EUROPEAN AND MEDITERRANEAN PLANT PROTECTION ORGANIZATION
ORGANISATION EUROPEENNE ET MEDITERRANEENNE POUR LA PROTECTION DES PLANTES

Pest Risk Analysis for

Chionaspis pinifoliae (Hemiptera: Diaspididae), pine needle scale

C. Sadof, Purdue University, USA – EPPO Global Database (EPPO Code: PHECPI) – *Pinus mugo*

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The risk assessment follows EPPO standard PM 5/5(1) *Decision-Support Scheme for an Express Pest Risk Analysis* (available at http://archives.eppo.int/EPPOStandards/pra.htm), as recommended by the Panel on Phytosanitary Measures. Pest risk management (detailed in ANNEX 1, with additional information collected in ANNEX 2) was conducted according to the EPPO Decision-support scheme for quarantine pests PM 5/3(5). The risk assessment uses the terminology defined in ISPM 5 *Glossary of Phytosanitary Terms* (available at https://www.ippc.int/index.php).

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Based on this PRA, *Chionaspis pinifoliae* was added to the EPPO A1 List of pests recommended for regulation as quarantine pests in 2022. Measures for host plants for planting and cut branches (including Christmas trees) are recommended

Pest Risk Analysis for *Chionaspis pinifoliae* (Hemiptera: Diaspididae), pine leaf scale

PRA area: EPPO region
Prepared by: Expert Working group (EWG) on *Chionaspis pinifoliae*.
Date: The EWG met on 2021-10-25/28 & 2021-11-15/17 by videoconference. The text was further reviewed and amended following comments by EPPO core members and the EPPO Panel on Phytosanitary Measures (2022-03, see below).

Composition of the Expert Working Group (EWG)

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The first draft of the PRA was prepared by the Nordic PRA Network: Mariela Marinova-Todorova, Juha Tuomola and Salla Hannunen (all from Ruokavirasto, Finnish Food Authority), Niklas Björklund and Johanna Boberg (both from Swedish University of Agricultural Sciences), as well as Daniel Flø and Micael Wendell (both from VKM, Norwegian Scientific Committee for Food and Environment).

All personal communications in this PRA were obtained in April-November 2021 from the following experts: Roxana Ciceoi and Minodora Gutue (Universitatea de Ştiinţe Agronomice şi Medicină Veterinară din Bucureşti, Romania), Christoph Hoffmann (Julius Kühn-Institut, Germany), Rob Johns (Canadian Forest Service), John Letourno (Natural Ressources Canada), Benjamin Normark (University of Massachusetts Amherst, USA), Maximilian Pock (Federal Ministry of Agriculture, Regions and Tourism, Austria), Douglass R. Miller (Florida State Collection of Arthropods, USA), Clifford S. Sadof (Purdue University, USA), Bill Schroeder (GreenTree Agroforestry Solutions, Canada), Matthew Wright (The Canadian Christmas Trees Association).

The draft PRA was commented upon before the meeting by Clifford S. Sadof (Purdue University, USA). The EWG thanks him for his availability to exchange with the EWG during the meeting, as well as for the pictures provided. The EWG also thanks Carolyn Glynn (Swedish University of Agricultural Sciences) for presenting her research that showed the high reproductive success that *C. pinifoliae* have in its naïve hosts *Pinus sylvestris*, as well as Giuseppina Pellizzari (University of Padova, Italy) for providing some publications before the meeting.

The Nordic PRA Network and the EPPO Secretariat would also like to thank the Russian NPPO for having shared the Russian PRA on *C. pinifoliae* with the authorization to use it; as well as Martin Damus and the Canadian NPPO for having shared the Canadian PRA.

For the determination of ratings of likelihoods and uncertainties, experts were asked to provide a rating and level of uncertainty individually during the meeting, based on the evidence provided in the PRA and on the discussions in the group. Each EWG member provided anonymously a rating and level of uncertainty, and proposals were then discussed together in order to reach a final decision.

Following the EWG, the PRA was further reviewed by the following core members: Emmanuel Gachet, Fabienne Grousset, Jose Maria Guitian Castrillon (with Nuria Avendano Garcia), Alan MacLeod, Conor McGee, Françoise Petter, Roel Potting, Muriel Suffert and Rob Tanner.

The PRA, in particular the section on risk management, was reviewed and amended by the EPPO Panel on Phytosanitary Measures on 2022-03-14/16. EPPO Working Party on Phytosanitary Regulation and Council agreed that *Chionaspis pinifoliae* should be added to the A1 Lists of pests recommended for regulation as quarantine pests in 2022.

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PRA area: *EPPO region* (Albania, Algeria, Austria, Azerbaijan, Belarus, Belgium, Bosnia and Herzegovina, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Georgia, Germany, Greece, Guernsey, Hungary, Ireland, Israel, Italy, Jersey, Jordan, Kazakhstan, Kyrgyzstan, Latvia, Lithuania, Luxembourg, Macedonia, Malta, Moldova, Montenegro, Morocco, Netherlands, Norway, Poland, Portugal, Romania, Russia, Serbia, Slovakia, Slovenia, Spain, Sweden, Switzerland, Tunisia, Turkey, Ukraine, United Kingdom, Uzbekistan).			
Describe the endangered area: *Chionaspis pinifoliae* could establish throughout most of the EPPO region, except the northernmost part (including parts of Siberia) where it is highly unlikely that the pest could complete its life cycle (section 9). Because there are some host plants native to and widely distributed in the EPPO region (e.g. *Pinus sylvestris*) which are reported to be particularly susceptible to *C. pinifoliae* (Annex 7), and because this may also be the case for other conifer species which have not evolved together with *C. pinifoliae*, the endangered area is considered to be the whole area of potential establishment.			
Main conclusions *Entry:* Several EPPO countries already prohibit the import of most host plants for planting and cut branches (including Christmas trees) (e.g. *Abies, Cedrus, Juniperus, Larix, Picea, Pinus, Pseudotsuga, Taxus* and *Tsuga* in the EU). However, there are EPPO countries where the import of these host plants is not prohibited. Therefore, the likelihood of entry in the EPPO region was considered as high with a high uncertainty; the highest rating being for host plants for planting (except seeds, tissue cultures, pollen) and cut branches of hosts (including Christmas trees) into countries where there is no import prohibition. *Establishment*: As climatic conditions appear to be suitable, the likelihood of establishment of *C. pinifoliae* outdoor in the EPPO region was considered very high with a low uncertainty. *Chionaspis pinifoliae* is not known as a pest under protected conditions, but it was considered as able to establish and difficult to control in greenhouse production, as is the case for other scale insects. The *magnitude of spread* was considered moderate with a moderate uncertainty. The pest is mostly sedentary but could spread long-distances either naturally via wind, or with human assisted spread. The ability to reproduce parthenogenetically when there are no males around allows a single female to potentially establish a new population, which greatly increases its spread capacity. *Chionaspis pinifoliae* is known to have been moved with plants for planting and cut branches of hosts (including Christmas trees), a phenomenon which is expected to increase the spread rate. *Impact (economic, environmental and social)* was considered high with a moderate uncertainty. Host plants are major forest, ornamental, and nursery trees in the EPPO region. *Chionaspis pinifoliae* only occasionally kills trees, but is difficult to control, especially on ornamental trees (e.g. in urban environment) and in nurseries. *Pinus sylvestris* and *P. mugo*, which are native to the EPPO region and widely distributed, are reported to be particularly susceptible. *Phytosanitary measures to reduce the probability of entry*: The EWG considered that phytosanitary measures should be recommended for all host plant genera. Risk management options are considered for host plants for planting (except seeds, tissue cultures, pollen) and cut branches of hosts (including Christmas trees).			
Phytosanitary risk for the *<u>endangered area</u>* The ratings for the likelihood of entry, establishment, the magnitude of spread and impact (which are provided in the document) were combined (cf. calculations in Pratique/Prima Phacie following Holt *et al.* (2014)). The phytosanitary risk for the endangered area was consequently rated as 'high' on a 5-level scale (very low, low,	High ☐	Moderate to High ☒	Low ☐

moderate, high and very high) and rated as 'moderate to high' on a 3-level scale (from 'low' to 'high').			
Level of uncertainty of assessment *(See Section 17 for a justification of the rating. Individual ratings of uncertainty of entry, establishment, spread and impact are provided in the document)*	High ☐	Moderate ☐	Low ☒
Other recommendations: The EWG made recommendations (detailed in section 18) related to the screening of old collection scale insect slides, surveys in the EPPO region and research about taxonomy and spread rates.			

Stage 1. Initiation

Reason for performing the PRA:

Chionaspis pinifoliae was identified as a potential threat to Nordic coniferous forests (Finland, Sweden and Norway) when screening for potential pests associated with the trade of ornamental plants (Marinova-Todorova *et al.*, 2020). The pest was assessed to potentially fulfil the criteria to become regulated as a quarantine pest in the European Union territory and Norway. A PRA for *C. pinifoliae* has been carried out for Canada (Watler and Stahevitch, 1992), Russia (VNIIKR, 2017), and Australia (together with other scale insects, Australian Government, 2020). For Russia the phytosanitary risk of *C. pinifoliae* was considered high (see also Gura and Shiplin, 2021), but for Australia the risk of scale insects in general was considered low. None of the previous PRAs are entirely valid for the EPPO region. Based on a proposal by the Nordic PRA Network, *C. pinifoliae* was added to the EPPO Alert List in April 2020. This addition was supported by the Panel on Quarantine Pests for Forestry (EPPO, 2021a). The Panel on Phytosanitary Measures (PPM) selected *C. pinifoliae* as a possible priority for PRA in 2020, and the Working Party on Phytosanitary Regulations selected it for PRA in June 2020.

PRA area:

EPPO region in 2021 (map at https://www.eppo.int/ABOUT_EPPO/eppo_members)

Stage 2. Pest risk assessment

1. Taxonomy

Taxonomic classification
Kingdom: Animalia / Phylum: Arthropoda / Subphylum: Hexapoda / Class: Insecta / Order: Hemiptera / Family: Diaspididae / Genus: *Chionaspis* / Species: *Chionaspis pinifoliae* (Fitch, 1856)

Scientific names
Preferred scientific name: *Chionaspis pinifoliae* (Fitch, 1856)

Other Scientific names
Aspidiotus pinifoliae Fitch, 1856; *Chionaspis pinifolii* Riley 1882; *Chionaspis pinifolia* Ruhl 1913; *Chionaspis* (*Phenacaspis*) *pinifoliae* Balachowsky 1930; *Leucaspis pinifoliae* García Mercet, 1912; *Mytilaspis pinifoliae* LeBaron, 1872; *Phenacaspis pinifoliae* Ferris, 1937; *Polyaspis pinifolii* Lindinger, 1935; *Trichomytilus pinifolii* Lindinger, 1933 (García Morales *et al.*, 2016)

International common names
English: pine leaf scale, pine needle scale, white pine needle scale, white pine scale
French: cochenille des aiguilles du pin, kermès du pin
Russian: сосновая хвойная щитовка
Spanish: guagua de las hojas del pino

Notes on the taxonomy: This PRA is conducted at the species level but recognizing that there are several morphologically, genetically and geographically overlapping cryptic *Chionaspis* species in North America feeding on Pinaceae. *Chionaspis heterophyllae* was originally described as a variety of *C. pinifoliae*, but was later recognized as a separate species (Andresen, 1957; Vea *et al.* 2012 and references therein; Grebennikov and Mukhanov, 2021). *Chionaspis pinifoliae heterophyllae* is currently considered as a synonym of *C. heterophyllae*. More recently, Gwiazdowski *et al.* (2011) provided molecular evidence that the *Chionaspis pinifoliae – Chionaspis heterophyllae* species complex should be recognized as 10 cryptic species. Vea *et al.* (2012) built upon the work of Gwiazdowski *et al.* (2011) and described four new *Chionaspis* species feeding on Pinaceae in North America, namely *Chionaspis brachycephalon* Vea sp. n., *Chionaspis caudata* Vea sp. n., *Chionaspis sonorae* Vea sp. n. and *Chionaspis torreyanae* Vea sp. n.

Gwiazdowski *et al.* (2011) provide information about the distribution and host range of the sampled populations of the 10 cryptic species. It is, however, not possible to link the literature on *C. pinifoliae* pre-dating the Gwiazdowski *et al*. (2011) study to the newly described species, and some of the cryptic species remain undescribed (Vea *et al.* 2012). This PRA was performed on *C. pinifoliae*, recognizing that some of the data used may relate to cryptic species within the species complex. *Chionaspis heterophyllae* is not covered by this PRA.

EPPO code: PHECPI

2. Pest overview

Note: In this PRA, all elements considered relevant are presented in the text. However, readers wishing a rapid overview can focus on the bold highlighted text.

2.1 Morphology

An overview of the morphology of the different life stages of *C. pinifoliae* is provided in Table 1. The life stages are illustrated in ANNEX 3.

The eggs of *C. pinifoliae* are elliptical, about 0.26 mm long and 0.14 mm wide, and rusty-brown or red (Cooley, 1899; Cummings, 1953; Kosztarab, 1963; Wood and Ross, 1972). **Eggs are laid under the scale covering of their mother** (Cumming, 1953; Wood and Ross, 1972; USDA, 2011).

The first instar nymphs (crawlers) have well developed legs, antennae, and mouth parts. They **are broadly oval, about 0.3 mm long and 0.18 mm wide, and light purple, reddish brown or reddish pink** (Cummings, 1953; Peterson and DeBoo, 1969; Watler and Stahevitch, 1992; USDA, 2011; Natural Resources Canada, 2021). Shortly after hatching, first instar nymphs start to feed and **their bodies begin to flatten and turn light brown** (Cummings, 1953; Peterson and DeBoo, 1969; Natural Resources Canada, 2021). **At that time (hyaline stage), they are about 0.4 mm long and 0.3 mm wide** (Cummings, 1953). The first instar exuviae are almost colourless (Kosztarab, 1963).

The second instar nymphs are tiny, yellowish and without legs or eyes, with antennae reduced to small tubercles (Cummings, 1953). At first, the male and female second instar nymphs are difficult to distinguish. However, after few days, the female nymphs secrete a broad transparent waxy film over their bodies, and the male nymphs secrete a narrow (1.0 × 0.4 mm) white waxy scale (Cummings, 1953) what allows distinguishing males from females. The scale of the male is attached at the front end to the cast skin of the first instar (Watler and Stahevitc, 1992). While moulting, Diaspididae exuviae split marginally-posteriorly and dorso-ventrally allowing the new instar growth that is mostly centrifugal with respect to the stylet's insertion point in host plant. For elongate species, such as *Chionaspis*, growth is mostly posterior. Exuviae rest above (dorsal to) and below (ventral to) the insect prosoma. The second exuviae of the female nymphs are orange yellow, with the transparent waxy film partially embedded in the adult female dorsal shield (Cummings, 1953; McKenzie, 1956; Kosztarab, 1963; Furniss and Carolin, 1977; Takagi, 1983).

Adult females are spindle-shaped, dorso-ventrally flattened and side-lobed, dark orange or purplish red in colour, and about 1.1–1.7 mm long, with stylets approximately five times the body length (Cummings, 1953; Kosztarab, 1963; Watson, 2002). **Adult females are wingless and have no eyes or legs** (Cummings, 1953). **They are shielded by 2.5–4.0 mm long, elongated oval, mussel-shaped waxy scale covers. The shield is almost pure white whereas the apical exuviae is yellowish or translucent** (Cooley, 1899; Cummings, 1953; Kosztarab, 1963; Furniss and Carolin, 1977; Liu *et al.*, 1989; Kosztareb, 1996; McCullough *et al.*, 1998; Rose *et al.*, 1999; Watson, 2002; Natural Resources Canada, 2021)[1].

Adult males are pale red, about 1–1.5 mm long and have bristly legs and antennae, black compound eyes, and **well-developed wings** that are longer than the body (Cooley, 1899; Furniss and Carolin, 1977; Bullington *et al.*, 1989; Watler and Stahevitch, 1992; USDA, 2011; Natural Resources Canada, 2021).

2.2 Life cycle

The development times of *C. pinifoliae* life stages are summarized in Table 1.

Eggs

In warmer climates of its current distribution, *C. pinifoliae* may overwinter either as an adult female or as an egg, whereas in cooler climates overwintering mainly occurs in the egg stage. These differences in overwintering tendancy reflect the greater sensitivity of adult females to cold winter temperatures.

For univoltine populations, the eggs are laid in the autumn under the scale made by the female on the host plant's needles. Hatching occurs in the spring, just before new shoots shed their bud cap and begin to expand (Furniss and Carolin, 1977; Rose *et al.*, 1999; USDA, 2011). The hatching period may vary from late April to late June depending on location and weather (Cummings, 1953; Watler and Stahevitch, 1992; USDA, 2011).

According to Luck and Dahlstein (1974), hatching in the spring begins earlier for populations with two generations per year than for those with one generation per year. **Eggs are also laid during other periods of the year such as during the summer for multivoltine populations (i.e. two or more generations per year).**

First instar nymphs

The newly hatched first instar nymphs (crawlers) crawl over the needles during the first 2–4 days post-emergence in search of a suitable feeding site (Cooley, 1899; Luck and Dahlstein, 1974). However, in cool and cloudy weather newly hatched nymphs may remain under the maternal scale for several days before starting to crawl (Cummings, 1953). **Crawlers are typically dispersed to new trees by wind** (Brown, 1958) (section 2.5). **After finding a suitable needle, crawlers insert their mouthparts into the leaf tissues and become immobile as they begin to feed on the sap** (Watler and Stahevitch, 1992; USDA, 2011; Natural Resources Canada, 2021). Female crawlers remain in that position for the rest of their life, whereas males remain in that position only until the adult stage (Cumming, 1953). The females are often found on the flat lower surface of the needle, whereas the males are more common on the rounded upper surface of the needle (Luck and Dahlsten, 1974).

In areas with one generation per year, the crawlers are present in June–July (Cumming, 1953; Stimmann, 1969; Peterson and DeBoo, 1969). **When there are two generations, first-generation crawlers are present from April to June and second-generation crawlers are present from July to early August. Further south in especially warm climates such as South Georgia, USA, crawlers may be present year-round, including through the warm winters** (Cooley, 1899; Kosztarab, 1963; Cranshaw *et al.*, 1994; Fondren and McCullough, 2002; Ellis, 2008; Katovich *et al.*, 2014).

Second instar nymphs

[1] Note that according to Peterson & DeBoo (1969) and USDA (2011) the armour scale covering of the adult female is about 8 mm long, which is much larger than other sources suggest.

After feeding for one to two weeks, the male and female crawlers moult to become second stage nymphs (Fondren and McCullough, 2002; Natural Resources Canada, 2021). **After a few days, the male nymphs form a scale covering under which they complete their development into tiny, winged adults with atypical compound eyes, antennae, and legs** (Cummings, 1953; Peterson and DeBoo, 1969; Bushbeck and Hauser, 2009; Natural Resources Canada, 2021). **About two weeks later, female nymphs undergo a second moult** (Cummings, 1953) **to become adults**.

In areas with one generation per year, the second instar nymphs are present in July–September (Cumming, 1953; Stimmann, 1969; Peterson and DeBoo, 1969). When there are two generations, the first-generation second instar nymphs are present in May–June and the second-generation second instar nymphs in August (Kosztarab, 1963; Fondren and McCullough, 2002; Katovich *et al.*, 2014).

Adult males

About two weeks after the beginning of scale formation, the adult males with newly grown legs emerge from their scale covering to find mates (Cumming, 1953). During the mating period, males can frequently be seen hovering in swarms in sunny, protected areas between infested trees (Natural Resources Canada, 2021). **Males are weak flyers and crawl up and down branches to find females** (C. Sadof, pers. comm.). Males locate females for mating supposedly from pheromone cues emitted by females (Watler and Stahevitch, 1992). **As with other armored scale species, the *C. pinifoliae* males do not have functional mouthparts** to feed (Beardsley and Gonzalez, 1975) **and consequently die soon after mating** (Wood and Ross, 1972).

Adult females

About three weeks after the second moult, female nymphs moult again into the adult stage (Watler and Stahevitch, 1992; Natural Resources Canada, 2021). After mating, females continue to secrete a white wax scale under which they lay an average of 30–50 eggs (minimum 10 and maximum 100 eggs) (Peterson and DeBoo, 1969; Watler and Stahevitch, 1992; Cumming, 1953; Liu *et al.*, 1989; Eliason and McCullough, 1997; Glynn and Herms, 2004; Natural Resources Canada, 2021). As they lay eggs, the females gradually shrink in size as the scale fills up with eggs (Wood and Ross, 1972; USDA, 2011). Egg laying continues until late autumn unless stopped by cold weather (Wood and Ross, 1972). **Females die shortly after egg laying is completed, with their scales persisting on the needles through the winter as protection for eggs** (Wood and Ross, 1972; Watler and Stahevitch, 1992).

Adult females are generally present from June to late autumn. In areas with one generation per year, the adults mature from the end of the summer to late autumn (Cummings, 1953; Stimmann, 1969; USDA, 2011). When there are two generations, the first generation matures in June–July whereas the second generation matures in late autumn (Kosztarab, 1963; Luck and Dahlstein, 1974; Katovich *et al.*, 2014; USDA, 2011). **In some areas, mated females can survive the winter to lay eggs in the spring** (Stimmann, 1969; Luck and Dahlstein, 1974; Cranshaw *et al.*, 1994). In South Georgia (USA), for example, where winters are often warm, adults may be present year-round, including through the warm winters (Ellis, 2008).

Number of generations

***Chionaspis pinifoliae* usually has one or two generations per year, depending on the geographical location and climate** (Cummings, 1953; Luck and Dahlstein, 1974; Furniss and Carolin, 1977; Watler and Stahevitch, 1992; Smith and Hurley, 1993; Fondren and McCullough, 2002; USDA, 2011; Katovich *et al.*, 2014; García Morales *et al.*, 2016; Natural Resources Canada, 2021).

In most of Canada, *C. pinifoliae* has one generation per year (Cummings, 1953; Martel and Sharma, 1968; Peterson and DeBoo, 1969; Luck and Dahlstein 1974 and references therein; Furniss and Carolin, 1977; Smith and Hurley, 1993; Natural Resources Canada, 2021), whereas in southern Ontario two generations may occur (McGauley and Kirby, 1991).

In the USA, voltinism varies depending on geographical location and associated climatic conditions, resulting usually in either one or two generations per year (Britton, 1922; Furniss and Carolin, 1977; Cranshaw *et al.*, 1994; Fondren and McCullough, 2002; Katovich *et al.*, 2014; Luck and Dahlstein, 1974; USDA, 2011). In Indiana, *C. pinifoliae* may complete part of a third generation in early autumn if the weather is warm (Fondren and McCullough, 2002). Also, Watler and Stahevitch (1992) and Burden and Hart (1989) suggest that ***C. pinifoliae* may have more than two generations per year**, although they don't specify geographical areas where this occurs nor the maximum number of generations. **It is assumed that in the Southern part of its range, generations become more asynchronous and overlapping, and thus more difficult to distinguish** (C. Sadof, pers. comm.).

Cooley (1899) notes that when multivoltinism occurs, it is almost impossible to distinguish different generations because the hatching is almost continuous and all stages may be present simultaneously throughout the year.

Sexual and parthenogenetic populations

***Chionaspis pinifoliae* has biparental (sexual) and uniparental (parthenogenetic) populations** (Brown, 1959; Stimmann, 1965; Luck and Dahlstein, 1974; Watler and Stahevitch, 1992; Guay *et al.*, 2018). **The only type of parthenogenesis known in Diaspididae is obligate thelytoky, which results in unfertilized eggs yielding only female progeny** (Nur, 1990). Predominantly parthenogenic populations have been reported repeatedly in the USA. For example, Brown (1960) reported parthenogenetic population of *C. pinifoliae* in Crescent City, California, USA. Stimmann (1969) described a parthenogenetic population from Corvallis, Oregon. Cooper and Cranshaw (2005) described a parthenogenetic population in Northeastern Colorado. Both in Oregon and Colorado the populations were univoltine and overwintered as either eggs or gravid females (Stimmann, 1969; Cooper and Cranshaw 2005). Luck and Dahlstein (1974) described from South Lake Tahoe, California two distinct populations that occurred sympatrically, one on *Pinus contorta* and one on *P. jeffreyi*. The population on *P. contorta* was mainly parthenogenetic, since only 0.6% of 8 721 scales encountered were males. This particular population overwintered as eggs. In contrast, the biparental population on *P. jeffreyi* had a roughly even mix of males and females with a reported 1.13 sex ratio. This population was found to overwinter as gravid females (95% of the 12 223 scales overwintered as gravid females).

The new uniparental form is likely to have fewer viable offspring than the biparental form from which it arose. However, the advantage conferred by parthenogenesis may be the preservation of a superior genotype, increased reproductive potential of the population because all offspring are females, or the ability to reproduce without males (Nur, 1990).

Table 1. Overview of the morphology and development times of *C. pinifoliae.*

Stage	Colour/shape	Size	Season and duration, one generation	Season and duration, two generations	
				1st (overwintering generation)	2nd (non-overwintering generation)
Eggs	Rusty-brown or red; elliptical	0.26 mm long; 0.14 mm wide	Overwintering stage	Overwintering stage	4 weeks
First instar nymphs (crawlers)	First light purple, reddish brown or reddish pink; oval After starting to feed, light brown; flatten	First 0.3 mm long; 0.18 mm wide After starting to feed 0.4 mm long; 0.3 mm wide	June–July. Start to feed 2–4 days after hatching. Feeding continues for about 2 weeks	April–June. Starts to feed 2–4 days after hatching. Feeding continues for about 1–2 weeks	July–early August

Second instar male nymphs	First yellowish; without legs, eyes, or antennae. Later covered with a narrow waxy white scale	Scale 1.0 mm long; 0.4 mm wide	July–September; 3 weeks[#]	May–June; 6–8 weeks[#]	August
Second instar female nymphs	First yellowish; without legs, eyes, or antennae. Later covered with a broad transparent waxy film				
Adult males	Well-developed wings, legs, antennae, and compound eyes	1.0–1.5 mm long	July–October	June–July	Late summer – late autumn
Adult females	Wingless and no eyes or legs. Shielded by a scale almost pure white; elongate oval and mussel-shaped	Female: 1.1–1.7 mm long Scale: 2.5–4 mm long	July–October; Overwintering stage	June–July	Late summer – late autumn; Overwintering stage

[#] *The difference in development time for the second instar nymphs, in areas where only one generation occurs compared to areas where two generations occur, may be linked to the different references that have been used.*

2.3 Climatic requirements

Eggs are the main overwintering stage and egg masses can tolerate low temperature conditions. Egg hatching is highly dependent on temperature (Natural Resources Canada, 2021). Hatching begins in the spring and hot dry weather stimulates early and rapid hatching, whereas cool wet weather delays incubation and prolongs the hatching period (Peterson and DeBoo, 1969). In its native Canadian range, *C. pinifoliae* has been found as far north as Aiyansh, BC (i.e., at a latitude of ~55.2°N in western Canada) (Wood and Ross, 1972).

Burden and Hart (1989) suggested that the lower development threshold of *C. pinifoliae* eggs lies between 10.8 °C and 11.8 °C with no hatching occurring at or below a mean temperature of 9 °C. Hatching rates increased from 11.2% at 11 °C to 86.2% at 13 °C and above 90% at higher temperatures (Burden and Hart, 1989). The time required for 50% of eggs to hatch was 154 days at 11°C and 12.3 days at 23 °C.

Doherty *et al.* (2018) estimated the development times and postdiapause hatch rates of overwintering *C. pinifoliae* eggs in southern Québec, Canada. The egg developmental threshold was 9.3 °C (95% confidence interval (CI) ±0.1 °C). The mean development time of eggs was 144.9 days (95% CI ±12.9) at 11 °C and 21.1 days (95% CI ±0.7) at 23 °C. The egg hatch rate was 33.0% (95% CI 24.4-42.9%) at 11 °C and 64.0% (95% CI 55.3-71.9%) at 23 °C.

After hatching, the viability and movement of the crawlers may also be affected by temperature, as was observed for *Aonidiella aurantii* (Diaspididae) crawlers which were active for 2 days at 10°C, but only 3 hours at 40°C. In this latter case of low temperatures many crawlers died before settling (Willard, 1976). **No comparable information is available on high temperatures affecting survival of crawlers for *C. pinifoliae*.** The survival time of unfed crawlers may also be enhanced by high relative humidity (Greathead, 1990). **Heavy rain may also kill many crawlers** (Peterson and DeBoo, 1969; Natural Resources Canada, 2021). In the autumn, egg laying continues until it is stopped by cold weather (Wood and Ross, 1972). Severe cold temperatures are thought to limit outbreaks by reducing survival of the overwintering stages (USDA, 2011). However, in areas with mild winters where populations overwinter as adult females, the females may continue to deposit eggs throughout the winter during warm daytime temperatures (Stimmann, 1969; Luck and Dahlstein, 1974). An indication of the impact of temperatures is provided by an outbreak of *C. pinifoliae* in a valley in which the most noticeable infestations were restricted to below 600 m elevation and only low infestation levels were observed at up to 900 m elevation (Cottrell and Ross, 1972).

