EUROPEAN AND MEDITERRANEAN PLANT PROTECTION ORGANIZATION
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POUR LA PROTECTION DES PLANTES

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PM 9/14 (1)

National regulatory control systems
Systèmes de lutte nationaux réglementaires

Agrilus planipennis: procedures for official control

Specific scope
This standard describes the procedures for official control with the aim of containing and eradicating *Agrilus planipennis*.

Specific approval and amendment
First approved in 201X-09.

Introduction
Agrilus planipennis (EPPO Code: AGRLPL), the emerald ash borer, is on the EPPO A2 List of pests recommended for regulation. Details about its biology, distribution and economic impact can be found in the EPPO datasheet (EPPO, 2005) and in the Pest Risk Analysis (PRA) for this pest (EPPO, 2013). Hosts of *A. planipennis* include *Fraxinus americana, F. chinensis, F. excelsior, F. japonica, F. mandshurica, F. nigra, F. pennsylvanica, F. profunda, F. quadrangulata, F. rhynchophylla. A. planipennis* has also been reported on *Juglans mandshurica, Pterocarya rhoifolia, Ulmus davidiana* and *U. propinqua* in Japan only (Haack *et al.,* 2002; Baranchikov *et al.,* 2008). In China, Russia and North America only *Fraxinus* spp. are reported as hosts for *A. planipennis* therefore the present Standard focus on *Fraxinus* spp. Recent studies (Rebek, Herms & Smitley, 2008) have shown that *Fraxinus americana, F. excelsior, F. nigra, F. pennsylvanica* and *F. quadrangulata* are the most susceptible hosts. *F. mandshurica* and *F. chinensis* are the least susceptible. Its area of origin includes North-Eastern China, Democratic People's Republic of Korea, Japan, Republic of Korea, Russian Far East and Taiwan (Jendek, 1994; Haack *et al.,* 2002). As a non-indigenous species, *A. planipennis* was first detected in the USA in 2002 in Michigan. It subsequently spread to Ontario and Quebec (Canada), and to a number of US states (widely in Michigan, Illinois, Indiana and Ohio; limited in Kentucky, Maryland, Minnesota, Missouri, New York, Pennsylvania, Virginia, West Virginia, and Wisconsin). Most infestations are believed to have been established for at least 5 years prior to their discovery. Tree death usually occurs within 3-4 years following initial attack although higher level of infestation can kill trees within 1-2 years (Haack *et al.,* 2002). More than 20 million ash trees have already been killed in North America. It is suspected that *A. planipennis* entered the USA in Detroit, in wood packaging material on cargo ships from China (Bray *et al.,* 2008).

In the EPPO region, *A. planipennis* occurs naturally in the Russian Far East, where it lives on *Fraxinus mandshurica* and *F. chinensis* without causing serious damage (Baranchikov *et al.,* 2008, Baranchikov & Kurteyev, 2012). In Europe, it was first detected in Moscow in 2005 during investigations conducted to determine the cause of ash (*Fraxinus excelsior* and *F. pennsylvanica*) dieback. By 2012, the pest had spread to a radius of about 250 km around Moscow (Baranchikov & Kurteyev, 2012). European ash (*Fraxinus excelsior*) has shown high susceptibility to the pest (Baranchikov *et al.,* 2008).

Signs and symptoms of *A. planipennis* attack include, externally, yellowing and thinning of foliage, dying of branches, dieback and mortality of ash trees and, internally, frass-filled larval galleries in the

cambium, D-shaped exit holes and the presence of *A. planipennis* life stages inside the tree (Cappaert *et al.,* 2005; Poland & McCullough, 2006). Usually, ash trees have been infested with *A. planipennis* for 3 to 4 years before trees show strong external symptoms and begin to die (Siegert *et al.,* 2009). Since very few species of *Agrilus*, originating from North America or Europe, are known to attack trunks of ash trees, the occurrence of galleries typical for the genus *Agrilus* in ash trees should be considered suspect.

In China, *A. planipennis* typically attacks ash trees that grow in open areas or at the edges of dense forests with closed canopies. However, entire stands can be killed during outbreaks (Yu, 1992). In North America, on the other hand, *A. planipennis* has infested and killed ash trees in both open settings and closed forests. Attacks often begin in the upper bole and main branches of host trees and then move downward in subsequent years. *A. planipennis* can infest and kill both healthy and stressed trees that vary in diameter and from young to mature trees. It can infest trees and branches as small as 1 cm in diameter (Baranchikov, 2013, pers. comm. and Fig. 1).

Fig. 1. Exit hole of *A. planipennis* in an ash tree smaller than 1 cm in diameter (Photo courtesy of YN Baranchikov, taken in Michigan, 2013).

Long distance flights of several kilometres are possible for *A. planipennis* (Taylor *et al.,* 2007, Taylor *et al.,* 2010, Siegert *et al.,* 2008, 2009). It is, therefore, possible that a fertilized female could fly several kilometres, lay eggs, and thereby start new infestations a considerable distance from a known infestation. However, it appears that the majority of adults originating from a single source will disperse less than 500 m depending on the density of potential host trees in the area of migration (McCullough *et al.,* 2005, Mercader *et al.,* 2009). The pest can also spread with live ash plants and ash wood products (e.g., round and sawn wood, wood packaging material, wood chips, and firewood, especially when bark is present). Therefore, phytosanitary measures should cover movement of host plants of *A. planipennis* and in particular, untreated wood (including wood packing material, wood chips, and firewood) from infested areas.

In North America, internal quarantine requirements have been imposed to restrict the movement of ash nursery plants, firewood, branches and logs from infested to uninfested areas (Haack *et al,* 2002). *A. planipennis* is included in the NAPPO Alert List, the EPPO A2 list of pests recommended for regulation, and the EU Annex II/A1.

A PRA performed by the EPPO Panel on Quarantine Pests for Forestry in 2003 and the PRA revision done by EPPO in 2013 has shown that the probability of establishment of *A. planipennis* in Europe is high, and considering its establishment in Moscow, it seems likely that, once introduced, *A. planipennis* would be able to survive in a substantial part of the EPPO region.

The North-American experience shows that, once introduced, *A. planipennis* is very difficult to eradicate. Therefore, NPPOs should focus initially on phytosanitary measures aiming to prevent introduction of the pest, measures are identified in the PRA for *A. planipennis* (EPPO, 2013). There should also be strong emphasis on processes to maximise the likelihood of detecting the pest in the places of destination of pathways able to carry it (mainly ash wood and plants for planting). If, nevertheless, introduction takes place, it is highly recommended to carry out a very rapid survey and evaluation of the pathway(s) of arrival and their distribution within the country to determine the extent of *A. planipennis* spread. Based on this information, a decision should be taken whether to aim for eradication, or containment and suppression of the pest. Nevertheless, EPPO recommends that if the pest is detected for the first time, all possible and feasible measures should be taken to eradicate it. This Standard provides the basis for a national regulatory control system for surveillance, eradication, containment and suppression of *A. planipennis*.

