Emerald Ash Borer Trapping Guide

IPSN
International Plant Sentinel Network

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Contents

EMERALD ASH BORER TRAPPING GUIDE

Background

The emerald ash borer (EAB), *Agrilus planipennis*, is an exotic beetle pest of ash trees (*Fraxinus* species).

The EAB is native to China, Japan, Taiwan, Korea, Mongolia and the Russian Far East. In July 2002 it was identified in the USA (Detroit) and it is now established across many thousands of squares miles of the USA and Canada. It has also spread westwards across the Eurasian landmass from Moscow as far west as Ukraine (2020) at a rate of up to 41 kilometres (25 miles) a year.

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 could do significant damage to woodland biodiversity and hardwood industries. EAB infestation is usually difficult to detect until the symptoms become severe.

Indicators to look for include:

- Dying branches and dieback of the foliage, typically from the top (crown) down (figure 1a).
- Yellowing and thinning foliage
- Longitudinal fissures between 5 and 10 cms long in the bark, caused by the growth of callus tissue produced by the tree in response to feeding by the larvae (the life stage which lives within the tree).

- Epicormic shoots (foliage sprouting from the trunk) (figure 1b)
- Woodpecker activity
- D-shaped holes in the bark, about 3mm wide, produced by adult beetles as they emerge from the larval stage (figure 1c);
- Characteristic serpentine galleries, which can be exposed when pieces of bark fall or are cut from damaged trees which have been infested for one or two years (figure 1d). Typically EAB galleries meander, bend sharply, and are packed with frass (the fine brown powdery refuse produced by the boring activity and the excrement of the larvae).

Figure 1. Symptoms of EAB infestation: a) branch and dieback on top crown (Daniel Herms, The Ohio State University, Bugwood.com), b) epicormic growth on ash tree (Edward Czerwinski, Ontario Ministry of Natural Resources, Bugwood.org), c) D-shaped holes on bark (Michigan State University), d) serpentine galleries (Christopher Asaro, Virginia Department of Forestry, Bugwood.org

1. Life cycle – Emerald Ash Borer

In eastern North America, the adult beetles are active from mid-May through to the end of June. In regions with a cooler climate, such as European Russia and potentially north-western Europe, many larvae overwinter twice and the life-cycle may take two years.

The adults are 8.5-14mm long and 3.1-3.4mm wide. The body is narrow and elongate, fusiform and metallic blue-green (see figure 2 for adult image). Most live for about three weeks, feeding on ash foliage and chewing out small, irregularly shaped pieces from around the margins of the leaves. At least a few days of feeding are required before the adult beetles mate, and 1–2 weeks of feeding can be required before the females begin to lay eggs. The eggs may be laid on the surface of the bark, in bark cracks and crevices or just under the outer bark of ash trees. After the eggs hatch, the larvae tunnel beneath the bark of ash trees and feed on the cambium and outer sapwood (see figure 2 for larvae image and figure 3 for full life cycle). The tunnels disrupt the transport of water and nutrients, and effectively girdle the branches and stem, which then die above this area of infestation.

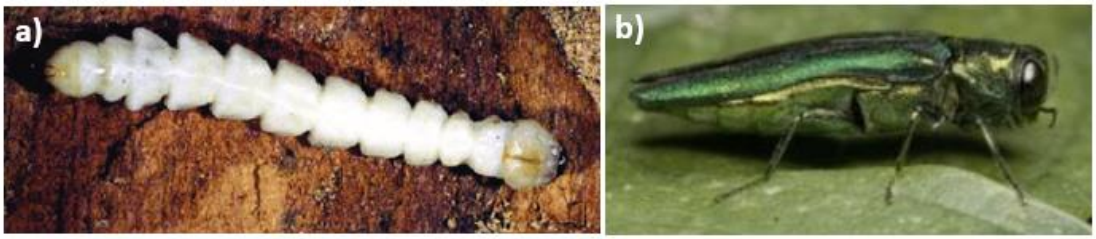

Figure 2. Emerald ash borer a) larvae and b) adult (images from Bugwood.org)

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 produced by *A. planipennis* are relatively large and 3–4mm wide (see Figure 3 below).

