Bark Beetle Ground Survey Course

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Regional Entomologist
Kootenay Boundary

Ministry of Forests

Land Acknowledgement (Revelstoke)

- As a visitor on this land, I would like to begin by acknowledging that we are gathered on the traditional and unceded territory of the Sinixt, the Secwepemc, the Syilx and the Ktunaxa.
- As a settler from Europe, I am committed to working towards reconciliation.

Course Overview

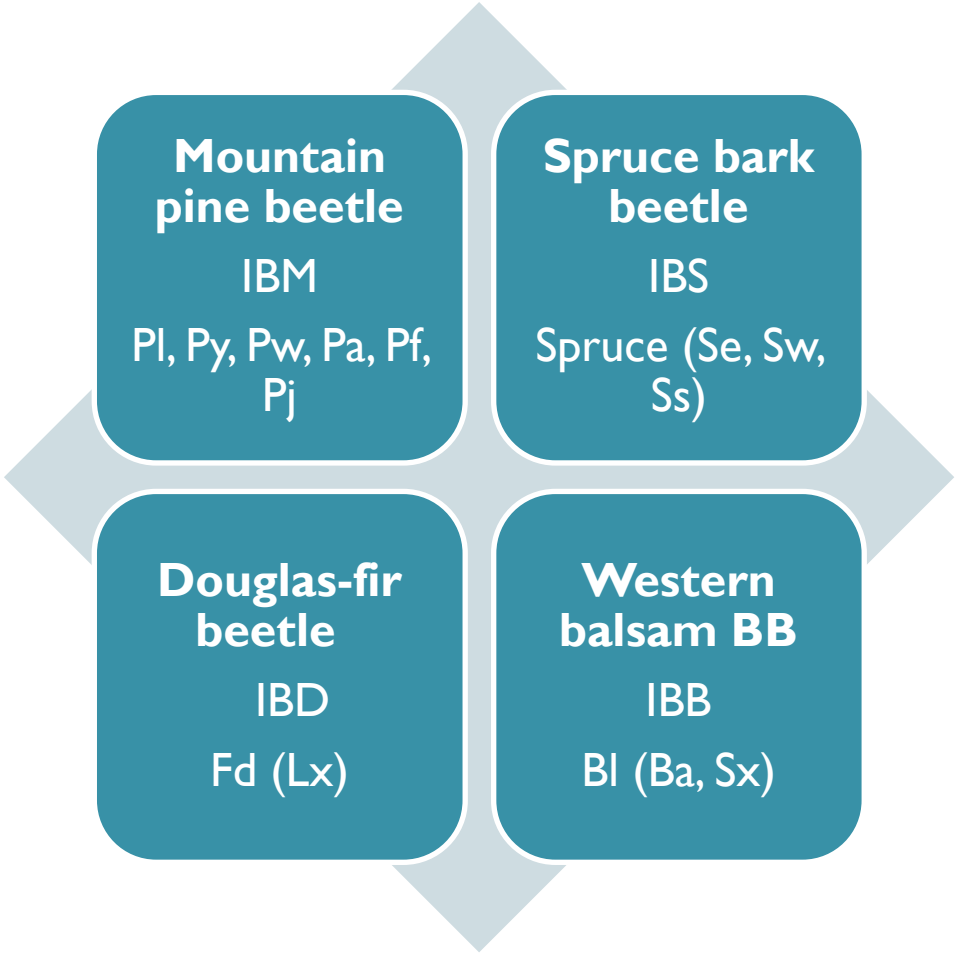
Welcome and introductions

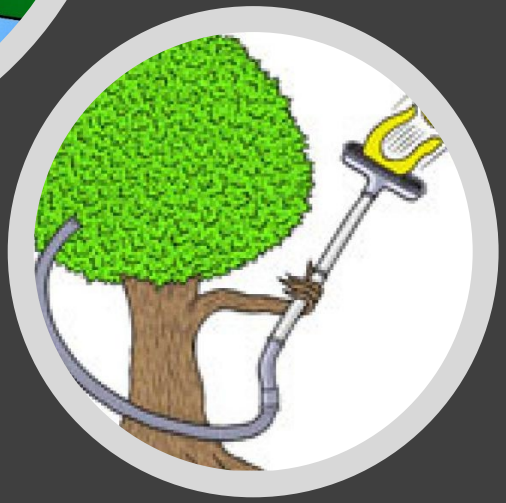
Bark beetle biology

Life cycles

Detection techniques

Fab 4: Main 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.

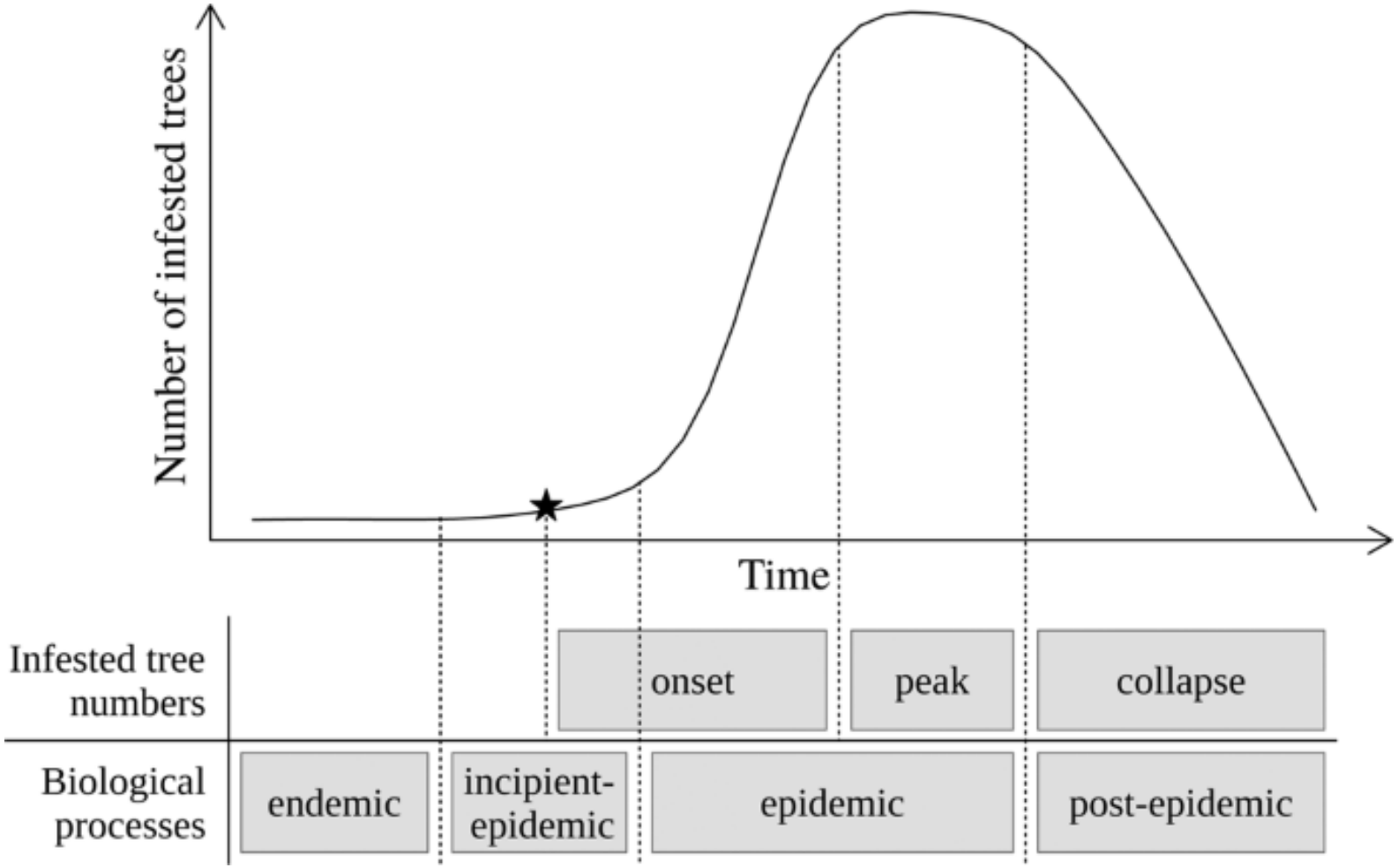
Fab 4: Main Bark Beetles

Most bark beetles cause little or no economic damage but a few will attack and kill living, apparently health trees.

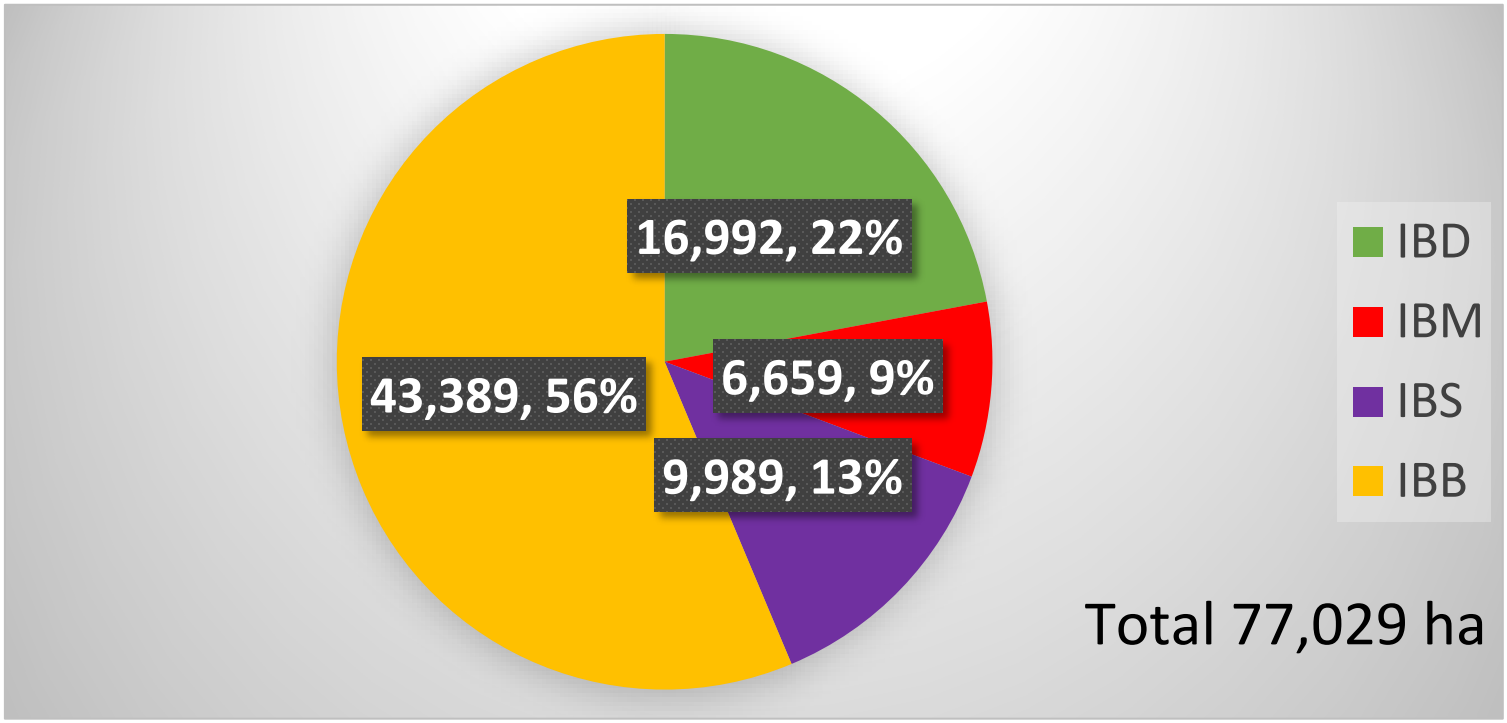
Bark beetles are integral components in forest ecosystems. All these BBs are **native** to western NA but range expansion has occurred due to warmer climate

Bark beetles - most common and widespread damaging agents affecting about 70% of the damage in our area.

Bark beetle outbreak dynamics



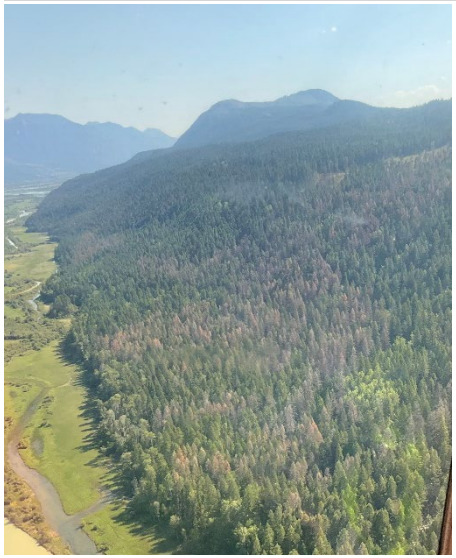
2022 KBR Bark Beetle Summaries

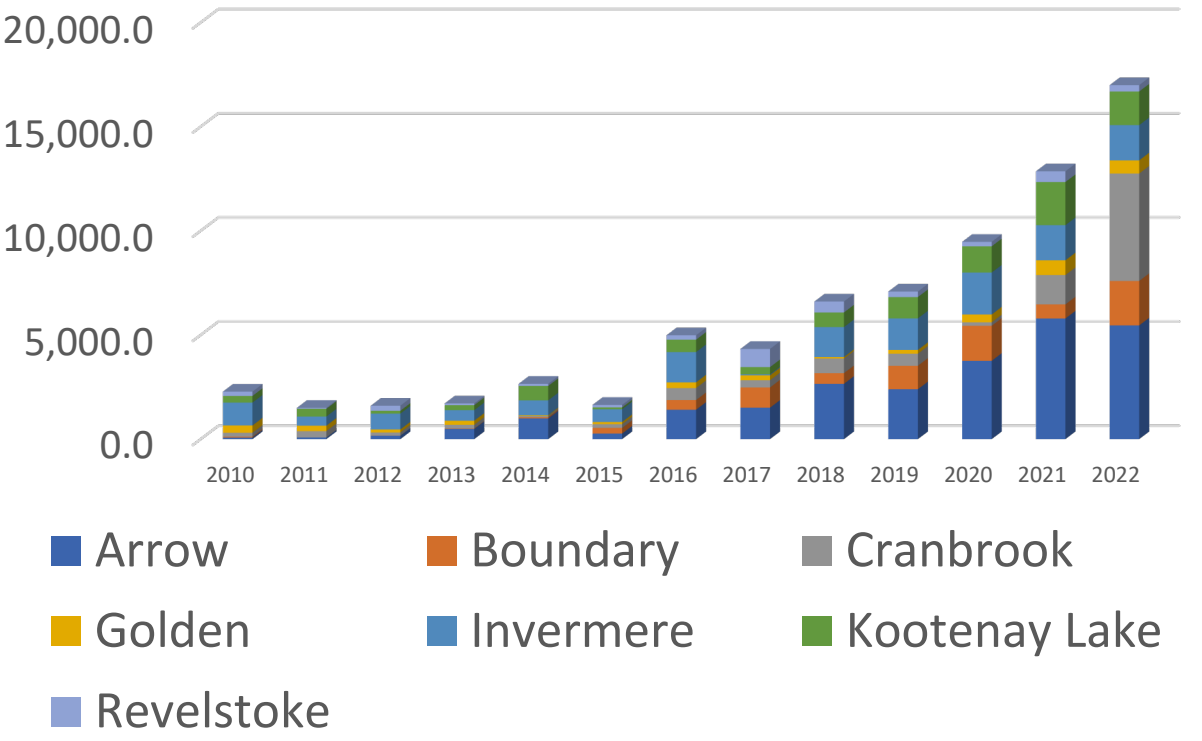


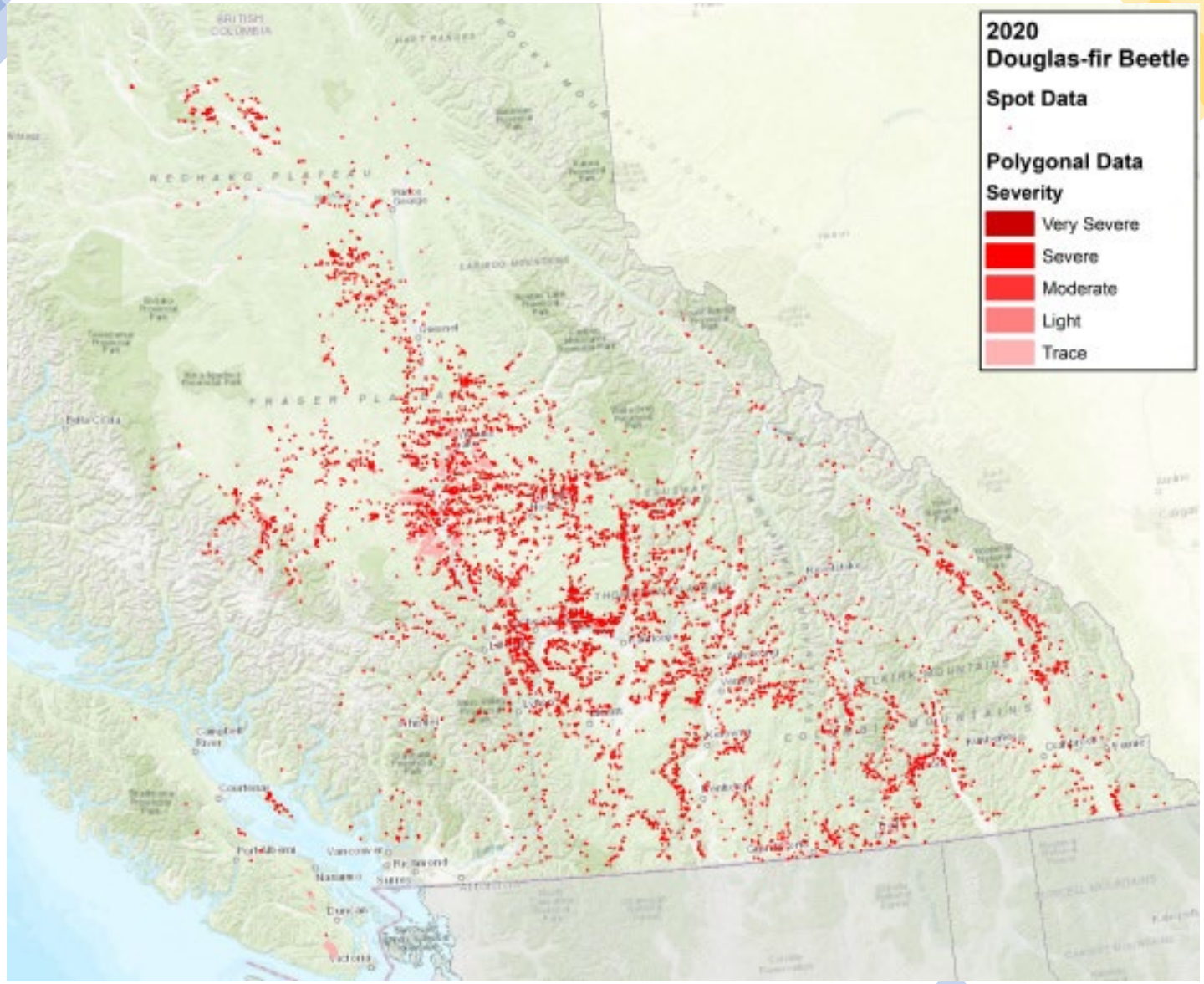
Douglas-fir beetle (IBD) 2010-2022 by TSA