Monitoring of *A. planipennis*

Surveillance for the presence of *A. planipennis* in a country or area not known to have the pest is usually based on a detection survey (methods used for detection surveys are described in Appendix 1). If *A. planipennis* is found and confirmed, an evaluation of the pathway(s) of arrival and their distribution within the country should be carried out in order to determine the origin of the infestation and whether human assisted spread may have occurred over distances greater than would be expected from adult flight dispersal. Furthermore, a delimiting survey of at least 1 km radius around the first tree(s) found infested should be undertaken. The size of the radius should be defined by the NPPO concerned depending on the distribution of host trees. In addition, a survey of at least a 1 km radius should be carried out around any new tree(s) found infested in order to provide a preliminary assessment of the infested area (see 'Eradication'). Methods used for delimiting surveys are described in Appendix 2. Surveillance should continue in the infested area until *A. planipennis* is eradicated. More intense surveillance is proposed during the clear cut procedure (see 'Eradication').

The collection of samples is described in Appendix 3.

Eradication of *A. planipennis*

From experience with other pests, it should not be assumed that the initial finding is a centre of infestation. Therefore, the initial survey should take into account that there could be infested trees at greater distances since adult beetles are strong flyers and have a high capacity for natural spread. The possibility of human assisted movement both locally and internationally needs to be investigated. Upon detection of *A. planipennis* in the initial tree(s) in a country or region, official eradication measures should immediately be taken in the following sequence.

1) first detection of *A. planipennis* e.g. as a result of a detection survey;
2) establish an initial regulated area of at least 20 km radius around first finding of *A. planipennis* to prevent movement of (possibly) infested material (wood including firewood, plants for planting, etc.) out of the regulated area. The exact radius of the initial regulated area should be determined by the NPPO concerned depending on the distribution of host trees;
3) carry out a delimiting survey of at least 1 km radius (see Figs. 2, 3 & 4) based mainly on visual inspection for D-shaped adult exit holes as a most rapid detection strategy. The results of this survey will give a preliminary indication of the range of infestation and possibly some indication of the location and timing of the initial introduction. It will not however provide an

accurate assessment of current infestation so the survey results should be used to provide the baseline for more detailed surveys;

4) fell and destroy infested trees (including removal of stumps) detected during surveys;
5) fell all host (ash) trees in a radius of at least 100 m (to be defined by the NPPO concerned depending on the distribution of host trees[1]) around each infested tree (see Fig. 5);
6) check, by bark removal, each felled tree meticulously for the presence of *A. planipennis* (which would increase the probability of detection of the pest within this radius to nearly 100%);
7) upon detection of additional infested trees, establish new clear-cut areas of at least 100 m radius around each infested tree (see Fig. 6) and carry out intensive check of all felled trees for the presence of *A. planipennis* according to step 6;
8) continue step 7 until no new infested trees are found;
9) map all infested trees and demarcate the infested area (see Fig. 7);
10) fell, in addition to the already established clear-cuts, all host (ash) trees within the infested areas and check all felled trees meticulously for the presence of *A. planipennis* according to step 6;
11) establish at least a 100 m radius (to be defined by the NPPO concerned[1]) clear-cut area around the infested area (see Fig. 8) and check all felled trees for the presence of *A. planipennis* (each new finding in the clear cut would lead to the repetition of steps 6-10: see Fig. 9);
12) establish an intensive survey area of at least 1 km radius around the clear-cut area and, as appropriate, re-define (to be defined by the NPPO concerned) the regulated area (at least 20 km around the infested area) to prevent movement of possibly infested material (wood including firewood, plants for planting, etc.) from it. Analysis of the infestation chronology should be used to delimit the extent of the intensive survey area and regulated area and the likely sequence of attacks over time.
13) Investigate whether there has been any human assisted long distance movement of wood, plants for planting etc. out of the regulated area and carry out a survey in any area which is at risk of infestation due to this movement.

The aim of the measures applied within the regulated area is to eradicate *A. planipennis* and to prevent spread of *A. planipennis* to other areas of the country and to other countries by continually removing foci of infestation. Measures for preventing spread to other areas and for reducing infestation levels are described in Appendix 4. The efficacy of proposed measures will depend on the scale of infestation and on how early it was detected.

A. planipennis can be considered eradicated when the following condition is fulfilled:
No findings of *A. planipennis* during 2 life cycles of the pest and for at least 3 years of annual monitoring in the regulated area.

Containment and suppression of *A. planipennis*

When eradication is considered not to be feasible (e.g. because the pest has spread over a wide area) or eradication has failed, containment measures should be applied. Containment measures intend to stop spread but based on North American experience this may not always be possible. Therefore, suppression measures are also needed in the infested areas to reduce populations of *A. planipennis*. For the containment measures, the regulated area should be increased to at least 100 km width around the known infested area because of high capacities of the pest to spread naturally.

[1] If the pest is first detected in a dense pure ash stand, the clear cut area of 100 m radius (200 m diameter) may include hundreds of ash trees. The Standard assumes that if the first infested tree is not the only infested tree, than the probability of finding other infestations among these hundreds trees following instructions of step 6 is very high (nearly 100%): Mercader *et al.* (2009) found that 88.9 % to 90.3 % of the larvae were within 100 m of the point source. Ideally all trees should be inspected according to step 6, but if this is not practical due to too large numbers of trees, specific sampling procedure should be implemented (to be designed by the NPPO concerned). All cut trees should be destroyed according to Appendix 4. In the case of low density of ash trees (urban situation, ash plantation along the roads, small proportion of ash in the forest with other main tree species), the NPPO may decide to increase the radius of the clear cut area accordingly keeping approximately the same number of trees to be analysed following instructions of step 6.

Containment and suppression measures should include the following:

- Intensive survey to delimit infested area;
- Destruction or processing of infested trees;
- Prohibition of the movement of untreated (according to Appendix 4) ash wood (including firewood and particle wood), products made of untreated ash wood and plants for planting of ash from the infested area to the rest of the regulated area.
- Prohibition of the movement of untreated (according to Appendix 4) ash wood (including firewood and particle wood), product made of untreated ash wood and plants for planting of ash outside the regulated area.

In addition, other suppression measures reducing pest populations could be used. These could be biological or chemical.

