Cinnamomum camphora. © *John Robert McPherson. CC BY-SA 4.0.*

The management of camphor tree (*Cinnamomum camphora*)

Measures and associated costs

Species (scientific name)	*Cinnamomum camphora* (L.) J. Presl
Species (common name)	Camphor tree
Author(s)	Johannes Le Roux (Center for Invasion Biology Stellenbosch University, South Africa)
Date Completed	21/09/2017
Reviewer	Ana Novoa (Department of Invasion Ecology, Institute of Botany, Academy of Sciences of the Czech Republic)
Reference	Le Roux, J. 2017. Information on measures and related costs in relation to species considered for inclusion on the Union list: *Cinnamomum camphora*. Technical note prepared by IUCN for the European Commission.

Table of contents

Summary of the measures, emphasizing the most cost-effective options.

Cinnamomum camphora is a large evergreen tree native to the warm temperate to subtropical areas of East Asia. The species has been introduced to many regions globally for commercial and ornamental purposes and is now considered invasive in many parts of the world, such as in Australia and South Africa. In Europe, *C. camphora* is recorded mainly as planted specimens, and not invasive, in France, Germany, Italy, the Netherlands, Portugal, and Spain. Deliberate planting of *C. camphora* seeds or individual plants for ornamental horticulture remains the most likely pathway for intentional introduction. Seeds from individual trees already present in Europe are unlikely to be spread via human operations due to the low ornamental value of the species, but dispersal via waterways and frugivorous birds is likely to occur within the region. In both its native and non-native regions, dense populations of *C. camphora* are primarily found in areas with warm moist summers and mild winters. Accordingly, a recent bioclimatic modelling exercise found the overall establishment potential of the species in Europe to be limited, with only marginal climate suitability present in the Mediterranean and Black Sea biogeographical regions (EPPO, 2016).

Trade bans (seeds and ornamental plants) of *C. camphora* will enhance prevention of intentional introductions but is likely to be compromised by the ease of bypassing such regulations (such as mislabelled seed imports from internet suppliers). Prevention of secondary (unintentional) introductions from existing occurrences via waterways can be effective if designated authorities target mature and seed-bearing individuals for eradication. Early Detection of *C. camphora* within Europe via active (expert teams) and passive (citizen-science) surveillance and Rapid Eradication are perceived to be effective measures given 1) the limited number of climatically suitable areas for establishment of the species in Europe, 2) the low longevity of *C. camphora* seed under natural conditions, and 3) the distinctiveness, and therefore ease of identification, of mature trees. *Cinnamomum camphora* is not a popular ornamental tree in Europe with apparently low commercial value, and therefore stakeholder acceptability to Prevention, Early Detection and Rapid Eradication measures is perceived to be high.

Given the potential non-target and other environmental impacts associated with both chemical and mechanical control measures (such as contamination of waterways), management of widespread *C. camphora* infestations in Europe will only be effective when management goals are geographically restricted to small areas. Chemical and mechanical control measures for the management of widespread *C. camphora* infestations are perceived to enjoy low acceptability by most stakeholders due to environmental disturbance (mechanical control) and risks associated with environmental contamination and non-target impacts (chemical control). There are currently no biological control options available for *C. camphora*.

Measures for preventing the species being introduced, intentionally and unintentionally.

This section assumes that the species is not currently present in a Member State, or part of a Member State's territory.

Banning of trade in plants and seeds.

MEASURE DESCRIPTION

Prevention of non-native species intentional introductions through blacklisting and trade bans is by far the most cost-effective strategy in dealing with potentially invasive species that are found in trade, compared to costs associated with the management and control of widespread invasive populations (Leung *et al.,* 2002). Such measures have been promoted as preventative measures in European nations (Essl *et al*., 2011). *Cinnamomum camphora* is currently present in Europe. It mostly occurs as planted ornamental individuals, in some instances indoors (EPPO, 2017). Since it is not a popular ornamental tree and therefore it still presents a limited occurrence in the Member States (EPPO, 2016), it is necessary to prevent the introduction of additional individuals and the associated wider genetic variation into Europe. Such higher propagule pressure and its associated wider genetic diversity have often been linked to invasiveness (Lockwood *et al.,* 2005). Banning trade of the species is considered a desirable measure to prevent intentional introductions of *C. camphora* (EPPO, 2016).

Effective prevention measures require some knowledge of the introduction pathway(s) (for example, routes along which a species are moved) and vectors (such as the actual mechanism used during movement) associated with introduction (Wilson *et al.,* 2017). The major pathways for intentional introductions of *C. camphora* into Europe are seeds and plants for ornamental planting (EPPO, 2016). Seeds and plants are available for sale from nurseries within Europe (http://www.gorinipiante.it/en/mediterranean-plants/cinnamomum-camphora-2-00-2-50-clt-30-35_1959997703_en_gb-detail) and from various online traders (for example, ebay.com).

EFFECTIVENESS OF MEASURE

It is difficult to estimate the effectiveness of trade bans, as this would rely on the ability of biosecurity and border control authorities (in all Member States) to correctly identify cases of import and to successfully intercept any prohibited material. Elsewhere in the world, such as in South Africa, where the possession and transport of *C. camphora* is regulated (Henderson, 2001), the effectiveness of these measures in preventing further introductions remains unknown.

The effectiveness of trading bans for plants can also be impacted on by the ease of species identification by responsible authorities. Correct species identification is almost impossible for imported seed material, which is the main pathway of *C. camphora* introductions into Europe (EPPO, 2016). Further, incorrect labelling of imported seeds is probably a common phenomenon (see Novoa *et al.,* 2017), meaning that prohibited species can potentially be imported unnoticed. *Cinnamomum camphora* is also often misidentified as *C. granduliferum* but can be distinguished from the latter by leaf nervation. This again illustrates obstacles to the effective identification and intervention by authorities when *C. camphora* plants are imported, especially as seeds.

Regulatory non-compliance by nurseries is probably commonplace. For example, a recent assessment in South Africa found that, despite widespread awareness of invasive alien species regulations in the nursery industry, more than 50% of nurseries (out of 58) still stocked regulated species (Cronin *et al.*, 2017). Lastly, without mechanisms to verify regulatory compliance, particularly in the face of escalating internet trade in plants (Humair *et al.*, 2015; *C. camphora* is available for purchase on various internet sites) and poor species identification (Thum *et al.*, 2012), regulations aimed at banning trade of certain species can be easily bypassed (Hulme, 2015).

EFFORT REQUIRED

This measure needs to be continuous.

RESOURCES REQUIRED

The measure requires typical, and possibly existing, biosecurity infrastructure in terms of staff and equipment, routinely used at ports of entry. No information is available on costs associated with the implementation of trade bans, but prevention is considered more cost-effective than managing established invasions (Rejmánek and Pitcairn, 2002; Leung *et al.*, 2002).

SIDE EFFECTS

None.