Figure 3. EAB Life-cycle (images obtained from Bugwood.org)

2. The IPSN-EAB project

During 2021, a number of botanic gardens and arboreta in Eastern Europe have been visually surveying the Ash trees in their collections for signs of EAB, to monitor the spread of the beetle along the Western Russian border.

As the next step in the project, selected gardens will use more sensitive detection methods (trapping) in their EAB monitoring work. Training and tools for trapping will be provided to collaborating gardens, with training workshops taking place during the late spring/early summer of 2022.

The information below provides an introduction to EAB trapping methodology.

Trapping

Trapping normally takes place during late-spring early summer (late May-June), to coincide with the emergence of the adult beetles.

1. Multi-funnel traps

Lindgren Green Multi-funnel traps and MultiZ traps have been selected 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 (see Figure 4a).

MultiZ traps consist or 8 plastic funnels arranged in 2 columns back to back with a plastic collection back at the bottom (See Figure 4b).

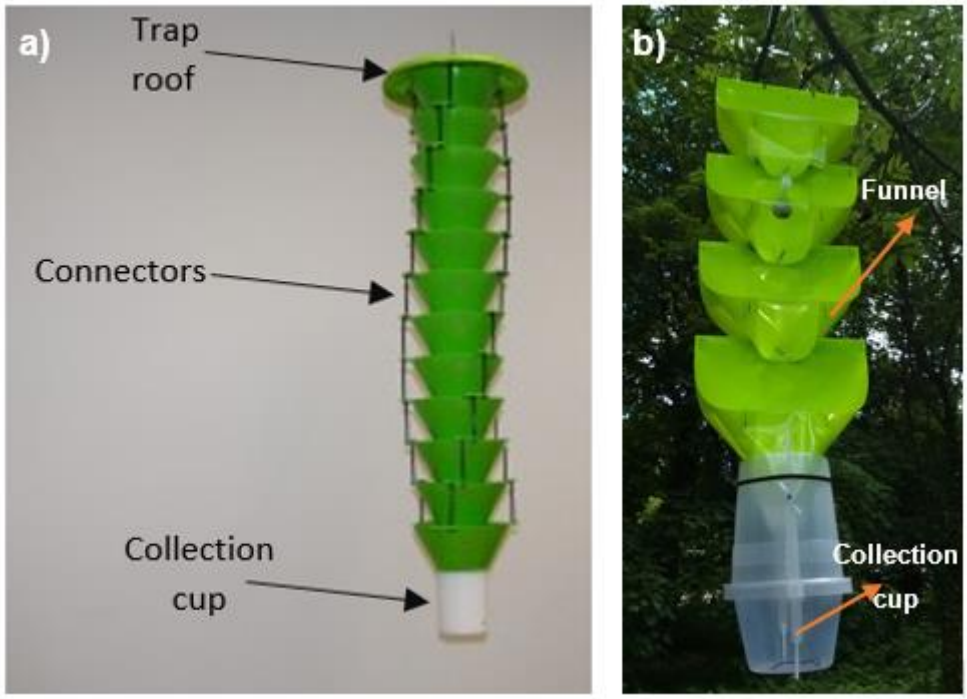

Figure 4. a) Lindgren green multi-funnel trap b) MultiZ trap

The Lindgren traps are pre-assembled and pre-coated in a 1:1 solution of Fluon that provides a slippery surface that assists with the capture of EAB. The assembling instructions for the MultiZ traps are provided in the reference section.

An eye at the top of both the Lindgren and a wire hook in MultiZ traps should be used to hang the traps on the tree branches. Each trap should also be set with a non-toxic lure pack to attract EAB adults to them (see next section for more information on the lures). The collection cups at the bottom of the trap should be filled with a 40% dilution of propylene glycol or a mixture of water and wash-up liquid (approximately 200ml) to help preserve and retain any captured insects (see Figure 5 for location of different component/anchors in the traps).

