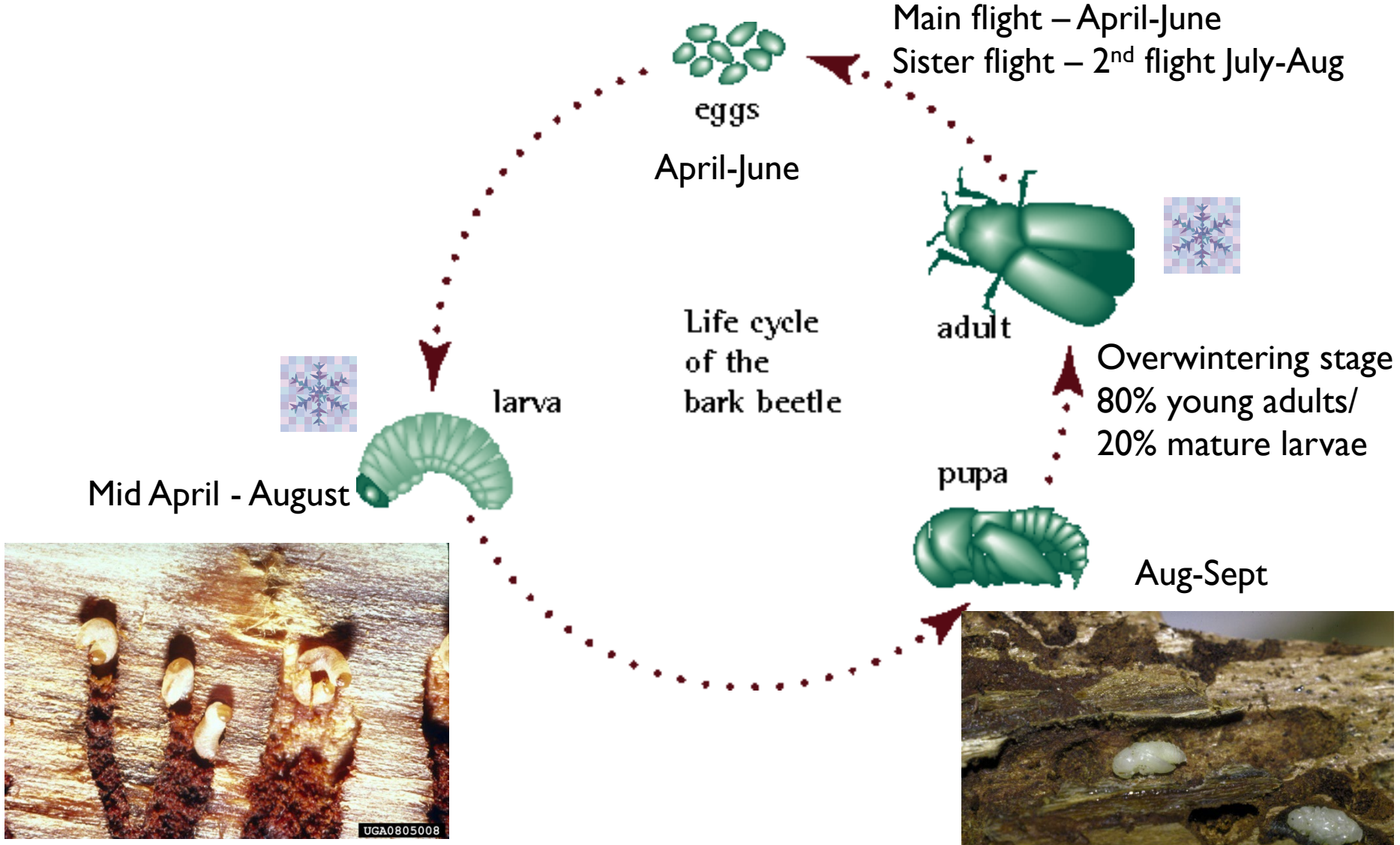


LIFE CYCLE (4 stages) IBM

1 cycle life cycle
Overwinter as larvae



LIFE CYCLE (4 stages) IBD



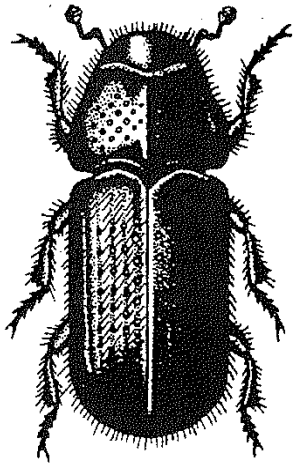
Spruce Beetle

Typical 2-year cycle

Eggs

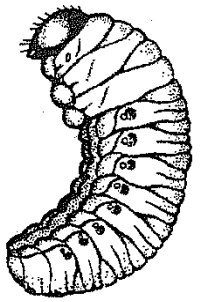
Fly in late May/June

Adults



Overwinter

Larvae

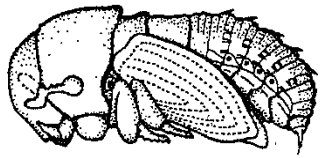


Overwinter

Winter 2

Winter I

Pupae

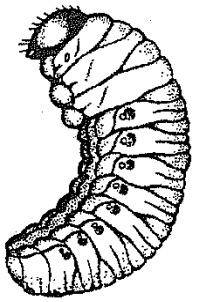


Spruce Beetle

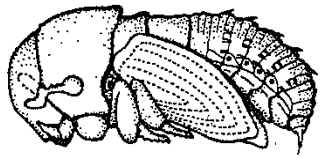
1- year cycle

Eggs

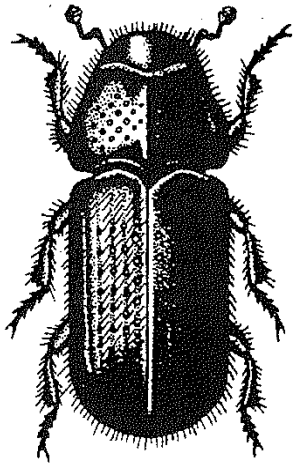
Larvae



Pupae



Adults



Winter 1

Overwinter

No matter the lifecycle length, IBS must overwinter as an ADULT once during their lifecycle

Spruce beetle life cycle

- **2 year cycle**
  - 40-60% of immature adults emerge and overwinter at the base of the tree or duff 2nd winter
  - Warm blanket of snow and no woodpeckers
- **1 year cycle**
  - Warmer temperatures

Woodborers

- Flatheaded
- Rounded headed
- Wasp wasps

Metallic beetles

Long horn beetles

NATURAL CONTROL: Parasites and predators

Parasitic wasp

- Beneficial insect like parasites and predators (checkered beetles= clerids) kill larvae and adults

Checkered/ clerid beetle

NATURAL CONTROL: Woodpeckers

- **Woodpeckers** and other beneficial birds effective predators
- <0^{o}C woodpeckers can eat more than 2,200 larvae/day
- even if 90-95% of beetles killed outbreak can still continue!
- Woodpeckers are territorial keeping bird numbers down