Biological control

The only natural enemies of *A. planipennis* recorded in the Moscow region are woodpeckers. In the Far East of Russia, the following natural enemies are recorded on *A. planipennis*: *Spathius depressithorax* Belokobylskiy (Braconidae), *Spathius generosus* Wilkinson (Braconidae) and *Tetrastichus* sp. (Eulophidae). Also, the following potential competitors (bark beetles) of *A. planipennis* are recorded on ash in the Far East of Russia: *Hylesinus cholodkovskyi* Berger (Col.: Curculionidae), *Hylesinus laticollis* Berger (Col.: Curculionidae) and *Hylesinus fraxini* (Panzer) (Col.: Curculionidae). There is a strong possibility that *A. planipennis* could spread to temperate regions of Western, Central and Eastern Europe: Moscow is situated in the north-eastern corner of *Fraxinus excelsior* (which is highly susceptible to *A. planipennis*) distribution in Europe. A program of introduction and release of biological control agents may help to slow down the natural spread of *A. planipennis* and increase survival of European ashes infested by this pest. The use of biological control agents introduced from areas of native distribution of *A. planipennis* may be developed in future in Europe and would need research before a first release. In the USA, field releases of three Chinese parasitoids for *A. planipennis* began in 2007, and as of 2009 to 2012, all three have become established at multiple sites (Bauer *et al,* 2008; Gould *et al,* 2012; USDA, 2013). These three species are: the egg parasitoid *Oobius agrili* (Encyrtidae) and two larval parasitoids: *Tetrastichus planipennisi* (Eulophidae) and *Spathius agrili* (Braconidae). The search for other species of biological control agents in China and Russian Far East continues.

To reduce the impact of *A. planipennis* in Europe, it is recommended to start as soon as possible programs of introduction and releases of biological control agents in the infested areas (e.g. Moscow region of Russia) to reduce damage from *A. planipennis*. However, environmental risk assessment should be done before releases.

Chemical control

The use of insecticides against *A. planipennis* may be effective but could be costly and have undesirable side effects. No low-cost control methods are currently available (Poland, 2007). Research is underway on the evaluation of systemic insecticides (Poland, 2007; Bauer *et al,* 2008). Infested trees containing larvae and pupae can be cut and chipped to destroy the pest (McCullough *et al,* 2007). Trunk or soil systemic injections (e.g. with imidacloprid, emamectin benzoate or azadirachtin according to methodologies being developed in USA and Canada) (Petrice & Haack, 2006) or soil drenches could be used to prevent tree infestations (100% effective) or kill *A. planipennis* already present in trees (not 100% effective except for emamectin benzoate).

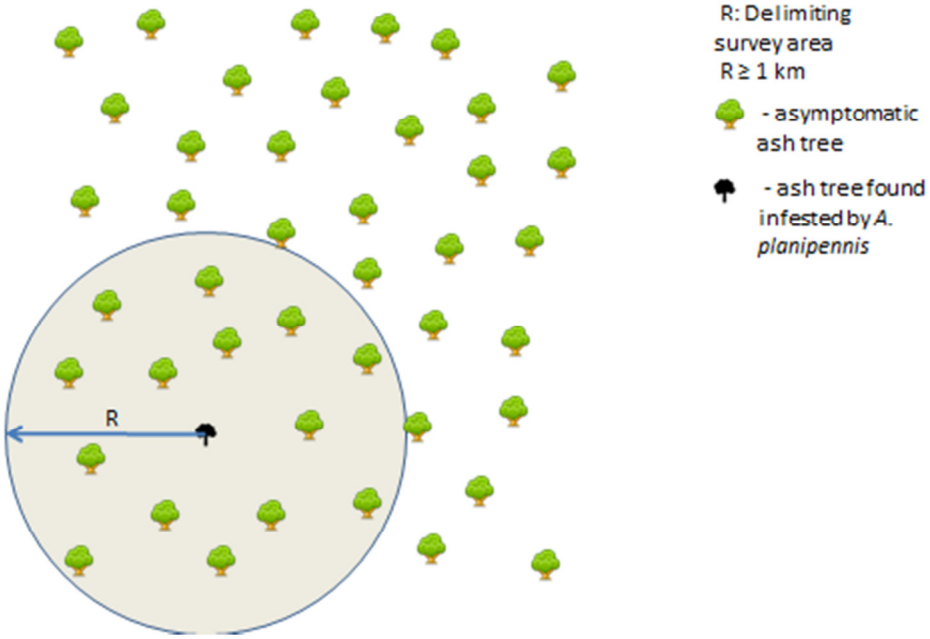

Fig. 2. Delimiting survey in at least 1 km radius around first finding of *A. planipennis* in order to delimit the infested area should be conducted as soon as possible after the detection of the infestation.

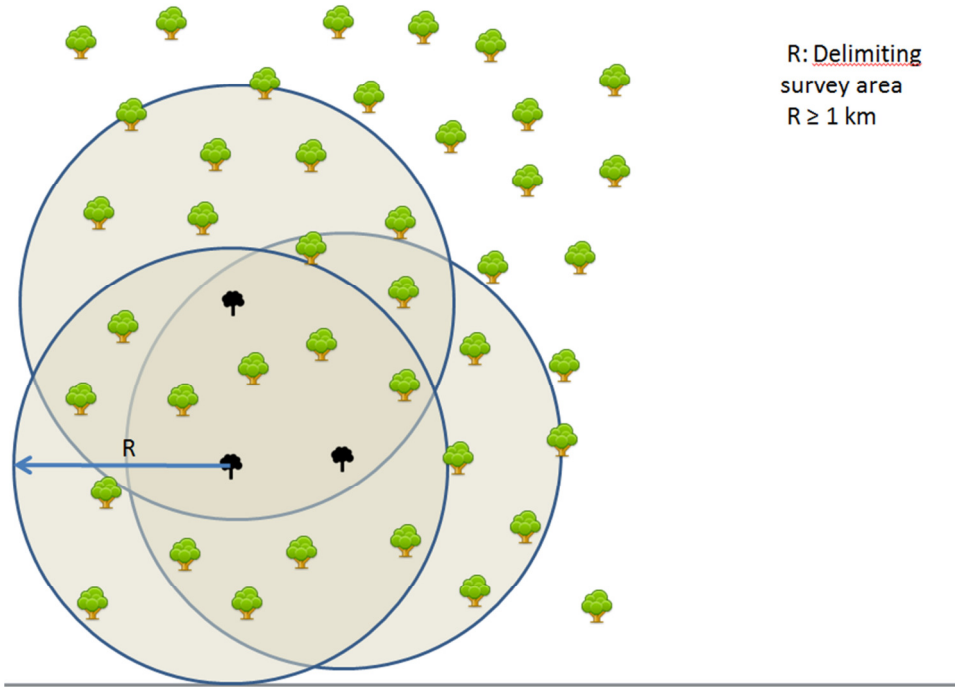

Fig. 3. Delimiting survey in at least 1 km radius around each new finding of *A. planipennis* in order to provide a preliminary indication of the infested area should be conducted as soon as possible after the detection of the infestation.

