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Polyphagous Shot Hole Borer (PSHB) Information Presentation

Importance of the Urban forest

- The City of Cape Town recognises the important role of trees in the urban environment in terms of:
  - Providing desirable areas to live, work, play and de-stress (health and well-being)
  - Transforming under-utilised spaces
  - They change roadways into scenic routes becoming symbols as part of City landscapes (heritage)
  - In the built environment, trees serve to buffer noise, sun, and wind
  - Trees also support other life forms by providing food and habitat as well as providing other essential ecosystem services (e.g. improving air and water quality)

Photo: Steve Kretzmann

What is PSHB?

- Polyphagous Shot Hole Borer (PSHB), *Euwallacea fornicatus*, is a wood-loving ambrosia beetle native to Southeast Asia
- Polyphagous – relying on a variety of host tree species for food
- PSHB is a small, cryptic beetle
  - Female 2.5mm (wings; dark brown to black)
  - Male 1.5mm (no wings; reddish brown)
- Males spend most of their lives in their tunnels (natal galleries)

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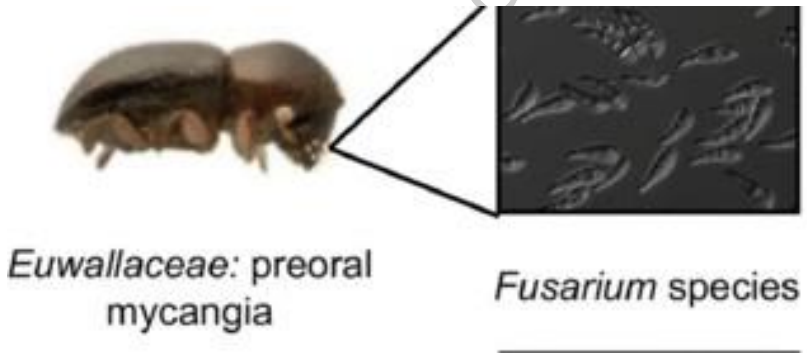
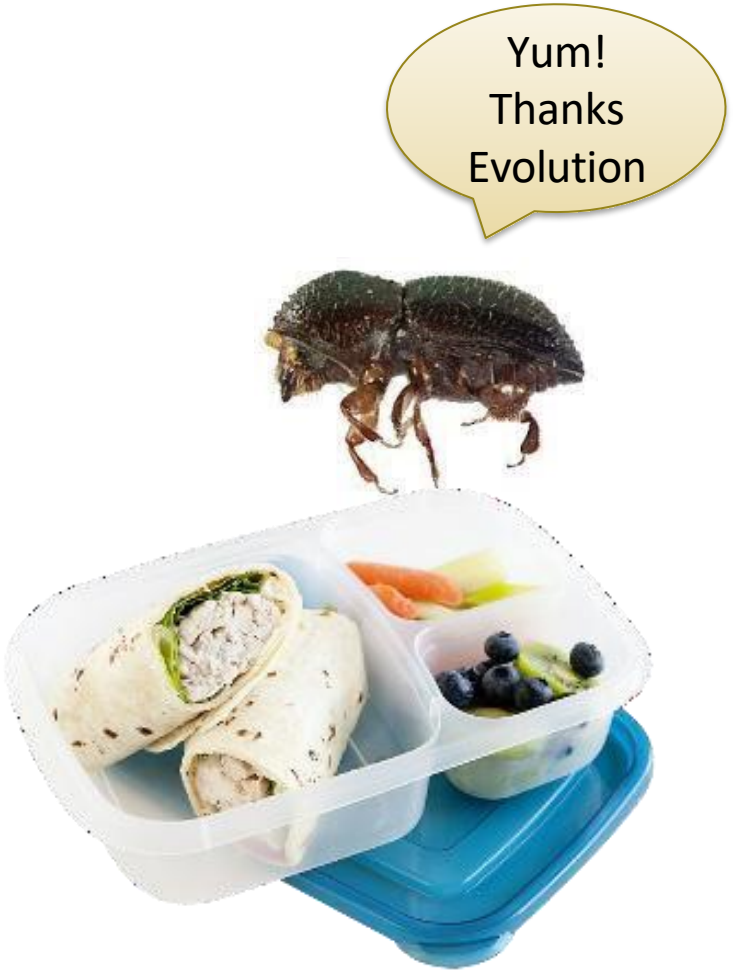
PSHB Diet

- PSHB beetles have symbiotic relationships with three different fungi species which are a food source for both adults and larvae:
  - *Fusarium euwallaceae (most important)*
  - *Graphium* sp
  - *Paracremonium* sp
- PSHB have a sac-like structure close to their mouths that carry the spores of these fungi – "packed living lunch"





Why is PSHB so destructive?

- Upon burrowing into a host, much like a farmer, spores are inoculated into the sapwood walls from the entry tunnels all the way into their brooding chambers (galleries)
- *Fusarium euwallaceae* is a plant pathogen that only grows in living tissue where it:

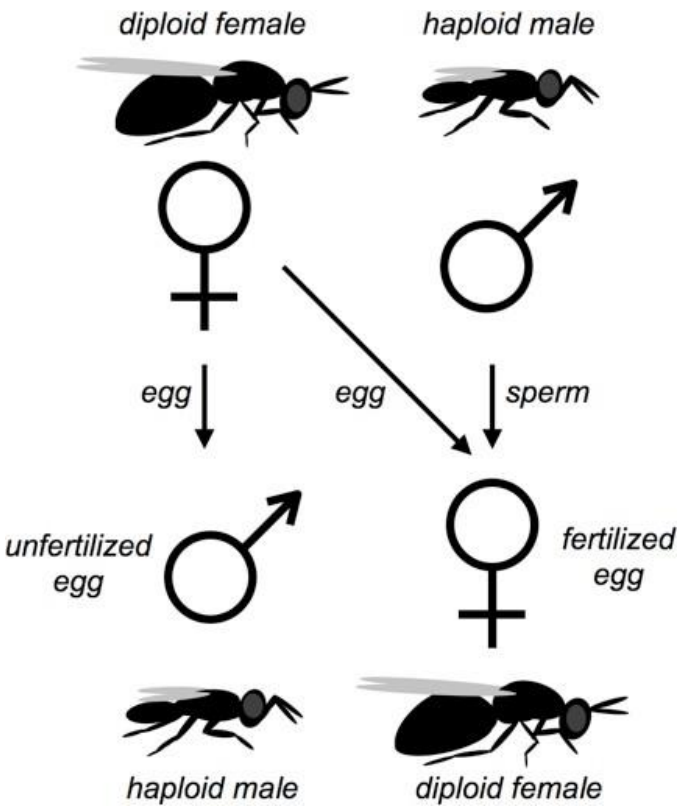
  - Kills xylem and phloem tissue blocking any movement of water and nutrients
- The dead tissue becomes a growing medium for the other two fungi in a tree
- If the tree dies PSHB continue to feed on the other two fungi

Why is PSHB so Invasive?