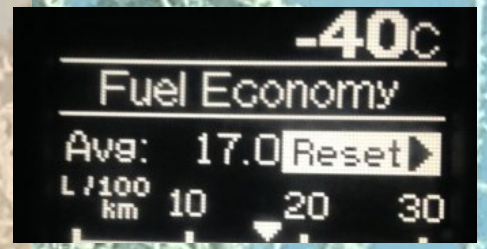
NATURAL CONTROL: Climate/ Weather

Climate/ Weather

Tree diameter and phloem thickness major factors in population control by weather (underbark temp)

Larvae most cold tolerant – **GLYCEROL** (anti-freeze)

Cold/wet – spring – during flight as effective killing beetles

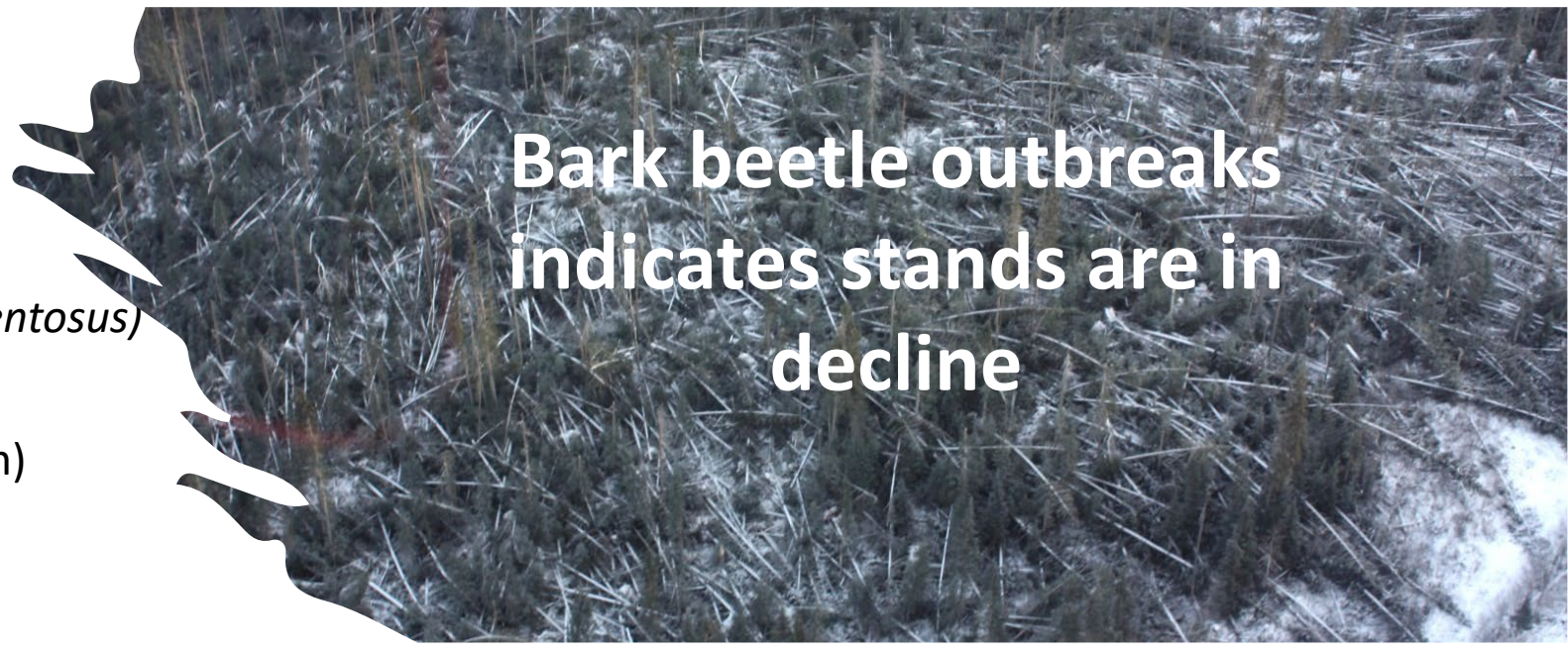


Bark beetles and cold temperatures

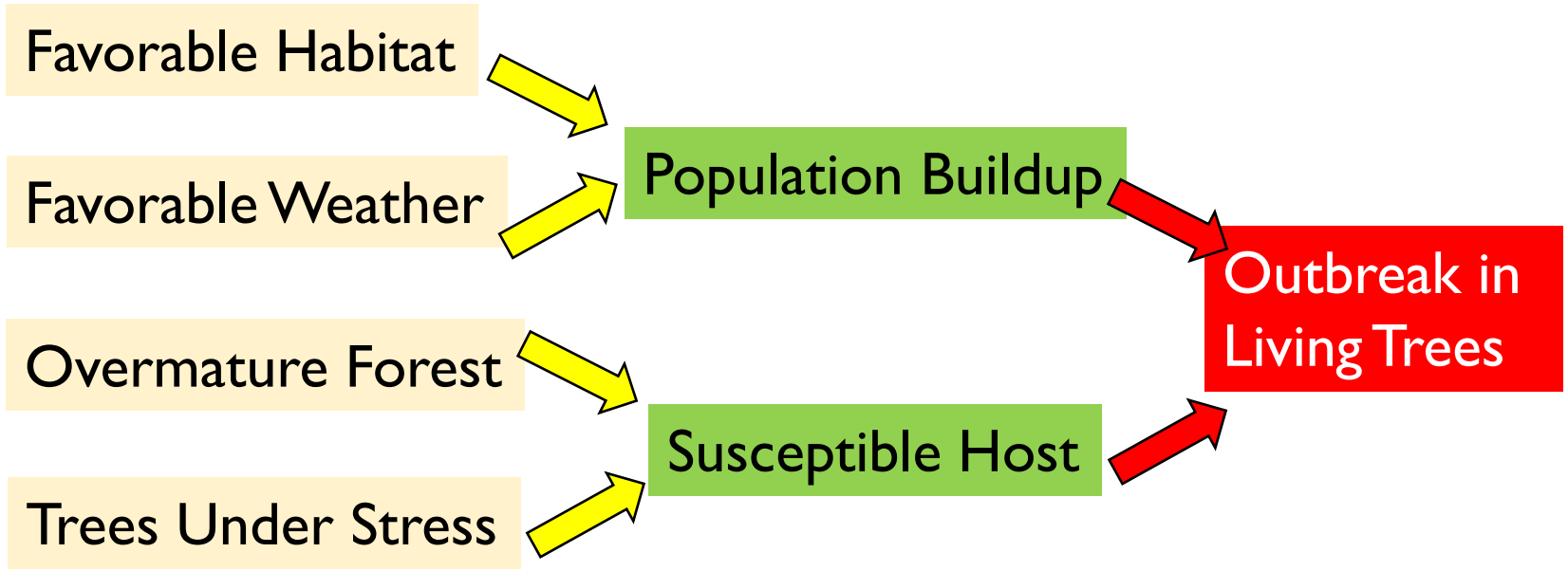
- As a cold-intolerant pest, cold temperatures in winter are key constrains limiting the distribution
- Overwintering success is critical for sustained pest outbreaks
- With reduced cold stress limitations in the future, bark beetles will be more likely to cause outbreaks in severe cold regions and expand its range into higher latitudes

Why do populations increase to epidemics (Natural Caused)?

