

## Indicator 3.1a: Scale and impact of agents and processes affecting forest health and vitality (2024)



This indicator identifies the scale and impact on forest health of a variety of processes and agents, both natural and human-induced. Through the regular collection of this information, significant changes to the health and vitality of forest ecosystems can be monitored and measured.

### Context

Maintenance of forest ecosystem health and vitality while supporting the productive capacity of forests is a key component of sustainable forest management.

### Key points

- The five main introduced vertebrate pests that damage forests are widespread in one or more states and territories: rabbit, feral pig, feral deer, feral goat and feral horse.
- The most damaging insect species in eucalypt plantations are locally native species, except in Western Australia where native *Gonipterus* spp. have spread from eastern Australia.
- Insects damaging sandalwood (*Santalum* spp.) plantations are reported for the first time.
- The area proportion of softwood (*Pinus* spp.) plantations suffering damage from insect pests is low.
- Two introduced pathogens, *Phytophthora cinnamomi* and *Austropuccinia psidii* (myrtle rust), are established in multiple-use public native forests and in native forests in nature conservation reserves in several states and continue to cause damage. Both pathogens are subject to active management.
- Weeds are widespread through Australia's forests, with prickly pear (*Opuntia* spp.) the most widespread and occurring in all states and territories.
- Forests in the Australian Capital Territory and New South Wales have the highest overall proportion of forest area affected by weeds, and Tasmania the lowest.
- Record-breaking heatwave events caused mass tree deaths in large areas of forest, and mass deaths of Vulnerable and Endangered flying foxes, between 2017 and 2021 which was Australia's hottest five-year period in the past 100 years.

### Governance and management of forest health and biosecurity

National arrangements for forest biosecurity continued to be strengthened over the period 2016-21, with the introduction of a National Forest Pest Surveillance Program. Key initiatives of this program include the appointment of a Chief Environmental Biosecurity Officer, and a [National Priority List of Exotic Environmental Pests, Weeds and Diseases](#) which was released in 2021 to support strengthening of environmental biosecurity by identifying significant threats and developing a national approach to addressing them. In addition, a National Forest Biosecurity Coordinator was appointed to coordinate and administer activities for the national program under the guidance of a National Forest Biosecurity Steering Group representing major stakeholders, and active surveillance of high-risk sites by technical experts.

National action plans now underpin management of the most damaging introduced vertebrate predators and herbivores, each of which are established in most Australian states and territories. National coordinators have been appointed for most of the key feral vertebrate pests to facilitate consistent, best-practice landscape-scale management across properties.

Australia's weed policy was updated in 2017 to build on previous work with the Weeds of National Significance and provide better delivery of management actions at the landscape level. This enabled many organisations and groups to make rapid, targeted responses after the Black Summer bushfires in 2019-20, when bushfire recovery funding from the Australian Government assisted the treatment of weeds across 40 thousand hectares of land (DCCEEW 2022). The *National Priority List of Exotic Environmental Pests, Weeds and Diseases* includes 20 potentially invasive weed species in addition to the 24 common existing weeds reported here for forests (Tables 3.1a-4a, b, c).

Systems and procedures for detecting and controlling invasive weeds at an early stage of establishment have been strengthened. Regular surveillance and mapping underpin the detection and management of early weed invasions. For example, since 2017, 19 weed species have been classed as early invaders in the Central Highlands of Victoria, and are the focus of eradication campaigns. All known individuals of four of those 19 weed species have since been eradicated. In Queensland, 37 of 59 high-risk weed species have either been eradicated or are on track for eradication.

### Vertebrate pests impacting forests

Five main introduced vertebrate herbivore pest species (rabbit, feral pig, feral deer, feral goat and feral horse) are known to be widespread in commercial plantations and publicly managed forests in one or more states and territories (Table 3.1a-1). All cause damage to forests, particularly to young regenerating forests and plantations. Use of the term feral refers to unmanaged populations.

Of the five introduced herbivores identified as widespread pests in forests, rabbits (*Oryctolagus cuniculus*) and feral pigs (*Sus scrofa*) are identified as the most widespread across the commercial plantations, forest in nature conservation reserves and other publicly managed native forest (Table 3.1a-1). Feral goats (*Capra hircus*) have been detected in forests in all states and territories, but not in commercial plantations or nature conservation reserves of the Northern Territory. Feral deer (Cervidae species) have been detected in forests in all states and territories except for the Northern Territory. Feral horses (*Equus caballus*) have been detected in forests in all states and territories except for Tasmania.

**Table 3.1a-1: Occurrence of five introduced vertebrate herbivore pests in forest, 2017-21**

| Vertebrate pest species                      |             | Occurrence rating by jurisdiction |     |    |     |    |      |      |    |
|----------------------------------------------|-------------|-----------------------------------|-----|----|-----|----|------|------|----|
| Scientific name                              | Common name | ACT                               | NSW | NT | Qld | SA | Tas. | Vic. | WA |
| <b>Commercial plantations</b>                |             |                                   |     |    |     |    |      |      |    |
| <i>Oryctolagus cuniculus</i>                 | Rabbit      | 4                                 | 4   | 0  | 4   | 4  | 4    | 4    | 4  |
| <i>Sus scrofa</i>                            | Feral pig   | 4                                 | 4   | 4  | 4   | 2  | 1    | 2    | 4  |
| Cervidae                                     | Feral deer  | 3                                 | 4   | 0  | 3   | 3  | 2    | 3    | 3  |
| <i>Capra hircus</i>                          | Feral goat  | 4                                 | 3   | 0  | 1   | 3  | 2    | 2    | 2  |
| <i>Equus caballus</i>                        | Feral horse | 0                                 | 2   | 2  | 2   | 0  | 0    | 1    | 0  |
| <b>Nature conservation reserves</b>          |             |                                   |     |    |     |    |      |      |    |
| <i>Oryctolagus cuniculus</i>                 | Rabbit      | 4                                 | 4   | 2  | 4   | 4  | 2    | 4    | 4  |
| <i>Sus scrofa</i>                            | Feral pig   | 4                                 | 4   | 4  | 4   | 2  | 1    | 3    | 3  |
| Cervidae                                     | Deer        | 4                                 | 3   | 0  | 2   | 2  | 2    | 4    | 2  |
| <i>Capra hircus</i>                          | Feral goat  | 3                                 | 4   | 0  | 2   | 4  | 2    | 4    | 3  |
| <i>Equus caballus</i>                        | Horse       | 2                                 | 2   | 4  | 1   | 1  | 0    | 2    | 3  |
| <b>Other publicly managed native forests</b> |             |                                   |     |    |     |    |      |      |    |
| <i>Oryctolagus cuniculus</i>                 | Rabbit      | 4                                 | 4   | 1  | 4   | 4  | 4    | 4    | 4  |
| <i>Sus scrofa</i>                            | Feral pig   | 4                                 | 4   | 4  | 4   | 2  | 1    | 2    | 3  |
| Cervidae                                     | Feral deer  | 4                                 | 3   | 0  | 2   | 2  | 2    | 4    | 2  |
| <i>Capra hircus</i>                          | Feral goat  | 3                                 | 3   | 1  | 2   | 4  | 2    | 2    | 3  |
| <i>Equus caballus</i>                        | Feral horse | 0                                 | 2   | 4  | 0   | 1  | 0    | 2    | 2  |

Occurrence: 4, present in >50% of forest area; 3, present in >25-50% of forest area; 2, present in >1-25% of forest area; 1, present in >0-1% of forest area; 0, present in 0% of forest area.

Other publicly managed native forests includes native forest on Multiple-use public forest and Other Crown land tenures, see [Indicator 1.1a.ii Forest area by tenure](#) for further information on tenure.

Feral refers to unmanaged populations.

Source: National pest animal mapping, ABARES; *Tenure of Australia's Forests (2018)* (ABARES 2018).