2.4 Natural enemies

Natural enemies of *C. pinifoliae* include parasitic wasps, which lay eggs into adult females, small beetles (ladybirds) which predate on all life stages, and mites which predate on eggs (Watler and Stahevitch, 1992).

Natural enemies can have a major impact on *C. pinifoliae* populations (section 12), especially in undisturbed environments. Tooker and Hanks (2000) found that plant community structure influences natural enemies of *C. pinifoliae*. They suggest that *C. pinifoliae* parasitism rates are highest in 'impoverished habitats' (i.e. ornamental landscape plantings with pines in proximity to paved roads or parking lots, and surrounded by gravel or mulch) and that aphelinid wasps do not effectively suppress *C. pinifoliae* populations in urban habitats. On the other hand, they also found that generalist predators appear to be effective at controlling scales in structurally complex plant communities. According to Rose *et al.* (1999), *C. pinifoliae* is often preyed upon by e.g. ladybirds (Coleoptera), and so *C. pinifoliae* pest management has not been necessary in forests. *Chilocorus stigma* and *Microweisia misella*, in particular, are common and important *C. pinifoliae* predators in Michigan (Fondren and McCullough, 2002). Generalist predators are considered more efficient at controlling dense scale insect populations than parasitoids (Hanks and Denno, 1993; Huffaker and Messenger, 1976). A list of known natural enemies of *C. pinifoliae* and their presence/absence in the PRA area is provided in ANNEX 4. This list includes species from 8 families and 15 genera. Most frequent are species in the families of Aphelinidae (Hymenoptera) and Coccinellidae (Coleoptera).

2.5 Dispersal capacity

The only mobile life stages are the first nymphal stage (crawler) and the adult males. However, adult males are weak flyers.

Brown (1958) found that, on average, the male nymphs moved about 2.6 cm from the maternal scale, whereas the female nymphs moved about 10.8–11.3 cm before settling. Male nymphs move only a few centimetres and settle on old needles near the maternal scale, whereas female nymphs may also crawl to new needles on some host plant species (Cummings, 1953; Luck and Dahlsten, 1974; Watler and Stahevitch, 1992). However, Cummings (1953) noted that this did not occur on pine because the sheaths were still surrounding the needles when hatching began. **For Diaspididae, crawlers are the most vulnerable stage and can move across sand or bare soil only very short distances and with great difficulty**. Some species have been reported to be able to crawl up to 0.7 m (Beardsley and Gonzalez, 1975). **Crawling is therefore most often likely to be a mode of dispersal at short distance within trees or from a tree to another where branches are touching.**

***Chionaspis pinifoliae* crawlers can be dispersed over longer distances by wind, i.e. from tree to tree or to another stand** (Brown, 1958; Watler and Stahevitch, 1992; USDA, 2011). This is facilitated by their flattened shape and the positive phototactic response which prompts the crawlers to move towards the sunlit branch tips where they may be picked up and carried away by the wind (Washburn and Frankie, 1981; Greathead, 1990). Based on laboratory experiments, Brown (1958) calculated that with a settling rate of 0.12 m/s a first instar nymph released from 2.4 m height at a wind speed of 18 m/s would travel about 375 m. **In field experiments, most individuals were caught at distances of up to 320 m from their point of origin within 48 h (Table 2). However, in this field experiment, some first instar nymphs were caught at distances of up to 2.8 km.** The field experiments to demonstrate intra-stand *C. pinifoliae* spread showed that large numbers of nymphs were transported for short distances (Table 3) with the largest number of nymphs being caught on traps nearest the trees of origin.

Scale insect crawlers tend to disperse passively on wind currents. **Passive wind dispersal of the aeroplankton community is highly influenced by weather conditions and can in some instances lead to a single scale**

insect being dispersed hundreds of kilometres (Washburn and Frankie, 1981; Greathead, 1990, Cusimano *et al*, 2016;). **For *C. pinifoliae*, dispersal distances of longer than 2.8 km have not been evaluated.**

Table 2. Inter-stand spread of nymphs of *C. pinifoliae* when carried by the wind in field experiments (Brown, 1958).

	Distance from source (m)				
	91	320	1 200	2 000	2 800
Number of crawlers per 0.02 m² of trap	46.3	41.3	0.3	1.0	3.0

Table 3. Intra-stand spread of nymphs of *C. pinifoliae* when carried by the wind in field experiments (Brown, 1958).

	Direction from source	Distance from source (m)			
		0	3	6	9
Number of crawlers per 0.02 m² of trap	South	846	787	566	342
	North	3636	n/a[1]	n/a[1]	496
	East	2556	711	513	441
	West	1845	1026	765	990

[1]There is no explanation in the publication and thus it is not known if there were no traps at these locations or if no nymphs were caught.

Magsig-Castillo *et al.* (2010) suggested that for relatively monophagous or oligophagous species with low fecundity (which is true of most Diaspididae species), wind dispersal is unlikely to be the only means of dispersal. **As is the case for other scale insects, phoretic transfer by insects, birds and mammals is possible** (Washburn and Frankie, 1981). Magsig-Castillo *et al.* (2010) showed that under laboratory conditions some Diaspididae species were also able to attach to other insect species to be carried for short distances, with some individuals remaining attached to their carrier after one hour. There is also recent evidence for a North American invasive species, *Adelges tsugae* (hemlock wooly adelgid), that foraging birds may serve as a vector for long-distance movement of crawlers (Russo *et al.*, 2019). **However, such experiments have not been conducted for *C. pinifoliae*. Brown (1958) stated that phoresy is unlikely for *C. pinifoliae* because nymphs have difficulty crossing small gaps** (e.g. to climb onto birds).

All life stages of *C. pinifoliae* may be transported over longer distances on living infested plant material (Wood and Ross, 1972; Furniss and Carolin, 1977; Watler and Stahevitch, 1992; Watson, 2002).

2.6 Nature of the damage

***Chionaspis pinifoliae* feeds by inserting its sucking mouthparts into the needles of its host plant (Brown, 1916; Watler and Stahevitch, 1992). This feeding destroys the needle's mesophyll cells, leading to a yellowing (chlorosis) of the needles in the area surrounding the scale. When trees are heavily infested, the chlorotic areas coalesce. The chlorotic condition and/or light intercepted by the insect bodies covering the needles diminishes the photosynthetic capacity of the needles. As a result, declines in photosynthetic rates in damaged needles of heavily infested trees reduces the tree vigour** (Dadof and Neal, 1993; Watson, 2002).

On pines, infestations can result in a marked reduction in needle length and diminished shoot growth rates (USDA, 2011). The needles of heavily infested trees may drop prematurely, and branches may die. Young plants can also be infested, as reported in Iowa, USA, from seedlings and second year conifers (Burden and Hart, 1989).

In extreme cases, the tree may be killed (Rose *et al.*, 1999; Watson, 2002). According to USDA (2011), planted pines can be severely damaged and prolonged infestations can kill young trees, weaken larger trees, and leave them predisposed to secondary attack by opportunistic insects and diseases. According to Furniss and Carolin (1977), dense populations of *C. pinifoliae* often weakens trees and slows growth.

2.7 Detection and identification methods

Symptoms

Chionaspis pinifoliae **is a small insect and light infestations are difficult to detect. When more individuals are present, it is easier to see both the white scales and the chlorosis of the needles** (Watler and Stahevitch, 1992). According to Johnson and Lyon (1976), adult scales are easily noticed during inspections even when only a few specimens are present. However, **for the purpose of this pest risk analysis, experts considered that single insect specimens may easily remain undetected during inspection (e.g. during inspections of consignments of plants or christmas trees, not every individual plant and needle will be inspected visually). Possible signs of *C. pinifoliae* on needles are the 2.5–4.0 mm long, almost pure white, elongated oval, mussel-shaped waxy female scale covers, as well as the yellowish or translucent apical exuviae, and browning of foliage** (Cooley, 1899; Cummings, 1953; Kosztarab, 1963; Furniss and Carolin, 1977; Liu *et al.*, 1989; Rose *et al.*, 1999; Watson, 2002; Natural Resources Canada, 2021). The white scales can be seen at any time of the year, although not all observed scales necessarily contain live specimens (USDA, 2011). **Infestations frequently begin on the lower branches** (Easterling, 1934; McCullough *et al.*, 1998). Foliage of heavily infested trees may appear white or greyish (section 2.6). In addition to signs of pest presence, indications of infestation are dull-colored short needles, severe needle loss (unrelated to drought), and dead trees (Wood and Ross, 1972).

Identification

According to Vea *et al.* (2013), all of the described species of pine-feeding *Chionaspis*, including *C. pinifoliae*, are indistinguishable from one another by the naked eye. *Chionaspis pinifoliae* and *C. heterophyllae*, which overlap broadly in host range and geographic distribution (Watler and Stahevitch, 1992; Philpott *et al.*, 2009) are so morphologically similar that they are frequently confused with one another (García Morales *et al.*, 2016). Furthermore, Gwiazdowski *et al.* (2011) argued based on molecular evidence that the *Chionaspis pinifoliae – Chionaspis heterophyllae* species complex should be recognized as 10 cryptic species (section 1). **Several sequences (including all sequences used by Gwiazdowski *et al.* (2011)) were deposited in GenBank, which could be used for identification using molecular methods**.

Philpott *et al.* (2009) concluded that the morphology of the pygidial lobes of the adult female is a reliable and convenient characteristic for distinguishing *C. pinifoliae* from *C. heterophyllae*. **Liu *et al.* (1989) and Bullington *et al.* (1989) presented keys for identification of females and males of the North American *Chionaspis* species, and Vea *et al.* (2013) presented diagnostic morphological characters (and a key) for six North American pine feeding *Chionaspis* species, including for *C. pinifoliae.* A detailed description of slide-mounted adult females was also given by Miller and Davidson (2005).**

Due to their size and the lack of available descriptions, nymphs cannot be identified morphologically to species. They would thus need to be reared to allow morphological identification or to be identified using molecular methods.

In the EPPO region, several Diaspididae species occuring on *Pinus* could be confused with *C. pinifoliae* when observed with the naked eye, even if done by a trained observer. Any possible specimens would thus require identification by a scale expert for confirmation. Species that can be confused with *C. pinifoliae* include *Chionaspis austriaca*, *Fiorina pinicola*, *Gomezmenoraspis pinicola*, *Leucaspis knemion*, *Leucaspis löwi, Leucaspis pini, Leucaspis pusilla* and *Leucaspis signoreti*. Details of geographical distribution, host plant range and morphology of these species are provided in ANNEX 5.

Remark: The presence of many individuals on the same host may also be a barrier to early identification of a further species.

3. Is the pest a vector?

Yes ☐ No ▣

4. Is a vector needed for pest entry or spread?

Yes ☐ No ▣

5. Regulatory status of the pest

Chionaspis pinifoliae is not listed as a quarantine pest by any EPPO country according to EPPO Global Database (EPPO, 2021). It was added to the EPPO Alert List in 2020 (EPPO, 2021a).

Chionaspis pinifoliae is regulated in Chile (EPPO, 2021b), China, Japan, and New Zealand (IPPC, 2020). Since the sources of information consulted (i.e. EPPO, 2021b; IPPC, 2020) are not exhaustive, the pest may be regulated in other countries not listed, as is the case of Australia (Government of Western Australia, 2021) and Peru (MAR Peru, 2015). Costa Rica (WTO, 2014) requires that non-fumigated Christmas trees (*Abies alba*) from Canada should be accompanied by a phytosanitary certificate certifying that the material is free from *C. pinifoliae*, produced by companies following provisions of a specific program and subject to control at the point of entry. Bermuda has a zero-tolerance policy at import for *C. pinifoliae* (Christmas Trees Atlantic Association, 2019). Further, even though *C. pinifoliae* is not regulated federally in the USA and at a state level, nursery inspectors can stop a sale of heavily infested plants for any established pests to prevent planting of infested plants in otherwise uninfested landscapes (See link to Indiana State Law for example. https://www.in.gov/dnr/entomology/nursery-growers-and-dealers/).

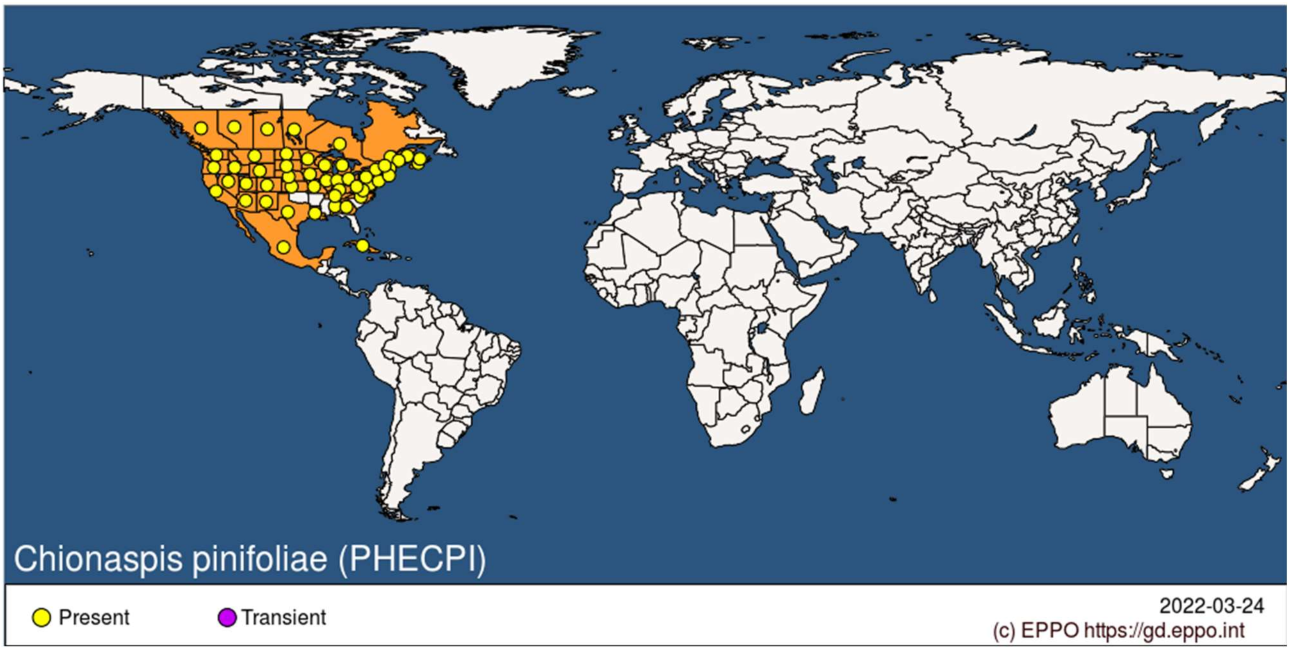
6. Distribution

Chionaspis pinifoliae is native to North America (Burden and Hart, 1989). Although it is distributed throughout North America from Canada to Mexico (Ferris, 1937; Furniss and Carolin, 1977; Watler and Stahevitch, 1992), it is most common in the northern half of the USA and southern parts of Canada (USDA, 2011). *Chionaspis pinifoliae* has also been reported in Cuba (Table 4).

Table 4. Distribution of *Chionaspis pinifoliae.*

Continent	Distribution	Comments	References
North America	**Canada** (Alberta, British Columbia, Manitoba, New Brunswick, Nova Scotia, Ontario, Prince Edward Island, Québec, Saskatchewan)	Present, widespread	Magasi, 1992; Watson, 2002; García Morales *et al.*, 2016
	Mexico (Baja California, Distrito Federal, Durango, Mexico, Michoacan, Nuevo Leon, Sinaloa, Zacatecas)	Present, widespread	Nakahara, 1982; Liu *et al.*, 1989; Miller, 1996; Watson, 2002; García Morales *et al.*, 2016
	USA (Alabama, Arizona, California, Colorado, Connecticut, Washington D.C., Georgia, Idaho, Illinois, Indiana, Iowa, Kansas, Kentucky, Louisiana, Maine, Maryland, Massachusetts,	Present, widespread	Cooperative Plant Pest Report, 1976; Liu *et al.*, 1989; Watson, 2002; Miller and Davidson, 2005; García

	Michigan, Minnesota, Missouri, Montana, Nebraska, Nevada, New Hampshire, New Jersey, New Mexico, New York, North Carolina, North Dakota, Ohio, Oregon, Pennsylvania, Rhode Island, South Dakota, Tennessee, Texas, Utah, Vermont, Virginia, Washington, West Virginia, Wisconsin, Wyoming)		Morales *et al.*, 2016; Ahmed and Miller, 2019
Central America and the Caribbean	**Cuba**	Present	Nakahara, 1982; Mestre *et al.*, 2006; Mestre *et al.*, 2011; Mestre *et al.*, 2015



Uncertain or invalid records (not included in Table 4):

- **Austria:** A finding of *C. pinifoliae* in 2014 in the Botanical Garden of the University of Vienna is mentioned in the MSc thesis of Becker (2017). However, the pest was identified based solely on photographic evidence, thus generating a reasonable doubt regarding the correctness of the determination. Officially, the pest is not present in Austria (M. Pock, pers. comm.).
- **Bermuda:** *Chionaspis pinifoliae* has been intercepted on imported pine trees on several occasions in Bermuda (Smith and Hurley, 1993; Bermuda Department of Agriculture and Fisheries, 1997). Hodgson and Hilburn (1991) remarked that *C. pinifoliae* does not appear to have established in Bermuda.
- **Chile**: The pest is reported as present on Easter Island by Watson (2002) but the occurrence is not supported by the cited paper, i.e. Charlin (1973) (EPPO, 2021b). In addition, *C. pinifoliae* is not in the list of native or exotic Diaspididae species for Argentina, Brazil and Chile (Claps *et al.*, 1999; Claps *et al.*, 2001).
- **Cyprus:** According to Watler and Stahevitch (1992) there are records from Cyprus. However, no references are provided and the records could not be confirmed.
- **Egypt:** Borchsenius (1966) listed the pest as present in the United Arab Republic, a political union between Egypt (including the occupied Gaza strip) and Syria, without further details. According to García Morales *et al.* (2016), the record of *C. pinifoliae* in Egypt "*by Newstead (1907) and Hall (1923)*" was based on a misidentification of *Leucaspis pusilla*.
- **El Salvador:** Nakahara (1982) has listed *C. pinifoliae* as present in El Salvador, but do not provide the primary sources for these records. No other sources were found.

- **Florida, USA**: According to Ahmed and Miller (2019), *C. pinifoliae* is not present in Florida and all previous records from Florida are either interceptions on commodities from other states or countries, or misidentifications of *C. heterophyllae*.
- **Germany:** *C. pinifoliae* is listed as present in Germany (Schmutterer and Hoffmann, 2016). This report is based on the report by Miller and Davidson (2005) (C. Hoffmann, pers. comm.), which is based on a unique interception in 1935. Therefore, the imported plants could have originated from another country (D. Miller, pers. comm.). The records of *C. pinifoliae* from Germany are considered unreliable and in need of further confirmation (EPPO, 2021b).
- **Honduras:** Nakahara (1982) listed *C. pinifoliae* as present in Honduras, but did not provide the primary sources for these records. In 1927, *C. pinifoliae* has been intercepted in California on *Pinus* sp. imported from Honduras (USDA, 1929).
- **Libya:** Lal and Naji (1979) reported serious damage on *Pinus* sp. in Libya, but no details were provided. It is uncertain if the species is currently present there since no additional publications were found. Danzig and Pellizzari (1998) also listed *C. pinifoliae* as present in Libya based on old observations, i.e. before 1966. This report needs confirmation.
- **Romania:** *Chionaspis pinifoliae* was reported on pine trees in one park and in one private garden in Bucharest (Ciceoi *et al*., 2017). The infested trees were probably imported and the park trees were removed. There is currently no evidence that the previously reported populations persisted (R. Ciceoi, pers. comm.). The pest was identified solely based on external morphological characteristics, including the shape and colour of larvae and the adult females' pygidium. No slides were available for re-examination (M. Gutue, pers. comm.).
- **Spain**: According to Watler and Stahevitch (1992) there are records from Spain. However, no references are provided and no other references were found to confirm those records.
- **United Kingdom:** *C. pinifoliae* has been listed as present in the United Kingdom (Nakahara, 1982; Miller, 1996; Danzig and Pellizzari, 1998; Miller and Davidson, 2005; Watler and Stahevitch, 1992). This report is based on an interception in 1956 which could therefore have originated from another country (D. Miller, pers. comm.). According to Watson (2002), "*In spite of records published in Nakahara, 1982, and Danzig and Pellizzari, 1998,* C. pinifoliae *is not present in the United Kingdom (C.P. Malumphy, Central Science Laboratory, UK, pers. comm.)*". In addition, in the UK Plant Health Risk Register (2021) *C. pinifoliae* is considered absent from the United Kingdom.

The pest is not considered to be present in these countries for the purposes of this PRA.

7. Host plants

Chionaspis pinifoliae is a pest of conifers with known hosts in the following genera (number of species in parentheses): *Abies* (5), *Calocedrus* (1), *Cedrus* (1), *Cupressus* (NA), *Juniperus* (1), *Larix* (1), *Picea* (9), *Pinus* (69), *Pseudotsuga* (1), *Taxus* (1), *Torreya* (1) and *Tsuga* (3). A list of all known host plants of *C. pinifoliae* is provided in ANNEX 6. Note that Eliason and McCullough (1997) demonstrated differential survival rates and fecundity on four varieties of *Pinus sylvestris* suggesting the possibility of host plant resistance.

Other species within these genera may also host *C. pinifoliae* especially considering that hosts naïve to *C. pinifoliae* have been shown to be very susceptible (section 12).

8. Pathways for entry

Diaspididae species have often been introduced into new areas with imported plant material due to their immobility and cryptic appearance (Kosztarab, 1990). It should be noted that some pine scale species have recently established in the EPPO region, e.g. *Toumeyella parvicornis* and *Crisicoccus pini* (Garonna *et al*., 2015; Boselli and Pellizzari, 2016), showing that *C. pinifoliae* could also enter.

Chionaspis pinifoliae occurs on needles of host plants, either on new or older foliage (Walstad *et al*., 1973). The pest is found in forest stands and on ornamental/landscape trees, but high populations are mainly associated with the latter. The pest is frequently reported in Christmas tree plantations and plant nurseries in North America (section 12). In Iowa, USA, for example, it was one of the most reported pest of nursery conifers in the 1980s, recorded from seedlings and second year conifers (Burden and Hart, 1989). In Quebec, Canada, *C. pinifoliae* is considered an emerging pest in Christmas tree plantations, although it is not known to cause any significant damage (Guay *et al.*, 2018).

Chionaspis pinifoliae was the most frequent Diaspididae species submitted to the National Plant Diagnostic Network in the USA during the period 2005–2017 (Klingeman *et al.*, 2020). The network received submissions from both private persons and professionals and 758 submissions were recorded for *C. pinifoliae* during this period.

The following pathways for entry of *C. pinifoliae* are discussed in this PRA. Pathways in bold are described in detail and evaluated in section 8.1 while the others are considered unlikely pathways and are described in section 8.2.

- **Host plants for planting (except seeds, tissue cultures, pollen)** (Table 5)
- **Cut branches of hosts (including Christmas trees)** (Table 6)
- Stored products/dried plant parts
- Wood of host plants
- Bark of host plants
- Conifer nuts and cones of host plants
- Hitchhiking on other commodities
- Intentional human assisted movement of individuals, e.g. trade by collectors
- Natural spread

No life stages of *C. pinifoliae* are associated with the following products which are, therefore, not considered relevant as potential pathways: soil and other growing media; seeds, tissue cultures and pollen of host plants; wood packaging material. Wood packaging material is even less likely to be a pathway than wood because crawlers will not survive the production process and the compulsory phytosanitary treatments. These pathways have therefore not been included in section 8.2.

8.1 Pathways investigated in detail

Information on import prohibitions and phytosanitary measures is not provided for all countries in the PRA area.

Table 5. Host plants for planting (except seeds, tissue cultures, pollen)

Pathway 1	**Host plants for planting (except seeds, tissue cultures, pollen)**
Coverage	• The pathway includes plants for planting in pots or similar (including bonsais), plants with bare roots, cuttings, scions of host plants. • Seeds, tissue cultures and pollen are excluded, because the pest is not associated with these categories of plant material. This pathway covers all commercial trade, including internet trade by private persons, and non-commercial exchanges. This pathway also includes travelers carrying in their luggage plants for planting from areas where the pest occurs.
Plants concerned	• All host plants (section 7): *Abies*, *Calocedrus*, *Cedrus*, *Cupressus*, *Juniperus*, *Larix*, *Picea, Pinus*, *Pseudotsuga, Taxus, Torreya* and *Tsuga*
Pathway prohibited in the PRA area?	Partly. In several EPPO countries, import of plants for planting belonging to the genera *Abies, Cedrus, Juniperus, Larix, Picea*, *Pinus, Pseudotsuga, Taxus* and *Tsuga* is prohibited: - In the EU, the genus *Taxus* is listed on the provisional list of 'high risk plants', i.e. the introduction into the EU of plants for planting (other than seeds, in vitro material and naturally or artificially dwarfed woody plants for planting) originating from all third countries is **prohibited** pending a risk assessment (Annex I of (EU) 2018/2019 (EU, 2018)). - Introduction into the EU of plants of *Abies, Cedrus, Juniperus, Larix, Picea*, *Pinus, Pseudotsuga,* and *Tsuga* is **prohibited** from certain third countries, including all of the countries where the pest is currently present: Canada, Cuba, Mexico, USA (Annex VI of (EU) 2019/2072 (EU, 2019)). Thus, in the EU there are import prohibitions for plants for planting of most host genera but not for *Calocedrus*, *Cupressus* and *Torreya*, or for naturally or artificially dwarfed plants for planting of *Taxus.*
Pathway subject to phytosanitary measures, including inspection at import?	Partly. In the EU, **some** plants for planting originating in areas where the pest occurs are covered by various phytosanitary requirements (summarized below) and **all** plants for planting (excluding seeds) must be accompanied by a Phytosanitary certificate ((EU) 2016/2031 (EU, 2016); (EU) 2019/2072 (EU, 2019)). Following the EU legislation (Annex VII of (EU) 2019/2072 (EU, 2019)):

	- Trees and shrubs intended for planting and originating from certain third countries are required to have been grown in nurseries, inspected at appropriate times prior to export and found to be free from signs or symptoms of harmful insects, or subjected to appropriate treatment to eliminate such organisms. - Naturally or artificially dwarfed plants for planting originating in certain third countries (all countries where the pest is known to occur) are required to have been kept in officially registered nurseries and subjected to officially supervised control regime for at least two years prior to dispatch and officially inspected for and ensured to be free from union quarantine pests and packed in closed containers. - There are additional pest-specific requirements (e.g. for plants of *Pinales*, other than fruit and seeds, originating in third countries, for *Pissodes* and Scolytidae[2] spp. (non-European)). However, these pest-specific requirements were regarded as less important by the EWG for *C. pinifoliae* compared to the more general requirements. In the EurAsian Economic Union (EAEU), *Pinus* and other Coniferae (except *Thuja* and *Taxus*) plants for planting are also covered by various pest-specific phytosanitary requirements (EEC, 2016): - Plants for planting (including bonsai) of Coniferae (except for the genera *Thuja*, *Taxus* and *Pinus*) should originate from areas free of the causal agents of branch canker of pine (*Atropellis piniphila* and *Atropellis pinicola*), eastern six-spined engraver (*Ips calligraphus*), mountain pine beetle (*Dendroctonus ponderosae*), western pine beetle (*Dendroctonus brevicomis*), California pine engraver (*Ips plastographus*), brown-spot needle blight (*Lecanosticta acicola* [syn. *Mycosphaerella dearnessi*]), forest tent caterpillar (*Malacosoma disstria*), pine engraver (*Ips pini*), Japanese rust of apple (*Gymnosporangium yamadae*), red turpentine beetle (*Dendroctonus valens*), needle cast of Japanese larch (*Mycodiella laricis-leptolepidis* [syn. *Mycosphaerella laricis-leptolepidis*]), sitka-spruce weevil (*Pissodes strobi*), western conifer seed bug (*Leptoglossus occidentalis*), lodgepole terminal weevil (*Pissodes terminalis*), pine wood nematode (*Bursaphelenchus xylophilus*), phymatotrichum root rot (*Phymatotrichopsis omnivora*); *Pinus* sp. for planting (including bonsai) should originate from areas free of fusiform rust of pine (*Cronartium fusiforme*), the causal agents of branch canker of pine (*Atropellis piniphila* and *Atropellis pinicola*), five-spined bark beetle (*Ips grandicollis*), eastern six-spined engraver (*Ips calligraphus*), mountain pine beetle (*Dendroctonus ponderosae*), western pine beetle (*Dendroctonus brevicomis*), pine-to-pine gall rust (*Cronartium harknessii* [syn. *Endocronartium harknessii*]), California pine engraver (*Ips plastographus*), brown-spot needle blight (*Lecanosticta acicola* [syn. *Mycosphaerella dearnessi*]), spanish red scale (*Chrysomphalus dictyospermi*), pine engraver (*Ips pini*), eastern gall rust of pine (*Cronartium quercuum*), red turpentine beetle (*Dendroctonus valens*), western conifer seed bug (*Leptoglossus occidentalis*), and pine wood nematode (*Bursaphelenchus xylophilus*). The expert working group questioned whether there was any area in North America that could fulfil all these

[2] Bark beetles were previously considered a distinct family (Scolytidae) but now constitute a subfamily (Scolytinae) of the family Curculionidae.

	requirements since several of these pests are fairly widespread. It should, however, be noted that *Pinus* seedlings have been imported to Russia (see in section 'trade' below). These requirements are likely to reduce the likelihood of association of the pest with the commodity as they imply inspection before export and at import, which increases the likelihood of detection. However, as *C. pinifoliae* is not a quarantine pest in EPPO countries (e.g. in EU and EAEU countries), presence of the pest on an intercepted commodity may not result in its rejection.
Pest already intercepted?	No interceptions reported through EUROPHYT for the EU on this pathway and no interceptions reported to EPPO for other EPPO countries. Spread of *C. pinifoliae* by infested nursery stock has been reported frequently in the literature (Cummings *et al.*, 1953; Brown, 1958; Wood and Roos, 1972; Furniss and Carolin, 1977; Benyus, 1983). In 1920, for example, *C. pinifoliae* was reported to have been intercepted on Douglas fir from Oregon (Maskew, 1920). The pest has also been intercepted on Christmas trees in Florida and Bermuda (Hodgson and Hilburn, 1991; Ahmed and Miller, 2019).
Most likely stages that may be associated	**All life stages** can be present on the needles of the host plants. After the crawler stage, the females (later with eggs deposited under their scale) remain attached to needles. Adult males do not remain attached but fly in search of females.
Important factors for association with the pathway	Factors affecting the likelihood of association with the pathway at the point(s) of origin: • The first instar nymphs (crawlers) are mobile and crawl around the twigs and needles, and can be dispersed by wind over several kilometres to new host plants. After the crawler stage, females remain attached to the needles and do not move. The eggs are laid under the scales of the female. Eggs are the main overwintering stage, though gravid females may also overwinter in warmer habitats. • The pest is associated with plants for planting irrespective of their size (seedlings are also infested, see section 2.6). • The pest is widespread in North America but is most common in the northern half of the USA and southern Canada (USDA, 2011). The wide distribution of the pest in North America favors association with trade. • Several chemical products can be used to control the pest in nurseries (e.g. Ontario Ministry of Agriculture, Food and Rural Affairs, 2019), but most of these are effective only if applied during the highly vulnerable crawler stage. Pesticide treatment may, on the other hand, negatively affect the natural enemies of *C. pinifoliae*, which could hinder predation rates thus leading to pest population increases. • If host trees are grown in protected conditions, which may be common for rooted cuttings and scions, there would be a lower probability of infestation by wind-blown crawlers. Moreover, such plants are often subject to several control measures.