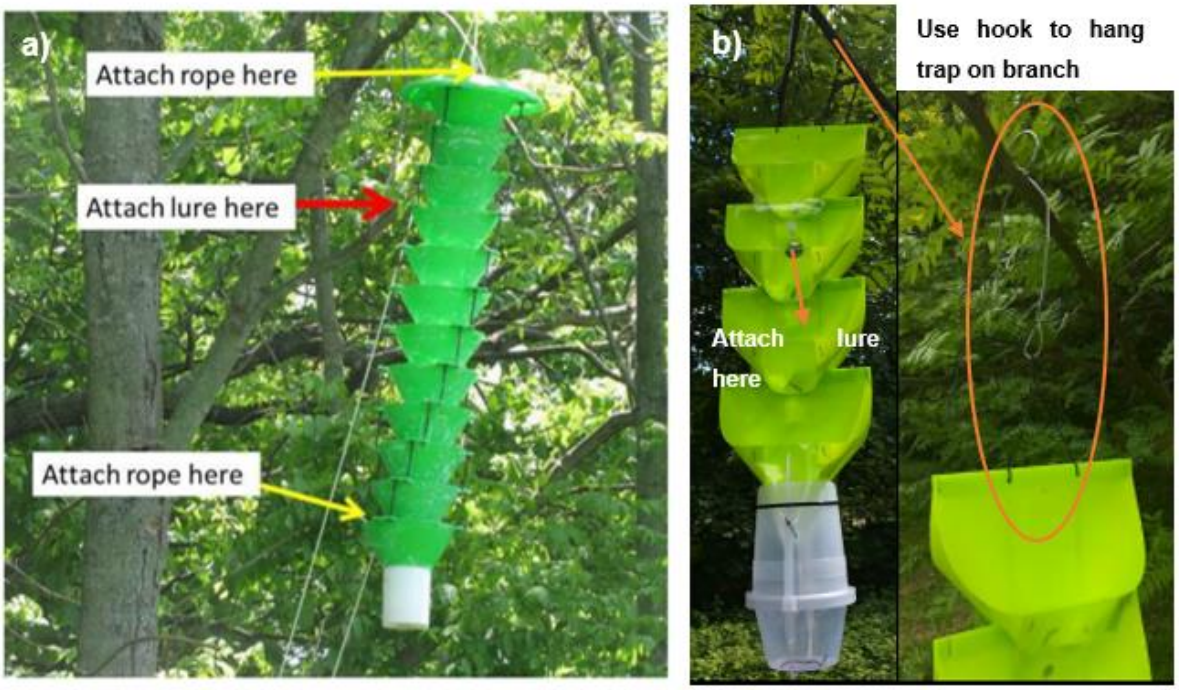

Figure 5. Location of rope attachments and lure within: a) Lindgren multi-funnel traps, b) MultiZ traps

Trap location

Trap position is key in improving the chances of early detection of EAB with height and exposure to sunlight being important factors in influencing trap captures (Ryall et al. 2012). Traps should be hung at the highest point accessible just below the canopy as it has been reported that traps placed high in the canopy of ash trees catch more. This is because most of the flight and mating activities of *A. planipennis* has been shown to occur in the canopy of ash trees and in the sunshine (Ryall et al, 2012).

Hence, ideally traps would be:

- Mounted on trees that are over 20cm in diameter and over 10metres high.
- If trapping takes place within a stand of trees (more than 3 individuals), the largest tree should be selected.
- Placed on the sunny side of the tree (typically south/southwest).

Trap installation

To install the traps on the selected trees there are various methods that could be used.

1) With a catapult/throw weight: A rope/line should be thrown over a branch a minimum of 5-8 m above the ground. The branch should be alive and sturdy, as smaller or dead branches could snap under the weight of the trap. A throw weight (300-500gr) can be tied to one end of the rope (see Figure 6) and once the suitable branch has been identified, the line can be set using a catapult (see figures 6a/b).

