EPPO Datasheet: *Celastrus orbiculatus*

Last updated: 2022-08-30

IDENTITY

Preferred name: *Celastrus orbiculatus*
Authority: Thunberg
Taxonomic position: Plantae: Magnoliophyta: Angiospermae: Fabids: Celastrales: Celastraceae
Other scientific names: *Celastrus articulatus* Thunb., *Celastrus insularis* Koidz., *Celastrus jeholensis* Nakai ex Nakai & Kitag., *Celastrus lancifolia* Nakai, *Celastrus stephanotiifolius* (Makino) Makino, *Celastrus strigillosus* Nakai, *Celastrus tatarinowii* Rupr., *Celastrus versicolor* Nakai
Common names: Asian bittersweet, Asiatic bittersweet, Chinese bittersweet, oriental bittersweet (US), round-leaved bittersweet, staff vine
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EPPO Categorization: A2 list
view more categorizations online...
EPPO Code: CELOR

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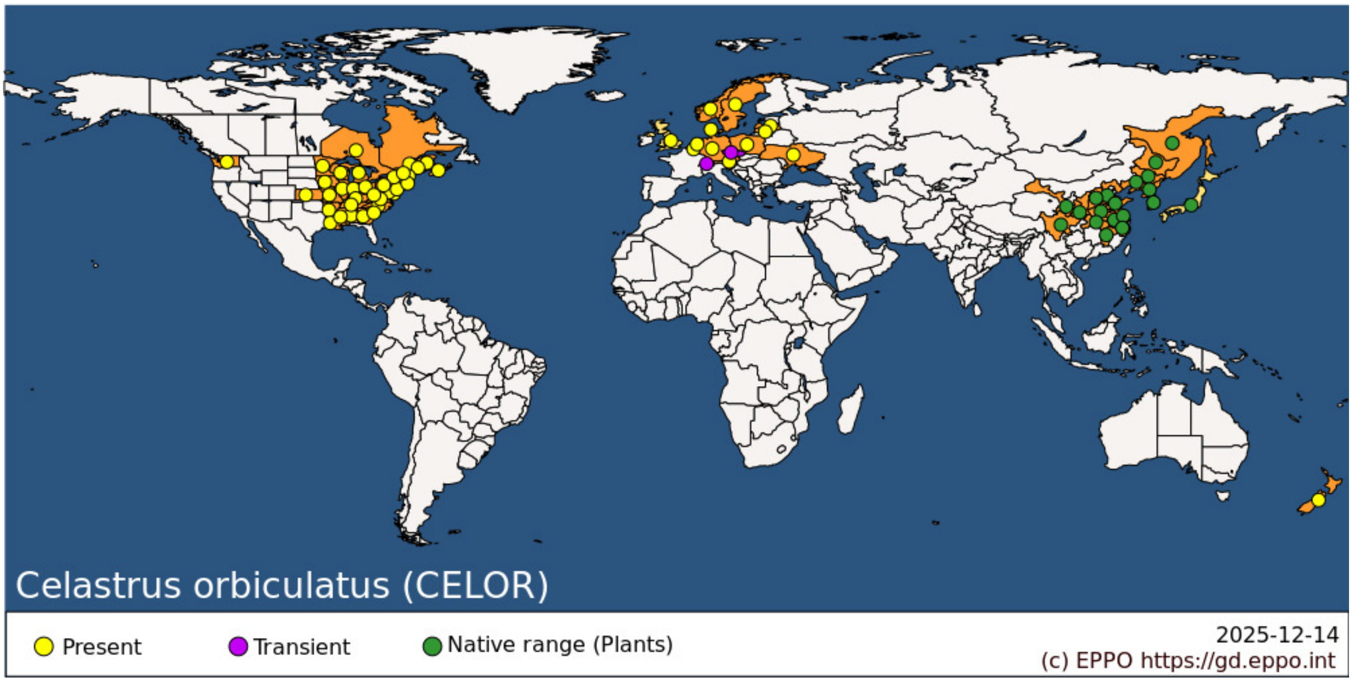
GEOGRAPHICAL DISTRIBUTION

Celastrus orbiculatus is native to China. It is also recorded as native in the Korean Peninsula, Japan and the Russian Far East and Sakhalin Island.