- Fire Suppression = Overmature trees
- Wildfire
- Climate: Drought/ Heat dome
- Windthrow/ Avalanches/ Flooding
- Windshake/ broken tops
- Root disease
  - IBD: DRA (*Armillaria ostoyae)*
    DRL (Laminated root rot)
  - IBS: DRT (Tomentosus - *Onnia tomentosus)*
- Defoliators
  - <u>IBD</u>: IDW (Western spruce budworm)
    IDT (Douglas-fir tussock moth)
  - <u>IBS</u> IDB (2-year cycle budworm)



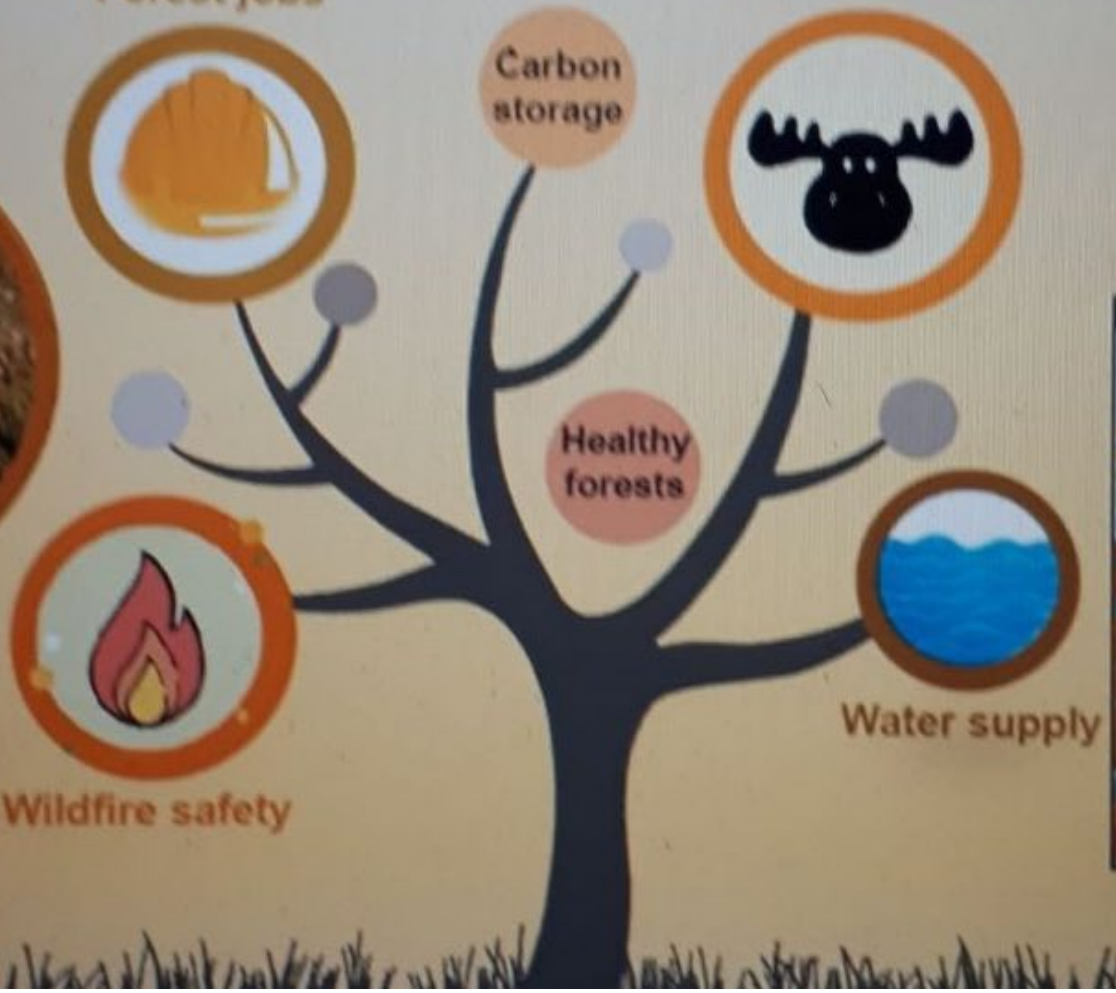
Why do populations increase to epidemics (Natural Caused)?



Drought Affects Everything

Drought threatens our **values**

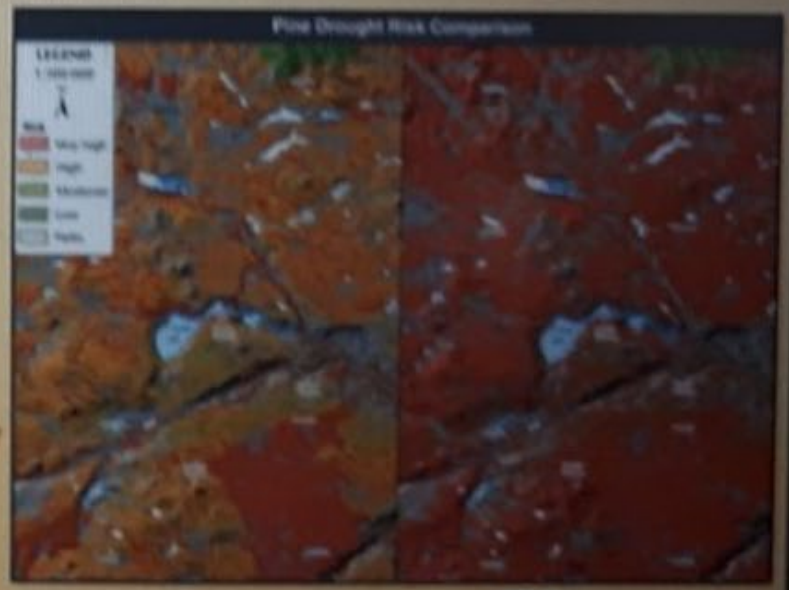
Drought threatens our **forests**



Drought Risk Assessment Tool

- Was designed to integrate climate change into forest management decisions (e.g., timber supply review)
- The tool projects the risk of tree mortality from future climate change driven moisture stress