[Click here for a Microsoft Excel workbook of the data for Table 3.1a-1.](#)

During the period from 2017 to 2021:

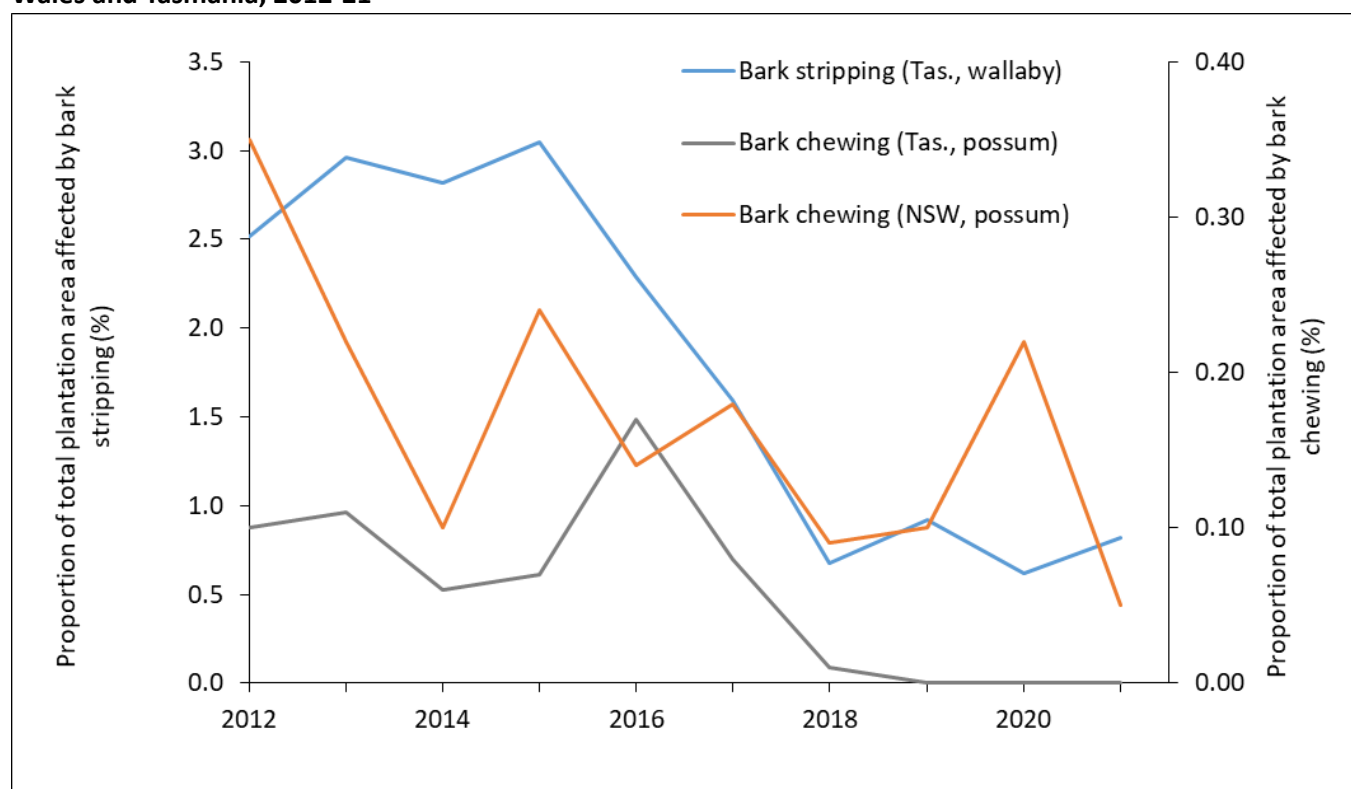
- rabbit populations declined due to new strains of the rabbit haemorrhagic disease virus (Calicivirus)
- feral deer populations increased in Tasmania, Victoria and New South Wales
- feral horse populations increased sharply in alpine areas of Victoria and New South Wales, and are becoming an increasing road issue in South East Queensland coastal plantations.

After the Black Summer fires in 2019-20, there was a sharp increase in control operations against feral animals in New South Wales and Victoria to protect native forest regeneration.

Native vertebrate species continue to impact forests due to:

- browsing by wallabies, possums and pademelons which damage young plantations and regenerating native forests in temperate south-eastern Australia
- bark stripping and chewing of trees by native herbivores in young *Pinus radiata* plantations which is an ongoing problem in Tasmania and New South Wales, although the impact by Bennett's wallaby (*Notamacropus rufogriseus*) and brushtail possum (*Trichosurus vulpecula*) on *Pinus radiata* plantations declined in Tasmania during the period 2017-21 and the area of plantation suffering bark chewing by brushtail possum in New South Wales remained at levels comparable with that recorded in the previous five-year period (Figure 3.1a-1).

**Figure 3.1a-1: Proportions of *Pinus radiata* plantation suffering bark stripping or bark chewing in New South Wales and Tasmania, 2012-21**



Left vertical axis, bark stripping of young (1-6 years-old) trees by wallabies (Tasmania). Right vertical axis, bark chewing of the upper stem of trees in mid-rotation plantations by possums (Tasmania, New South Wales).

Source: State and territory data.

[Click here for a Microsoft Excel workbook of the data for Figure 3.1a-1.](#)

## Insect pests impacting forests

### Insect damage in commercial and sandalwood (*Santalum* spp.) plantations

The most damaging insect species in eucalypt plantations are locally native species, except for *Gonipterus* species that have spread from eastern Australian to become established in Western Australia (Table 3.1a-2a). Control operations against defoliating insects in eucalypt plantations were undertaken in only Tasmania and Western Australia.

The scale and impact of plantation insect pests in New South Wales, Tasmania and Victoria in 2017-21 were mostly unchanged from 2012-16 (23 of the 38 jurisdiction-pest combinations for which scale and impact data are available in both periods, Table 3.1a-2b). In instances where change in scale and impact did occur between these periods, the change was mostly an increase (12 of 38 instances) and more rarely a decrease (3 of 38 instances). Data on change in scale and impact between 2012-16 and 2017-21 for insects damaging sandalwood (*Santalum* spp.) plantations are not available because this is first time data on insects damaging sandalwood have been reported in Indicator 3.1a. A number of species remained relatively localised (restricted in scale), but their impact increased in these areas (for example, psyllids in Tasmania and sawflies in Victoria).

Data on the major insect pests causing damage in both commercial and sandalwood (*Santalum* spp.) plantations include:

- scale and impact of damage to plantations caused by insect pests in 2017-21 (Table 3.1a-2a)

- change in scale and impact of damage to plantations caused by insect pests between 2012-16 and 2017-21 (Table 3.1a-2b)
- extent of control of insect pests in plantations in 2017-21 (Table 3.1a-2c).

**Table 3.1a-2a: Scale and impact of damage to plantations caused by insect pests, 2017-21**

| Insect pest species by plantation type                               |                                  | Scale and impact rating |     |    |     |    |      |      |    |
|----------------------------------------------------------------------|----------------------------------|-------------------------|-----|----|-----|----|------|------|----|
| Scientific name                                                      | Common name                      | ACT                     | NSW | NT | Qld | SA | Tas. | Vic. | WA |
| <b>Eucalypt plantations</b>                                          |                                  |                         |     |    |     |    |      |      |    |
| <i>Anoplognathus</i> spp.                                            | Christmas beetles                | -                       | 1   | -  | -   | 3  | 0    | 2    | 1  |
| <i>Cardiaspina</i> spp. and other Psyllidae                          | Psyllids                         | -                       | 1   | -  | -   | 3  | 1    | 2    | 1  |
| <i>Culama</i> spp. and other Cossidae                                | Cossid moths                     | -                       | 2   | -  | -   | 0  | 0    | 2    | 0  |
| <i>Gonipterus</i> spp.                                               | Eucalypt snout weevil            | -                       | 1   | -  | -   | 3  | 1    | 3    | 4  |
| <i>Heteronyx</i> spp. and other Melolonthinae                        | Swarming scarab & spring beetles | -                       | 0   | -  | -   | 1  | 0    | 1    | 4  |
| <i>Paropsisterna</i> spp. and other Chrysomelidae                    | Leaf beetles                     | -                       | 1   | -  | -   | 3  | 2/4* | 3    | 4  |
| <i>Perga</i> spp. and other Pergidae                                 | Sawflies                         | -                       | 0   | -  | -   | 3  | 0    | 2    | 1  |
| <i>Phoracantha</i> spp.                                              | Longicorn beetles                | -                       | 0   | -  | -   | 3  | 1    | 2    | 0  |
| <i>Mnesampela privata</i>                                            | Autumn gum moth                  | -                       | 0   | -  | -   | 4  | 1    | 2    | 2  |
| <i>Uraba lugens</i>                                                  | Gum leaf skeletoniser            | -                       | 0   | -  | -   | 1  | 1    | 1    | 1  |
| <b>Pine (<i>Pinus</i> spp.) plantations</b>                          |                                  |                         |     |    |     |    |      |      |    |
| <i>Essigella californica</i>                                         | Monterey pine aphid              | -                       | 2   | -  | -   | 3  | 0    | 4    | 4  |
| <i>Ips grandicollis</i> , <i>Hylastes</i> spp., <i>Hylurgus</i> spp. | Bark beetles                     | -                       | 2   | -  | -   | 3  | 1    | 2    | 2  |
| <i>Sirex noctilio</i>                                                | Sirex wood wasp                  | -                       | 2   | -  | 1   | 1  | 1    | 2    | 0  |
| <b>Sandalwood (<i>Santalum</i> spp.) plantations</b>                 |                                  |                         |     |    |     |    |      |      |    |
| <i>Mastotermes darwiniensis</i>                                      | Giant Northern Termite           | -                       | -   | 4  | -   | -  | -    | -    | 4  |
| <i>Hyposidra janitaria</i> and other Geometridae                     | Looper caterpillars              | -                       | -   | 4  | -   | -  | -    | -    | 4  |
| <i>Nipaecoccus viridis</i> and other Pseudococcidae                  | Mealybugs                        | -                       | -   | 4  | -   | -  | -    | -    | 4  |

-, no data; 0, not detected, no impact; 1, restricted scale, minimal impact; 2, restricted scale, adverse impact; 3, widespread scale, minimal impact; 4, widespread scale, adverse impact.