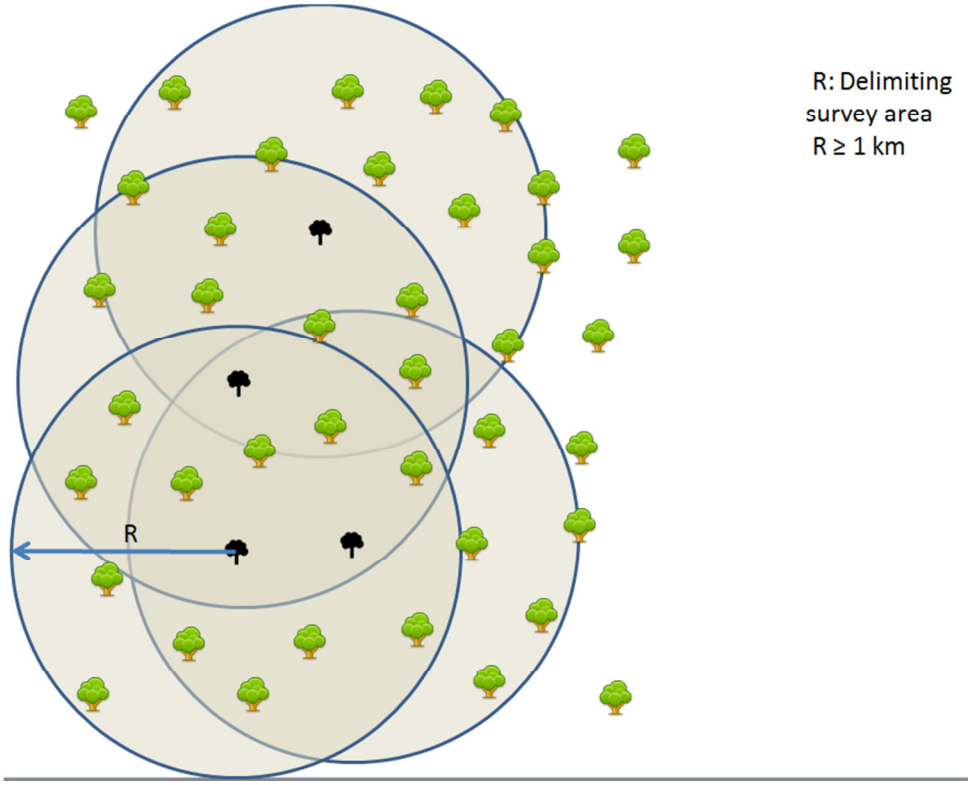

Fig. 4. The process shown in Figs 2 & 3 should be continued until no further trees infested with *A. planipennis* are detected.

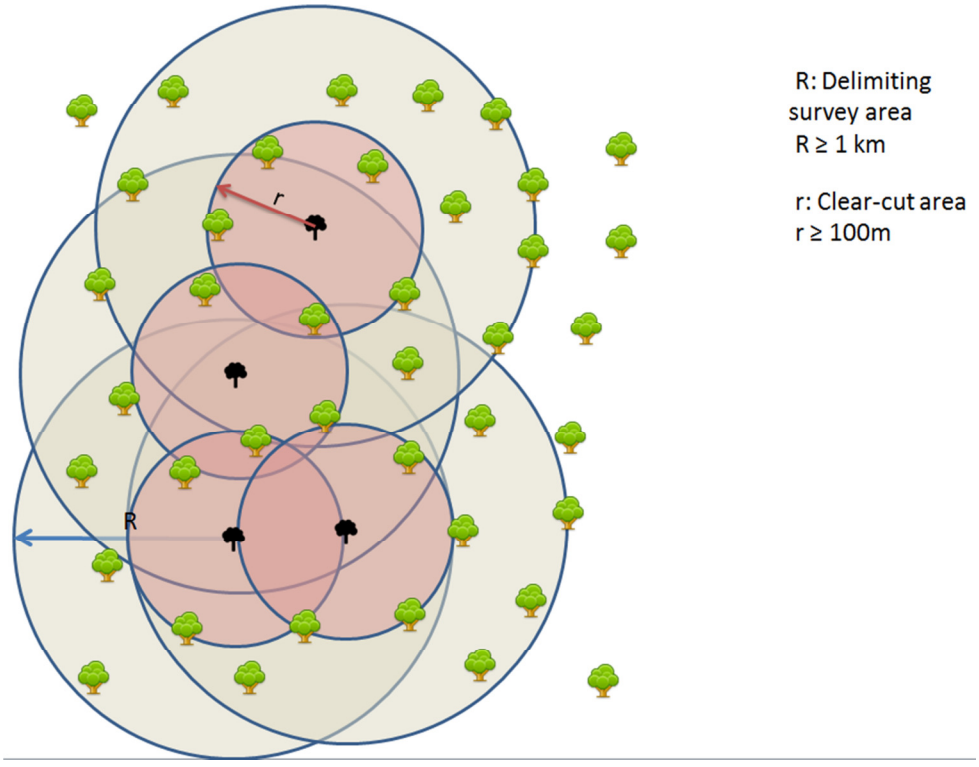

Fig. 5. All infested trees should be destroyed and all ash trees within a radius of at least 100 m should be felled. Each felled tree should be checked meticulously (taking off the bark) for the presence of *A. planipennis*.