- PSHB are Haplodiploid (reproductive strategy)
  - Males are haploid (single set of chromosomes)
    - Females are diploid (two sets of chromosomes)
- Females will lay and hatch unfertilized male eggs
- And then mate with own offspring to create female eggs
- No ill effects result from inbreeding – gene mutations/corruption
- **Only a single female is needed to colonise a new area – perfect invader**
- Single Foundress female can produce 57 reproductive females within 6-7 weeks

Scale bars = 1 mm

Figure 1: (a) Adult and (b) larva of the polyphagous shot hole borer beetle, *Euwallacea fornicatus*



PSHB Host trees

- Currently 161 known host species split into 3 categories:

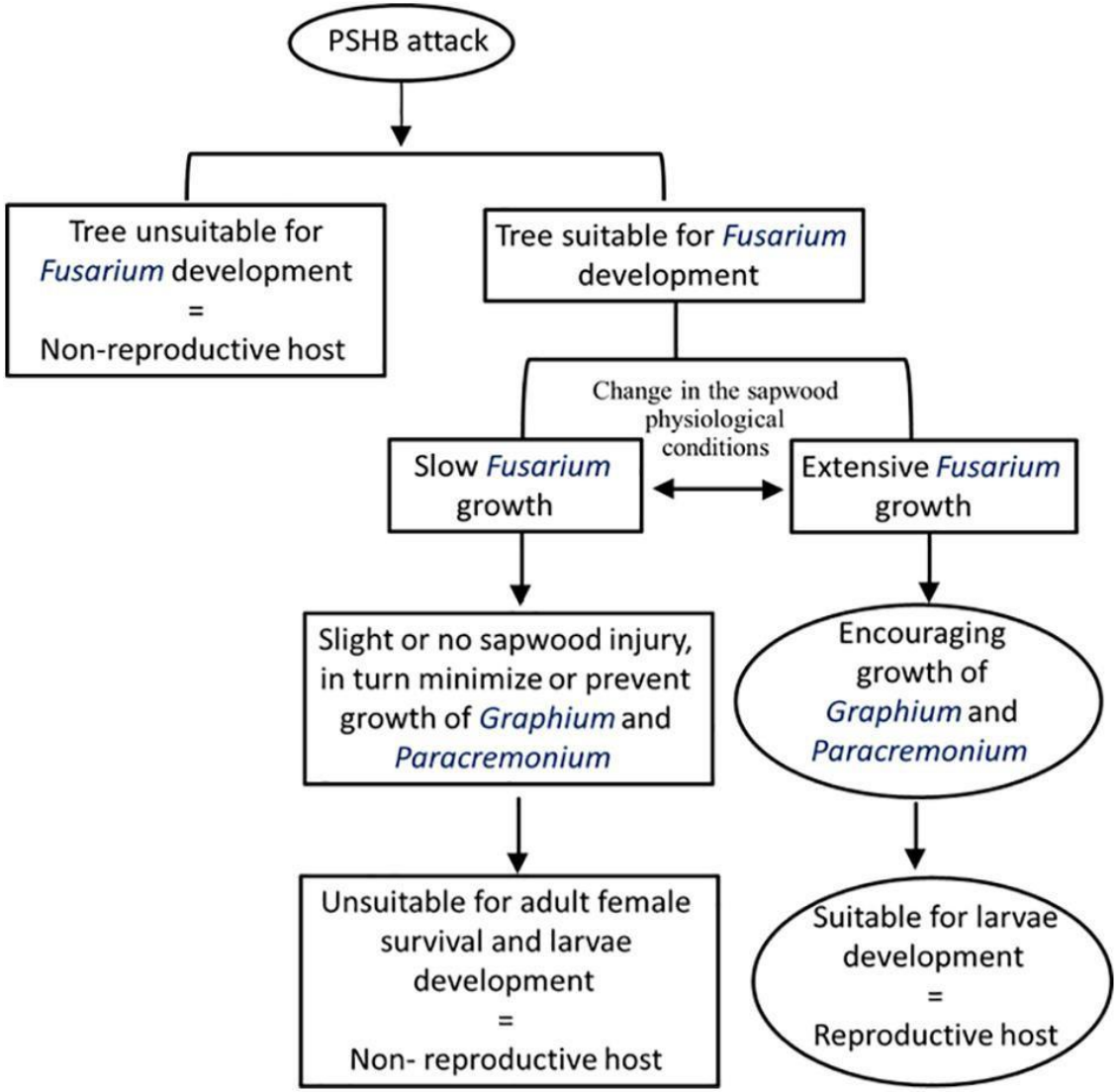
  - 4 Highly Susceptible reproductive host trees (HSRH)
    - ❖ Hosts in which both the beetles and the fungus establish, and where the beetle successfully reproduces. Typically die within a few years of PSHB attack. These species amplify the PSHB population and increase the risk of infestation to surrounding trees.

  - 79 Reproductive host trees
    - ❖ Hosts in which both the beetles and the fungus establish, and where the beetle successfully reproduces. Some reproductive hosts may be killed.

  - 78 Non-reproductive host trees
    - ❖ Hosts that are attacked but the beetles do not establish breeding galleries. The fungus may, or may not cause disease. Non-reproductive hosts are generally not expected to die

- Note that these categories are not fixed and very specific conditions determine a tree falling within one of these categories.

Type of Host Tree Species



Mendel et al 2021

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Highly Susceptible Reproductive Hosts

Species	Common name	Family	Indigenous or alien
Acer negundo	boxelder	Sapindaceae	invasive alien
Quercus robur	English oak	Fagaceae	alien
Ricinus communis	castor bean	Euphorbiaceae	invasive alien
Salix babylonica	weeping willow	Salicaceae	alien

→ ± 1 year to die

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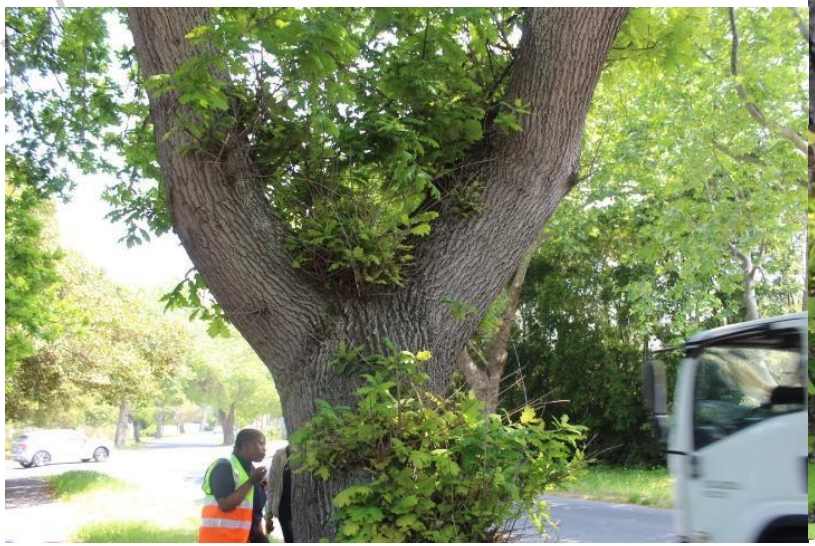
± 2 years to die