Cranbrook TSA largest increase by 3.748 ha

Boundary TSA 2nd largest increase by 1,456 ha

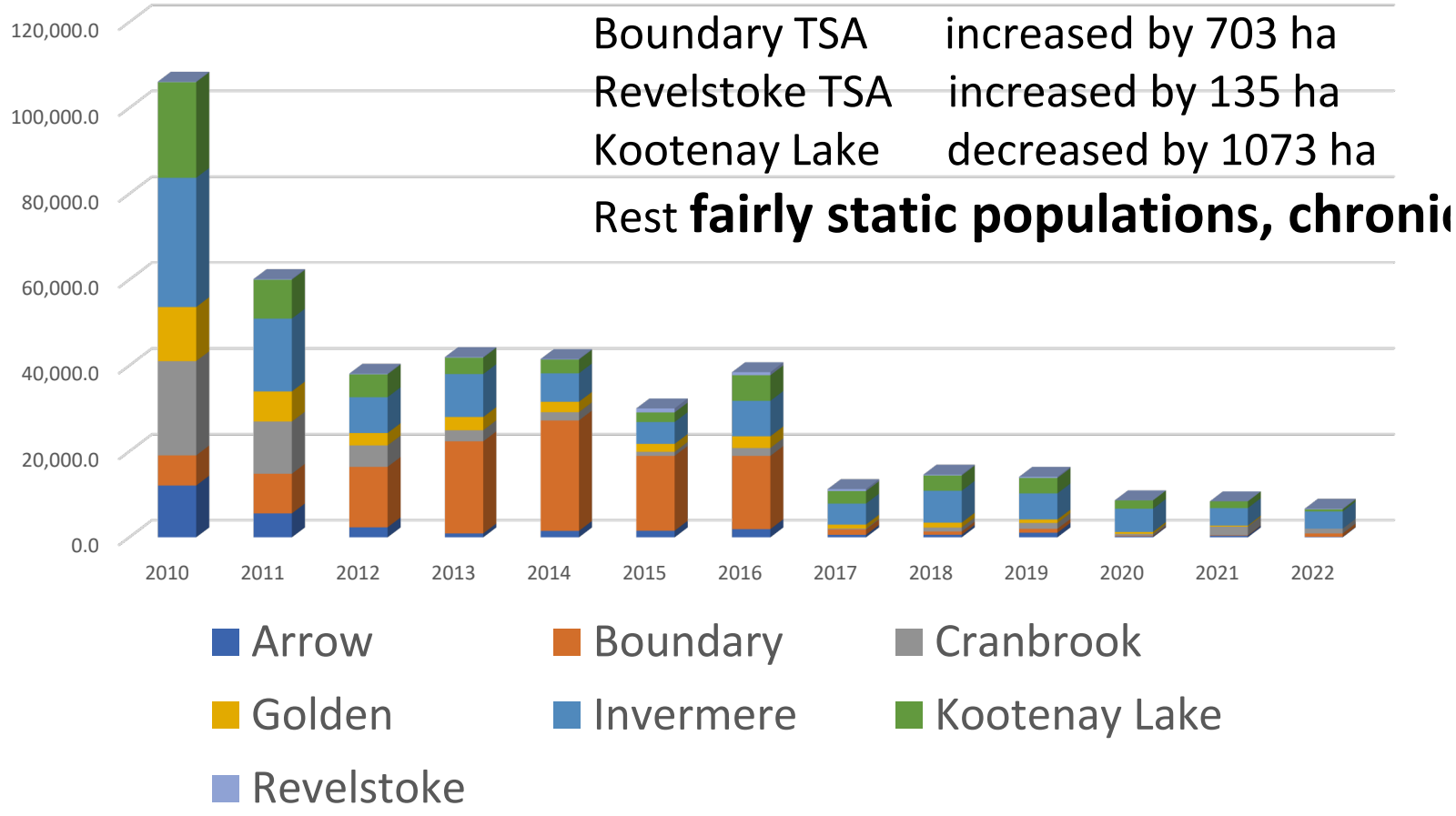






98,497 ha 2020

Mountain pine beetle (IBM) 2010-2022 by TSA



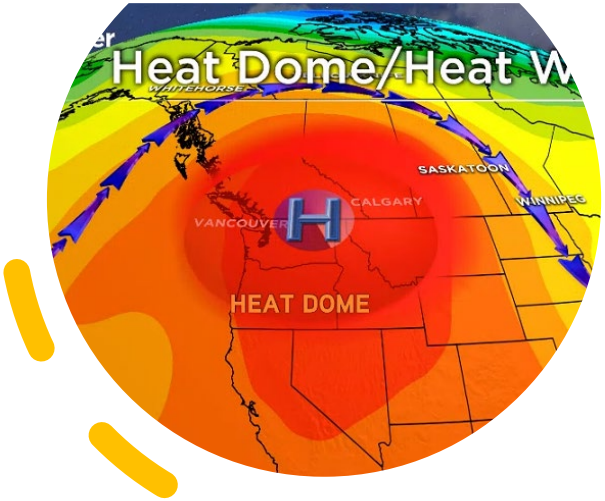
Spruce beetle (IBS) 2010-2022 by TSA

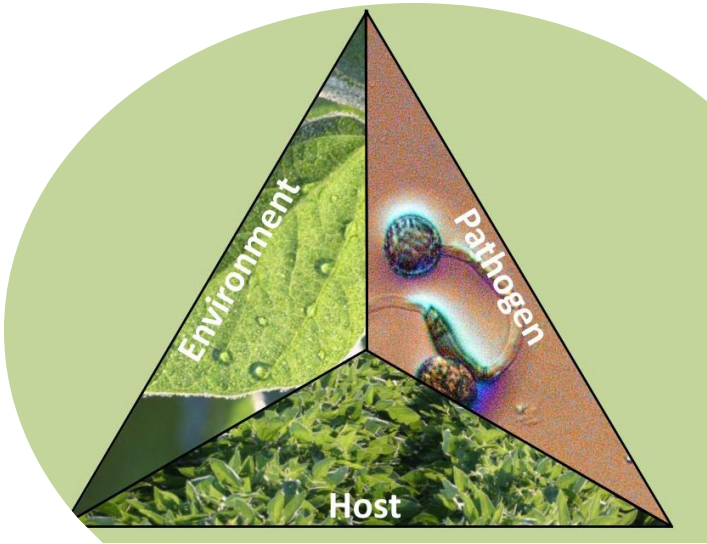
Cranbrook TSA largest increase by 5,291 ha

Golden TSA decreased by 1,868 ha

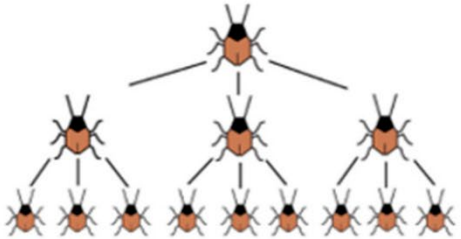
Climate change and FHFs

- Interaction of **environment** (weather conditions) – **hosts** – **insects/ pathogens**
- Cumulative effects cause damage/ mortality
- Climate change brings on;
  - **Drought** (earlier insect flights; hosts easier to overcome, sublethal effects caused by secondaries)
  - **Heat domes** (2021 new national record 49.6 degrees Lytton;
  - **Atmospheric rivers**
  - **Cool wet springs** (increases in pathogens, delayed insect development)
  - **Extreme winds** (blowdown, increase in susceptible hosts)
  - **Early snow** (snow snap, increase in host material)
  - **Fire** (increase host material)

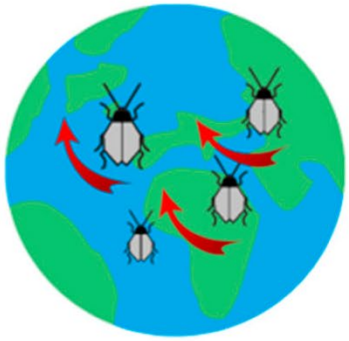




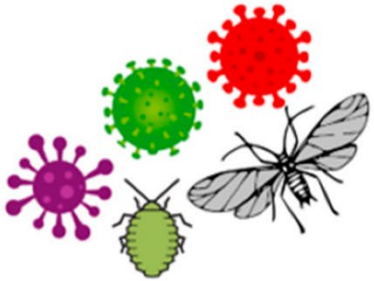
HOW DOES TEMPERATURE INCREASE AFFECTS INSECT PESTS?



Increased number of generations

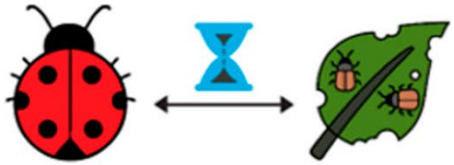


Expansion of geographic range



Outbreak of plant diseases transmitted by insects

Increased overwintering survival



Desynchronization of insects and their natural enemies

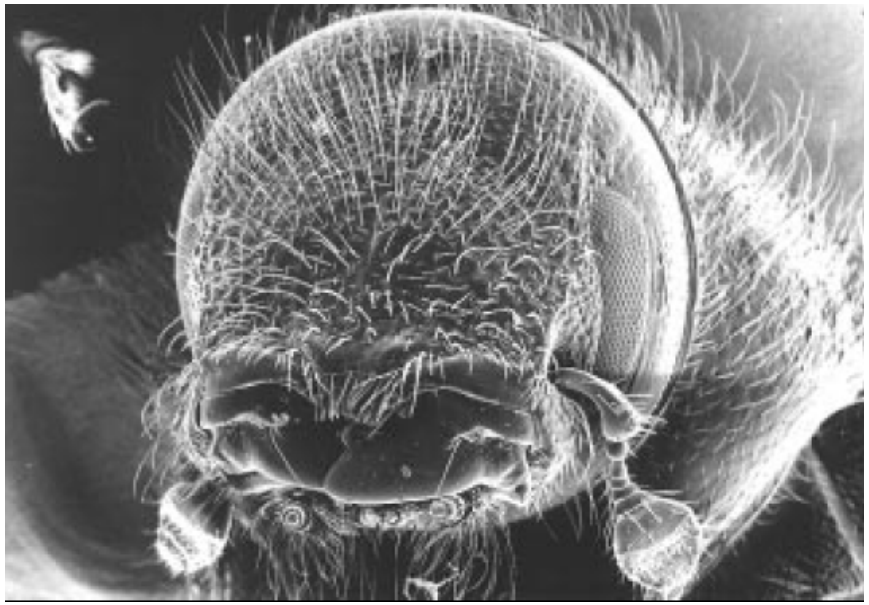
Loss of synchrony with the host plant

BIOLOGY

- Host selection
- Mass attack
- Phloem feeders
- Fungal interactions

Where will I raise my young?

Will they have enough to eat?



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

Douglas-fir Host Selection

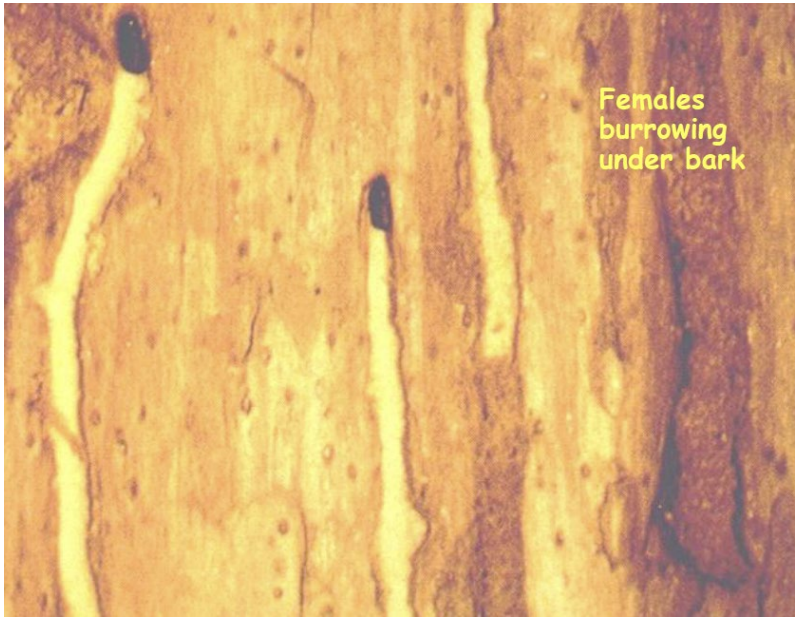
- Prefers large, old trees (mature/ overmature) (>20cm DBH)
- Trees with reduced growth in past ±10 years
- weakened and downed (recently cut/ windthrown) host material (Fd; occasionally Lw)
- Stress factors such as;
  - Fire
  - Drought
  - Root disease
  - Defoliation
  - Injury (snow snapped, salt damage, mechanical damage, etc.)

- IBD populations are high/ increasing in the Kootenay Boundary Region. Cumulative result of blowdown, fires, drought, and forest characteristics over last decade

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

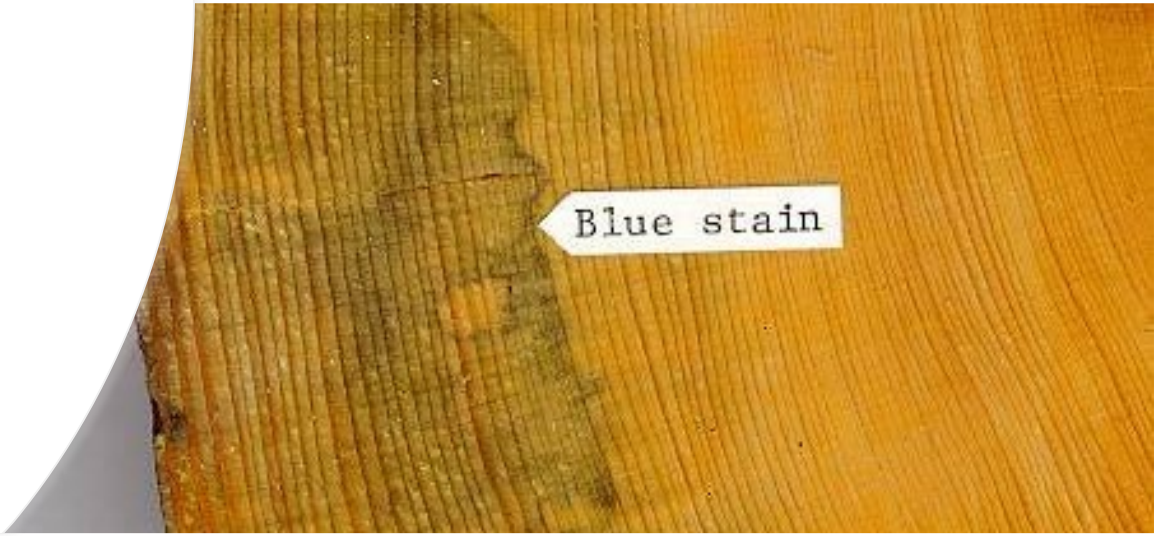
PHLOEM FEEDERS



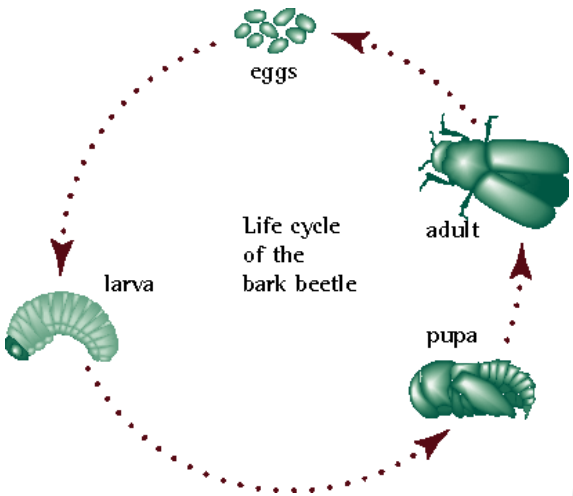
- Create egg galleries in inner bark (phloem)
- Require **fresh, moist** phloem for food
- Trees that have been dead for more than one year NOT suitable habitat
- Trees damaged by FIRE or DROUGHT sometimes attractive longer – not killed by stress event

FUNGAL INTERACTIONS

- A symbiotic relationship – helps beetle kill tree - “Blue stain” kill the tree in combination with larval feeding
- Prevents resinosis and translocation – tree dies of thirst!
- Maintains micro-climate (moisture) under the bark
- Volatile (pheromone) production
- Nutritional role