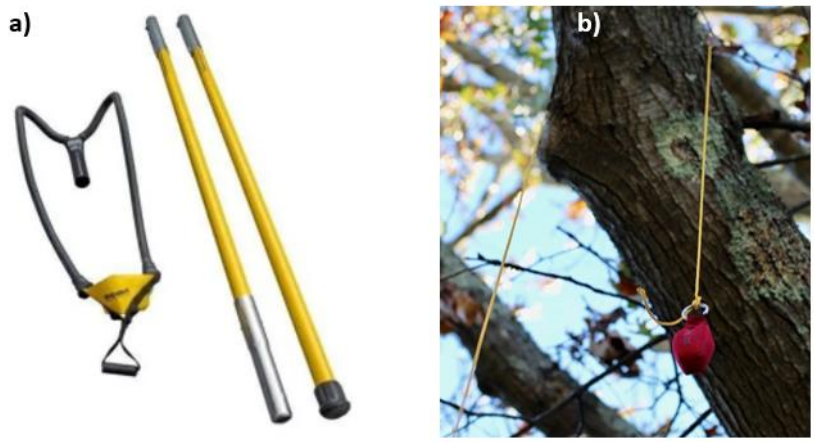

Figure 6. a) catapult and b) throw weight and line

Care should be taken when setting the line on the branch, to ensure the line/rope is clear from all lower branches so that the trap can be pulled up and down. The rope should, as well, have a clear path to the ground as the trap may need to be raised and lowered at an angle from the tree so it can be manipulated without the interference of branches. Also ensure there is enough slack on the rope so that it can be tied to the branch or an adjacent tree (Figure 7).

Figure 7. Set up of Lindgren multi-funnel traps

2) With a telescopic pole and hook: After selecting the most suitable branch on the tree, the trap can be hanged using a telescopic pole/hook (this might be most suitable for MultiZ traps as they are lighter than Lindgren traps).

Figure 8. Telescopic extension pole and hook attachment used to place the multi-funnel traps

Remember to fill the collecting cup with about 150ml of either 50:50 non-toxic antifreeze (propylene glycol)/water solution or 50:50 water/wash-up liquid solution BEFORE attaching it to the trap and make sure to replace the solution every time the trap is checked. Also note chicken wire can be added at the bottom of the trap (before the collection cup to avoid bats falling in.

2. Lures

Lures are components of the trapping system that use volatile compounds (pheromones or kairomones) to attract pests into the trap. For our work with *Agrilus planipennis* the compound is Z3-6OH ((Z)-3-hexenol) which is a foliage volatile corresponding to the scent of green leaves.

The lure pouches/tubes should attached to the trap (as showed in the previous section) for the trap to be fully functional (see the lure pouches for Lindgren traps and tubes for MultiZ traps for reference in Fig 9 below, note they can be used interchangeably).