Historic **Current**



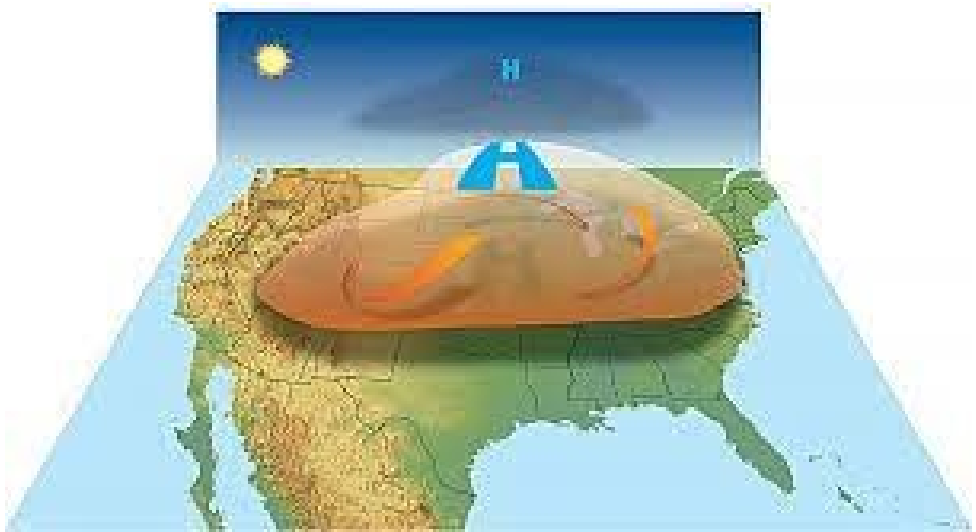
Learn More

Drought

- 1 year of drought – causes damage
- 2 years of drought – compounds damage
- Not enough resources left year 2 to deal successive years of drought
- Therefore, not twice as damage – exponential!

Heat dome (June 2021)

- Scorching one sided
- South and west facing slopes most severe
- Sun burning on boles
- Fd, Hw, and Cw



Fire

- Bark beetles and woodboring beetles will infest recently fire-killed trees and fire-scarred trees that are still alive

- Py (ponderosa pine):
  - Mountain pine beetle IBM
  - Western pine beetle IBW
  - Red turpentine beetle IBT
- Fd (Douglas-fir):
  - Douglas-fir beetle IBD

FIRE AND IBD ATTACK

- Classification of burned areas
  - **Black**: tree boles completely charred and blackened, foliage destroyed, and understory vegetation burned. ***No IBD***

None

Some

Black/brown: mostly black but some brown foliage. ***May develop IBD***

Lots

- **Mixed green/brown/black**: mostly green foliage, with brown and black spots, understory variously burned. ***Sig. beetles may develop.***

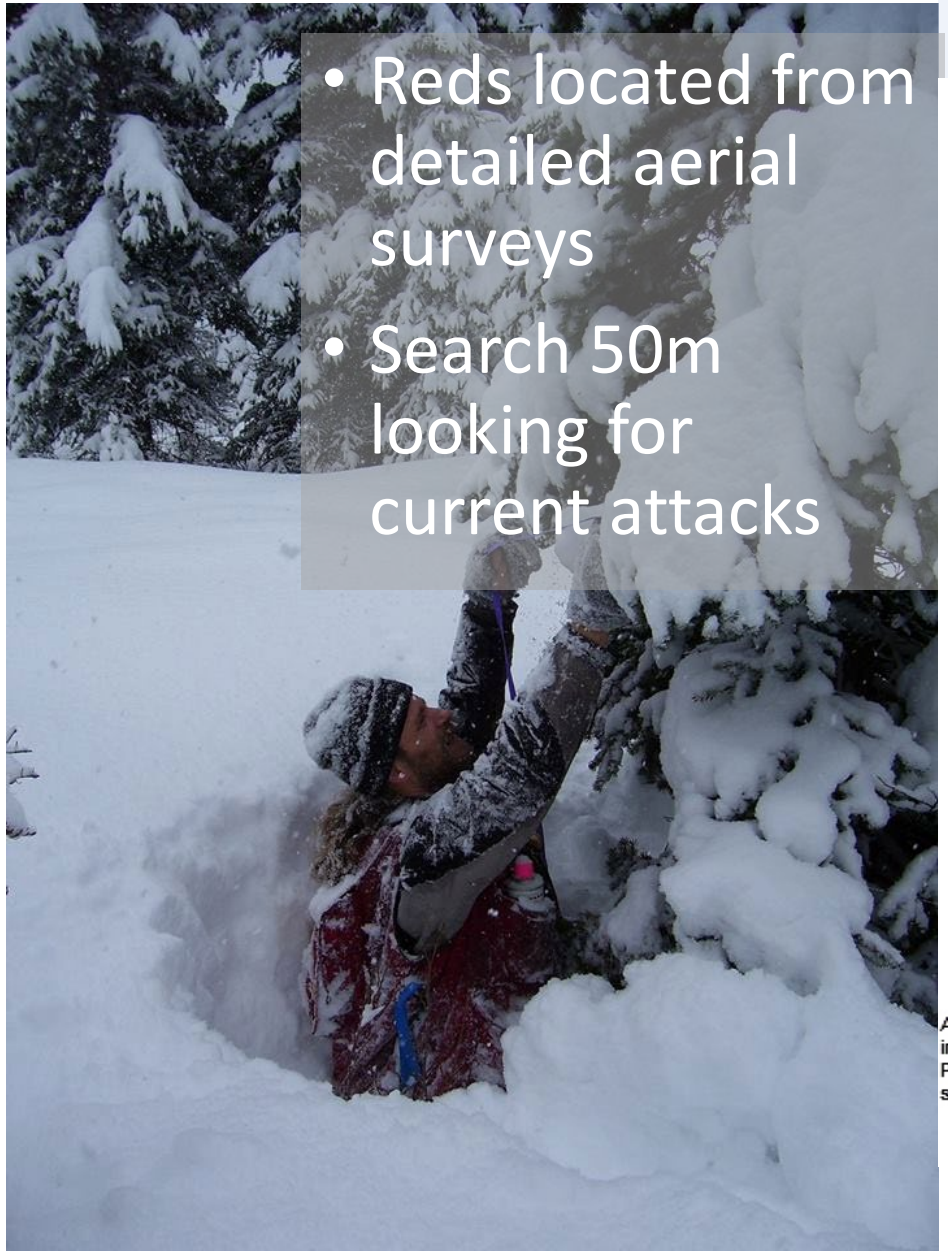
Why do populations increase to epidemics (Human Caused)?