C. orbiculatus has been introduced into the EPPO region, and New Zealand and North America. USDA (2020) record *C. orbiculatus* as present in 25 eastern states. However, 31 states document *C. orbiculatus* as present in at least one county according to EDDMapS (https://www.eddmaps.org/). The current distribution of the species in the United States extends from Maine south to Georgia and west to Iowa (IPSAWG, 2019). Patterson (1973) stated that *C. orbiculatus* had spread to 33 US states, which included California and Washington. POWO (2020) confirmed that the species is present in Washington State. *C. orbiculatus* is also present in Canada in New Brunswick, Ontario, and Quebec (USDA, 2020) and Nova Scotia (CABI, 2021).

C. orbiculatus was first introduced into New Zealand as a garden ornamental in 1905. Williams and Timmins (2003) state that *C. orbiculatus* has a localized distribution in New Zealand but it is widely distributed in the northern areas of the North Island.

Beringen *et al*., (2017) report that *C. orbiculatus* is present in eight EU countries (Austria, Belgium, the Czech Republic, Germany, the Netherlands, Poland, Sweden, and the United Kingdom) and Gudžinskas *et al.* (2020) record the species in 13 European countries (adding Latvia, Lithuania, Norway, European Russia, and Ukraine to the previous list) (see EPPO, 2021a).



EPPO Region: Austria, Belgium, Czechia, Denmark, Germany, Latvia, Lithuania, Netherlands, Norway, Poland, Russian Federation (the) (European Russia, Far East), Sweden, Switzerland, Ukraine, United Kingdom
Asia: China (Anhui, Gansu, Hebei, Heilongjiang, Henan, Hubei, Jiangsu, Jiangxi, Jilin, Liaoning, Shaanxi, Shandong, Shanxi, Sichuan, Zhejiang), Japan, Korea, Democratic People's Republic of, Korea, Republic of
North America: Canada (New Brunswick, Nova Scotia, Ontario, Québec), United States of America (Alabama, Arkansas, Connecticut, Delaware, Georgia, Illinois, Indiana, Iowa, Kansas, Kentucky, Louisiana, Maine, Mainland USA, Maryland, Massachusetts, Michigan, Minnesota, Mississippi, Missouri, New Hampshire, New Jersey, New York, North Carolina, Ohio, Pennsylvania, Rhode Island, South Carolina, Tennessee, Vermont, Virginia, Washington, West Virginia, Wisconsin)
Oceania: New Zealand

MORPHOLOGY

Plant type

Deciduous woody vine (the form can vary between vine and shrub).

Description

Both Chinese and North American morphological descriptions have been given as the species could be imported from both regions.

The following information on the morphology of *C. orbiculatus* has been taken from the Flora of China (efloras.org, 2020) and Hou (1955).

‘Deciduous twining shrubs, up to 10 or 18 m tall; branchlets glabrous, grey-brown or brown, with sparse and inconspicuous lenticels; axillary buds small, ovate to elliptic, 1–3 mm. Petiole slender, 1–2 cm; leaf blade generally broadly ovate, suborbicular, or rectangular-elliptic, 5–13 × 3–9 cm, glabrous or abaxially sparsely pubescent on veins, base broadly cuneate to obtuse orbicular, margin serrate, apex broadly rounded, muriculate, or shortly acuminate; secondary veins 3–5 pairs. Inflorescences (cymes) axillary, sometimes terminal, 1–3 cm, 1–7- flowered; pedicels jointed below middle or nearly to base. Male flowers: sepals obtuse-triangular; petals obovate-elliptic to rectangular, 3–4 × 2–2.5 mm; disk shallowly cupuliform, lobe shallow, apex rounded-obtuse; stamens 2–3 mm. Female flowers: corolla relatively shorter than that of male flower; disk slightly thick, carnose; staminodes very short; ovary approximately globose; styles ca. 1.5 mm; stigma deeply 3-lobed, lobe apex shallowly 2-lobed. Fruit (capsule) approximately globose, 8–13 mm wide, yellow, 3-valved. Seeds elliptic, slightly flat, 4–5 × 2.5–3 mm, reddish brown; aril orange-red. *Celastrus orbiculatus* has deep and spreading roots which can grow to 2 cm thick.'

Root surface is deep orange in colour (Bugwood, 2021) (also true of *C. scandens*).