<table>
<tr><td></td><td>

There is no reported damage on potential host plants belonging to the genera Calocedrus, Cupressus or Torreya and the pest may have a lower risk of association with these host genera.

Factors affecting the likelihood of detecting C. pinifoliae during inspection or testing at the point(s) of origin:

C. pinifoliae scales are very small and light infestations are difficult to detect.
During more severe infestations it is easier to see both the white scales and the discoloration of the needles. However, other insect scales are also known to infest Pinaceae, and misidentifications are possible (section 2.7). Such symptoms would make the commodity less likely to be traded for ornamental purposes because of quality requirements.

</td></tr>
<tr><td>Survival during transport and storage</td><td>
Trees traded for planting are recommended to be transported in refrigerated containers at 0.6-4.4 °C (e.g. GDV, 2021). Eggs are likely to survive on the host plant during transport since eggs as the overwintering stage can presumably tolerate low storage temperatures. Gravid females may also overwinter (USDA, 2011) but are more sensitive to low temperatures (section 2.2).
All life stages would presumably continue their development if temperatures were suitable.
</td></tr>
<tr><td>Trade</td><td>
Information on trade of trees for planting into the EU was obtained from two sources, i.e. from Eschen et al. (2017) where information is available at the plant species level but which only includes data from 14 countries in the PRA area and from EUROSTAT (2021) where information is mainly available for large categories but includes data only for the EU.
The database used in Eschen et al. (2017) provides trade data for the period 2000–2012. During that time, in total, 420 pieces of plants for planting of host species/genera of C. pinifoliae were traded to 14 countries in the PRA area from the countries where the pest is present (Canada, Cuba, Mexico and USA). Details are presented in the table below. These plants must have been imported through a post entry quarantine regime (or consignments were rejected) because importing these commodities into EU member states was prohibited (except Taxus).
<table>
<tr><th>Exporter</th><th>Importer</th><th>Year</th><th>Plant species</th><th>Pieces</th></tr>
<tr><td>Canada</td><td>Germany</td><td>2010</td><td>Pseudotsuga menziesii</td><td>160</td></tr>
<tr><td>USA</td><td>France</td><td>2006</td><td>Pinus thunbergii</td><td>10</td></tr>
<tr><td>USA</td><td>Germany</td><td>2010</td><td>Pseudotsuga menziesii</td><td>120</td></tr>
<tr><td>USA</td><td>Netherlands</td><td>2000</td><td>Juniperus sp.</td><td>50</td></tr>
<tr><td>USA</td><td>Netherlands</td><td>2006</td><td>Larix sp.</td><td>25</td></tr>
<tr><td>USA</td><td>Poland</td><td>2009</td><td>Juniperus sp.</td><td>17</td></tr>
<tr><td>USA</td><td>Poland</td><td>2009</td><td>Taxus sp.</td><td>38</td></tr>
<tr><td>Total</td><td></td><td></td><td></td><td>420</td></tr>
</table>
</td></tr>
</table>

	EUROSTAT does not provide data for the import of *C. pinifolia* host plants for planting (details are provided in Annex 8). Information on trade of plants for planting into Russia was obtained from the Russian pest risk analysis (VNIIKR, 2017). Customs statistics (based on packing lists) show that during 2013–2015 thirty-six consignments containing seedlings of coniferous plants were imported from North America to the Russian Federation (of which 26 consignments contained *Pinus* plants). In total, 54 454 seedlings were imported, with the largest number of plants having been shipped to North Caucasus (Krasnodar Territory) and North-West (Pskov and Leningrad regions) federal districts. It is likely that retail sales of these products are carried out in other regions as well. VNIIKR (2017) considered that given the relatively small total volume the distribution of products in the PRA area [Russia] can be assessed as moderately broad. Consequently, imports are reported into the EU and Russia; however, the expert working group noted that there were relatively few consignments.
Transfer to a host	All life stages may continue their development once at the export destination if the plants traded are planted during a season with favourable environmental conditions (i.e. spring/summer). Egg masses, and to a lesser extend gravid females, would presumably survive at destination during less favourable conditions of arrival (autumn/winter). Females would already be on a suitable host (for the offspring) and, if from a parthenogenetic population, would be able to produce eggs without males. Statistics show that the consignments arrived in the Russian Federation from February to May, which is the optimal time for planting seedlings in outdoor conditions (VNIIKR, 2017). Even though a high failure rate for transfer is likely to be associated with the passive dispersal by wind; when the population builds up and the pest is present at high density, some crawlers from the new generation(s) are likely to be transferred to new hosts since suitable host plants are widely distributed in the PRA area.
Likelihood of entry and uncertainty (ratings: e.g. very low, low, moderate, high, very high)	**Ratings for host plants for planting to countries where import of *Abies*, *Cedrus*, *Juniperus*, *Larix*, *Picea*, *Pinus*, *Pseudotsuga*, *Taxus*[3] and *Tsuga* is prohibited:** very low likelihood with a moderate uncertainty (probability of association with the host species belonging to the genera *Calocedrus*, *Cupressus* and *Torreya*, volume of plants traded for the three non-prohibited host genera). **Ratings for host plant for planting to countries where there is no prohibition at import:** high likelihood with a high uncertainty (import volume for countries other than Russia, type of commodities imported, origin of the consignments, plant species that are traded, intended use of these plants). For host plants for planting in countries where there is no prohibition, very limited trade data is available (i.e. only for Russia). As recommended by the Panel on Phytosanitary Measures in 2021-10, the EWG decided not to put too much weight on the very limited trade data available and rated the likelihood of entry mainly based on the information on association, survival during transport and transfer. The lack of trade data is reflected in the uncertainty.

[3] Except bonsais.

Table 6. Cut branches of hosts (including Christmas trees)

Pathway 2	**Cut branches of hosts (including Christmas trees)**
Coverage	• The pathway includes Christmas trees (without roots) and other cut branches of host plants (e.g. for decorative purpose). • The pathway does not include fruits of host plants (i.e. cones) when traded on their own. This pathway also includes travellers carrying, in their luggage, cut branches of hosts (including Christmas trees), from areas where the pest occurs.
Plants concerned	• All host plants (section 7): *Abies*, *Calocedrus*, *Cedrus*, *Cupressus*, *Juniperus*, *Larix*, *Picea, Pinus*, *Pseudotsuga, Taxus, Torreya* and *Tsuga*
Pathway prohibited in the PRA area?	Partly. In several EPPO countries (e.g. in the EU) the introduction of parts of plants belonging to *Abies, Cedrus, Juniperus, Larix, Picea, Pinus, Pseudotsuga,* and *Tsuga* is **prohibited** from certain third countries, including all the countries where the pest is currently present (Canada, Cuba, Mexico, USA) (Annex VI of (EU) 2019/2072 (EU, 2019)). It should be noted that in the EU there are no prohibitions of import for parts of plants of *Calocedrus*, *Cupressus*, *Torreya* and *Taxus.*
Pathway subject to phytosanitary measures, including inspection at import?	Partly. In several EPPO countries Phytosanitary certificates are required for import of all fresh parts of plants (e.g. in the EU, from third countries other than Switzerland; Annex XI of (EU) 2019/2072 (EU, 2019)). In addition, in the EU the emergency measure against *Phytophthora ramorum* (Decision 2002/757/EC (EU, 2002)) includes requirements that would apply for *Taxus* spp., e.g. subject to inspection. However, these pest-specific requirements were considered to be of limited importance by the EWG for *C. pinifoliae* compared to the more general requirements. • In the EurAsian Economic Union, *Pinus* and other Coniferae (except *Thuja* and *Taxus*) cut branches (including Christmas trees) are also covered by various pest-specific phytosanitary requirements (EEC, 2016): Cut branches of Coniferae (except for the genera *Thuja*, *Taxus* and *Pinus*) should originate from areas free of fusiform rust of pine (*Cronartium fusiforme*), the causative agents of branch canker of pine (*Atropellis piniphila* and *Atropellis pinicola*), eastern black-headed budworm (*Acleris variana*), six-spined engraver beetle (*Ips calligraphus*), five-spined bark beetle (*Ips grandicollis*), eastern spruce budworm (*Choristoneura fumiferana*), spruce beetle (*Dendroctonus rufipennis*), pine-to-pine gall rust (*Cronartium harknessii* [syn. *Endocronartium harknessii*]), western black-headed bud worm (*Acleris gloverana*), western spruce budworm (*Choristoneura occidentalis*), California pine engraver (*Ips plastographus*), brown-spot needle blight (*Lecanosticta acicola* [syn. *Mycosphaerella dearnessi*]),

	forest tent caterpillar (*Malacosoma disstria*), pine engraver (*Ips pini*), Japanese apple rust (*Gymnosporangium yamadae*), eastern pine gall rust (*Cronartium quercuum*), sitka-spruce weevil (*Pissodes strobi*), lodgepole terminal weevil (*Pissodes terminalis*), pine wood nematode (*Bursaphelenchus xylophilus*), and sudden oak death (*Phytophthora ramorum*) • Cut branches of *Pinus* (including Christmas trees) should originate from areas and (or) places of production free of white spotted sawyer (*Monochamus scutellatus*), the causative agent of brown-spot needle blight (*Lecanosticta acicola* [syn. *Mycosphaerella dearnessi*]), the causative agents of branch canker of pine (*Atropellis piniphila* and *Atropellis pinicola*), five-spined bark beetle (*Ips grandicollis*), six-spined engraver beetle (*Ips calligraphus*), California pine engraver (*Ips plastographus*), Carolina sawyer (*Monochamus carolinensis*), pine engraver beetle (*Ips pini*), spotted pine sawyer (*Monochamus clamator*), north-eastern sawyer (*Monochamus notatus*), pine wood nematode (*Bursaphelenchus xylophilus*), obtuse sawyer (*Monochamus obtusus*), balsam-fir sawyer (*Monochamus marmorator*), spotted pine sawyer (*Monochamus mutator*) and southern pine sawyer (*Monochamus titillator*). The expert working group questioned whether there was any area in North America that could fulfil all these requirements, since several of these pests are fairly widespread. These requirements are likely to reduce the likelihood of association of the pest with the commodity as they imply inspection before export and at import, which increases the likelihood of detection. However, as *C. pinifoliae* is not a quarantine pest in EPPO countries (e.g. in the EU and EAEU), presence of the pest on an intercepted commodity may not result in its rejection.
Pest already intercepted?	The pest has been regularly intercepted in Florida (USA) on Christmas trees imported from other jurisdictions in USA or Canada (Ahmed and Miller, 2019). No interceptions have been reported through EUROPHYT for the EU on this pathway or to EPPO for other EPPO countries. Interception occurred on Christmas trees (*Pinus* sp.) in Bermuda in 1971, 1986 and 1991 (Hodgson and Hilburn, 1991; Watler and Stahevitch, 1992).
Most likely stages that may be associated	**All life stages** can be present on the needles of the host plants. After the crawler stage the females (later together with eggs) remain attached to needles. Adult males do not remain attached but fly in search of females.
Important factors for association with the pathway	Factors affecting the likelihood of association with the pathway at the point(s) of origin: • The first instar nymphs (crawlers) are mobile and crawl around on the twigs and needles and can be dispersed by wind over distances of several kilometres to new host plants (section 2.2; 2.5). After the crawler stage, females remain attached to the needles and do not move. The eggs are laid under the scales of the female. Eggs are the main overwintering stage, but sometimes also gravid females overwinter. Adult males can fly between host plants to find a female in order to mate.

	• The pest is widespread in North America, but is most common in the northern half of the USA and southern Canada (section 6). The wide distribution of the pest in North America favors association with trade. • Chemical products can be used to control the pest in Christmas tree plantations (e.g. Katovich *et al.*, 2014), but they are effective only if applied when the vulnerable crawlers are present. On the other hand, relatively broad-spectrum pesticide treatments that affect natural enemies of *C. pinifoliae* may promote population increases. • The pest may be present on branches of all diameters. • There is no reported damage associated with host plants belonging to the genera *Calocedrus*, *Cupressus* or *Torreya* and the pest may have a lower risk of association with these host genera. Factors affecting the likelihood of detecting the organism during inspection or testing at the point(s) of origin: • *C. pinifoliae* scales are very small and light infestations are difficult to detect. When many individuals are present, it is easier to see both the white scales and the discoloration of the needles (section 2.7). Such symptoms would also make the commodity less likely to be traded for ornamental purposes because of the quality requirements.
Survival during transport and storage	Eggs are likely to survive on cut branches of hosts (including Christmas trees) during transport since eggs are the overwintering stage and can tolerate low storage temperatures. Gravid females may also overwinter (USDA, 2011). All life stages are likely to continue their development if temperatures were suitable. Development threshold of *C. pinifoliae* eggs lies between 9.3 °C and 11.8 °C (section 2.3). In experiments, cut branches infested with eggs were placed in display boxes. Eggs remained viable even after the needles had dried (C. Sadof, pers. comm.). This suggests that eggs could survive some moderate host desiccation and thus any fresh cut branches of pine or other potential host species could be a pathway for entry.
Trade	According to EUROSTAT (2021) less than 100 kg of 'fresh Christmas trees' (CN 06042020) and about 8 700 kg of 'fresh conifer branches, suitable for bouquets or ornamental purposes' (CN 06042040) were imported from the countries where the pest is present into the EU in 2015–2019. For both commodities the only exporter was the USA. 'Fresh Christmas trees' were imported only to France and 'fresh conifer branches suitable for bouquets or ornamental purposes' only to Luxembourg. Assuming that these were recorded hosts, they should belong either to the genera *Calocedrus*, *Cupressus*, *Torreya* or *Taxus*, or have been imported under strict quarantine conditions because of existing import prohibitions. Additional import data for 'foliage, branches and other parts of plants, without flowers or flower buds, and grasses, mosses…' (Product 0604) to non-EU countries, is available in ITC (2021). However, these data do not make any distinction between broadleaf trees and conifers.
Transfer to a host	Christmas trees would in most cases be used indoors and imported during a short period in winter. Transfer to suitable hosts outdoors is thus unlikely. Cut branches used for Christmas decorations may also be used outdoors. These commodities typically arrive during winter when environmental conditions are unsuitable for nymphs and adults, at least in cooler parts of the EPPO region. Since eggs are the overwintering

	stage in the native range, they could survive until conditions improve if the commodities are placed or discarded outdoors. The likelihood of transfer is higher if cut branches are used outside and arrive during the vegetation period. Eggs would continue their development once at their destination and the insect scale could even complete its developmental cycle on the imported commodity, providing that the needles are fresh enough to feed on. Some crawlers are likely to be transferred by wind to new hosts since suitable host plants are widely distributed in the PRA area, but a very high failure rate for transfer is likely to be associated with this passive dispersal (which implies e.g. wind carrying crawlers upwards from a commodity discarded/placed close to the ground). Transfer from cut branches used in bouquets, which are often placed indoors, is less likely than if they are placed outdoors. If the commodity arrives at nurseries or garden centres, other hosts are likely to be found in the vicinity, but the likelihood of transfer remain low as, even in these circumstances, the mobility of the pest is very low.
Likelihood of entry and uncertainty (ratings: e.g. very low, low, moderate, high, very high)	**Ratings for cut branches of hosts (including Christmas trees) to countries where import of *Abies, Cedrus, Juniperus, Larix, Picea, Pinus, Pseudotsuga,* and *Tsuga* is prohibited:** very low likelihood with a moderate uncertainty (probability of association with the host species belonging to the genera *Calocedrus*, *Cupressus, Taxus* and *Torreya*, volume of plants traded for the four non-prohibited host genera). The experts considered that the likelihood of entry via this pathway was lower than for plants for planting due to the low probability of transfer. However, this does not change the rating of the likelihood for cut branches of hosts (including Christmas trees) on a 5-level scale. **Ratings for cut branches of hosts (including Christmas trees) to countries where there is no prohibition at import:** low likelihood with a high uncertainty (import volume, types of commodities, origin of the consignments, plant species that are traded, period of import, intended use of these plants, proportion of situations that will allow transfer e.g. when plants are later deposited in a forest).

8.2 Unlikely pathways: very low likelihood of entry

- **Stored products/dried plant parts**
  Pine needles may be used as mulch for gardens, or for phytotherapy. However, for such uses pine needles are generally dried and nymphs are not expected to survive. If eggs did happen to survive, transfer of emerging nymphs to the needles of a host by crawling would most probably fail.

Figure 1: Pine needles as mulch from the USA. Source: Amazon (Link)

  'Preserved' or 'stabilized' cut branches bearing needles can be traded for decorative purposes (e.g. Christmas decoration). However, the pest is not expected to survive the preservation process when preservation fluids saturate the plant material. When such decorations are traded fresh they are covered by the pathway *'cut branches of hosts'*.
  Uncertainty: low.

- **Wood of host plants**
  This pathway includes round wood, sawn wood, wood chips, processing wood residues and hogwood[4]. None of the life stages of *C. pinifoliae* are associated with wood. The newly hatched nymphs (crawlers) can be present on this pathway while they search for a suitable location on the needles to feed, which would only constitute a few days at most. Their presence on other parts of the plants was assessed by the EWG to be negligible compared to that on needles. Moreover, several EPPO countries regulate the importation of wood of conifers from third countries in relation to the risk posed by *Bursaphelenchus xylophilus* (e.g. in the EU, wood from several countries including USA, Canada, Mexico and Cuba should be bark free, have undergone a kiln-drying process, an appropriate fumigation, a chemical pressure impregnation or a heat treatment).
  Uncertainty: low.

- **Bark of host plants**
  This pathway relates to bark alone (i.e. isolated bark as a commodity). *C. pinifoliae* is found on needles. The closely related species *C. heterophyllae* has been observed on bark of young succulent twigs (Cooley, 1899), but no such reports were found for *C. pinifoliae*. First instar nymphs are also likely to crawl on bark (mainly on twigs) in search of a suitable needle for feeding. Nymphs ending up on coarser bark are not expected to survive. The likelihood of them occurring on other parts of the plants was assessed by the EWG to be negligible compared to that on needles. Moreover, several EPPO countries regulate the importation of isolated bark of conifers from third countries in relation to the risk posed by *Bursaphelenchus xylophilus* (e.g. in the EU, isolated bark from several countries

[4] Hogwood: wood with or without bark in the form of pieces of varying particle size and shape, produced by crushing with blunt tools such as rollers, hammers or flails.

including USA, Canada, Mexico and Cuba should have undergone an appropriate fumigation or heat treatment).
Uncertainty: low.

- **Conifer nuts and cones of host plants**
  Fruits of host plants, i.e. cones, only very rarely host the pest. Infestation of pinecones was reported from Mexico (Cibrán-Tovar *et al.*, 1986). Life stages that end up on cones are not expected to survive.
  Uncertainty: low.

- **Hitchhiking on other commodities**
  First instar nymphs may be associated with objects other than host plants if carried there by wind. They will however not survive longer than a few days without finding a host (needle).
  Uncertainty: low.

- **Intentional human assisted movement of individuals**, e.g. trade by collectors.
  Specimens of *C. pinifoliae* may be traded between hobby entomologists, but presumably only after they are dead. Live insects for research purposes may be circulated but are likely to be studied only in laboratories.
  Uncertainty: low.

- **Natural spread**
  Chionaspis pinifoliae is mostly sedentary, but the first instar nymphs (crawlers) are mobile and can be dispersed by wind up to several kilometres to new host plants, and possibly further (section 2.5). In addition, Diaspididae species can be carried by insects, birds and mammals. However, considering the limited life span of the crawlers and the current distribution range, natural spread from North America to the EPPO region is not considered possible.
  Uncertainty: low.

8.3 Overall rating of the likelihood of entry

For all pathways and at the scale of the PRA area the current phytosanitary requirements in place are likely not enough to prevent introductions of *C. pinifoliae* into the EPPO region by import. There are prohibitions on the import of *Abies*, *Cedrus*, *Juniperus*, *Larix*, *Picea*, *Pinus*, *Pseudotsuga*, *Taxus* (except for bonsais) and *Tsuga* plants for planting, as well as cut branches (except for *Taxus*) for some countries (e.g. into the EU), but this is not the case for all EPPO countries.

Overall rating of the likelihood of entry taking the worst-case scenario from the individual pathways considered:

Rating of the overall likelihood of entry	*Very low* ☐	*Low* ☐	*Moderate* ☐	*High* ☒	*Very high* ☐
Rating of uncertainty			*Low* ☐	*Moderate* ☐	*High* ☒

9. Likelihood of establishment outdoors in the PRA area

Chionaspis pinifoliae is distributed throughout North America but is most common in the northern half of the USA and southern Canada. The pest has also been reported from Cuba. Within its native range *C. pinifoliae* occurs in many types of climates and on a variety of conifer species.

9.1. Climatic suitability

Climate match

Considering records with known location coordinates from the GBIF database (GBIF, 2021a), there are observations of *C. pinifoliae* from 14 Köppen-Geiger climate types that cover nearly the whole PRA area, except parts of the Russian Far East (ANNEX 9, Figure 3).

Low temperatures are thought to negatively affect survival of overwintering stages (section 2.3). Detailed information on the cold tolerance of these stages was not found. However, as *C. pinifoliae* is present in cold climates (e.g. with a subarctic climate) it can clearly survive temperatures below 0°C. No information is available on the extreme heat conditions affecting survival of *C. pinifoliae* crawlers, but it does occur in warm areas (e.g. South California, Texas (USA), Mexico). The presence of the pest in southern areas may be positively affected by irrigation of agricultural plots.

According to a climatic niche comparison by Zhao *et al.* (2019) the mean diurnal range (i.e. the difference between day and night temperatures) and the mean temperature of the wettest quarter of the year are the main factors affecting the distribution of the *Chionaspis pinifoliae* – *Chionaspis heterophyllae* species complex (see section 1 for details on this complex). Note that Zhao *et al.* (2019) only used North American observations of the species complex in the niche comparison.

Degree days

Burden and Hart (1989) suggested that in Iowa (USA) the development threshold for *C. pinifoliae* eggs lies between 10.8 °C and 11.8 °C. They calculated using 10.8 °C as a base temperature that 136 growing degree-days (GDD) are required for *C. pinifoliae* to hatch. Doherty *et al.* (2018) estimated that the development threshold of *C. pinifoliae* eggs is 9.3 °C (± 0.1 °C) and, using that as base temperature, they calculated that 277.8 GDD (± 11.2) is required for the hatching of the population in Southern Québec, Canada. Fondren and McCullough (2002) and Katovich *et al.* (2014) calculated using 10 °C as base temperature that in the North Central and Northeastern USA ~121–204 GDD is required for the spring generation to hatch and most crawlers should be in the hyaline stage by 204–260 GDD. The summer generation eggs begin hatching at around 676-732 GDD. The ideal timing to control the summer generation is in the hyaline stage at about 816 GDD (Fondren and McCullough, 2002; Katovich *et al.*, 2014). Using 10 °C as base temperature, Cornell Cooperative Extension (2010) suggested that the first- and second-generation nymphs, respectively, develop in 148–231 GDD and 699–1047 GDD. According to Luck and Dahlstein (1974) hatching in the spring begins earlier for populations with two generations than for those with one generation per year.

Although exact information on the GDD required for *C. pinifoliae* to complete one or two generations was not found, based on above mentioned studies on development rates they can be estimated to be between 400–800 GDD and 1000–1600 GDD, respectively (with 10 °C as base temperature). In North America 400–800 GDD is, in general, reported in areas where one generation was reported and more than 1000 GDD was reported in areas where there may be two generations or more (section 2.2; ANNEX 9, Figure 1, Figure 2).

Conclusions

- The climatic conditions appear to be suitable for *C. pinifoliae* in almost the entire PRA area.
- It is, however, considered unlikely that the pest establishes in the northernmost part of the EPPO region (including parts of Siberia) (0-400 $GDD_{10°C}$ area in Figure 2, ANNEX 9) because it is highly unlikely that the pest could complete its life cycle there.

- In the PRA area 400-800 $GDD_{10°C}$ is achieved in Southern Fennoscandia, Baltic states, Ireland and in some areas in United Kingdom and Russia, suggesting that only one generation could be achieved in these areas (ANNEX 9, Figure 1; Figure 2).
- In the PRA area more than 1000 $GDD_{10°C}$ is achieved in Southern Europe, North Africa and Central Asia, and in some areas in Northern and Central Europe and Russia, suggesting that two generations or more could occur in these areas (ANNEX 9, Figure 1, Figure 2).

The estimates of where temperature allows one or more generations are rough and uncertain.

9.2. Host plants in the PRA area

Chionaspis pinifoliae is a pest of conifers with known hosts in the genera *Abies*, *Calocedrus, Cedrus*, *Cupressus*, *Juniperus*, *Picea, Pinus*, *Pseudotsuga, Taxus, Torreya* and *Tsuga* (section 7, ANNEX 6).

Most of the known host plants of *C. pinifoliae* are present in the PRA area either as native or introduced species (ANNEX 6). Some host plant species, such as *Abies alba, Picea abies, Pinus halepensis, Pinus mugo, Pinus nigra, Pinus sylvestris* and *Pseudotsuga menziesii* are widespread in the PRA area (ANNEX 7).

In the PRA area, a high density of host plants for *C. pinifoliae* is present especially in boreal forests in Fennoscandia and Russia (European Environmental Agency, 2006) (Figure 2). Moreover, a high density of host plants of *C. pinifoliae* is present in coniferous and mixed broadleaved-coniferous forests, which are located mostly in Northern and Eastern Europe, Baltic states and Russia, and in coniferous forests of the Mediterranean, Anatolian, Macaronesian regions and Alpine regions (European Environmental Agency, 2006) (Figure 2). Potential host plants are also well distributed in Southern Europe, concentrated in mountains (Farjon and Filer, 2013).

Host plants of *C. pinifoliae* are also common in the whole EPPO region in plant nurseries, Christmas tree plantations, parks, home gardens, and as shade trees. Several host species are commonly planted in the EPPO region (ANNEX 6) and pine trees in particular are very important as well as lanscape trees e.g. in the whole Mediterranean area. *Pinus pinea* is also used for pine nut production.