- Abandoned log decks
- Large debris (either green or with beetles)
- Unburned slash piles
- Right of way/roads
  - Damaged/buried roots
  - Windthrow
  - High stumps
  - Basal scars
  - Salt damage

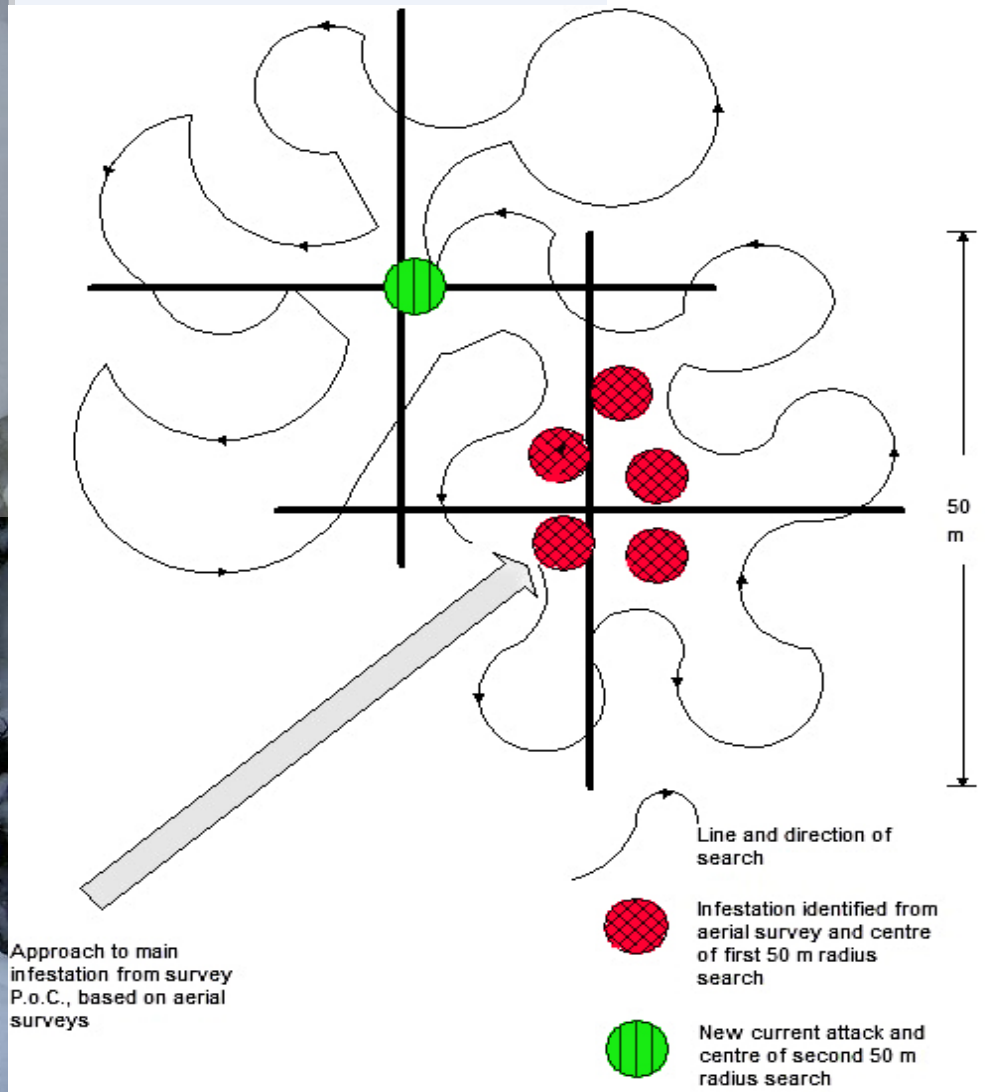
Monitoring Techniques

- Aerial surveys
  - **Aerial overview** (fixed wing – 1:100,000 scale, high, rough, cover all of BC for all pests)
  - **Detailed surveys** (helicopter – 1:30,000 scale, low, slow, specific areas for specific pests)
- Ground surveys
  - Walkthroughs
  - Star probes
  - Grid probes

Star Probe

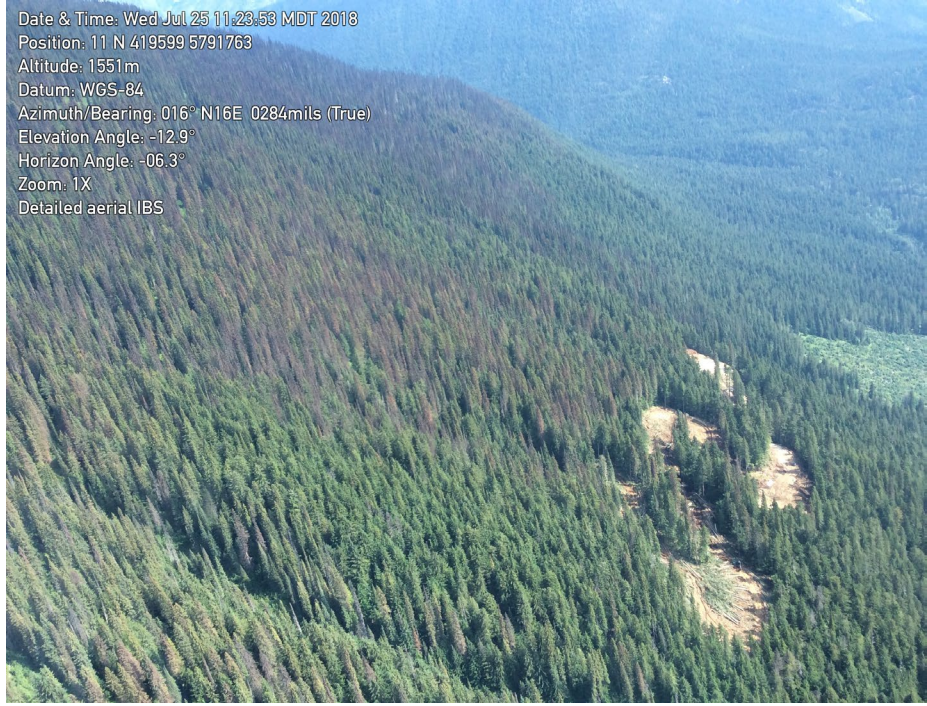


- Reds located from detailed aerial surveys
- Search 50m looking for current attacks



Ground surveys

- **Grid Probe**: uniform survey lines,50-100m apart
- GPS all current attacks, probe line strips at 5m wide



Monitoring Techniques

- <u>Population surveys</u>
  - Green to red ratio (fall)
  - *r*-value and overwinter mortality (spring)

Green to red ratio surveys

- Measure of current to previous years attack
- Capture all “greens” and “reds” within 50m of detailed aerial survey point

