GUIDE

Emerald Ash Borer (*Agrilus planipennis*) trapping

IPSN
International Plant Sentinel Network

BOTANIC GARDENS CONSERVATION INTERNATIONAL

Contents:

Emerald Ash Borer Background

The Emerald Ash Borer (EAB), *Agrilus planipennis*, is an exotic beetle pest of ash trees (*Fraxinus* species).

Distribution

The EAB is native to China, Japan, Taiwan, Korea, Mongolia, and the Russian Far East. It was first identified in North America in July 2002, near Detroit, Michigan, and has since become established across vast areas of the United States and Canada. In Eurasia, the EAB has spread westward from Moscow, reaching as far as Ukraine by 2020 (Figure 1), advancing at a rate of up to 41 kilometers (25 miles) per year.

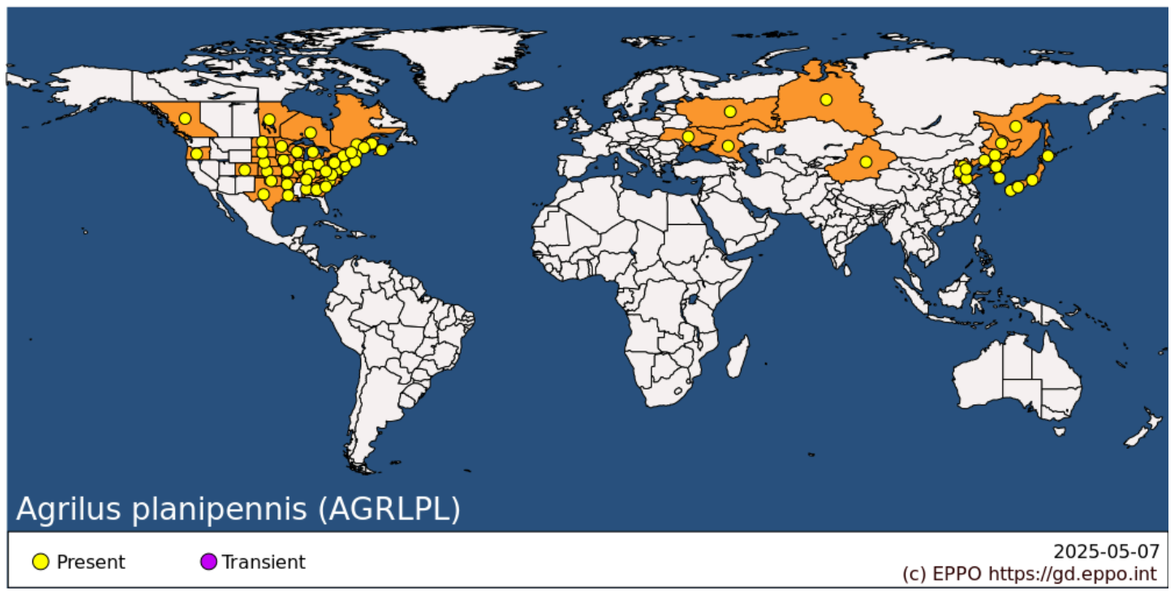

Figure 1. Distribution of the Emerald Ash Borer by 2025. For updated distribution maps: https://gd.eppo.int/taxon/AGRLPL/distribution.

Threats

EAB has been found infesting several North American, Asian and European species of ash, including common ash (*Fraxinus excelsior*) and narrow-leaved ash (*F. angustifolia*).

Infestation is usually fatal to the affected ash trees and, if established, it can do significant damage to woodland biodiversity and hardwood industries. EAB infestation is usually difficult to detect until the symptoms become severe.

Key Symptoms

- Dying branches and dieback of the foliage, typically at the top (crown) (Figure 2).
- Yellowing and thinning foliage (Figure 2).
- Epicormic shoots (foliage sprouting from the trunk) (Figure 3).
- Longitudinal fissures form in the bark, between 5 and 10 cm long, as a result of callus tissue growth induced by the tree's response to larval feeding.
- Woodpecker activity evidence resulting from feeding on the beetles. This presents as holes surrounded by light coloured patches where the bark has been stripped away (Figure 4).
- D-shaped holes in the bark, about 3-4 mm wide, produced by adult beetles as they emerge from the larval stage (Figure 5).
- Characteristic serpentine galleries, often revealed when bark falls or is removed from trees infested for one to two years (Figure 6). They typically meander, bend sharply and are filled with frass (i.e. fine, brown, powdery waste from larval boring activity and excrement).