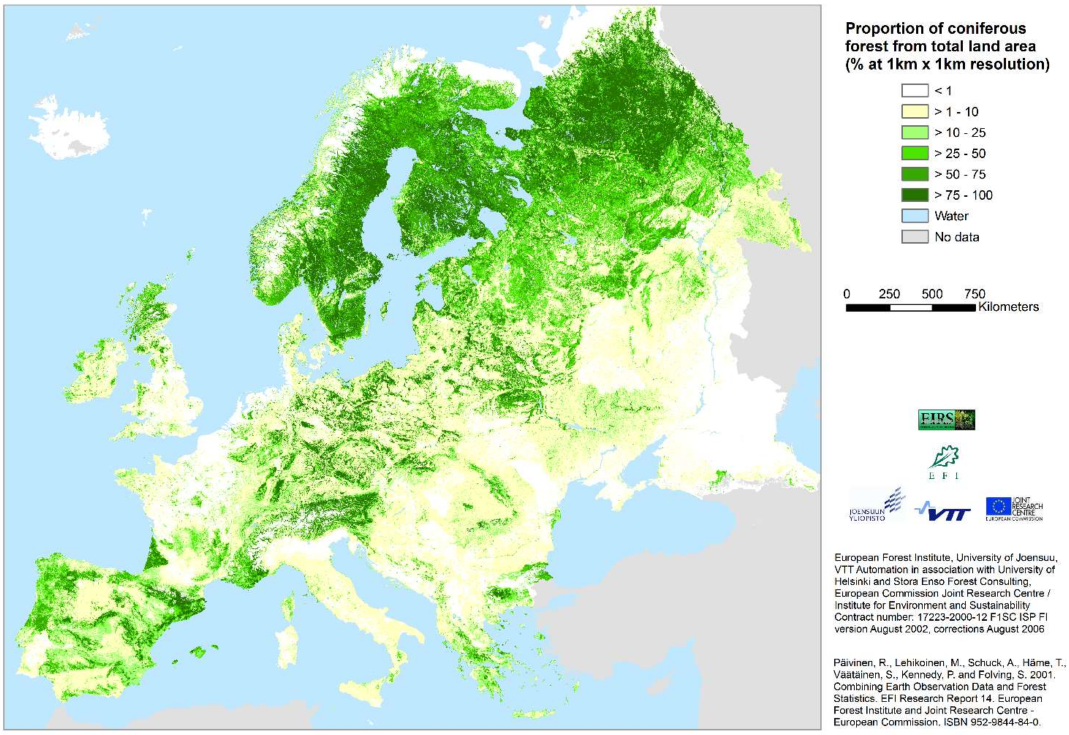


Figure 2. The proportion of coniferous forest relative to the total land area of Europe (Päivinen *et al.*, 2001; Schuck *et al.*, 2002; Kempeneers *et al.*, 2011).

9.3. Biological considerations

Arrival of a single infested plant in the PRA area may be sufficient for *C. pinifoliae* to establish. The parthenogenetic populations are not expected to be as vulnerable to Allee effects as would occur in species whose sexual reproduction requires mating with males (Drake, 2004). In any case, high densities of host plants is a prerequisite for population build up.

Females of *C. pinifoliae* cannot fly. It has been suggested that this trait increases the likelihood of establishment of localized sexually reproducing populations (Robinet and Liebhold, 2009). Although the ability to fly may assist in finding suitable host plants, flightless individuals may have an advantage at low population densities because mating success is more likely when offspring stay relatively close to the eggs from which they originate (Robinet and Liebhold, 2009).

Although natural enemies can have a major impact on populations of *C. pinifoliae* there is no evidence that natural enemies could prevent its establishment. Of the natural enemies of *C. pinifoliae* the following predators, *Chilocorus kuwanae, Chilocorus orbus, Chilocorus renipustulatus, Chilocorus stigma*; and the following parasitoids, *Aphytis chilensis*, *Aphytis diaspidis*, *Aphytis mytilaspidis Aphytis proclia, Coccobius varicornis, Encarsia aurantii*, *Encarsia citrina,* are present in the PRA area (ANNEX 4).

There is no evidence indicating that establishment of *C. pinifoliae* could be prevented by competition from other species. Several Diaspididae species occur on conifer needles in Europe (Ellis, 2021), such as species belonging to the genera *Aonidia*, *Carulaspis, Chionaspis, Dynaspidiotus, Lepidosaphes*, *Leucaspis* and *Lineaspis* (ANNEX 5). These species are not present in high density on conifers in the EPPO region and most are unlikely to have any impact on the probability of establishment of *C. pinifoliae*.

9.4 Overall rating of the likelihood of establishment outdoor

Rating of the likelihood of establishment outdoors	*Very low* ☐	*Low* ☐	*Moderate* ☐	*High* ☐	*Very high* ☒
Rating of uncertainty			*Low* ☒	*Moderate* ☐	*High* ☐

10. Likelihood of establishment in protected conditions in the PRA area

Chionaspis pinifoliae is a pest of woody plants, which are not commonly grown under protected conditions in the PRA area. Smaller hosts, including bonsais and ornamental plants, may be grown in protected conditions (in heated glasshouses). In Fennoscandia there is also production of propagation material for forestry in protected conditions. These plants are generally smaller and more frequently inspected than trees in the field, thus increasing the likelihood that the pest will be detected and eliminated before it establishes. Host plants may also be grown in protected conditions in botanical gardens.

Bonsais and other ornamental plants

Scale insects are a significant problem in glasshouse floriculture in the Netherlands and companies that have plants that become infested rarely get rid of these pests (NVWA, 2017; Kruidhof *et al*., 2018). For example, the rose scale (*Aulacaspis rosae*) in rose and the Boisduval scale (*Diaspis boisduvalii*) in *Cymbidium* are mentioned as pests that are difficult to control (Kruidhof *et al*., 2018). Host plants of *C. pinifoliae* are probably grown at a limited scale in glasshouses for ornamental use. In particular, they may be grown as bonsai trees (e.g. *Pinus* and *Juniperus*), which are usually spaced apart in the glasshouse (plants do not touch each other). In such crops, scale insects may be easier to control than in more densely distributed crops such as rose and *Cymbidium* where they may more easily spread from plant to plant by crawling and by human assisted spread (i.e. due to contact between crops and workers during crop management). In such instances establishment may be prevented by removing infested bonsai plants.

Propagation material for forestry

Coniferous seedlings are planted from seeds which greatly reduces the risk of infestation by *C. pinifoliae*. Seedlings may be subject to preventive measures such as rigorous cleaning of the greenhouses and pots between crop rotations, use of horticultural oils on the dormant plant material before entering the greenhouse (such as in Canada; J. Letourno, pers. comm.). Such measures would reduce the likelihood of establishment in protected conditions. When producing seedlings, plants only remain indoors for about 2–3 months (Katajisto 2015; Skogsplantor, 2021), which is not long enough for scale insects to establish.

In botanical gardens

In botanical gardens the use of pesticides is generally very limited, the vegetation may be dense, and plants are often very tall. For these reasons the likelihood of establishment may rises if *C. pinifoliae* enters a greenhouse with suitable host plants in a botanical garden. However, the EWG does not know to what extent suitable host plants are grown in greenhouses of botanical gardens. In such greenhouses, (sub)tropical plants are usually grown and host plants susceptible to *C. pinifoliae* may be uncommon.

10.1 Overall rating of the likelihood of establishment in protected conditions

Rating of the likelihood of establishment in protected conditions	*Very low* ☐	*Low* ☐	*Moderate* ☒	*High* ☐	*Very high* ☐
Rating of uncertainty			*Low* ☐	*Moderate* ☒	*High* ☐

Uncertainty: scale insects are known as difficult to control in glasshouse floriculture, but the ease of control may depend on the crop. *C. pinifoliae* is not known as a pest under protected conditions.

11. Spread in the PRA area

11.1 Natural spread

Chionaspis pinifoliae is mostly sedentary as the only mobile stages are the adult male (which can crawl and are weak flyers) and the first nymphal stage (crawler). The first instar nymphs of *C. pinifoliae* may crawl short distances but can also be dispersed to new host trees passively by wind (up to several kilometres or more in one generation) (section 2.5).

Given the limited movement capacity of crawlers, their particular vulnerability e.g. to climatic conditions, and the lower chance of new populations being established far from the outbreak, this mode of dispersal by wind is considered effective at two scales:

- locally (intra-plant or intra-stand) and
- in particular situations (inter-stand) when
    - the source population is sufficiently large, where host plants are present in sufficient high density to allow crawlers to be transported directly to another host plant, and where enough crawlers are transported so that adult males can more easily find adult females, or
    - when the population is parthenogenetic.

The ability of uniparental (parthenogenetic) populations to reproduce without males may be important in an episode of colonization by one or a few crawlers under conditions of low density (Nur, 1990).

Natural spread could be promoted when conifers are planted along highways, which could serve as ecological corridors (e.g. *Pinus nigra* which is often planted along highways (Impens *et al*., 1973)).

Some Diaspididae species can be carried over short and long distances by animal vectors (phoresy), but this is considered unlikely for *C. pinifoliae* (Brown, 1958) (section 2.5).

The presence of host plants in relatively high densities would allow population build up and facilitate spread of *C. pinifoliae*. Natural spread would also be facilitated by widespread and contiguous distribution of several of potential host species in the PRA area (section 9; ANNEX 7). However, natural spread is expected to be reduced due to the intrinsic restrictions of the available modes of dispersal, i.e. crawling, wind dispersal, and animal vectors (section 2.5).

11.2 Human assisted long-distance spread

Chionaspis pinifoliae could spread over long distance via transportation of infested plants for planting and cut branches (including Christmas trees) (section 8). *Chionaspis pinifoliae* is frequently reported as a pest of Christmas tree plantations and plant nurseries in North America. The pest has also been intercepted on Christmas trees in North America, in Bermuda, and Florida, USA (section 8).

There is a large trade of woody plants for planting within the PRA area. Within the EU a plant passport is required to move all plants for planting (excluding seeds), implying inspection at the place of production (Regulation (EU) 2016/2031). The white scales can be seen on needles any time of the year. However, infestation may not be detected until significant symptoms appear (section 2.7).

11.3 Overall rating of the magnitude of spread in the PRA area

Chionaspis pinifoliae generally lacks the capacity to search for host plants such that the insect would be more likely to remain on previously infested plants. Long distance spread would mainly occur via wind or human assisted spread. The speed of natural spread will depend on host plant availability (e.g. density and distribution) and local climatic conditions (e.g. wind currents). The ability to reproduce parthenogenetically when there are no males around allows a single female to establish a new population and thus greatly increases the spread potential of *C. pinifoliae*. *Chionaspis pinifoliae* is also known to have been moved with plants for planting and cut branches, a phenomenon which may lead to multiple outbreaks and thereby decrease the time to spread to its maximum extent within the EPPO region. The magnitude of spread would be higher in areas where two or more generations could occur and where host plants are present in high densities.

Rating of the magnitude of spread	*Very low* ☐	*Low* ☐	*Moderate* ☒	*High* ☐	*Very high* ☐
Rating of uncertainty			*Low* ☐	*Moderate* ☒	*High* ☐

Uncertainty: limited data about long-distance natural spread, variability depending on the area of first introduction (e.g. forestry environment vs. Christmas tree plantation). There is also uncertainty on how often a female from a biparental (non-parthenogenetic) population can reproduce parthenogenetically and settle a new population.

12. Impact in the current area of distribution

Chionaspis pinifoliae is a common and widespread pest of conifers, especially in shelterbelts, ornamental plantings, nurseries, and Christmas tree plantations (Cumming, 1953; Peterson and DeBoo, 1969; Ahmed and Miller, 2019; Klingeman *et al.* 2020). Typically, plants heavily infested with scale insects are found in disturbed environments, or where hosts are stressed (Dale and Frank 2017). Trees are usually attacked by *C. pinifoliae* when they are young (Hiratsuka *et al.*, 1995) and infestations occur more frequently on recently transplanted pines (Felt, 1905). Nitrogen concentration and availability in host plants is a significant driver of insect fitness and pest outbreaks (White, 1984). Native and non-native naturalized scale insects (Malumphy and Badmin, 2012; Gertsson and Isacsson, 2012) can infest planted ornamentals along highways (Kozár, 2009; Kozár *et al*., 2012) as other hemipteran pests do on cultivated plants (Cocco *et al.*, 2015; Rashid *et al*., 2017). Scale insects develop better on plants with excess nitrogen from fertilization, which enhances insect growth, or on drought stressed plants, which can impair tree defenses (Rashid *et al*., 2016; Dale & Franck, 2017; Navarro *et al*., 2020; Cocco *et al*., 2021).

Pinus sylvestris and *P. mugo*, which are introduced to North America (and native to the EPPO region), are particularly susceptible to *C. pinifoliae* (Martel and Sharma, 1968; Nielsen and Johnson, 1973; Kosztarab, 1996; Eliason and McCullough, 1997; Glynn and Herms, 2004). Infestation rates on *Pinus sylvestris* can reach 1.18 scales per mm of a needle and more than 61 scales per needle (Martel and Sharma, 1968) and the reproductive rate on the non-native *P. sylvestris* was twice as high as that on the native host *P. resinosa* (Glynn and Herms, 2004).

The pest is considered to cause an unsightly appearance because its white waxy secretion gives the foliage a grey appearance, which is undesirable in many commercial plants sold based on aesthetics, e.g. ornamental plantings (Cumming, 1953; Fondren and McCullough, 2002). Trees subjected to attack for several years may ultimately be killed (e.g. Peterson and DeBoo, 1969; Wood and Ross, 1972; Hiratsuka *et al.*, 1995). However, more often the impact of severe *C. pinifoliae* infestation is reduced vigor and increased susceptibility to attack by secondary insects such as borers and bark beetles, or adverse weather conditions such as drought (Brown, 1916; Peterson and DeBoo, 1969; Wood and Ross, 1972; Furniss and Carolin, 1977). It has been shown experimentally that net photosynthetic rate is reduced by ~40% when the scales of *C. pinifoliae* cover 30% of the foliage (Walstad *et al*., 1973).

12.1 Economic impact (sensu stricto)

The host preference and thereby the impact of *C. pinifoliae* seems to differ between regions depending on the availability of apparently favoured host species (Peterson and DeBoo, 1969). Such variations in plant composition could partly reflect local adaptations of *C. pinifoliae* to particularly abundant host species (Glynn and Herms, 2004). *Pinus* spp. were most frequently infested east of the Mississippi River in the USA; *Picea glauca* in central Canada; and *Pseudotsuga menziesii* in British Columbia (Peterson and DeBoo, 1969; section 12.1.2). Further support for regional differences comes from the observation that *C. pinifoliae* frequently developed outbreaks in Washington on *Pinus ponderosa* but did not use *Picea glauca*, *P. pungens* or *Pseudotsuga menziesii* as regular hosts, despite the fact that these species were all present in the infested *Pinus ponderosa* stands (Edmunds, 1973). Similarly in Connecticut, many *Pinus* species were reported to be attacked but not *Picea* sp. (Turner, 1930). It should, however, be noted that experimental studies do not provide firm support for the hypothesis that local adaptations are important drivers of interactions between scales and trees (Glynn and Herms (2004) and references therein).

12.1.1 Ornamental trees, shelterbelts and nurseries

Chionaspis pinifoliae is a common pest in nurseries, e.g. it was one of the most frequently recorded insect pests found in nursery inspections in Indiana (Meyer, 1987) and it was the most commonly encountered insect pest of nursery conifers in Iowa in the 1980s (Burden and Hart, 1990). Regulatory measures associated with *C. pinifoliae* were commonly used to halt sale and transport of infested nursery stock (Burden and Hart, 1990). *Chionaspis pinifoliae* is also a frequent pest on ornamental trees and shelterbelts. Below is a description of its reported impacts in different regions.

<u>Canada</u>

- *Chionaspis pinifoliae* infestations occur throughout Canada, and it was considered a major pest of planted *Picea* spp. and *Pinus* spp. in the agricultural regions of Alberta, Saskatchewan, and Manitoba (Prairie Provinces) where serious injury and mortality of trees has been recorded (Cumming, 1953; Peterson and DeBoo, 1969; Kusch and Langor, 1992). The high impact of *C. pinifoliae* in these provinces was presumably due to the high prevalence of suitable hosts in high-risk environments, i.e. *Picea glauca*, *P. pungens*, and *Pinus sylvestris* had been widely planted for ornamental purposes (c.f. section 12.1.3 which shows that *C. pinifoliae* rarely causes significant damage in forests).
- In eastern Canada, *C. pinifoliae* was listed as one of the more important shade tree insect pests (Swaine and Hutchings, 1926) and high infestation rates have been noted on *Pinus sylvestris* and *P. mugo* in the province of Québec (Martel and Sharma, 1968).
- In British Colombia, sporadic infestations occurred from 1946 to 1971, resulting in some tree mortality (Wood and Ross, 1972). *Pinus ponderosa,* which is the preferred host tree in British Colombia, was particularly impacted.
- Edmunds (1973) mentions an outbreak that caused the death of many *Picea glauca* in Saskatchewan and severe outbreaks on *Pseudotsuga menziesii* near Summerland in British Columbia (no details provided).

<u>Cuba</u>

- In Cuba, *C. pinifoliae* was listed among insects "meaningfully to agriculture" due to outbreaks on *Pinus caribaea* (Mestre *et al.*, 2006).

<u>USA</u>

- In a review of scale insects in northeastern North America providing information on their economic importance, *C. pinifoliae* is considered to be one of the most important pests of ornamental pines in the USA (Kosztarab, 1996).
- It has been identified as an important pest of street trees in southeastern USA (Frank, 2019).

- It is a frequent pest of ornamentals and trees in shelterbelts in western North America (Furniss and Carolin, 1977).
- In Missouri it is a common pest of *Pinus* spp. It is most frequently found on *Pinus mugo*, *P. sylvestris*, and *P. ponderosa*, but also infests *P. nigra*, *P. resinosa*, *P. strobus*, and most *Picea* spp. (Missouri Botanical Garden, 2021).
- In Ohio, it was considered to be a common and troubling 'key pest' when *Pinus mugo* was a common landscape plant (Boggs, 2019).
- In Philadelphia, *C. pinifoliae* is considered to be a major pest on urban trees and is one of the twenty most frequently reported pests (Yang, 2009).
- In Colorado, *C. pinifoliae* is the most important Diaspididae species infesting conifers (Cooper and Cranshaw, 2005) and damage has been especially severe on *Pinus mugo* (Cranshaw *et al.*, 1994).
- In Pennsylvania, *C. pinifoliae* is considered to be a 'key pest' of *Pinus* spp. in landscapes, nurseries, and Christmas tree plantations where it attacks *Pinus mugo*, *P. nigra*, *P. resinosa*, *P. sylvestris*, *P. strobus*, *Pseudotsuga menziensii*, most *Picea* spp., and *Cedrus* spp. (Hoover, 2002).
- In Montana and northeastern Idaho, *C. pinifoliae* is considered a chronic pest throughout the northern Rocky Mountains. In Montana, severe outbreaks occurred in the Glacier National Park in the early 1960's, in the Helena National Forest in 1975, and on the Flathead Indian Reservation from 1977 to 1978 (Forest Health Protection and State Forestry Organizations, 2010).
- In New York, chronic infestations precluded the planting of *Pinus mugo* (Nielsen and Johnson, 1973).
- In Nebraska, *C. pinifoliae* was considered to be the most injurious insect of evergreen shade and ornamental trees (Muma, 1946).
- In the Pacific States, *C. pinifoliae* was ranked as the 17th most important insect pest of trees used for ornamental, shade and park purposes based on a questionnaire sent to universities, cities, counties etc. (Burke, 1930).
- In Connecticut, *C. pinifoliae* was reported to be a pest of considerable importance on young trees due to its negative impact on growth, the loss of foliage and the mortality caused by persistent attacks (Turner, 1930). Also, older trees that grow in shaded locations were very susceptible to attacks and sometimes became seriously injured (Turner, 1930).

12.1.2 Christmas tree plantations

According to a Christmas tree pest manual, *C. pinifoliae* weakens trees by sucking sap from the needles and killing shoots (Katovich *et al.*, 2014). Heavily infested trees develop with sparse, discoloured foliage and suffer lowered vigour, thus making them unmarketable as Christmas trees. In *Pinus sylvestris* Christmas tree plantations the populations can reach very high levels (i.e. on average 46 scales per needle) and cause severe damage (DeBoo and Weidhaas, 1976).

In Washington (USA), *C. pinifoliae* was listed as a major pest on spruces in Christmas tree plantations (Rinehold, 1999). In Ohio, USA, *C. pinifoliae* was a common and troubling key pest during a period when *P. sylvestris* was grown in the Christmas tree plantations (Boggs, 2019).

In southern Québec, Canada, *C. pinifoliae* is considered to be an important pest for the Christmas tree industry (Doherty *et al.*, 2018). In an inventory of a commercial plantation of *Abies fraseri* in Québec, *C. pinifoliae* was observed on about 21% of the plantation trees and it was also regularly observed on naturally growing *Abies balsamea*, *Picea glauca* and *Picea mariana* surrounding the plantation (but not on *Thuja occidentalis*) (Guay *et al.*, 2018). However, according to Canadian growers, this pest was mainly considered as an obstacle for international exportation. Growers reported that the pest was not known to cause significant damage and that the size of the populations were not a barrier to the domestic trade of trees (R. Johns, pers. comm, for Québec; similar statements reported in Doherty *et al.*, 2018 and Guay *et al.*, 2018; B. Schroeder, pers. comm., for the prairies provinces i.e. Alberta, Saskatchewan and Manitoba). For example, in 1991 Christmas trees originating from Nova Scotia, Canada, were found infested with *C. pinifoliae* by the Plant Protection Agency of Bermuda, and from the following year the Christmas trees imported from Canada were required to be certified free from this pest (Watler and Stahevitch, 1992). Another example is from 2017–2018 when many *Abies fraseri* and *Pinus strobus* Christmas trees were imported to Florida, USA, from North Carolina and Canada and were rejected for sale because of contamination by *C. pinifoliae* (Ahmed and Miller, 2019).

Figure 3. Infested tree in a Christmas tree plantation. Credit: C. Sadof, Purdue University, USA.

12.1.3 Forests

According to Furniss and Carolin (1977) *C. pinifoliae* sometimes occurs as a forest pest. According to Peterson and DeBoo (1969) infestations in forests '*seldom reach serious proportions and the damage is usually negligible*'. Accordingly, several authors claim that *C. pinifoliae* is not a threat to natural forests and that control in forests has not been necessary (Hiratsuka *et al.*, 1995; Kusch and Langor, 1992; Rose *et al.*, 1999). This is in line with a study that showed that *C. pinifoliae* was abundant in "impoverished habitats", such as ornamental landscapes, but scarce in more "natural" park-like habitats (Tooker and Hanks, 2000). It is also in line with Burden and Hart (1990) who claim that throughout its range *C. pinifoliae* is rarely a problem in undisturbed environments, with Kusch and Langor (1992) who state that *C. pinifoliae* is not considered a threat to the natural forests of the Prairie Provinces of Canada, and with Kosztarab (1996) who states that *C. pinifoliae* is a pest that is frequently present in artificial or urban habitats in the northeastern North America but not in forests.

Four cases were found where infestations of *C. pinifoliae* in forests are described in the literature. The first case is an outbreak on *Pinus strobus* and *P. resinosa* in York Forest in southeastern Ohio, USA, where the lower branches of some trees contained such high densities of *C. pinifoliae* that the infestations were considered to be of economic importance. Nonetheless, the outbreak was not considered serious (Easterling, 1934). The second case is from the Kamloops forest district in Canada where many trees that had suffered from drought or winter injury became severely infested by *C. pinifoliae.* A few of these trees died (Cottrell and Ross 1972). The third case is from the Spokane area in Washington (USA) where outbreaks were reported as common in *Pinus ponderosa* forests, especially along dirt roads where the dust had a negative impact on the natural enemies (Edmunds, 1973). However, as soon as some parasitism by chalcidoid parasitoids was detected the populations of *C. pinifoliae* were reduced to low densities within one or two seasons (Edmunds, 1973). The fourth case involves an extensive outbreak (526 ha) on *Pinus contorta* and *P. jeffreyi* in the city of South Lake Tahoe, California, USA (Luck and Dahlsten, 1975). Luck and Dahlsten (1975) provided evidence that the cause of the outbreak was a large-scale spraying campaign against mosquitoes, which also killed the natural enemies of *C. pinifoliae*. They also provided evidence that it was the natural enemies that were responsible for the outbreak decline, with their resurgence likely due to a cessation of insecticide treatments.

In conclusion, *C. pinifoliae* has rarely caused damage in forests and when it has it appears to be due to factors negatively impacting natural enemies, e.g. dust from roads or aerial spraying with insecticides.

12.2 Environmental impact

No reports were found on the impact of *C. pinifoliae* on the environment. This may be because outbreaks seldom occur in natural environments (section 12.1.3). However, the presence of the pest can result in an increased use of pesticides in Christmas tree plantations and on ornamentals, which may have unintended impacts in the environment on local insect community structure and function (section 12.4).

12.3 Social impact

Large pest populations can give infested trees a greyish or "snowy" look which may decrease their aesthetic value in urban and recreational areas (Swaine and Hutchings, 1926; Cumming, 1953; Luck and Dahlsten, 1974; USDA, 2011; Mc Cullough *et al.* 1998). For example, the infestation of about 526 ha in 1968 at South Lake Tahoe, California (USA) was considered aesthetically displeasing and damaging to the recreational appeal of the area (Luck and Dahlsten, 1974). During the 1980s, aesthetic damage resulting from infestations caused concern for urban plantings of *Pinus sylvestris* in Iowa (Burden and Hart, 1990).

12.4 Existing control measures

Control measures are frequently considered necessary to decrease the impact of *C. pinifoliae* in Christmas trees, ornamental trees and nurseries. Such measures involve the use of pesticides as well as mechanical control. Most farms that export Christmas trees from Canada to Bermuda have a quality systems management plan with prescribed measures and treatments. However, such treatments may also harm beneficial insects and lead to more issues with twig aphids. In Quebec mirrors on poles with lights were developed to scout the lower branches without having to do it on hands and knees or bent over all day (M. Wright, pers. comm.).

In forests, however, to our knowledge no control measures have been used for *C. pinifoliae*.

12.4.1 Pesticides

Diaspididae species are difficult to kill once they are settled and protected by their hard scale cover (Watler and Stahevitch, 1992; Fondren and McCullough, 2002; Boggs, 2017). When needed, sprays of insecticides (others than horticultural oils) should therefore be applied when *C. pinifoliae* is most vulnerable, i.e., when nearly all eggs have hatched and most crawlers are in the hyaline stage (Fondren and McCullough, 2002; Katovich *et al.*, 2014; Boggs, 2019; Missouri Botanical Garden, 2021).

The time when the first instar nymphs will be present can be predicted using growing degree days (GDD) (section 9). Determining the time of this stage is especially relevant where a bivoltine or a multivoltine population has the potential for rapid population increase (Burden and Hart, 1989). Adequate spray coverage is also important for effective control (Fondren and McCullough, 2002; Boggs, 2019).

Effective management of *C. pinifoliae* with insecticides (others than horticultural oils) involves careful scouting to monitor egg hatching and natural enemy activity since insecticides can have a negative effect on natural enemies. Such losses of natural enemies can lead to an increase of the pest population (Fondren and McCullough, 2002). Thus, to minimize impacts on natural enemies, insecticides should be applied only when crawlers are active (Cranshaw, 2013). Furthermore, spraying against other pests should also be reduced whenever practical since outbreaks of scales frequently occur after repeated spraying for other insect pests (again, owing to their impact on natural enemis) (Katovich *et al*. 2014). The most striking example of this is the 526 ha outbreak of *C. pinifoliae* in South Lake Tahoe, California (USA), which probably was a result of the five-year insecticidal control program against mosquitoes (Luck and Dahlsten, 1975). This is consistent with observations that trees and shrubs in parks and recreation areas when treated periodically with aerosol sprays for mosquito and biting midge control were associated with high population densities of Diaspididae species. This was likely because of the absence of that parasitic wasp populations normally control the scale insects (Kosztarab, 1990).

Fondren and McCullough (2002) suggested that spraying may not be necessary when Christmas trees and ornamentals are at least a year from harvest and when *C. pinifoliae* populations are at low or moderate levels. Control becomes more important when trees are near harvest since even a light infestation can damage aesthetics and reduce associated tree marketability.

According to Fondren and McCullough (2002), horticultural oils are often used on landscape trees to control scale insects. The use of horticultural oils (dormant oils[5]) is also suggested for controlling overwintering forms of some Christmas tree pests, including scales' eggs because it helps to reduce the number of insects that survive the winter, while having little to no impact on natural enemies (Fondren and McCullough, 2002; O'Donnell, 2009; Boggs, 2019); however, horticultural oils in general have not been widely used in Christmas tree production (Fondren and McCullough, 2002). According to Cranshaw (1994; 2013), horticultural oils can kill young, settled scales (up to three weeks old) as well as crawlers and eggs, but the wax on the needles may temporarily be removed.

Pesticides containing the following active ingredients have been recommended against first instar nymphs of Diaspididae, including *C. pinifoliae* on *Pinus* spp. and *Picea* spp.: acephate, bifenthrin, carbaryl, chlorpyrifos (nursery only), deltamethrin, fluvalinate, lambda cyhalothrin, horticultural oil, insecticidal soap, malathion, permethrin and pyriproxyfen (Krischik and Hahn, 2018; Quesada and Sadof, 2017; 2020). In addition, the following active ingredients are mentioned in the literature: azadirachtin, cyfluthrin, dimethoate, imidacloprid, oxydemeton-methyl, neem oil, spiromesifen and spirotetramat (Watler and Stahevitch, 1992; O'Donnell, 2009; Cranshaw, 2013; Michigan State University Extension, 2018; Rose *et al.*, 1999; Ontario Ministry of Agriculture, Food and Rural Affairs, 2019; Quesada and Sadof, 2020; Missouri Botanical Garden, 2021).