BIOLOGY AND ECOLOGY

General

Celastrus orbiculatus is a deciduous twining woody vine with leaves emerging in the spring. It flowers from April in the native range, May and June in the North-Eastern United States and the non-native region of the EPPO region. Depending on the habitat, plants can flower after one or two years of growth (Pooler *et al.*, 2002). Flowers are frequently functionally unisexual because of abortion or reduction of male or female parts, thus the plants are usually dioecious, sometimes monoecious, though plants develop both unisexual and perfect flowers: polygamo-dioecious (Brizicky, 1964; Gleason & Cronquist, 1991; Burnham & Santana, 2015).

In the United States, *C. orbiculatus* is, in most cases, functionally dioecious and thus may require cross-pollination. Insect (Brizicky, 1964) and wind pollination (Wyman, 1950) have been documented for this species, suggesting that male and female plants may need to be relatively close for successful cross-pollination. Pollen is shed approximately 24 h after flowers open (Pooler *et al.*, 2002). Fruit and seeds mature around late September in the United States with each fruit containing three to six seeds (Hou, 1955; Greenberg *et al*., 2001).

Gudžinskas *et al.* (2020) showed that only monoecious individuals were present from 12 sampled individuals at four populations in Lithuania. In other studies, Verloove (2020) showed that the species rarely flowers in Belgium.

Individual plants that do not reproduce sexually, due to age, plant size or lack of light, are dependent on vegetative reproduction for growth. All individuals have the potential to resprout from aerial buds on branches, basal buds on the root collar or stump, and subterranean buds that permit root suckering if above-ground portions are removed (Pavlovic & Leicht-Young, 2011). Small pieces of root left during clearing operations can resprout quickly and may form new plants (Dreyer *et al*., 1987; Ellsworth *et al.*, 2004).

Celastrus orbiculatus can grow rapidly, possibly up to 3 m/year (Patterson, 1973; McNab and Meekers, 1987). In the United States, studies have shown that growth rates differ according to the amount of sunlight the plant receives (Ellsworth *et al*., 2004).

Seed production may vary among habitats where open habitats, including canopy gaps, promote abundant fruiting (Webster *et al.,* 2006). In 15 sites in Massachusetts, United States, *C. orbiculatus* seed rain averaged 168 seeds/m², but was highly variable with a range of 13–826 seeds/m² (Ellsworth *et al*., 2004). In the EPPO region, there is variation in fruit production between areas where the species occurs. This may be caused by functionally dioecious plants in the absence of the other gender.

Habitats

In the native range (in China), *C. orbiculatus* is reported to grow in mixed forests, forest margins and in thickets on grassy slopes (eflora.org, 2020).

In the eastern United States, the following habitats where the species is found, but not limited to, include mixed-hardwood forests (all successional stages), coniferous forests (all successional stages), forest edges, woodlands, shrublands, old-fields, dunelands-field, duneland, coastal beaches, and tidal freshwater and saltmarsh communities (Kearsley, 1999; Wells & Brown, 2000; Merhoff *et al.*, 2003; Von Holle & Motzkin, 2007). Though found in forest systems, a thick litter layer may deter seedling establishment (McNab *et al.*, 2002).

The species clearly benefits from disturbance hence it is commonly found growing along roads and sites disturbed by logging and animal foraging (Ellsworth *et al*., 2004).

In Europe, *C. orbiculatus* has been found in areas close to urban environments and occupying disturbed habitats, but also in natural or semi-natural habitats (Alberternst & Nawrath, 2018; Gudžinskas *et al*., 2020). For example, in Lithuania, Gudžinskas *et al.* (2020) showed that the species invades dry dune woodlands, grasslands, pine, spruce, and alluvial and riparian forests.

Celastrus orbiculatus uses trees and other vegetation for support for its climbing habit where it twines around support structures. The utilization of trees and other vegetation enables the species to inhabit the upper canopy. In North America, Putz (1995) estimated that *C. orbiculatus* successfully twines around trees with a 15 cm diameter and can climb larger trees by utilizing the lower branches of the tree (Robertson & Handel, 1993) and other vegetation in the understory. It can also utilize its own stem as structural support to grow up trees with larger diameters (Z. Gudzinskas, personal communication, 2021). Stems can also creep along the ground to increase surface area (Leicht & Silander, 2006).