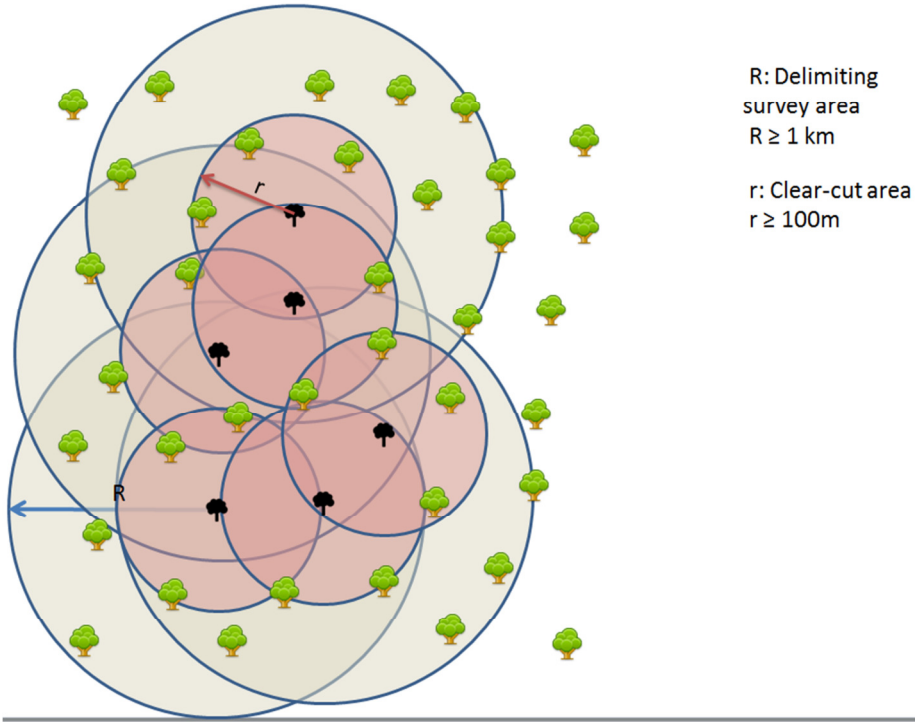

Fig. 6. Since new infested felled trees are detected after removing the bark, the process shown on fig 5 is continuing until no more infested ash trees are found.

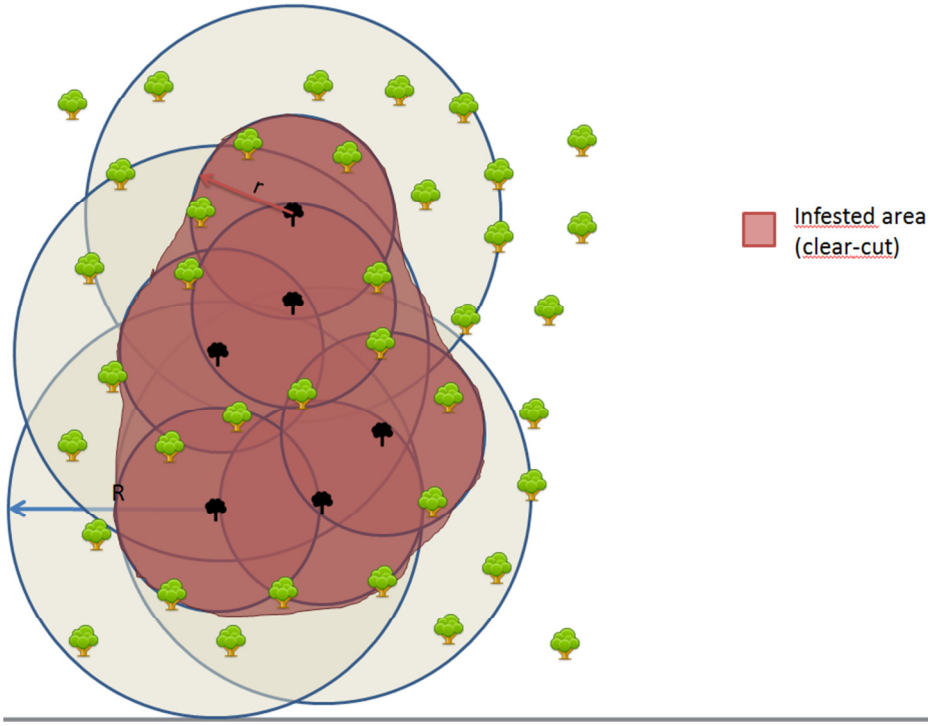

Fig. 7. All clear-cut areas should be merged into the "infested area". All ash trees in this area should be felled and checked meticulously (taking off the bark) for the presence of *A. planipennis*.

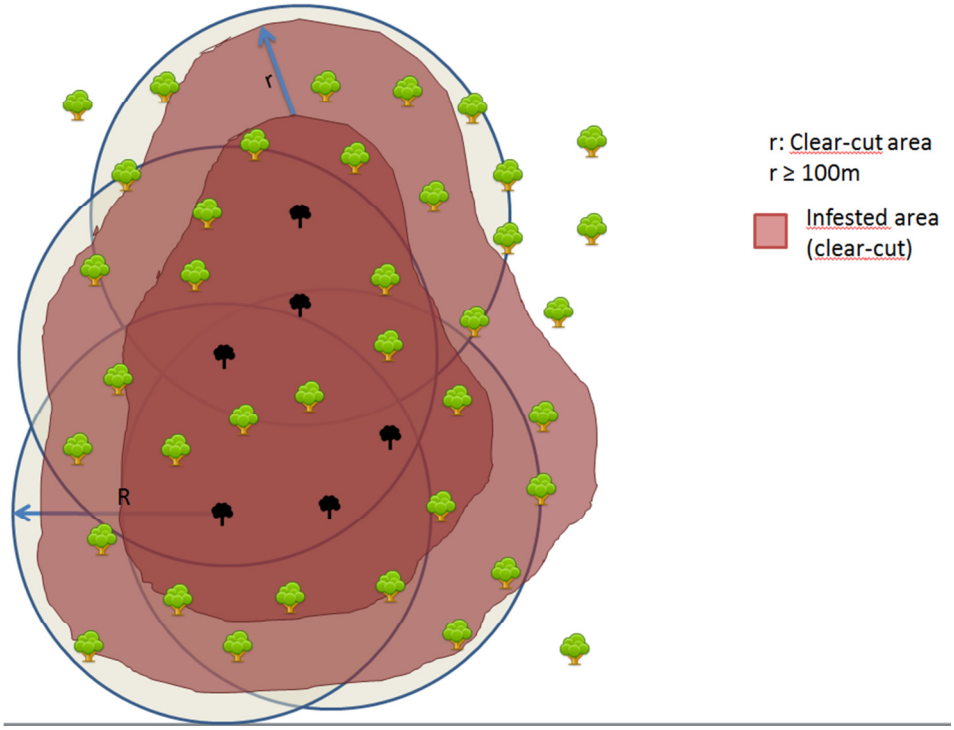

Fig. 8. A zone large of at least 100 m should be established around the infested area. All ash trees in this zone should be felled and checked meticulously (taking off the bark) for the presence of *A. planipennis*.