In Canada, where horticultural oils and malathion are registered and used against *C. pinifoliae*, the use of systemic active ingredients is currently being explored to control adults (acetamiprid, pyriproxyfen, afidopyropen, spirotetramat and spiromesifen) (M. Wright, pers. comm.).

12.4.2 Mechanical control

For controlling severe infestation of *C. pinifoliae,* cutting, removing and destroying the infested trees is suggested (Katovich *et al.*, 2014). Mild infestations that are detected early can be controlled by pruning out infested branches (Missouri Botanical Garden, 2021).

12.5 Rating of the magnitude of impact and uncertainty

Main impact reported in North America is related to the economic impact (no report about social and environmental impact). *Chionaspis pinifoliae* rarely kills trees but is difficult to control, especially on ornamental trees (e.g. in urban environments) and in nurseries (with impacts on exportation).

[5] Oil applied to woody plants during dormant stage of growth (winter) before buds open in the spring at a higher concentration than summer oil. Refers to season of suggested use.

Rating of the magnitude of impact in the current area of distribution	Very low ☐	Low ☐	Moderate ☒	High ☐	Very high ☐
Rating of uncertainty			Low ☐	Moderate ☒	High ☐

Uncertainty: importance of the treatments applied specifically for this pest, very different situations with different impact reported (and uncertainty related to the frequency of these situations), lack of precise data on yield losses and control costs.

13. Potential impact in the PRA area

Will impacts be largely the same as in the current area of distribution? ~~Yes /~~**No**

The climatic conditions appear suitable for establishment of *C. pinifoliae* in a large part of the PRA area (section 9; ANNEX 9) and *C. pinifoliae* is a pest of many important host plants that are widely distributed in the PRA area (sections 9.2; 12). As in its native range, the potential impact of *C. pinifoliae* is expected to be reduced by two factors: (I) some potentially important natural enemies of *C. pinifoliae* are widely distributed in the PRA area (section 2.4; 9.3; ANNEX 4) and (II) some insecticides that could control *C. pinifoliae* are approved for outdoor use in some parts of the PRA area and could be used in Christmas trees, ornamental trees and nurseries, e.g. deltamethrin, fluvalinate, lambda-cyhalothrin, insecticidal soap (fatty acids C7 to C20 (pelargonic acid (CAS 112-05-0)), pyriproxyfen, azadirachtin, and spirotetramat (EU Pesticides database, 2021).

However, the particular susceptibility of *Pinus sylvestris* and *P. mugo* to *C. pinifoliae* (Martel and Sharma, 1968; Nielsen and Johnson, 1973; Eliason and McCullough, 1997; Glynn and Herms 2004), which are introduced to North America but native to the EPPO region and widely distributed there (section 9.2), would suggest a potentially higher potential impact in the PRA area. More species are present that are evolutionarily naïve to *C. pinifoliae* and these may be particularly susceptible. In general, polyphagous Diaspididae species that establish in new geographic areas usually have a higher impact than in their native area, e.g. *Pseudaulacaspis pentagona* and *Quadraspidiotus perniciosus* (Kosztarab, 1990).

Chionaspis pinifoliae has historically invaded new areas (section 6), but very little information was found about the impact it has caused in those areas (section 12). It can, however, be noted that *C. pinifoliae* was listed among insects '*meaningfully to agriculture*' in Cuba due to previous outbreaks on *Pinus caribaea* (Mestre *et al*., 2006).

13.1 Economic impact (sensu stricto)

Chionaspis pinifoliae is a pest of conifers that can cause damage to several economically important plant species. The main economic impact in the PRA area would be expected in the following host communities/production sectors.

13.1.1 Ornamental trees, shelterbelts and nurseries

Chionaspis pinifoliae is considered to be a major pest on ornamental, shelterbelt, landscape trees and nursery trees (section 12.1.1) and its hosts are widely used for these purposes in the PRA area (section 9.2). Potentially, trees used in ornamentals, shelterbelts, and nurseries in the PRA area are more likely to be evolutionary naïve to *C. pinifoliae.* This may lead to a higher impact in the PRA area than has been reported in its native range. This contention is strengthened by evidence from North America that the evolutionary naïve *P. sylvestris* is a more susceptible host than *P. resinosa* with which *C. pinifoliae* shares a very long evolutionary history (Glynn and Herms, 2004).

13.1.2 Christmas tree plantations

The cultivation area of Christmas trees in the EPPO region is large. In Europe alone it covers 120 000 ha (SDW, 2021). Germany has the largest acreage constituting 25% of the total area cultivated with Christmas trees, followed by Denmark with 20%, Poland with 11%, Great Britain with 10% and France with 8% (SDW, 2021). Many of the species cultivated as Christmas trees in the PRA area are host plants of *C. pinifoliae*, i.e. *Abies alba, A. concolor, Picea abies* and *P. pungens* (ANNEX 6). The market for Christmas trees in Europe is approximately 60 million trees a year (Teagasc, 2006). For example, the Christmas tree plantations in Germany generate sales of 700 million Euros per year (SDW, 2021). However, the susceptibility of *Abies nordmanniana* to *C. pinifoliae,* one of the major species cultivated as Christmas tree in central Europe (Nielsen *et al.*, 2020), is unknown. If *C. pinifoliae* would establish in Christmas tree plantations in the PRA area, its presence might result in unmarketable trees. Moreover, high densities could reduce tree growth and vigour as is the case in its native range. Finally, there might be additional costs associated with international trade because of quarantine pest requirements imposed on importing countries (this is especially likely if *C. pinifoliae* becomes established in the PRA area).

13.1.3 Forests for wood production

Several host plants are widely grown as forest species for wood production in the PRA area (ANNEX 7), but the literature review in section 12 shows that *C. pinifoliae* only rarely has caused damage in forests. When it has caused damage, it seems to have been due to factors that have had a negative impact on the natural enemies, e.g. dust from roads or aerial spraying with insecticides (Edmunds, 1973; Luck and Dahlsten, 1975; Furniss and Carolin, 1977). It should, however, be noted that many of the natural enemies in its native range are not present in the PRA area (ANNEX 4). The fact that *Pinus sylvestris*, one of the most commercially important species for wood production (particularly in the Nordic countries), is evolutionarily naïve and particularly susceptible to *C. pinifoliae* may also have a major influence on the potential impact. For these reasons, more damage is expected to occur in forests in the EPPO region than has been reported in its native range.

13.2 Environmental impact

Some of the affected plant species, e.g. *Pinus mugo*, *P. nigra*, and *P. sylvestris*, are native and widespread in the PRA area (ANNEX 6) and in some areas they constitute key components for vulnerable habitats, e.g. the ancient pine forest in Highland Scotland. In its native range *C. pinifoliae* is rarely a problem for hosts in undisturbed environments (section 12), however, the presence of particularly susceptible host tree species and the absence of several species of natural enemies of *C. pinifoliae* (Annex 4) suggests the potential for a substantial environmental impact in the EPPO region. Furthermore, since *C. pinifoliae* is considered a key pest on conifers, e.g. planted as ornamentals, damage caused to these plants may have a negative impact on their ecosystem services.

None of the known host plant species of *C. pinifoliae* that are present in the PRA area are listed in the IUCN Red List (https://www.iucnredlist.org/) as threatened. However, several species that belong to the same genera as host species, i.e. *Abies, Cedrus, Cupressus, Juniperus, Picea, Pinus*, and *Taxus*, are described as 'endangered' or 'critically endangered'.

13.3 Social impact

Many hosts of *C. pinifoliae* are used as ornamentals in the PRA area. Their aesthetic value in parks, public and private gardens, in historical sites and in urban areas is expected to be affected if *C. pinifoliae* establishes in the PRA area. Trees of cultural significance and monumental trees could also become infested. The wide cultivation of the more susceptible species *P. sylvestris* as well as the cultivation in the EPPO region of species with a high social importance such *as P. pinea* could inflict a higher social impact in the EPPO region compared with North America.

13.4 Overall rating of the magnitude of impact and uncertainty

Rating of the magnitude of impact in the area of potential establishment	*Very low* ☐	*Low* ☐	*Moderate* ☐	*High* ☒	*Very high* ☐
Rating of uncertainty			*Low* ☐	*Moderate* ☒	*High* ☐

Uncertainty: whether *C. pinifoliae* would become a forest pest in the EPPO region, effect of natural enemies present in the EPPO region, impact on coniferous species widely grown but not known as host plants (e.g. *Abies nordmanniana*). The EWG considered that the uncertainty was higher than for the magnitude of impact in the current area of distribution, but remains moderate.

14. Identification of the endangered area

Chionaspis pinifoliae could establish throughout most of the EPPO region, except the northernmost part (including parts of Siberia) where it is highly unlikely that the pest could complete its life cycle (section 9). Because there are some host plants native to and widely distributed in the EPPO region (e.g. *Pinus sylvestris*) which are reported to be particularly susceptible to *C. pinifoliae* (Annex 7) and because this may also be the case for other conifer species which have not evolved together with *C. pinifoliae*, the endangered area is considered to be the whole area of potential establishment.

15. Overall assessment of risk

Summary of ratings:

	Likelihood	**Uncertainty**
Entry (overall)	**High**	**High**
Host plants for planting (except seeds, tissue cultures, pollen) to countries where import of *Abies, Cedrus, Juniperus, Larix, Picea, Pinus, Pseudotsuga, Taxus* and *Tsuga* is prohibited	Very low	Moderate
Host plant for planting (except seeds, tissue cultures, pollen) to countries where there is no prohibition at import	High	High
Cut branches of hosts (including Christmas trees) to countries where import of *Abies, Cedrus, Juniperus, Larix, Picea, Pinus, Pseudotsuga* and *Tsuga* is prohibited	Very low	Moderate
Cut branches of hosts (including Christmas trees) to countries where there is no prohibition at import	Low	High
Establishment outdoors	**Very high**	**Low**
Establishment in protected conditions	**Moderate**	**Moderate**
Spread	**Moderate**	**Moderate**
Magnitude of impact in the current area of distribution	**Moderate**	**Moderate**
Magnitude of potential impact in the PRA area	**High**	**Moderate**

Entry: Several EPPO countries already prohibit the import of most host plants for planting and cut branches (including Christmas trees) (e.g. *Abies, Cedrus, Juniperus, Larix, Picea, Pinus, Pseudotsuga, Taxus* and *Tsuga* in the EU). However, there are EPPO countries where the import of these host plants is not prohibited. Therefore, the likelihood of entry in the EPPO region was considered as high with a high uncertainty; the highest rating being for host plants for planting (except seeds, tissue cultures, pollen) and cut branches (including Christmas trees) into countries where there is no import prohibition.

Establishment: As climatic conditions appear to be suitable, the likelihood of establishment of *C. pinifoliae* outdoor in the EPPO region was considered very high with a low uncertainty. *Chionaspis pinifoliae* is not known as a pest under protected conditions, but it was considered able to establish and difficult to control in greenhouse production, as is the case for other scale insects.

The *Magnitude of spread* was considered moderate with a moderate uncertainty. The pest is mostly sedentary but could spread long-distances either naturally via wind, or with human assisted spreadThe ability to reproduce parthenogenetically when there are no males around allows a single female to potentially establish a new population, which greatly increases its spread capacity. *Chionaspis pinifoliae* is known to have been moved with plants for planting and cut branches (including Christmas trees), a phenomenon which is expected to increase spread rate.

Impact (economic, environmental and social) was considered high with a moderate uncertainty. Host plants are major forest, ornamental, and nursery trees in the EPPO region. *Chionaspis pinifoliae* only occasionally kills trees but is difficult to control, especially on ornamental trees (e.g. in urban environment) and in nurseries. *Pinus sylvestris* and *P. mugo,* which are native to the EPPO region and widely distributed are reported to be particularly susceptible.

Phytosanitary measures to reduce the probability of entry: The EWG considered that phytosanitary measures should be recommended for all host plant genera. Risk management options are considered for host plants for planting (except seeds, tissue cultures, pollen) and cut branches of hosts (including Christmas trees).

Stage 3. Pest risk management

16. Phytosanitary measures

16.1 Measures on individual pathways to prevent entry

The EWG concluded that phytosanitary measures should be recommended for ’host plants for planting (except seeds, tissue cultures, pollen)’ and ’cut branches of hosts (including Christmas trees)’.
The EWG recommended that measures should apply to all host plant genera. Measures were studied for these two pathways in ANNEX 1.

Possible pathway *(in order of importance)*	**Measures identified for the exporting country (see ANNEX 1 for details)**
Plants for planting (except seeds, tissue cultures, pollen) of *Abies*, *Calocedrus*, *Cedrus*, *Cupressus*, *Juniperus*, *Larix*, *Picea, Pinus*, *Pseudotsuga, Taxus*, *Torreya* and *Tsuga*	Pest free area (PFA) (see requirements below) or Plants should be produced in a pest-free place of production/pest-free production site[1] for *Chionaspis pinifoliae*, established according to EPPO Standard PM 5/8 *Guidelines on the phytosanitary measure ‘Plants grown under physical isolation’* or Systems approach (in the framework of a bilateral agreement) combining • Absence of *C. pinifoliae* after visual inspection of the consignment • Dipping the whole plant in horticultural oils (summer oils or botanical oils) or insecticidal soap • Storage and transportation in conditions preventing new infestation, i.e. outside the crawler active period, or not in/through areas infested with the pest, or with a suitable packaging (i.e. solid material not net). or Post-entry quarantine for 1 year (in the framework of a bilateral agreement)
Cut branches (including Christmas trees) of *Abies*, *Calocedrus*, *Cedrus*, *Cupressus*, *Juniperus*, *Larix*, *Picea, Pinus*, *Pseudotsuga, Taxus*, *Torreya* and *Tsuga*	PFA (see requirements below) or Plants should be produced in a pest-free place of production/pest-free production site for *Chionaspis pinifoliae*, established according to EPPO Standard PM 5/8 *Guidelines on the phytosanitary measure ‘Plants grown under physical isolation’* or Systems approach combining • Absence of *C. pinifoliae* after visual inspection of the consignment • Dipping the whole plant part in horticultural oils (summer oils or botanical oils) or insecticidal soaps • Storage and transportation in conditions preventing new infestation, i.e. outside the crawler active period, or not in/through areas infested with the pest, or with a suitable packaging (i.e. solid material not net).

[1]*: The choice between pest-free place of production and pest-free production site is a decision to be taken by the NPPO based on the operational capacities of the producers and biological elements.*

Requirements for establishing a pest-free area (PFA):

The EWG considered that the data available is not sufficient to recommend a minimum distance between a PFA and the closest area where the pest is present. In any case, the EWG considered that this should take into consideration the possible long-distance natural spread by wind of large or parthenogenetic populations (see information provided in section 2.5) and would represent many kilometers (i.e. > 10 km). Considering the current distribution of *C. pinifoliae* in Canada, Cuba, Mexico and USA or any country where the pest would become established in the future, a PFA would not be possible in these countries.

To establish and maintain a PFA, detailed surveys should be conducted in the area in the 2 years prior to establishment of the PFA (to provide enough time for a population to build-up and be detected) and should be repeated every year. Similar surveys should also be carried out in the zone between the PFA and known infestation to demonstrate pest freedom. Surveys should include high risk locations, including places where potentially infested material may have been imported.

There should be restrictions on the movement of host material (originating from areas where the pest is known to be present) into the PFA and into the area surrounding the PFA, especially the area between the PFA and the closest area of known infestation.

16.2 Eradication and containment

Eradication and containment measures should involve:

- **surveillance** by visual examination
- **destruction of infested plants** (e.g. cut/chip plants before burning or before composting under controlled conditions)
- **chemical treatments** (section 12)
- regulatory measures such as **restrictions on the movement** of host material originating from areas where the pest is present
- Public information and outreach campaigns (support of growers, other stakeholders, [hobby] entomologists, or arborists) may help an earlier reporting of findings and a better implementation of measures

The EWG considered that eradication is possible indoors and in a nursery soon after entry, whereas it is likely to fail in natural environments or a managed forest for wood production.

Remark: No pheromone has been identified for *C. pinifoliae,* but it has been suggested that the localization of the Diaspididae females by flying males probably is largely in response to female sex pheromones (Beardsley and Gonzalez, 1975). However, pheromones are used for monitoring of several other Diaspididae species, e.g. *Aonidiella aurantii*, *Aonidiella citrina*, and *Quadraspidiotus perniciosus* (UC IPM, 2017a) and mating disruption using pheromones is possible for these species (UC IPM, 2017a & b). Such control strategies were tested and found efficient for controlling *Aonidiella aurantia* (Vacas et al., 2010; 2015).

Natural enemies appear to regulate the populations of *C. pinifoliae* in natural undisturbed environments. However, to our knowledge, no biological control agents are currently used against *C. pinifoliae* although there are commercially available predators that may be suitable, e.g. *Chrysoperla rufilabris* and *Rhyzobius lophanthae* (Quesada and Sadof, 2020).

Examples of eradication campaigns of related species are presented in ANNEX 2.

Factors favoring eradication and containment

- *Chionaspis pinifoliae* is mostly sedentary. Before the population builds up most of the individuals would probably remain on the plants that were initially infested.

- The white scale coverings can be found on the plants throughout the year, although not all the insects under them are necessarily alive.
- Some insecticides that are effective against *C. pinifoliae* are approved for outdoor use in some parts of the PRA area.
- The most effective timing for pesticide treatments can be predicted using growing degree days.

Factors hampering eradication and containment

- Some individuals could spread long distance and successfully establish because of wind dispersal and parthenogenesis.
- Surveillance would have to rely on visual inspection of plants since pheromones or other lures are not available.
- Low levels of infestation are difficult to detect since the pest is very small and light infestations do not cause easily detectable symptoms, especially on large trees.
- Identification to species can be done only based on morphological characters of slide-mounted adult insects under a microscope or using molecular methods.
- Similar symptoms can be caused by other scale insects that are present in the PRA area.
- Generally, scale insects are difficult to control by insecticides (section 12.4.1). Most insecticides are not effective against the life stages that have a scale covering (i.e. all other life stages except the newly hatched first instar nymphs and the hyaline stage) and treatments with horticultural oils (e.g. summer oils, botanical oils) or insecticidal soaps are not practical for (large) trees (i.e. it would be difficult to cover an entire tree by an insecticide). In warmer climates, multiple generations can overlap with one another such that all life stages may be present at any time during the summer. In many EPPO countries (e.g. in the Netherlands) insecticides that are effective are not registered for use in forests or public green spaces. Similarly applying insecticides in urban areas may not be authorized.

17. Uncertainty

Main sources of uncertainty within the risk assessment are linked to:

- The presence of the pest in other countries than Canada, Cuba, Mexico and USA, in particular in EPPO countries where it has been reported but not confirmed. In certain parts of Southern Germany, practically every pine tree is infested with white elongated diaspids on the needles, which cannot be easily differentiated from *C. pinifoliae* with the naked eye (C. Hoffmann, pers. comm.).

- Trade volume and the origin of conifer host plants moved from North America to the EPPO region (in particular to non-EU countries).

- Existing natural enemies in the EPPO region and whether they would control *C. pinifoliae* and thus prevent establishment or outbreaks, and associated economic impacts.

18. Remarks

The EWG recommended that:

- Old collection scale insect slides should be screened to look at possible *C. pinifoliae* presence in EPPO countries.
- Survey should be conducted targetting EPPO countries for which reports need confirmation (e.g. Germany).
- More research should be conducted on taxonomy. This could allow some clarification of host preferences to refine the risk assessment or identify more precisely the risk following an outbreak in the EPPO region.

- More research should be performed to quantify the natural spread rate of the pest to better estimate the appropriate distance for a buffer zone.
- The susceptibility of popular Christmas trees in the EPPO region (e.g. *A. nordmanniana*) should be further evaluated.

19. References (including for Annexes) (all websites mentioned were accessed in October 2021)

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ANNEX 1. Evaluation of possible phytosanitary measures for the main identified pathways, using EPPO Standard PM 5/3

Measures are considered for the pathways 'host plants for planting (except seeds, tissue cultures, pollen)', and 'cut branches of hosts (including Christmas trees)'. When a measure is considered appropriate it is noted 'yes', or 'yes, in combination' if it should be combined with other measures in a systems approach. 'No' indicates that a measure is not considered appropriate. A short justification is included. Elements that are common to several pathways are in bold.

Option	**'Host plants for planting (except seeds, tissue cultures, pollen)'**	**'Cut branches of hosts (including Christmas trees)'**
Existing measures in the PRA area	Partly, see section 8	Partly, see section 8
Options at the place of production		
Visual inspection at place of production	Yes, in combination* (for measures marked with *, see after the table) **Detection by visual inspection of the plants is unlikely to be completely effective. This is because the pest is very small and light infestations do not cause easily detectable symptoms.** **Species identification can only be done based on morphological characters of slide-mounted adult insects under a microscope or using molecular methods.** **Plants should be free from signs and symptoms of infestation.** **Remark: The white scale coverings can be found throughout the year, although the insects beneath the coverings may not be alive. The presence of live insects could be checked either simply squeezing the presumed to be infested needles to observe diaspid body fluids or using the iodine tests (Ishaaya & Swirski, 1989; Rosen et al., 1971). The presence of remaining ventral shields (i.e. 'flags') would also inform the observer on previous almost exhausted infestations.**	Yes, in combination*. As for plants for planting.
Testing at place of production	No. **Not relevant**. Remark: Identification after visual examination is already covered by 'visual inspection at place of production'.	No. As for plants for planting.

Option	‘Host plants for planting (except seeds, tissue cultures, pollen)’	‘Cut branches of hosts (including Christmas trees)’
Treatment of crop	Yes, in combination*. **One group of insecticides, horticultural oils, can be used to reduce the number of eggs, crawlers and settled scales.** **Other insecticides against *C. pinifoliae* are available (section 12.4.1) but the life stages that have a scale covering are difficult to kill. Thus, sprays should be applied at crawler active period when the nymphs do not yet have a scale cover. The correct time can be predicted based on growing degree days. Insecticide applications that are not timed correctly have been shown to cause increases in pest populations due to negative effects on natural enemies.** In Canada, a range of stem-injected systemic insecticides are being tested to provide protection of small trees. Such products are likely to provide protection for nursery material, but it still has to be proven. It is currently not used for *C. pinifoliae* in nurseries in the USA and Canada. Stem injection as a tactic for controlling *C. pinifoliae* is time consuming and likely cost-prohibitive.	Yes, in combination*. As for plants for planting.
Resistant cultivars	No. **Resistant cultivars are not available**.	No. As for plants for planting.
Growing under physical isolation	Yes, for bonsais. Yes (theoretically), for others. Plants for planting could be grown under protected conditions with sufficient measures to exclude the pest, following EPPO Standard PM5/8 *Guidelines on the phytosanitary measure ‘Plants grown under physical isolation’* (EPPO, 2016). However, this is not common practice for nurseries producing coniferous plants and would be realistic only for high value material. Note that the dispersing first instar larvae are very small (First 0.18 mm wide). Therefore, a glass structure or equivalent solid material should be used (a net is not considered suitable). In addition to the cost for such an option, the EWG also highlighted the problem of ventilation if windows may not be opened, as required	No Such material would not be of sufficient value to be produced, as for plants for planting, under protected conditions.

Option	**‘Host plants for planting (except seeds, tissue cultures, pollen)’**	**‘Cut branches of hosts (including Christmas trees)’**
	in Standard PM 5/8 for pests spread by air. The use of impregnated nets may be a solution but needs experimental testing.	
Specified age of plant, growth stage or time of year of harvest	No. **The pest can be present on all sizes of plants and throughout the year.**	No. As for plants for planting.
Produced in a certification scheme	No. Not relevant.	No. Not relevant.
Pest freedom of the crop	Yes, in combination. **A combination of inspection at the place of production and treatment of the crop (see the respective points above) is unlikely to fully guaranty pest freedom due to reinfestation from the surrounding plants which may take place if the pest is common in the area.** Remark: this option is not repeated in the table of measures that could be used in combination (*), because it is already a combination of measures described individually.	Yes, in combination. As for plants for planting.
Pest free production site	Yes (under physical isolation) **Pest free production site may be achieved by growing plants under physical isolation (see above).** Yes, in combination* (outdoor) **In outdoor environments, invasions from the surrounding plants may take place if the pest is common in the area. A wide enough buffer zone with no host plants would decrease the likelihood of invasion but would not eliminate it.**	Yes, in combination* As for plants for planting.
Pest free place of production	Yes (under physical isolation) /Yes, in combination* (outdoor). **As for pest free production site.**	Yes/Yes, in combination*. As for plants for planting.

Option	‘Host plants for planting (except seeds, tissue cultures, pollen)’	‘Cut branches of hosts (including Christmas trees)’
Pest-free area (PFA)	Yes. Currently (2022), this is not considered an option for Canada, Cuba, Mexico and USA. **The EWG considered that the data available is not sufficient to recommend a minimum distance between a PFA and the closest area where the pest is present. In any case, the EWG considered that this should take into consideration the possible long-distance natural spread by wind of large or parthenogenetic populations (see information provided in section 2.5) and would represent many kilometers (i.e. > 10 km).Considering the current distribution of *C. pinifoliae* in Canada, Cuba, Mexico and USA, a PFA would not be possible in these countries.** **To establish and maintain a PFA, detailed surveys should be conducted in the area in the 2 years prior to establishment of the PFA (to provide enough time for a population to build-up and be detected) and continued every year. Similar surveys should also be carried out in the zone between the PFA and known infestation to demonstrate pest freedom. Surveys should include high risk locations, such as places where potentially infested material may have been imported. There should be restrictions on the movement of host material (originating from areas where the pest is known to be present) into the PFA, and into the area surrounding the PFA, especially the area between the PFA and the closest area of known infestation**	Yes. As for plants for planting.
Options after harvest, at pre-clearance or during transport		
Visual inspection of consignment	Yes, in combination*. **Visual inspection is unlikely to be completely effective, especially on large plants since the pest is very small and light infestations do not cause clear symptoms.** **Since nymphs cannot be identified morphologically to species, when nymphs from scale insects that cannot be differentiated from *C. pinifoliae* are**	Yes, in combination*. As for plants for planting.

Option	‘Host plants for planting (except seeds, tissue cultures, pollen)’	‘Cut branches of hosts (including Christmas trees)’
	present, the nymphs should be either reared to allow morphological identification or identified using molecular methods.	
Testing of commodity	No. Not relevant.	No. Not relevant.
Treatment of the consignment	Yes, in combination*, when dipping plants in horticultural oils (summer or botanical oils) or insecticidal soaps. **When the pest population is low or not detected, treating the whole plant by summer oils[6] (Liang *et al*., 2010; Tansey *et al*., 2015; Tomkins *et al.*, 1996; Khalid *et al.,* 2012; Chueca *et al*., 2009; McKenna *et al.*, 2007), botanical oils (Ciriminna *et al.,* 2017; El Aalaoui *et al.*, 2021)), or insecticidal soap (Walufa *et al.*, 2017; Ralston *et al*., 1941; Parry & Rose, 1983), would kill most if not all of hidden eggs, crawlers and adults. Surviving adults, or eggs still protected by the scale, would be most probably detected by visual inspection when performed on small plants. The EWG recommended dipping the whole plant in [or similar approach guarantying that all the needles are covered by] these generalist products, which also makes this option mainly available for small plants because of practicality. For plants for planting, this option generally requires that there is no soil attached.** **Plant protection products (other than horticultural oils) against *C. pinifoliae* are available but the life stages that have a scale covering are difficult to kill with these products. Such life stages can be present on the plants throughout the year and thus, the pest cannot be eliminated from consignments with these insecticides.**	Yes, in combination*. As for plants for planting.
Pest only on certain parts of plant/plant product, which can be removed	No. The pest is present only on needles but removing the branches or needles of coniferous plants is not feasible.	No. As for plants for planting.

[6] Oil applied when plants are in leaf at a lower concentration than dormant oil. Refers to season of suggested use.