Environmental requirements

Celastrus orbiculatus can tolerate a wide range of soil and other environmental conditions (Leicht-Young *et al*., 2007). Sinclair *et al.* (1987) highlights that the species does not grow well in waterlogged soils. The species is able to grow slowly in forest understories, foraging for openings in the canopy, and grow rapidly in full sunlight (Greenberg *et al*., 2004; Leicht & Silander, 2006). *C. orbiculatus* is recorded to grow from 400 to 2200 m a.s.l. (eflora, 2020). Others, e.g. Hou (1955), report an altitudinal range of 100–1400 m in the native range, which is supported by Yang *et al*. (2014).

Natural enemies

Within the EPPO region, there are no host-specific natural enemies of *C. orbiculatus*. Generalist natural enemies will potentially attack the plant, but these are unlikely to inflect enough damage at the population level to influence establishment.

Uses and benefits

In the EPPO region, the species is utilized as an ornamental species in gardens, and it can also be grown as a bonsai plant. In the United States, cut branches of *C. orbiculatus* may be incorporated into decorative wreathes or other floral displays, especially around the festive period (Thanksgiving and Christmas) (Mehrhoff *et al*., 2003). Cut branches may also be displayed on their own. In almost all cases, fruit and seed will be present as it is the colour of the fruit (orange, red) that makes the species attractive in such displays.

PATHWAYS FOR MOVEMENT

Plants for planting (including bonsais) is the main pathway for the entry of *C. orbiculatus* into the EPPO region. *C. orbiculatus* has been utilized as a garden ornamental species in the EPPO region since 1860 (Gudžinskas *et al*., 2020). Beringen *et al*. (2017) detail that in the EU the species is available in trade in Belgium, Croatia, the Czech Republic, Denmark, Estonia, Germany, Finland, France, Hungary, Italy, Latvia, Lithuania, the Netherlands, Poland, Romania, Slovenia, Spain, Sweden and the United Kingdom.

Costley (2006) and Fryer (2011) highlight that *C. orbiculatus* was historically utilized as a species for erosion control in the United States, for landscaping purposes and for wildlife food. These planting purposes are not likely to be practiced nowadays. In the EPPO region, *C. orbiculatus* is recommended as a species to plant for noise reduction along roads and railways or as a species for green walls (e.g. Eppel-Hotz, 2012).

It should be noted that *C. orbiculatus* can be mistaken for *C. scandens* (native to North America) in horticultural trade and it is reported that many nurseries in the United States accidentally sell *C. orbiculatus* (Ritterskamp, 2018). Zaya *et al.* (2017) identified 34 plants from 11 vendors in the United States and found that 18 samples (53%) were mislabelled, and 7 out of the 11 vendors sold mislabelled plants.

In the United States *C. orbiculatus* has spread from sites where it has been planted for ornamental purposes and has subsequently established extensively in natural and managed habitats. An important factor for this spread is the natural spread of the species by mammals and birds (Greenberg *et al*., 2001; LaFleur *et al*., 2009; Merow *et al*., 2011). Throughout the literature, the European starling (*Sturnus vulgaris*), which is present in North America and native to parts of the EPPO region, is detailed to spread seed of *C. orbiculatus* (La Fleur *et al*., 2009; Merow *et al*., 2011). Additionally, in North America other frugivorous birds are reported to eat the fruit of *C. orbiculatus*, including northern flickers (*Colaptes auratus*), yellow-rumped warblers (*Setophaga coronata*), American robins (*Turdus migratorius*) and other thrushes (Turdidae), mockingbirds mand catbirds (Mimidae), and mynas (Sturnidae). Greenberg *et al.* (2001) highlight that 75% of seed was apparently removed by vertebrates and presumably dispersed in an oak forest in North Carolina. The fruit are not a preferred fruit of migratory birds, which select, when they are available, several native vines with higher polyphenol and anthocyanin concentrations over *C. orbiculatus* (Bolser *et al*., 2013). Seeds ingested by birds have a higher germination rate compared to seeds with intact fruits.

In the EPPO region, there is no additional information on bird species which use *C. orbiculatus* berries as a food source, but it is likely a number of frugivorous species do. In Germany, bird dispersal has been recorded at 400 m from the parent plants (Alberternst & Nawrath, 2018). Deer have been reported to feed on *C. orbiculatus* in the United States (Averill *et al*., 2016; Mundahl & Borsari, 2016), though it is not clear to what extent, if any, they spread propagules.