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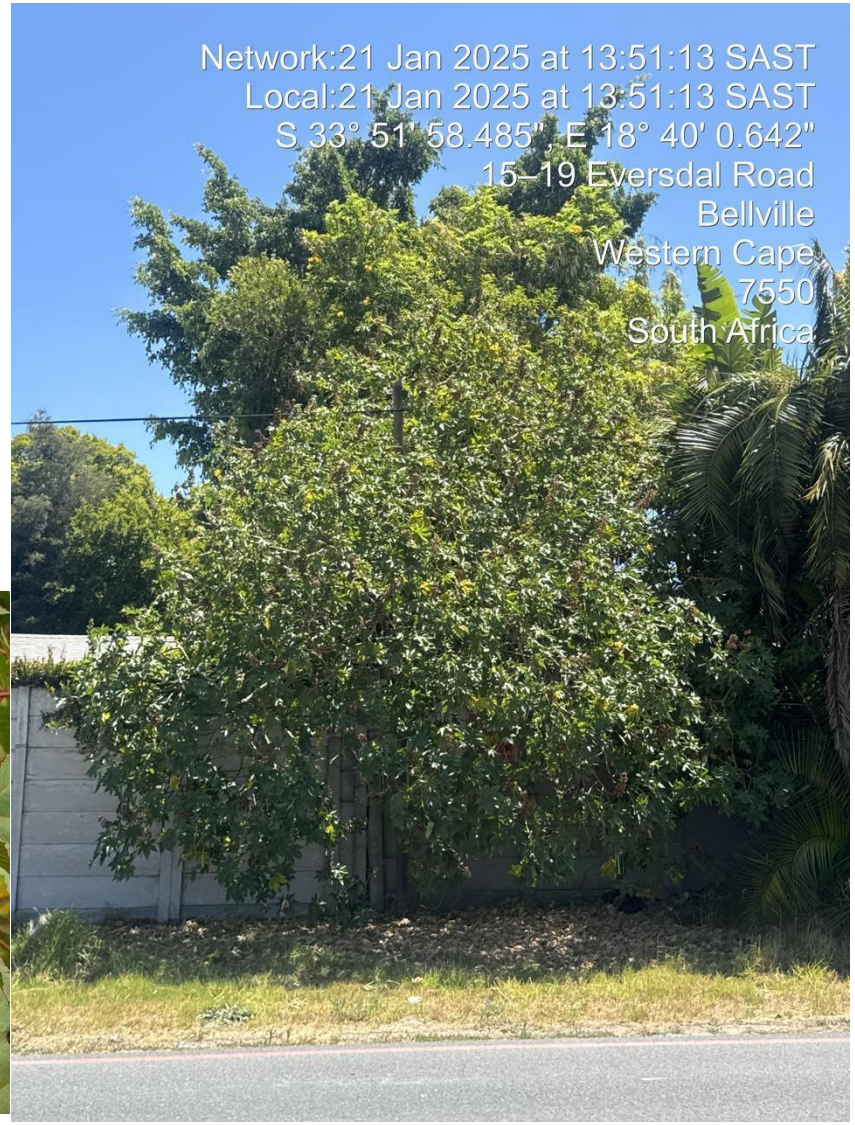

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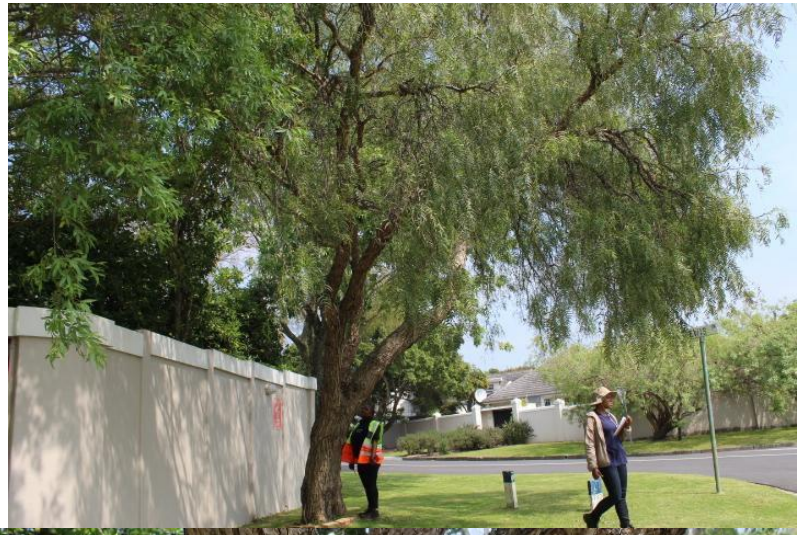

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Reproductive Hosts to note

Acacia mearnsii	black wattle	Fabaceae	invasive alien

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Agricultural Reproductive Hosts to note

Carya illinoinensis	pecan nut	Juglandaceae	alien
Malus domestica	apple	Rosaceae	alien
Persea americana	avocado	Lauraceae	alien
Prunus armeniaca	apricot	Rosaceae	alien
Pyrus communis	pear	Rosaceae	alien

Common Reproductive Hosts

Platanus x acerifolia	London plane	Platanaceae	alien

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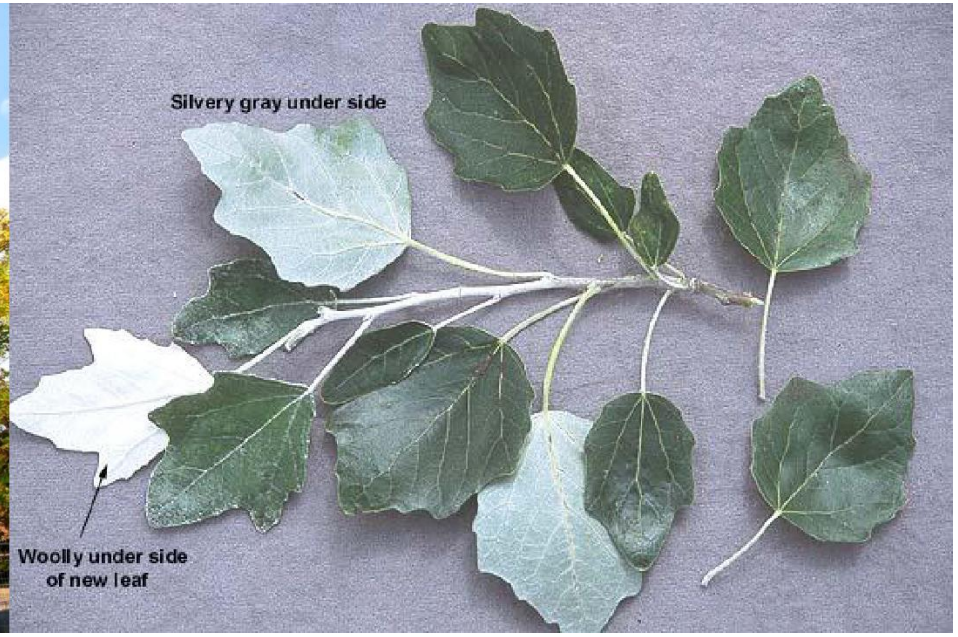
Common Reproductive Hosts