General Bark Beetle Life cycle



2.EGGS

3.LARVAE

eetle Larvae

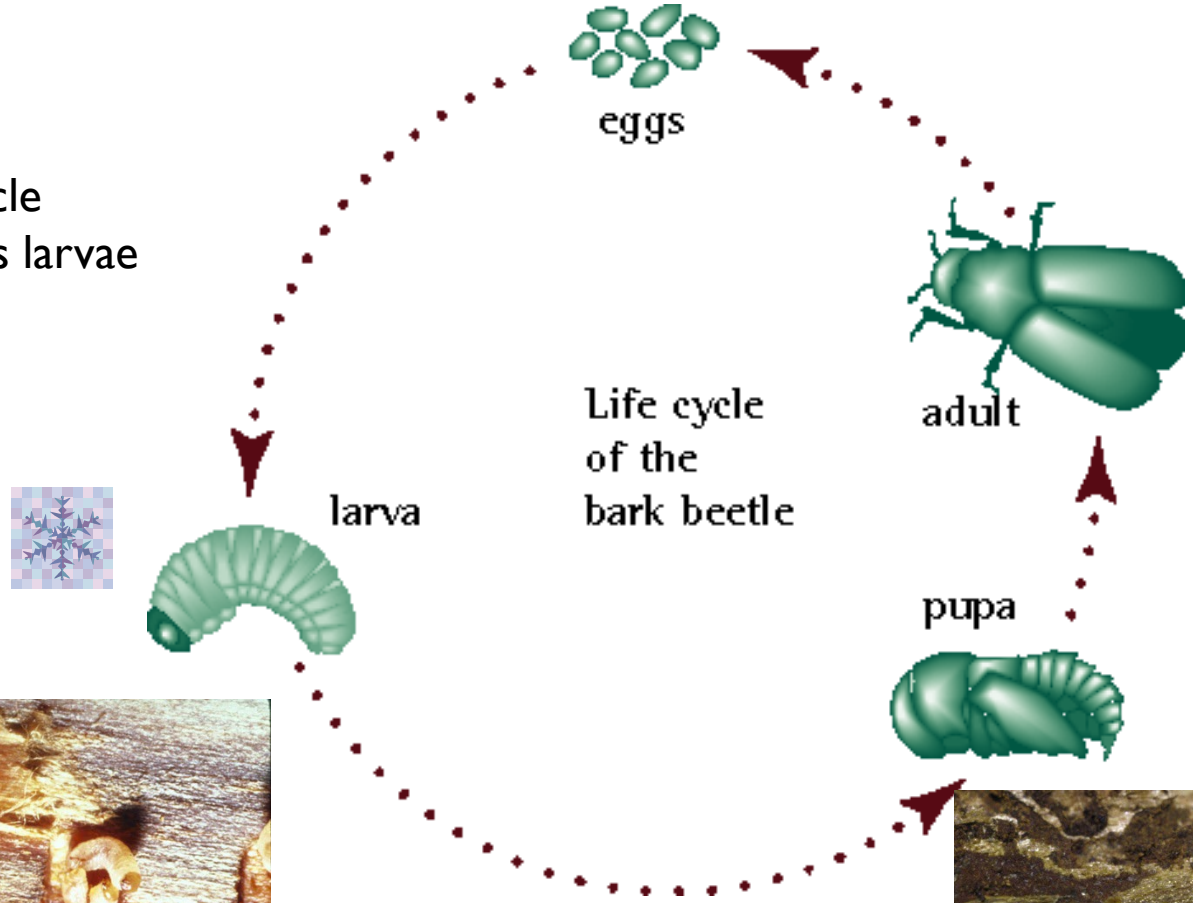
t Beetle
mm long

1. ADULT

4. PUPAE

LIFE CYCLE (4 stages) IBM

1 cycle life cycle
Overwinter as larvae



DISTRIBUTION: IBM

IBM

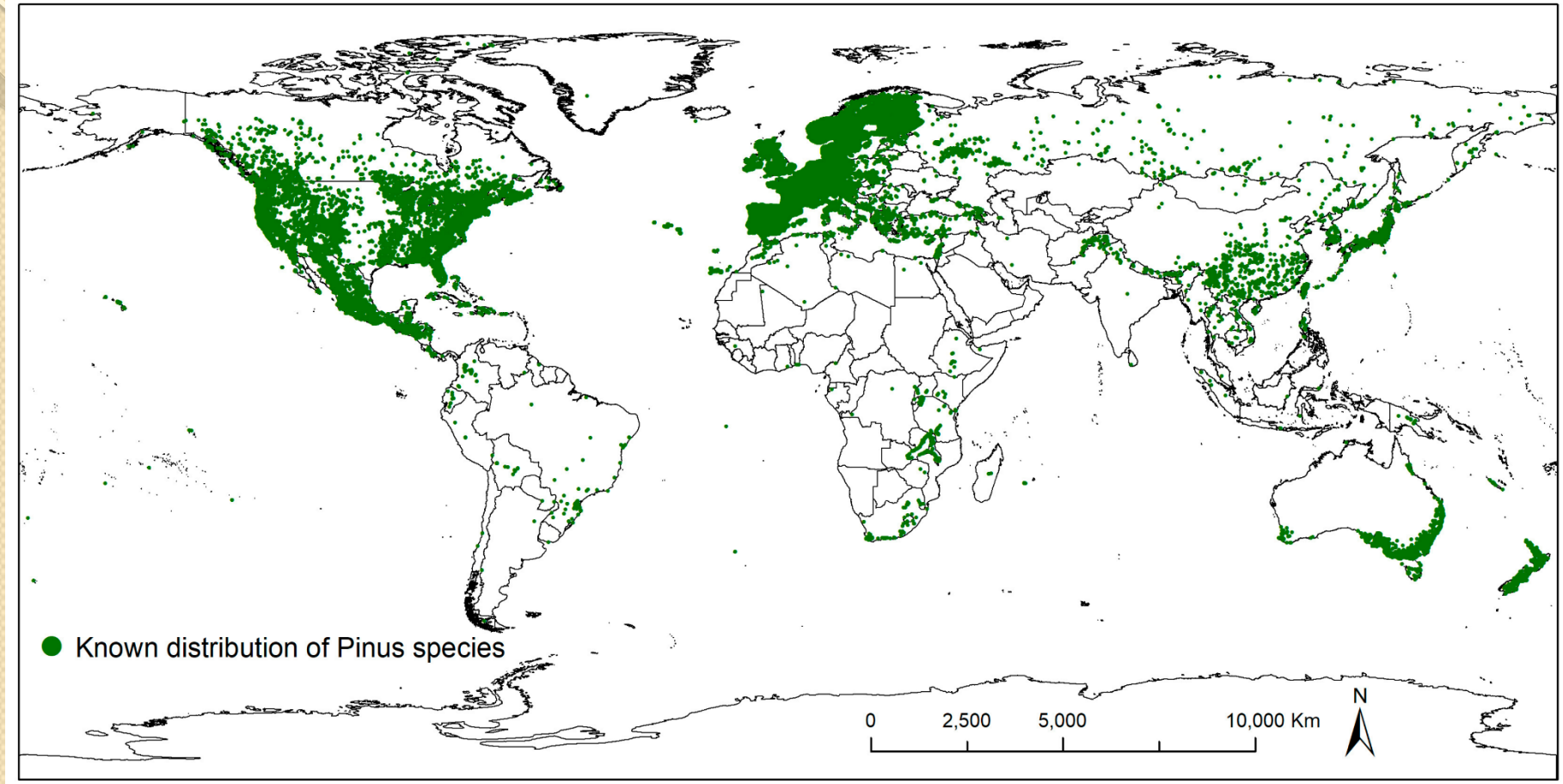
Native to western North America
Range expansion due to warmer climate

Pine (*Pinus*) characteristics

- *Pinus* spp. are among the most widely distributed plant species in the world
- can tolerate low temperatures of −60 °C and high temperatures of 50 °C
- lack a strict demand for soil, while most species prefer a well-drained soil-flourishing in sandy conditions
- leaves of pines have the structural characteristics of xerophytes, allowing them to adapt to long periods of drought and cold

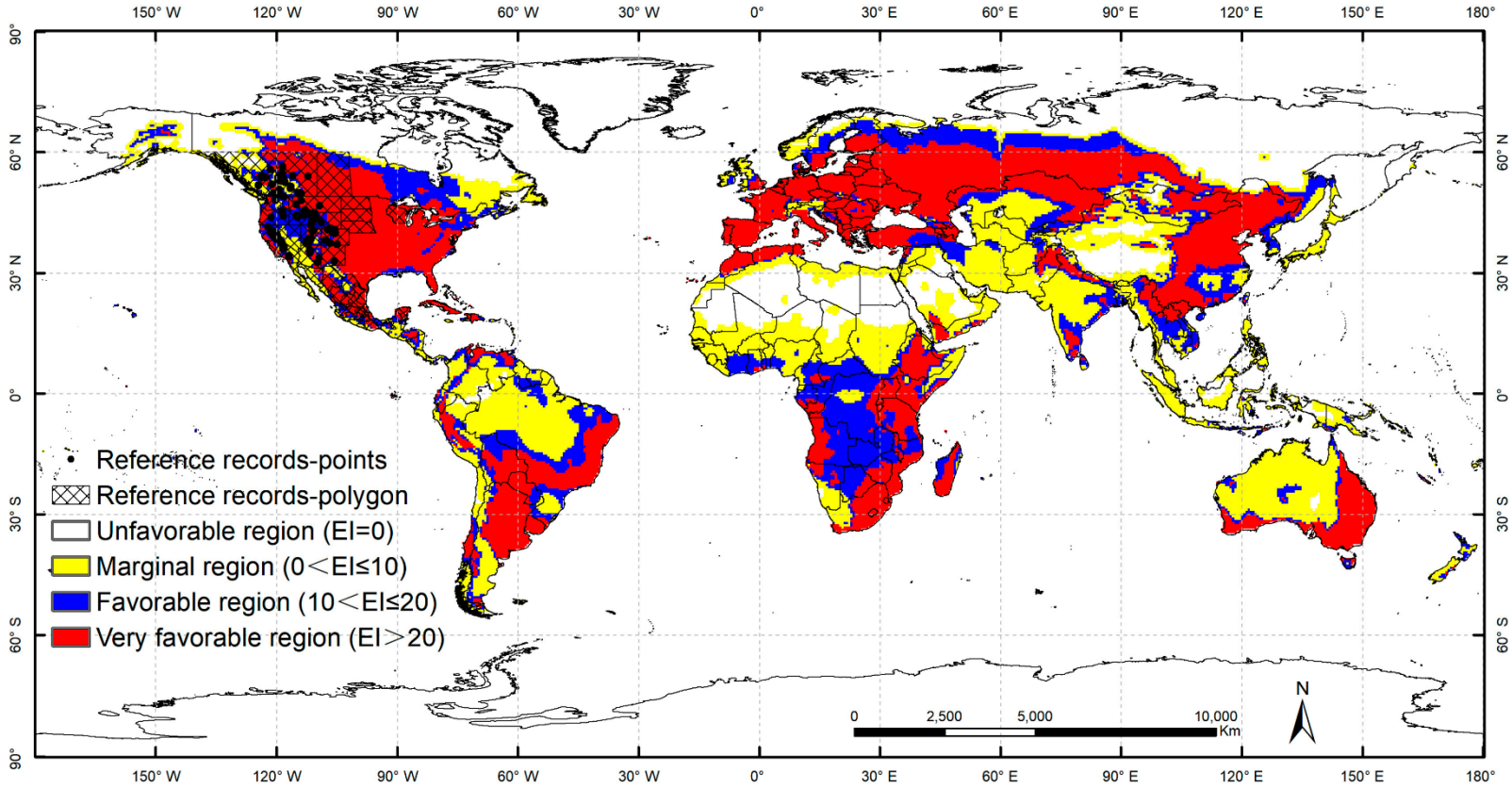
So…. Range expansion of IBM is quite possible!

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.



LIFE CYCLE (4 stages) IBD

Main flight – April-June
Sister flight – 2nd flight July-Aug

eggs

April-June

adult

Overwintering stage
80% young adults/
20% mature larvae

Life cycle of the bark beetle

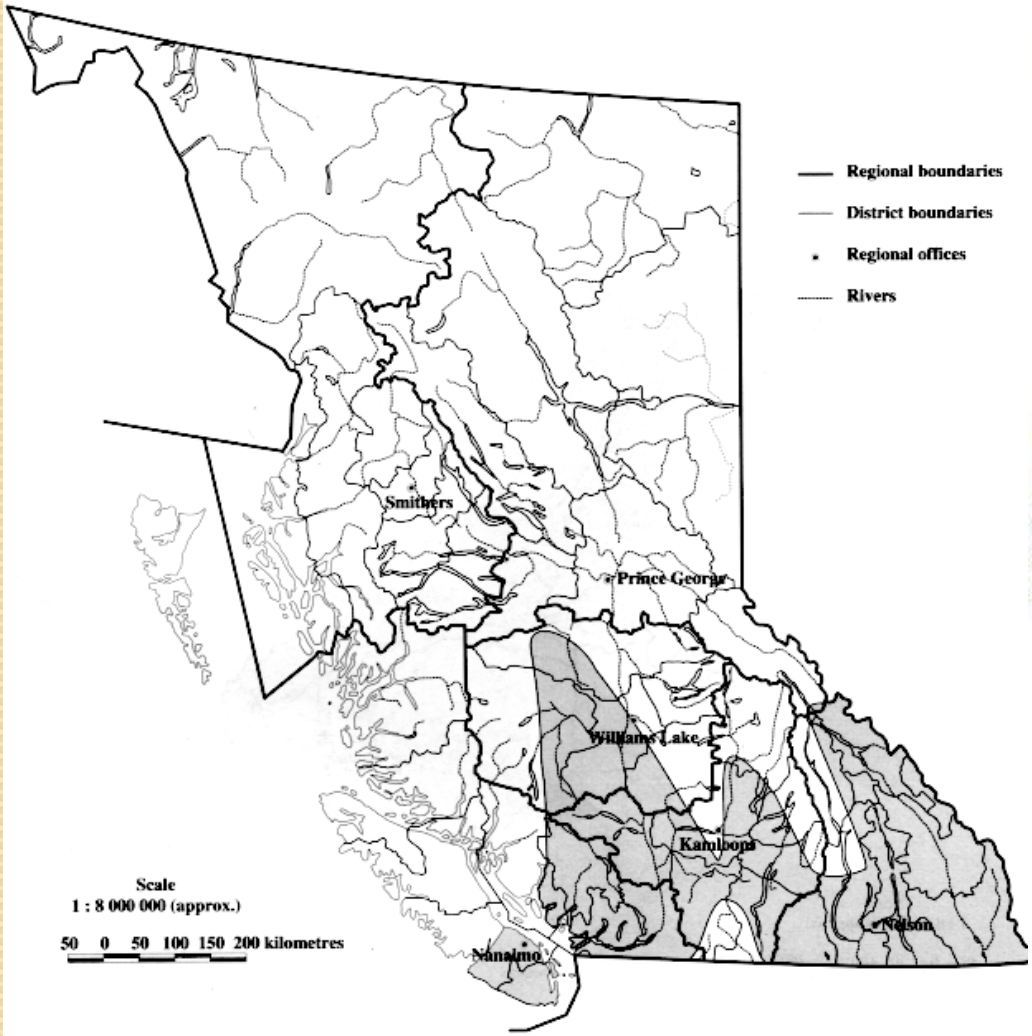
pupa

Aug-Sept

larva

Mid April - August

IBD and Douglas-fir distribution in BC



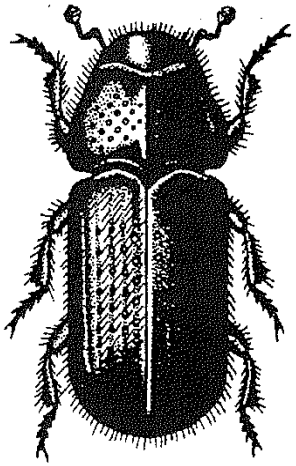
Spruce Beetle

Typical 2-year cycle

Eggs

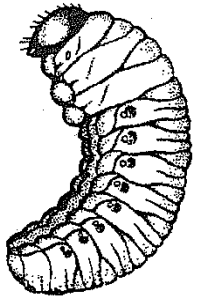
Fly in late May/June

Adults



Overwinter

Larvae

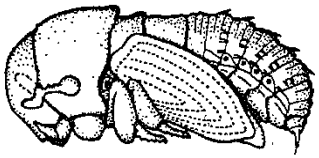


Overwinter

Winter 2

Winter 1

Pupae

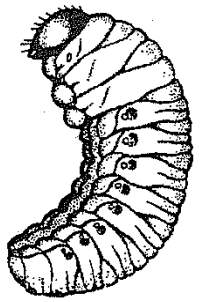


Spruce Beetle

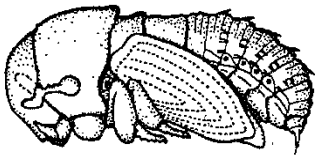
1- year cycle

Eggs

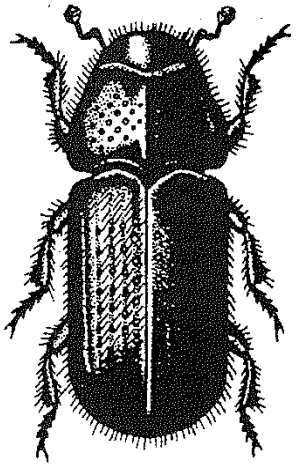
Larvae



Pupae



Adults



Winter 1

Overwinter

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

Distribution IBS

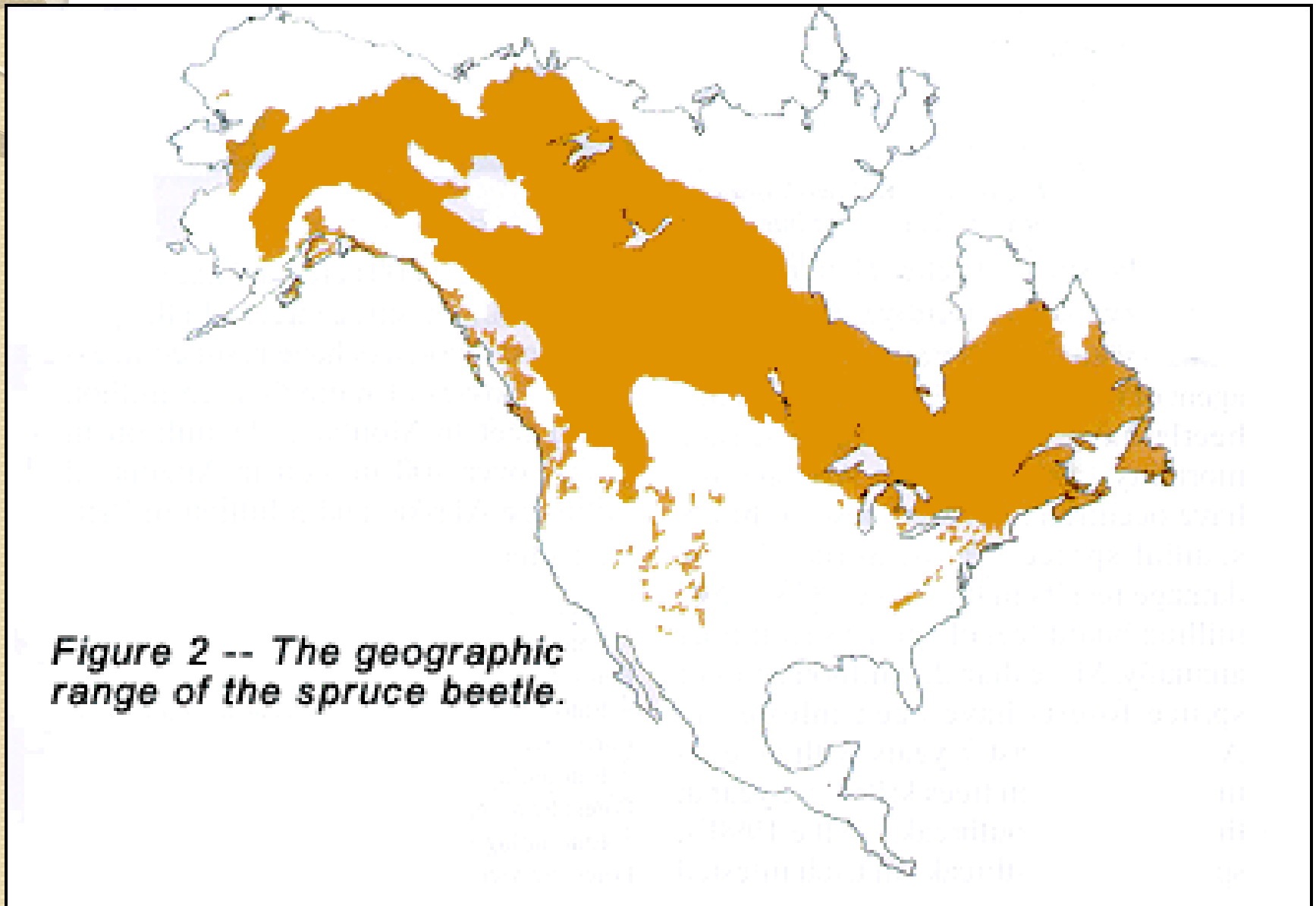


Figure 2 -- The geographic range of the spruce beetle.