Ratio G:R	Population estimates
>1	Increasing
1	Static
<1	Decreasing

r-value=avg. no. progeny per sample/ avg. no. entrance holes

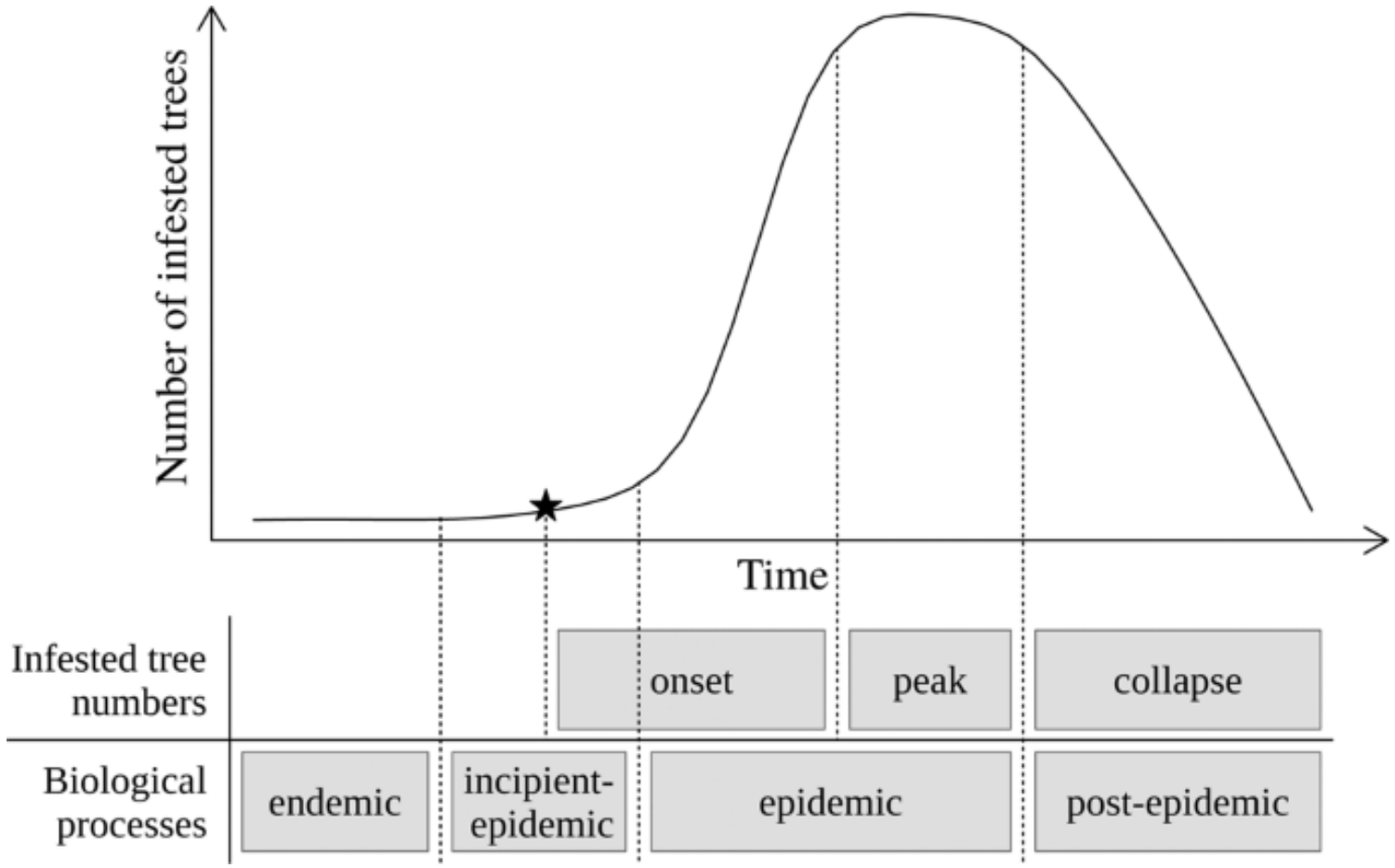
R-value	Population Interpretation
0-2.5	Decreasing
2.6-4.0	Static
>4.1	Increasing

Bark Beetle Management Strategies

1. Proactive
2. Targeted
3. Reactive
4. Salvage
5. No Action

https://www2.gov.bc.ca/gov/content/industry/forestry/managing-our-forest-resources/forest-health/forest-pests/bark-beetles/management-strategies

Bark beetle outbreak dynamics



Bark Beetle Management Strategies

1. **Proactive**

- applied where beetle populations are in the **endemic** population phase
- key goal is to prevent beetle populations from expanding to unmanageable levels.

Bark Beetle Management Strategies

2. Targeted

- beetle populations that are in the **incipient** population phase

- applied where pest populations are building but can still be effectively reduced before more widespread infestation occurs.

Bark Beetle Management Strategies

3. Reactive

- pest populations that are in the **epidemic** population phase

- goal is to reduce and mitigate widespread bark beetle-caused host tree morality.

Bark Beetle Management Strategies

4. Salvage

- Focus on the harvesting of mostly dead or dying trees and stands to minimize timber value losses in widespread infestations
- applied where management efforts would be ineffective in reducing beetle populations and subsequent levels of damage.
- most suited for beetle populations nearing the end of epidemic phase or in the post-epidemic phase.
- goal is to recover timber value, to regenerate impacted areas and to reduce fire risk to promote future more resilient forests.

Bark Beetle Management Strategies

5. No Action

- applied to designated areas where:
  - Natural disturbances are left unmanaged
- Management efforts would be ineffective in substantially reducing beetle populations and impacts
- There is no short-term possibility of salvaging dead timber
- Access cannot be put in place before substantial merchantable degradation of the dead material (economically constrained areas)
- Non-timber values or other management constraints such as wilderness areas, Parks or ecological reserves, culturally significant areas, supersedes that of timber or wood products
- Areas designated as no action should be large enough to allow for the full range of ecosystem processes through time.

Control Tactics

Tactic	IBM	IBD	IBS
Sanitation harvest*	Yes	Yes	Yes
Trap trees	No	Yes	Yes
Single tree treatments (Fall n burn; fall n peel; fall n chip)	Yes	Yes	Yes
Anti-aggregants	Verbenone	MCH	MCH+ (Research stage)
Baited funnel trap	Yes	Yes	Yes
Bait trees	Yes	Yes	Yes