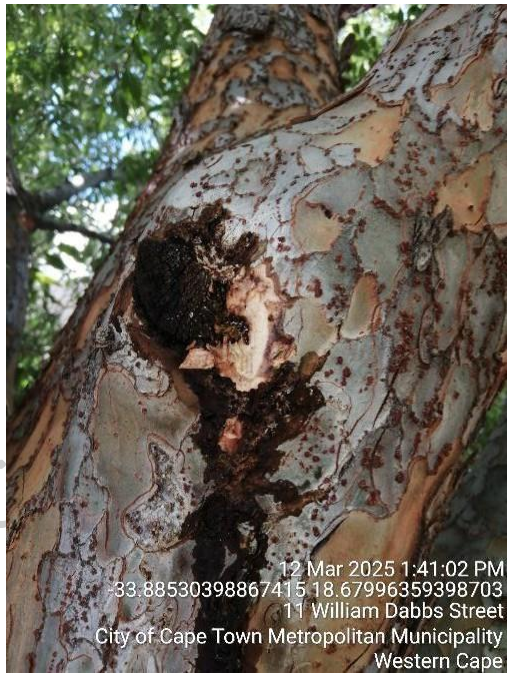
Populus x canescens	grey poplar	Salicaceae	invasive alien



Common Reproductive Hosts

Ulums parvifolia	Chinese elm	Ulmaceae	Alien

www.gardenia.net



www.palmtreeworld.co.za

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Common Reproductive Hosts

Populus simonii	Chinese poplar	Salicaceae	Invasive alien

invasives.org.za

invasives.org.za

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How do they spread?

- Females fly from tree to tree over short distances (±30m)
  - Maximum dispersal distance can get up to 400m (leading edge)
- Wind is an important dispersal factor as it can determine the distance and direction of dispersal
- Through people:
  - The movement of firewood
  - Other uses e.g. art

Tree Condition

- Trees in the following scenario are more likely to be infested by PSHB
  - Larger trees
  - Trees that are further away from water
  - Trees with physical damage
  - An area with low tree diversity (urban environment)
  - Street trees being smothered in concrete create more stress

- Well maintained trees have a better fighting chance

PSHB Dispersal

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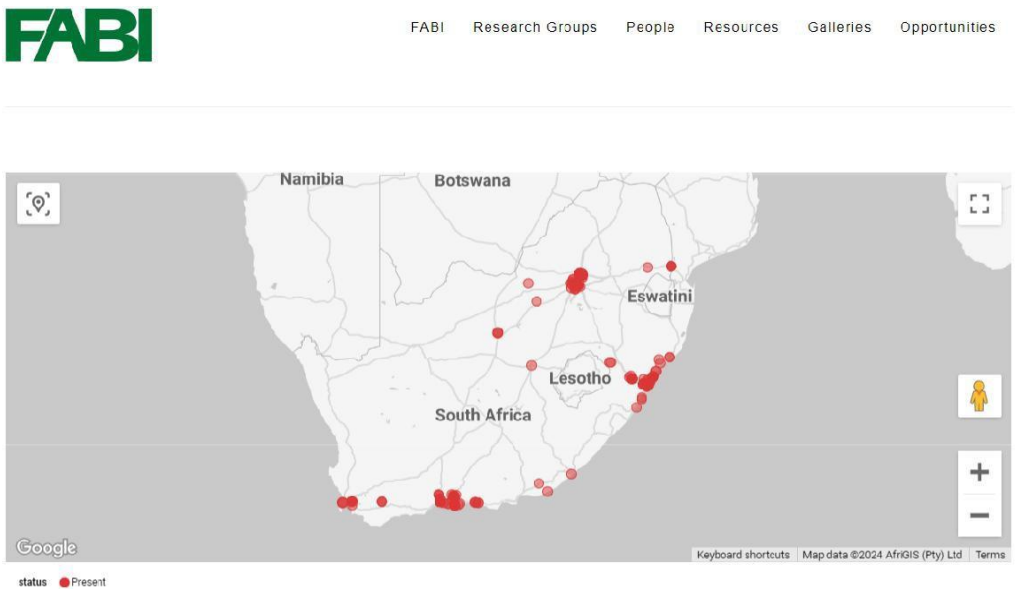
Invasion History and Legislation

- First confirmed in 2017 (KZN) PSHB has actually been in SA since 2012 (Stouthamer et al. 2017)
- It has since spread to 8 provinces in SA except Limpopo - using the movement of infested wood as a pathway
- First positive case of PSHB within the City of Cape Town was in Somerset West in 2019
- First confirmed case in Southern suburbs was at the beginning of 2023
  - Evidence suggests that PSHB was present in the southern suburbs much earlier (dead tree)

- PSHB and *Fusarium* are not yet listed under NEMBA however, in 2020, two ministers (Environment & Agriculture) issued emergency notifications, making the two species notifiable invasive pests in South Africa proposing Category 1(b) listing



PSHB Home (up.ac.za)

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Why worry about PSHB?