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

LIFE CYCLE - adults

LIFE CYCLE- eggs

LIFE CYCLE – Larvae

4 instars (stages)

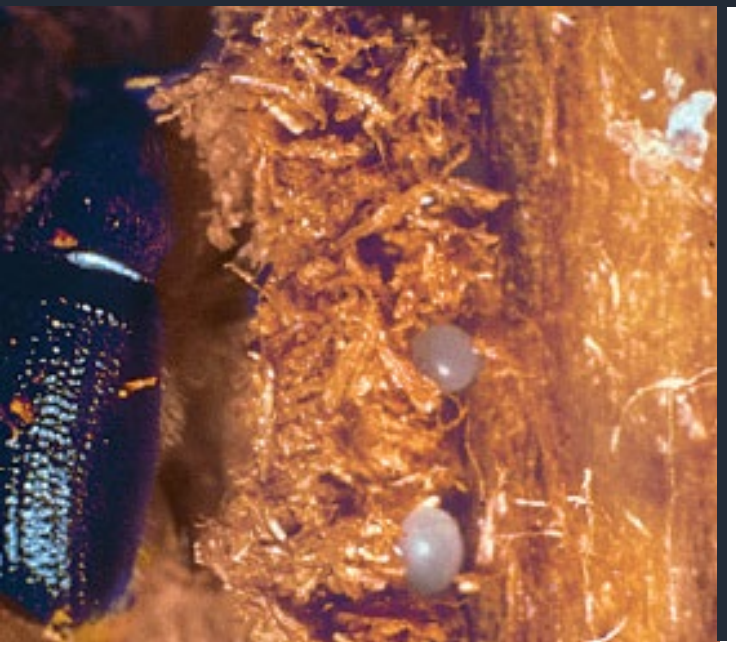
LIFE CYCLE – IBS larvae

2 anal shields

LIFE CYCLE - Pupae

LIFE CYCLE – immature adults (callow)

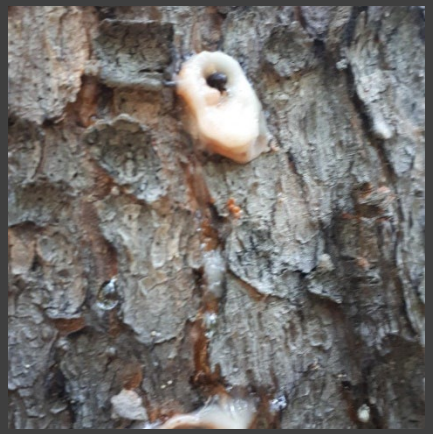
Life cycle



1. Eggs: pearly white, oblong, 0.75-1.0mm long. Laid in individual niches along egg gallery
2. Larvae: creamy white, cylindrical, stout, wrinkled, legless grub 6-7mm (L4), head pale tan to pale rusty (4 instars)
3. Pupa: creamy white, 6mm long, pale tan at maturity. Have legs and wings are mature.
4. Adult: immature/ callow adult – from pupa initially white, then brown, mature adults black or rusty wing coverings. 6mm long

Timing of life cycle events

Factor	IBM	IBS	IBD
Adult flight	July – Sept	May-June	April-August (main); July (sister)
Host preference	Living trees	Windfall/slash, stressed trees	Windfall/slash, stressed trees
Life cycle	1 year	2 years (1 or 3 possible)	1 year (sister flight)*
Overwintering stage	Larvae (L3/L4)	Larvae Yr1/ Adult Yr2	Adult 80%; Larvae 20% (Sister flight)
Where overwinter	under bark	Yr 1 of 2: under bark	thick bark
		Yr 1 of 1/ Yr 2 or 2: 40-60% in duff/ root collar	



SURVEYS: Symptoms of attack

1. Crowns symptoms
2. Pitch tubes/ resin/ pouch fungus
3. Boring frass
4. Woodpeckering
5. Position of attack
6. Galleries
7. Blue staining fungus

CROWN SYMPTOMS - IBM

GREEN – YELLOW (chlorotic) – RED - GREY

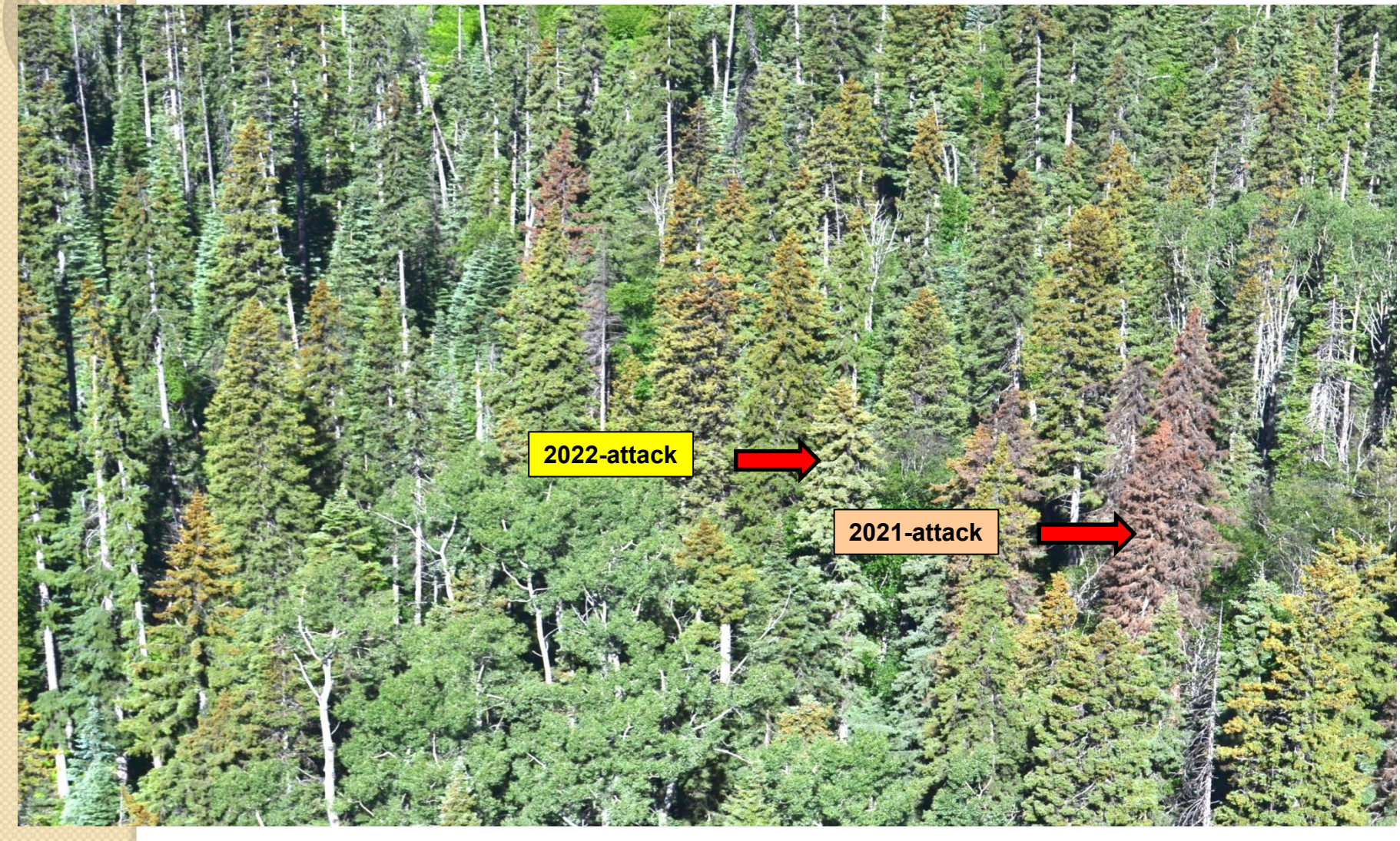
sition: 11 N 420307 5792423
itude: 1471m
tum: WGS-84
imuth/Bearing: 017° [illegible] 0302mils (True)
evation Angle: -15.4°
rizon Angle: -02.9°
om: 4X
tailed aerial IBS

IBS crown

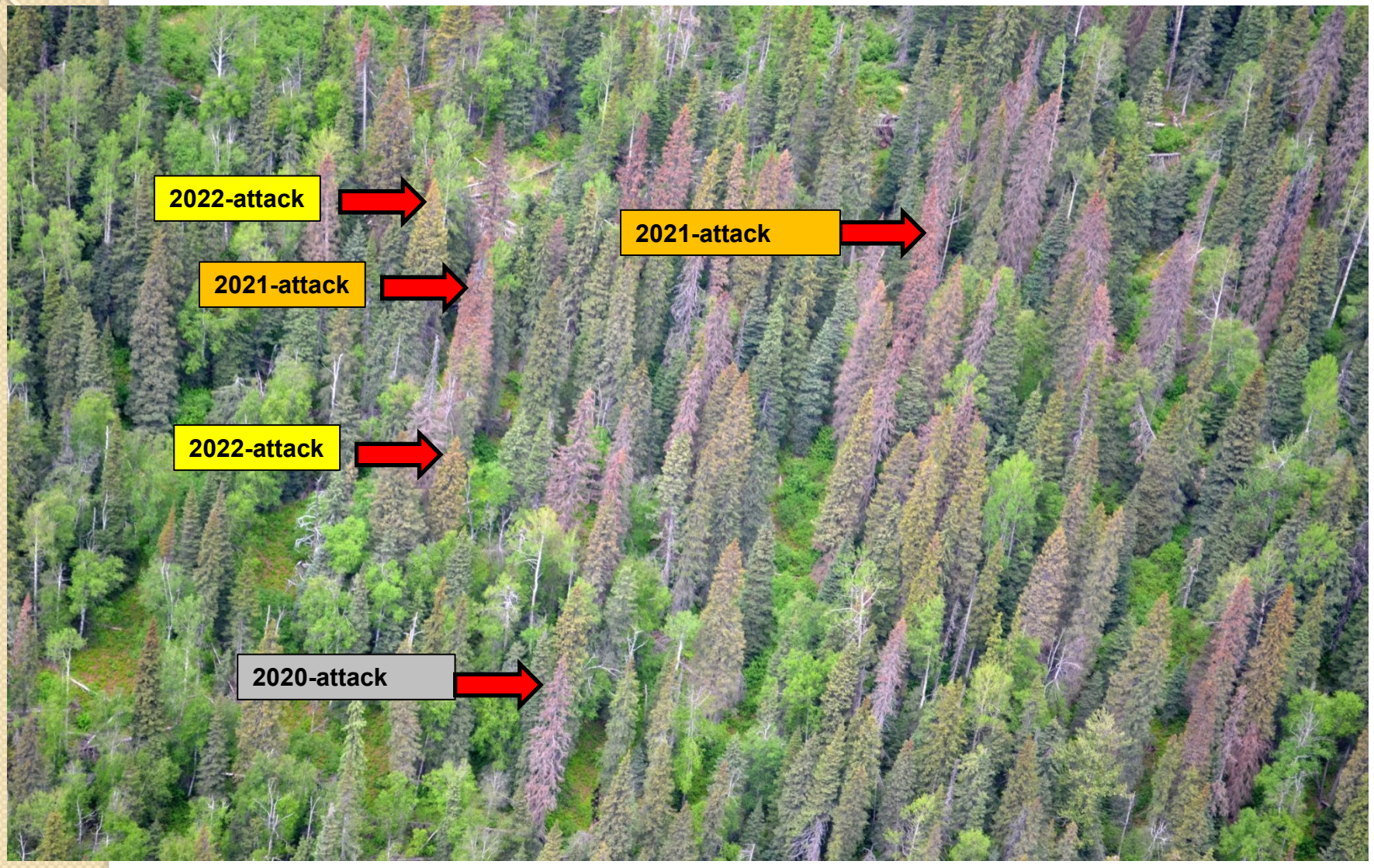
- GREEN
- CHLOROTIC
- YELLOW
- DULL RED

Sx often show no signs from the air for 13-18 months post attack.

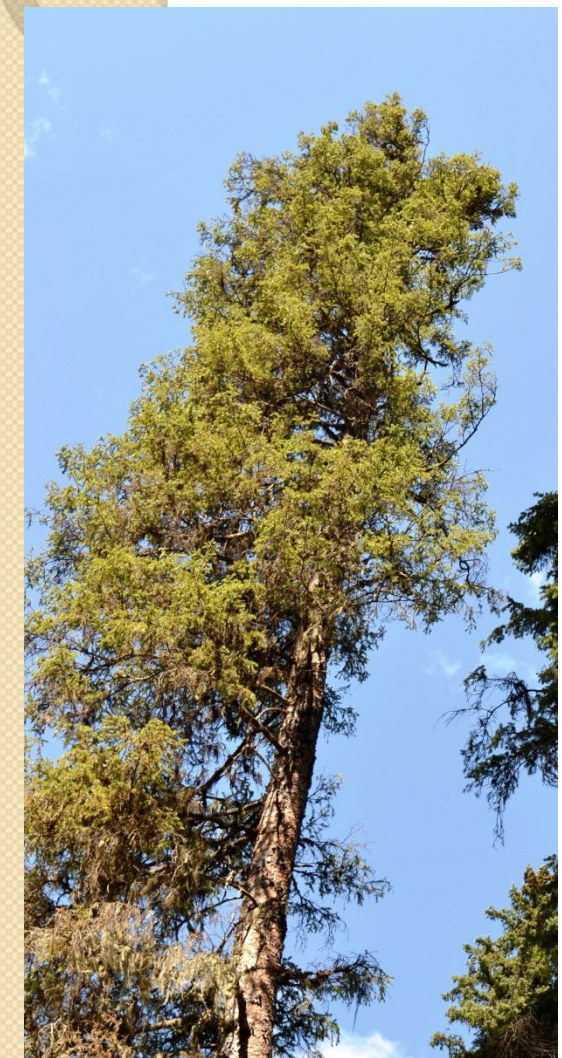
IBS crown symptoms



IBS Progression of color change



Spruce fully attacked in 2013.
Photo taken July 20, 2014



Same tree re-photographed.
Photo taken Sept. 17, 2014

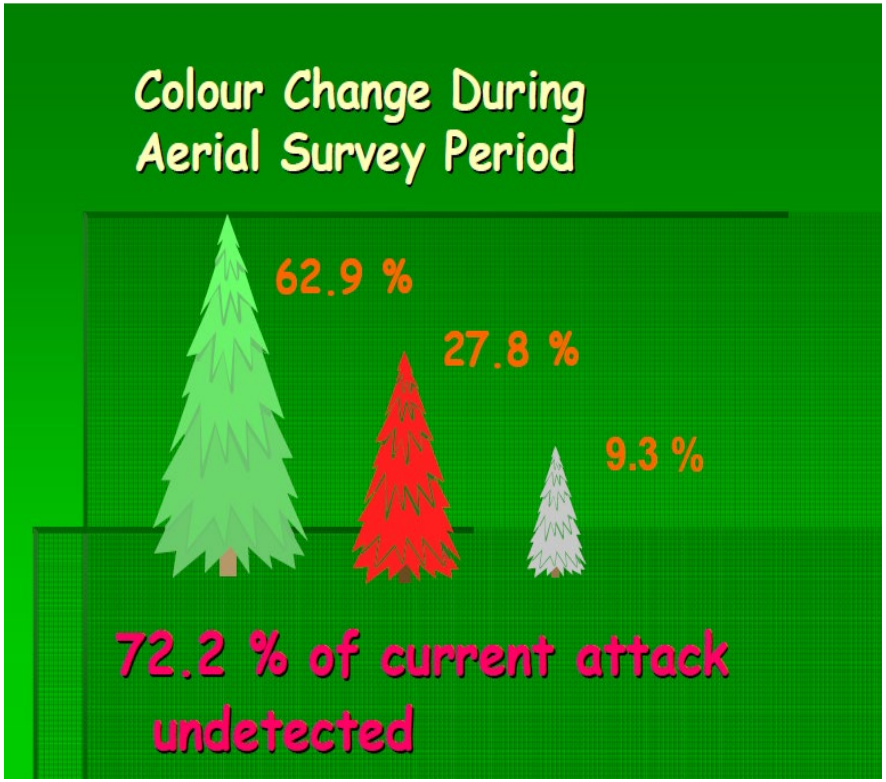
Same tree re-photographed.
Photo taken Oct. 2, 2014

Sometimes newly-attacked spruce will drop interior green needles first if under extra stress then the lower bole can turn chlorotic and then brown.

Foliage fade from green to brown in fast succession

IBD: Crown symptoms

- GREEN – YELLOW – RED - GREY
- Variable color change; gradual or rapid
- Never assume red and grey trees have NO beetles, always do under bark checks!

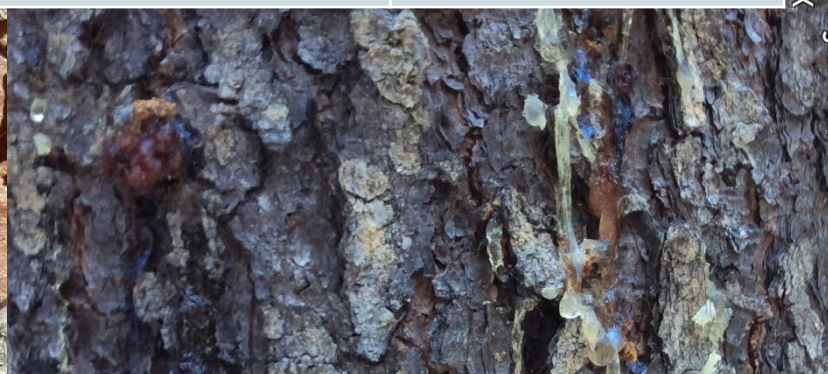


IBD Crown

GREEN – YELLOW - ORANGE/RED - GREY

Bole symptoms of successful bark beetle attack

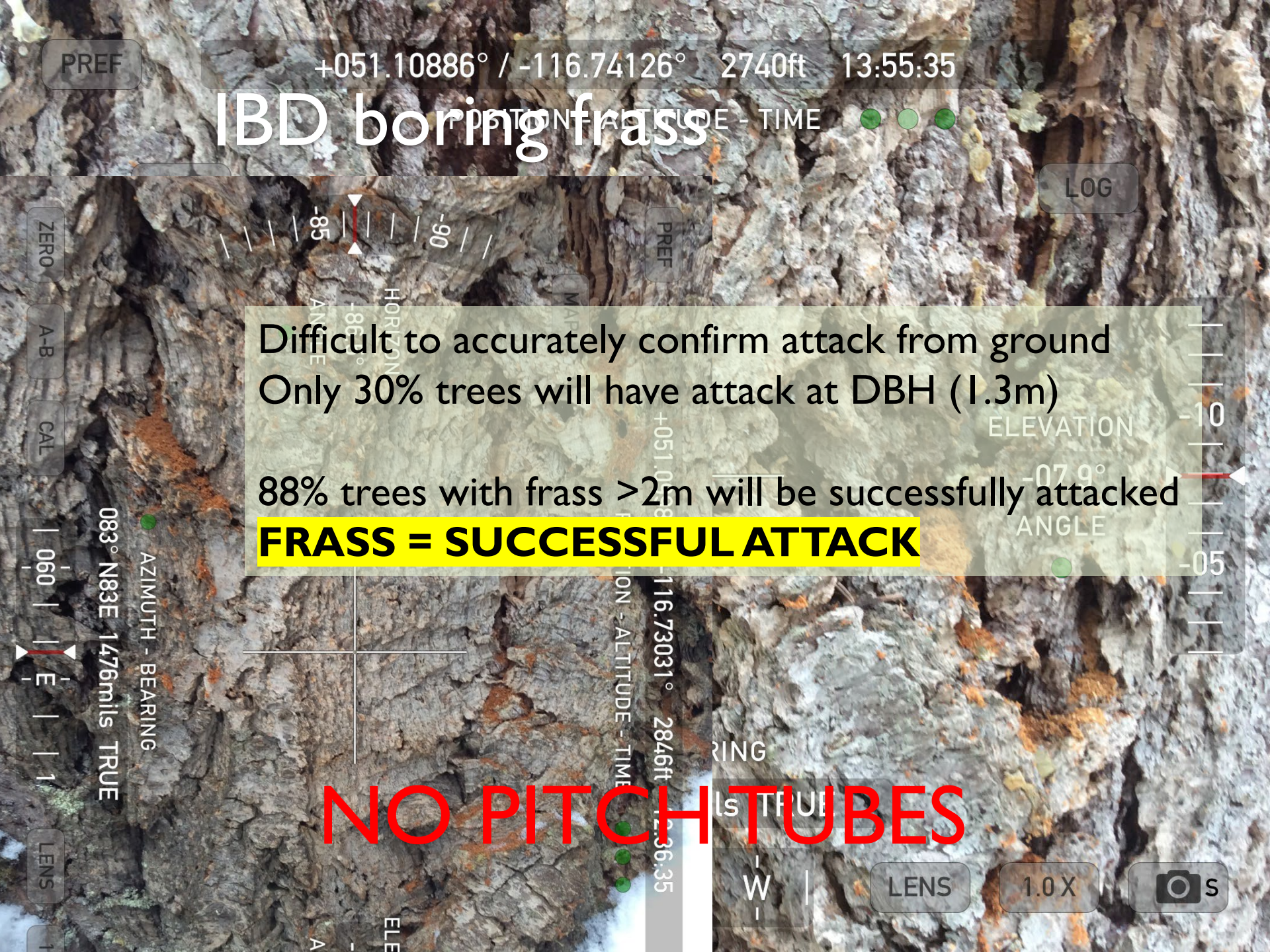
	IBM	IBS	IBD
Pitch tubes/ resin/ boring frass	Yes, usually & boring dust	Yes, small, boring dust	Rarely present, **boring dust**, resin flow upper bole
Woodpecker signs	Yes, winter/spring	Yes, fall/winter	Little
Position of attack	Lower ¾, **living** trees	Lower 4m standing trees; underside downed trees	Lower 2/3 live standing trees difficult to find at DBH; downed material