*Most effective tactic

Sanitation Harvesting

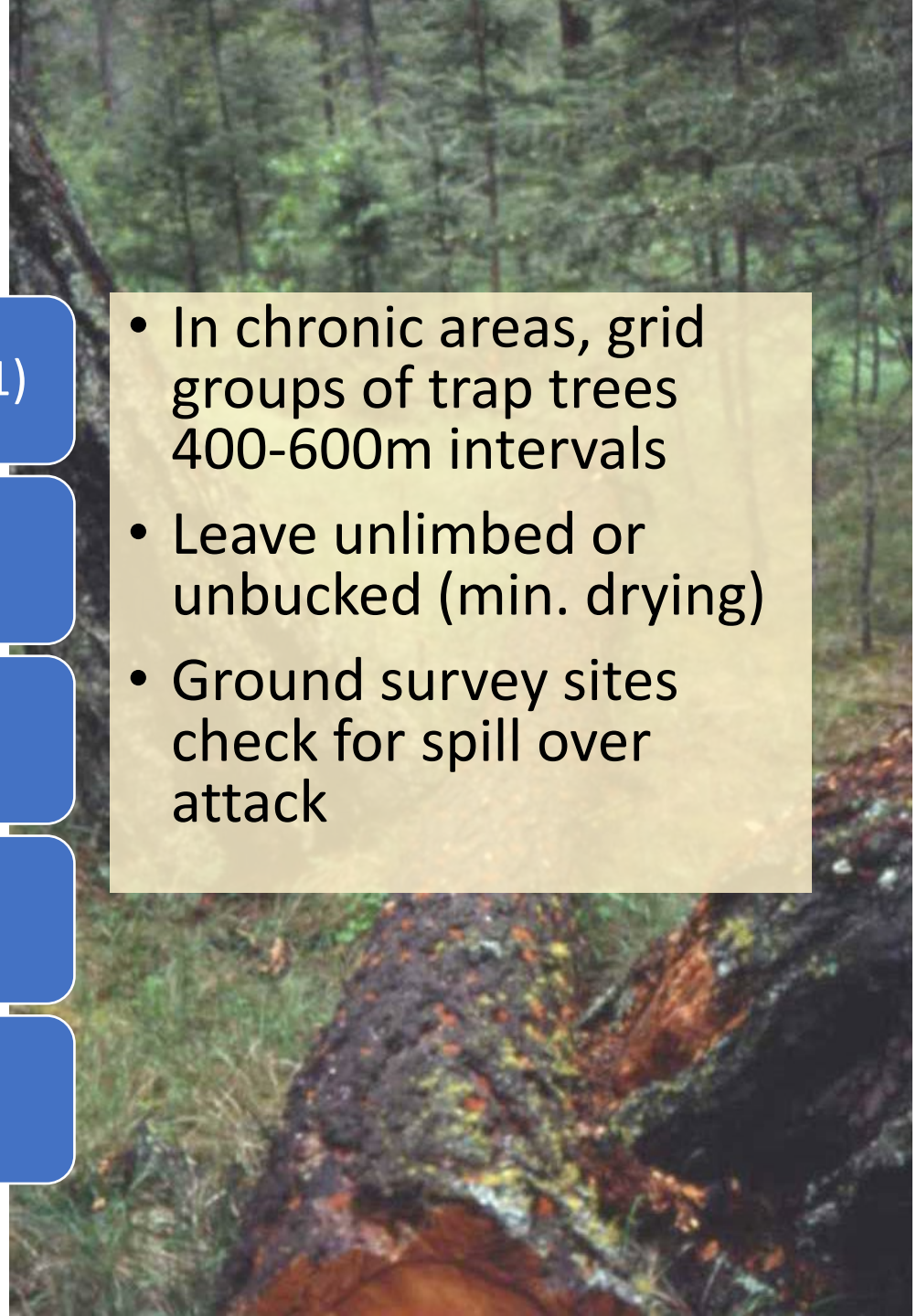
- Strategic target of stands to reduce beetle populations while maintaining non-timber values
- Remove all currently infested trees & mill before beetle flight
- Low stumps <30cm
- Planned over multiple years
- Burn debris piles
- **Most effective tactic, especially with trap trees** (IBD)

Salvage harvest

- Recover value
- Denim wood

Trap trees (IBD/ IBS)

- Place fall/late winter (before April 1)
- Choose larger trees (>30cm DBH)
- Into SHADE, min. opening size
- Remove before next beetle flight (late summer-early fall)
- Can leave green decks over beetle flight to act as trap trees



- In chronic areas, grid groups of trap trees 400-600m intervals
- Leave unlimbed or unbucked (min. drying)
- Ground survey sites check for spill over attack

Singe tree treatments

- Fall and burn
- Fall and peel
- Fall and chip

Control standard: all bark and cambium completely destroyed for all treatments.
Chip size for IBM determined at 5.1cm or smaller bark attached to wood

Pheromones (4 main uses)

Grid/spot baiting aggregation pheromones to contain and concentrate populations prior to harvesting

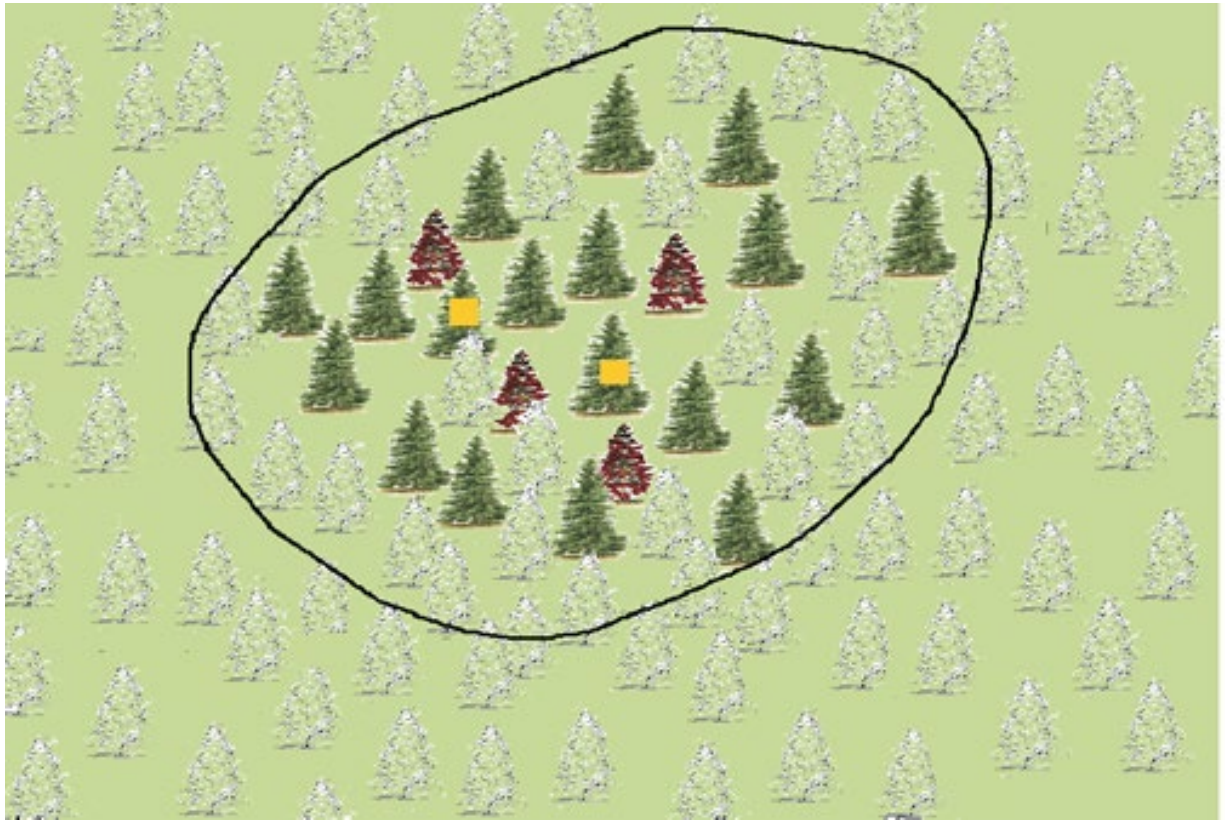
Trapping to monitor or suppress populations

