

Indicator 1.3a: Forest associated species at risk from isolation and the loss of genetic variation, and conservation efforts for those species (2024)



This indicator assesses the risks to loss of forest genetic variation and describes the formal measures designed to mitigate this risk. A loss of genetic diversity in species can result in a decreased ability to adapt to future environmental change, and thus a higher risk of extinction.

Definitions

Forest-dwelling species: extant (not extinct) native species that use a forest habitat for at least part of its life cycle. Forest-dwelling species reported include only **vertebrate fauna and vascular flora**. Invertebrates and non-vascular floras are not reported for reasons including a lack of reliable data and a potentially uneven representation across taxon groups.

Nationally threatened species: listed under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act), they are not limited to species but can include infraspecific-level taxa such as subspecies, ecotypes, varieties, and hybrids. Threatened forest-dwelling 'species' in this indicator, therefore, also covers those listed at infraspecific levels.

Native: species with natural distribution (including naturalised) within Australia's National Forest Inventory (NFI) boundaries. Species endemic to Australia's outer islands and territories such as Christmas Island, Lord Howe Island and Norfolk Island are not reported as these regions are beyond NFI boundaries.

Key points

- Genetic-related threats were identified for 819 (67%) of the 1,227 listed threatened forest-dwelling species (as at December 2021), specifically:
 - 113 of 244 (46%) of threatened forest-dwelling vertebrate fauna species
 - 706 of 983 (72%) of forest-dwelling threatened vascular flora species.
- The most common genetic-related threats for both threatened forest-dwelling fauna and flora were small populations, fecundity issues, and fragmented populations.
- Australia relies on in situ conservation of forest genetic resources as the main mechanism for conservation of forest genetic resources.

Risks to forest genetic variation

This indicator focuses on genetic-related threats for threatened forest-dwelling species. All 1,277 threatened forest-dwelling species are assessed against specific genetic-related threat categories: small populations, fragmented populations, low genetic diversity, hybridisation and fecundity issues.

Genetic variation is an essential component of the diversity of Australia's forests and forest species, and their productive capacity. Understanding Australia's forest genetics allows better conservation management of forests and forest species, and better management and development of forest resources (Lott and Read 2021).

The number of forest-dwelling native fauna and flora for which data on genetic diversity are available remains small, although knowledge in this field is increasing. Information on the structure of species genetic diversity is increasingly being used to underpin biodiversity management, including conservation efforts after disturbance events (Catullo and Moritz 2021). The overall status of Australia's forest genetic resources, and implementation of genetic resource conservation mechanisms, are described in [Indicator 1.3b](#).

Key drivers of risks to forest-dwelling species genetic variation include forest fragmentation, small populations and climate change. These factors can expose species to increased extinction risks due to loss of genetic variation. Species with a lower level of genetic variation are less able to respond to gradual or immediate threats, or adapt to change, and so face a higher risk of extinction (Saunders et al. 1998), although other factors can apply for individual species. While it is difficult to determine how much of the genetic variation within a species has been historically lost, it is possible to identify if certain species are becoming threatened by the increased isolation of specific populations due to habitat depletion and fragmentation, and by other threatening abiotic and biotic factors such as those discussed in [Indicator 1.2b](#). Genetic-related threats are increasingly being addressed in the conservation planning documents (conservation advice, recovery plans and/or listing advice) for threatened species.

The process of forest fragmentation (see [Indicator 1.1d](#)), mainly caused by clearing for agriculture and urban and industrial development, is a significant contributor to a reduction in genetic variation of certain species. Populations that have become fragmented are at greater risk of restricted gene flow between populations, potential inbreeding and progressive loss of genetic diversity. Populations at greatest risk and of greatest concern are those that are already small or fragmented and with high conservation value.

Climate change is likely to have complex and far-reaching effects on population genetics, influencing connectivity, diversity, adaptation, and overall evolution of species. It is expected to lead to losses in genetic connectivity between populations as climatic zones shift, particularly for species with naturally restricted geographic ranges and habitats, or narrow climate niches (Hoffmann et al. 2019; Meza-Joya et al. 2023). Climate change can also disrupt the interaction of plants with pollinators, potentially reducing pollination with consequences for increased inbreeding and losses of genetic variation.