Pitch tubes - Tree defense

- **Tree defence** against bark beetle attack with resin (pitch)
- Host defense increases with tree size
  - Flushes beetles out of entrance hole
  - **Toxic chemicals** kills eggs & larvae
  - Vigorous trees have more resources to produce defensive compounds
- Pitch tubes may not be present if trees are **drought stressed** (not present with IBD attack, frass & streaming resin only)

IBM pitch tubes

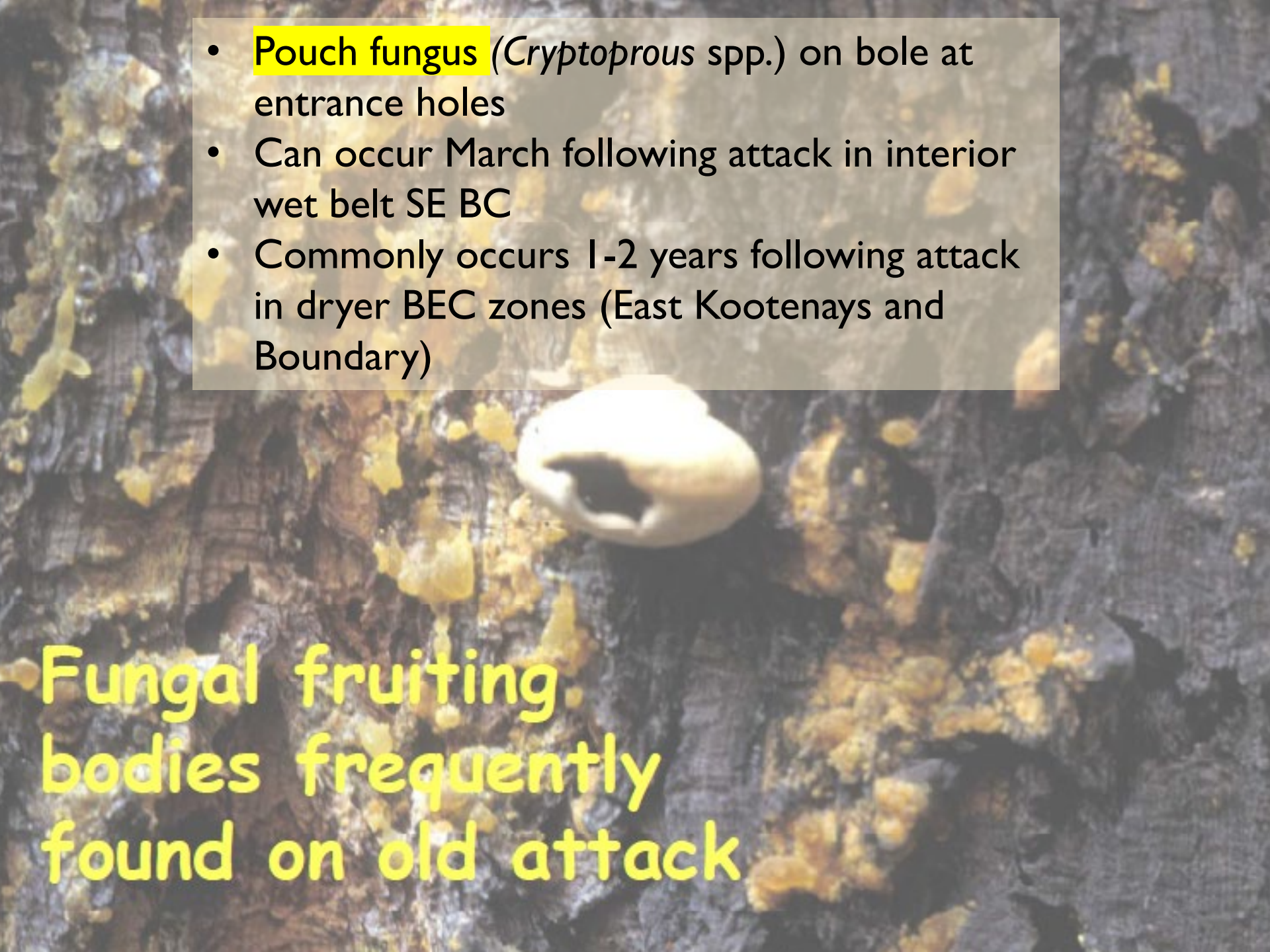

IBD boring frass
Difficult to accurately confirm attack from ground
Only 30% trees will have attack at DBH (1.3m)
88% trees with frass >2m will be successfully attacked
FRASS = SUCCESSFUL ATTACK
NO PITCH TUBES
+051.10886° / -116.74126° 2740ft 13:55:35
POSITION - ALTITUDE - TIME
PREF
LOG
ZERO
A-B
CAL
LENS
1.0 X
ELEVATION
-07.9°
ANGLE
AZIMUTH - BEARING
083° N83E 1476mils TRUE
-116.73031° 2846ft
W
E

IBD Streaming resin

- trees mainline of defence: resin flow to drown the attacking beetles
- No pitch tubes

- Pitch streams & No frass =
- **UNSUCCESSFUL ATTACK**

IBD external signs

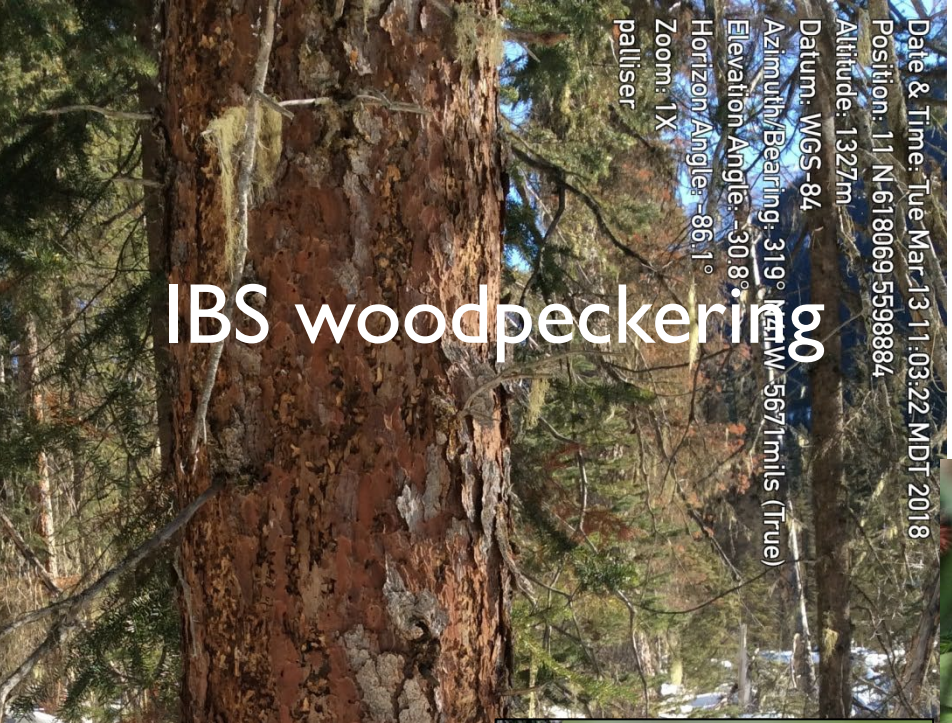


- Pouch fungus *(Cryptoprous* spp.) on bole at entrance holes
- Can occur March following attack in interior wet belt SE BC
- Commonly occurs 1-2 years following attack in dryer BEC zones (East Kootenays and Boundary)

IBD Pouch fungus

IBD on downed tree

IBS pitch tubes and boring frass

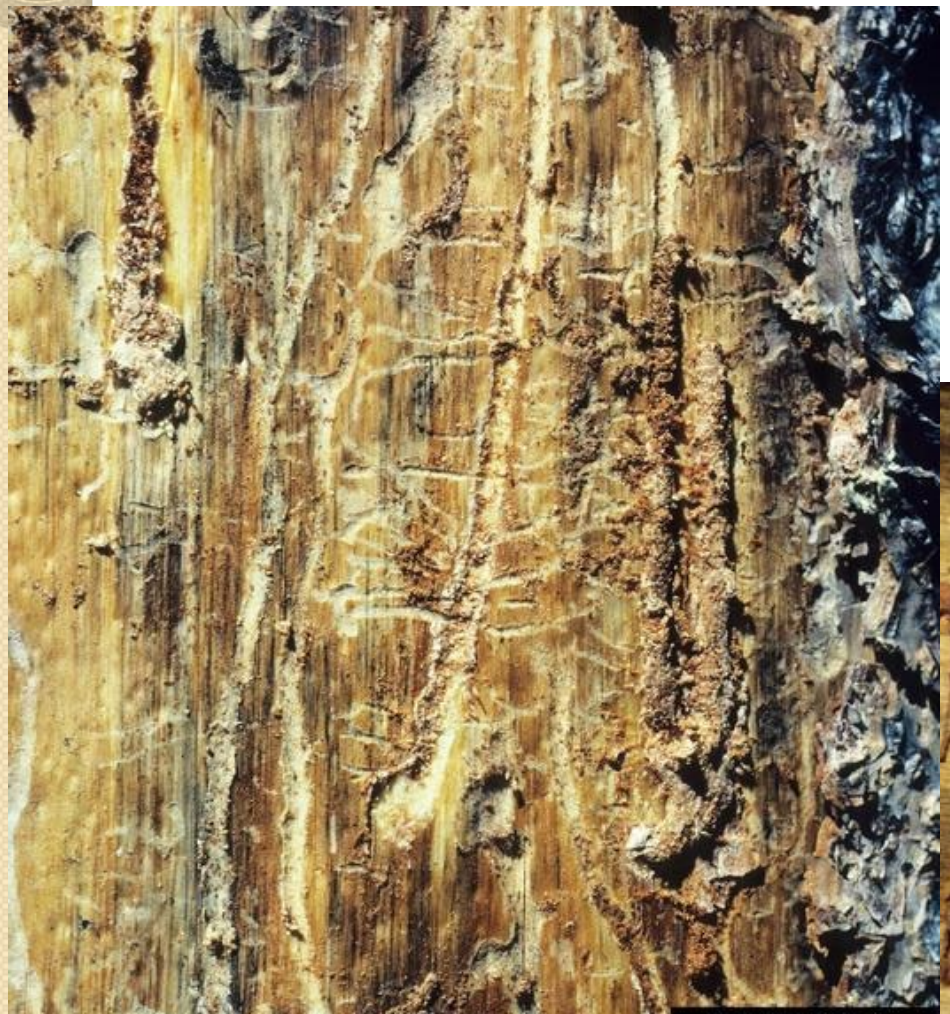


IBS woodpeckering

IBD infested blowdown

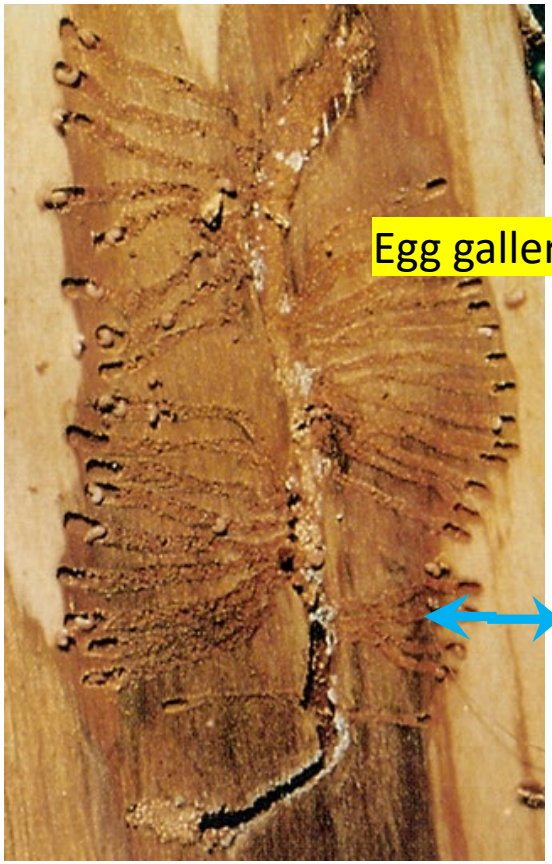
Galleries – different size and shape for each bark beetle

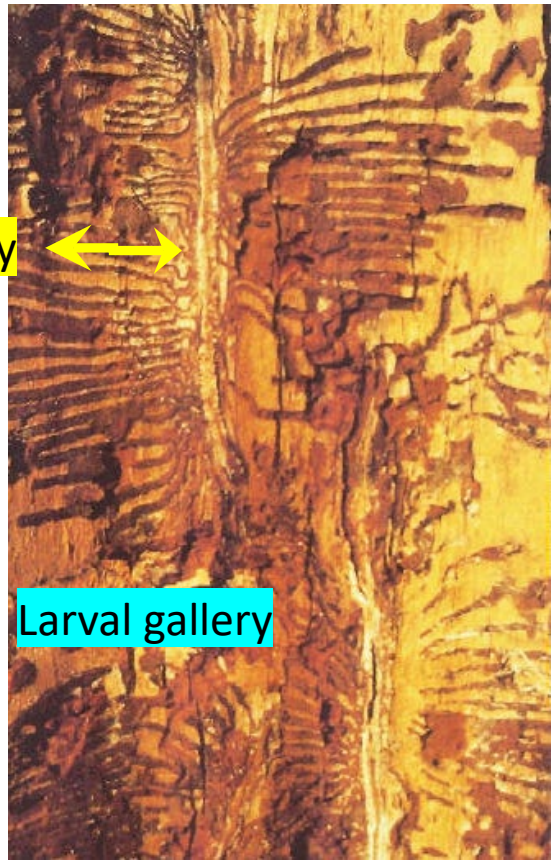
- IBM – J shaped gallery



- Vertical egg galleries
- Each egg laid singly
- Larval galleries right angles to egg galleries

5. Galleries: IBD





- Bottom hook on gallery
- 20-25 cm long
- Alternate **fan shaped** groups
- Packed with boring frass

- Egg gallery –vertical

- Larval galleries - horizontal

IBS attack after a couple of days

IBS gallery – dense fanning on each side of egg gallery

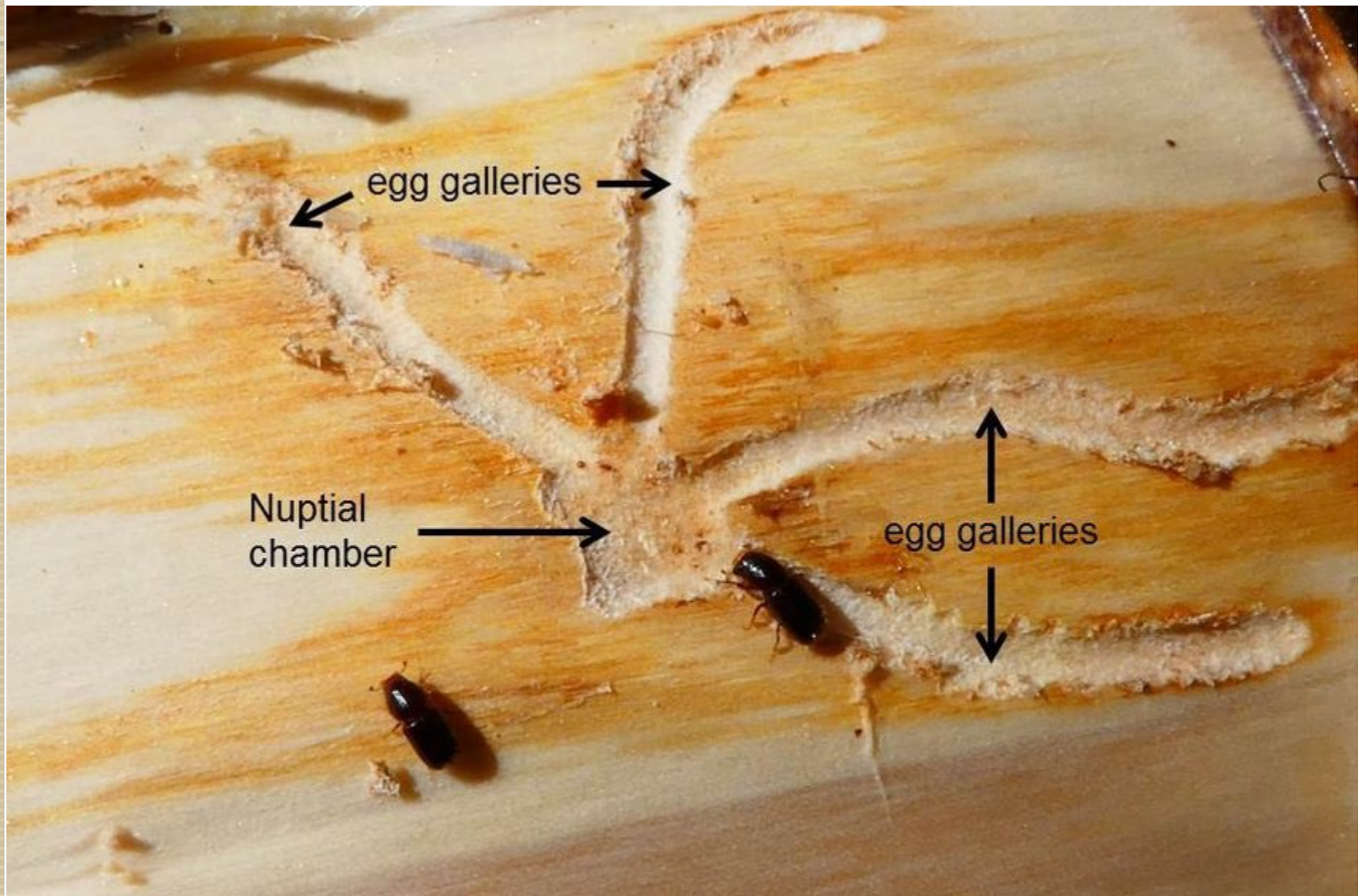
- Dense fanning on each side of egg gallery
- Eggs laid in clusters

Larval galleries

Egg gallery

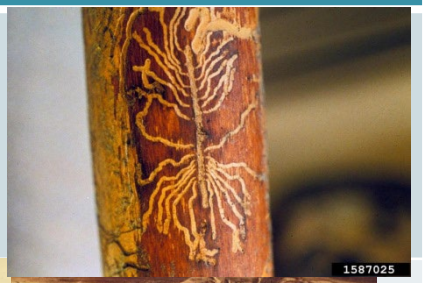
PUPAE
LARVAE

Western balsam bark beetle (IBB) Star-shaped egg galleries



Secondary Insects: Bark Beetles

With IBD: 1-2 generations/ year

Insect	Scientific Name	Habitat	Characteristic	Adult/ Gallery
Douglas-fir pole beetle	*Psudohylesinus nebulosus*	Small diameter Fd, or tops etc.	Adults: dense scales 3mm long round posterior	
Engraver beetle	*Scolytus tsugae*	Small diameter Fd, or tops etc.	Adults: sawed off posterior G: defined nuptial chamber; egg gallery horizontal, larval galleries vertical	