Option	'Host plants for planting (except seeds, tissue cultures, pollen)'	'Cut branches of hosts (including Christmas trees)'
Prevention of infestation by packing/handling method	Yes, in combination*. The pest's mobility is low but plants can be infested during storage if this takes place during the time when the pest is dispersing in an area where the pest population is very high. Any packaging (solid material not nets) covering the whole plant would be enough to prevent new infestations by crawlers dispersed by wind during transportation or storage.	Yes, in combination*. As for plants for planting. The measure is not needed for items that are traded only during winter, such as Christmas trees, in areas where crawlers are not present all year round. In the USA, Christmas trees are cut in October-December.
Options that can be implemented after entry of consignments		
Post-entry quarantine	Yes, in the framework of a bilateral agreement. The pest usually has 1 or 2 generations per year. One year of post-entry quarantine would be enough to reveal possible infestations if the plants are carefully inspected at the end of the quarantine period. This measure is likely to be applicable only for small scale import of high value plants, and it may pose practical difficulties for large trees. The Panel on Phytosanitary Measures considered that this measure should only be proposed in the framework of a bilateral agreement.	No. Not relevant for plant parts.
Limited distribution of consignments in time and/or space or limited use	No. The endangered area covers most of the PRA area and the pest is present on the plants throughout the year.	Yes, in combination*. If the plant parts are intended only for indoor use, the pest is unlikely to be able to disperse to new hosts; however, the indoor use can not be guaranteed. If the plants are imported only in the winter (Christmas trees), this would limit the risk that crawlers are associated with this pathway and remain undetected. Such plant parts imported during winter (except from areas where crawlers are present all year round) may

Option	‘Host plants for planting (except seeds, tissue cultures, pollen)’	‘Cut branches of hosts (including Christmas trees)’
		be used outdoors, or used indoors and discarded outdoors. If living individuals are still present on the plants in the next growing season, they may transfer to a new host plant. However, this would be unlikely since a very high failure rate is likely to be associated with the passive dispersal by wind, especially in areas where the host density is low.
Surveillance and eradication in the importing country	No. Natural dispersal of the pest would be rather slow and plant protection products could be used in eradication campaigns. However, surveillance would have to rely on visual inspections and laboratory examination of specimen since pheromones or other lures are not available and the pest cannot be identified in the field. Therefore, ensuring that that the pest is always detected at an early enough stage to enable successful eradication would require a huge amount of resources.	No. As for plants for planting.

***The EWG considered whether the measures identified above as ‘Yes in combination’ (listed below) could be combined. This was possible for all commodities when inspecting the consignment for absence of *C. pinifoliae*, dipping the whole plant in horticultural oils (summer or botanical oils) or insecticidal soap [or similar approach guarantying that all the needles are covered] and preventing new infestation by packing. For host plants for planting, the Panel on Phytosanitary Measures recommended that such a system approach is only recommended based on bilateral agreement (see risk of insects remaining undetected, and higher likelihood of transfer than for cut branches of hosts).**

Host plants for planting	Cut branches of hosts (including Christmas trees)
Visual inspection at place of production	Visual inspection at place of production
Treatment of crop	Treatment of crop
Pest free production site / Pest free place of production (outdoor)	Pest free production site / Pest free place of production (outdoor)
Visual inspection of the consignment	Visual inspection of the consignment
Treatment of the consignment (dipping the wole plant in horticultural oils (summer or botanical oils) or insecticidal soap, or similar approach guarantying that all the needles are covered)	Treatment of the consignment (dipping the wole plant in horticultural oils (summer or botanical oils) or insecticidal soap, or similar approach guarantying that all the needles are covered)
Prevention of new infestation by packing/handling method	Prevention of new infestation by packing/handling method
	Limited distribution of consignments in time and/or space or limited use

ANNEX 2. Examples of eradication campaigns of related species

Eradication campaigns have been undertaken against several Diaspididae species in various countries, states and smaller areas. Campaigns have been run in glasshouses and outdoors, and against highly polyphagous species and those with a narrower host range. Some have been very quick while others have lasted for several years. The information found on the campaigns is very limited, and it is summarized below.

Successful campaigns

- *Parlatoria ziziphi* was detected in Darwin, Australia in 1913, and it was eradicated probably as a result of a citrus canker programme in 1916–1922, which removed all citrus trees from the area (Smith *et al.*, 2013). The species is mainly found on *Citrus* and other Rutaceae (Watson, 2002).
- Eradication of *Quadraspidiotus perniciosus* has been successful in a few orchards in France and Switzerland (Madsen & Morgan 1970, citing others). The species is highly polyphagous (Watson, 2002).
- Twelve Diaspididae species have been eradicated from USA but only some of the species were subjected to eradication measures while the rest were considered eradicated merely due to lack of recent observations (Nakahara, 1982). No details are given for any of the cases.
- Eradication campaigns of *Parlatoria pergandii* succeeded in northern California (Gill, 1990). The species is polyphagous (Watson, 2002).
- *Chionaspis wistariae*, which is a pest of *Wisteria* species, was detected on six occasions on imported bonsai at nurseries in the UK in 1981–1990. In all cases, all infested plants were destroyed, and eradication apparently achieved (Pellizzari, 2010, referring to Malumphy, 2010, personal communication).
- *Chrysomphalus aonidum* was eradicated from a couple of glasshouses in Auckland, New Zealand in 2005 (Gill, 2005). The species is highly polyphagous with a preference for *Citrus* (Watson, 2002).

Campaigns that failed but were followed by a successful campaign

- According to Boyden (1941), *Parlatoria blanchardi* was introduced to southwestern USA in 1890. The first attempt at its eradication was taken in 1909 but it failed due to inefficient measures. In 1934, eradication of the relatively isolated infestation was achieved as a result of "heroic measures" (Boyden, 1941; Beardsley & Gonzalez, 1975; Gill, 1990).
- *Nilotaspis halli* was found in California in 1934. The first eradication efforts began in 1935, but they failed due to inadequate treatment and survey methods. In 1941, a new campaign was started and the last *Nilotaspis halli* was found in 1956 (Gill, 1990). This species has host plants in the family Rosaceae (Watson, 2002).

Failed campaigns

- According to Borg (1922a), *Pseudaulacaspis pentagona* was introduced in Malta in 1912 and eradicated by early action. However, later the species was found to affect several species in a wide area in Malta and Gozo, thus the eradication campaign was probably not successful after all (Mifsud *et al.*, 2014 citing Borg, 1922b). The species is highly polyphagous (Watson, 2002).
- According to the global eradication and response database (Gerda, 2021) *Parlatoria blanchardi* was introduced in Deep well, Australia in 1950. Eradication was attempted in 1991-1998 but it was not successful (Gerda 2021, referring to Kenna *et al.*, 1990-1998). The species is mainly a pest of palm trees (Watson, 2002).
- According to Madsen & Morgan (1970, citing others), eradication of *Quadraspidiotus perniciosus* has been attempted and failed in several countries. The species is highly polyphagous (Watson, 2002).
- An eradication campaign of *Parlatoria oleae* in California was not successful (Beardsley & Gonzalez, 1975, citing McKenzie, 1952). The species is highly polyphagous (Watson, 2002).
- Eradication campaigns of *Parlatoria pergandii* failed in southern California where it was widespread (Gill, 1990). The species is polyphagous (Watson, 2002).

Campaigns for which information is uncertain

- According to Gerda (2021) *Chrysomphalus aonidum* has been eradicated from Valencia, Spain in 1999. However, no details are given, and the reference given in Gerda (2021) does not have any information about this scale in Spain. The species is highly polyphagous with a preference for *Citrus* (Watson, 2002).
- *Lepidosaphes beckii*, which is polyphagous (Watson, 2002), is reported as eradicated from Darwin, Australia in 2001 but neither details nor a reference is given (Gerda, 2021).

ANNEX 3. Life stages of *Chionaspis pinifoliae.*

A – First instars nymphs (crawlers) (Credit: A: Cliff Sadoff, Purdue University, USA; A bis: E. Bradford Walker, Bugwood.org); B – Second instar nymphs settled (Credit: United States National Collection of Scale Insects Photographs, USDA Agricultural Research Service, Bugwood.org); C – Adult females on a pine needle, with a parasitoïd escape opening (Credit: Cliff Sadoff, Purdue University, USA). D: Female body and scale cover removed (Credit: John A. Davidson, Univ. Md, College Pk, Bugwood.org).

Pictures of all life stages are available in Guay *et al*. (2018), and additional pictures of signs and symptoms are available in EPPO Global Database (https://gd.eppo.int/taxon/PHECPI/photos), ForestryImages (https://www.forestryimages.org/browse/subthumb.cfm?sub=297).

ANNEX 4. Natural enemies of *Chionaspis pinifoliae*

Natural enemies of *C. pinifoliae* and their presence/absence in the PRA area according to de Jong *et al.* (2014). Note that only the natural enemies that are present in the current distribution area of *C. pinifoliae* according to GBIF (2021b) have been included.

Scientific name	Family	Presence in PRA area (Yes/No)	Parasitoid (Pa)/ Predator (Pr)	Reference for natural enemy status
Aphytis chilensis	Aphelinidae	Yes	Pa	García Mercet, 1930, as cited in García Morales *et al.*, 2016
Aphytis diaspidis	Aphelinidae	Yes	Pa	Martel & Sharma, 1968; Burden & Hart, 1990
Aphytis mytilaspidis (Aphelinus mytilaspidis)	Aphelinidae	Yes	Pa	Cooley, 1899; Felt, 1905; Britton, 1922; Kosztarab, 1963; Martel & Sharma, 1968; Martel & Sharma, 1975
Chilocorus orbus	Coccinellidae	No	Pr	Luck & Dahlsten, 1974; Luck & Dahlsten, 1975
Chilocorus renipustulatus[2] *(C. kuwanae)*	Coccinellidae	Yes	Pr	Lambdin, 1995
Chilocorus stigma (Chilocorus bivulnerus)	Coccinellidae	No	Pr	Cooley, 1899; Easterling, 1934; Peterson & Deboo, 1969; Nielsen & Johnson, 1973[1]; Cranshaw *et al.*, 1994; Cooper & Cranshaw, 1999; Fondren & McCullough, 2002
Chrysonotomyia phenacapsia (Acheysocharis phenocapsia)	Eulophidae	No	Pa	Luck & Dahlsten, 1974
Coccidophilus atronitens (Cryptoweisea atronitens)	Coccinellidae	No	Pr	Luck & Dahlsten, 1974; Luck & Dahlsten, 1975; Cooper & Cranshaw, 1999
Coccidophilus marginata	Coccinellidae	No	Pr	Peterson & Deboo, 1969;
Coccobius howardi	Aphelinidae	No	Pa	Luck & Dahlsten, 1974
Coccobius varicornis (Physcus varicornis)	Aphelinidae	Yes	Pa	Cumming 1953; Martel & Sharma, 1968; Martel & Sharma, 1975; Burden & Hart, 1990; Cooper & Cranshaw, 1999
Coccophagus flavifrons	Aphelinidae	No	Pa	Cooper & Cranshaw, 1999; Watson, 2002
Cybocephalus nigritulus	*Cybocephalidae*	No	Pr	Cooley, 1899; Felt, 1905
Encarsia bella (Prospaltella bella)	Aphelinidae	No	Pa	Nielsen & Johnson, 1973[1]; Luck & Dahlsten, 1974; Luck & Dahlsten, 1975; Cooper & Cranshaw, 1999
Hemisarcoptes malus	Hemisarcoptidae	No	Pr	Nielsen & Johnson, 1973*
Leucopis minor	*Chamaemyiidae*	No	Pr	Fulmek,1943, as cited by García Morales *et al.*, 2016
Marietta mexicana	Aphelinidae	No	Pa	Martel & Sharma, 1968, as cited by García Morales *et al.*, 2016; Nielsen & Johnson, 1973[1]

Marietta pulchella (Perissopterus pulchellus)	Aphelinidae	No	Pa	Felt, 1905; Britton, 1922; Cumming 1953; Martel & Sharma, 1975; Burden & Hart, 1990
Melanocoris nigricornis	Anthocoridae	No	Pr	Herting & Simmonds, 1972, as cited by García Morales *et al.*, 2016
Microweisia misella	Coccinellidae	No	Pr	Nielsen & Johnson, 1973[1]; Fondren & McCullough, 2002
Mulsantina picta (Coccinella picta, Harmonia picta)	Coccinellidae	No	Pr	Cooley, 1899; Felt, 1905
Zygoribatula pyrostigmata	Oribatulidae	No	Pr	Kosztarab, 1963

[1] In some more recent publications it was suggested that Nielsen & Johnson (1973) may have worked with *Chionaspis heterophyllae* (Watler & Stahevitch, 1992; Ahmed & Miller, 2019).

[2] *Chilocorus renipustulatus* (*C. kuwanae*) has only been shown to prey *C. pinifoliae* in an experimental study by Lambdin (1995).

ANNEX 5. Diaspididae on Pinaceae in EPPO (adjusted from ScaleNet, October 2021)

Note: the in-field misidentification risk is based either on scale colour (> white) or on scale shape (> mussel-shaped). With some training, it is possible to evaluate the scale shape that may adapt to the shape of the needle, thus changing from the typical shape for polyphagous taxa infesting Pinaceae (see cases indicated with a '#' below).

Scientific name	Host plant family	Scale-related	EPPO country of collection	Impact	In-field misidentification
Aonidiella aurantii (Maskell, 1879)	86 host plant families, including **Cupressaceae**, **Pinaceae** and **Taxaceae**	Scale: quite thin and pale permitting the red-brown colour of the heavily sclerotized adult female to show through, circular, quite flat	Algeria, Croatia, Cyprus, France, Georgia, Germany, Greece, Israel, Italy, Jordan, Malta, Morocco, Poland, Portugal, Romania, Slovenia, Spain, Tunisia, Turkey, United Kingdom	The major *Citrus* pest worldwide	unlikely
Aspidiotus cryptomeriae Kuwana, 1902	Cephalotaxaceae, **Cupressaceae, Pinaceae, Taxaceae**	Scale: grayish sub transparent, elliptical, flatly convex	Russia	**pest of conifers**	unlikely
Aspidiotus nerii Bouche, 1833	121 host plant families, including **Cupressaceae, Pinaceae** and **Taxaceae**	Scale: white or pale gray, circular, flat	Algeria, Austria, Azerbaijan, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, France, Georgia, Germany, Greece, Hungary, Ireland, Israel, Italy, Jordan, Luxembourg, Malta, Morocco, Poland, Portugal, Romania, Russia, Slovenia, Spain, Tunisia, Turkey, United Kingdom	A serious pest of *Citrus* (mainly lemon trees) and olive in the Mediterranean basin. A pest of kiwifruit in Chile, and of avocado in Israel and Chile. A frequent pest of many ornamental plants.	unlikely
Carulaspis juniperi (Bouché, 1851)	**Cupressaceae, Pinaceae, Taxaceae**	Scale: white, circular, moderately convex	Algeria, Austria, Belgium, Bosnia and Herzegovina*, Bulgaria, Croatia, Czech Republic, France, Georgia, Germany, Greece, Hungary, Italy, Luxembourg, The Republic of North Macedonia*, Malta, Montenegro*, Morocco, Netherlands, Norway, Poland, Portugal, Romania, Russia, Serbia*, Spain, Switzerland, Turkey, Ukraine, United Kingdom, Uzbekistan	**widespread and serious pest of conifers**	**possible (#)**
Carulaspis minima (Signoret, 1869)	Cephalotaxaceae, **Cupressaceae, Pinaceae, Taxaceae**	Scale: dirty white, rounded	Algeria, Austria, Azerbaijan, Bosnia and Herzegovina*, Bulgaria, Croatia, France, Georgia, Germany, Greece, Hungary, Ireland, Israel, Italy, Jordan, The Republic of North Macedonia*, Malta, Montenegro*, Morocco, Portugal, Romania, Russia, Serbia*, Spain, Sweden, Turkey, Ukraine, United Kingdom	**widespread and serious pest of juniper**	**Possible (#)**
Chionaspis austriaca Lindinger, 1912	**Pinaceae**	Scale: white, mussel shaped, wide	Austria, Bosnia and Herzegovina*, France, Hungary, The Republic of North Macedonia*, Montenegro*, Serbia*, Spain, Switzerland	A species at risk of introduction by trade in US (1918)	**possible**

Chionaspis kabyliensis Balachowsky, 1930	**Pinaceae**	Scale: pure white, silky, long an straight, convex	Algeria, Morocco, Turkey	**specific of *Cedrus libanotica* ssp *atlantica*. Does not exist on *Cedrus libanotica* in Lebenon**	**possible**
Chrysomphalus aonidum (Linnaeus, 1758)	75 host plant families, including **Pinaceae**	Scale: somewhat variable in color but tending to be quite dark, flat, circular	Algeria, Belgium, Bulgaria, Croatia, Denmark, France, Germany, Greece, Hungary, Israel, Italy, Malta, Morocco, Poland, Portugal, Romania, Slovenia, Spain, Tunisia, Turkey, United Kingdom	a serious pest on other families than Pinaceae	unlikely
Chrysomphalus dictyospermi (Morgan, 1889)	81 host plant families, including **Cupressaceae, Pinaceae** and **Taxaceae**	Scale: greyish-white, brown or yellowish, rather thin, circular, flat, light,	Algeria, Azerbaijan, Bulgaria, Croatia, Czech Republic, France, Georgia, Germany, Greece, Hungary, Ireland, Israel, Italy, Malta, Morocco, Poland, Portugal, Romania, Russia, Slovenia, Spain, Tunisia, Turkey, United Kingdom	a serious pest on other families than Cupressaceae, Pinaceae and Taxaceae	unlikely
Comstockaspis perniciosa (Comstock, 1881)	42 host plant families, including **Pinaceae**	Scale: gray, circular, but slightly convex	Algeria, Austria, Azerbaijan, Bulgaria, Croatia, Czech Republic, France, Georgia, Germany, Greece, Hungary, Italy, Kazakhstan, Moldova, Poland, Portugal, Romania, Russia, Slovenia, Spain, Sweden, Switzerland, Turkey, Ukraine, United Kingdom, Uzbekistan	A major pest of deciduous fruit trees worldwide. Origin in the north of the Oriental region and first recorded in USA, 1870, with description in 1881	unlikely
Cupressaspis mediterranea (Lindinger, 1910)	**Cupressaceae, Pinaceae,** Pittosporaceae	Scale: faint yellow; adult secretion white, subcircular, flat	Algeria, France, Georgia, Greece, Italy, Morocco, Spain, Turkey, Uzbekistan		unlikely
Cynodontaspis piceae Takagi, 1962	**Pinaceae**	Scale: Lepidosaphes-like, mussel shaped	Russia	Associated with *Septobasidium kameei* **A possible pest species.**	unlikely (because very rare)
Diaspidiotus ancylus (Putnam, 1878	35 host plant families, including **Pinaceae**	Scale: pale gray or white, variable form	Portugal, Spain	a secondary pest in USA, on other families than Pinaceae	unlikely
Diaspidiotus jaapi (Leonardi, 1920)	Amaranthaceae, Asteraceae, Fabaceae, Oleaceae, **Pinaceae**	Scale: yellow, brown, almost circulars lightly convex	France, Italy, Spain, Turkey		unlikely
Diaspidiotus lenticularis (Lindinger, 1912)	11 host plant families, including **Pinaceae**	Scale: gray, or slightly brown, quite flat, circular	Bulgaria, Croatia, Cyprus, France, Georgia, Greece, Hungary, Italy, Morocco, Spain, Sweden, Switzerland, Turkey, Ukraine		unlikely

Diaspidiotus ostreaeformis (Curtis, 1843)	20 host plant families, including **Pinaceae**	Scale: gray, circular, moderately convex	Algeria, Azerbaijan, Bulgaria, Croatia, Czech Republic, France, Georgia, Germany, Greece, Hungary, Ireland, Israel, Italy, Kazakhstan, Kyrgyzstan, Lithuania, Luxembourg, Malta, Morocco, Netherlands, Poland, Portugal, Romania, Russia, Slovakia, Slovenia, Spain, Sweden, Switzerland, Tunisia, Turkey, United Kingdom, Uzbekistan		unlikely
Dynaspidiotus abieticola (Koroneos, 1934)	**Pinaceae**	Scale: light brown, subrectangular, margins parallel, contracted laterally, truncated at two apices; sometimes subcircular	Greece, Turkey	A scarce species	unlikely
Dynaspidiotus abietis (Schrank, 1776)	Cupressaceae, **Pinaceae**, Rosaceae, Sapindaceae	Scale: gray, suboval, convex; contracted laterally, and truncated at apices	Algeria, Austria, Azerbaijan, Bulgaria, Croatia, Czech Republic, France, Georgia, Germany, Greece, Hungary, Italy, Lithuania, Luxembourg, Netherlands, Poland, Romania, Russia, Slovakia, Slovenia, Spain, Sweden, Turkey	**A pest of conifers in Central Europe.**	unlikely
Dynaspidiotus britannicus (Newstead, 1898)	22 host plant families, including **Pinaceae** and **Taxaceae**	Scale: dusky ochreous, circular or almost so, moderately convex	Algeria, Croatia, Cyprus, Czech Republic, France, Georgia, Greece, Israel, Italy, Latvia, Morocco, Poland, Portugal, Russia, Slovenia, Spain, Switzerland, Turkey, United Kingdom	A lesser pest of olive in Mediterranean, **can cause discoloration and falling on cedar.**	unlikely
Dynaspidiotus regnieri (Balachowsky, 1928)	**Pinaceae**	Scale: white, scale oval, elongate, thin and truncated at apices; highly convex, retracted laterally	Algeria, France, Morocco, Spain	**a serious pest of Cedrus in Spain**	**possible (#)**
Dynaspidiotus tsugae (Marlatt, 1911)	**Pinaceae, Taxaceae**	Scale: dark brown; rather pointed or nippled at center, circular; strongly convex	Russia	A serious pest of Eastern hemlock USA	unlikely
Fiorinia externa Ferris, 1942	**Cupressaceae, Pinaceae, Taxaceae**	Scale: pale yellow or slightly reddish brown, elongate, pupillarial	United Kingdom	***Fiorinia externa* is "undoubtedly an invader in North America from Japan.**	unlikely
Fiorinia fioriniae (Targioni Tozzetti, 1867)	48 host plant families, including **Cupressaceae, Pinaceae** and **Taxaceae**	Scale: brownish yellow to orange- brown, elongate elliptical, shield-shaped, thin; translucent, pupillarial	Algeria, Belgium, Croatia, France, Georgia, Germany, Greece, Ireland, Israel, Italy, Malta, Morocco, Romania, Russia, Spain, Turkey, United Kingdom	a pest of avocado, palms, tea, and ornamentals. undoubtedly an introduction into the western hemisphere	unlikely
Fiorinia japonica Kuwana, 1902	13 host plant families, including **Cupressaceae,**	Scale: brown, elongate, sides nearly parallel, anterior margin round, covered with a	France	**a pest of conifers in the Washington D.C. area USA, a serious**	unlikely

	Pinaceae and **Taxaceae**	white powdery substance, pupillarial		**pest of pine trees in Beijing, China,** or an occasional pest. undoubtedly an introduction into the western hemisphere	
Fiorinia pinicola Maskell, 1897	15 host plant families, including **Cupressaceae, Pinaceae** and **Taxaceae**	Scale: white, second exuviae covered with a thin, frost-like coating of wax which extends past the posterior end of the exuviae as a white appendage, pupillarial	Italy, Portugal	a pest, undoubtedly an introduction into the western hemisphere, on other families than Cupressaceae	**possible**
Gomezmenoraspis pinicola (Leonardi, 1906)	**Pinaceae**	Scale: white, oval, convex	Cyprus, Portugal, Spain, Turkey		**possible**
Hemiberlesia lataniae (Signoret, 1869)	120 host plant families, including **Cupressaceae** and **Pinaceae**	Scale: yellow, white, quite convex, little elongated; transparent in center and white in the circumference or around the exuviae	Algeria, Austria, Bulgaria, Croatia, Cyprus, Czech Republic, France, Georgia, Greece, Israel, Italy, Malta, Morocco, Poland, Portugal, Romania, Spain, Tunisia, Turkey, United Kingdom	a pest of several agricultural crops and ornamental plants, on other families than Cupressaceae and Pinaceae	unlikely
Hemiberlesia palmae (Cockerell, 1893)	57 host plant families, including **Pinaceae**	Scale: white, somewhat oval, quite convex	Czech Republic, Germany, Poland, Portugal, United Kingdom	a pest of crops in the tropics, on other families than Pinaceae	unlikely
Lepidosaphes beckii (Newman, 1869)	44 host plant families, including **Cupressaceae, Pinaceae** and **Taxaceae**	Scale: light brown, mussel shaped	Algeria, Bulgaria, Croatia, Cyprus, France, Georgia, Germany, Greece, Hungary, Israel, Italy, Malta, Morocco, Netherlands, Portugal, Romania, Russia, Slovenia, Spain, Tunisia, Turkey, United Kingdom	a serious and widespread pest on other families than Cupressaceae, Pinaceae and Taxaceae	unlikely
Lepidosaphes gloverii (Packard, 1869)	28 host plant families, including **Pinaceae**	Scale: light to dark brown, mussel shaped, slender with parallel sides	Algeria, Azerbaijan, Croatia, France, Georgia, Greece, Israel, Italy, Malta, Morocco, Netherlands, Portugal, Romania, Spain, Sweden, Turkey, United Kingdom, Uzbekistan	a serious and widespread pest on other families than Pinaceae	unlikely
Lepidosaphes juniperi Lindinger, 1912	**Cupressaceae, Pinaceae**	Scale: light brown, small mussel shaped, narrow, flattened	Azerbaijan, Bosnia and Herzegovina*, Bulgaria, Croatia, France, Georgia, Greece, Italy, The Republic of North Macedonia*, Malta, Montenegro*, Poland, Russia, Serbia*, Spain, Switzerland, Turkey, Uzbekistan	**a pest**	unlikely
Lepidosaphes newsteadi (Sulc, 1895)	**Cupressaceae, Pinaceae,** Sciadopityaceae, Theaceae	Scale: pale brown, mussel shaped, quite slender	Austria, Bulgaria, Croatia, Czech Republic, France, Germany, Greece, Hungary, Italy, Netherlands, Norway, Poland, Romania, Sweden, Switzerland, Turkey	**a pest**	unlikely

Lepidosaphes pallida (Maskell, 1895)	15 host plant families, including **Cupressaceae, Pinaceae** and **Taxaceae**	Scale: light yellow-brown or tan, mussel shaped, slender	Georgia, Turkey	a pest, **occasionally a serious pest of juniper in Florida**	unlikely
Lepidosaphes pseudotsugae Takahashi, 1957	**Pinaceae**	Scale: brown (presumably), mussel shaped (presumably)	Russia	a scarce species	unlikely
Lepidosaphes ulmi (Linnaeus, 1758)	73 host plant families, including **Cupressaceae, Pinaceae** and **Taxaceae**	Scale: light brown or yellow, mussel shaped	Algeria, Austria, Azerbaijan, Bulgaria, Croatia, Czech Republic, Denmark, Finland, France, Georgia, Germany, Greece, Hungary, Ireland, Israel, Italy, Kazakhstan, Latvia, Lithuania, Luxembourg, Malta, Morocco, Netherlands, Norway, Poland, Portugal, Romania, Russia, Spain, Sweden, Switzerland, Tunisia, Turkey, United Kingdom, Uzbekistan	A serious and worldwide pest, on other families than Cupressaceae,.	unlikely
Leucaspis ilicitana (Gómez-Menor Ortega, 1968)	**Pinaceae**	Scale: white, silky, Elongated elliptical, wider at the end, pupillarial	Spain		**possible**
Leucaspis knemion Hoke, 1925	**Pinaceae**	Scale: white, elongate, straight, pupillarial	Cyprus, Israel, Turkey		**possible**
Leucaspis lowi Colvee, 1882	**Pinaceae,** Poaceae, Taxaceae	Scale: white, ends tapering, larger in the middle,convex, pupillarial	Austria, Belgium, Bulgaria, Croatia, Czech Republic, Denmark, France, Georgia, Germany, Greece, Hungary, Ireland, Israel, Italy, Lithuania, Morocco, Netherlands, Norway, Poland, Portugal, Romania, Russia, Spain, Sweden, Switzerland, Turkey		**possible**
Leucaspis pini (Hartig, 1839)	**Cupressaceae**, Oleaceae, **Pinaceae**	Scale: white, elongate, almost parallel sided, pupillarial	Austria, Bosnia and Herzegovina*, Bulgaria, Croatia, Czech Republic, France, Georgia, Germany, Greece, Hungary, Israel, Italy, Luxembourg, The Republic of North Macedonia*, Malta, Montenegro*, Morocco, Netherlands, Norway, Poland, Portugal, Romania, Serbia*, Spain, Sweden, Switzerland, Turkey, Ukraine	A single incursion of this species has occurred in Britain.	**possible**
Leucaspis pusilla Löw, 1883	**Pinaceae**	Scale: white, elongate, narrow, slight convex, pupillarial	Albania, Algeria, Austria, Azerbaijan, Bosnia and Herzegovina*, Bulgaria, Croatia, Cyprus, Czech Republic, France, Georgia, Germany, Greece, Hungary, Israel, Italy, The Republic of North Macedonia*, Malta, Montenegro*, Morocco,	**a pest**	**possible**