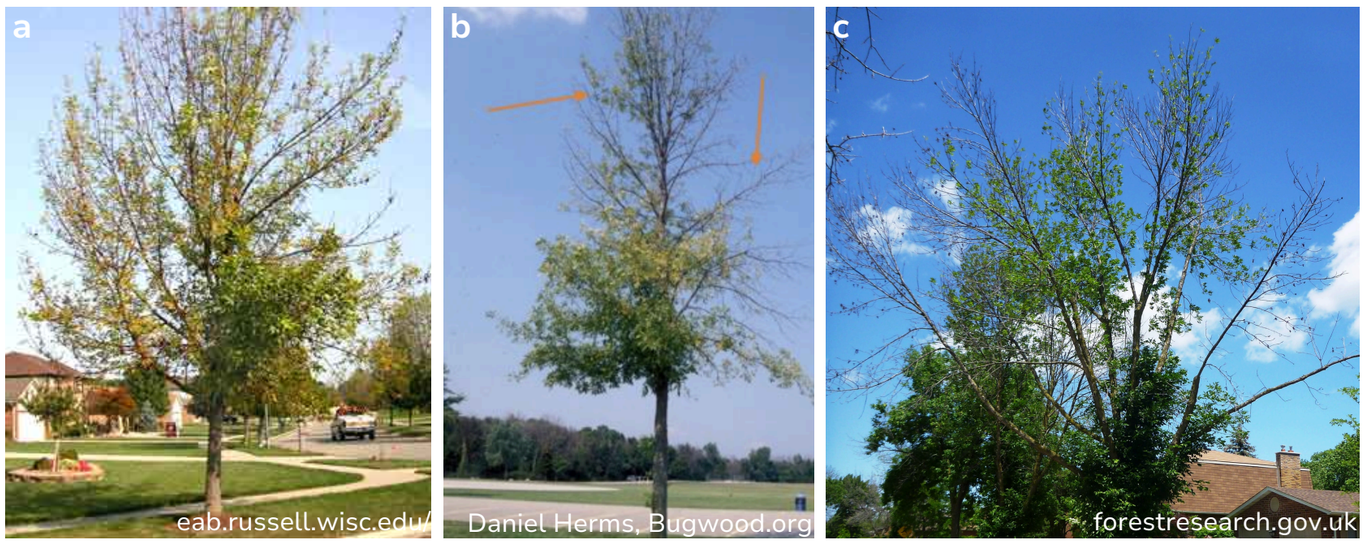

Figure 2. a, b & c) Ash trees showing crown dieback, dying branches and thinning and yellowing of foliage.

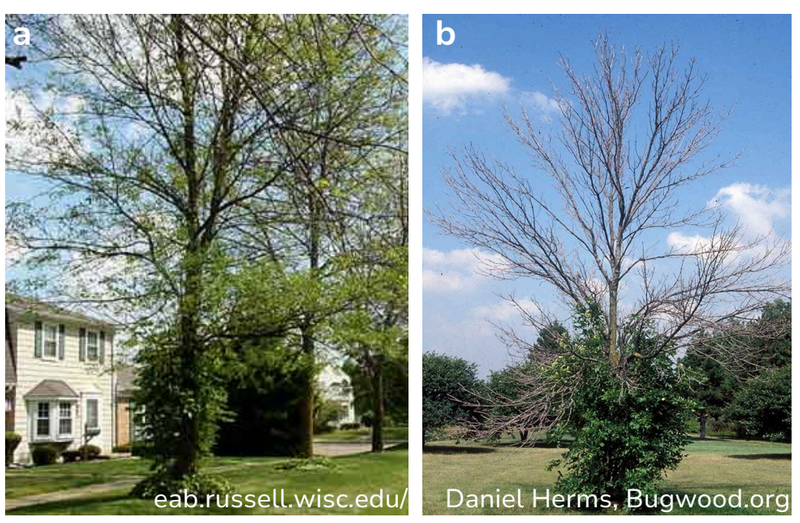

Figure 3. a & b) Ash trees showing epicormic shoots on the trunk.

Figure 4. Woodpecker activity.

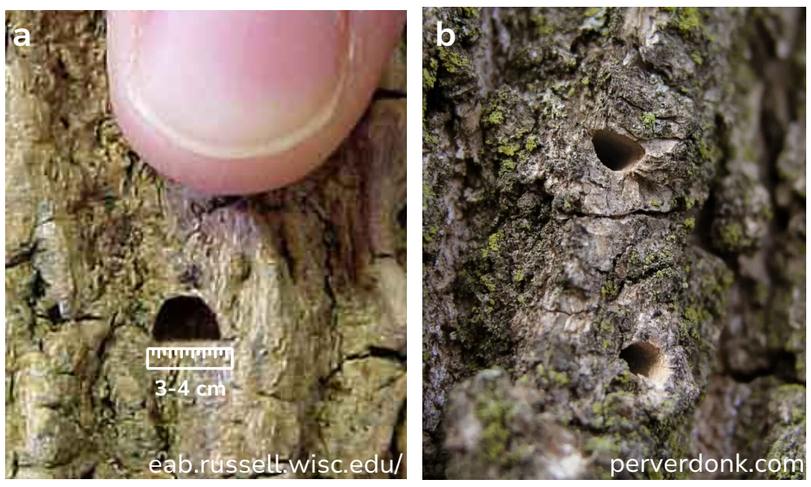

Figure 5. a & b) D-shaped exit holes on the bark.

Figure 6. S shaped galleries underneath the bark.

Life cycle of the Emerald Ash Borer

In eastern North America, adult beetles are typically active from mid-May to the end of June (Figure 7). In regions with a cooler climate, such as European Russia and potentially north-western Europe, many larvae overwinter twice resulting in a life cycle that may extend for two years.

Adult beetles measure 8.5–14 mm in length and 3.1–3.4 mm in width. Their bodies are narrow, elongate, fusiform, and metallic blue-green in color (Figure 8a). Most adults live for about three weeks, during which they feed on ash foliage, chewing small, irregular pieces from the leaf margins. At least a few days of feeding is necessary before the adult beetles mate, and females generally require 1–2 weeks of feeding before they begin laying eggs.

The eggs may be laid on the surface of the bark, within bark cracks and crevices, or just beneath the outer bark of ash trees. After the eggs hatch, the larvae (Figure 8b) bore into the tree and feed on the cambium and outer sapwood. This feeding behaviour creates winding tunnels that disrupt the tree's transport of water and nutrients, effectively girdling branches, or the main stem, and causing dieback above the site of infestation.