ACCEPTABILITY TO STAKEHOLDERS

Cinnamomum camphora is not a popular ornamental species in Europe (EPPO, 2016), probably because of the region's unsuitable climate conditions for its establishment and growth. It is anticipated that a ban of trade of the species will be acceptable to the general public as well as industry (for example, nurseries, traders, etc.) as it is not widely planted or sold.

ADDITIONAL COST INFORMATION

Currently no data is available on the implementation costs associated with the banning of trade in specific species. The current unattractiveness of *C. camphora* as an ornamental species and the apparent low numbers in trade in Europe mean that low or no economic losses will be incurred by the horticultural industry (such as traders, nurseries, etc.). The reasons for trade in *C. camphora* in Europe remain unknown but may reflect the apparent climatic unsuitability of the region for the species. While the potential spread of the species is considered low in Europe due to climate unsuitability, a recent modelling exercise identified limited areas in the Mediterranean and Black Sea biogeographical regions as having marginal suitability for the species (EPPO, 2016). Therefore, inaction could potentially lead to further introductions and establishment of the species in these regions with the potential of incurring costs associated with future eradication or control efforts.

LEVEL OF CONFIDENCE[1]

Medium.

Some plant species have been successfully listed and banned in Europe before. However, given the reasons outlined above ('Effectiveness of measure') many parameters with high levels of uncertainty (such as the misidentification of seed imports, regulatory compliance, etc.) may hamper effective implementation of prevention through trade bans. These inferences are based on published literature but are not species-specific.

Identifying known occurrences for eradication to reduce risk of secondary dispersal.

MEASURE DESCRIPTION

Within Europe, *C. camphora* is present in France, Germany, Ireland, Italy, the Netherlands, Portugal and Spain (GBIF, 2017; Eaton, 1912), primarily as individually planted specimens, in some instances indoors. Overall, both incidences of occurrence and their densities are very limited in Europe (EPPO, 2016) and, given this, it is perceived that the chances of unintentional dispersal of *C. camphora* are relatively low.

Cinnamomum camphora is self-compatible (Schenk, 2009, and references therein) and reproduce entirely through seed. While seeds tend to have very low fecundity under natural conditions (only 1% viability after 12 months, Panetta, 2001), individual mature trees can produce up to 100,000 seeds per season (Firth, 1981). The species produces small seed-harbouring drupes that are readily dispersed, primarily by frugivorous birds, but also by waterways (Jordan, 2011; Firth and Ensbey, 2014). While this would constitute natural dispersal, it can be viewed as a possible form of unintentional secondary introduction, as such dispersal events would not have been possible without human intervention, for example, the planting of *C. camphora* trees and/or man-made waterways. The drupes of *C. camphora* are unlikely to be accidentally spread via human operations, such as the movement of soils (EPPO, 2016). However, given that birds and waterways can disperse seeds, any tree producing drupes within Europe could act as a source for new populations in areas where the species is currently absent.

Given this, a further preventative measure would be to identify existing occurrences of the species within Europe and undertake eradication measures (see *Early detection* and *Rapid eradication* sections below) in order to prevent further unintentional introductions into Member States or areas where the species is currently absent. All historical plantings/known occurrence records (herbaria, botanical garden records, etc.) should be documented and prioritised to locate and remove possible mature and drooping trees, especially when trees are planted near watercourses.

EFFECTIVENESS OF MEASURE

Effectiveness is difficult to gauge in this instance, but given the apparent limited distribution of the species and possible ease of locating mature and fruiting individual trees, this measure could be effective in preventing further introductions of the species into areas or Member States or areas where the species is currently absent.

EFFORT REQUIRED

This would be achievable within a relatively short amount of time (>5–7 years) assuming adequate resources are made available.

1 See Appendix

RESOURCES REQUIRED

Please refer to *Early detection* section below.

SIDE EFFECTS

Please refer to *Early detection* section below.

ACCEPTABILITY TO STAKEHOLDERS

Please refer to *Early detection* section below.

ADDITIONAL COST INFORMATION

Please refer to *Early detection* section below.

LEVEL OF CONFIDENCE[1]

High.

Removal of drooping trees would greatly enhance the prevention of further introductions of the tree through long-distance dispersal along waterways.

Cinnamomum camphora *is native to several Southeast Asian countries and introduced in many others. © Martinvl. CC BY-SA 4.0.*

1 See Appendix

Measures for early detection of the species and to run an effective surveillance system to detect efficiently new occurrences.

Active surveillance of high risk/sentinel sites.

MEASURE DESCRIPTION

Surveillance approaches for the detection of new occurrences of any species can broadly be divided into two groups, active and passive surveillance. The former encompasses the design of specific activities for the detection of a specific species in a particular area by trained staff, whereas the latter entails the general public detecting and actively reporting, particular species, for example, through citizen-science) (Wilson *et al.,* 2017).

The success of early detection (and therefore rapid response) relies on (modified from Westbrooks, 2004):

1) **Identification** of the target species by both scientists and the public;
2) **Reporting of new occurrences** through centralised portals (such as online tools);
3) **Verification** of target species identity by experts;
4) **Reviewing the geographical extent** of an infestation, for example, where new occurrences have been reported and how quickly the target is spreading;
5) **Assessment of biodiversity and economic risks** posed by the species by experts (see EPPO, 2016 for *C. camphora* assessment);
6) **Establishing an eradication plan** for the target species; and
7) **Rapidly responding** by reporting all available information to authorities responsible for rapid eradication.

The likelihood of detection through active surveillance is related to ease of identification of the target species, its distinctiveness from surrounding vegetation, and the accessibility of potential sites of occurrences (Wilson *et al.*, 2017). Moreover, completely random or unbiased survey techniques may be unlikely to detect new cryptic invaders, especially if sampling intensity and completeness is constrained by costs. It is therefore advisable that areas most suitable for the establishment of the target species should be surveyed first for new occurrences, especially when large areas are to be surveyed (Stohlgren and Schnase, 2006). Given the apparent and overall climatic unsuitability in Europe for the establishment of *C. camphora*, such surveillance exercises should initially be concentrated on the limited areas in the Mediterranean and Black Sea biogeographical regions that were previously identified as having only marginal suitability for the establishment of *C. camphora* (EPPO, 2016). Together with surveillance, a review of historical plantings/known occurrence records (herbaria records, botanical garden planting records, etc.) should be conducted to determine documented known occurrences of the species. Areas surrounding known plantings of *C. camphora* should be prioritised for surveillance efforts for new instances of naturalisation or invasion. Such sites can serve as 'sentinel sites' (*sensu* Wilson *et al.*, 2017) for active surveillance efforts.

Misidentification of *C. camphora* as *C. granduliferum* has been noted (EPPO, 2016) but, as indicated elsewhere in this report, trained staff should easily be able to discriminate between these two species. Site accessibility also plays a role in the likelihood of detectability (Wilson *et al.*, 2017). Given that most *C. camphora* trees in Europe are most commonly planted individuals in urban areas, and as spread is only likely to occur close to these sites, accessibility to surveillance sites is expected to be high.