IMPACTS

Effects on plants

Celastrus orbiculatus forms dense thickets in open natural and disturbed areas as well as in forest understories and canopies. Such growth reduces light availability and may smother native plant species, suppressing or excluding them (McNab and Meeker, 1987). In the eastern United States, *C. orbiculatus* invades the same habitats as the native *C. scandens.* There has been a decline in *C. scandens* occurrence while *C. orbiculatus* has shown an increase, especially in areas with older *C. orbiculatus* populations (Steward *et al*., 2003). Hybridization with *C. scandens*, though hybrids appear to be in relatively low numbers, is asymmetrical, with pollen coming primarily from *C. orbiculatus*, potentially accelerating *C. scandens*' decline (Zaya *et al*., 2015).

In North America, *C. orbiculatus* grows in close proximity to the threatened pitcher thistle (Cirsium pitcheri (Leicht-Young & Pavlovic, 2012) and the threatened bird, the piping plover in coastal areas (Dreyer, 1994), potentially threatening their habitats (Leicht-Young & Pavlovic, 2012). If migratory birds are limited to consuming *C. orbiculatus* over other native vine fruits, they may suffer from an inadequate diet, possibly hindering their migration (Bolser *et al*., 2013).

Locally, *C. orbiculatus* can act as an ecosystem engineer by transforming the structure of habitats, such as forests, in which it may affect all strata (understory, mid-story, and canopy) (Fike & Niering, 1999). *C. orbiculatus* growth in tree canopies may weaken the host trees, making them more vulnerable to abiotic influences, including damage from wind, ice and snow (Siccama *et al.*, 1976). *C. orbiculatus* may facilitate the growth of other destructive vines in forests (Fike & Niering, 1999). *C. orbiculatus* responds positively to fire via root suckering, adding potential fuel to forest systems (Pavlovic *et al*., 2016). *C. orbiculatus* can have negative impacts on tree regeneration, which may impact the course of succession in a forest system (Ellsworth *et al*., 2004).

In New Zealand, this species is in the early stage of invasion, putting vulnerable habitat communities at risk, including open scrub, shrublands, early successional forest and the margins of mature forests, particularly those on alluvial or colluvial sites (Williams & Timmins, 2003).

Within the EPPO region, *C. orbiculatus* often invades urban and ruderal environments, where its impact on biodiversity is likely to be low. However, Gudžinskas *et al*. (2020) highlight that *C. orbiculatus* is documented to invade natural and semi-natural environments in Austria, Germany, Poland and Lithuania. Similar impacts on biodiversity may be seen in the rest of the EPPO region, especially as the species can cover the canopy (80–100%), as recorded in Hessen, Germany (Alberternst & Nawrath, 2018). Even under more open forest canopies, as observed in Lithuania, light penetration was reduced to the lower vegetation layers when *C. orbiculatus* was present.

Purcel (2010) details that in Poland in natural forests *C. orbiculatus* is a strong competitor of native vegetation and forms a dense ground cover which can prevent the formation of native vegetation. *C. orbiculatus* can entangle two or more tree crowns, increasing the risk of trees being toppled by wind. Trees and shrubs, on which it twines, are often deformed, moreover, they are also more susceptible to damage from snow, ice and wind.

Hybridization is unlikely to be a negative impact in the EPPO region as there are no native congeners and *C. scandens* has a limited occurrence in the EPPO region. It is possible that both *C. scandens* and *C. orbiculatus* are imported and hybridization may occur where both species are established. Additionally, material imported from North America may include the hybrid. The hybrid is more vigorous than *C. scandens* though hybrid seed are smaller than seed of either species (Pooler *et al*., 2002; Zaya *et al*., 2015).

Environmental and social impact

C. orbiculatus has negative impacts in managed forests. Reductions in tree regeneration and timber production are the most-documented negative impacts on ecosystem services due to *C. orbiculatus.* The twining habit of *C. orbiculatus* on trees restricts tree growth, overtops canopies and increases the probability of wind and ice damage (Horton & Francis, 2014). Increased weight in the tree crowns can lead to major limb breakage or trunk failure (Delisle & Parshall, 2018). Marks and Canham (2015) demonstrated that tree mortality in Connecticut (United States) caused by vines is primarily due to *C. orbiculatus* and that this vine causes 9.8% of tree mortality where *C. orbiculatus* is present. Additionally, Delisle and Parshall (2018) showed that *Populus grandidentata* and *Quercus rubra* trees that had *C. orbiculatus* growing over them for many years had reduced growth.