The adult beetles emerge in May (possibly later in cooler climates) by chewing an exit hole through the bark. The exit holes produced by *Agrilus* species are D-shaped (i.e. with one flat and one curved side). Those made by *A. planipennis* are relatively large, measuring 3–4 mm in wide.

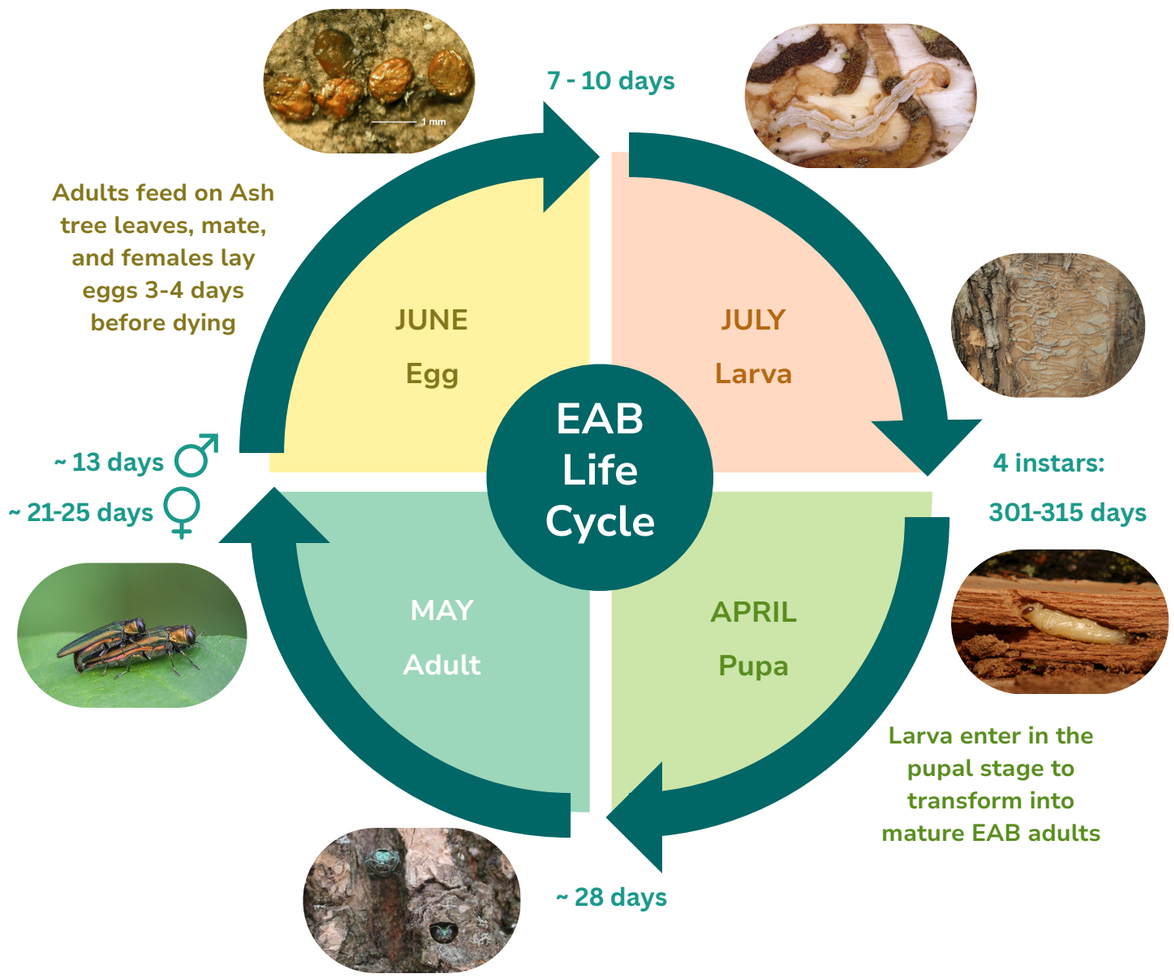

Figure 7. Life cycle of the Emerald Ash Borer.