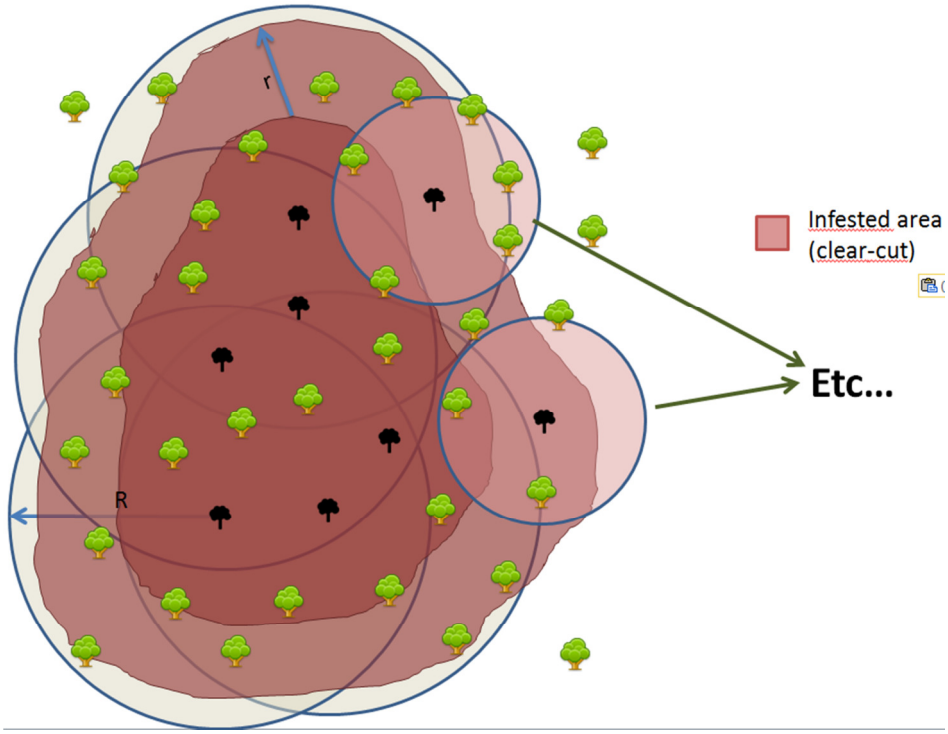

Fig. 9. In case of detection of new infested trees around the infested area, the process shown in Figs 5, 6 & 7 (with re-definition of the infested area) should be continued until no trees infested with *A. planipennis* are detected.

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APPENDIX 1

Detection survey in an area where *A. planipennis* is not known to occur

In order to verify and ensure that a country is free from *A. planipennis* annual surveys should be carried out (according to ISPM 4 *Requirements for the establishment of pest free areas* and ISPM 6 *Guidelines for surveillance*: FAO, 1996 and FAO, 1997 respectively).

Strategy

Breeding populations of *A. planipennis* are extremely difficult to eradicate, because surveys designed to locate infested trees are not 100% effective and *A. planipennis* is capable of dispersing several kilometres per year. It is of paramount importance, therefore, to prevent breeding populations from becoming established. Survey criteria to determine both presence and absence of *A. planipennis* are based on biological characteristics of the pest and targeted on host trees most likely to be infested by *A. planipennis*. Therefore, the following should be considered when designing a survey strategy: host distribution, points of ash wood import (including wood packaging and firewood), wood processing facilities that utilize imported ash, nurseries trading ash plants, planting, handling and storage of imported ash plants for planting, and occurrence of declining ash trees.

Surveys should be more intensive in the close vicinity to the most high risk places (at least 500 m around) by checking ash trees:

- nurseries, parks, cities, gardens, forests edges, etc. where imported host trees were stored or planted, especially those ash plants imported from areas where the pest is present.
- wood-processing yards that utilize ash. It is important for reasons of traceability to know the exact origin of wood, since processing yards may contain wood of diverse origins, including imported material.
- wood chip burning power plants
- stands of declining ash trees (even if the reason of decline is not *A. planipennis*, debarking of trees could help to detect the larval tunnels).

Surveys should be pathway based, which will allow resources to be targeted to those pathways with the highest likelihood of *A. planipennis* being present. The larval stages of *A. planipennis* may be present in the vascular cambium and living phloem but, later (mid-October), they enter the outer sapwood and pupate in the following spring or early summer. Consequently the main pathways (including types of wood) for *A. planipennis* are:

1. Ash round wood with or without bark including firewood (originating from countries and areas where *A. planipennis* occurs).

2. Host plants for planting (mainly ash) including bonsai plants (originating from countries and areas where *A. planipennis* occurs) may be infested by *A. planipennis*. Survey effort should concentrate on all ash plants, with emphasis on detection of signs of breeding in the stems (discolouration and deformation of bark, larval galleries, grub and exit holes).

3. Sawn ash wood with or without bark (originating from countries and areas where *A. planipennis* occurs): if trees have been infested by *A. planipennis*, the pest may still be present in sawn wood, even if the outer bark has been removed (pupation occurs in the outer sapwood).

4. Wood packaging material: if trees have been infested by *A. planipennis*, different life stages of the pest may still be present in wood packaging material, even if the outer layers with bark have been removed. The correct implementation of ISPM No 15 reduces the risk to an acceptable level.

5. Ash cut branches (originating from countries and areas where *A. planipennis* occurs): if trees have been infested by *A. planipennis*, they may still be present in cut branches. There is some doubt

about the frequency of cut branches of ash moving in international trade: this makes this pathway less important if not insignificant. However there is a theoretical risk associated with the import of cut branches of ash and regardless of the level of trade the risk needs to be mitigated.

6. Bio fuel and particle wood (exceeding 2.5 cm in any dimensions) of host plants.

Surveys should be carried out annually, concentrating on trapping and biosurvey, using hunting wasps, during summer months when *A. planipennis* adult activity is highest. Direct tree surveys can also be enhanced by use of purple (at the basis of trunks) or green (ideally in the crown) sticky traps with attractant lures. Sticky bands on host trunks could also be used, although they do not usually allow detection of initial infestations. If it is not possible to survey during the main activity period, inspection of trees can be carried out over the winter months.

Visual detection

- Signs caused by *A. planipennis*
  - foliage feeding (not specific),
  - D-shaped emergence holes (specific to *Agrilus* spp.),
  - larval galleries near the wood (including branches) surface (after peeling off bark to increase the probability of detection in declining trees).

Since very few species of *Agrilus*, originating from North America or Europe, are known to attack trunks of ash trees, the occurrence of exit holes and long serpentine galleries typical for the genus *Agrilus* in ash trees should be considered suspect.