Changes in fire regimes and fire-related ecological processes can drive declines in genetic diversity (DAWE 2022). Changes in fire regimes are linked to both changes in human interaction with fire in the landscape since European colonisation of Australia and with climate change. The lack of fire, and more frequent high severity fires, can disturb reproduction and recruitment processes, reduce population size and consequently lower genetic variation.

Genetic-related threats to threatened forest-dwelling species

Genetic-related threats are identified for 819 (67%) of the 1,227 threatened forest-dwelling species listed as at December 2021 (Table 1.3a-1). Genetic-related threats in the context of this Indicator are small populations, fragmented populations, low genetic diversity, hybridisation, and fecundity issues (see [Supporting Information for Indicator 1.3a](#) for definitions).

Genetic-related threats were more commonly cited for flora than for fauna, and were specified for:

- 113 of 244 species of forest-dwelling threatened vertebrate fauna (46%)
- 706 of 983 species of forest-dwelling threatened vascular flora (72%).

The 113 fauna species with genetic-related threats are represented almost equally across the five taxon groups (Table 1.3a-1). Fish have the largest proportion of species with genetic-related threats (60%), and reptiles have the lowest proportion (42%).

A total of 681 angiosperm species (flowering plants) have genetic-related threats (Table 1.3a-1), which is 73% of the threatened forest-dwelling angiosperms. This includes:

- 80% of 185 threatened forest-dwelling Orchidaceae
- 70% of 128 threatened forest-dwelling Myrtaceae
- 74% of 93 threatened forest-dwelling Fabaceae

- 84% of 83 threatened forest-dwelling Proteaceae

Threatened angiosperms with genetic-related threats include species of high economic importance, such as Queensland nut tree (*Macadamia integrifolia*) and rough-shelled bush nut (*M. tetraphylla*). The other macadamia species less frequently used in commercial production, gympie nut (*M. ternifolia*) and bulburin nut tree (*M. jansanii*), are also threatened forest-dwelling species and identified to be prone to genetic-related threats.

Fifteen gymnosperm-species (83% of the threatened forest-dwelling gymnosperms) have genetic-related threats (Table 1.3a-1). Most are cycads from the families *Cycas* and *Macrozamia*, but also include wollemi pine (*Wollemia nobilis*).

Table 1.3a-1: Listed threatened forest-dwelling species for which genetic-related threats are reported in conservation planning documents, by taxonomic group, as at December 2021

Taxonomic group	Number of threatened species with genetic-related threats	Total number of threatened species	Proportion of threatened species with genetic-related threats
Fish	18	30	60%
Amphibians	20	39	51%
Reptiles	13	33	39%
Birds	28	66	42%
Mammals	34	76	45%
All vertebrate fauna	113	244	46%
Lycophytes	2	8	25%
Ferns	8	18	44%
Gymnosperms	15	18	83%
Angiosperms	681	939	73%
All vascular flora	706	983	72%
All species^a	819	1,227	67%

Genetic-related threats for listed threatened forest-dwelling species were identified in conservation documents (conservation advice, recovery plans and/or listing advice).

^aThreatened forest-dwelling species includes only extant (not extinct) vertebrate fauna and vascular flora, naturally distributed within National Forest Inventory (NFI) boundaries. Species that are extinct or extinct in the wild are excluded.

Listed infraspecific taxa are reported separately, as for Indicator 1.2b.

Lycophytes comprise clubmosses and quillworts.

Source: Australian Government Department of Climate Change, Energy, the Environment and Water (DCCEEW) Species Profile and Threat (SPRAT) Database.