Ips (Engraver beetle) on Sx & P

- Star shaped gallery
- Spines on back end
- Multiple females to one male

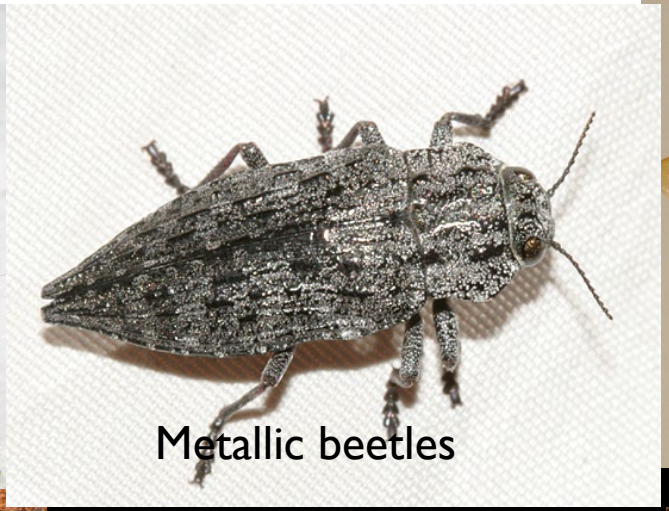
Woodborers

- Flatheaded
- Rounded headed
- Wasp wasps

Metallic beetles

Long horn beetles

Long horn beetles

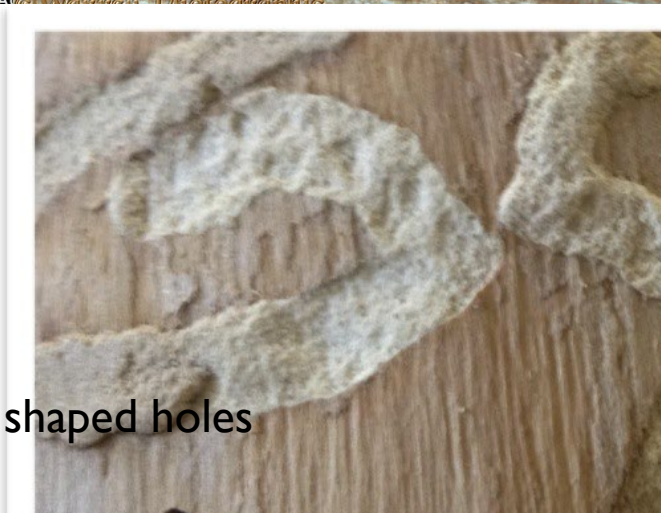

Metallic beetles

Wood wasps

Round heads

D shaped head

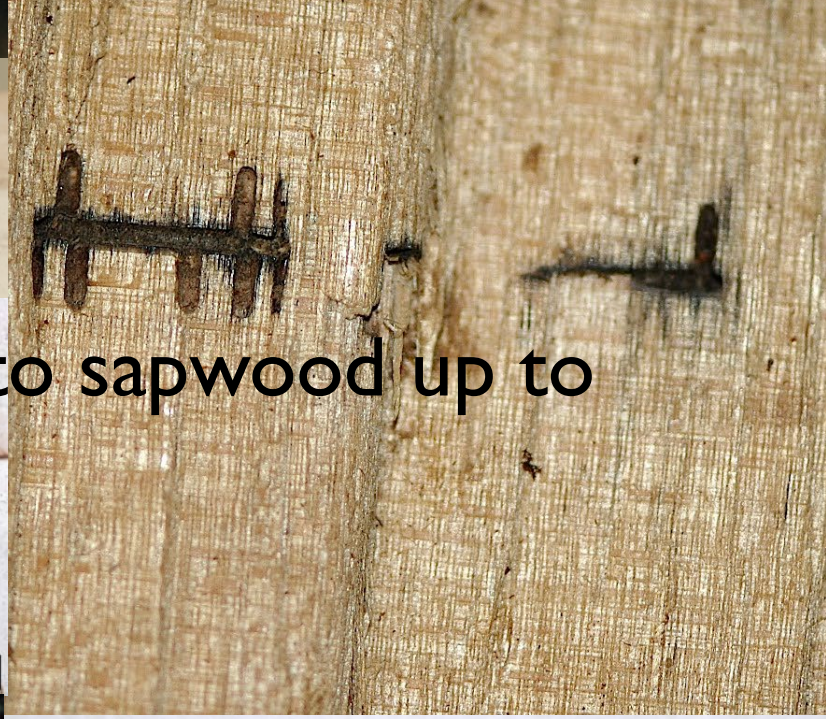
Round holes


D shaped holes

IBD and woodborers

Ambrosia beetle

- Pin holes directly into sapwood up to 10cm
- Fine, white frass

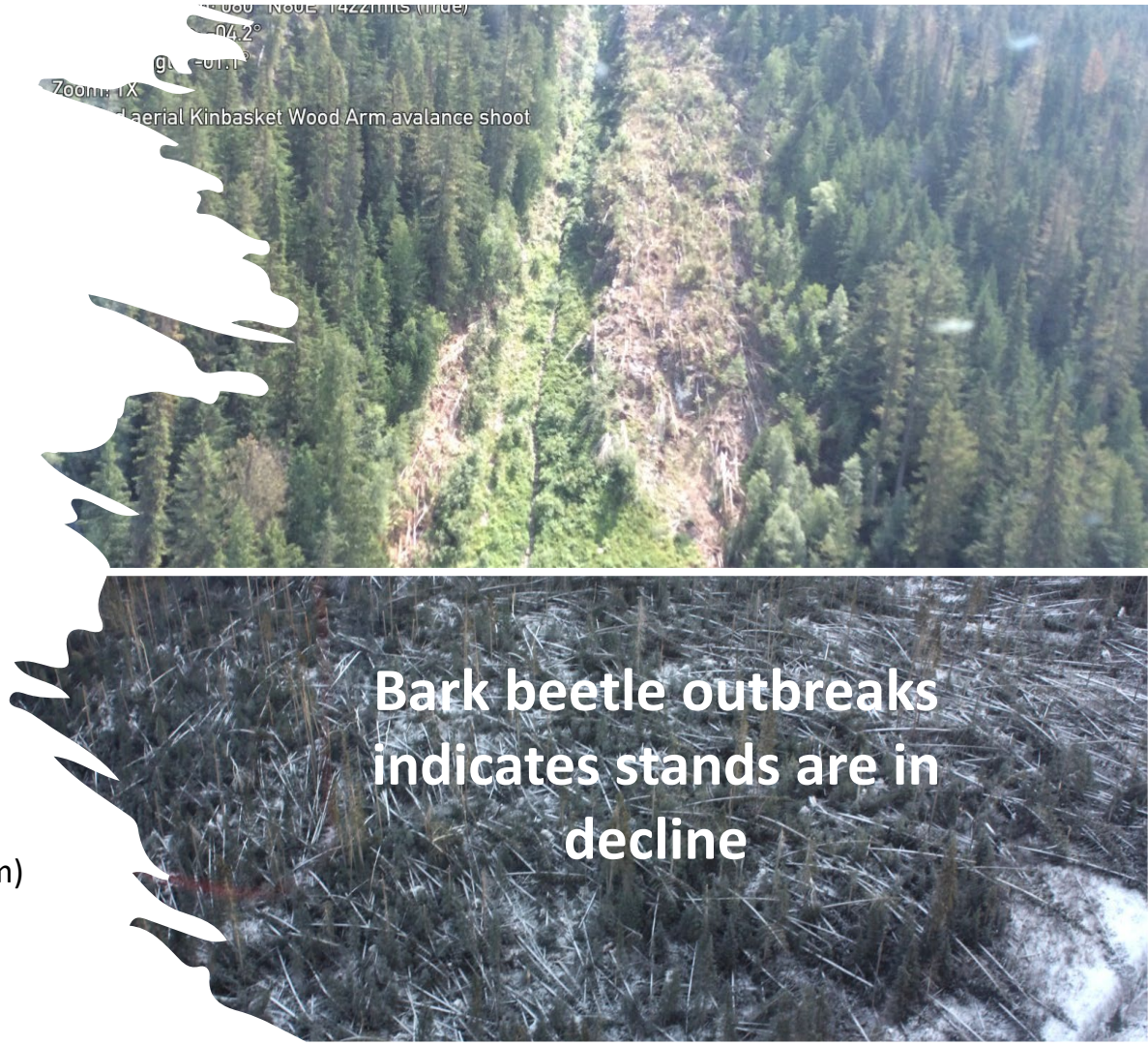


Management Strategy Criteria

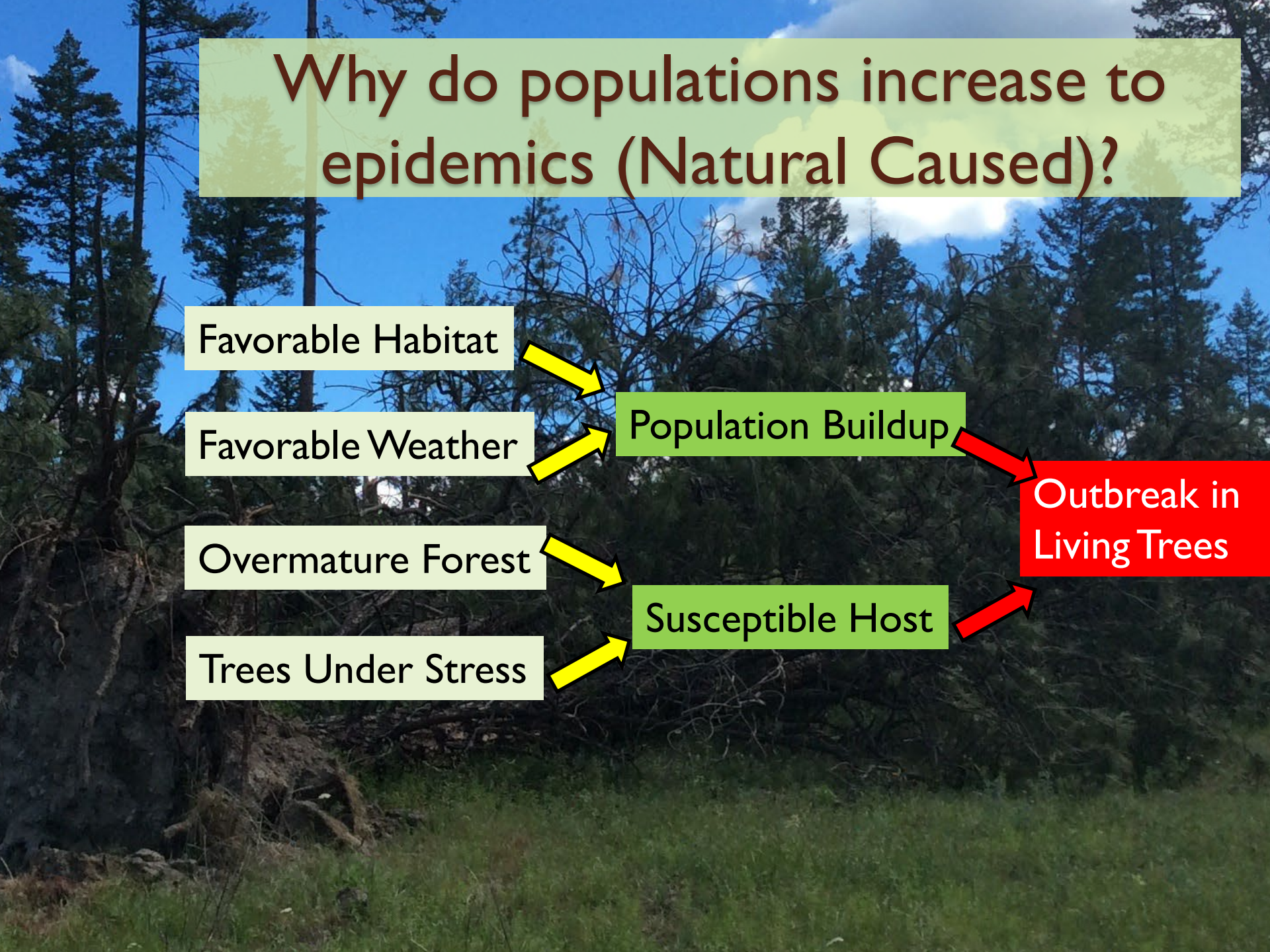
- Depend on;
  - Infestation size
  - Stand susceptibility
  - Values at risk
  - Access to infestations
  - Infestation history

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)
- Defoliators
  - IBD: IDW (Western spruce budworm)
    IDT (Douglas-fir tussock moth)



Why do populations increase to epidemics (Natural Caused)?



Date & Time: Tue Aug 7 08:53:24 MDT 2018
Position: 11 N 585404 5557920
Altitude: 1133m
Datum: WGS-84
Azimuth/Bearing: 353° N07W 6276mils (True)
Elevation Angle: -01.4°
Horizon Angle: -00.0°
Zoom: 2X
drm detailed aerial drought
Trees under stress:
DROUGHT

Heat dome (June 2021)

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

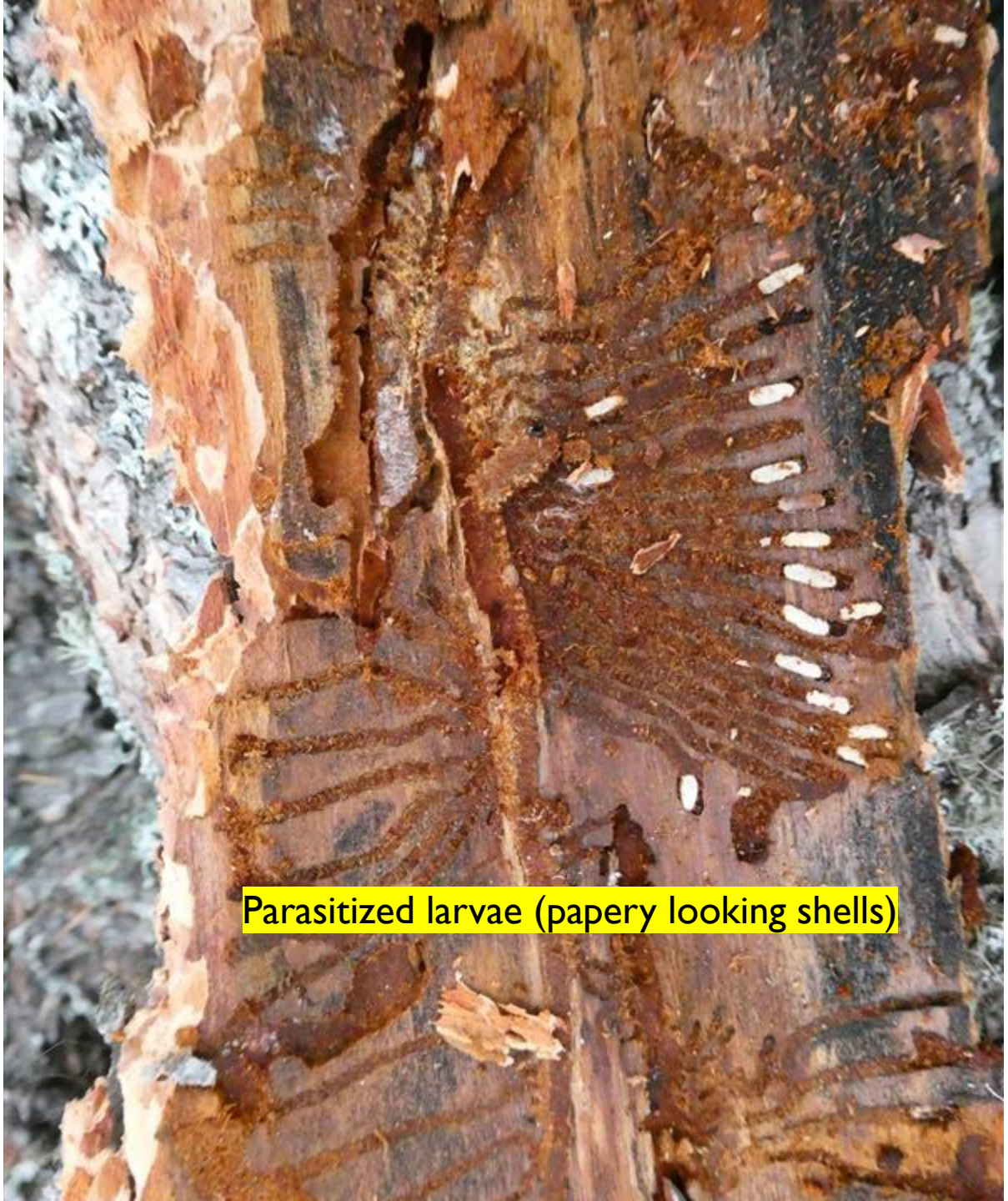
FIRE AND IBD ATTACK

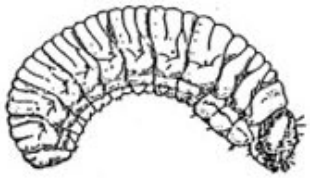
- Classification of burned areas
  - None — **Black**: tree boles completely charred and blackened, foliage destroyed, and understory vegetation burned. ***No IBD***
  - Some — **Black/brown**: mostly black but some brown foliage. ***May develop IBD***
  - **Lots** — **Mixed green/brown/black**: mostly green foliage, with brown and black spots, understory variously burned. ***Sig. beetles may develop.***

NATURAL CONTROL

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

Predator: clerid larvae

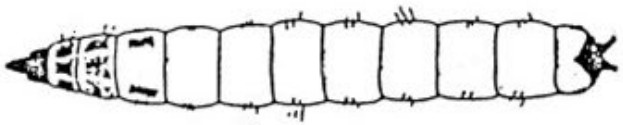

Parasitized larvae (papery looking shells)



Bark beetle larva

Wood borer larvae

Predacious beetle



Fly larvae

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

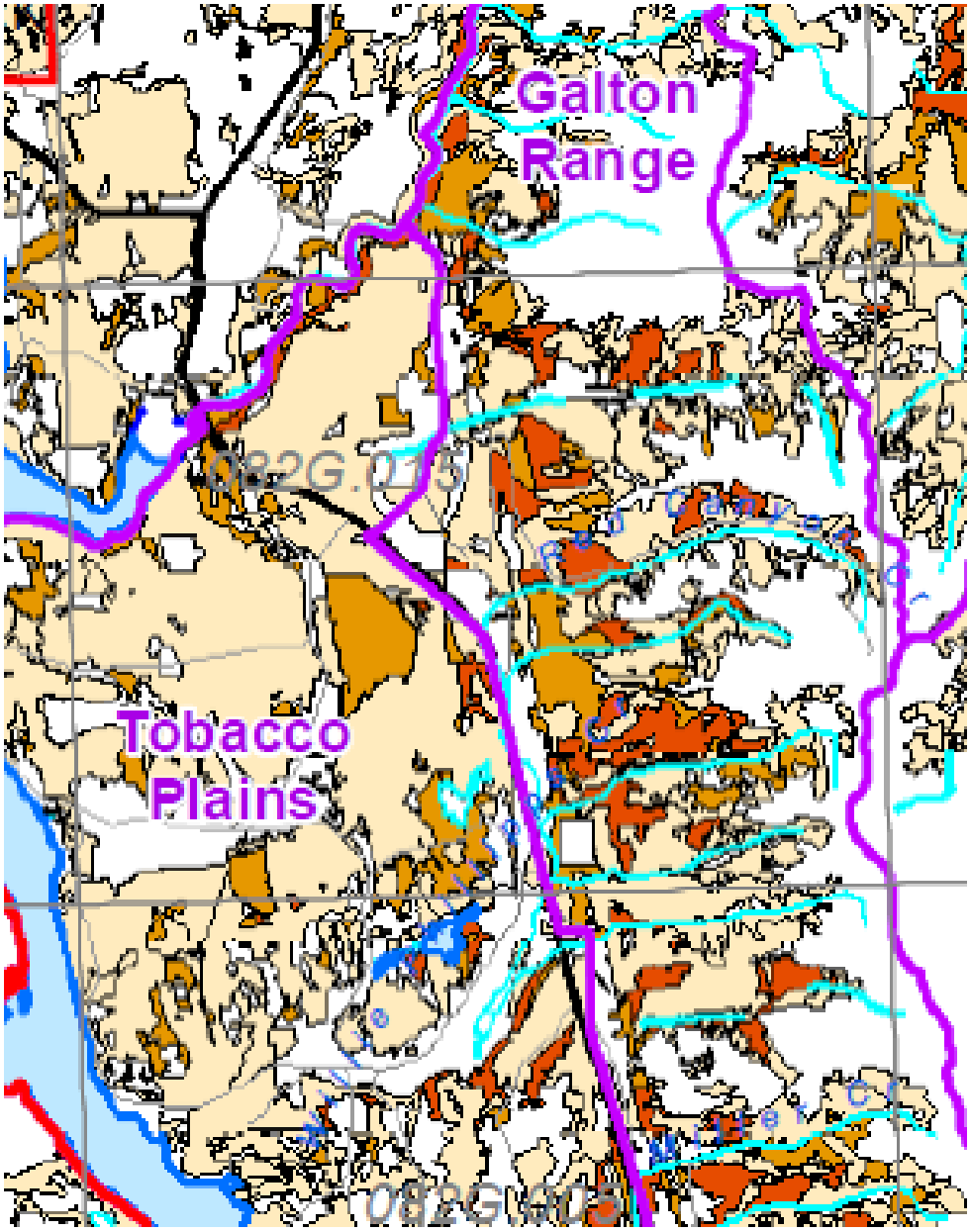
- Aerial surveys
  - **Aerial overview** (fixed wing – 1:100,000 scale, high, rough, cover all of BC for all pests)
  - **Detailed surveys** (helicopter – 1:30,000 scale, low, slow, specific areas for specific pests)
- Ground surveys
  - Walkthroughs
  - Star probes
  - Grid probes