			Poland, Portugal, Romania, Serbia*, Spain, Switzerland, Turkey, Ukraine		
Leucaspis signoreti Signoret, 1870	**Pinaceae**	Scale: white, narrow, tapering anterior end, with a rounded posterior end, pupillarial	Algeria, Cyprus, France, Georgia, Italy, Romania, Russia, Turkey, Ukraine	**a pest**	**possible**
Lindingaspis rossi (Maskell, 1892)	58 host plant families, including **Cupressaceae** and **Pinaceae**	Scale: very dark brown or black, quite flat, circular	France, Italy, Portugal, Spain	a secondary pest	unlikely
Lopholeucaspis cockerelli (Grandpre & Charmoy, 1899)	34 host plant families, including **Cupressaceae** and **Pinaceae**	Scale: light brown, white, elongate, narrow, slightly curvedpupillarial	Germany, Greece, United Kingdom	a pest, on other families than Cupressaceae and Pinaceae	unlikely
Parlatoria crotonis Douglas, 1887	14 host plant families, including **Pinaceae**	Scale: yellowish, elongate-oval	France, Hungary, Israel, Italy, Netherlands, United Kingdom		unlikely
Parlatoria oleae (Colvée, 1880)	61 host plant families, including **Cupressaceae** and **Pinaceae**	Scale: whitish grey to pale grey, ovate or slightly round, convex	Algeria, Azerbaijan, Belgium, Bosnia and Herzegovina*, Bulgaria, Croatia, Cyprus, France, Georgia, Germany, Greece, Hungary, Israel, Italy, Jordan, Kazakhstan, The Republic of North Macedonia*, Malta, Montenegro*, Morocco, Portugal, Romania, Serbia*, Spain, Tunisia, Turkey, Ukraine, United Kingdom, Uzbekistan	a worldwide pest, mostly on fruits (on other species than Cupressaceae and Pinaceae)	unlikely
Parlatoria parlatoriae (Šulc, 1895)	**Pinaceae**	Scale: white, ovoidal	Austria, Bosnia and Herzegovina*, Bulgaria, Croatia, Czech Republic, Georgia, Germany, Hungary, Italy, Kazakhstan, The Republic of North Macedonia*, Montenegro*, Poland, Romania, Russia, Serbia*, Turkey, Ukraine	**a lesser pest**	**possible**
Parlatoria pergandii Comstock, 1881	36 host plant families, including **Pinaceae**	Scale: greyish brown, irregular oval	Algeria, Bosnia and Herzegovina*, Bulgaria, Cyprus, Czech Republic, Denmark, France, Georgia, Germany, Greece, Ireland, Israel, Italy, Jordan, The Republic of North Macedonia*, Malta, Montenegro*, Morocco, Poland, Portugal, Serbia*, Spain, Switzerland, Turkey, United Kingdom	a serious and widespread pest on other families than Pinaceae	unlikely
Parlatoria pittospori Maskell, 1891	26 host plant families, including **Cupressaceae** and **Pinaceae**	Scale: dull dark greenish-gray, sometimes almost black, sub-elliptical, flattish	United Kingdom	a lesser pest	unlikely
Parlatoria proteus (Curtis, 1843)	54 host plant families, including **Pinaceae**	Scale: brownish yellow, more or less oval, transparent	Belgium, Bulgaria, Czech Republic, Denmark, France, Georgia, Germany, Israel, Italy, Malta,	a serious and widespread pest on	unlikely

			Poland, Romania, Russia, Spain, Ukraine, United Kingdom	other families than Pinaceae.	
Pinnaspis buxi (Bouché, 1851)	49 host plant families, including **Cupressaceae** and **Pinaceae**	Scale: pale brownish or almost colorless, mussel shaped, very small	Czech Republic, Denmark, France, Germany, Ireland, Italy, Romania, Russia, Spain, Sweden, Switzerland, United Kingdom	a pest on other species than Cupressaceae and Pinaceae	unlikely
Pseudaulacaspis pentagona (Targioni Tozzetti, 1886)	90 host plant families, including **Pinaceae**	Scale: white, opaque, nearly circular, convex	Austria, Azerbaijan, Bosnia and Herzegovina*, Bulgaria, Croatia, France, Georgia, Germany, Greece, Hungary, Israel, Italy, Luxembourg, The Republic of North Macedonia*, Malta, Montenegro*, Netherlands, Poland, Portugal, Romania, Russia, Serbia*, Spain, Switzerland, Turkey, Ukraine, United Kingdom	a serious and widespread pest on other species than Pinaceae	**possible**
Pseudoparlatoria ostreata Cockerell 1892	34 host plant families, including **Pinaceae**	Scale: dark grey, subcircular, thin, papery	France, Germany, United Kingdom	a pest on other species than Pinaceae	unlikely
Pseudoparlatoria parlatorioides (Comstock, 1883)	53 host plant families, including **Pinaceae**	Scale: yellow or yellowish brown, circular or oval,flat, thin, papery,	Belgium, Czech Republic, France, Georgia, Germany, Italy, Netherlands, Spain, Sweden, United Kingdom		unlikely
Symeria pyriformis (Maskell, 1879)	31 host plant families, including **Cupressaceae** and **Pinaceae**	Scale: from light brown to very dark brown, pyriform (pear-shaped)	United Kingdom		unlikely
Torosaspis cedricola (Balachowsky & Alkan, 1956)	**Cupressaceae, Pinaceae**	Scale: light brown, straight, long, narrow, on needles	Turkey	**a *Cedrus libani* pest**	unlikely
Torosaspis turcica Ülgentürk & Kozár, 2011	**Pinaceae**	Scale: light brown, mussel shaped, posteriorly broadest, elongate, flat	Turkey		unlikely
Unaspidiotus corticispini (Lindinger, 1909)	**Pinaceae**	Scale: light brown, elongate-oval	Germany	scarce species	unlikely

* means a country originating from former Yugoslavia splitting

ANNEX 6. Hosts plants of *Chionaspis pinifoliae*

Information on the presence and status of the plants in the PRA area was obtained from the Euro+Med plantbase database (http://ww2.bgbm.org/EuroPlusMed/query.asp), Royal Horticultural Society database (https://www.rhs.org.uk/Plants), EPPO Global Database (EPPO, 2021b), CABI Invasive Species Compendium (CABI, 2021) and Euforgen platform (Euforgen, 2021). Remark: only the genus is indicated when the publication does not give the name of the species.

Scientific name	EPPO code	Common name	Family	Presence in the PRA area *(Yes/No)*	Status in the PRA area	Reference for host status
Abies	1ABIG	fir	Pinaceae	Yes	native in some areas, introduced and cultivated in some areas	Liu, 1987; Miller and Davidson, 2005
Abies alba	ABIAL	silver fir	Pinaceae	Yes	native in most of the PRA area, introduced and naturalized in some areas, cultivated	Cooley, 1899; Nakahara,1982
Abies balsamea (including *Abies balsamea* var. *phanerolepsis*)	ABIBA	balsam fir (including also canaan fir)	Pinaceae	Yes	introduced, cultivated	Liu, 1987; Kosztarab and Rhoades, 1999 as cited by García Morales *et al*., 2016; Magasi, 1992
Abies concolor	ABICO	white fir	Pinaceae	Yes	introduced, cultivated	Coleman, 1903; Jorgensen, 1934, as cited by García Morales *et al*., 2016
Abies fraseri	ABIFR	fraser fir	Pinaceae	Yes	introduced, cultivated in UK and Baltic states	Liu, 1987; Kosztarab and Rhoades, 1999, as cited by García Morales *et al*., 2016
Abies grandis	ABIGR	grand fir	Pinaceae	Yes	introduced, naturalized, cultivated	King, 1901, as cited by García Morales *et al*., 2016; Wood and Van Sickle, 1992 (only single collections, i.e. 0.025% of the total)
Calocedrus decurrens	CCDDE	Incence cedar	Cupressaceae	Yes	Introduced, cultivated	Coleman, 1903
Cedrus[2]	1CEUG	cedar	Pinaceae	Yes	native in some areas, introduced, naturalized and cultivated in some areas	Borchsenius, 1966, as cited by García Morales *et al*., Furniss and Carolin, 1977; 2016; Miller and Davidson, 2005
Cedrus deodara	CEUDE	deodar cedar, Himalayan cedar	Pinaceae	Yes	introduced, cultivated in some areas	McKenzie, 1956; Ahmed and Miller, 2019[1]
Cupressus	1CVBG	cypress	Cupressaceae	Yes	native in some areas, introduced, naturalized and cultivated in some areas	Watson, 2002
Juniperus[2]	1IUPG	juniper	Cupressaceae	Yes	native	Miller and Davidson, 2005

Juniperus virginiana	IUPVI	red cedar	Cupressaceae	Yes	introduced, naturalized, cultivated	Lambdin and Watson, 1980; Liu, 1987; Liu *et al.* 1989;
Larix laricina	LAXLA	American larch	Pinaceae	Yes	introduced	Cooley, 1899
Picea	1PIEG	spruce	Pinaceae	Yes	native in most of the PRA area, introduced and naturalized in some areas, cultivated	Kosztarab, 1963; Furniss and Carolin, 1977; Nakahara,1982; Liu, 1987; Miller and Davidson, 2005;
Picea abies	PIEAB	Norway spruce	Pinaceae	Yes	native in most of the PRA area, introduced and naturalized in some areas, cultivated	Cooley, 1899; Kosztarab, 1963; Liu, 1987; Shour and Schuder, 1987; Gwiazdowski *et al*., 2011
Picea engelmannii	PIEEN	Engelmann spruce	Pinaceae	Yes	introduced, cultivated	Liu, 1987
Picea glauca	PIEGA	white spruce	Pinaceae	Yes	introduced, naturalized, cultivated	King, 1901, as cited by García Morales *et al*., 2016; Liu, 1987; Magasi, 1992
Picea mariana	PIEMA	black spruce	Pinaceae	Yes	introduced, cultivated	Cooley, 1899; Watler and Stahevitch, 1992; Guay *et al*., 2018
Picea orientalis	PIEOR	oriental spruce	Pinaceae	Yes	native in some areas, introduced and cultivated in some areas	Kosztarab, 1963; Liu, 1987
Picea pungens	PIEPU	blue spruce	Pinaceae	Yes	introduced, cultivated in some areas	Amos, 1933; Edmunds, 1973; Kosztarab, 1963; Liu, 1987; Shour and Schuder, 1987; Magasi, 1992; Cooper and Cranshaw, 2005; Gwiazdowski *et al*., 2011
Picea rubens	PIERU	red spruce	Pinaceae	Yes	introduced, cultivated	Lambdin and Watson, 1980; Liu, 1987; Magasi, 1992
Pinus	1PIUG	pine	Pinaceae	Yes	native in most of the PRA area, introduced and naturalized in some areas, cultivated	Kosztarab, 1963; Furniss and Carolin, 1977; Nakahara,1982
Pinus albicaulis	PIUAB	whitebark pine	Pinaceae	No/Yes	introduced, rarely cultivated	Coleman 1903; Liu, 1987
Pinus attenuata	PIUAT	knobcone pine	Pinaceae	No/Yes	introduced, rarely cultivated	Turner, 1903; Liu, 1987; Gwiazdowski *et al*., 2011; Normark *et al.* 2019
Pinus arizonica	PIUPR	Arizona pine	Pinaceae	No/Yes	introduced, rarely cultivated	Gwiazdowski *et al*., 2011
Pinus ayacahuite	PIUAY	mexican white pine	Pinaceae	No/Yes	introduced, rarely cultivated	Cibrán-Tovar et al, 1986; Liu, 1987; Gwiazdowski *et al*., 2011

Pinus banksiana	PIUBN	jack pine	Pinaceae	Yes	introduced, cultivated	Britton, 1922; Liu, 1987; Rhoades, 1986, as cited by Shour and Schuder 1987; Burns and Honkala, 1990; Magasi, 1992; Gwiazdowski *et al.* 2011
Pinus canariensis	PIUCA	canary island pine	Pinaceae	Yes	native in some areas, introduced and naturalized in some areas, cultivated	Liu, 1987; Rhoades, 1986, as cited by Shour and Schumer 1987; Gwiazdowski *et al.*, 2011
Pinus caribaea	PIUCB	Caribbean pine	Pinaceae	No		Alayo Soto, 1976 as cited by García Morales *et al.*, 2016; Mestre *et al.* 2011; Normark *et al.* 2019
Pinus cembra	PIUCE	swiss Pine	Pinaceae	Yes	native in some areas, introduced and cultivated in some areas	Cooley, 1899; Liu, 1987; Shour and Schuder, 1987
Pinus cembroides	PIUCM	Mexican nut pine	Pinaceae	No/Yes	introduced, rarely cultivated	Gwiazdowski *et al.*, 2011
Pinus clausa	PIUCL	sand pine	Pinaceae	No/Yes	introduced, rarely cultivated	Ahmed and Miller, 2019[1]
Pinus contorta	PIUCN	lodgepole pine / cortada pine	Pinaceae	Yes	introduced, cultivated and naturalized	Coleman 1903; Furniss and Carolin, 1977; Liu, 1987; Burns and Honkala, 1990; Magasi, 1992; Wood and Van Sickle, 1992;Gwiazdowski *et al.*, 2011; Normark *et al.* 2019
Pinus cooperi (Pinus arizonica var. cooperi)	PIUCP	Cooper pine	Pinaceae	No		Gwiazdowski *et al.*, 2011
Pinus coulteri	PIUCO	big-cone pine	Pinaceae	No/Yes	introduced, rarely cultivated	Turner, 1903; Liu, 1987; Gwiazdowski *et al.*, 2011
Pinus densiflora	PIUDE	Japanese red pine	Pinaceae	Yes	introduced, cultivated in some areas	Britton, 1922
Pinus devoniana	PIUDV	Michoacan pine	Pinaceae	No/Yes	introduced, rarely cultivated	Liu, 1987; Gwiazdowski *et al.*, 2011
Pinus discolor (Pinus cembroides var. bicolor)	PIUDR	Border pinyon	Pinaceae	No		Gwiazdowski *et al.*, 2011
Pinus douglasiana	PIUDO	Douglas pine	Pinaceae	No		Cibrán-Tovar et al, 1986; Gwiazdowski *et al.*, 2011
Pinus echinata (as Pinus mitis)	PIUEC	shortleaf pine	Pinaceae	No/Yes	introduced, rarely cultivated	Cooley, 1899
Pinus edulis	PIUED	Pinyon pine	Pinaceae	Yes	introduced, cultivated	Liu, 1987; Burns and Honkala, 1990; Cooper and

						Cranshaw, 2005; Gwiazdowski *et al.*, 2011
Pinus elliottii	PIUEL	slash pine	Pinaceae	No/Yes	introduced, rarely cultivated	Ahmed and Miller, 2019[1]
Pinus elliottii var. densa (as *Pinus densa*)	PIUDN	Florida slash pine	Pinaceae	No/Yes	introduced, rarely cultivated	Ahmed and Miller, 2019[1]
Pinus engelmannii	PIUEN	Apache pine	Pinaceae	No/Yes	introduced, rarely cultivated	Gwiazdowski *et al.*, 2011
Pinus flexilis	PIUFL	limber pine	Pinaceae	Yes	introduced, cultivated in some areas (Czech Republic)	Liu, 1987; Horning and Barr, 1970; as cited by García Morales *et al.*, 2016; Gwiazdowski *et al.*, 2011
Pinus glabra	PIUGL	American spruce pine	Pinaceae	No/Yes	introduced, rarely cultivated	Ahmed and Miller, 2019[1]
Pinus greggii	PIUGG	Gregg's pine	Pinaceae	No/Yes	introduced, rarely cultivated	Liu, 1987; Gwiazdowski *et al.*, 2011
Pinus halepensis	PIUHA	Aleppo pine	Pinaceae	Yes	native in some areas, introduced, naturalized and cultivated in some areas	Liu, 1987; Gwiazdowski *et al.*, 2011
Pinus hartwegii	PIUHW	Hartweg's pine	Pinaceae	No		Gwiazdowski *et al.*, 2011
Pinus herrerae	PIUHR	Herrera's pine	Pinaceae	No		Gwiazdowski *et al.*, 2011
Pinus jeffreyi	PIUJE	jefrey's pine	Pinaceae	Yes	introduced, cultivated in some areas	Luck and Dahlsten, 1974; Shour and Schuder, 1987; Gwiazdowski *et al.*, 2011
Pinus lambertiana	PIULA	sugar pine	Pinaceae	No/Yes	introduced, rarely cultivated	Coleman 1903; Liu, 1987; Gwiazdowski *et al.*, 2011
Pinus lawsonii	PIULW	Lawson's pine	Pinaceae	No/Yes	introduced, rarely cultivated	Gwiazdowski *et al.*, 2011
Pinus leiophylla	PIULE	chihuahua pine,	Pinaceae	No/Yes	introduced, rarely cultivated	Liu, 1987; Gwiazdowski *et al.*, 2011; Normark *et al.* 2019
Pinus lumholtzii	PIULH	Lumholtz's pine	Pinaceae	No		Gwiazdowski *et al.*, 2011
Pinus maximartinezii		Martinez pinyon	Pinaceae	No/Yes	introduced, rarely cultivated	Gwiazdowski *et al.*, 2011
Pinus monophylla	PIUMP	single-leaf pinyon	Pinaceae	No/Yes	introduced, rarely cultivated	Liu, 1987; Gwiazdowski *et al.*, 2011; Normark *et al.* 2019
Pinus monticola	PIUMO	Western white pine	Pinaceae	Yes	introduced, cultivated	Coleman 1903; Liu, 1987; Gwiazdowski *et al.*, 2011

Pinus montezumae	PIUMZ		Pinaceae	Yes	introduced, cultivated	Cibrán-Tovar et al, 1986; Liu, 1987
Pinus mugo	PIUMU	mountain pine	Pinaceae	Yes	native in most of the PRA area, introduced, naturalized and cultivated in some areas	Cooley, 1899; Britton, 1922; Martel and Sharma, 1968; Liu, 1987; Shour and Schuder, 1987; Magasi, 1992; Wood and Van Sickle, 1992; Cooper and Cranshaw, 2005; Gwiazdowski *et al.*, 2011
Pinus muricata	PIUMR	bishop pine	Pinaceae	Yes	introduced, cultivated	Turner, 1903; Gwiazdowski *et al.*, 2011
Pinus nelsonii	PIUNE	Nelson's pinyon	Pinaceae	No		Gwiazdowski *et al.*, 2011
Pinus nigra	PIUNI	Austrian pine / black pine	Pinaceae	Yes	native in most of the PRA area, introduced, naturalized and cultivated in some areas	Cooley, 1899; Felt, 1905; Britton, 1922; Amos, 1933; Kosztarab, 1963; Martel and Sharma, 1968; Liu, 1987; Wood and Van Sickle, 1992; Gwiazdowski *et al.*, 2011; Cooper and Cranshaw, 2005
Pinus parviflora	PIUPF	Japanese white pine	Pinaceae	Yes	introduced, cultivated	Liu, 1987
Pinus patula	PIUPT	Mexican yellow pine	Pinaceae	Yes	introduced, cultivated	Liu, 1987; Gwiazdowski *et al.*, 2011
Pinus pinceana	PIUPC	weeping pinyon	Pinaceae	No		Gwiazdowski *et al.*, 2011
Pinus pinea	PIUPN	stone pine	Pinaceae	Yes	native to the Mediterranean region, cultivated in other areas	Britton, 1922; Ahmed and Miller, 2019[1]
Pinus ponderosa	PIUPO	ponderosa pine	Pinaceae	Yes	introduced and cultivated in some areas	Coleman 1903; Liu, 1987; Wood and Van Sickle, 1992; Cooper and Cranshaw, 2005; Gwiazdowski *et al.*, 2011; Normark *et al.* 2019
Pinus ponderosa var. *ponderosa* (as *Pinus washoensis*)		Washoe pine	Pinaceae	No		Gwiazdowski *et al.*, 2011
Pinus quadrifolia	PIUQU	Parry pinyon	Pinaceae	No		Gwiazdowski *et al.*, 2011
Pinus radiata	PIURA	Monterey pine	Pinaceae	Yes	introduced and cultivated in some areas	Essig and Parker, 1909; Turner, 1903; Gwiazdowski *et al.*, 2011

Pinus remota	PIURM	Texas pinyon	Pinaceae	No		Gwiazdowski *et al.*, 2011
Pinus resinosa	PIURE	red pine	Pinaceae	Yes	introduced, cultivated in some areas	Cooley, 1899; Britton, 1922; Amos, 1933; Easterling, 1934; Martel and Sharma, 1968; Shour and Schuder, 1987; Magasi, 1992; Wood and Van Sickle, 1992; Gwiazdowski *et al.*, 2011
Pinus rigida	PIURI	pitch pine	Pinaceae	Yes	introduced, cultivated in some areas	Kosztarab, 1963; Gwiazdowski *et al.*, 2011
Pinus sabiniana	PIUSA	foothills pine	Pinaceae	No/Yes	introduced, rarely cultivated	Essig and Parker (1909); Gwiazdowski *et al.*, 2011
Pinus strobiformis	PIUSF	Mexican white pine	Pinaceae	No/Yes	introduced, rarely cultivated	Gwiazdowski *et al.*, 2011
Pinus strobus	PIUST	Weymouth pine	Pinaceae	Yes	introduced, naturalized, cultivated	Cooley, 1899; Amos, 1933; Easterling, 1934; Kosztarab, 1963; Lambdin and Watson, 1980; Shour and Schuder, 1987; Liu *et al.* 1989; Magasi, 1992; Gwiazdowski *et al.*, 2011
Pinus sylvestris	PIUSI	Scots pine	Pinaceae	Yes	native in most of the PRA area, introduced, naturalized and cultivated in some areas	Cooley, 1899; Britton, 1922; Turner, 1929; Kosztarab, 1963; Martel and Sharma, 1968; Shour and Schuder, 1987; Liu *et al.* 1989; Magasi, 1992; Gwiazdowski *et al.*, 2011
Pinus teocote	PIUTE	Aztec pine	Pinaceae	No/Yes	introduced, rarely cultivated	Gwiazdowski *et al.*, 2011
Pinus thunbergia (as *Pinus thunbergiana*)	PIUTH	Japanese black pine	Pinaceae	Yes	introduced, cultivated	Rhoades, 1986, as cited by Shour and Schumer, 1987; Liu *et al.* 1989; Ahmed and Miller, 2019[1]
Pinus torreyana	PIUTO	Torrey	Pinaceae	No/Yes	introduced, rarely cultivated	Coleman 1903; Gwiazdowski *et al.*, 2011
Pinus tropicalis	PIUTR	tropical pine	Pinaceae	No		Alayo Soto, 1976 as cited by García Morales *et al.*, 2016
Pinus wallichiana	PIUWA	Bhutan pine	Pinaceae	Yes	introduced and cultivated in some areas	Cooley, 1899; Amos, 1933
Pinus virginiana	PIUVI	Virginia pine / scrub pine	Pinaceae	No/Yes	introduced, rarely cultivated	Lambdin and Watson, 1980; Rhoades, 1986; as cited by Shour and Schuder, 1987; Liu *et al.* 1989

Pseudotsuga menziesii	PSTME	douglas fir	Pinaceae	Yes	introduced, naturalized and cultivated	Cooley, 1899; Furniss and Carolin, 1977; Shour and Schuder, 1987; Liu *et al.* 1989; Ferris, 1920; Turner, 1929; Wood and Van Sickle, 1992; Gwiazdowski *et al.*, 2011; Normark *et al.* 2019
Taxus[2]	1TAXG	yew	Taxaceae	Yes	native	Borchsenius, 1966; as cited by García Morales *et al.*, 2016; Miller and Davidson, 2005;
Taxus brevifolia	TAXBR	Californian yew	Taxaceae	Yes/No	introduced, rarely cultivated	McKenzie, 1956
Torreya	1TOYG	torreya	Taxaceae	Yes	introduced, cultivated	Borchsenius, 1966, as cited by García Morales *et al.*, 2016; Miller and Davidson, 2005
Torreya californica	TOYCA	California nutmeg	Taxaceae	Yes	introduced, cultivated in some areas	Ferris, 1920; McKenzie, 1956; Liu *et al.* 1989
Tsuga	1TSUG	hemlocks	Pinaceae	Yes	introduced, cultivated	Britton, 1922; Nakahara, 1982; Miller and Davidson, 2005
Tsuga canadensis	TSUCA	eastern hemlock	Pinaceae	Yes	introduced, cultivated	Turner, 1929; Kosztarab, 1963; Lambdin and Watson, 1980; Shour and Schuder, 1987; Liu *et al.* 1989; Normark *et al.* 2019
Tsuga caroliniana	TSUCR	Carolina hemlock	Pinaceae	Yes	introduced, cultivated	Rhoades, 1986, as cited by Shour and Schuder, 1987; Liu *et al.* 1989
Tsuga heterophylla	TSUHE	western hemlock-spruce	Pinaceae	Yes	introduced, cultivated	Wood and Van Sickle, 1992 (only occassionally observed)

[1] Ahmed and Miller (2019) listed these plant species when presenting the interceptions of *C. pinifoliae* in Florida, USA. In the same publication there is an additional list of host plants which do not contain these species.
[2] In the host plants reported by Miller and Davidson 2005, all hosts except *Cedrus*, *Juniperus* and *Taxus* present a higher confidence of being host plants because they could be checked by the authors.

Erroneous host records

In Normark *et al*. (2019) *C. pinifoliae* was reported to have been collected from *Arctostaphylos* sp.. However, the record is erroneous and the specimens were collected on needles of *Pinus* sp. (B. Normark, pers. comm.).

ANNEX 7. Presence of *Chionaspis pinifoliae* host plants in the PRA area

Host plants of *C. pinifoliae* occur throughout the PRA area in different environments, either as native or introduced conifer species. This annex presents information on seven host plants of *C. pinifoliae* that are widespread in the PRA area.

Abies alba

From the different *Abies* species growing naturally in Europe, *Abies alba* (silver fir) has the greatest economic and ecological significance (Euforgen, 2021). It is used for wood and as a Christmas tree. In forested areas, *A. alba* is important for maintaining high biodiversity (Euforgen, 2021). In Europe, the distribution of *A. alba* is limited mainly to the mountainous regions of eastern, western, southern and central Europe (Figure 1).

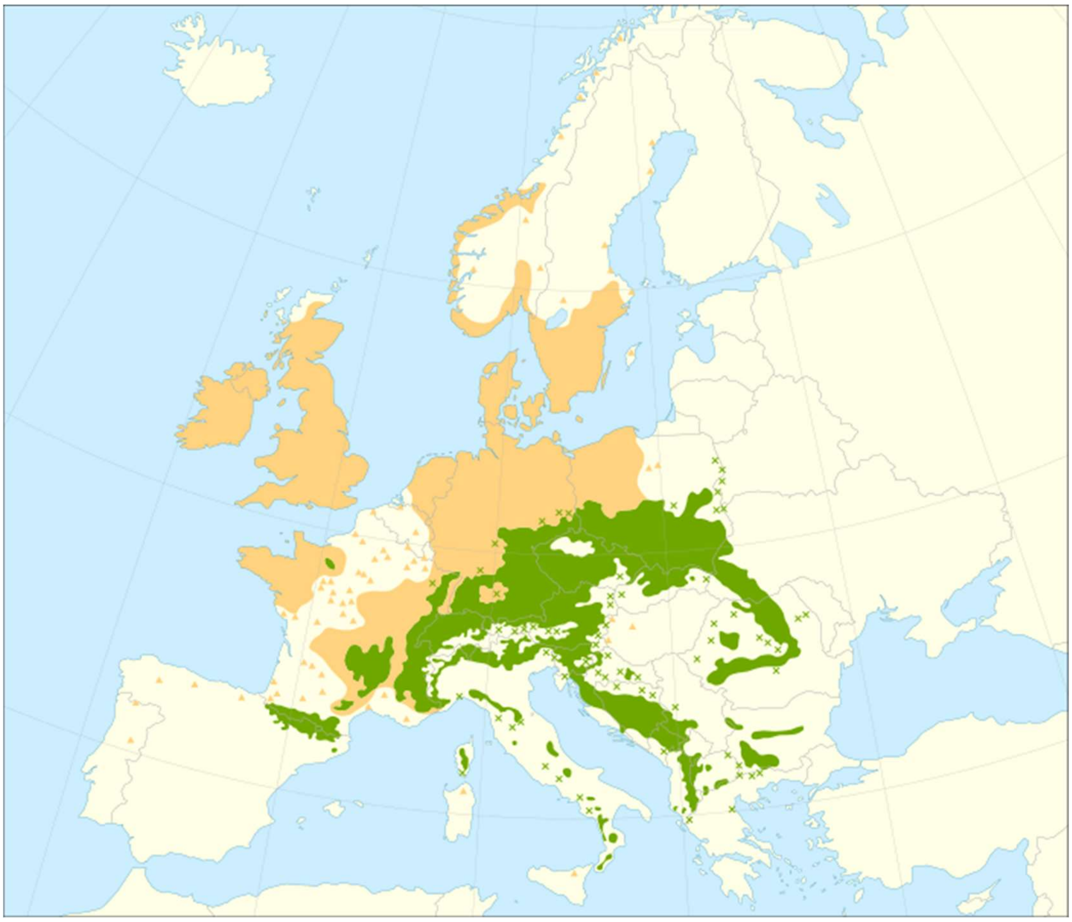

Figure 1. Distribution on *Abies alba* (Caudullo *et al.*, 2017; Euforgen, 2021). Green areas indicate the native range of the species, green crosses isolated populations, orange areas introduced and naturalized populations and orange triangles introduced and naturalized isolated populations.

Picea abies

Picea abies (Norway spruce) is one of the most important tree species in Europe with high ecological importance, especially in northern Europe (Farjon and Filer, 2013; Euforgen, 2021). It is used for wood and as a Christmas tree. The tree is native in northern and central Europe and in eastern Russia (Figure 2). It has also been introduced far outside its native range (Figure 2).