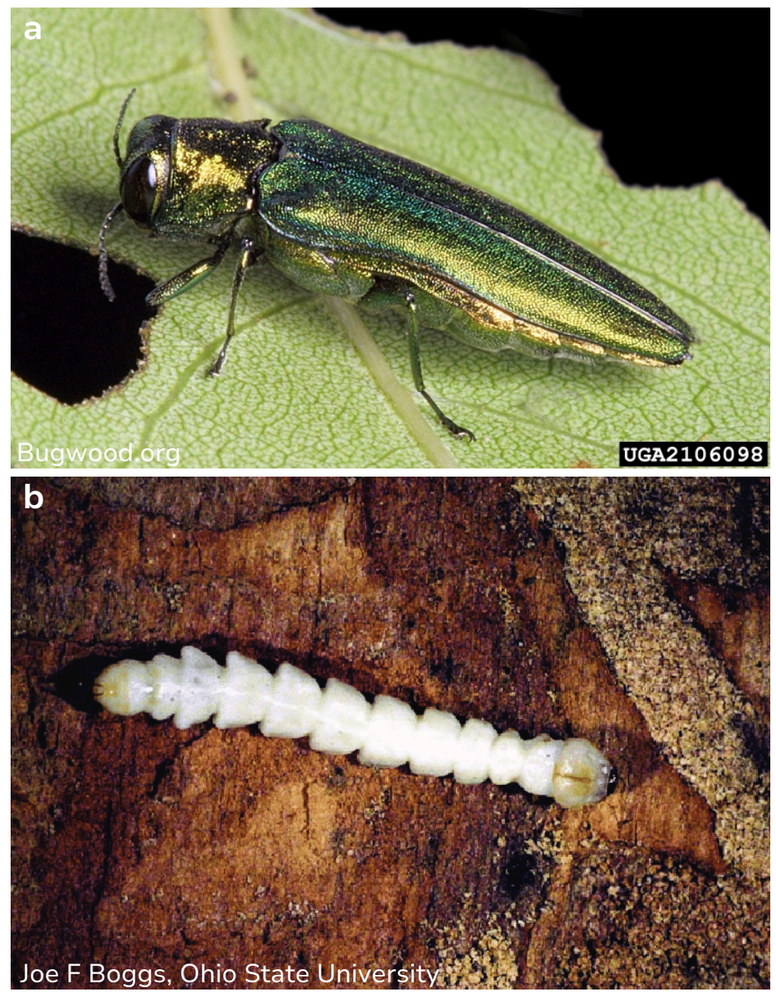

Figure 8. Emerald Ash Borer a) adult and b) larva.

The IPSN Emerald Ash Borer Project

The International Plant Sentinel Network (IPSN) initially received funding from the UK's Department for Environment, Food and Rural Affrairs (DEFRA) for the development of a 3-year pilot project (2021-2024) to combat the threat posed by the EAB. This project allowed us to spearhead preparatory work for monitoring the spread of *Agrilus planipennis* in Eastern Europe.

In spring 2021, visual surveys of Ash trees began in several botanic gardens and arboreta in Eastern Europe for signs of EAB, aiming to track the beetle's spread along the western Russian border. In 2022, the first trapping activities were initiated. Since then, trapping and visual surveillance has been conducted during the spring and summer months across Eastern Europe.

Diagnostic support has been provided by Fera (UK) and national entomologists. With potential positive observations being promptly reported to the relevant National Plant Protection Organization (NPPO).

The information below provides an introduction to EAB trapping methodology.

If you would like to take part in EAB monitoring activities, please contact: lara.salido@bgci.org

Trapping methodology

Traps & Lures

Multi-funnel traps

Lindgren Green Multi-funnel traps and MultiZ traps have been identified as the most appropriate traps to carry out this monitoring work.

Lindgren traps are constructed from 12 or 8 green plastic funnels with a green dome-shaped roof and a plastic collection cup at the bottom. The trap funnels and the roof are held together by black connectors in a twist form. The collection cup is secured at the bottom with a twist-on motion (Figure 9).

The Lindgren traps come pre-assembled and are coated with a special 1:1 Fluon solution, creating a slippery surface that helps capture the EAB.

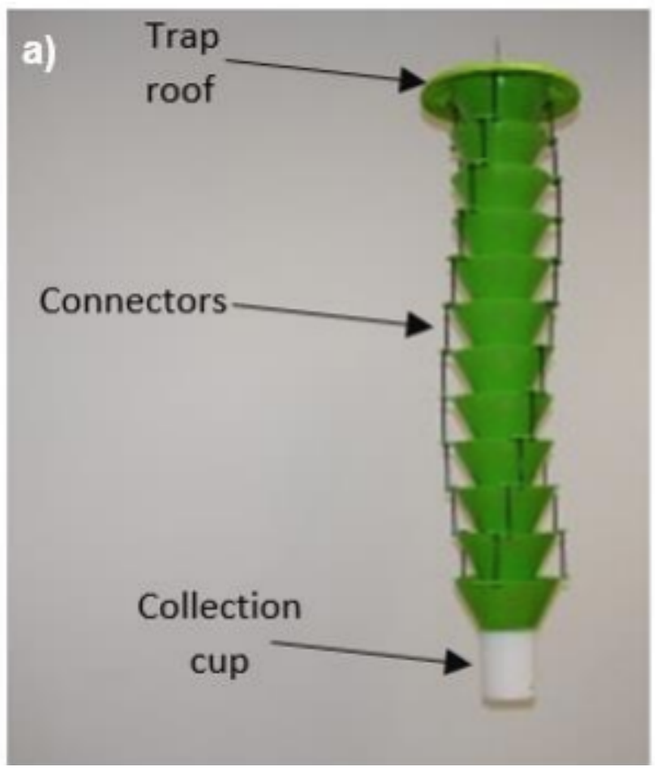

Figure 9. Lindgren green multi-funnel trap.

MultiZ traps consist or 8 plastic funnels arranged in 2 columns back to back with a plastic collection back at the bottom (Figure 10).

The assembling instructions for the MultiZ traps are provided here.

Figure 10. MultiZ trap.

Lures

Lures are essential components of the trapping system. They release volatile compounds, such as pheromones or kairomones, that attract target pests into the trap. For our work with *Agrilus planipennis* (EAB) **the compound used is Z3-6OH ((Z)-3-hexenol)**, a foliage volatile that mimics the scent of green leaves.

Lures are available in two formats (Figure 11): pouches (commonly used with Lindgren traps) and tubes (typically used with MultiZ traps). Note these formats can be interchangeable.

To ensure the trap functions properly, lure pouches or tubes must be attached as described in the instructions (see Page 6). Lures in the traps must be replaced every 3 weeks to keep attraction rates high.