Active surveillance can be supported by remote sensing, especially for populations in disturbed and peri-urban areas, or sites not easily accessible to ground teams (Turner *et al.,* 2003). Outside of forested areas, these environments would enable the detection of spectral signatures that are unique to *C. camphora* and would allow detection and mapping of the species with relative ease.

EFFECTIVENESS OF THE SURVEILLANCE

The likelihood of successful detection is reliant on how easy it is to identify *C. camphora*. As *C. camphora* is a large tree and relatively easy to identify through distinct morphological characteristics, it is perceived to be easily identified and detected by trained and skilled staff in natural and semi-natural habitats, especially outside of forested areas. Detectability is also reliant on the extent of established populations and their accessibility to surveillance teams. As all known *C. camphora* occurrences in Europe are from urban and peri-urban areas (EPPO, 2016), these limiting factors will have negligible impact on detectability.

There have been some reports of the misidentification of *C. camphora* as *C. granduliferum*. *Cinnamomum camphora* can be easily distinguished from the latter by leaf nervation together with its strongly camphor-scented bark, leaves, and branches (EPPO, 2016).

EFFORT REQUIRED

Compiling known occurrence records of *C. camphora* through initial desktop studies, especially in the Mediterranean and Black Sea biogeographical regions, can be achieved over a short amount of time and with limited staff requirements. Surveillance of 'sentinel' sites should also be easily achieved within a reasonable timeframe, as these sites are mostly known from urban and peri-urban settings, making vehicular surveys possible. Surveillance in semi-natural or natural environments would require more time and would be dependent on the area earmarked for surveillance as well as the accessibility of sites. Remote sensing may be particularly useful for detection and mapping of *C. camphora* under these circumstances.

RESOURCES REQUIRED

Direct cost estimates for active surveillance of *C. camphora* are not available. Initial surveillance efforts would require at least one coordinator responsible for compiling and distributing a comprehensive list of known occurrences by identifying possible sentinel sites. In Member States where the species is present, such sentinel sites would require active surveillance around planting sites for any new occurrences of the species, and will require additional resources (staff, travel expenses, etc.).

SIDE EFFECTS

Active surveillance may result in detection of additional unwanted and invasive taxa. Active surveillance by trained staff will have negligible impact through disturbance, on biodiversity in survey sites.

ACCEPTABILITY TO STAKEHOLDERS

High acceptability by stakeholders is expected.

ADDITIONAL COST INFORMATION

Direct estimates of costs associated with early detection of *C. camphora* are not available. The costs and benefits of early detection and rapid response will however outweigh potential costs associated with the management of dense infestations (Rejmánek and Pitcairn, 2002).

LEVEL OF CONFIDENCE[1]

High.

Given the ease of identification of the species by experts and trained staff, the limited potential distribution of *C. camphora* in Europe, and known occurrences of the species in Europe, early detection, before the species becomes widespread, is feasible.

Citizen-science.

MEASURE DESCRIPTION

Citizen-science can be an invaluable source of information for invasive species management and has been shown to contribute to the increased detection and management of invasive populations (for example, in Portugal, Marchante and Marchante, 2016). Information sources such as pamphlets, factsheets, social media, popular magazine articles, and identification apps, highlighting potentially invasive species, have been found to play an important role in raising public awareness about their potential impacts and have led to the reporting of new occurrences (Maistrello *et al.,* 2016). For example, in Europe, the European Alien Species Information Network (EASIN) provides applications for alien species identifications (see https://easin.jrc.ec.europa.eu/NewsAndEvents/DetailNews/5aa5e059-c15c-4724-8ff0-9662c0f471d0?AspxAutoDetectCookieSupport=1). Similarly, in Portugal a dynamic webpage (www.invasoras.pt) that includes a citizen-science platform (online maps and android apps) provides valuable reports of new sightings of invasive species (Marchante *et al.,* 2016).

For *C. camphora* passive surveillance must include the distribution of printed or electronic media that includes background information, an identification guide, and areas where the species is likely to be found. Contact information where new sightings can be reported must also be included in these materials.

EFFECTIVENESS OF THE SURVEILLANCE

Species-specific information on the effectiveness of passive surveillance approaches in detecting new *C. camphora* records is scant. In other Mediterranean-type climate regions (such as South Africa), citizen-science has contributed to the reporting of new occurrences of *C. camphora* (see https://www.ispotnature.org/communities/southern-africa/species-dictionary/48711/cinnamomum-camphora/observations). However, the general helpfulness of passive surveillance in detecting new occurrences of species is well documented. For example, information pamphlets for the invasive tree, *Acacia stricta*, in South Africa, have facilitated the identification (detection) of previously

1 See Appendix

unknown populations of this tree during an eradication attempt (Kaplan *et al.*, 2012). Similarly, in Europe, citizen-science helped in establishing new occurrence records and enhanced early detection of the Asian brown marmorated stinkbug, *Halyomorpha halys* (Maistrello *et al.,* 2016). At country-level, citizen and volunteer science has contributed tremendously to surveillance efforts of invasive species and the recording of new occurrences (for example, in Britain, Roy *et al.*, 2015).

EFFORT REQUIRED

This measure would be continuous but with relatively low resource requirements. Resources would need to be put in place for the production and distribution of public awareness information (such as factsheets, pamphlets, websites and social media etc.), as well as the reporting of occurrences (such as websites, hotlines, etc.). Given the low overall bioclimatic suitability for establishment of *C. camphora* in Europe, the effort required for an awareness campaign for *C. camphora* would be relatively low compared to invasive species with wide potential distributions.

RESOURCES REQUIRED

Costs involved in the development of public awareness material are hard to estimate. However, the costs of implementing a successful public awareness campaign will be low compared to the costs incurred by managing widespread invasive species.

Low implementation costs are also linked to the fact that public awareness campaigns would only need to only focus on the limited areas within Europe with suitable climate conditions for *C. camphora*.

SIDE EFFECTS

None.

ACCEPTABILITY TO STAKEHOLDERS

High, as indicated elsewhere in this report.

ADDITIONAL COST INFORMATION

Inaction may lead to widespread invasive *C. camphora* populations. These may have substantial unforeseen economic and environmental impacts. Examples of these are listed under the *Additional cost information* in the *Rapid eradication* section below.

LEVEL OF CONFIDENCE[1]

Medium.

The cost-effectiveness of early detection is perceived to be high. Numerous aspects make early detection through passive surveillance (for small *C. camphora* populations) highly likely in Europe: 1) limited number of climatically suitable areas for establishment in Europe (EPPO, 2016); 2) distinctiveness, and therefore ease of identification, of mature *C. camphora* trees.

1 See Appendix

Measures to achieve rapid eradication after an early detection of a new occurrence.

Prioritising mature trees near waterways for felling and stump removal or treatment.

MEASURE DESCRIPTION

A fundamental prerequisite for any eradication attempt to succeed is the delimitation of the extent of occurrences of the target species in order to confirm whether eradication is indeed a viable intervention option or not (Wilson *et al.*, 2017). Currently the extent of known occurrences of *C. camphora* in Europe appears highly restricted. For example, the species is recorded (but not as invasive) in France, Portugal, and Spain. In France, a single occurrence is recorded growing near Bordeaux. The species occurs in other European countries (for example, the Netherlands, Italy and Germany) but only as planted specimens in gardens.