- Risk of infestation into our PA, Natural Forests and Parks as well as our Nurseries

- Most notable impact has been seen on Urban trees
  - Storm water run-off (trees assisting with flood mitigation)
  - Losses to ecosystem services
  - Carbon dioxide sequestration

- Loss of trees results in the reduction of shade
  - Inducing what we call the urban heat island effect
    - ❖ Cities are concrete jungles that tend to reflect and retain heat whereas greener areas absorb and regulate temperature

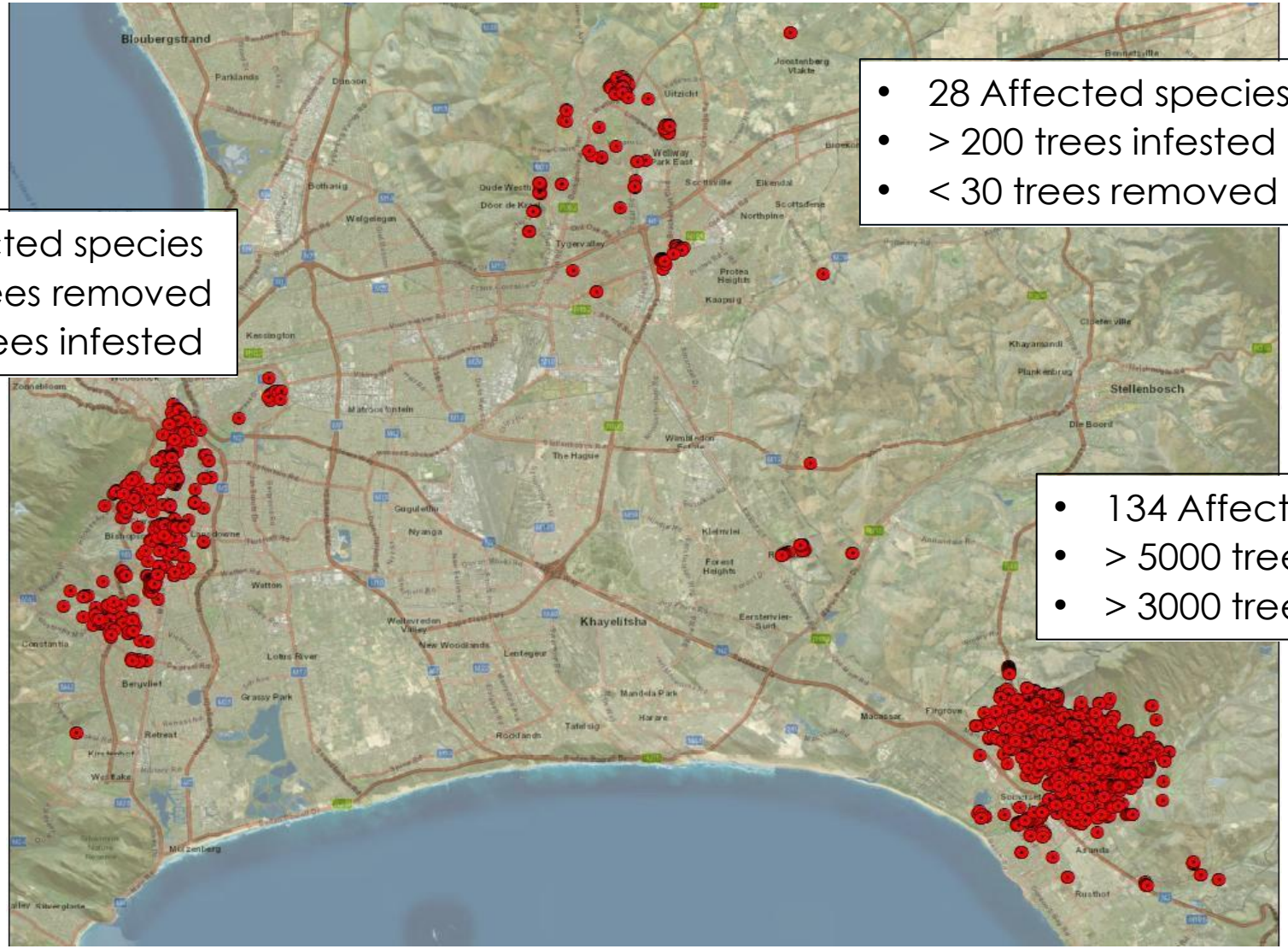
- Dying trees may cause physical damage in terms of falling branches/trees
  - Health and Safety
  - Traffic accidents
  - Vehicle damage
  - Infrastructure damage

Why worry about PSHB?

- De Wit *et al*., 2022 estimated the unmitigated Economic Impact to be R275b
  - ❖ 0.66% of the SA's GDP
  - ❖ Visual surveys in the invaded area of SA indicate that all English Oak's, Box Elders and Other Maples will succumb to PSHB infestation
  - ❖ 50% of infested London plane trees showed will show decline
  - ❖ PSHB is the last financial year cost CCT more than R8m to manage. Breakdown includes
    - Trees removals
    - Biomass management
    - Research and advocacy (staff budget, vehicles and equipment budget and tree planting budget
  - ❖ Estimated R4.5m-R5.7m to replace trees removed in Somerset West

PSHB Distribution

- 41 Affected species
- > 250 trees removed
- > 500 trees infested



- 28 Affected species
- > 200 trees infested
- < 30 trees removed

- 134 Affected tree species
- > 5000 trees infested
- > 3000 trees removed

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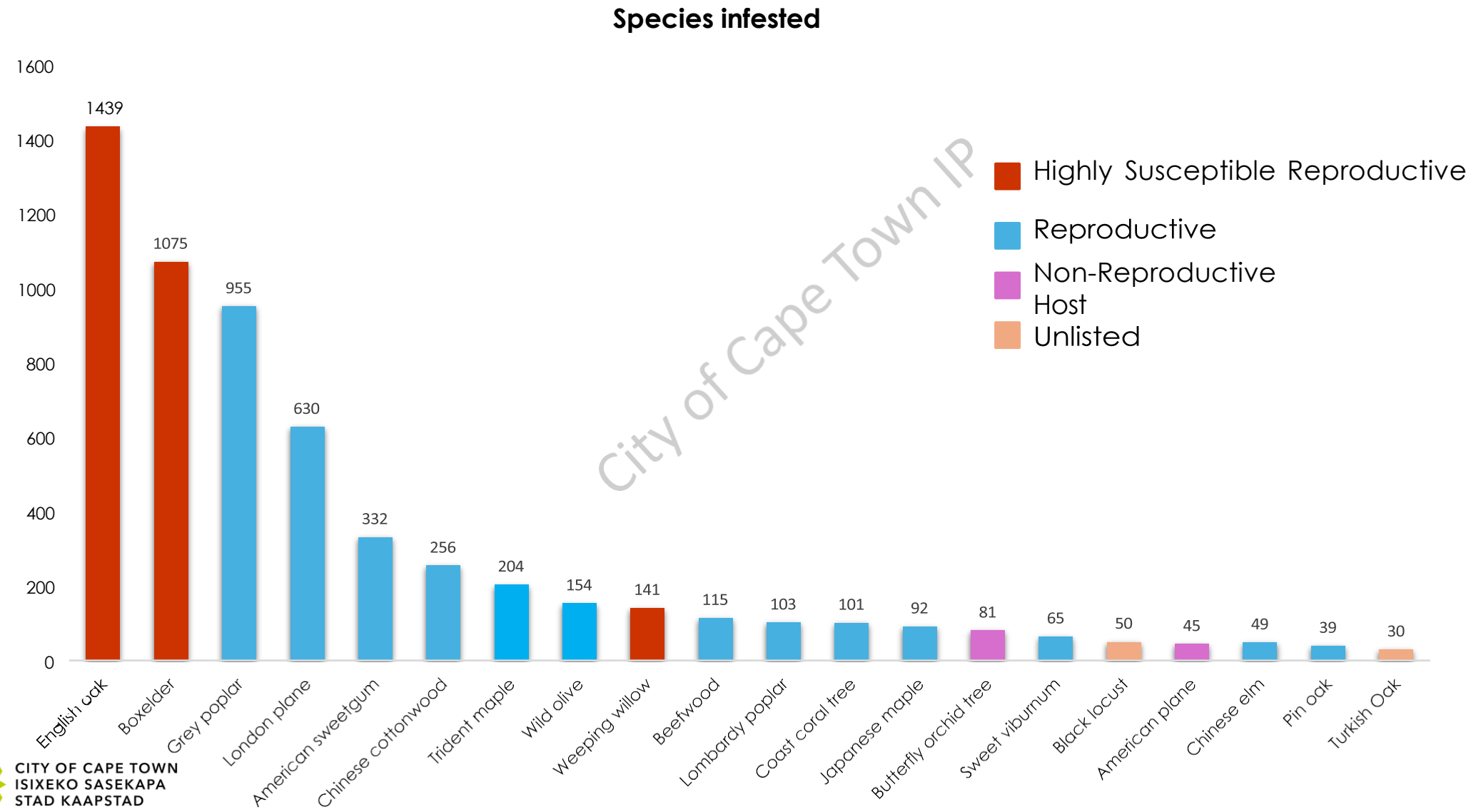
PSHB - Field data