- Symptoms due to the tree response (these symptoms are in most cases not host-specific)
  - discolouration of foliage,
  - crown dieback/thinning/chlorosis,
  - epicormic shoots,
  - bark deformities(especially on plants for planting including bonsais),
  - bark splitting often with *A. planipennis* larval galleries exposed beneath,
  - bark bleeding
  - overabundant seed production.

- Signs caused by other organisms like woodpeckers

Note: These signs/symptoms usually indicate a later stage of A. planipennis *infestation. Development of molecular tools could help in future to identify the pest in the absence of adults.*

Trapping **A. planipennis** *adult beetles*

- on sticky traps with lure[2] (e.g. manuka oil from Manuka tree – *Leptospermum scoparium* or Phoebe oil from Brazilian "walnut" – *Phoebe porosa* or both) on 3-flat sided purple plastic prism (at the bases of trunks) or 3-flat sided green plastic prism (in the crown) panel sticky traps in ash trees during *A. planipennis* flight period (Francese *et al*, 2005),
- on sticky bands (Cappaert *et al*., 2005),
- subject to approval of the NPPO, girdled trees could be used for trapping *A. planipennis* for delimiting survey after the first detection (USDA protocol, 2006: http://nrs.fs.fed.us/disturbance/invasive_species/eab/risk_detection_spread/trap_trees/).

Note: The research being conducted in North America has shown that:

1) *3-flat sided purple plastic prism sticky traps are more efficient than girdled trap trees if used with lure,*
2) *the combination of Manuka oil with Phoebe oil is more effective to attract* A. planipennis *beetles than each of these oils separately*

[2] Lure is recommended if traps are placed in ash trees and obligatory in the case of host trees absence.

3) *green traps catch more males whereas purple traps catch more females*
4) *the most sensitive trap is the 3-flat sided green plastic prism sticky trap baited with Manuka/Phoebe oil lure (3 times more sensitive than purple trap) but they must be placed high up in the trees, which is not practical for large scale trapping whereas baited purple traps at 1.5 m or 6 m are sufficiently effective to be used for large-scale trapping.*

New traps for *A. planipennis* are under development (including pheromone traps), these could become available in future and their efficacy will need to be evaluated.

"Biosurvey"

- by using wasps that specialize in hunting buprestids,

Note: in North America, the wasp Cerceris fumipennis *(Hymenoptera, Sphecidae) is used and its nests are transported in vehicles from one site to another, but studies are needed to determine European species of wasps hunting buprestids and to develop procedures of their use (Careless* et al.*, 2009). This method could possibly detect* A. planipennis *populations at a low population density by regularly checking the harvest of the wasp in nature and/or in wasp nests transported on vehicles and allow earlier detection compared with visual inspection alone.*

Public awareness

- Public awareness activities should especially target those trading plants and plant products, agencies and stakeholders working with ash plantations (e.g. municipalities), parks, nurseries, shelterbelts, ash forests, etc. This is very important for early detection and reduced spread of *A. planipennis*. Public awareness activities can be achieved, for example, via the Internet and workshops involving growers, gardeners, school children, tree pruning company employees, entomologists, etc.
- Organisations mentioned in the above bullet point should also be aware of a recently discovered disease on *Fraxinus excelsior* and *F. angustifolia* caused by *Hymenoscyphus pseudoalbidus* (anamorph: *Chalara fraxinea*) and its occurrence in a number of European countries. This oomycete leads to dieback and possible tree death on a larger scale than has previously been seen for any other harmful organisms affecting ash. This may result in high numbers of host trees potentially more suitable for *A. planipennis*. Trees found to be infected by *Hymenoscyphus pseudoalbidus* during the survey described in the current Standard may also be infested with *A. planipennis*.
- Since very few buprestid beetle species are known to attack trees of the genus *Fraxinus* in Europe (e.g. *Agrilus convexicollis, Agrilus cyanescens, Anthaxia podolica, Chrysobothris affinis*), infestations are rarely seen. Therefore any sign of infestation by buprestids (D-shaped exit holes, zigzag larval galleries in the cambium layer) should be investigated in all cases and to be identified to species level.

Communication

A system should be in place so that each finding or suspicion of *A. planipennis* should be immediately reported to the NPPO.

APPENDIX 2

Delimiting survey in an area where *A. planipennis* has been found

Purpose

When *A. planipennis* is detected and its identity confirmed an intensive delimiting survey to establish the full extent of the infestation should be carried out immediately within at least a 1 km radius from the first finding. The purpose of this will be to determine geographic limits of the infested area (or

areas) and then to demarcate the regulated area.

Strategy

If *A. planipennis* is found, a delimiting survey should be as described in the sections "Eradication" and "Containment and suppression" of this Standard. Delimiting surveys should be more intensive than detection surveys. During the adult flight period, traps and other methods of survey mentioned in Appendix 1 could be used.

The survey should focus first on open-grown ash trees and those along the forest edge (especially on surfaces of trunks with a southern exposure). Ash trees including cut trunks and branches, stumps, cutting residues and naturally occurring debris showing signs of buprestid activity should be assessed for the presence of the pest. Apparently healthy trees may be infested with *A. planipennis;* therefore the checking of apparently healthy trees for the presence of *A. planipennis* is necessary. It should be noted that detection of *A. planipennis* at low population densities is very difficult.

APPENDIX 3

Sampling procedures

The likelihood of detecting *A. planipennis* in a tree is determined by the distribution of *A. planipennis* through the tree. The first oviposition usually takes place in bark crevices along the upper trunk and crown branches. The female lays only one egg (very small and difficult to detect) per site and marks the site using volatiles to discourage other females from laying eggs at the same site. In a dead tree *A. planipennis* may also be present in the lower part of the tree due to multiple attacks by the beetle. Therefore, the strategy that gives the highest likelihood of detecting *A. planipennis* in all circumstances is to check several positions along the trunk, especially from the side most exposed to the sun, but always focusing on bark with crevices.

Symptoms, which can be used as indicators for sampling include: discolouration of foliage, branch dieback, woodpecker activity, epicormic shoots, bark bleeding, deformation of bark and bark splitting; as well as signs of *A. planipennis* such as larval galleries and exit holes. There is currently no method to visually distinguish between trees that are dying from *A. planipennis* and those dying for other reasons. It should also be considered that presence of *A. planipennis* in trees is not immediately associated with wilt symptoms and wilting can occur from many other reasons besides an infestation with *A. planipennis.*

The use of trap logs does not seem effective for *A. planipennis* since the pest prefers to attack live standing trees.