\* Ratings for public / private plantations differ because public plantations have a concentration of less susceptible older age classes.

No data are available for the Australian Capital Territory.

Source: State and territory data.

[Click here for a Microsoft Excel workbook of the data for Table 3.1a-2a.](#)

**Table 3.1a-2b: Change in scale and impact of damage to plantations caused by insect pests between 2012-16 and 2017-21**

| Insect pest species by plantation type                               |                                  | Change in scale and impact rating, 2012-16 to 2017-21 |     |    |     |    |      |      |    |
|----------------------------------------------------------------------|----------------------------------|-------------------------------------------------------|-----|----|-----|----|------|------|----|
| Scientific name                                                      | Common name                      | ACT                                                   | NSW | NT | Qld | SA | Tas. | Vic. | WA |
| <b>Eucalypt plantations</b>                                          |                                  |                                                       |     |    |     |    |      |      |    |
| <i>Anoplognathus</i> spp.                                            | Christmas beetles                | -                                                     | ↓   | -  | -   | -  | ↔    | ↔    | -  |
| <i>Cardiaspina</i> spp. and other Psyllidae                          | Psyllids                         | -                                                     | ↔   | -  | -   | -  | ↑    | ↔    | -  |
| <i>Culama</i> spp. and other Cossidae                                | Cossid moths                     | -                                                     | ↑   | -  | -   | -  | -    | ↑    | -  |
| <i>Gonipterus</i> spp.                                               | Eucalypt snout weevil            | -                                                     | ↔   | -  | -   | -  | ↔    | ↑    | -  |
| <i>Heteronyx</i> spp. and other Melolonthinae                        | Swarming scarab & spring beetles | -                                                     | ↔   | -  | -   | -  | ↔    | ↔    | -  |
| <i>Paropsisterna</i> spp. and other Chrysomelidae                    | Leaf beetles                     | -                                                     | ↔   | -  | -   | -  | ↔    | ↑    | -  |
| <i>Perga</i> spp. and other Pergidae                                 | Sawflies                         | -                                                     | ↔   | -  | -   | -  | ↔    | ↑    | -  |
| <i>Phoracantha</i> spp.                                              | Longicorn beetles                | -                                                     | ↓   | -  | -   | -  | ↔    | ↑    | -  |
| <i>Mnesampela privata</i>                                            | Autumn gum moth                  | -                                                     | ↔   | -  | -   | -  | ↑    | ↔    | -  |
| <i>Uraba lugens</i>                                                  | Gum leaf skeletoniser            | -                                                     | ↔   | -  | -   | -  | ↔    | ↔    | -  |
| <b>Pine (<i>Pinus</i> spp.) plantations</b>                          |                                  |                                                       |     |    |     |    |      |      |    |
| <i>Essigella californica</i>                                         | Monterey pine aphid              | -                                                     | ↔   | -  | -   | -  | ↓    | ↑    | -  |
| <i>Ips grandicollis</i> , <i>Hylastes</i> spp., <i>Hylurgus</i> spp. | Bark beetles                     | -                                                     | ↑   | -  | -   | -  | ↔    | ↔    | -  |
| <i>Sirex noctilio</i>                                                | Sirex wood wasp                  | -                                                     | ↑   | -  | ↑   | -  | ↔    | ↑    | -  |
| <b>Sandalwood (<i>Santalum</i> spp.) plantations</b>                 |                                  |                                                       |     |    |     |    |      |      |    |
| <i>Mastotermes darwiniensis</i>                                      | Giant Northern Termite           | -                                                     | -   | -  | -   | -  | -    | -    | -  |
| <i>Hyposidra janiaria</i> and other Geometridae                      | Looper caterpillars              | -                                                     | -   | -  | -   | -  | -    | -    | -  |
| <i>Nipaecoccus viridis</i> and other Pseudococcidae                  | Mealybugs                        | -                                                     | -   | -  | -   | -  | -    | -    | -  |

-, no data; ↑, increase; ↓, decrease; ↔, no change.

No data are available for the Australian Capital Territory, Northern Territory, South Australia, and Western Australia.

Source: State and territory data.

[Click here for a Microsoft Excel workbook of the data for Table 3.1a-2b.](#)

**Table 3.1a-2c: Extent of control of insect pests in plantations, 2017-21**

| Insect species by plantation type                                    |                                  | Extent of control |     |    |     |    |      |      |    |
|----------------------------------------------------------------------|----------------------------------|-------------------|-----|----|-----|----|------|------|----|
| Scientific name                                                      | Common name                      | ACT               | NSW | NT | Qld | SA | Tas. | Vic. | WA |
| <b>Eucalypt plantations</b>                                          |                                  |                   |     |    |     |    |      |      |    |
| <i>Anoplognathus</i> spp.                                            | Christmas beetles                | -                 | -   | -  | -   | -  | -    | -    | -  |
| <i>Cardiaspina</i> spp. and other Psyllidae                          | Psyllids                         | -                 | -   | -  | -   | -  | -    | -    | -  |
| <i>Culama</i> spp. and other Cossidae                                | Cossid moths                     | -                 | -   | -  | -   | -  | -    | -    | -  |
| <i>Gonipteris</i> spp.                                               | Eucalypt snout weevil            | -                 | -   | -  | -   | -  | -    | -    | LT |
| <i>Heteronyx</i> spp. and other Melolonthinae                        | Swarming scarab & spring beetles | -                 | -   | -  | -   | -  | -    | -    | WT |
| <i>Paropsisterna</i> spp. and other Chrysomelidae                    | Leaf beetles                     | -                 | -   | -  | -   | -  | WT   | -    | LT |
| <i>Perga</i> spp. and other Pergidae                                 | Sawflies                         | -                 | -   | -  | -   | -  | -    | -    | -  |
| <i>Phoracantha</i> spp.                                              | Longicorn beetles                | -                 | -   | -  | -   | -  | -    | -    | -  |
| <i>Mnesampela privata</i>                                            | Autumn gum moth                  | -                 | -   | -  | -   | -  | -    | LT   | -  |
| <i>Uraba lugens</i>                                                  | Gum leaf skeletoniser            | -                 | -   | -  | -   | -  | -    | -    | -  |
| <b>Pine (<i>Pinus</i> spp.) plantations</b>                          |                                  |                   |     |    |     |    |      |      |    |
| <i>Essigella californica</i>                                         | Monterey pine aphid              | -                 | AH  | -  | -   | -  | -    | LT   | -  |
| <i>Ips grandicollis</i> , <i>Hylastes</i> spp., <i>Hylurgus</i> spp. | Bark beetles                     | -                 | LT  | -  | -   | -  | -    | LT   | -  |
| <i>Sirex noctilio</i>                                                | Sirex wood wasp                  | -                 | WT  | -  | LT  | -  | LT   | WT   | -  |
| <b>Sandalwood (<i>Santalum</i> spp.) plantations</b>                 |                                  |                   |     |    |     |    |      |      |    |
| <i>Mastotermes darwiniensis</i>                                      | Giant Northern Termite           | -                 | -   | WT | -   | -  | -    | -    | WT |
| <i>Hyposidra janaria</i> and other Geometridae                       | Looper caterpillars              | -                 | -   | WT | -   | -  | -    | -    | WT |
| <i>Nipaecoccus viridis</i> and other Pseudococcidae                  | Mealybugs                        | -                 | -   | WT | -   | -  | -    | -    | WT |