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Identifying PSHB

- Trees that are infested with PSHB will show external physical signs at or near the entry holes
- Important: PSHB will predominantly attack living hosts
- The external physical signs depends on the tree species

  - There are five different external signs
    - ❖ Branch Dieback
    - ❖ Frass
    - ❖ Gumming
    - ❖ Staining
    - ❖ Sugary Exude

Identifying PSHB – *Fusarium* Dieback

- Fusarium dieback entails dieback in branches
  - Caused by destruction of the xylem tissue by F. euwallaceae preventing movement of water and nutrients and physical burrowing damage caused by PSHB
  - The presence of Fusarium dieback is usually seen in highly infested trees

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Identifying PSHB

- Entry hole of a PSHB beetle is about 0.85mm in diameter which is roughly the size of a medium ball point pen

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Identifying PSHB - Frass

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Identifying PSHB - Gumming

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Identifying PSHB - Staining

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Identifying PSHB – Sugary exudes

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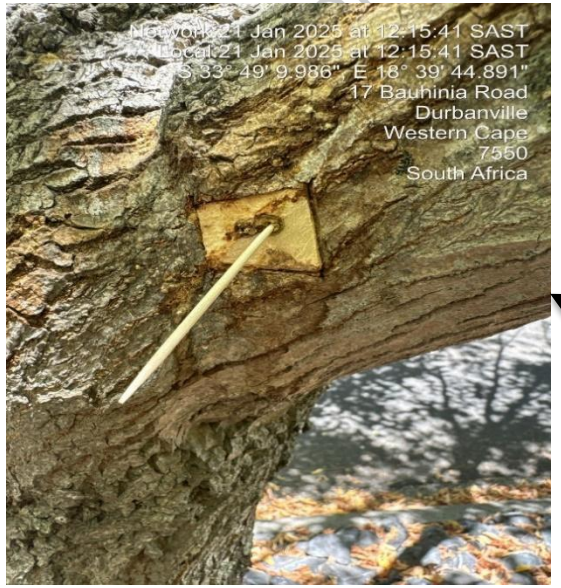
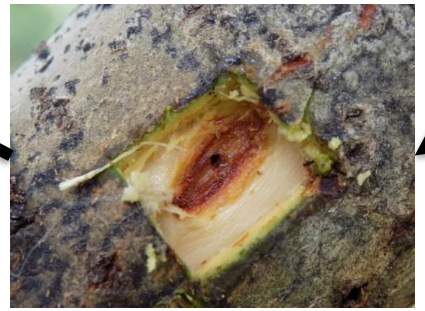
Identifying PSHB – *F. euwallaceae*

- After the bark is lifted with a chisel the entry hole is seen in the sap wood with the staining of *F. euwallaceae* around the edges of the hole

Identifying PSHB – Confirming Procedure





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Not to be confused with…

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Treatment of PSHB

- PSHB is difficult to control
  - ➢ Spend most of their lives within the host tree - insecticides have a limited efficacy
  - ➢ When dispersing they only move short distances (approx. 30m)
    - They fly already mated to another tree
    - Walk to unoccupied area of the current tree

- Currently, there are no solutions to save an infested tree from PSHB – only option is management

- Cutting down of heavily infested host trees, or pruning of infested branches is the recognised method of control – followed by continued monitoring

Managing PSHB infested green waste - Chipping

- It is important to keep infested material covered until such time that it can be processed
- One of the most effective ways to kill a majority of the beetles is to chip the cut logs to a size no greater than 25mm in diameter
  - Kills 93-97% of beetles inside the infested wood
- Chips must be expelled into a tightly closed container - ideally on site
- There are three methods to completely kill all remaining PSHB
  1. Incineration
  2. Solarization
  3. Composting

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Transporting Infested Material

- Movement of infested wood is the main pathway of long distance dispersal of PSHB – so all infested wood must remain tightly closed during transport to prevent dispersal (Integrated Waste Management By-Law)
- Cut logs or chips must be closed in heavy duty bags during transport
- When traveling with infested waste the safest route must be selected to travel – avoiding PA, greenbelts etc.

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1. Incineration

- Chips can be incinerated at a designated incineration facility
  - www.sustainableheating.co.za
  - info@sustainableheating.co.za
- Burning the chips in the open is not advisable as these beetles will fly to surrounding trees
- Burning large pieces of infected wood or using infested wood as firewood will further spread the beetle – not an option
  - Black wattle as a dispersal agent

2. Solarization/Sunning

- Infested wood chips and/or logs are placed in closed clear heavy-duty plastic bags and left in the sun with the goal of suffocating PSHB
  - Summer 6 weeks
  - Winter 6 months
- Solarization is most effective in a large open area that is not surrounded by trees - requires a large area that receives direct sunlight all day
- Those without space there are two drop-off facilities:
  - Gordon's Bay drop off
  - Chukker road sports field Kenwyn/Lansdowne
- PSHB clear biomass is re-used for initiatives like the Carbon Smart Skills Development programme - produce Biomass Insulated Concrete (BIC).