Eradication approaches against *C. camphora* in areas where the species is already invasive, for example, in Australia, are informative on how rapid eradication of newly detected small *C. camphora* infestations in Europe can be achieved. In low density populations (the typical target of eradication efforts) smaller trees (up to 10 cm in diameter) can be lopped and the stumps treated with chemicals to avoid resprouting (Firth 1981, also see chemical control below under *Management* for details). Professional tree arborists can cut down larger mature trees, but stumps should be ground out of the ground or treated chemically to avoid resprouting. The latter is a particularly good technique in urban and peri-urban areas, the typical known habitat of the tree in Europe.

Individual *C. camphora* trees have been found to produce hundreds of thousands of seeds (Firth, 1981). As seeds can be dispersed by water and frugivorous birds, mature *C. camphora* trees capable of fruiting, and those found in close proximity to waterways, should be prioritised for eradication to minimise any further spread via seeds. Annual follow up and monitoring should be conducted for a minimum period of 3 years at all eradication sites where mature fruiting trees were present in order to monitor for the re-emergence of *C. camphora* through resprouting or seedling recruitment. Follow up and monitoring are recommended for three years as, although *C. camphora* seeds have low fecundity under field conditions (Panetta, 2001), seed banks can remain viable under suitable microclimatic conditions for up to 3 years (CABI, 2017).

EFFECTIVENESS OF MEASURE

Taxon-specific estimates of the effectiveness of various eradication measures are almost non-existent. The following considerations make *C. camphora* an ideal candidate for eradication. According to Panetta's (2015) general classification scheme on eradication feasibility, *C. camphora* would be deemed a highly feasible eradication target because 1) the species has a relatively short-lived seed bank (< 3 years, Panetta, 2001) and low seed viability under natural conditions (Panetta, 2001); 2) once introduced, the species is mostly dispersed naturally and not by humans; and 3) the species has a long juvenile period (7 years, Firth and Ensbey, 2014). Also, a recent assessment found most European climate conditions to be unfavourable for the establishment of *C. camphora* (EPPO, 2016). This would reduce the likelihood of extensive spread from existing populations/plantings and therefore the potential area that needs to be considered during eradication operations. The latter is important as Rejmánek and Pitcairn (2002) found eradication to be successful in 30% of cases when infestations were less than 100 hectares (ha), dropping to 25% success when infestations are between 101–1,000 ha. Eradication is therefore perceived to be highly effective if *C. camphora* infestations are not dense and geographically restricted.

EFFORT REQUIRED

The amount of effort required for successful eradication efforts would be dependent on the density and extent of target populations. Low-density populations should be easily removed using the measures described above. All sites where eradication has been attempted should be revisited for follow-up monitoring once a year (for up to 3 years) to identify any instances of re-emergence (seedling recruitment or coppicing).

RESOURCES REQUIRED

This will be dependent on the size of infestations targeted for eradication. For example, according to South Africa's Working for Water Programme, an extensive invasive species management programme aimed at clearing invasive trees, between 1,000–2,000 person-days are needed to clear and apply cut stump treatments to 100 ha of dense invasive trees (Kraaij *et al.*, 2017). These figures are likely applicable across various countries when similar approaches are used. Initial eradication of small and isolated populations of *C. camphora* (tens of hectares) should be feasible at relative low cost.

SIDE EFFECTS

Cutting/felling of individual trees is species-specific, especially when executed by trained staff, and therefore will have limited non-target impacts. Similarly, in instances where localised chemical treatment is used (cut stump treatment), non-target impacts will be limited as herbicides are not broadly applied.