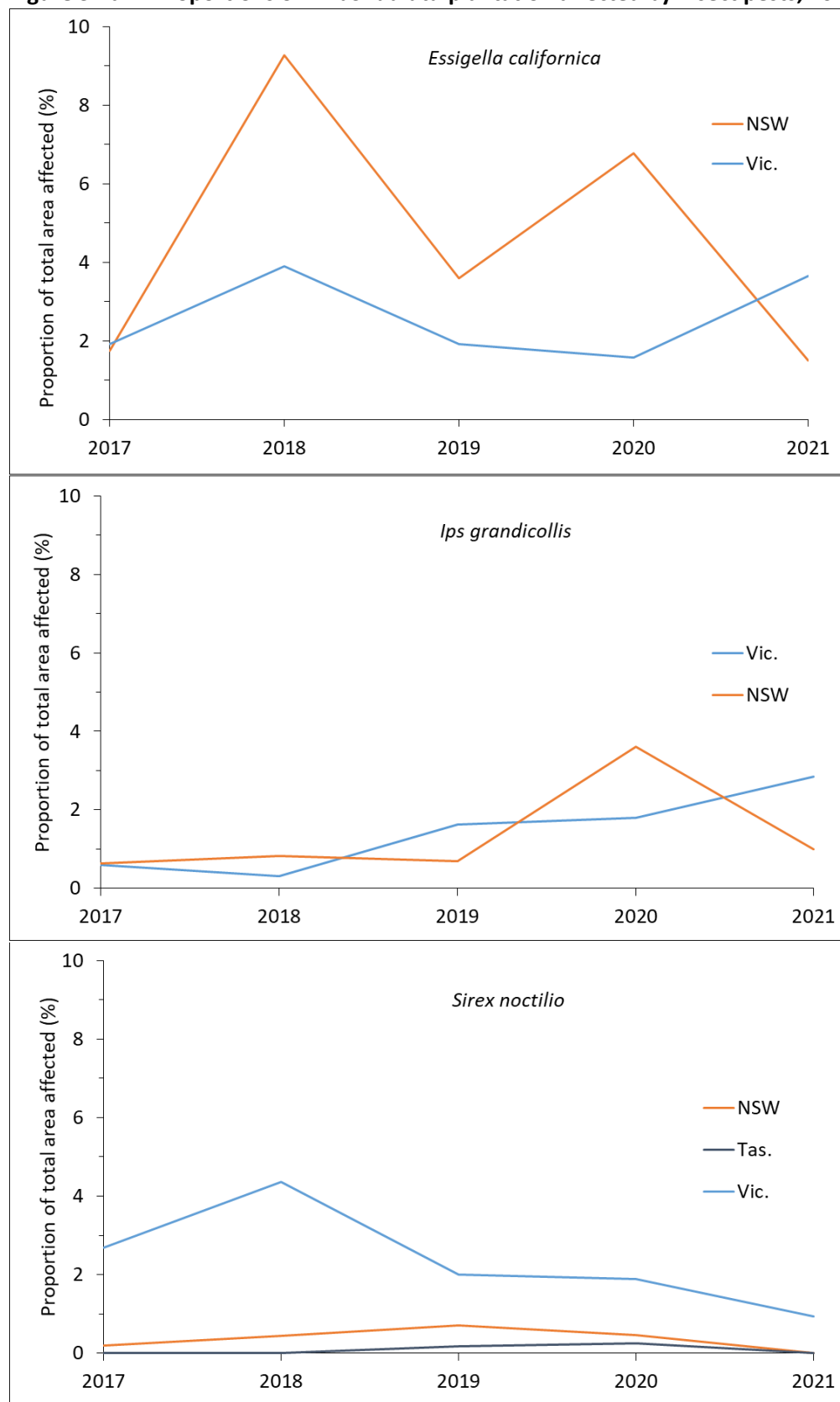
-, none or agent not listed; AH, ad hoc (unplanned); LT, limited targets; WT, widespread targeted; WG, widespread general; E, eradication. No data are available for the Australian Capital Territory and South Australia.

Source: State and territory data.

[Click here for a Microsoft Excel workbook of the data for Table 3.1a-2c.](#)

The area proportion of pine (*Pinus* spp.) plantations suffering damage from the three main groups of introduced insect pests (*Ips grandicollis*, *Essigella californica* and sirex wood wasp—*Sirex noctilio*) was generally low, although there were slight increases in *E. californica* damage in response to drought and in *I. grandicollis* damage in response to fire (Figure 3.1a-2), while in Tasmania, *E. californica* is only detected periodically in low populations in the south of the state, and *I. grandicollis* has not established. There was a slow movement of sirex wood wasp across the New South Wales border into Queensland, and a transient increase in the area of Victorian pine plantations affected by sirex wood wasp in 2018 (Figure 3.1a-2), associated with the replacement of the main biological control agent (the Kamona strain of the nematode *Deladenus siricidicola*) with another established strain of that species.

**Figure 3.1a-2: Proportions of *Pinus radiata* plantation affected by insect pests, 2017-2021**



Data on proportion of forest affected by these insects over time is not available for remaining states and territories.

Source: Formal annual forest health surveillance.

[Click here for a Microsoft Excel workbook of the data for Figure 3.1a-2.](#)

### **Insect damage in native forests**

Most insects causing damage in native forests are native species and are not subject to active monitoring or management programs, except in the case of rare or unusual damaging outbreaks. As such, quantitative data on the scale and impact of insect pests in multiple-use native forests or forests in nature conservation reserves are not available.

Attack by a native longicorn beetle, *Phoracantha mastersi*, was associated with dying snow gum (*Eucalyptus pauciflora* subsp. *niphophila*) trees in alpine areas across the Australian Capital Territory, New South Wales and Victoria. Drought conditions coupled with warming temperatures over the last decade, which favour the beetle, were implicated in the increased beetle activity.

### **Biosecurity responses**

The giant pine scale (*Marchalina ornicate*), which in heavy infestations can defoliate and kill *Pinus* species, remains in the Melbourne area after an unsuccessful eradication campaign in 2014, and is now the focus of research to support a transition to management. The scale was also detected in metropolitan Adelaide in 2014 and again in 2018. A priority of South Australia's management of the pest is to protect forest industries and amenity tree plantings through surveillance and the urgent removal of infested trees. This is currently the best-known option for eliminating giant pine scale and preventing its spread in South Australia.

A national biosecurity response led by Western Australia was triggered when an exotic wood-boring beetle native to south-east Asia—the polyphagous shot-hole borer (*Euwallacea ornicates*)—was detected in Fremantle in winter 2021. The detection was declared an Emergency Plant Pest due to the threat it poses for trees in native and urban forests, as well as horticulture tree crops. Quarantine restrictions have been implemented with removal of infested trees and gathering information necessary to determine the feasibility of eradication is underway. As of October 2024, containment measures were ongoing.

## **Pathogens impacting forests**

Pathogens such as fungi, viruses, bacteria and worms, continue to impact native forests and commercial plantations, especially via the roots and leaves or needles of trees which can affect a tree's nutrient transport system. Of the pathogens for which data on scale (extent), impact and control measures are available, the following were observed:

- in 5 instances pathogens declined in scale and impact
- in 29 instances pathogens had no change in their scale and impact
- in 22 instances pathogens increased in scale and impact.

Data on the major pathogens causing damage in commercial plantations, in multiple-use public native forests and in native forests in nature conservation reserves include:

- scale and impact in the period 2017-21 (Table 3.1a-3a)
- change in scale and impact of damage between 2012-16 and 2017-21 (Table 3.1a-3b) and
- extent of control programs for pathogens in the period 2017-21 (Table 3.1a-3c).

**Table 3.1a-3a: Scale and impact of damage caused by pathogens in plantations, in multiple-use public native forests and in native forests in nature conservation reserves, 2017-21**

| Pathogen                                               | Scale and impact rating |     |     |            |     |     |            |     |     |            |     |     |            |     |     |
|--------------------------------------------------------|-------------------------|-----|-----|------------|-----|-----|------------|-----|-----|------------|-----|-----|------------|-----|-----|
|                                                        | NSW                     |     |     | SA         |     |     | Tas.       |     |     | Vic.       |     |     | WA         |     |     |
|                                                        | Plantation              | MUF | NCR | Plantation | MUF | NCR | Plantation | MUF | NCR | Plantation | MUF | NCR | Plantation | MUF | NCR |
| <i>Armillaria luteobubalina</i><br>Armillaria root rot | 1                       | -   | -   | 0          | -   | -   | 1          | -   | -   | 0          | 3   | 3   | -          | 3   | 3   |
| <i>Austropuccinia psidii</i><br>Myrtle rust            | 1                       | 1   | 2   | 0          | -   | -   | 0          | 0   | 0   | 0          | 1   | 0   | 0          | 0   | 0   |
| <i>Botryosphaeria</i> spp.<br>Canker                   | 1                       | -   | -   | 1          | -   | -   | 1          | -   | -   | 2          | 0   | 0   | 1          | -   | -   |
| <i>Chalara australis</i><br>Myrtle wilt                | -                       | -   | 0   | -          | -   | -   | -          | 3   | 3   | -          | 3   | 1   | -          | -   | -   |
| <i>Holocryphia eucalypti</i><br>Canker                 | -                       | -   | -   | 0          | -   | -   | 1          | -   | -   | 0          | 1   | 0   | 1          | -   | -   |
| <i>Phytophthora cinnamomi</i><br>Root rot              | 2                       | -   | -   | 0          | -   | -   | 2          | 2   | 2   | 2          | 4   | 4   | 2          | 4   | 4   |
| <i>Quambalaria</i> spp.<br>Shoot blight                | 1                       | 1   | -   | 0          | -   | -   | 0          | -   | -   | 0          | 1   | 1   | -          | 3   | 3   |
| <i>Teratosphaeria</i> spp.<br>Leaf disease             | 1                       | 1   | -   | 2          | -   | -   | 1          | -   | -   | 2          | 2   | 1   | 3          | -   | -   |
| <i>Dothistroma septosporum</i><br>Needle blight        | 2                       | -   | -   | 0          | -   | -   | 1          | -   | -   | 2          | -   | -   | 0          | -   | -   |
| <i>Cyclaneusma minus</i><br>Spring needle cast         | 2                       | -   | -   | 3          | -   | -   | 3          | -   | -   | 3          | -   | -   | 3          | -   | -   |
| <i>Diplodia sapinea</i><br>Diplodia canker             | 2                       | -   | -   | 3          | -   | -   | 2          | -   | -   | 2          | -   | -   | 2          | -   | -   |

Plantation, commercial plantations; MUF, multiple-use public native forests; NCR, native forest in nature conservation reserves.