Lure packs should be stored in a cool, dry place, away from sunlight. For long-term storage, refrigeration is recommended as this can preserve their effectiveness for over 12 months.

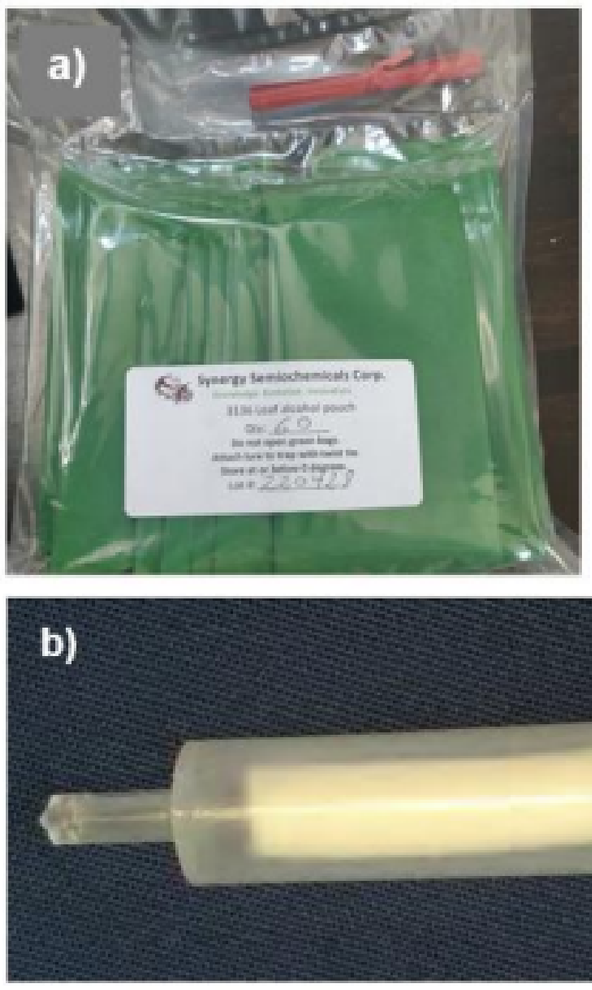

Figure 11. Lures a) in poches, commonly used for Lindgren multi-funnel traps, and b) in tube, commonly used for MultiZ traps (Note that they can be used interchangeably).

Trap installation

1 Setting up the trap

Before hanging the trap, fill the collection cup at the bottom of the trap with 150-200 ml of either 50:50 non-toxic antifreeze (propylene glycol) / water solution OR 50:50 water / wash-up liquid solution. This will help preserve and retain any captured insects.

Then attach a non-toxic lure pack to the trap to attract adult EAB (see Figure 12, for location of the lures in different traps).

Once all components are in place, use the eyelet at the top of the Lindgren trap or the wire hook on the MultiZ trap to securely hang them from a tree branch (Figure 12).