IBD Management Treatments

Proactive:

- **High hazard host removal** – take trees out before beetles get to them

Proactive: High hazard host removal



1. Sanitation Harvesting

- **Most effective tactic, especially with trap trees**
- Remove all currently infested trees & mill before beetle flight

1. Low stumps <30cm
2. Clean logging
3. Debris pile management

1. Sanitation Harvesting

- High infestation levels make this more difficult
- Permits may need to be expedited
- Blanket salvage permit?
- Avoid damage of residual trees

1. Salvage harvest

- Recover value
- Denim wood

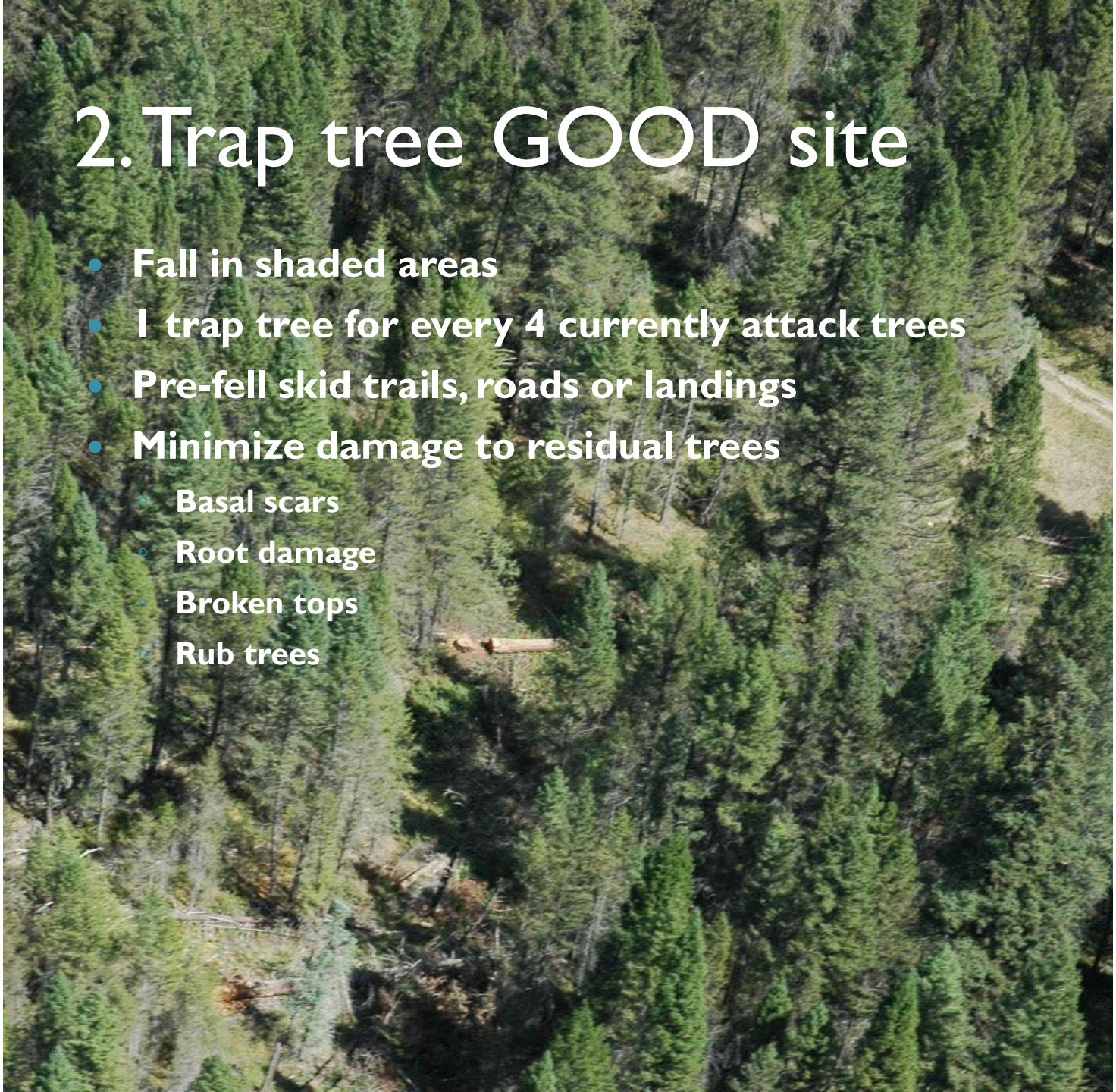
2. Trap trees

- 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 log 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

2. Trap tree GOOD site

- Fall in shaded areas
- 1 trap tree for every 4 currently attack trees
- Pre-fell skid trails, roads or landings
- Minimize damage to residual trees
  - Basal scars
  - Root damage
  - Broken tops
  - Rub trees



2. Trap tree POOR site

- Exposed to direct sun
- Too hot and dry
- No attack on top of log in exposed sites – don't catch as many beetles

2. Trap tree - POOR

- Avoid contact with standing trees. Touching standing trees results in overflow attack.

2. Trap Trees

- Keep stumps as low as possible
- Maximum stump height 30cm
- Peel stumps or use MCH

Pheromones (3 main uses)

1. *Grid/spot baiting* - aggregation pheromones to contain and concentrate populations prior to harvesting
2. *Trapping* to monitor or suppress populations
3. *Anti-aggregants* (MCH) deter attack

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

Pheromones

- Release rate is temperature dependent; warmer air=higher release rate (N side)
- Wind speed and direction determines where the pheromone plume will go.
- Insects can only 'sense' these chemicals from a downwind position.
- Use wind to your advantage

3. 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
- Bycatch potential - bats

4. Anti-aggregant MCH

- MCH (Methylcyclohexenone)

- 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
- Timing & population levels important
- Benefits: one entry, fairly cheap to buy

4. MCH

- Works best small infestations (avoid larger sites - 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)

- WestGreen MCH label and on page 3 it states, “In areas where high bystander exposure is expected, attach the dispensers at a height that is hard to or out of reach. Applications are limited to woodlots, forest and sawmill yards.
- Do not apply near or in areas frequented by small children and companion animals, e.g. residential lots, parks, camping sites, resorts and scenic vistas.”

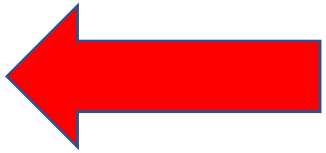
5. Single tree treatments

Thanks

Forest Landscape Plans

FIVE OBJECTIVES TO CONSIDER IN PREPARING AN FLP

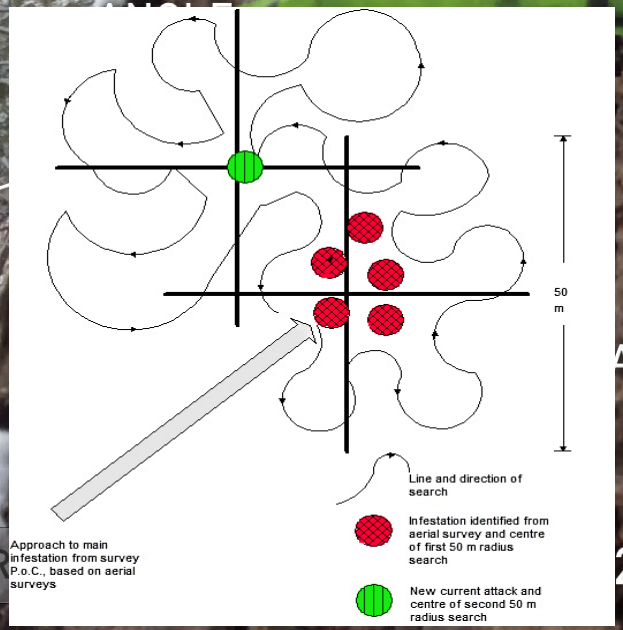
- Supporting the production and supply of timber in the forest landscape area
- Supporting the protection and conservation of the environment
- Managing the values placed on forest ecosystems by Indigenous peoples
- Managing the values placed on forest ecosystems by local communities
- Preventing, mitigating, and adapting to impacts caused by significant disturbances to forests and forest health, including wildfire, insects, disease, and drought



*There is no hierarchy associated with these objectives and the 11 FRPA values would be reflect in these 5 objectives.

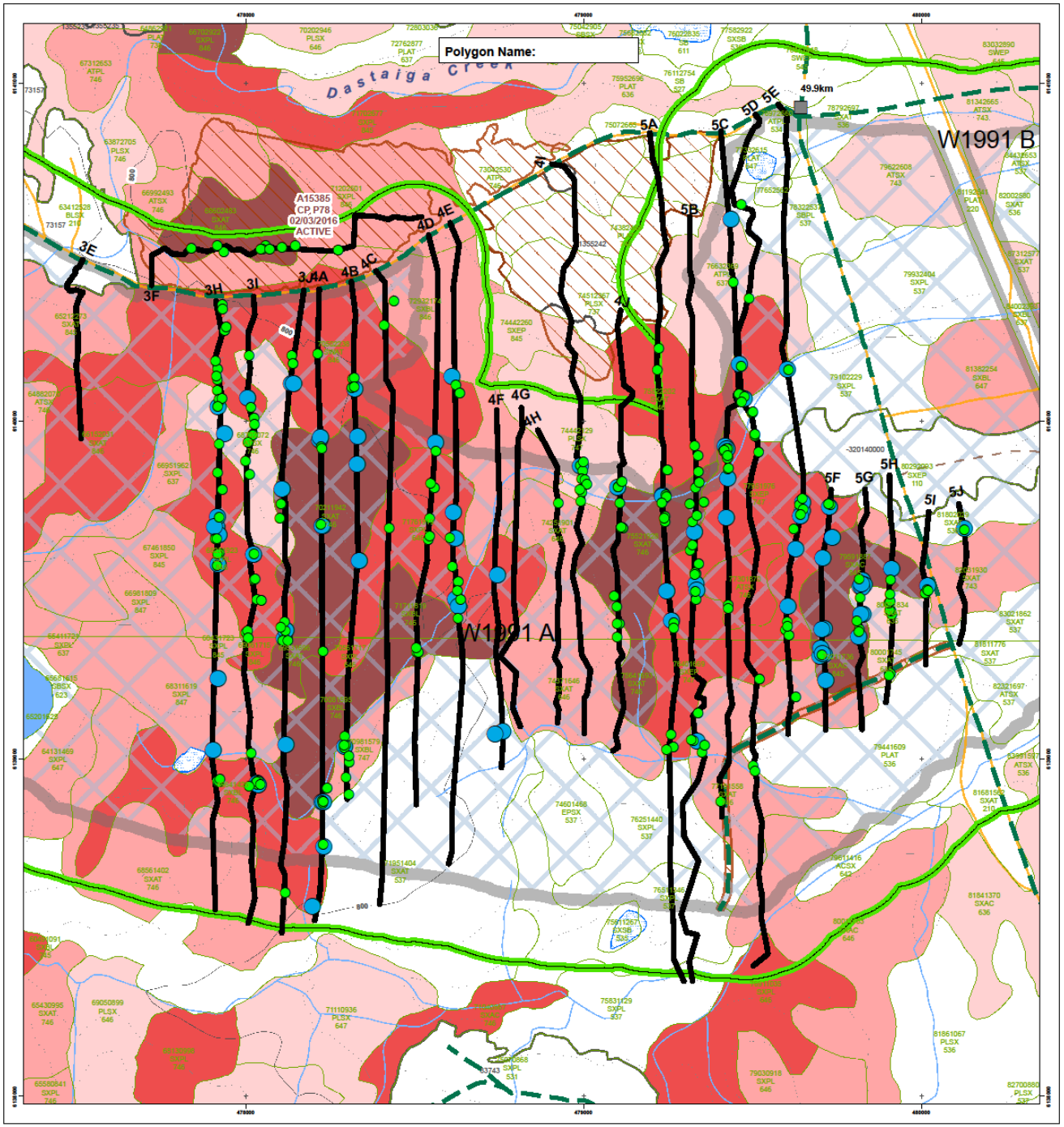
Ground Survey Techniques

- Walkthrough
- Star Probe
- Probe



Walkthrough

- **Non-systematic preliminary ground reconnaissance by an experienced crew**
- **rough estimates of extent and severity of beetle attack**
- **Done prior to recommendation of any possible further ground surveys, e.g., star probe or grid probe or other management decision.**

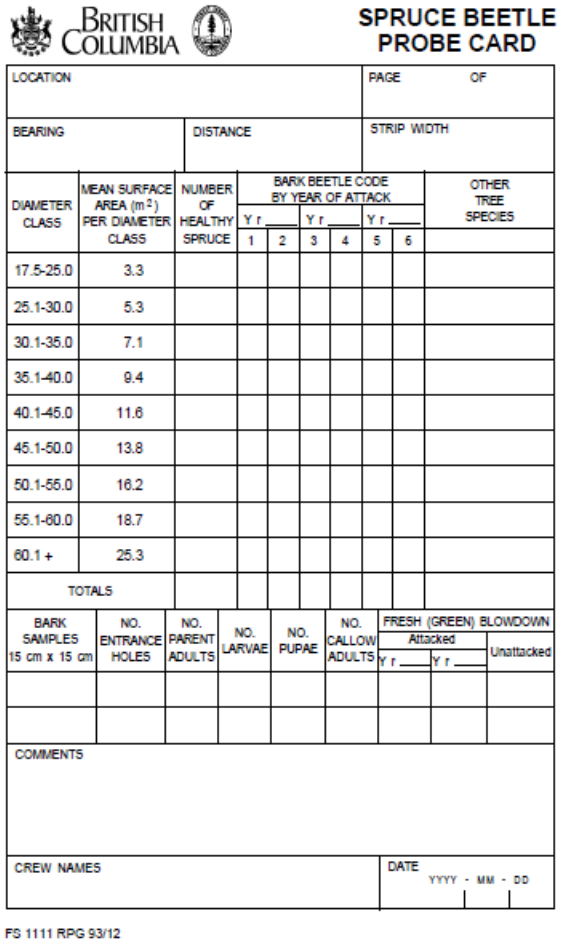


Walkthrough strip lines spaced varying distances apart

Blue circles = flight in 2021

Green circles = flight in 2022

IBS Probing card examples



BRITISH COLUMBIA

SPRUCE BEETLE PROBE CARD

LOCATION			PAGE	OF
BEARING	DISTANCE		STRIP WIDTH	

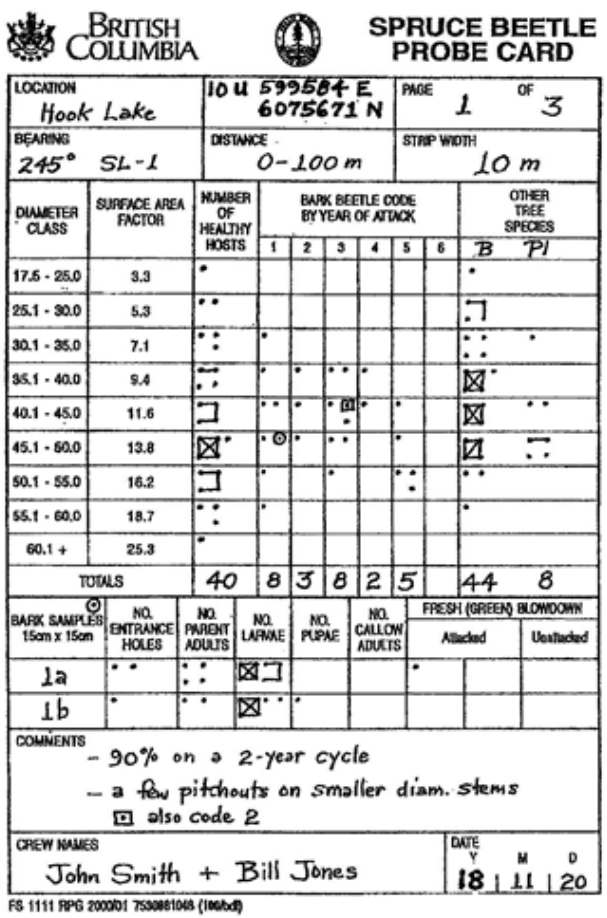
DIAMETER CLASS	MEAN SURFACE AREA (m^2) PER DIAMETER CLASS	NUMBER OF HEALTHY SPRUCE	BARK BEETLE CODE BY YEAR OF ATTACK						OTHER TREE SPECIES
			Yr ____				Yr ____		
			1	2	3	4	5	6	
17.5-25.0	3.3								
25.1-30.0	5.3								
30.1-35.0	7.1								
35.1-40.0	9.4								
40.1-45.0	11.6								
45.1-50.0	13.8								
50.1-55.0	16.2								
55.1-60.0	18.7								
60.1 +	25.3								
TOTALS									

BARK SAMPLES 15 cm x 15 cm	NO. ENTRANCE HOLES	NO. PARENT ADULTS	NO. LARVAE	NO. PUPAE	NO. CALLOW ADULTS	FRESH (GREEN) BLOWDOWN		
						Attacked		Unattacked
						Yr ____	Yr ____	

COMMENTS

CREW NAMES	DATE YYYY - MM - DD

FS 1111 RPG 93/12



BRITISH COLUMBIA

SPRUCE BEETLE PROBE CARD

LOCATION	10U 599584 E 6075671 N	PAGE	1 OF 3
Hook Lake			
BEARING	DISTANCE	STRIP WIDTH	
245° SL-1	0-100 m	10 m	

DIAMETER CLASS	SURFACE AREA FACTOR	NUMBER OF HEALTHY HOSTS	BARK BEETLE CODE BY YEAR OF ATTACK						OTHER TREE SPECIES	
			1	2	3	4	5	6	B	Pl
17.5 - 25.0	3.3	•							•	
25.1 - 30.0	5.3	• •							⌐	
30.1 - 35.0	7.1	• •	•						• •	•
35.1 - 40.0	9.4	⊢ •	•	•	• •	•			⊠ •	
40.1 - 45.0	11.6	⌐	• •	•	⊡ •	•	•		⊠	• •
45.1 - 50.0	13.8	⊠ •	• ⊙	•	• •		•		⊠	⊢
50.1 - 55.0	16.2	⌐	•		•		• •		• •	
55.1 - 60.0	18.7	• •	•						•	
60.1 +	25.3	•								
TOTALS		40	8	3	8	2	5		44	8

BARK SAMPLES ⊙ 15cm x 15cm	NO. ENTRANCE HOLES	NO. PARENT ADULTS	NO. LARVAE	NO. PUPAE	NO. CALLOW ADULTS	FRESH (GREEN) BLOWDOWN	
						Attacked	Unattacked
1a	• •	• •	⊠ ⌐			•	
1b	•	• •	⊠ •	•			

COMMENTS
- 90% on a 2-year cycle
- a few pitchouts on smaller diam. stems
- ⊡ also code 2

CREW NAMES	DATE Y M D
John Smith + Bill Jones	18 | 11 | 20

FS 1111 RPG 2000/01 7530861048 (196/bd)

Attack codes: IBM

- **C** (*Current Attack, Green Attack*)

- Foliage may be green or red
- Reddish brown boring dust around the base of the tree
- Pitch tubes usually found on the lower trunk of the tree
- Woodpecker activity may occur leaving bark flakes around the base of the tree
- Any IBM beetles or eggs present along the parent gallery
- Any IBM larvae present in the side galleries off the main parent gallery
- Pupae present in the pupal chamber
- Blue stain fungus may be present
- IBM constructs a vertical parent gallery with a slight J like hook at the base, with evenly spaced larval galleries that extend at right angles from the parent gallery. Care must be taken not to confuse the galleries and brood of other species of bark beetle with IBM.
- If a significant number of pitch tubes occur above a height that can be checked, default to calling the tree a current / green attack.