-, none or agent not listed; 0, Not detected, no impact; 1, Restricted scale, minimal impact; 2, Restricted scale, adverse impact; 3, Widespread scale, minimal impact; 4, Widespread scale, adverse impact.

No data were available for the Australian Capital Territory, Northern Territory, and Queensland.

Source: State and territory data.

[Click here for a Microsoft Excel workbook of the data for Table 3.1a-3a.](#)

**Table 3.1a-3b: Change in scale and impact of damage caused by pathogens in plantations, in multiple-use public native forests and in native forests in nature conservation reserves between 2012-16 and 2017-21**

| Pathogen                                               | Change in scale and impact rating, 2012-16 and 2017-21 |     |     |            |     |     |            |     |     |            |     |     |            |     |     |
|--------------------------------------------------------|--------------------------------------------------------|-----|-----|------------|-----|-----|------------|-----|-----|------------|-----|-----|------------|-----|-----|
|                                                        | NSW                                                    |     |     | SA         |     |     | Tas.       |     |     | Vic.       |     |     | WA         |     |     |
|                                                        | Plantation                                             | MUF | NCR | Plantation | MUF | NCR | Plantation | MUF | NCR | Plantation | MUF | NCR | Plantation | MUF | NCR |
| <i>Armillaria luteobubalina</i><br>Armillaria root rot | ↔                                                      | -   | -   | -          | -   | -   | ↔          | -   | -   | ↔          | -   | -   | -          | -   | -   |
| <i>Austropuccinia psidii</i><br>Myrtle rust            | ↔                                                      | ↔   | ↑   | -          | -   | -   | ↔          | ↔   | ↔   | ↔          | ↔   | ↔   | ↔          | ↔   | ↔   |
| <i>Botryosphaeria</i> spp.<br>Canker                   | ↑                                                      | -   | -   | -          | -   | -   | ↑          | -   | -   | -          | ↓   | ↓   | -          | -   | -   |
| <i>Chalara australis</i><br>Myrtle wilt                | -                                                      | -   | -   | -          | -   | -   | -          | -   | ↑   | -          | ↑   | ↓   | -          | -   | -   |
| <i>Holocryphia eucalypti</i><br>Canker                 | -                                                      | -   | -   | -          | -   | -   | ↔          | -   | -   | ↔          | ↑   | ↔   | -          | -   | -   |
| <i>Phytophthora cinnamomi</i><br>Root rot              | -                                                      | -   | -   | -          | -   | -   | -          | -   | -   | -          | -   | -   | -          | -   | -   |
| <i>Quambalaria</i> spp.<br>Shoot blight                | ↔                                                      | -   | -   | -          | -   | -   | ↔          | -   | -   | ↔          | ↑   | ↑   | -          | -   | -   |
| <i>Teratosphaeria</i> spp.<br>Leaf disease             | ↔                                                      | ↔   | -   | -          | -   | -   | ↓          | -   | -   | ↔          | ↑   | ↔   | -          | -   | -   |
| <i>Dothistroma septosporum</i><br>Needle blight        | ↑                                                      | -   | -   | -          | -   | -   | ↔          | -   | -   | ↔          | -   | -   | -          | -   | -   |
| <i>Cyclaneusma minus</i><br>Spring needle cast         | ↔                                                      | -   | -   | -          | -   | -   | ↑          | -   | -   | ↑          | -   | -   | -          | -   | -   |
| <i>Diplodia sapinea</i><br>Diplodia canker             | ↔                                                      | -   | -   | -          | -   | -   | ↑          | -   | -   | ↔          | -   | -   | -          | -   | -   |

Plantation, commercial plantations; MUF, multiple-use public native forests; NCR, native forests in nature conservation reserves.

-, none or agent not listed; ↔ no change; ↓ decrease; ↑ increase.

No data are available for the Australian Capital Territory, Northern Territory, and Queensland.

Source: State and territory data.

[Click here for a Microsoft Excel workbook of the data for Table 3.1a-3b.](#)

**Table 3.1a-3c: Extent of control programs for pathogens in plantations, in multiple-use public native forests and in native forests in nature conservation reserves, 2017-21**

| Pathogen                                               | Extent of control programs |     |     |            |     |     |            |     |     |            |     |     |            |     |     |
|--------------------------------------------------------|----------------------------|-----|-----|------------|-----|-----|------------|-----|-----|------------|-----|-----|------------|-----|-----|
|                                                        | NSW                        |     |     | SA         |     |     | Tas.       |     |     | Vic.       |     |     | WA         |     |     |
|                                                        | Plantation                 | MUF | NCR | Plantation | MUF | NCR | Plantation | MUF | NCR | Plantation | MUF | NCR | Plantation | MUF | NCR |
| <i>Armillaria luteobubalina</i><br>Armillaria root rot | -                          | -   | -   | -          | -   | -   | -          | -   | -   | -          | AH  | AH  | -          | LT  | -   |
| <i>Austropuccinia psidii</i><br>Myrtle rust            | -                          | -   | LT  | -          | -   | -   | -          | -   | -   | -          | -   | -   | -          | LT  | LT  |
| <i>Botryosphaeria</i> spp.<br>Canker                   | -                          | -   | -   | -          | -   | -   | -          | -   | -   | LT         | -   | -   | -          | -   | -   |
| <i>Chalara australis</i><br>Myrtle wilt                | -                          | -   | -   | -          | -   | -   | -          | LT  | LT  | -          | LT  | AH  | -          | -   | -   |
| <i>Holocryphia eucalypti</i><br>Canker                 | -                          | -   | -   | -          | -   | -   | -          | -   | -   | -          | -   | -   | -          | -   | -   |
| <i>Phytophthora cinnamomi</i><br>Root rot              | -                          | -   | -   | -          | -   | -   | WT         | WG  | WG  | LT         | WG  | WG  | AH         | WG  | WG  |
| <i>Quambalaria</i> spp.<br>Shoot blight                | -                          | -   | -   | -          | -   | -   | -          | -   | -   | -          | -   | -   | -          | -   | -   |
| <i>Teratosphaeria</i> spp.<br>Leaf disease             | -                          | -   | -   | -          | -   | -   | -          | -   | -   | -          | -   | -   | AH         | -   | -   |
| <i>Dothistroma septosporum</i><br>Needle blight        | LT                         | -   | -   | -          | -   | -   | -          | -   | -   | LT         | -   | -   | -          | -   | -   |
| <i>Cyclaneusma minus</i><br>Spring needle cast         | -                          | -   | -   | -          | -   | -   | WT         | -   | -   | AH         | -   | -   | -          | -   | -   |
| <i>Diplodia sapinea</i><br>Diplodia canker             | -                          | -   | -   | LT         | -   | -   | -          | -   | -   | LT         | -   | -   | -          | -   | -   |

Plantation, commercial plantations; MUF, multiple-use public native forests; NCR, native forest in nature conservation reserves.

-, none or agent not listed; AH, ad hoc (unplanned); LT, Limited targets; WT, Widespread targeted; WG, Widespread general; E, Eradication.

No data were available for the Australian Capital Territory, Northern Territory, and Queensland.

Source: State and territory data.

[Click here for a Microsoft Excel workbook of the data for Table 3.1a-3c.](#)

### Pathogen damage in native forests

Two introduced pathogens, *Phytophthora* dieback (*Phytophthora cinnamomi*) and myrtle rust (*Austropuccinia psidii*), are established and cause damage in multiple-use public native forests and native forests in nature conservation reserves in several states, and are subject to active management.

There are two *Phytophthora* species known to impact forests in Australia. *P. cinnamomi* is the most damaging species, particularly in south-west Western Australia where 15% of the forests are infested. The more localised *P. multivora* was associated with dieback and mortality of bunya pine (*Araucaria bidwillii*) in the Bunya Mountains National Park in Queensland. Damage by *P. multivora* intensified between 2017 and 2020 when drought conditions developed after a period of higher-than-normal rainfall, adding water stress to disease stressed plants.

Myrtle rust continues to cause severe damage to Myrtaceae plant species in subtropical wet sclerophyll and rainforest communities in New South Wales and Queensland.