[Click here for a Microsoft Excel workbook of the data for Table 1.3a-1.](#)

Genetic-related threats often operate simultaneously to drive species extinction. The most common genetic-related threats for threatened forest-dwelling species were (Table 1.3a-2):

- small population (33% and 67% of total threatened forest-dwelling fauna and flora and, respectively)
- fecundity issues (20% and 31% of total threatened forest-dwelling fauna and flora, respectively)
- fragmented population (30% and 26% of total threatened forest-dwelling fauna and flora, respectively).

There was a higher proportion of threatened forest-dwelling flora species with extremely small population size (consisting of fewer than 1,000 individuals) than forest-dwelling fauna. Several flora species are known to only have fewer than 10 individuals remaining in the wild, for example, mongarlowe mallee (*Eucalyptus recurva*), slender-nerved acacia (*Acacia leptoneura*), dwarf-spider orchid (*Caladenia pumila*), Trigwell's rullingia (*Commersonia erythrogyna*) and Bolivia Hill rice-flower (*Pimelea venosa*).

Hybridisation is specified as a genetic risk to only 4% of threatened forest-dwelling fauna and 3% of threatened forest-dwelling flora, but when it occurs, can lead to a rapid decline in the numbers of genetically pure individuals.

Table 1.3a-2: Listed threatened forest-dwelling species with genetic-related threats, as at December 2021

Genetic-related threat	Number of threatened species with that threat	Proportion of threatened species with that threat
Vertebrate fauna		
Small population	81	33%
Fragmented population	72	30%
Low genetic diversity	31	13%
Hybridisation	9	4%
Fecundity issue	49	20%
All genetic-related threats	113	46%
Vascular flora		
Small population	658	67%
Fragmented population	257	26%
Low genetic diversity	164	17%
Hybridisation	30	3%
Fecundity issue	300	31%
All genetic-related threats	706	72%
All species^a, all genetic-related threats	819	67%

Genetic-related threats for listed threatened forest-dwelling species were identified in conservation planning documents (conservation advice, recovery plans, and/or listing advice).

^aThreatened forest-dwelling species includes only extant vertebrate fauna and vascular flora, naturally distributed within National Forest Inventory (NFI) boundaries. Species that are extinct or extinct in the wild are excluded. See definitions for further detail.

Listed infraspecific taxa are reported separately, as for Indicator 1.2b.

Source: Australian Government Department of Climate Change, Energy, the Environment and Water (DCCEEW) Species Profile and Threat (SPRAT) Database.

[Click here for a Microsoft Excel workbook of the data for Table 1.3a-2.](#)

Change in genetic-related threats over time

The number of threatened forest-dwelling flora and fauna identified with genetic-related threats have changed over time (Table 1.3a-3):

- 71% (70 of the 99) of threatened forest-dwelling flora and fauna species listed between August 2016 and December 2021 have genetic-related threats, compared to 66% (749 of 1,128 species) listed between 2000 and August 2016
- a greater proportion (88%) of flora listed between August 2016 and December 2021 (60 of 68 species) have genetic-related threats compared to 71% of flora listed between 2000 and August 2016 (646 of 915 species)
- a smaller proportion (32%) of fauna listed between August 2016 and December 2021 (10 of 31 species) have genetic-related threats compared to 48% of fauna listed prior to August 2016 (103 of 213 species).

Table 1.3a-3: Change in listed threatened forest-dwelling species for which genetic-related threats are reported in conservation planning documents, by taxonomic group

Taxonomic group	Threatened forest-dwelling species listed 2000-16			Threatened forest-dwelling species listed 2016-21			Threatened forest-dwelling species listed 2000-21		
	Number with genetic-related threats	Total number	Proportion with genetic-related threats	Number with genetic-related threats	Total number	Proportion with genetic-related threats	Number with genetic-related threats	Total number	Proportion with genetic-related threats
Fish	14	25	56%	4	5	80%	18	30	60%
Amphibians	16	27	59%	4	12	33%	20	39	51%
Reptiles	12	32	38%	1	1	100%	13	33	39%
Birds	28	57	49%	0	9	-	28	66	42%
Mammals	33	72	46%	1	4	25%	34	76	45%
All vertebrate fauna	103	213	48%	10	31	32%	113	244	46%
Lycophytes	2	8	25%	0	0	-	2	8	25%
Ferns	7	17	41%	1	1	100%	8	18	44%
Gymnosperms	15	18	83%	0	0	-	15	18	83%
Angiosperms	622	872	71%	59	67	88%	681	939	73%
All vascular flora	646	915	71%	60	68	88%	706	983	72%
All species^a	749	1,128	66%	70	99	71%	819	1,227	67%