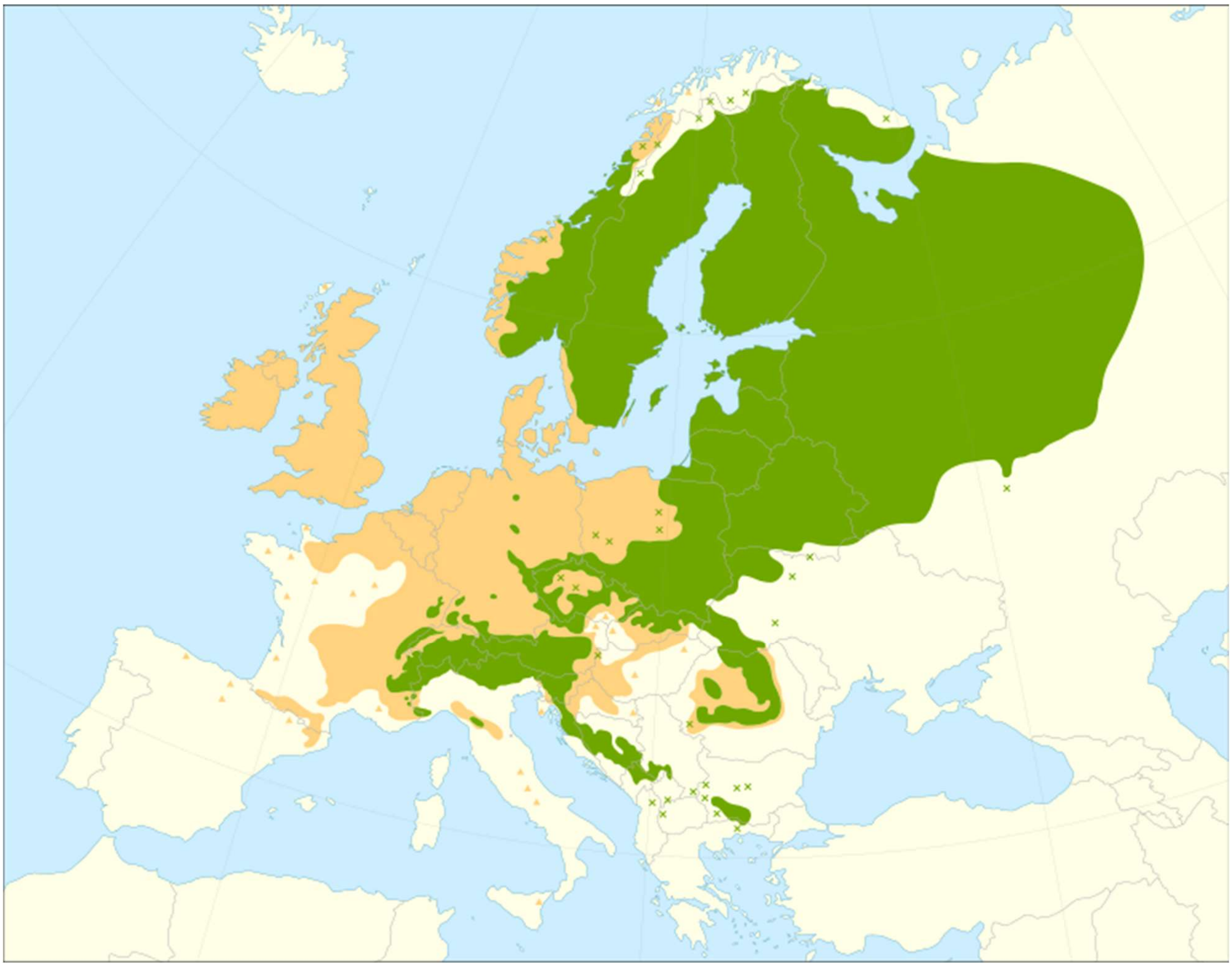

Figure 2. Distribution of *Picea abies* (Caudullo *et al.*, 2017; Euforgen, 2021). Green areas indicate the native range of the species, green crosses isolated populations, orange areas introduced and naturalized populations and orange triangles introduced and naturalized isolated populations.

***Pinus* (*Pinus halepensis, Pinus mugo, Pinus nigra* and *Pinus sylvestris*)**

Pinus halepensis (Aleppo pine) is mainly found in the Mediterranean region (Figure 3) where it is widely distributed. It is mainly a coastal species. It is ecologically significant in southern France and Italy and the most important forest species in North Africa (Euforgen, 2021). The species is also important for afforestation programmes, because it improves water infiltration, prevents soil erosion on dry slopes and serves as windbreaks (Farjon and Filer, 2013; Euforgen, 2021).

Pinus mugo (mountain pine) grows mainly in the mountains of central and eastern Europe (Figure 4). It is important for soil stabilization and its wood is used for constructing small artefacts and as firewood (Farjon and Filer, 2013; Euforgen, 2021).

Pinus nigra (European black pine) has a wide but scattered distribution across Europe and Asia (Figure 5). It is mainly found in mountainous areas and is one of the most economically important native conifers in southern Europe (Euforgen, 2021), with extension into Turkey and some outlying populations in coastal North Africa (Algeria, Morocco), Ukraine and East Black Sea coast. It is used for wood, Christmas trees and as an ornamental. It is also effective for controlling soil erosion and landslides and hence widely used for reforestation (Farjon and Filer, 2013; Euforgen, 2021).

Pinus sylvestris (Scots pine) is found throughout Eurasia (Figure 6), for a distance of 10 000 km (Farjon and Filer, 2013). It is economically important, especially in the northern Europe. It is used for wood and for stabilizing sandy soils and
is also a pioneer species, able to colonize nutrient-poor soils in disturbed areas (Euforgen, 2021).

Figure 3. Distribution of *Pinus halepensis* (Caudullo *et al.*, 2017; Euforgen, 2021). Green areas indicate the native range of the species and green crosses isolated populations.

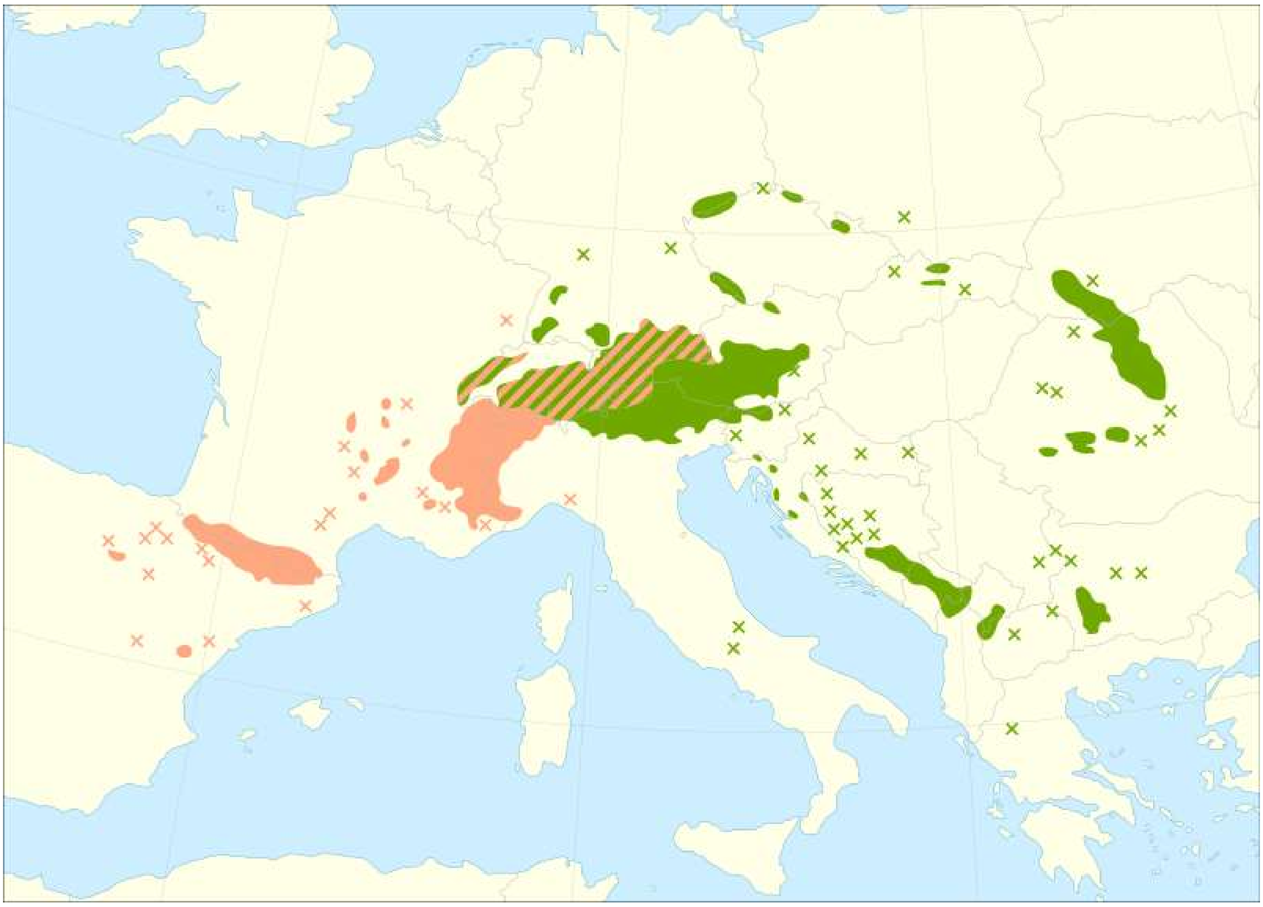

Figure 4. Distribution of *Pinus mugo* (Caudullo *et al.*, 2017; Euforgen, 2021). Green areas indicate the native range of the species, green crosses isolated populations, orange areas introduced and naturalized populations and orange crosses introduced and naturalized isolated populations.

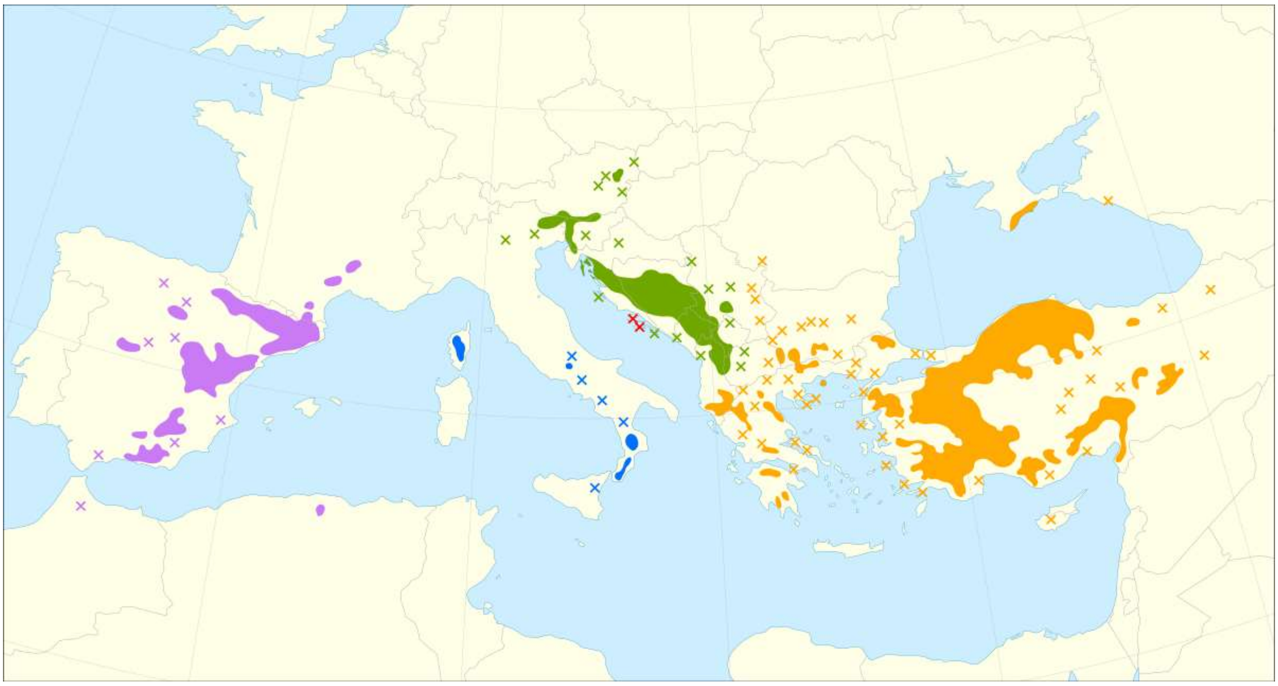

Figure 5. Distribution of *Pinus nigra* (Caudullo *et al.*, 2017; Euforgen, 2021). Different colours indicate different subspecies of *P. nigra*. Areas indicate ranges and crosses isolated populations.

Figure 6. Distribution of *Pinus sylvestris* (Caudullo *et al.*, 2017). Green areas indicate the native range of the species, green crosses isolated populations, orange areas introduced and naturalized populations and orange triangles introduced and naturalized isolated populations.

Pseudotsuga menziesii

Pseudotsuga menziesii (Douglas fir) is a widespread introduced species in many European countries (Euforgen, 2021). It is grown in plantations for wood, as an ornamental and for reforestation (Euforgen, 2021).

ANNEX 8. Trade in the pathway 'host plants for planting'

Table 1. Live forest trees (CN 06029041). Imports by EU countries in 2015–2019. EUROSTAT. Quantities in 100 kg (0 means below 100 kg). Empty cells mean that no trade was reported.

Exporter	Importer	2015	2016	2017	2018	2019
USA	France	0		0		0
	Netherlands	2	51	67	0	
	Finland			0	0	
	United Kingdom		1			
	Total	2	52	67	0	0
Mexico	France	2				
	Total	2				
Total		**4**	**52**	**67**	**0**	**0**

Table 2. Outdoor rooted cuttings and young plants of trees, shrubs and bushes (excl. fruit, nut and forest trees) (CN 06029045). Imports by EU countries in 2015–2019. EUROSTAT. Quantities in 100 kg (0 means below 100 kg). Empty cells mean that no trade was reported.

Exporter	Importer	2015	2016	2017	2018	2019
Canada	Germany		3			0
	Netherlands		0			
	Finland	0	0	0	0	
	Sweden			1		
	United Kingdom	4				
	Total	4	3	1	0	0
USA	Belgium		3	0		
	Germany	125	1	2	5	9
	Ireland			1		
	Spain	2			10	51
	France	7	42	18	12	17
	Italy		1			
	Latvia	1				
	Hungary				3	
	Netherlands	17	14	20	19	127
	Portugal		0		0	0
	Finland	1		0	1	1
	Sweden	0	0		0	
	United Kingdom	88	2	1	9	12
	Total	241	63	42	59	217
Mexico	Netherlands				0	11
	United Kingdom	0				
	Total	0			0	11
Total		**871**	**66**	**43**	**59**	**228**

Table 3. Outdoor trees, shrubs and bushes, incl. their roots (excl. cuttings, slips and young plants, and fruit, nut and forest trees) (CN 06029049). Imports by EU countries in 2015–2019. EUROSTAT. Quantities in 100 kg (0 means below 100 kg). Empty cells mean that no trade was reported.

Exporter	Importer	2015	2016	2017	2018	2019
Canada	Belgium	0				
	Germany	0				
	Total	0				
USA	Germany	89				
	Ireland	0				
	Spain	1				
	France	49				
	Latvia	6				
	Netherlands	2				
	Portugal	2				
	Sweden	47				
	Total	196				
Mexico	Spain	469				
	Portugal	19				
	Total	488				
Total		**684**				

Table 4. Outdoor trees, shrubs and bushes, incl. their roots, with bare roots (excl. cuttings, slips and young plants, and fruit, nut and forest trees) (CN 06029046). Imports by EU countries in 2015–2019. EUROSTAT. Quantities in 100 kg (0 means below 100 kg). Empty cells mean that no trade was reported.

Exporter	Importer	2015	2016	2017	2018	2019
USA	Germany		14		1597	
	Portugal				0	15
	Total		14		1597	15
Total			**14**		**1597**	**15**

Table 5. Conifer and evergreen outdoor trees, shrubs and bushes, incl. their roots (excl. with bare roots, cuttings, slips, young plants and fruit, nut and forest trees) (CN 06029047). Imports by EU countries in 2015–2019. EUROSTAT. Quantities in 100 kg (0 means below 100 kg). Empty cells mean that no trade was reported.

Exporter	Importer	2015	2016	2017	2018	2019
USA	Germany		0			
	Hungary					0
	Netherlands		3094			
	Total		3094			0
Total			**3094**			**0**

ANNEX 9. Annual growing degree days and climate in the current distribution area and in the PRA area.

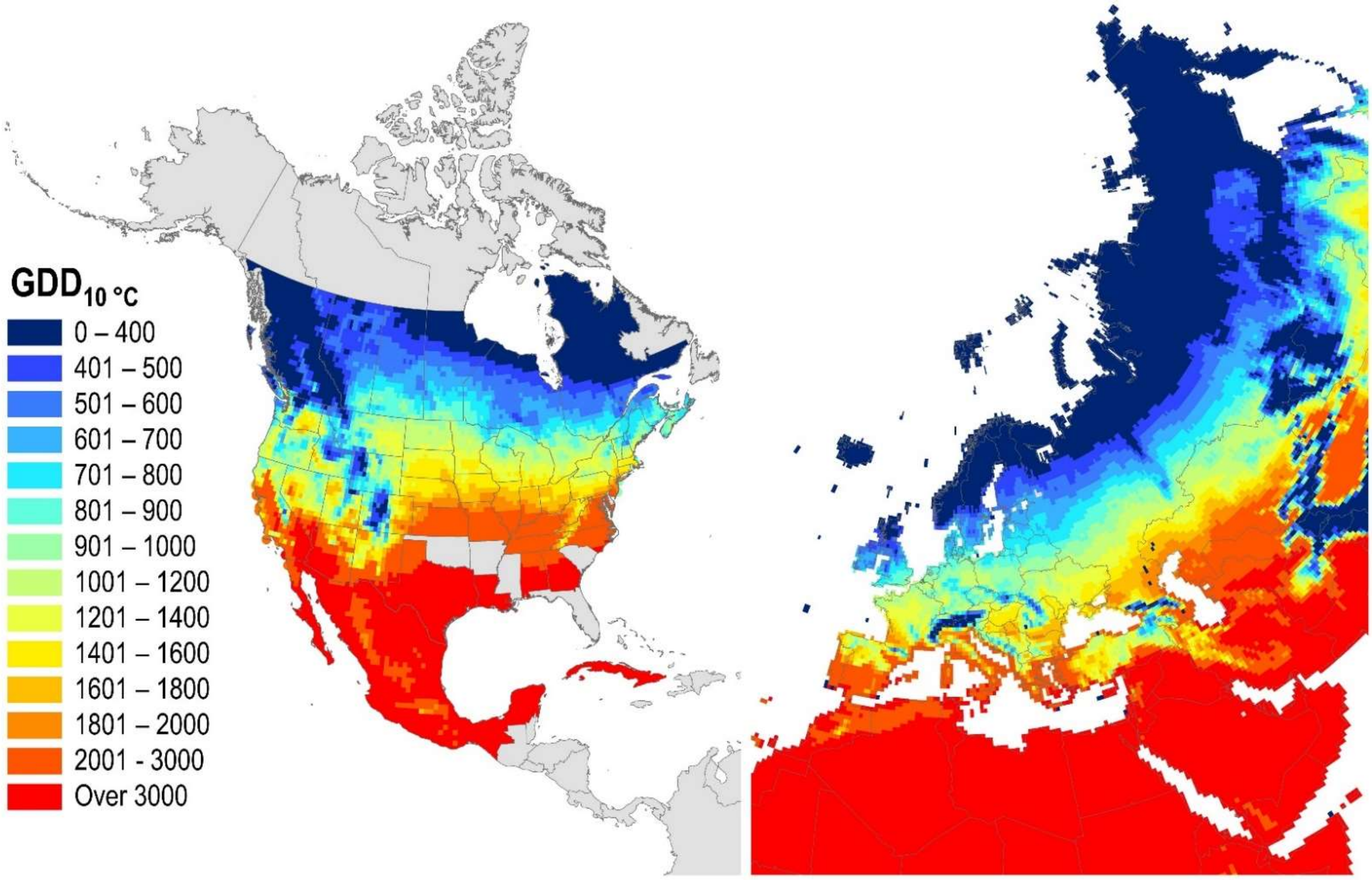

Figure 1. Annual growing degree days ($GDD_{10\,°C}$) calculated using the CLIMEX software (Kriticos *et al.*, 2015) and temperature data for 1981–2010 (Kriticos *et al.*, 2012). For the current distribution range of *C. pinifoliae,* GDD are only shown for the states (USA), provinces (Canada) and countries (Mexico and Cuba,) where the pest is reported to occur.

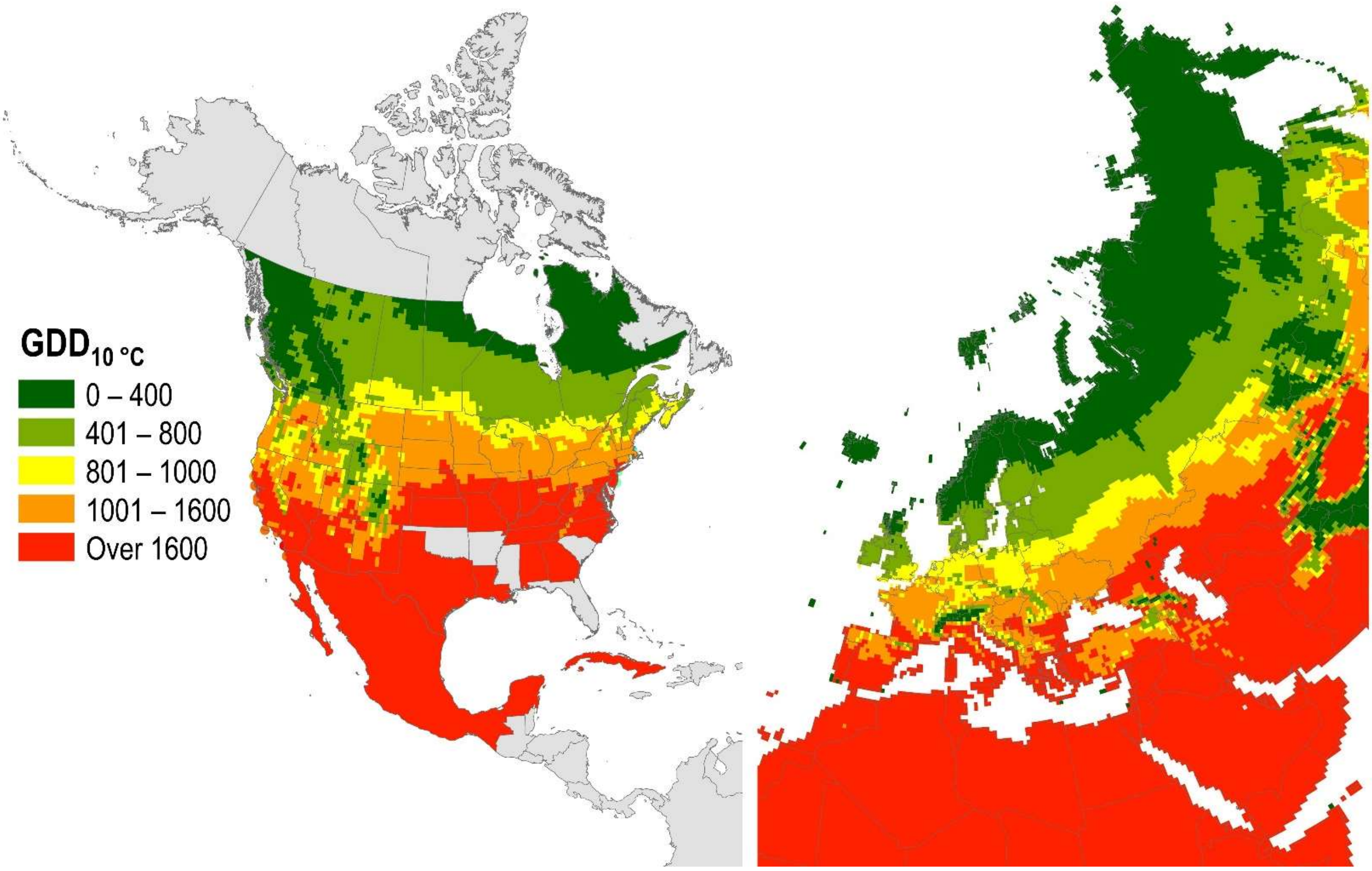

Figure 2. Annual growing degree days ($GDD_{10\,°C}$) calculated using the CLIMEX software (Kriticos *et al.*, 2015) and temperature data for 1981–2010 (Kriticos *et al.*, 2012) and classified based on the estimated GDD needed for one (400–800 GDD) and two (1000–1600 GDD) generations. For the current distribution range of *C. pinifoliae,* GDD are only shown for the states (USA), provinces (Canada) and countries (Mexico and Cuba) where the pest is reported to occur.

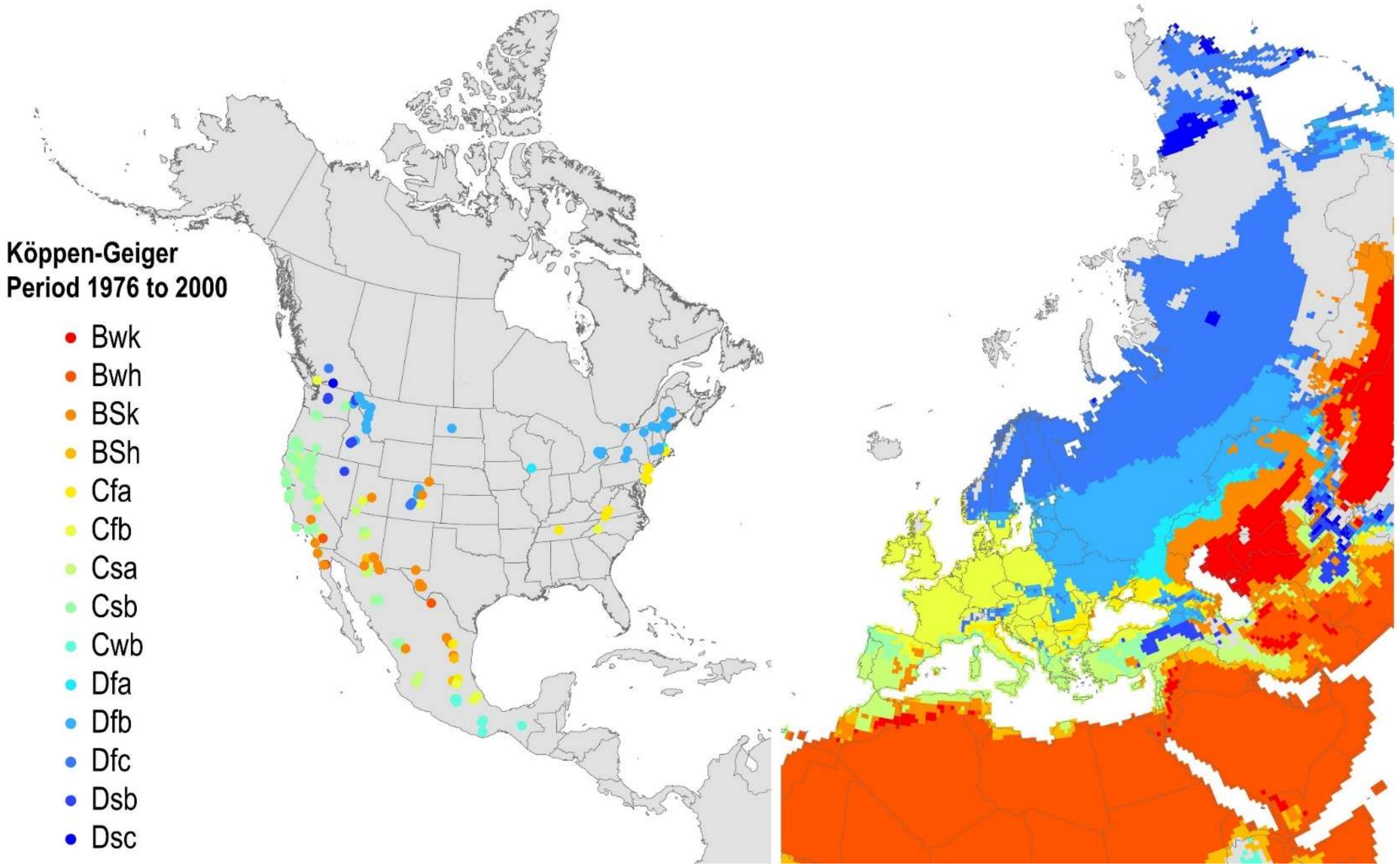

Figure 3. Köppen-Geiger climate classification calculated from observed temperature and precipitation data 1976–2000 by Rubel and Kottek (2010). For the current distribution range of *C. pinifoliae*, climate types are only shown for the observation points of the pest recorded in the GBIF database (GBIF, 2021a). For the PRA area, only the climate types occurring in the observation points of the pest are presented.