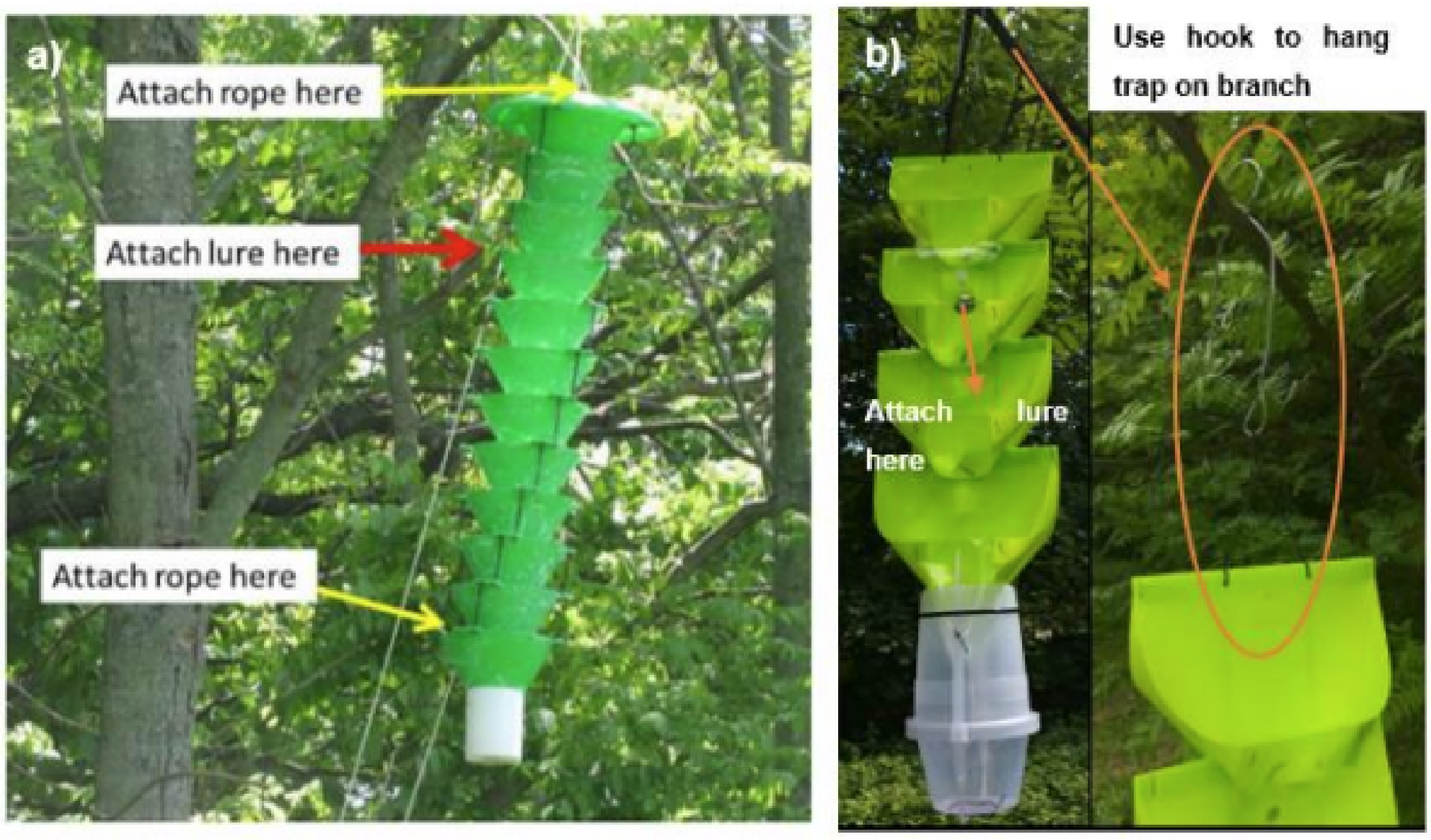

Figure 12. Location of rope attachments and lure within : a) Lindgren multi-funnel traps, b) MultiZ traps.

Figure 13. Addition of mesh-wire to last funnel to void capture of non-target species, e.g. bats.

NOTE: If needed, the las funnel of the traps can be covered with mesh-wire to the avoid capture of non-target species such as bats (FIgure 13).

2 Location of the trap

Trap position is key for increasing the likelihood of early detection of EAB. Both trap height and exposure to sunlight significantly influence capture rates (Ryall et al., 2012). Research has shown that traps positioned high in the canopy of ash trees are more effective. This is because most of the flight and mating activities of *A. planipennis* occurs in the canopy of ash trees, especially in sunny conditions.

For optimal results, traps should be:

- Mounted on trees that are over 20 cm in diameter and taller than 10 meters.
- If trapping takes place within a stand of trees (more than 3 individuals), the largest tree should be selected.
- Positioned on the sunny side of the tree (typically the south/southwest side).
- Installed just below the canopy at the highest accessible point.

3 Hanging the trap

For hanging the traps, look for a sturdy branch at least 5–8 m above the ground - Avoid dead or thin branches, as they may break under the trap’s weight.

Care should be taken when hanging the trap, to ensure the trap is clear from all lower branches so that it can be pulled up and down.

To hang the traps on the selected trees various methods could be used (see page below for instructions).

A) Using a Catapult or Throw Weight:

Use a rope or a line and tie a throw weight (a small weighted bag, around 300–500 gr) securely to one end (Figure 14b). This weight helps the line fly over the branch.

Use a catapult (Figure 14a) to shoot the weighted end of the line over the chosen branch.

Make sure the rope has a clear, unobstructed path to the ground (Figure 16) as the trap may need to be raised and lowered at an angle away from the tree to avoid interference from branches.

Also ensure there is enough slack on the rope so that it can be tied to the branch or an adjacent tree.

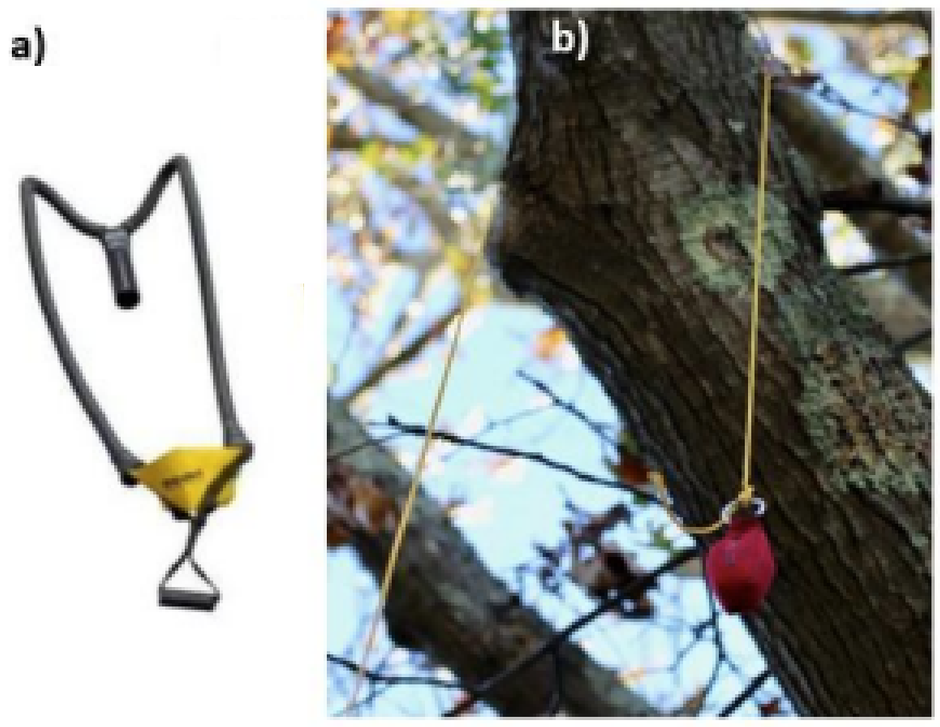

Figure 14. a) catapult and b) throw weight and line.

Figure 15. Telescopic extension pole and hook attachment used to place the multi-funnel traps.