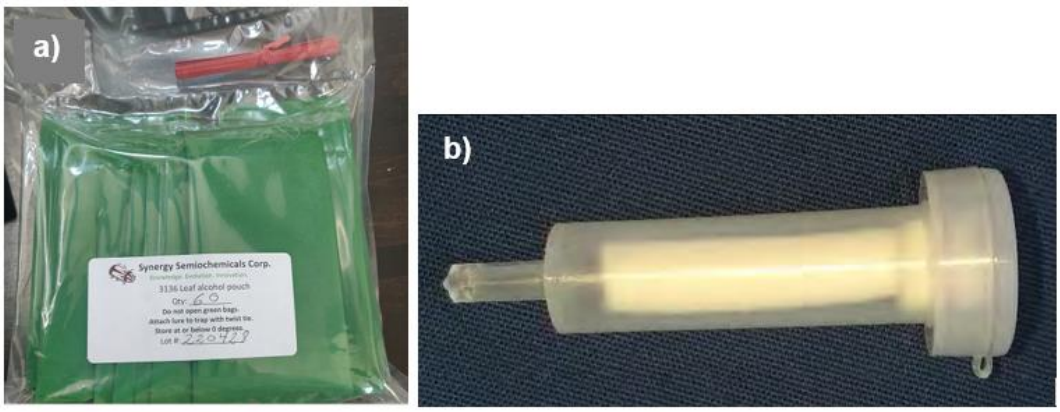

Figure 9. Lures for a) Lindgren multi-funnel traps and b) MultiZ traps

Lures in the traps must be replaced every 2 weeks to keep attraction rates high.

Lure packs should be stored in a cool, dry place, away from sunlight. Ideally, for conservation of lures for longer periods of time it is recommended to refrigerate the product, in which case they can be effective for over 12 months.

3. Traps monitoring schedule and forms

Traps should be ideally checked every third week (or if there has been extreme weather conditions, e.g. strong winds/heavy rain…) to decant the content of the collection cups, ensure specimens do not degrade and refresh both the lures and the cups with fresh bait and solution respectively.

The 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 2023	Lure Change
2nd week of May 2023 (w/c 8th May) – installation of traps	1st Installation
1st week of June 2023 (w/c 29th May)	
3rd week of June 2023 (w/c 19th June)	2nd
2nd week of July 2023 (w/c 10th July)	
1st week of August 2022 (w/c 31st July)	3rd
4th week of August 2022 (w/c 21st Aug)	
2nd week of September 2023 (w/c 11th Sep)	4th
1st week of October 2023 (w/c 2nd Oct) – end of trapping season	

Make sure that before you hang the trap back after inspection you:

- Examine the trap for damage.
- Remove any debris that might be blocking the funnels (e.g. leaves, twigs, spider webs, etc.).
- all connectors in the trap are securely locked in place. Ensure you have changed the lure if it's due.
- Ensure the collection cups have appropriate levels of solution (50:50 water: propylene glycol solution or 50:50 water:wash-up liquid).

It is important to also write this date down in your collection jars/ plastic zipper bags with the specimens so that different catches can be identified by the local entomologist throughout the survey season.

4. Beetle specimen collection and Identification

Every time the traps are inspected (8 time points in total), the contents of the collection cups should be decanted into screw-top jars or plastic bags and the collection cups cleaned and refilled for the next collection period.

To best decant the contents we recommend using a paper filter (coffee filters can also be a good low cost substitute). Please ensure you are wearing adequate protective equipment if handling propylene glycol /alcohol.

The following steps should be followed to process the catches to be taken to the offices or send to the collaborating entomologists for processing and identification:

1) Place a paper cone paper strainer over a wide mouth container (e.g. plastic yogurt container or similar).
2) Pour the contents of the collection cup (collecting solution and specimens) through the filter situated over the cup (Fig 10a).
3) Add some more fresh solution to the collection cup to remove all small insects and debris and pour the remaining insects into the paper filter (Fig 10b).

4) Fold the paper filter carefully and place in a zippered plastic bag/screw-top jar containing a paper towel wetted with 70% alcohol to help preserve the specimens until they are sort out in the lab (Figs 10c/d).
5) Use a pencil to write a label with the key information (i.e. date, trap number, *Fraxinus* species where the trap was set up, etc…) and stick it to the sample bag/jar.
6) Place samples in a cooler/fridge so that they do not degrade before identification.