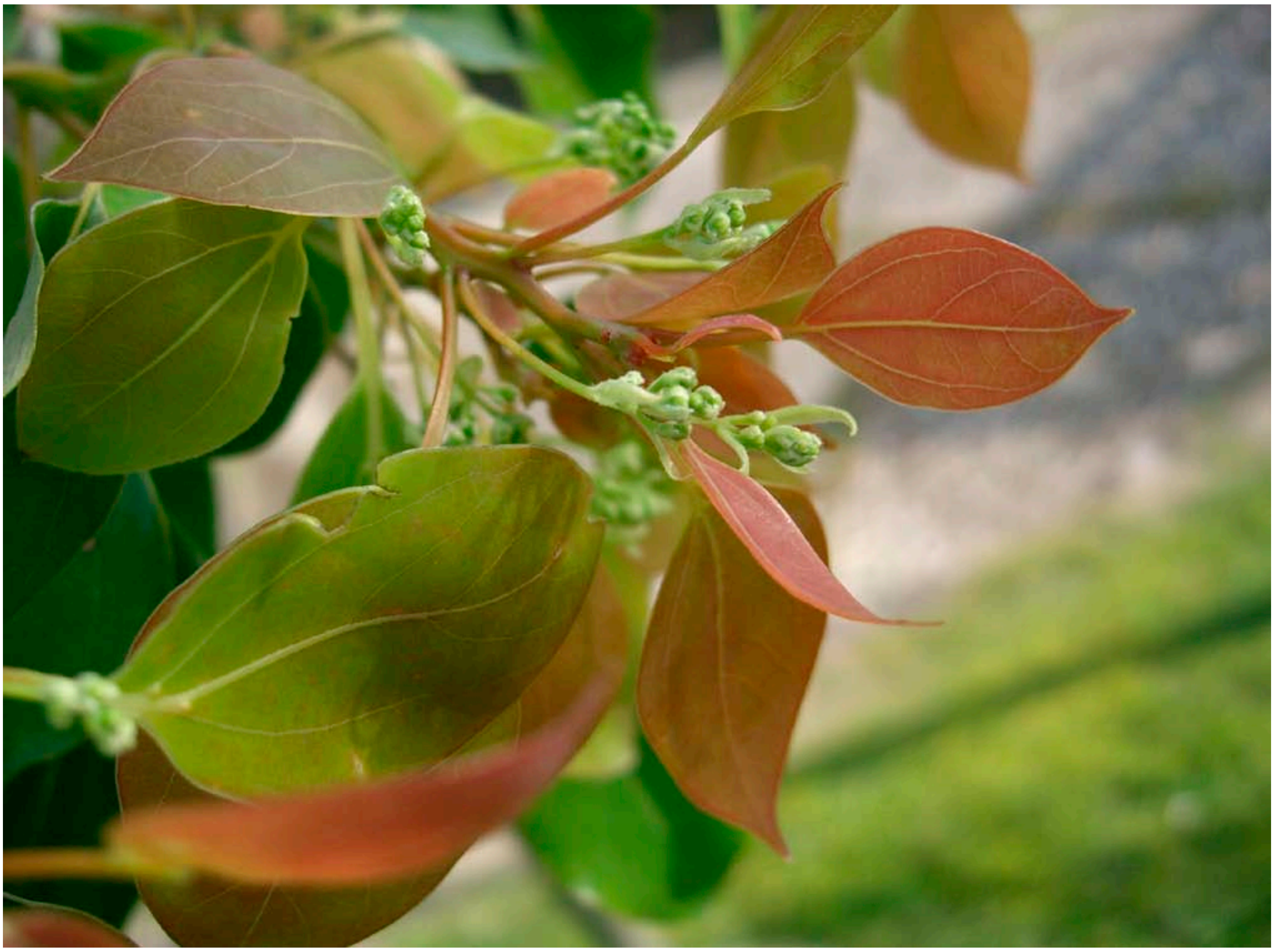
ACCEPTABILITY TO STAKEHOLDERS

Given the low commercial value of *C. camphora* as an ornamental species in Europe, eradication efforts are expected to enjoy high acceptability from all stakeholders (incl. public and nursery owners) and without any conflicts of interest. The use of chemical control of isolated individuals of *C. camphora* is likely to be acceptable to most stakeholders, including the general public, staff, environmental and land managers, and conservation officials due to the localized application (stump application) with very low likelihood of non-target impacts and environmental contamination. It is noteworthy to mention that elsewhere in the world conflicts of interest around the management of *C. camphora* have occurred. For example, in Bellingen, Australia, *C. camphora* trees were considered heritage trees, and an important source of shade. Therefore, efforts to control infestations failed, as the removal of four 90-year-old trees in the downtown area of Bellingen created controversy over more than 1 million trees growing outside the town (Dickie *et al.,* 2014).

ADDITIONAL COST INFORMATION

The cost-effectiveness of successful eradications far exceeds costs associated with the management of widespread invasive populations, and therefore, costs of inaction can be substantial. Increases in infestation sizes also dramatically increase the costs associated with eradication attempts (Rejmánek and Pitcairn, 2002). Therefore, early eradication of localized/restricted populations of invasive species can avoid more costly and continuous management down the line. In Australia, the removal of large *C. camphora* trees in dense infestations is extremely expensive and the species often regenerates through coppicing after felling (Firth and Ensbey, 2014). Kanowski and Catterall (2007) estimate costs of removing trees in rainforest habitats in Australia, where *C. camphora* is invasive, to vary between 5,000 and 30,000 AUS$ (ca. € 3,400–20,000) per hectare (ha). Similarly, Kaplan *et al.,* (2012) estimated that successful eradication of 96 ha of the invasive woody tree, *Acacia*

Close-up photo of Cinnamomum camphora*'s leaves and budding flowers. © KENPEI. CC BY-SA 3.0.*



stricta, in South Africa, would require ca. 1.5 million ZAR (€ 100,500) in funding. Some sources provide additional anecdotes of the economic effects associated with dense infestations of *C. camphora*, such as the devaluation of grazing land (CABI, 2017).

Following eradication operations, regular follow up and monitoring of target sites is needed and would add additional costs for staff, travel expenses, and possible ongoing eradication operations. Seeds of *C. camphora* do not survive long in natural habitats (Panetta, 2001), and overall seed banks are relatively short-lived (> 3 years, CABI, 2017), meaning that follow up operations (monitoring) are only needed for up to 3 years.

Eradication failure can have potential unforeseen socio-economic impacts. For example, *C. camphora* is a host for *Xyleborus glabratus* (redbay ambrosia beetle), a vector of *Rafaela lauricola*, a fungus that causes laurel wilt disease. Laurel wilt disease can impact commercially important trees like avocado (*Persea americana)* and other species in the Lauraceae family (Mayfield *et al.*, 2008). Both redbay ambrosia beetle and *R. lauricola* are currently absent in Europe, but *R. lauricola* can be transferred from potentially diseased *C. camphora* trees to other insects in Europe. The main areas at risk of impacts by laurel wilt disease in Europe are laurel forests and avocado production areas in Mediterranean countries such as Spain, areas also suitable for establishment of *C. camphora*.

Lastly, successful rapid eradication of *C. camphora,* before the species potentially becomes a popular ornamental tree in Europe, would safeguard against future costs associated with future conflict-resolution and stakeholder engagement.

LEVEL OF CONFIDENCE[1]

High.

The eradication measures described above are perceived to be highly effective if infestations are limited in geographic extent. Based on primary literature all described measures have been successfully used against *C. camphora*.

1 See Appendix

Chemical control using herbicides.

MEASURE DESCRIPTION

Chemical control has been used against *C. camphora* elsewhere (such as in Australia) by using various applications, including cut stump, stem injection, basal bark or foliar sprays (Firth and Ensbey, 2014). Overall, effective chemical control is obtained by spraying seedling trees up to 3 metres in height with triclopyr + picloram, or a strong solution of glyphosate. Established trees are killed by injecting concentrated solutions of glyphosate, triclopyr or picloram, ensuring that the chemical is administered around the entire circumference of all stems below approximately 1 m from ground level immediately following cutting.

The method of chemical treatment employed depends on the type of herbicide being used, the size/age of the trees, and the accessibility of sites (Firth and Ensbey, 2014). The various application rates and uses of chemicals known to be effective against *C. camphora* are listed below.

It is important to note that EU/national/local legislation on the use of plant protection products and biocides needs to be respected and authorities should check to ensure chemicals are licensed for use in their respective countries/regions.

Chemicals, application rates and uses against *C. camphora* (modified from State of Queensland, Department of Agriculture and Fisheries, 2016. Camphor laurel Factsheet, web link below):

1) Triclopyr 300 g/l + picloram 100 g/l (such as Conqueror), application rate: 350–500 ml/100 l water. For high-volume spraying of trees up to 3 m tall and higher rate (500 ml/100 l) for trees > 2 m tall.
   Application rate of 500 ml/10 l water for use as high concentration/low volume application (gas gun or sprinkler sprayer) for trees less than 1.5 m tall that can be sprayed from all sides.
2) Triclopyr 300 g/l + picloram 100 g/l + aminopyralid 8 g/l (such as Grazon Extra), application rate: 350–500 ml/100 l water for high concentration/low volume application (gas gun or splatter gun) on trees less than 1.5 m tall.
3) Triclopyr 600 g/l (for example, Garlon 600), application rate: 170 ml/100 l water for high-volume foliar spray for trees up to 3 m tall. Application rate of 1 l in 60 l diesel for use on basal bark trees to 10 cm diameter or cut stump trees.
4) Triclopyr 200 g/l + picloram 100 g/l (such as Slasher), application rate: 1-part herbicide to 4 parts water for stem injection application.
5) Triclopyr 200 g/l + picloram 100 g/l + aminopyralid 25 g/l (such as Tordon RegrowthMaster), application rate: 1-part herbicide to 4 parts water for stem injection application.
6) Glyphosate 360 g/l (such as Roundup®), application rate of 2 ml of 1:1 mix with water for stem injection for trees up to 25 cm in diameter or 2 ml undiluted glyphosate for stem injection of trees 25–60 cm in diameter. 4 ml of undiluted glyphosate per drill hole / axe cut. For spraying of seedlings and resprouting shoots an application rate of 1-part glyphosate to 50 parts water is recommended, while 1-part glyphosate to 1.5 parts water is recommended for cut stump/scrape stem application for saplings and stem injection application for large trees.