B) With a telescopic pole and hook:

The trap can be hanged using a telescopic pole and hook (Figure 15).

This method might be most suitable for MultiZ traps as they are lighter than Lindgren traps.

Figure 16. Set up of Lindgren multi-funnel traps on Ash trees.

Trap monitoring

Traps should ideally be checked every three weeks. However, inspections may be needed sooner following extreme weather conditions (e.g. strong winds or heavy rain).

During each check, complete the following task:

- Decant the content of the collections cups (see Page 9 for instructions).
- Replace the lures with fresh ones.
- Replace the solution from the collection cup (50:50 water:propylene glycol solution or 50:50 water:wash-up liquid).

Monitoring schedule: should be as close as possible to the one indicated in the trap monitoring forms provided in Annex 2 and copied below:

Trap check-up schedule	Lure Change
2nd week of May – installation of traps	1st Installation
1st week of June	
3rd week of June	2nd
2nd week of July	
1st week of August	3rd
4th week of August	
2nd week of September	4th
1st week of October– end of trapping season	

Before re-hanging the trap, ensure the following:

- Check the trap for any damage.
- Remove any debris obstructing the funnels (e.g., leaves, twigs, spider webs).
- Confirm all connectors and components are securely fastened.
- Verify that the lure has been replaced if due.
- Ensure the collection cup contains the correct amount of solution (150-200 ml).

Important: Record the inspection date on the container (collection jar or plastic zipper bag) that holds the specimens and on the survey form (available in Page 12). This labeling will allow the local entomologist to track and identify catch intervals throughout the survey season.

Beetle specimen collection and identification

Each time traps are inspected (a total of 8 time points), the contents of the collection cups must be decanted, the cups cleaned, and then refilled with fresh solution for the next collection period.

To decant the contents effectively, we recommend using a paper filter (standard coffee filters work well as a low-cost alternative).

⚠ **Safety Note:** When handling propylene glycol or alcohol, always wear appropriate personal protective equipment (e.g. gloves, eye protection).

Sample processing: Follow this steps to process trap contents.

1. Place a filter paper cone or coffee filter over a wide-mouth container, such as a clean yogurt pot or hard plastic glass.

2. Slowly pour the contents of the collection cup (including both solution and insects) into the paper filter (Figure 17).

3. Add a small amount of fresh solution to the collection cup, swirl it gently to loosen any remaining insects or debris, and pour this rinse into the same filter (Figure 18).

4. Carefully fold the paper filter containing the insects (Figure 19) and place it into a zippered plastic bag or screw-top jar.

5. Include a paper towel moistened with 70% alcohol to help preserve the specimens (Figure 20).

6. Label the sample clearly with a pencil. Attach or insert this label into the bag or jar:
   - Date of collection
   - Trap number
   - Tree species
   - Tree accession number
   - Trap location

7. Keep the samples in a cool environment, ideally in a cooler or refrigerator, to prevent degradation before identification.

8. Transport to the designated offices or forward to the collaborating entomologists for processing and identification.

Figure 17. Pouring of collection cup contents through filter cone.

Figure 18. Decanting of specimens.

Figure 19. Folding of paper filter for packing.

Figure 20. Packing of catch using plastic zipper bag and 70% ethanol.

References

- **USDA APHIS PPQ – Emerald Ash Borer Survey Guidelines** (https://www.aphis.usda.gov/plant_health/plant_pest_info/emerald_ash_b/downloads/eab-surveyguidelines.pdf)

- **Attraction of *Agrilus planipennis* (Coleoptera:Buprestidae) to a volatile pheromone: effects of release rate, host volatile and trap placement -** Ryall, K.L et al. (2012) Env. Ent. Soc. America 41(3): 648-656. (http://www.bioone.org/doi/full/10.1603/EN11312)

- **Threats to European trees from the emerald ash borer and bronze birch borer** (2021) (https://cdn.forestresearch.gov.uk/2022/02/prepsys-1.pdf)

- **Trap Designs, Colors, and Lures for Emerald Ash Borer Detection** (2019) (https://www.frontiersin.org/articles/10.3389/ffgc.2019.00080/full)

- **Exotic Wood Borer/Bark Beetle Survey Reference** (2014) (http://download.ceris.purdue.edu/file/3290)

ID RESOURCES

- **IPSN Agrilus spp beetles poster:** https://www.bgci.org/wp/wp-content/uploads/2023/04/IPSN-Agrilus_beetles_poster_final.pdf

- **An illustrated guide to distinguish Emerald Ash Borer (Agrilus planipennis) from its congeners in Europe** – Volkovitsh et al. (2020) Forestry 93: 316-325: https://doi.org/10.1093/forestry/cpz024

- **Emerald Ash Borer –look a likes chart:** https://nda.nebraska.gov/plant/entomology/eab/EAB-Look-Alikes-Chart-June2016.pdf

EQUIPMENT LIST:
Emerald Ash Borer trapping

- Green multiple funnel/ MultiZ traps
- Lures (4 per trap)
- Wire or string to hang lures to traps
- Rope (20 – 30 metres/trap)
- Mobile Elevating Working Platform (MEWP)/ ladder/ telescopic pole/ fishing pole or catapult for setting ropes for traps
- Throw weight
- 40% Propylene glycol/wash-up liquid:water mix (Approx. 6L)
- Alcohol
- Paper filters
- Jars/zip-plastic bags for beetle specimens' collection
- Forceps for insect handling
- Brush/cloth to clean trap

Monitoring Form:

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The threat: Emerald Ash Borer (*Agrilus planipennis*) is a wood-boring beetle native to East Asia which is currently causing significant damage to ash trees (*Fraxinus* spp.) in the USA and Canada with an estimated 100 million tree deaths being attributed to the pest. This has resulted in serious economic damage, and there is concern for the survival of several ash species and the associated biodiversity. The beetle has been recorded in Moscow, Russia and more recently in Ukraine, leading to serious concerns that it could spread rapidly to the rest of Europe. Infestation by Emerald Ash Borer beetles is usually fatal to affected ash trees and in Europe could pose as an additional threat to ash trees that are already under threat from Ash Dieback.