- Three species of Myrtaceae (*Rhodamnia rubescens*, *Rhodomyrtus psidioides* and *Lenwebbia* sp. “Main Range”) have been listed as Critically Endangered under both national and state legislation because their wild populations have declined largely due to myrtle rust; conservation measures in areas free of myrtle rust are underway.

- A further sixteen Myrtaceae species are at risk of extinction in the wild.

*Armillaria luteobubalina* and *Chalara australis* are the only two native pathogens that cause damage sufficient to warrant periodic management in multiple-use native forests and native forests in nature conservation reserves.

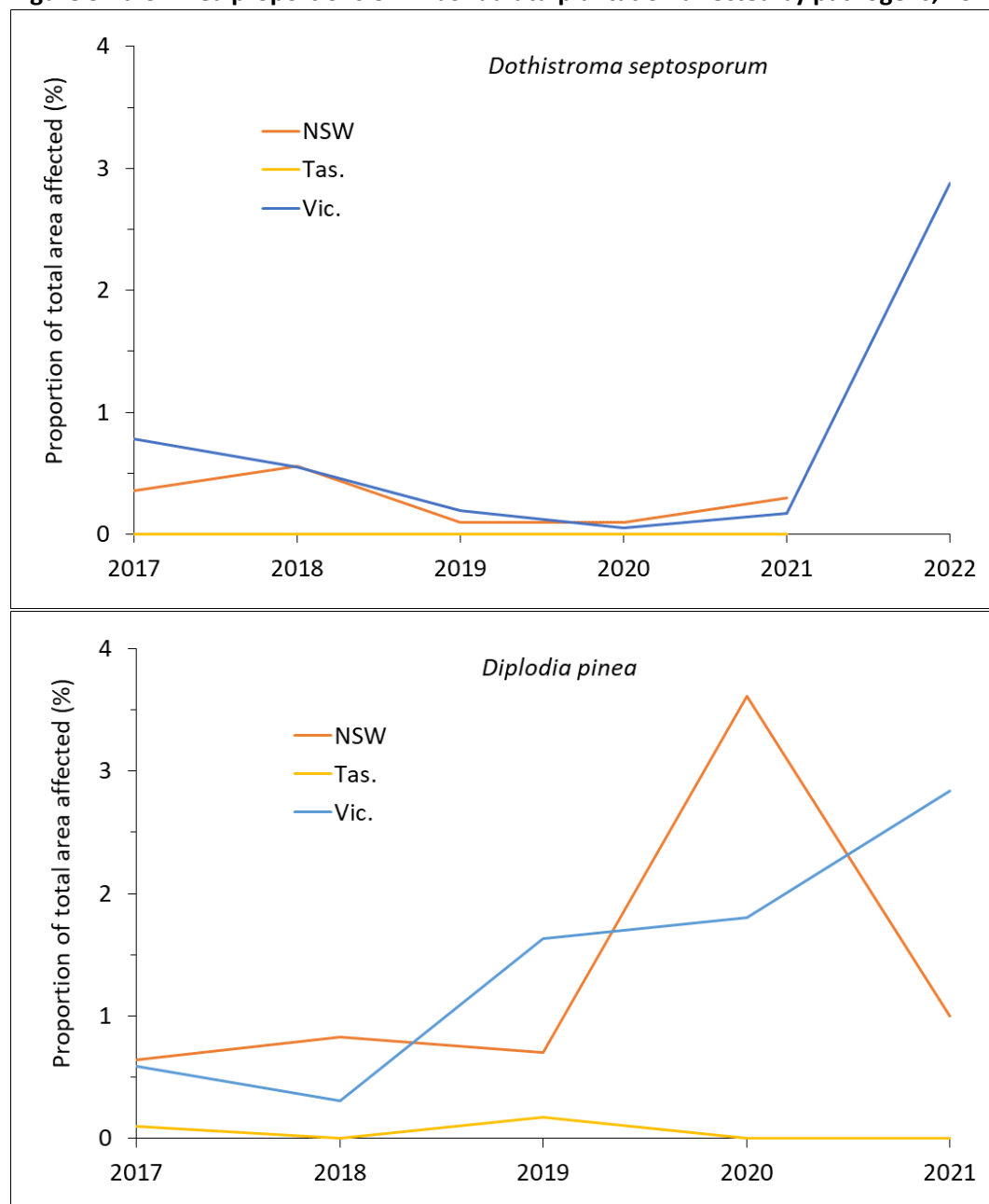
*Armillaria luteobubalina* causes root rot in eucalypt species, and *Chalara australis* causes mortality in myrtle beech tree (*Nothofagus cunninghamii*).

#### **Pathogen damage in commercial plantations**

The needle-infecting pathogen *Dothistroma septosporum*, which affects *Pinus radiata*, was constrained in the dry conditions occurring in much of Australia between 2017 and 2020, resulting in a low proportion of *P. radiata* plantations experiencing defoliation (Figure 3.1a-3). However, above-average rainfall in 2021 led to a sharp increase in defoliation due to this pathogen in Victoria.

In contrast, the dry conditions between 2017 and 2020 favoured *Diplodia pinea*, resulting in a sharp increase in infection (known as ‘top-death’) of *P. radiata* plantations in Victoria and New South Wales (Figure 3.1a-3). The portion of area in New South Wales impacted subsequently reduced because of the wet seasons that followed in 2021, while in Victoria, a combination of alternating wet and dry periods has resulted in continuing impact.

**Figure 3.1a-3: Area proportions of *Pinus radiata* plantation affected by pathogens, 2017-2021**



No areas were affected by *Dothistroma septosporum* in Tasmania.

Source: Formal annual forest health surveillance.

[Click here for a Microsoft Excel workbook of the data for Figure 3.1a-3.](#)

## Weeds impacting forests

Around 3,500 introduced plant species, many of which are considered weeds, are known in Australia (Martín-Forés et al. 2023). Of these, the 24 weeds most reported by states and territories in [Australia's State of the Forests Report 2018](#) were analysed against three forest classes (commercial plantations, multiple-use public native forests and native forest in nature conservation reserves) (Tables 3.1a-4a, b, c) (see [Supporting information for Indicator 3.1a](#) for methods).

The most widespread weed is prickly pear (*Opuntia* spp.), which is the only weed of the 24 reported that occur in forests in all states and territories. Thirteen of the 24 weed species occur in forests in all but one state or territory, including brambles (*Rubus* spp.) and Patterson's curse (*Echium plantagineum*).

The Northern Territory has the lowest number of the 24 weed species present in forests (9), while New South Wales has the most (22). Forests in the Australian Capital Territory and New South Wales have the highest overall occurrence of weeds by area, and the Northern Territory and Tasmania has the lowest.

**Table 3.1a-4a: Occurrence of 24 introduced weed species in commercial plantations, 2017-21**

| Weed species                       |                       | Occurrence in commercial plantations |     |    |     |    |      |      |    |
|------------------------------------|-----------------------|--------------------------------------|-----|----|-----|----|------|------|----|
| Scientific name                    | Common name           | ACT                                  | NSW | NT | Qld | SA | Tas. | Vic. | WA |
| <i>Andropogon gayanus</i>          | Gamba grass           | 0                                    | 0   | 3  | 1   | 0  | 0    | 0    | 0  |
| <i>Asparagus asparagoides</i>      | Bridal creeper        | 2                                    | 2   | 0  | 2   | 4  | 1    | 3    | 2  |
| <i>Baccharis halimifolia</i>       | Groundsel bush        | 0                                    | 2   | 0  | 3   | 0  | 0    | 0    | 0  |
| <i>Cenchrus pedicellatus</i>       | Annual mission grass  | 0                                    | 0   | 4  | 1   | 0  | 0    | 0    | 1  |
| <i>Chrysanthemoides monilifera</i> | Boneseed & bitou bush | 2                                    | 0   | 0  | 1   | 3  | 2    | 2    | 2  |
| <i>Cytisus scoparius</i>           | Scotch broom          | 4                                    | 2   | 0  | 0   | 2  | 2    | 2    | 0  |
| <i>Echium plantagineum</i>         | Patterson's curse     | 4                                    | 3   | 0  | 2   | 3  | 2    | 4    | 2  |
| <i>Genista monspessulana</i>       | Cape/Montpelier broom | 4                                    | 2   | 0  | 0   | 3  | 2    | 3    | 2  |
| <i>Hyparrhenia hirta</i>           | Coolatai grass        | 3                                    | 2   | 0  | 2   | 1  | 0    | 1    | 2  |
| <i>Hypericum perforatum</i>        | St John's wort        | 4                                    | 4   | 0  | 1   | 2  | 2    | 2    | 2  |
| <i>Lantana camara</i>              | Lantana               | 2                                    | 2   | 2  | 4   | 1  | 0    | 1    | 1  |
| <i>Leucaena leucocephala</i>       | Leucaena/coffee bush  | 2                                    | 1   | 2  | 2   | 0  | 0    | 0    | 1  |
| <i>Lycium ferocissimum</i>         | African boxthorn      | 4                                    | 2   | 0  | 1   | 3  | 2    | 2    | 1  |
| <i>Nassella trichotoma</i>         | Serrated tussock      | 4                                    | 2   | 0  | 0   | 0  | 1    | 2    | 0  |
| <i>Opuntia</i> spp.                | Prickly pear          | 4                                    | 2   | 0  | 2   | 2  | 1    | 2    | 2  |
| <i>Pinus</i> spp.                  | Pine                  | 2                                    | 2   | 0  | 2   | 3  | 0    | 2    | 2  |
| <i>Rosa rubiginosa</i>             | Sweet briar           | 4                                    | 4   | 0  | 1   | 3  | 2    | 4    | 1  |
| <i>Rubus</i> spp.                  | Brambles              | 4                                    | 4   | 0  | 2   | 4  | 3    | 3    | 2  |
| <i>Salix</i> spp.                  | Willow                | 3                                    | 2   | 0  | 1   | 2  | 1    | 2    | 2  |
| <i>Sporobolus</i> spp.             | Rat's tail grass      | 2                                    | 2   | 3  | 4   | 4  | 0    | 3    | 2  |
| <i>Themeda quadrivalvis</i>        | Grader grass          | 0                                    | 1   | 2  | 2   | 0  | 0    | 0    | 0  |
| <i>Ulex europaeus</i>              | Gorse                 | 4                                    | 2   | 0  | 0   | 2  | 2    | 4    | 1  |
| <i>Urochloa mutica</i>             | Para grass            | 0                                    | 1   | 2  | 2   | 0  | 0    | 0    | 0  |
| <i>Xanthium occidentale</i>        | Noogoora burr         | 3                                    | 2   | 2  | 2   | 0  | 0    | 0    | 2  |