State of Queensland, Department of Agriculture and Fisheries, 2016. Camphor laurel Factsheet: https://www.daf.qld.gov.au/__data/assets/pdf_file/0003/65181/IPA-Camphor-Laurel-PP46.pdf

EFFECTIVENESS OF MEASURE

Chemical control of *C. camphora* has been shown as effective in managing small infestations (Firth and Ensbey, 2014). For high density and widespread infestations chemical control is unlikely to be an effective measure for the sustained management of the species given the effort and resources required, the potential for environmental impacts associated with chemical control, the species' ability to resprout, and the potential of creating conflicts of interest due to risk perceptions by the general public. Evidence from other areas, including Australia and South Africa, where the species is highly invasive and widespread, suggest that chemical control has not contributed to the successful management of dense *C. camphora* infestations (Firth and Ensbey, 2014).

EFFORT REQUIRED

The amount of effort required would be directly related to the geographic and demographic characteristics (age structure and extent) of *C. camphora* infestations. Larger infestations containing mature individuals would require longer time periods and more resources (staff and equipment) than less dense infestations consisting mostly of smaller individuals.

RESOURCES REQUIRED

It is difficult to estimate the direct costs (ground staff, person day hours, equipment, chemicals, etc.) required, as these will all be dependent on the density and extent of *C. camphora* infestations. Examples from literature indicate that for fairly localised infestations with limited extent, chemical control can be costly. For example, Kaplan *et al.,* (2012) estimated that in South Africa, chemical treatment of a 96 ha infestation of the invasive woody tree, *Acacia stricta*, would require ca. 1.5 million ZAR (€ 100,500) in funding. It is noteworthy that the latter relates to resource requirements estimated for complete eradication, and not just management.

SIDE EFFECTS

Environmental contamination poses a significant threat in instances where chemical control of any invasive species occurs, especially in the close proximity to waterways. Such contamination may negatively affect both public health and biodiversity. For example, herbicides like picloram (often used against *C. camphora* – see above) can persist in soils for several years, therefore impacting on all susceptible plants present in seed banks, including natives, over long periods (Ortega and Pearson, 2011).

Herbicides are generally not target-specific and broad applications (such as spraying) will lead to impacts on most vegetation present at management sites, thereby posing a risk to native biodiversity. For example, herbicides such as picloram are selective for broadleaved plants and will impact on both native and non-native broadleaves, and can in turn promote invasion by grasses, leading to biodiversity impacts such as reduced native species richness and abundance (Ortega and Pearson, 2011).

Herbicides can have impacts on physical soil properties, soil chemistry, and soil microbial populations, but these will be dependent on herbicide concentration and initial soil conditions (Haney *et al.*, 2000). For example, herbicides can reduce the growth and function of mycorrhizal fungi which in turn reduces the ability of native plants to absorb and translocate soil nutrients (Haney *et al.,* 2000).

Large dead herbicide-treated trees could pose a hazard to humans due to falling of dead debris, like branches and stumps.

ACCEPTABILITY TO STAKEHOLDERS

Extensive use of chemical control for the management of widespread populations of *C. camphora* is unlikely to be acceptable to most stakeholders, including the general public, staff, environmental and land managers, and conservation officials, due to concerns about indirect health and environmental impacts. For these reasons the use of many herbicides is forbidden in some European countries.

ADDITIONAL COST INFORMATION

Included above.

LEVEL OF CONFIDENCE[1]

Medium.

Chemical control of *C. camphora* has failed (such as in Australia and South Africa) as an effective management strategy against dense and widespread invasive populations (Firth and Ensbey, 2014). For such infestations stakeholder acceptability of chemical control is likely to be low given concerns about non-target (biodiversity) and other environmental (contamination) impacts. However, for localised management of less dense infestations chemical control may be effective and acceptable to stakeholders as a management approach.

Mechanical control.

MEASURE DESCRIPTION

Mechanical control has been applied against *C. camphora* invasions outside Europe, most notably in Australia. Saplings can be hand pulled and smaller trees can be cut down easily, but the stumps of the latter can rapidly resprout, so they must be ground out or treated chemically (Firth, 1981, see section on chemical control under *Management* above). Professional tree arborists can cut down larger trees and grind the stump out of the ground. This approach is especially desirable in urban areas, roadsides and backyards where the tree needs to be totally removed.

Bulldozing is effective at removing entire trees and over larger areas, but is extremely expensive (Firth and Ensbey, 2014). Following the removal of large trees, continuous mowing will kill resprouting shoots, and burning can be effective, but larger trees often resprout following controlled fires (Queensland Government, 2016).

EFFECTIVENESS OF MEASURE

No direct data on the effectiveness of mechanical control of *C. camphora* is available, but in general even the most resource-rich clearing operations using mechanical means

1 See Appendix

Leaves and flowers of the camphor tree. © KENPEI. CC BY-SA 3.0.

usually fail to manage dense infestations to acceptable levels (van Wilgen *et al.*, 2012). Known mechanical control options against *C. camphora* come from regions including Australia and South Africa and they have had limited success in the management of invasive populations.

EFFORT REQUIRED

Effort associated with mechanical control will be directly related to the extent, density and age structure of *C. camphora* infestations and is difficult to estimate. Mechanical control would likely require continuous implementation if practitioners were faced with widespread and dense infestations. More localised infestations may require shorter time periods. As with all management approaches, mechanically cleared sites would need regular follow-up for at least three years (see description elsewhere in this report) to monitor management sites for resprouting and seedling recruitment.

RESOURCES REQUIRED

Mechanical control of *C. camphora* is expensive in terms of human resources (for example, professional tree arborists, ground staff, etc.) and equipment needs (bulldozers and industrial mowers). Treatment sites will require regular follow up and monitoring for the re-emergence of *C. camphora* either as seedlings from stored seed banks or resprouting individuals which would add additional costs (staff, travel expenses and possible follow-up control).

SIDE EFFECTS

With the exception of hand pulling, cutting and felling, all other mechanical control options will also impact on all vegetation components (native or non-native) in treatment areas during clearing operations. Unless desirable ground cover is immediately established, extensive clearing of *C. camphora* can lead to soil erosion, especially on slopes (CABI, 2017). The mechanical removal of entire trees will also result in high levels of soil disturbance that will encourage further invasions of *C. camphora* or other successional non-native species (Firth and Ensbey, 2014).

ACCEPTABILITY TO STAKEHOLDERS

Mechanical control of low density and localised infestations by felling and continuous mowing is expected to be acceptable to stakeholders, especially in areas where control will lead to the complete clearing of the species. Larger infestations may receive less public support due to perceived negative environmental impacts caused by disturbance.

ADDITIONAL COST INFORMATION

In addition to what has been included elsewhere in this document, mechanical control may incur additional costs. Restoration through the sowing of pasture or native species may be needed to reduce regeneration and recolonization of *C. camphora* and other invasive species following mechanical control (Firth and Ensbet, 2014), especially where high levels of disturbance is expected (such as bulldozing). These measures will add additional costs.