Anti-aggregants (verbenone/MCH) deter attack

"*Push-pull*" tactic - use of both aggregation and anti-aggregation pheromones

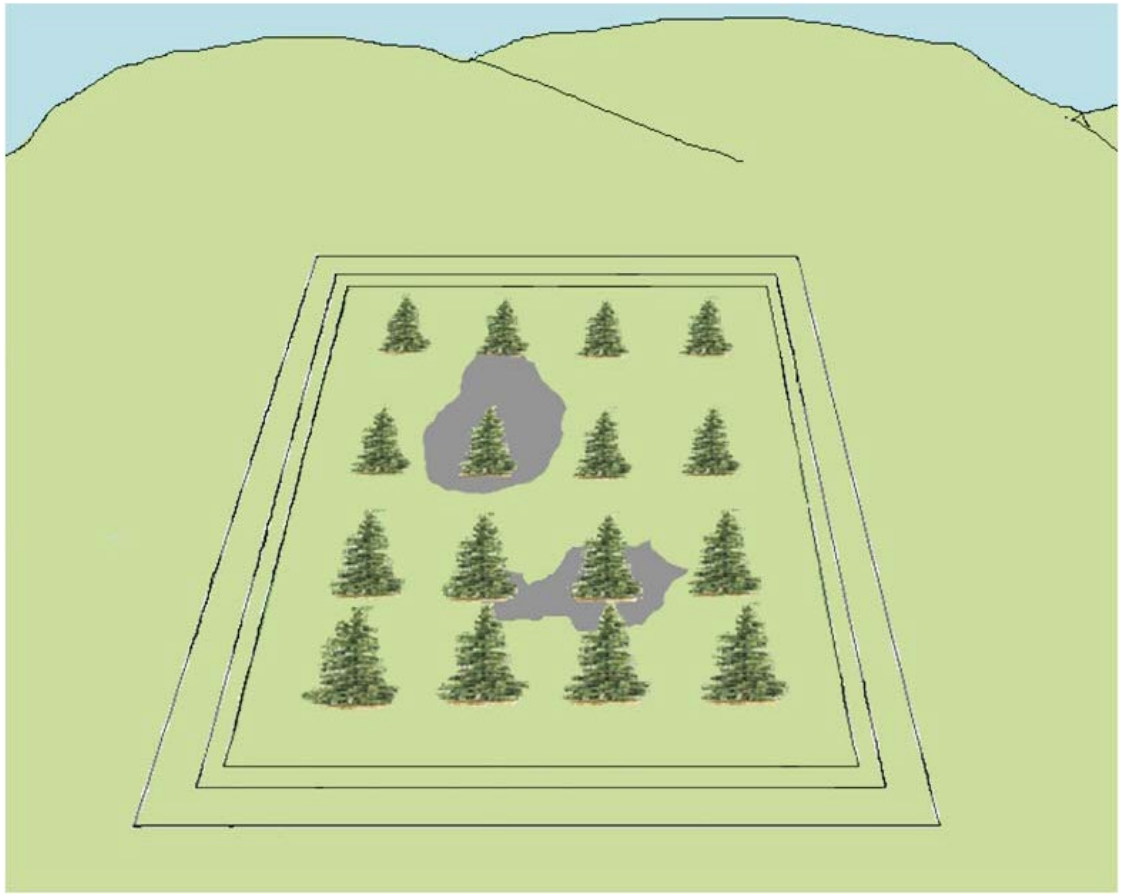
https://semiochemical.com/wp-content/uploads/2017/03/Tree-bait-bulletin.pdf

Spot baiting



- For use where infestations are limited to less than 30 trees (50 trees when dealing with IBM).
- Bait no less than 2-3 susceptible (unattacked) trees in the center of each spot, space baits at least 10 – 15 meters apart and up to 50 meters.
- Ensure all attacked trees are treated or removed and processed. (refer to – Tree Inspection and Removal)

GRID BAITING - To contain and concentrate beetles in infestations exceeding 50 trees or > 20 hectares



- Bait standing susceptible trees at 25 to 50 meter intervals to form a grid.
- Bait at least 25 meters (50 meters for IBM tree baits) within infestation or cut block boundaries to minimize beetle dispersal outside the boundaries = spillover effect

2. Trapping - Baited funnel trap (Monitoring and Control)

- Monitor time and magnitude of beetle flights
- Mop up tool after sanitation harvesting
- Population control – capture large numbers of beetles
- 3 multiple funnel trap clusters spaced 5-10m apart

- Use dry cups, hung from rebar
- Pheromone lures replaced mid-June (IBD)

2. Trapping - Baited Funnel Traps

PROS

Don’t become saturated like trap trees/ baited trees = unlimited capacity

Fully infested TT or baited trees can become source of anti-aggregation – spill over attack

TT/ Baited trees – females can re-emerge = SISTER flight – can’t in funnel traps

No disposal of infested trees

For ever 1,700 beetles caught = save a tree

- **CONS**
- Capital cost to purchase
- High risk of spill-over attack to standing trees if placed too near (within 100m)
- High maintenance (bears, wind, cows, hunters)
- High labour to monitor and maintain (traps must be checked & emptied regularly)
- Also catch predators (clerids)
- Vapona

IBS baited pheromone funnel traps near log storage (Bear Lake PG Area 2016)

3. Anti-aggregants

- IBM: Verbenone
- IBD: MCH (Methylcyclohexenone)
- IBS: MCH not effective by itself (Yet! Still in research phase)

- Tells beetles tree = full, go away
- No vacancy sign
- Repels and disperses beetles – die searching
- Use for high-value trees
- Protects healthy standing and uninfested windthrow
- Use as push-pull with aggregants/trap trees
- Timing & population levels important
- Benefits: one entry, fairly cheap to buy

Anti-aggregants

- Works best with small infestations (avoid in larger sites where may be ineffective or risky)
- Treat sites after sanitation harvesting to disperse beetles in stumps, debris, tops, etc.
- Protects damaged or stressed residual trees.
- Place on healthy Fd trees within 100m of baited funnel traps.

- Place on north side, as high as possible, at 10x10m spacing
- To protect individual trees – 2 bubble caps (opposite sides)

Research: SPLAT Verb

Bl Consortium Group

IBB
Balsam woolly adelgid

Fungal associates with IBM (UofA)

Pa and Pp

Thermoregulation (CFS)

Cold tolerance

Thank you for listening
Any questions?