Occurrence: 4, present in >50% of forest area; 3, present in >25-50% of forest area; 2, present in >1-25% of forest area; 1, present in >0-1% of forest area; 0, present in 0% of forest area.

Source: Australasian Virtual Herbarium; Tenure of Australia's Forests (2018) (ABARES 2018).

[Click here for a Microsoft Excel workbook of the data for Table 3.1a-4a.](#)

**Table 3.1a-4b: Occurrence of 24 introduced weed species in multiple-use public native forest, 2017-21**

| Weed species                       |                       | Occurrence in multiple-use public native forest |     |    |     |    |      |      |    |
|------------------------------------|-----------------------|-------------------------------------------------|-----|----|-----|----|------|------|----|
| Scientific name                    | Common name           | ACT                                             | NSW | NT | Qld | SA | Tas. | Vic. | WA |
| <i>Andropogon gayanus</i>          | Gamba grass           | 0                                               | 0   | -  | 1   | 0  | 0    | 0    | 1  |
| <i>Asparagus asparagoides</i>      | Bridal creeper        | 2                                               | 2   | -  | 1   | 4  | 1    | 2    | 2  |
| <i>Baccharis halimifolia</i>       | Groundsel bush        | 0                                               | 2   | -  | 2   | 0  | 0    | 0    | 0  |
| <i>Cenchrus pedicellatus</i>       | Annual mission grass  | 0                                               | 0   | -  | 1   | 0  | 0    | 0    | 2  |
| <i>Chrysanthemoides monilifera</i> | Boneseed & bitou bush | 2                                               | 2   | -  | 1   | 3  | 2    | 2    | 2  |
| <i>Cytisus scoparius</i>           | Scotch broom          | 4                                               | 2   | -  | 1   | 3  | 2    | 2    | 0  |
| <i>Echium plantagineum</i>         | Patterson's curse     | 4                                               | 3   | -  | 1   | 4  | 1    | 3    | 2  |
| <i>Genista monspessulana</i>       | Cape/Montpelier broom | 4                                               | 2   | -  | 0   | 4  | 2    | 2    | 2  |
| <i>Hyparrhenia hirta</i>           | Coolatai grass        | 4                                               | 2   | -  | 2   | 2  | 0    | 1    | 2  |
| <i>Hypericum perforatum</i>        | St John's wort        | 4                                               | 2   | -  | 1   | 3  | 2    | 2    | 2  |
| <i>Lantana camara</i>              | Lantana               | 2                                               | 3   | -  | 2   | 1  | 0    | 0    | 1  |
| <i>Leucaena leucocephala</i>       | Leucaena/coffee bush  | 2                                               | 1   | -  | 2   | 0  | 0    | 0    | 0  |
| <i>Lycium ferocissimum</i>         | African boxthorn      | 3                                               | 2   | -  | 2   | 4  | 2    | 2    | 0  |
| <i>Nassella trichotoma</i>         | Serrated tussock      | 4                                               | 2   | -  | 0   | 0  | 1    | 2    | 0  |
| <i>Opuntia</i> spp.                | Prickly pear          | 4                                               | 2   | -  | 3   | 2  | 1    | 2    | 2  |
| <i>Pinus</i> spp.                  | Pine                  | 2                                               | 2   | -  | 2   | 3  | 1    | 2    | 2  |
| <i>Rosa rubiginosa</i>             | Sweet briar           | 4                                               | 3   | -  | 1   | 3  | 2    | 3    | 1  |
| <i>Rubus</i> spp.                  | Brambles              | 4                                               | 4   | -  | 2   | 4  | 3    | 3    | 3  |
| <i>Salix</i> spp.                  | Willow                | 2                                               | 2   | -  | 1   | 2  | 2    | 2    | 2  |
| <i>Sporobolus</i> spp.             | Rat's tail grass      | 2                                               | 3   | -  | 2   | 4  | 0    | 2    | 2  |
| <i>Themeda quadrivalvis</i>        | Grader grass          | 0                                               | 1   | -  | 2   | 0  | 0    | 0    | 0  |
| <i>Ulex europaeus</i>              | Gorse                 | 4                                               | 2   | -  | 0   | 3  | 2    | 2    | 0  |
| <i>Urochloa mutica</i>             | Para grass            | 0                                               | 2   | -  | 2   | 0  | 0    | 0    | 0  |
| <i>Xanthium occidentale</i>        | Noogoora burr         | 4                                               | 2   | -  | 2   | 1  | 0    | 1    | 1  |

Occurrence: 4, present in >50% of forest area; 3, present in >25-50% of forest area; 2, present in >1-25% of forest area; 1, present in >0-1% of forest area; 0, present in 0% of forest area.

There is no multiple-use public forest in the Northern Territory.

Source: Australasian Virtual Herbarium; Tenure of Australia's Forests (2018) (ABARES 2018).

[Click here for a Microsoft Excel workbook of the data for Table 3.1a-4b.](#)