LEVEL OF CONFIDENCE[1]

Medium.

Mechanical control is not deemed an effective management strategy when *C. camphora* infestations are dense and widespread, as evidenced from countries such as Australia. However, for localised management of less dense infestations mechanical control is likely to be effective.

Biological control.

MEASURE DESCRIPTION

Biological control involves the deliberate introduction of host-specific pests or pathogens from the target species' native range into its invasive range, with the aim of reducing population densities and/or slowing further spread of the target weed. Biological control is generally perceived as being highly cost-effective and environmentally benign (van Wilgen *et al.*, 2004).

1 See Appendix

While various pests and diseases have been recorded to affect *C. camphora* in its native range (CABI, 2017), most of these appear to be generalist herbivores and pathogens. There are no known biological control agents for *C. camphora* and, to date, no biological control programme has been initiated for this species.

For any possible future biological control programs targeting *C. camphora* in Europe it should be noted that the release of macro-organisms as biological control agents is currently not regulated at EU level. Nevertheless national/regional laws are to be respected. Before any release of an alien species as a biological control agent an appropriate risk assessment should be made.

EFFECTIVENESS OF MEASURE

No information is available on biological control of *C. camphora*. The effectiveness of biological control programmes around the world is well known (van Wilgen *et al.*, 2004). Biological control is often the only sustainable and continuous management option when the extent and density of invasions preclude the successful application of other management actions like chemical and mechanical control (McFayden, 1998). The likelihood of a successful biological control programme for *C. camphora* in Europe can be perceived to be low given the apparent bioclimatic mismatch between Europe and the native range of *C. camphora* (EPPO, 2017). Climatic mismatches have been cited as the main reason for the establishment failure of many biological control agents released globally (Hoelmer and Kirk, 2005, and references therein). The risks of potential non-target impacts on native European laurels are perceived to be low should host-specific biological agents against *C. camphora* be tested and released in the future. This is because *C. camphora* has no close relatives in Europe. *Cinnamomum camphora* belongs to the tribe Cinnamomeae, comprising more than 500 species, none of which are native to Europe (Berry, 1914).

EFFORT REQUIRED

Not known for *C. camphora*.

RESOURCES REQUIRED

Generally, the implementation of biological control programmes is costly and includes costs associated with the exploration for potential control agents, testing for efficiency on the target species and possible non-target impacts, compliance for regional/local legislation, etc. For example, McFayden (1998) estimated that, in 1997, the testing and release of a single biological control agent required on average three scientist-years, totalling US$ 460,000 (ca. € 395,000), including technical support and facilities.

SIDE EFFECTS

Not known for *C. camphora.*

ACCEPTABILITY TO STAKEHOLDERS

Not known for *C. camphora.*

ADDITIONAL COST INFORMATION

Not known for *C. camphora*

LEVEL OF CONFIDENCE[1]

Low

No research/data related to the biological control of *C. camphora* is currently available.

1 See Appendix

Bibliography

Berry, E.W. (1914). The affinities and distribution of the Lower Eocene flora of southeastern North America. *Proceedings of the American Philosophical Society*, *53*(214), 129–250.

CABI. (2017). Invasive Species Compendium. Retrieved from www.cabi.org/isc/datasheet/13519.

Dickie, I., Bennett, B., Burrows, L., Nuñez, M.A., Peltzer, D.A., Porté, A., Richardson, D.M., Rejmánek, M., Rundel, P.W. and van Wilgen, B.W. (2014). Conflicting values: ecosystem services and invasive tree management. *Biological Invasions*, *16*(3), 705–719. http://dx.doi.org/10.1007/s10530-013-0609-6

Eaton, B.J. (1912). Camphor from *Cinnamomum camphora* (the Japanese camphor tree): cultivation and preparation in the Federated Malay States, Bulletin no. 15 (Kuala Lumpur: Department of Agriculture, Federated Malay States).

EPPO. (2016). Pest risk analysis for *Cinnamomum camphora*. EPPO, Paris.

Essl, F., Nehring, S., Klingenstein, F., Milasowszky, N., Nowack, C. and Rabitsch, W. (2011). Review of risk assessment systems of IAS in Europe and introducing the German-Austrian Black List Information System (GABLIS). *Journal for Nature Conservation*, *19*(6), 339–350. https://doi.org/10.1016/j.jnc.2011.08.005

Firth, D.J. (1981). Camphor laurel (*Cinnamomum camphora*) - a new weed in north-eastern New South Wales. *Australian Weeds*, *1*(2), 26–28.

Firth, D.J. and Ensbey, R. (2014). Camphor laurel. New South Wales WeedWise Factsheet. http://weeds.dpi.nsw.gov.au/Weeds/Details/28

GBIF. (2017). Secretariat: GBIF Backbone Taxonomy http://www.gbif.org/species/search?q=Cinnamomum+camphora

Haney, R.L., Senseman, S.A., Hons, F.M. and Zuberer, D.A. (2000). Effects of glyphosate on soil microbial activity and biomass. *Weed Science 48*(1), 89–93. https://doi.org/10.1614/0043-1745(2000)048[0089:EOGOSM]2.0.CO;2

Henderson, L. (2001). *Alien weeds and invasive plants*. Agricultural Research Council, Cape Town, South Africa.

Hoelmer, K.A., Kirk, A.A. (2005). Selecting arthropod biological control agents against arthropod pests: Can the science be improved to decrease the risk of releasing ineffective agents? *Biological Control*, *34*(3), 255–64. https://doi.org/10.1016/j.biocontrol.2005.05.001

Hulme, P.E. (2015). Invasion pathways at a crossroad: Policy and research challenges for managing alien species introductions. *Journal of Applied Ecology*, *52*(6), 1418–1424. https://doi.org/10.1111/1365-2664.12470

Humair, F., Humair, L., Kuhn, F., and Kueffer, C. (2015). E-commerce trade in invasive plants. *Conservation Biology*, *29*(6), 1658–1665. https://doi.org/10.1111/cobi.12579

Jordan, L.A., Johnson, S.D., Downs, C.T. (2011). The role of avian frugivores in germination of seeds of fleshy-fruited invasive alien plants. *Biological Invasions*, *13*(8), 1917–1930. https://doi.org/10.1007/s10530-011-0013-z

Kanowski, J. and Catterall, C.P. (2007). Converting stands of camphor laurel to rainforest. What are the costs and outcomes of different control methods? Griffith University. https://www.griffith.edu.au/__data/assets/pdf_file/0006/75786/Camphor-conversion-factsheet-NRCMA-Final.pdf

Kaplan, H., van Zyl, H.W.F., Le Roux, J.J., Richardson, D.M. and Wilson, J.R.U. (2012), Distribution and management of *Acacia implexa* (Benth.) in South Africa: A suitable target for eradication? *South African Journal of Botany*, *83*, 23–35. http://dx.doi.org/10.1016/j. sajb.2012.07.016