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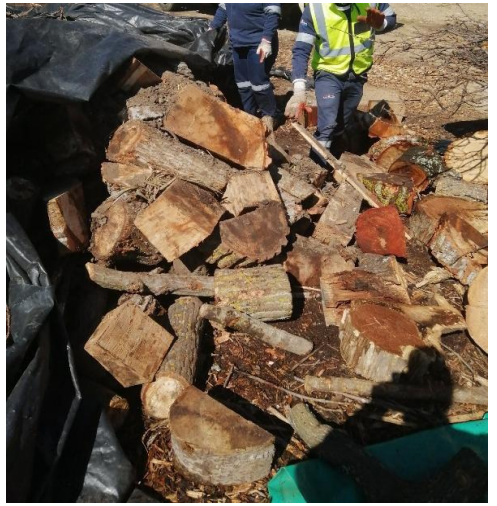
3. Composting

- Composting is an effective method to kill both PSHB and the pathogenic fungus *F. euwallaceae*
  - Only chips can be used for composting
- Important to follow a proper composting protocol to ensure that the composting is effective
  - chipped material must not be bigger than 25mm
  - An equal mixture of green and dry plant material will ensure a carbon-to- nitrogen ratio of 30 to 1
  - Soil, ashes, dairy, meat products and/or manure from meat-eating animals must not be added to the compost pile
  - The compost pile must be at least 1m^3 in volume
  - The internal temperature of the compost pile must be around 70°C within 2 days
  - If the composting is effective - it will give off a pleasant odour, heat Vapour when turned, and white fungal growth on decomposing material
  - Composting is complete once no more heat is generated



Post Tree Cutting/Pruning

- After an infested tree was cut down there could still be PSHB in the stump and roots
- Herbicide must be applied to the stump
- Tree stump must be closed with 150-micron plastic for at least 6 weeks (sunning)

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Sterilization of Tools

- Spores of *F. euwallaceae* can remain on tools that were used to process infested material
- These spores can possibly be transferred to other trees that do not have PSHB in them with the deadly pathogen
- All tools and/or machinery that have come in contact with PSHB infested material must be sterilized after use.
  - 10% solution of bleach will be sufficient

Challenges

- Access to private properties to confirm PSHB presence
- Trees that are half on City property and half on private property – decision to remove or not
- Servitudes with big trees that need removal – risk of damage to property as the space is limiting and the team has to work in very narrow spaces.
- Biomass management – incineration facilities at capacity cannot accept our truck loads.
- Solarisation at drop-off sites – space becomes an issue and wind at GB
- The areas where the contractors have to work are often on busy roads – traffic control is important.

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“What should I do if I think I have found PSHB?”

- If you think that you have found PSHB and/or PSHB symptoms report them immediately to the CCT Invasive Species Unit at Invasive.species@capetown.gov.za or call 021 444 2357.

- If possible, take clear and good quality photographs of the tree symptoms and beetles, if you can find them, and upload them with your report.

What to expect during inspection

- **You make a call or send an email**
- **You will be contacted within 10 days to set an appointment**
- **During the appointment an inspection will be done**
- **After inspection expect an email with our findings and recommendations**
- **Just a reminder this is the team for the whole of the city, so your patience really goes a long way for us.**
- **First come first serve basis**

Worried about the City's Urban Forest Canopy?

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Rec and Parks Tree Planting Strategy

Their ongoing urban forest strategy is as follows:

1. Grow the Urban Forest Through New Planting

2. Protect the urban forest from threats and loss by preserving the City's existing trees

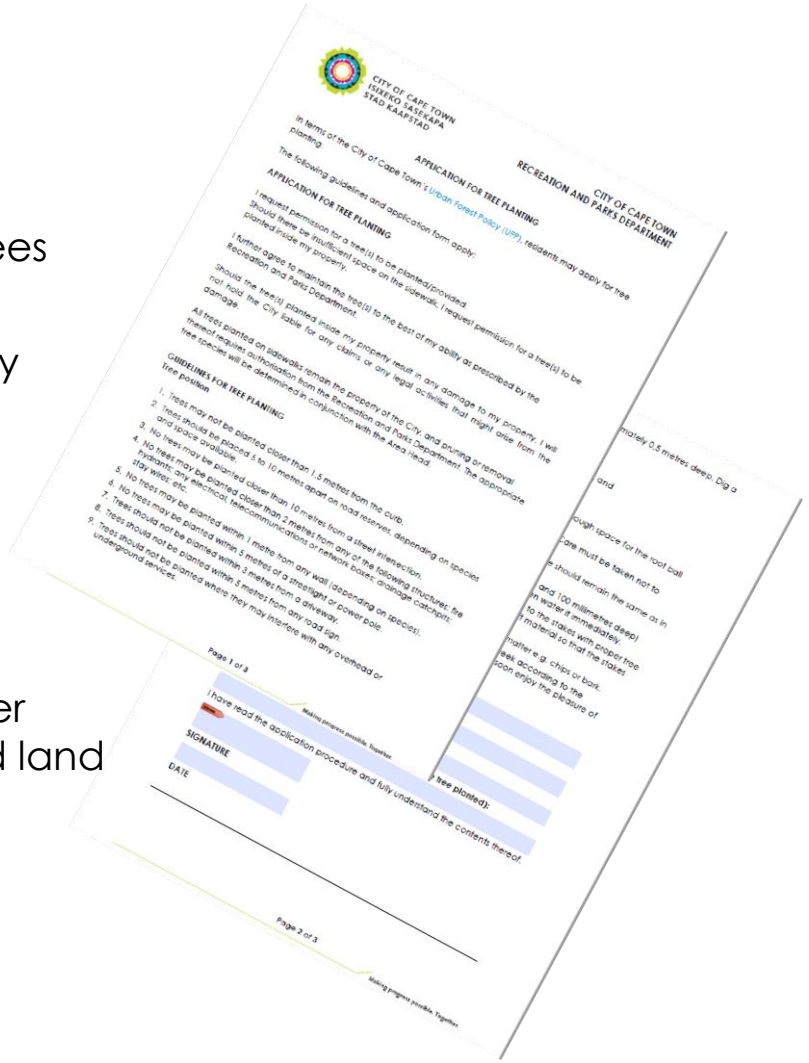
3. Manage, monitor, measure and maintain the urban forest to ensure sustainability

4. Secure Resources

5. Stakeholder Engagements and Awareness campaigns

- **For PSHB losses:** the intention is to replace each tree lost with **at least** one other tree; it may not necessarily be in the same location (This applies to City-owned land only. **R&P** department will focus planting on parks and open spaces).