**Table 3.1a-4c: Occurrence of 24 introduced weed species in native forest in nature conservation reserves, 2017-21**

| Weed species<br>Scientific name                      Common name |                       | Occurrence in native forest in nature conservation reserves |     |    |     |    |      |      |    |
|------------------------------------------------------------------|-----------------------|-------------------------------------------------------------|-----|----|-----|----|------|------|----|
|                                                                  |                       | ACT                                                         | NSW | NT | Qld | SA | Tas. | Vic. | WA |
| <i>Andropogon gayanus</i>                                        | Gamba grass           | 0                                                           | 0   | 4  | 2   | 0  | 0    | 0    | 1  |
| <i>Asparagus asparagoides</i>                                    | Bridal creeper        | 2                                                           | 2   | 0  | 1   | 2  | 1    | 2    | 2  |
| <i>Baccharis halimifolia</i>                                     | Groundsel bush        | 0                                                           | 2   | 0  | 2   | 0  | 0    | 0    | 0  |
| <i>Cenchrus pedicellatus</i>                                     | Annual mission grass  | 0                                                           | 0   | 4  | 1   | 0  | 0    | 0    | 1  |
| <i>Chrysanthemoides monilifera</i>                               | Boneseed & bitou bush | 0                                                           | 2   | 0  | 2   | 2  | 2    | 2    | 1  |
| <i>Cytisus scoparius</i>                                         | Scotch broom          | 2                                                           | 2   | 0  | 1   | 1  | 2    | 2    | 0  |
| <i>Echium plantagineum</i>                                       | Patterson's curse     | 4                                                           | 3   | 0  | 1   | 2  | 1    | 3    | 2  |
| <i>Genista monspessulana</i>                                     | Cape/Montpelier broom | 2                                                           | 2   | 0  | 0   | 2  | 2    | 2    | 2  |
| <i>Hyparrhenia hirta</i>                                         | Coolatai grass        | 2                                                           | 2   | 0  | 2   | 1  | 0    | 1    | 1  |
| <i>Hypericum perforatum</i>                                      | St John's wort        | 4                                                           | 3   | 0  | 1   | 2  | 1    | 2    | 1  |
| <i>Lantana camara</i>                                            | Lantana               | 2                                                           | 3   | 3  | 3   | 1  | 0    | 1    | 1  |
| <i>Leucaena leucocephala</i>                                     | Leucaena/coffee bush  | 2                                                           | 1   | 3  | 2   | 0  | 0    | 1    | 1  |
| <i>Lycium ferocissimum</i>                                       | African boxthorn      | 2                                                           | 2   | 0  | 1   | 2  | 2    | 2    | 1  |
| <i>Nassella trichotoma</i>                                       | Serrated tussock      | 4                                                           | 2   | 0  | 0   | 0  | 1    | 2    | 0  |
| <i>Opuntia</i> spp.                                              | Prickly pear          | 2                                                           | 3   | 1  | 2   | 2  | 1    | 2    | 2  |
| <i>Pinus</i> spp.                                                | Pine                  | 2                                                           | 2   | 0  | 2   | 2  | 1    | 2    | 2  |
| <i>Rosa rubiginosa</i>                                           | Sweet briar           | 4                                                           | 3   | 0  | 1   | 2  | 1    | 3    | 1  |
| <i>Rubus</i> spp.                                                | Brambles              | 3                                                           | 3   | 0  | 2   | 2  | 2    | 3    | 2  |
| <i>Salix</i> spp.                                                | Willow                | 2                                                           | 2   | 0  | 1   | 1  | 1    | 2    | 1  |
| <i>Sporobolus</i> spp.                                           | Rat's tail grass      | 2                                                           | 3   | 3  | 2   | 2  | 0    | 2    | 1  |
| <i>Themeda quadrivalvis</i>                                      | Grader grass          | 0                                                           | 2   | 3  | 2   | 0  | 0    | 0    | 1  |
| <i>Ulex europaeus</i>                                            | Gorse                 | 2                                                           | 2   | 0  | 0   | 2  | 2    | 2    | 1  |
| <i>Urochloa mutica</i>                                           | Para grass            | 0                                                           | 1   | 5  | 2   | 0  | 0    | 0    | 1  |
| <i>Xanthium occidentale</i>                                      | Noogoora burr         | 2                                                           | 2   | 2  | 2   | 1  | 0    | 2    | 1  |

Occurrence: 4, present in >50% of forest area; 3, present in >25-50% of forest area; 2, present in >1-25% of forest area; 1, present in >0-1% of forest area; 0, present in 0% of forest area.

Source: Australasian Virtual Herbarium; Tenure of Australia's Forests (2018) (ABARES 2018).

[Click here for a Microsoft Excel workbook of the data for Table 3.1a-4c.](#)

## Forests affected by climate events and climate change

Climate had a large influence on the health and vitality of Australia's forests during the 2017-21 period. This is reflected in changes over that period in the forest canopy, which is measured as the national average leaf area index (LAI, the projected leaf area per unit area of ground surface):

- The LAI was relatively stable from 2012 to 2017, then progressively declined between 2017 and 2019 as drought conditions intensified; 2019 was Australia's driest year on record
- LAI recovered in 2020-21 following above-average rainfall over much of the continent.

The period 2017-21 was also the hottest five-year period in the past 100 years. All years between 2017 and 2021 had above-average temperatures, and 2019 was the hottest year on record. Many parts of Australia experienced record-breaking heatwave events during the period. Impacts on health and vitality of forests included:

- Mass tree deaths in north-eastern Tasmania in late 2017, large portions of the Murray-Darling Basin region of New South Wales in late 2019, and in north-western Northern Territory in 2019-20, associated with heatwaves coinciding with drought conditions.
- Mass deaths of flying foxes, including an estimated 23,000 nationally Endangered spectacled flying fox (*Pteropus conspicillatus*) in northern Queensland in November 2018, and more than 72,000 flying foxes, including the nationally Vulnerable grey headed flying fox (*P. poliocephalus*) in coastal south-east Australia over the summer of 2018-19.
- Mistletoe (*Amyema miquelii*) was virtually eliminated from *Eucalyptus moluccana* and *E. fibrosa* trees in the Critically Endangered Cumberland Plains Woodland community in the Sydney Basin due to the record heatwave conditions during the 2019-20 summer. Mistletoe is a crucial food source for several birds, mammals and insects.
- Below-average carbon uptake by forests, as measured by carbon dioxide fluxes at several Terrestrial Ecosystem Research Network monitoring sites (Beringer et al. 2022), indicating reduced photosynthesis and subsequently reduced growth rates.

Tropical cyclones Owen (December 2018) and Trevor (March 2019) caused extensive damage to mangroves recovering from a 2015 dieback event, caused by combined low sea levels and several climatic anomalies, along 600 km of coastline between the Limmen and Calvert estuaries of the Gulf of Carpentaria.

The long-term effects of climate change in tropical rainforests have been revealed from analysis of 50 years of forest monitoring data in North Queensland (Bauman et al. 2022). Mortality rates have doubled for most tree species, indicating a potential halving in life expectancy and a subsequent reduction in the amount of carbon stored in these forests.

## Supporting information for Indicator 3.1a: Scale and impact of agents and processes affecting forest health and vitality

### Methods

#### Vertebrate herbivore pests

For this update, a national approach was taken to assess the occurrence of five vertebrate herbivore pest species—rabbit (*Oryctolagus cuniculus*), feral pig (*Sus scrofa*), feral deer (*Cervidae* sp.), feral goat (*Capra hircus*) and feral horse (*Equus caballus*)—in forests. Area-based records for each species were extracted from the national pest animal spatial dataset (West 2011). These spatial records, which identifies the presence of pests within 10 km-sized tiles, were intersected with the [Tenure of Australia's Forests \(2018\)](#) spatial dataset of national land tenure types and forest categories (ABARES 2018) to derive the area of occurrence of each pest species in commercial plantations, native forest on other Crown land, multiple-use public native forest, and native forest in nature conservation reserves. The [Tenure of Australia's Forests \(2023\)](#) spatial dataset (ABARES 2023) was not available at the time of analysis.

Commercial plantations comprise hardwood or softwood plantations managed commercially to supply logs to wood-processing industries for the manufacture of wood products.

Data and information on the tenure of Australia's forest can be found in [Indicator 1.1a.ii Forest area by tenure](#).

#### Insect pests and pathogens

Data on the scale and impact of insect pests and pathogens in forests were collated from responses provided by each state and territory through their representatives on the Forest Health and Biosecurity Committee of the Australian Forest Products Association.

Ratings that describe the scale and impact are as used previously in [Australia's State of the Forests Report 2018](#), with slight amendments:

- Restricted scale: occurs in <25% of the area of forest being reported
- Widespread scale: occurs in ≥25% of the area of forest being reported
- Minimal impact: damage events are of limited duration and/or severity enabling the forest to recover with minimal departures to composition, natural mortality rates and productivity
- Adverse impact: damage events are protracted or recurrent and/or of sufficient severity to cause a change in composition, sharp or sustained increase in mortality rates above natural rates, and/or a sustained decline in productivity.

Ratings that describe the extent of the control programs used as management response are unchanged from those used previously:

- 0: no control
- 1: ad hoc (unplanned) control
- 2: Limited, targeted control
- 3: Widespread, targeted control
- 4: Widespread, general
- 5: Eradication.

#### Weeds

For this update, a national approach was taken to assess the occurrence of the 24 weed species most commonly reported by jurisdictions in [Australia's State of the Forests Report 2018](#). Point-based records for these weeds

lodged between 1990 and 2019 were extracted from the Australasian Virtual Herbarium compiled for the national prioritisation of Australian plants affected by the 2019-20 bushfire season (Gallagher 2020). A 10 km buffer was applied to the point locations for each record, which were then intersected with the [Tenure of Australia's Forests \(2018\)](#) spatial dataset of national land tenure types and forest categories (ABARES 2018) to derive an area of occurrence of each weed species in commercial plantations, multiple-use public native forest, and native forest in nature conservation reserves. The [Tenure of Australia's Forests \(2023\)](#) spatial dataset (ABARES 2023) was not available at the time of analysis.

Commercial plantations comprise hardwood or softwood plantations managed commercially to supply logs to wood-processing industries for the manufacture of wood products.

Data and information on the tenure of Australia's forest can be found in [Indicator 1.1a.ii Forest area by tenure](#).

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## More information

Learn more about [Criterion 3 of Australia's State of the Forest Report](#).

Web [agriculture.gov.au/abares/forestsaustralia/sofr/](https://agriculture.gov.au/abares/forestsaustralia/sofr/)

[Download a Microsoft Excel workbook of the data presented in Indicator 3.1a.](#)

Email [Info.ABARES@aff.gov.au](mailto:Info.ABARES@aff.gov.au)

## Acknowledgement of Country

We acknowledge the Traditional Custodians of Australia and their continuing connection to land and sea, waters, environment and community. We pay our respects to the Traditional Custodians of the lands we live and work on, their culture, and their Elders past and present.

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