The IPSN is therefore conducting a trapping exercise to monitor the spread of Emerald Ash Borer in botanic gardens in eastern European countries. We would be most grateful if you could set up funnel traps on the *Fraxinus spp.* in your collection and report any findings related to jewel bettles (Fam. Buprestidae) and in particular Emerald Ash Borer (*Agrilus planipennis*). Please use one form per tree and refer to the accompanying trapping guidelines for further details on sample collection and identification.

Survey Details	
Name of Botanic Garden / Arboretum:	
Country:	
Address:	
Survey carried out by:	
Date of survey:	
Best description of season:	
Trapping schedule check point:	

Tree Details	
Species (cultivar)	
Accession number:	
GPS	
Country/region species is native to:	
Age (years):	

General Description of Health			
Generally healthy	✓	Some damage	✓
Dying	✓	Dead	✓

Any recent changes in health or overall look:

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Trap check-up schedule	Lure Change	Check-up details	
2nd half of May	1st Installation	**Installation of traps on selected trees**	
1st week of June		**Beetles found?** (i.e. Coleoptera)	**Yes / No**
		Number of jewel bettles found (i.e. Buprestidae family)? If yes, please specify number of individuals and genus if possible	
		Presence of EAB (*Agrilus planipennis*)	**Yes / No**
		Specimen ID confirmed by local enthomologist. If yes please specify contact name for verification.	
		Please attach a picture of any significant specimens found. Please ensure these are coded accordingly to facilitate cross-check (i.e.write picture name/reference in the box).	

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Trap check-up schedule	Lure Change	Check-up details	
3rd week of June	2nd	**Beetles found?** (i.e. Coleoptera)	**Yes / No**
		Number of jewel bettles found (i.e. Buprestidae family)? If yes, please specify number of individuals and genus if possible	
		Presence of EAB (*Agrilus planipennis*)	**Yes / No**
		Specimen ID confirmed by local enthomologist. If yes please specify contact name for verification.	
		Please attach a picture of any significant specimens found. Please ensure these are coded accordingly to facilitate cross-check (i.e.write picture name/reference in the box).	
2nd week of July		**Beetles found?** (i.e. Coleoptera)	**Yes / No**
		Number of jewel bettles found (i.e. Buprestidae family)? If yes, please specify number of individuals and genus if possible	
		Presence of EAB (*Agrilus planipennis*)	**Yes / No**
		Specimen ID confirmed by local enthomologist. If yes please specify contact name for verification.	
		Please attach a picture of any significant specimens found. Please ensure these are coded accordingly to facilitate cross-check (i.e.write picture name/reference in the box).	

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Trap check-up schedule	Lure Change	Check-up details	
1st week of August	3rd	**Beetles found?** (i.e. Coleoptera)	**Yes / No**
		Number of jewel bettles found (i.e. Buprestidae family)? If yes, please specify number of individuals and genus if possible	
		Presence of EAB (*Agrilus planipennis*)	**Yes / No**
		Specimen ID confirmed by local enthomologist. If yes please specify contact name for verification.	
		Please attach a picture of any significant specimens found. Please ensure these are coded accordingly to facilitate cross-check (i.e.write picture name/reference in the box).	
4th week of August		**Beetles found?** (i.e. Coleoptera)	**Yes / No**
		Number of jewel bettles found (i.e. Buprestidae family)? If yes, please specify number of individuals and genus if possible	
		Presence of EAB (*Agrilus planipennis*)	**Yes / No**
		Specimen ID confirmed by local enthomologist. If yes please specify contact name for verification.	
		Please attach a picture of any significant specimens found. Please ensure these are coded accordingly to facilitate cross-check (i.e.write picture name/reference in the box).	

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Trap check-up schedule	Lure Change	Check-up details	
2nd week of September	4rd	**Beetles found?** (i.e. Coleoptera)	**Yes / No**
		Number of jewel bettles found (i.e. Buprestidae family)? If yes, please specify number of individuals and genus if possible	
		Presence of EAB (*Agrilus planipennis*)	**Yes / No**
		Specimen ID confirmed by local enthomologist. If yes please specify contact name for verification.	
		Please attach a picture of any significant specimens found. Please ensure these are coded accordingly to facilitate cross-check (i.e.write picture name/reference in the box).	
1st week of October	**End of trapping season**	**Beetles found?** (i.e. Coleoptera)	**Yes / No**
		Number of jewel bettles found (i.e. Buprestidae family)? If yes, please specify number of individuals and genus if possible	
		Presence of EAB (*Agrilus planipennis*) Y/N	**Yes / No**
		Specimen ID confirmed by local enthomologist. If yes please specify contact name for verification.	
		Please attach a picture of any significant specimens found. Please ensure these are coded accordingly to facilitate cross-check (i.e.write picture name/reference in the box).	

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