The impact of *C. orbiculatus* on soils is less clear. Leicht-Young *et al.* (2009) showed that sites invaded by *C. orbiculatus* were associated with soils having significantly higher soil pH, potassium, calcium and magnesium levels. In a subsequent study, adding *C. orbiculatus* litter to previously uninvaded soil increased nutrients significantly after 3 years. However, positive soil feedback could not be documented. Growing *C. orbiculatus* in soil (*C. orbiculatus*-primed soil) showed an increase in potassium but lower nitrogen mineralization with no other nutrient changes. Native vines appeared to have more of an impact on soil nutrient use than *C. orbiculatus* (Leicht-Young *et al*., 2015). These results suggest that *C. orbiculatus* may indeed act like a nutrient pump, as suggested by Beringen *et al.* (2017), but impacts may be tempered by the presence of other vines.

Ellsworth *et al.* (2004) suggest that failure to control *C. orbiculatus* can result in severe forest degradation and considerably higher future costs associated with forest restoration. If detected early, especially prior to any timber harvest, removal costs can be minimal. Unfortunately, in forested areas of the United States this shade-tolerant species is often small and without flowers and fruit, making it difficult to distinguish from the native congener.

There are general management costs for controlling this species along with other invasive plants in natural areas as well as managed forests. There also may be management costs associated with control of *C. orbiculatus* along transportation networks in the United States, however, the EWG has not been able to find any additional information to support this.

Horse DVM (2020) detail that all parts of *C. orbiculatus* are considered toxic to horses though the toxin is an unknown gastrointestinal irritant. There is evidence that *C. scandens* is toxic to dogs, cats and horses due to chemical compounds such as cardenolides and alkaloids, which cause vomiting (not horses), diarrhoea, seizures (rare) and weakness. White-tail deer consume *C. orbiculatus* foliage (Lynch, 2009; McNab & Meeker, 1987). The fruit may be toxic to humans.

CONTROL

Mechanical control

Small liana plants can be hand-pulled but the entire plant should be removed, including the entire root system. For climbing vines, cutting the vines should be done near the ground at a comfortable height to kill upper portions and relieve the tree canopy. Attempts should be made to minimize damage to the bark of the host tree. Rooted portions can remain alive and should be pulled, repeatedly cut to the ground or treated with herbicide. Cutting without herbicide treatment will require vigilance and repeated cutting because plants will resprout from the base.

Chemical control

Herbicides with systemic active ingredients such as triclopyr and glyphosate are effective as they are absorbed into plant tissues and carried to the roots, killing the entire plant within about a week. Basal bark application can be highly effective (Lynch, 2009). Chemical control is effective if the stems are first cut by hand or mowed and herbicide is applied immediately to cut stem tissue.

Biological control

There are no known biological control agents against *C. orbiculatus*.

Integrated control

Integrated control or integrated pest management, i.e. a program based on a combination of preventive, cultural, mechanical and chemical practices, should be always considered, particularly in the case of large infestations.

REGULATORY STATUS

In the EPPO region, *C. orbiculatus* is included on the EPPO A2 list of pests recommended for regulation as a quarantine pest. At the time of writing (September 2021), it is being considered for inclusion on the EU List of invasive alien species of union concern (Regulation 1143/20141).

In New Zealand *C. orbiculatus* has been regulated as a quarantine pest since 2001. It is included in the Official New Zealand Pest Register (Pest Register for Importing Commodities to New Zealand, https://pierpestregister.mpi.govt.nz/Pests Register/ImportCommodity/).

In the United States *C. orbiculatus* is not regulated at the federal level, although it is regulated in some states (USDA, 2020), specifically Connecticut (invasive, banned noxious weed), Maine (prohibited invasive species), Massachusetts (prohibited noxious weed), New Hampshire (prohibited invasive species), New York (prohibited invasive species), North Carolina (Class C noxious weed), Rhode Island (listed as widespread and invasive, no legal authority), Vermont (Class B noxious weed) and Virginia (Tier 3 noxious weed).

PHYTOSANITARY MEASURES

EPPO (2021) recommends phytosanitary measures for plants for planting (including seed and bonsais). The measure identified includes the prohibition of import into the EPPO region.

Early detection is important to identify new occurrences of the species. *C. orbiculatus* should be monitored and where it occurs control measures should be implemented with the aim of eradication or containment. In addition, public awareness campaigns to prevent spread from existing populations in countries at high risk are necessary. *C. orbiculatus* should be banned from sale in countries within the EPPO region and action to remove it from the natural environment encouraged.

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