APPENDIX 4

Measures in the regulated area

The purpose of the regulated area is to prevent the spread of the pest outside this area. The measures should include:

For a localized or small infestation where eradication is the objective

- a clear-cut area of host trees with simultaneous intensive survey, as described in the "Eradication" section of this Standard;
- felling and destruction of all infested and potentially infested trees to eradicate or suppress the

pest in the infested area;
- further delimiting survey to detect new infestations;
- in the case of eradication, at least 20 km regulated area (to be defined by the NPPO concerned depending on the distribution of host trees) around the edge of the infested area to prevent human assisted spread and an area not less than 1 km wide adjacent to the clear-cut which will be monitored intensively.

To minimise the likelihood of breeding of *A. planipennis* in the stump, the trees should be cut close to the soil surface and/or stumps should be "top ground" (mechanically destroyed by special machines).

For a larger infested area where the objective is either eradication or containment

On the basis of visual inspection, it is generally not possible to distinguish living trees expressing early wilt symptoms caused by *A. planipennis* from those trees dying from any other cause. In an infested area, any dead or dying ash trees should therefore be considered to be potentially infested with *A. planipennis* and therefore checked. Throughout the infested area, all ash trees proved infested by *A. planipennis* should be felled and processed immediately if detected during the *A. planipennis* flight period (estimated to be between May 15 and August 15 for Central Europe, to be defined by the NPPO concerned). If detected outside the flight period, the trees should be felled and processed before the next flight period starts. To minimise the likelihood of breeding in the stump, the trees should be cut at the soil surface and/or stumps should be "top ground" according to a Canadian procedure or treated by an appropriate herbicide (e.g. Garlon® active substance triclopyr) (Petrice & Haack, 2010). All felled trees should be assessed for the presence of *A. planipennis*. If *A. planipennis* is detected, and eradication is aimed for, all host trees within a radius of 100 m should be felled and destroyed (including all felling debris), as described in the "Eradication" section of this Standard, since attacks by *A. planipennis* tend to be grouped on neighbouring trees. Ideally all, but at the very least a representative sample of the felled trees should be checked in detail for the presence of *A. planipennis*. If any positive trees are found, a further 100 m felling area should be established.

Around the edge of the infested area a regulated area of 20 km (in case of eradication) or 100 km (in case of containment and suppression) should be established to prevent human assisted spread and an area not less than 1 km wide adjacent to the clear-cut (in case of eradication) or infested area (in case of containment and suppression) which will be monitored intensively.

The measures applied to all host commodities from within the demarcated area, in order to prevent movement of *A. planipennis* from the infested area to other areas, should be at least as stringent as those applied to imports. This should be done to prevent the human assisted movement of the insects within plants or plant products to new areas where they could be emerging from infested plants or wood and create new foci of infestation. These measures should be applied in the regulated area to all ash species.

Plants for planting (either eradication or containment)

In the regulated area, host plants for planting may not be grown in a place of production unless that place of production is inspected and no activity of *A. planipennis* is found and host plants for planting are grown under insect-proof conditions that prevent any possibility of the plants for planting to being infested by *A. planipennis*.

Wood and isolated bark

The objective of measures is to prevent movement of infested materials (e.g. wood and isolated bark) from the infested area to the rest of the regulated area and outside the regulated area. Wood and isolated bark from the area (infested or regulated):

Measures for situations where the aim is eradication

- Can be transported out of the area provided that it is irradiated according to EPPO Standard PM 10/8 (1) under control and responsibility of the NPPO.
- Subject to an evaluation of the process by the NPPO, can be used for industrial purposes within the area before the next *A. planipennis* flight period

- Outside the *A. planipennis* flight period, wood can be moved under official control outside the area to an approved processing facility and processed or treated before the start of the next flight period under control and responsibility of the NPPO.
- Removal of the bark and of 2.5 cm of the outer sapwood under control and responsibility of the NPPO
- If not treated or processed using one of above mentioned procedures, the wood should be destroyed completely by burning (avoiding fire damage to adjoining trees which could act as an attractant to *A. planipennis*) or deep buried under control and responsibility of the NPPO.

Measures for situations where the aim is containment

- Can be transported out of the area provided that it is either heat-treated so that the wood-core temperature is maintained at 56 °C for 30 min according to EPPO Standard PM 10/6 (1), or fumigated with a suitable fumigant, according to EPPO Standard PM 10/7, or irradiated according to EPPO Standard PM 10/8 (1) under control and responsibility of the NPPO.
- Can be used for industrial purposes within the area before the next *A. planipennis* flight period.
- Chipped to a maximum size of 2.5 cm in any dimension and kept within the area or moved outside of the flight period.
- Outside the *A. planipennis* flight period, wood can be moved under official control outside the area to an approved processing facility and processed or treated before the start of the next flight period under control and responsibility of the NPPO.
- Can be processed into sawn wood for use within the area, provided that it is inspected and found free from *A. planipennis*. If the wood derives from trees felled during *A. planipennis* flight period and is not processed immediately into sawn wood, it should be debarked directly after felling.
- If wood packaging material is produced from ash wood in the area, it should be treated and marked according to the ISPM No 15 requirements.
- If not treated or processed using one of above mentioned procedures, the wood should be destroyed completely by burning (avoiding fire damage to adjoining trees which could act as an attractant to *A. planipennis*) or deep buried under control and responsibility of the NPPO.

Waste wood and debris

The objective of measures is to prevent movement of infested waste wood and debris from the infested area to the rest of the regulated area and from the regulated area outside. Waste wood and debris produced during felling in the area should be destroyed completely by burning at or near the place where the tree was felledor buried under control and responsibility of the NPPO. , Where the control strategy is containment, waste wood and debris may be chipped to a maximum size of 2.5 cm in any dimension and left on site until the end of *A. planipennis* flight period, Especially during the summer period, disposal or processing of waste wood should be done as soon after felling as possible. Any waste wood produced during other processing procedures should be destroyed by burning, used as industrial fuel, fumigated with a suitable fumigant under control and responsibility of the NPPO. Residual and waste wood can also be transported in closed containers and under official control to approved processing facilities outside the *A. planipennis* flight period and utilised before the start of the next flight period.

General measures

General measures taken in the regulated area should aim to decrease the likelihood of build-up and dispersal of *A. planipennis*, and hence reduce the likelihood of spread of the pest that could lead to new foci of *A. planipennis* infestation. This requires a high degree of forest hygiene. To eliminate breeding sites for *A. planipennis*, waste wood of host trees should be removed as soon as possible and certainly before the flight period of the beetles. In order to avoid damage from forest machinery that could impair tree vigour, forest operations should be limited to salvage activities of sun exposed trees in edges and storm-damaged trees and to the removal of dying and weakened trees.