Attack codes: IBM

- **Y2** (*Brood flown, Red Attack*)
- Bright reddish / brown needles will be present. Greater than 50% of the original crown foliage present.
- Pitch tubes will be a darker yellow than fresh pitch-tubes and the pitch tubes will be old dry to the touch.
- No eggs, larvae, pupae or live brood remaining in tree.
- There may be live adults present however, with no eggs, larvae, or pupae present, there is no threat for spread.
- Pupal chambers must be present to indicate past successful IBM activity
- Blue stain fungus in tree is obvious
- Woodpecker activity / damage.
- The tree may contain other insects such as engraver beetles.

Attack codes: IBM

- **P** (*Pitchout / Unsuccessful*)

- Tree attacked in most recent insect flight with pitch filled parent galleries and no live brood production
- Little or no visible boring dust
- Creamy yellow coloured pitch tubes with little to no boring dust mixed in
- Peeling the bark away from the parent gallery will be required to determine if the tree has callused off the IBM activity. Look for a brown margin around the parent gallery.
- No IBM eggs, larvae, pupae, or live adults are present. Must check on all 4 sides of the tree. Tree often has pitch filled parent galleries and no live brood production.
- No blue stain
- Green Foliage
- ***Generally has <10 pitch tubes on the tree***.

Attack codes: IBM

- **X** (*Grey attack*)
- Attacked two or more years ago
- Foliage sparse or lacking. Dull Reddish/brown needles will be present. Less than 50% of the original crown foliage present.
- Pupal chambers must be present to indicate past successful IBM activity.
- Empty galleries with no live brood
- Bark is sloughing off.
- Evidence of old blue stain.
-
- **H** (*Healthy)*
  Unattacked

IBM Field Card

MOUNTAIN PINE BEETLE STAR PROBE MAP CARD

Infest ID	Mapsheet	Polygon No.	Y	M	D

Rd. & Km.	Distance From Rd./Access	POC E UTM N
Crew		Day Rate Time (4th Sweep/Other)

SWEEP #: GPS Accuracy: M

UTM E:

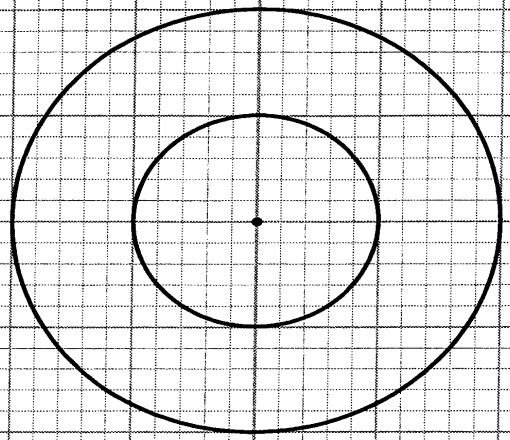
UTM N: Comments:

C:

Forked:

Y2:

P:



Avg Ht:

Ht Rng:

Avg Diam:

Diam Rng:

Timber Type: Vol/Ha:

Slope %: Stems/Ha:

Blowdown %: Snags/Ha:

N 50m 25m 0m 25m 50m N

SWEEP #: GPS Accuracy: M

UTM E:

Attack codes: IBD

- **2022 infestation (Code 1 & 2)**: most infestations are standing trees and don't have pouch mushroom. The foliage may have some discoloration and some tree may have a thin crown. The cambium is stained and dark with presence of Douglas-fir bark beetle brood with presence of some exit holes.

- **2021 infestation (Code 3& 4)**: most infestations are standing trees with red needles and may have *Cryptopurus volvatus* (pouch mushroom) along the trunk of the tree. The cambium is stained and dark and no Douglas-fir bark beetle brood are present. The bark is still hard and tight, galleries evident exit holes present.

- **2020 infestation (Code 5 & 6)**: most infestations are standing trees with **no foliage** remaining and may have *Cryptopurus volvatus* (pouch mushroom) along the trunk of the tree. The cambium is stained and dark and no Douglas-fir bark beetle brood are present. The galleries are still identifiable, small twig present, secondary wood borer may be present.

- **Note:** code 2, 4 & 6 may have been infested over two consecutive years

IBD Ground Detection (March-April)

- Overwintering adult beetles are ready to emerge, 50 percent of attacked trees will show some colour change, varying from yellow to "grey" as needles gradually fall off. Attacked trees sometimes drop needles with minimal colour change.
- Many grey and red trees, without much obvious external evidence of bark beetle emergence, will still contain beetles, and should be checked to ascertain whether beetles are present.
- “Late summer” flight attacked trees will have overwintering larvae.
- Pouch mushroom will start being evident on trees infested in the previous year in the ICH (e.g. Kootenay Lake), but ***not*** in IDF or very dry ICH (e.g. Invermere).

IBD Ground Detection (May-July)

- Exit holes are round 2.5 -3.0 mm holes coming straight out of the bark, produced when beetles emerge in spring.
- The obvious evidence of new attack is bright reddish brown boring dust on bark at the entrance holes of galleries.
- New attack is often not found below 2 m in ht in the ICH, but may be easier to find at lower ht in IDF or very dry ICH.
- Fresh pitch may be visible streaming down the bole. No pitch tubes are formed.
- Foliage is usually green.
- Cambium is mainly white and healthy looking however, some blue stain is located around the
- galleries.
- Bark is hard and tight and peeling is difficult.
- CHECK THE SHADED SIDE OF TREES

IBD Ground Detection (Aug-Oct)

- Some spring-attacked trees detectable through light foliage colour change (red bottom branches or thinning of the foliage).
- A few exit holes may be present on spring attack trees following re-emergence of some females.
- Cambium is stained and dark
- Most grey and red trees with large numbers of emergence holes, checks and loose bark will probably will not contain beetles

- must dig into the phloem and investigate the area between the phloem and the bark.

IBD Ground Detection (Aug-Oct)

- Some frass on bark usually located in the crevasses
- Watch for BARK MINERS, AMBROSIA BEETLES, WOOD BORERS.
- In stands with some understory vegetation, IBD will tend to attack trees above the understory height. Therefore, look for frass on upper bole (> 2 m ht). Binocular are very useful in that instance.
- second "late summer" flight occurs in July/August.
- **Starting in August**, IBD will migrate outward between the bark and the phloem and construct their chambers to get ready for overwintering.
- Therefore, to ascertain the presence of beetle, the surveyor must dig into the phloem and investigate the area between the phloem and the bark.

IBD Ground Detection (Dec)

- Some spring-attacked trees will be red, and a few will be “grey”.
- Woodpecker activity on the upper bole is a good indicator of bark beetle attack, but is not common.

Attack codes: IBS

TABLE 1 SPRUCE BEETLE CODES

Code 1 Most-recent year of full-attack (20)
Code 2 Most-recent year of strip-attack (20)

Revised Sept. 6, 2017

With spruce beetle on a 2-year life cycle, attacks occur mainly in June but extend into early August. With the 1-year cycle, the attack occurs in late May and early June.

All "external bark" and "phloem/sapwood" indicators refer to successfully attacked portions of the tree. Full-attacks are on 50% or more of the tree's circumference; strip-attacks are on less than 50%. Crown symptoms mainly refer to full-attacks, heavy strip-attacks, and/or multiple attacks.

Beetle Life Cycle	Time of Survey	External Bark Indicators				Phloem/Sapwood Indicators								Crown Symptoms
		pitch tubes	boring dust	woodpecker damage	exit holes	parent adults	larvae	pupae	immature adults	sapwood	blue staining	fungi	secondary insects	
2-year	July - Aug.	- sticky (if present)	- powdery dark brown	- light to moderate	- parent adult re-emergence holes	- alive	3 - 7 mm			- still moist	- light & shallow	-	- few	- none
2-year	Sept. - Oct.	- still pliable	- some left between bark scales	- moderate	- parent adult re-emergence holes	- dying	5 - 7 mm			- drying	- moderate & deepening	-	- mostly predators	- none
2-year	Nov. - May	- stiffening	- scarce	- moderate to heavy	- parent adult re-emergence holes	- dead	5 - 7 mm			- very dry	- heavy & deepening	- some	- predators and then secondary beetles	- none
1-year	July - Aug.	- still pliable	- some left between bark scales	- usually light		- alive	6 - 7 mm	- many	- some	- drying	- moderate & deepening		- mostly predators	- sometimes lower bole chlorotic
1-year	Sept. - Oct.	- stiffening	- scarce	- light to moderate	- variable	- dying	6 - 7 mm	- many	- many	- very dry	- heavy & deepening	- some	- mostly predators	- sometimes lower bole chlorotic
1-year	Nov. - May	- stiffer		- usually moderate	- variable	- dead		- few	- many	- very dry	- heavy & deep	- moderate	- predators & then by spring, ambrosia beetles, *Ips spp.*, etc. .	- sometimes lower bole chlorotic

Attack codes: IBS

TABLE 2 SPRUCE BEETLE CODES

Code 3 Second most-recent year of full-attack (20)
Code 4 Second most-recent year of strip-attack (20)

With spruce beetle on a 2-year life cycle, attacks occur mainly in June but extend into early August. With the 1-year cycle, the attack occurs in late May and early June. All "external bark" and "phloem/sapwood" indicators refer to successfully attacked portions of the tree. Full-attacks are on 50% or more of the tree's circumference; strip-attacks are on less than 50%. Crown symptoms mainly refer to full-attacks. Resin streams from the upper bole may be present and are characterized below.

Beetle Life Cycle	Time of Survey	External Bark Indicators				Phloem/Sapwood Indicators								Crown Symptoms
		pitch tubes	boring dust	woodpecker damage	exit holes	parent adults	larvae	pupae	immature adults	sapwood	blue staining	fungi	secondary insects	
2-year	July - Aug.	- stiffening	-	- heavy		- dead or dying	5 - 7 mm	- moderate to heavy	- moderate to heavy	- very dry	- moderate & deepening	- some	- predators & secondary beetles	- none
2-year	Sept. - Oct.	- stiffer	-	- heavy	- variable	- dead	-	- few	- heavy with some in root collar	- very dry & some checking	- heavy & deepening	- moderate	- predators & secondary beetles	- may be thinning slightly
2-year	Nov. - May	- brittle	-	- heavy	- variable	- dead	-	- few	- variable with some in root collar	- very dry & moderate checking	- heavy & deep	- heavy	- predators & secondary beetles	- may be thinning slightly with very minor coloration change
1-year	July - Aug.	- brittle	-	- heavy	- moderate to heavy	- dead	-	-	- few with possibly some in root collar	- very dry & some checking	- heavy & deepening	- moderate	- predators & secondary beetles	- very variable
1-year	Sept. - Oct.	- brittle	-	- heavy	- moderate to heavy	- dead	-	-	-	- very dry & some checking	- heavy & deep	- heavy	- predators & secondary beetles	- very variable
1-year	Nov. - May	- brittle		- heavy	- moderate to heavy	- dead	-	-	-	- very dry and moderate checking	- heavy & deep	- heavy	- predators & secondary beetles	- very variable

Attack codes: IBS

TABLE 3 SPRUCE BEETLE CODES

Code 5 Third most-recent year of full-attack (20)
Code 6 Third most-recent year of strip-attack (20)

With spruce beetle on a 2-year life cycle, attacks occur mainly in June but extend into early August. With the 1-year cycle, the attack occurs in late May and early June.

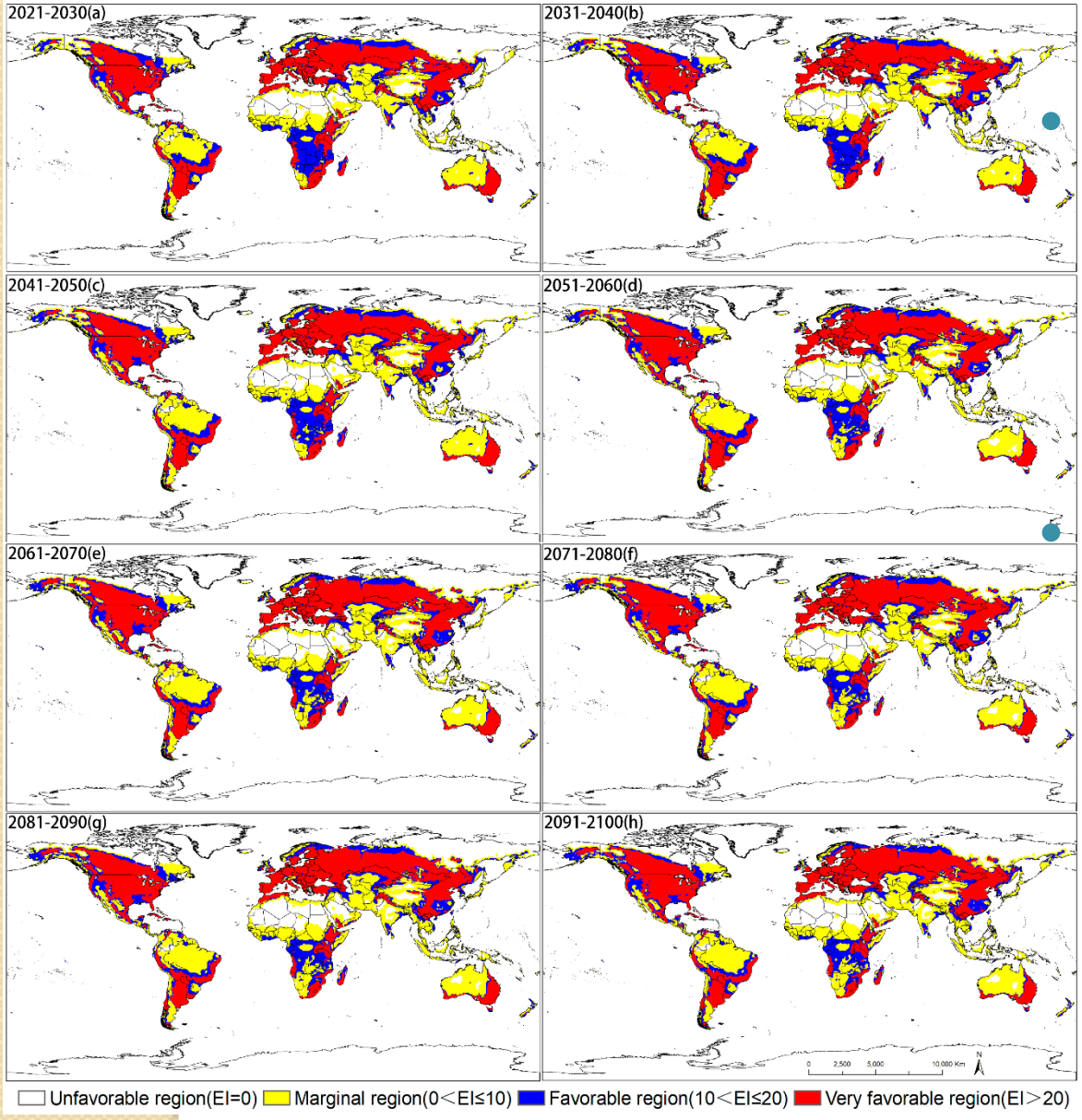
All "external bark" and "phloem/sapwood" indicators refer to successfully attacked portions of the tree. Full-attacks are on 50% or more of the tree's circumference; strip-attacks are on less than 50%. Crown symptoms mainly refer to full-attacks. Resin streams from the upper bole may be present and are characterized below.

Beetle Life Cycle	Time of Survey	External Bark Indicators				Phloem/Sapwood Indicators								Crown Symptoms
		pitch tubes	boring dust	woodpecker damage	exit holes	parent adults	larvae	pupae	immature adults	sapwood	blue staining	fungi	secondary insects	
2-year	July - Aug.	- brittle & yellow	-	- heavy*	- heavy	- dead	-	-	-	- very dry with heavy checking	- very heavy & deep	- variable	- ambrosia beetle & woodborer holes	- red or grey & thinning rapidly
2-year	Sept. - May	- brittle & yellow	-	- heavy*	- heavy	- dead	-	-	-	- very dry with heavy checking	- very heavy & deep	- variable	- ambrosia & woodborer holes	- little or no needles left
2-year	July - Aug.	- brittle & yellow	-	- heavy*	- heavy	- dead	-	-	-	- very dry with heavy checking	- very heavy & deep	- variable	- ambrosia beetle & woodborer holes	- grey & thinning rapidly
2-year	Sept. - May	- brittle & yellow	-	- heavy*	- heavy	- dead	-	-	-	- very dry with heavy checking	- very heavy & deep	- variable	- ambrosia & woodborer holes	- little or no needles left

Thank you for listening
Any questions?

Current and future IBM ranges globally

- The land between 67° N and 55° S is predicted to be climatically suitable for *D. ponderosae*, except for northern Africa, central and western Oceania, and western China, which are marginal or unfavorable for *D. ponderosae* under historical climate conditions
- Climate change can significantly affect the potential distribution of *D. ponderosae*, and the impacts on the suitability of the pest will vary with latitude. With climate change, the suitability will increase in middle and high latitude regions and decrease in the low latitude regions, while the most sensitive regions to climate change located in the mid-latitude zone.
- Under both historical and future climate conditions, climate-suitable areas were not only distributed in North America but spread across all continents (except Antarctica), including northern South America, most areas of Europe, northwest and southeast Asia, southeast Africa, and southeast Oceania
- 2021-2100: shift directions of central points in Asia, North America, and South America are highly correlated with climate change



Predicted potential global distribution of *D. ponderosae* under future climate conditions. (**a–h**) Predicted potential global distribution of *D. ponderosae* for 2021–2030, 2031–2040, 2041–2050, 2051–2060, 2061–2070, 2071–2080, 2081–2090, and 2091–2100. The unfavorable, marginal, favorable, and very favorable regions were painted in white, yellow, blue, and red, respectively.

Land Acknowledgement (Castlegar)

- As a visitor on this land, I would like to begin by acknowledging that we are gathered on the traditional and unceded territory of the Sinixt (Lakes), the Syilx (Okanagan), the Ktunaxa and the Secwépemc (Shuswap) Peoples.
- As a settler from Europe, I am committed to working towards reconciliation.

Land Acknowledgement (Grand Forks)

- As a visitor on this land, I would like to begin by acknowledging that we are gathered on the traditional and unceded territory of the Syilx (Okanagan) people.
- As a settler from Europe, I am committed to working towards reconciliation.