Kraaij, T., Baard, J.A., Rikhotso, D.R., Cole, N., and van Wilgen, B.W. (2016). Assessing the effectiveness of invasive alien plant management in a large Fynbos protected area. *Bothalia 47*(2), a2105. https://doi.org/10.4102/abc.v47i2.2105

Leung, B., Lodge, D.M., Finnoff, D., Shogren, J.F., Lewis, M.A. and Lamberti, G. (2002). An ounce of prevention or a pound of cure: bioeconomic risk analysis of invasive species. *Proceedings: Biological Sciences, 269*(1508), 2407–2413. https://doi.org/10.1098/rspb.2002.2179

Lockwood, J.L., Cassey, P., Blackburn, T. (2005). The role of propagule pressure in explaining species invasions. *Trends in Ecology and Evolution*, *20(5)*, 223–28. https://doi.org/10.1016/j.tree.2005.02.004

Maistrello, L., Dioli, P., Bariselli, M. and Forini Giacalone, I. (2016). Citizen science and early detection of invasive species: phenology of first occurrences of *Halyomorpha halys* in Southern Europe. *Biological Invasions*, *18*(11), 3109–3116. https://doi.org/10.1007/s10530-016-1217-z

Marchante, H., Morais, M.C., Gamela, A. and Marchante, E. (2016). Using a WebMapping platform to engage volunteers to collect data on invasive plants distribution. *Transactions in GIS*, *21*(2), 238–252. https://doi.org/10.1111/tgis.12198

Marchante, E. and Marchante, H. (2016). Engaging society to fight invasive alien plants in Portugal—One of the main threats to biodiversity. In P. Castro, U. M. Azeiteiro, P. Bacelar-Nicolau, W. Leal Filho and A. M. Azul (Eds.), *Biodiversity and education for sustainable development* (pp. 107–122). Cham: Springer.

Mayfield, A.E., Crane, K.H. and Smith, J.A. (2008). Laurel wilt: a threat to redbay, avocado and related trees in urban and rural landscapes. University of Florida. http://miami-dade.ifas.ufl.edu/pdfs/tropical_fruit/Laurel%20wilt%20Rural%20and%20Urban%20Landscapes.pdf

McFadyen, R.E.C. (1998). Biological control of weeds. *Annual Review of Entomology*, *43*, 369–393. https://doi.org/10.1146/annurev.ento.43.1.369

Novoa, A., Le Roux, J.J., Richardson, D.M., and Wilson, J.R.U. (2017). Level of environmental threat posed by horticultural trade in Cactaceae. *Conservation Biology,* https://doi.org/10.1111/cobi.12892

Ortega, Y.K. and Pearson, D.E. (2011). Long-term effects of weed control with picloram along a gradient of spotted knapweed invasion. *Rangeland Ecology and Management, 64*(1), 67–77. https://doi.org/10.2111/REM-D-10-00034.1

Panetta, F.D. (2001). Seedling emergence and seed longevity of the tree weeds *Celtis sinensis* and *Cinnamomum camphora*. *Weed Research*, *41*(1), 83–95. https://doi.org/10.1046/j.1365-3180.2001.00220.x

Panetta, F.D. (2015). Weed eradication feasibility: lessons of the 21st century. *Weed Research, 55*(3), 226–38. https://doi.org/10.1111/wre.12136

Rejmánek M., Pitcairn, M.J. (2002). When is eradication of exotic pest plants a realistic goal? In C.R. Veitch, and M.N. Clout (Eds.), *Turning the Tide: the Eradication of Invasive Species* (pp. 249–53). IUCN SCC Invasive Species Specialist Group, Gland, Switzerland.

Roy, H.E., Rorke, S.L., Beckmann, B., Booy, O., Botham, M.S., Brown, P.M.J., Harrower, C., Noble, D., Sewell, J. and Walker, K. (2015). The contribution of volunteer recorders to our understanding of biological invasions. *Biological Journal of the Linnean Society, 115*(3), 678–689. https://doi.org/10.1111/bij.12518

Schenk, J.R. (2009). Phytochemistry, allelopathy and the capability attributes of camphor laurel (*Cinnamomum camphora* (L.) Ness and Eberm.) (Ph.D. Thesis). Southern Cross University, Lismore, New South Wales, Austrlia.

State of Queensland (2016) Camphor laurel. Factsheet. https://www.daf.qld.gov.au/__data/assets/pdf_file/0003/65181/IPA-Camphor-Laurel-PP46.pdf

Stohlgren, T.J., Schnase, J.L. (2006). Risk analysis for biological hazards: what we need to know about invasive species. *Risk Analysis*, *26*(1), 163–173. https://doi.org/10.1111/j.1539-6924.2006.00707.x

Thum, R.A., Mercer, A.T. and Wcisel, D.J. (2012). Loopholes in the regulation of invasive species: Genetic identifications identify mislabeling of prohibited aquarium plants. *Biological Invasions*, *14*(5), 929–937. https://doi.org/10.1007/s10530-011-0130-8

Turner, W., Spector, S., Gardiner, N., Fladeland, M., Sterling, E. and Steininger, M. (2003). Remote sensing for biodiversity science and conservation. *Trends in Ecology and Evolution 18*(6), 306–314. https://doi.org/10.1016/S0169-5347(03)00070-3

van Wilgen, B.W., de Wit, M.P., Anderson, H.J., Le Maitre, D.C., Kotze, I.M., Ndala, S., Brown, B. and Rapholo, M.B. (2004). Costs and benefits of biological control of invasive alien plants: case studies from South Africa. *South African Journal of Science*, *100*(1/2), 113–122. https://doi.org/10.4001/003.019.0228

van Wilgen, B.W., Forsyth, G.G., Le Maitre, D.C., Wannenburgh, A., Kotzé, J.D., van den Berg, E. and Henderson, L. (2012). An assessment of the effectiveness of a large, national-scale invasive alien plant control strategy in South Africa. *Biological Conservation*, *148*(1), 28–38. https://doi.org/10.1016/j.biocon.2011.12.035

Westbrooks, R.G. (2004). New approaches for early detection and rapid response to invasive plants in the United States. *Weed Technology, 18*(1), 1468–1471. https://doi.org/10.1614/0890-037X(2004)018[1468:NAFEDA]2.0.CO;2

Wilson, J. R., Panetta, F.D. and Lindgren, C. (2017). *Detecting and responding to alien plant incursions*. Cambridge, U.K: Cambridge University Press.

Appendix

High: Information comes from published material, or current practices based on expert experience applied in one of the EU countries or third country with similar environmental, economic and social conditions.

Medium: Information comes from published data or expert opinion, but it is not commonly applied, or it is applied in regions that may be too different from Europe (for example tropical regions) to guarantee that the results will be transposable.

Low: Data are not published in reliable information sources and methods are not commonly practiced or are based solely on opinion; this is for example the case of a novel situation where there is little evidence on which to base an assessment.

Your feedback is important. Any comments that could help improve this document can be sent to ENV-IAS@ec.europa.eu