- Requests for tree planting/replacement may be addressed to: **Arborist@capetown.gov.za**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APPLICATION FOR TREE PLANTING

RECREATION AND PARKS DEPARTMENT

CITY OF CAPE TOWN

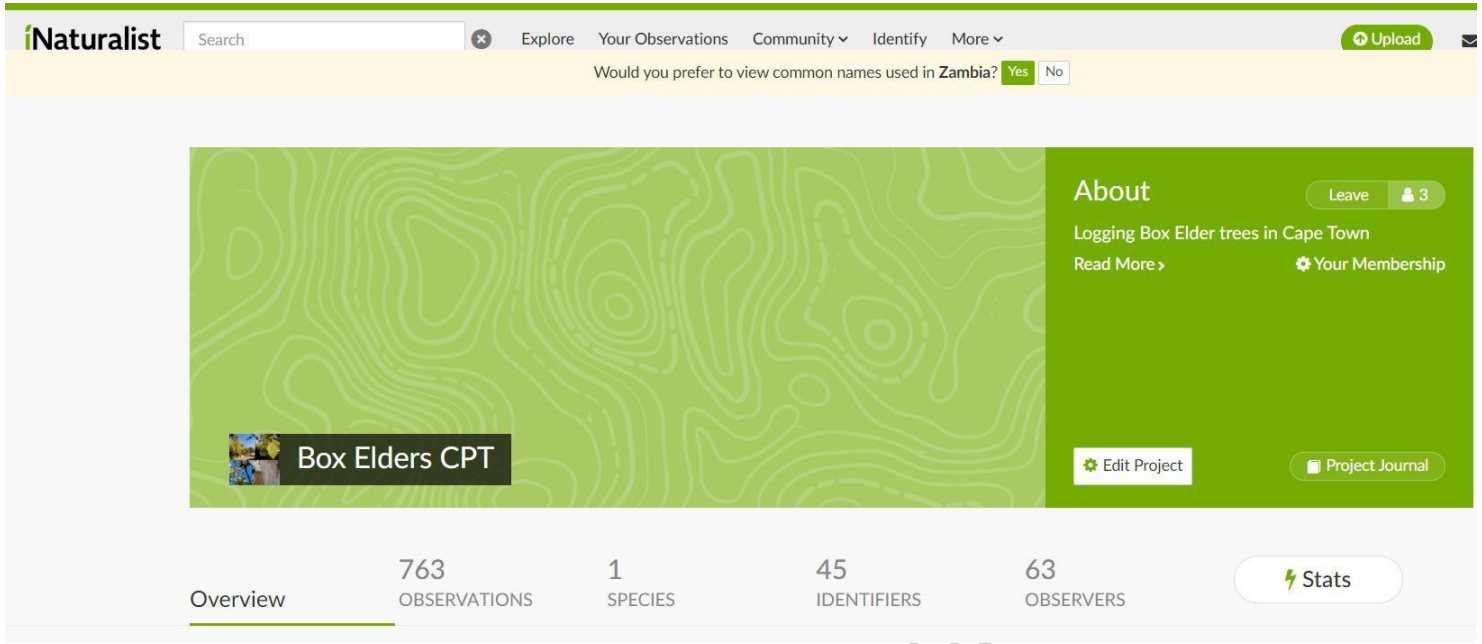
APPLICATION FOR TREE PLANTING

GUIDELINES FOR TREE PLANTING

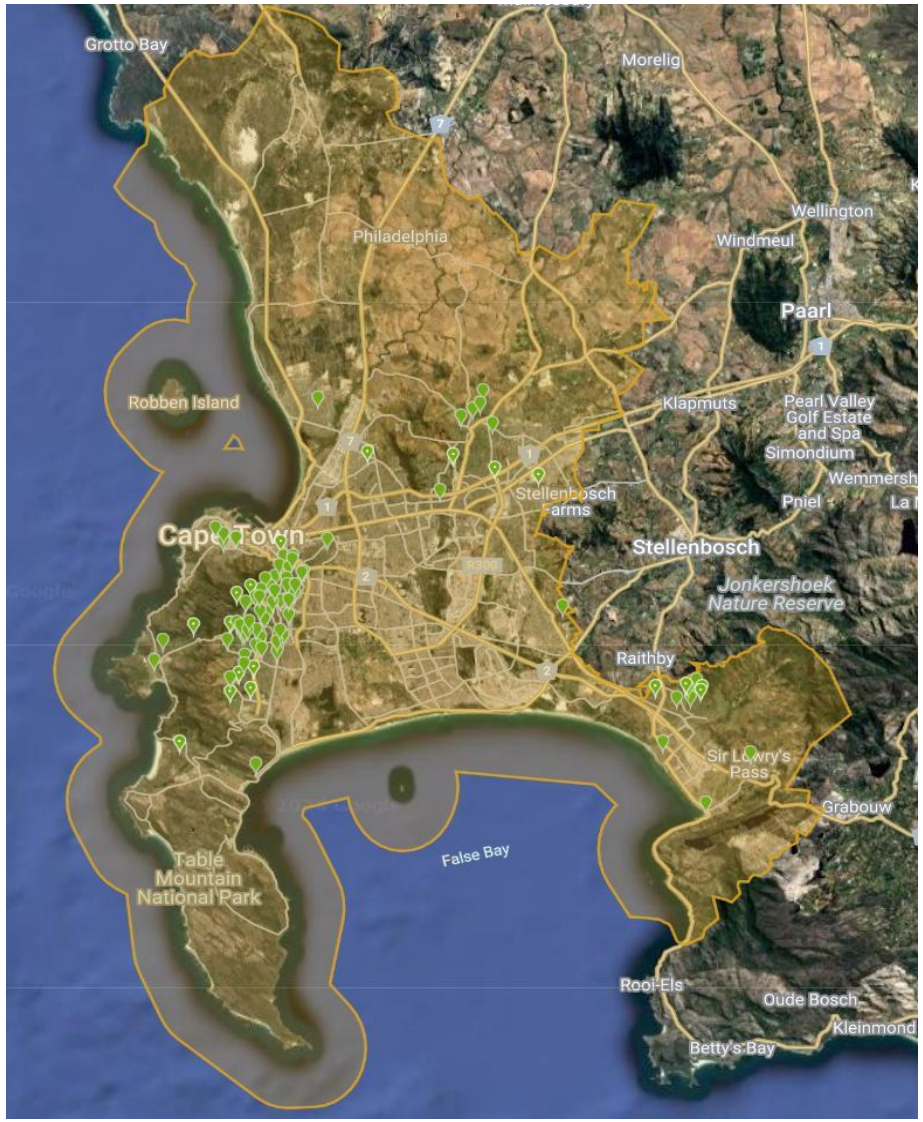
SIGNATURE

DATE

Boxelder sightings campaign



- https://www.inaturalist.org/projects/box-elders-cpt
- Invasive.species@capetown.gov.za
  - ✓ Include photos of the tree and address (GPS Coordinates are recommended)
- www.capetown.gov.za/InvasiveSpecies
  - ✓ Include address (GPS Coordinates are recommended)



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Thank You

Invasive.species@capetown.gov.za

www.capetown.gov.za/InvasiveSpecies

Making progress possible. Together.