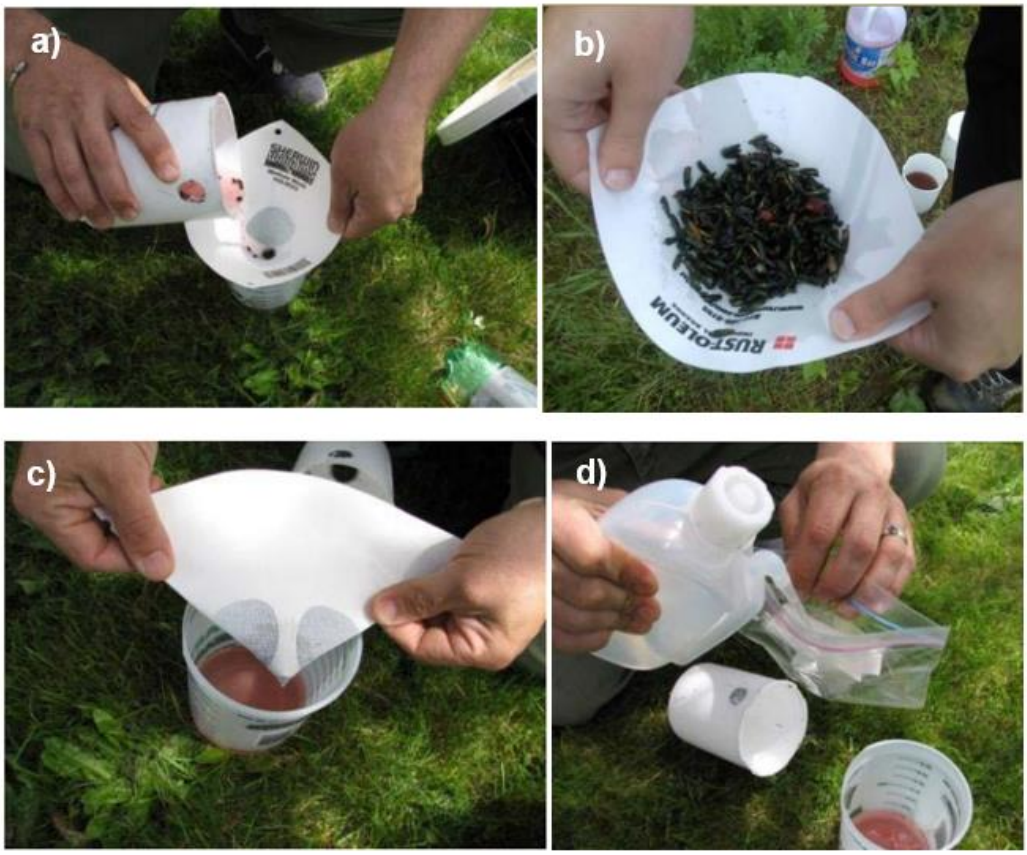

Figure 10. Steps in processing catches from multi-funnel traps using paper filters a) pouring of collection cup contents through filter cone, b) decanting of specimens, c) folding of paper filter for packing d) packing of catch using plastic zipper bag and 70% ethanol (from Exotic wood borer/bark beetle survey reference 2014 Manual).

When pouring the contents of the collection cups, ensure the jars/zipper bags where the specimens are being transported are labelled appropriately (i.e. Trap location, tree species, date).

References

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

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

- Assembly instructions for MultiZ traps : http://www.csalomontraps.com/6trapdesigns/osszerakasipdfek/multzassembling.pdf

- 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

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

ANNEX 1

EAB TRAPPING - EQUIPMENT LIST

- Green multiple funnel/ MultiZ traps (3 in total)
- 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

ANNEX 2

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:			

Trap check-up schedule 2023	Lure Change	Check-up details	
2nd week of May 2023 (w/c 8th May)	1st Installation	**Installation of traps on selected trees**	
1st week of June 2023 (w/c 29th May)		**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).	

Trap check-up schedule 2023	Lure Change	Check-up details	
3rd week of June 2023 (w/c 19th 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 2023 (w/c 10th 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).	

Trap check-up schedule 2023	Lure Change	Check-up details	
1st week of August 2022 (w/c 31st July)	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 2022 (w/c 21st Aug)		**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).	

Trap check-up schedule 2023	Lure Change	Check-up details	
2nd week of September 2023 (w/c 11th Sep)	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 2023 (w/c 2nd Oct)	**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).	