Genetic-related threats for listed threatened forest-dwelling species were identified in conservation planning documents (conservation advice, recovery plans and/or listing advice), and presented by listing periods 2000 to July 2016, August 2016 to December 2021, and 2000 to December 2021.

^aThreatened forest-dwelling species includes only extant vertebrate fauna and vascular flora, naturally distributed within National Forest Inventory (NFI) boundaries. Species that are extinct or extinct in the wild are excluded. See Definition box for further detail.

Listed infraspecific taxa are reported separately, as for Indicator 1.2b.

Lycophytes comprise clubmosses and quillworts.

Source: Australian Government Department of Climate Change, Energy, the Environment and Water (DCCEEW) Species Profile and Threat (SPRAT) Database.

[Click here for a Microsoft Excel workbook of the data for Table 1.3a-3.](#)

Small population, fragmentation and fecundity are the most common genetic-related threats for listed threatened forest-dwelling species over time (Table 1.3a-4). Small population and fragmentation are increasingly recognised in recent listings for flora. Fecundity issues are increasingly recognised in recent listings for both flora and fauna. The increased recognition of genetic risks in conservation planning documents are largely due to the growing body of knowledge on the species genetics structure and population quantitative genetics, as well as aggregating observed evidence on increased extinction risk from having little genetic exchange (fragmented and isolated population), inbreeding (small population), or other genetic consequences from various threats.

Table 1.3a-4: Change in listed threatened forest-dwelling species for which genetic-related threats are reported in conservation planning documents, by threat

Genetic-related threat	Threatened forest-dwelling species listed 2000-16		Threatened forest-dwelling species listed 2016-21		Threatened forest-dwelling species listed 2000-21	
	Number with that threat	Proportion with that threat	Number with that threat	Proportion with that threat	Number with that threat	Proportion with that threat
Vertebrate fauna						
Small population	73	34%	8	26%	81	33%
Fragmented population	65	31%	7	23%	72	30%
Low genetic diversity	30	14%	1	3%	31	13%
Hybridisation	8	3%	1	3%	9	4%
Fecundity issue	41	19%	8	26%	49	20%
All genetic-related threats	103	48%	10	32%	113	46%
Vascular flora						
Small population	599	65%	59	87%	658	67%
Fragmented population	223	24%	34	50%	257	26%
Low genetic diversity	156	17%	8	12%	164	17%
Hybridisation	27	3%	3	4%	30	3%
Fecundity issue	270	30%	30	44%	300	31%
All genetic-related threats	646	71%	60	88%	706	72%
All species^a, all genetic-related threats	749	66%	70	71%	819	67%

Genetic-related threats for listed threatened forest-dwelling species were identified in conservation planning documents (conservation advice, recovery plans and/or listing advice), and presented by listing periods 2000 to July 2016, August 2016 to December 2021, and 2000 to December 2021.

^aThreatened forest-dwelling species includes only extant vertebrate fauna and vascular plants, naturally distributed within National Forest Inventory (NFI) boundaries. Species that are extinct or extinct in the wild are excluded. See definitions for further detail.

Listed infraspecific taxa are reported separately, as for Indicator 1.2b.

Source: Australian Government Department of Climate Change, Energy, the Environment and Water (DCCEEW) Species Profile and Threat (SPRAT) Database.

[Click here for a Microsoft Excel workbook of the data for Table 1.3a-4.](#)

Conservation measures to mitigate genetic-related risks

Australia relies on in situ conservation of forest genetic resources as the main mechanism for conservation of forest genetic resources. In situ conservation is the conservation of species and genetic components of biological diversity in their natural habitats. All 115 native species and hybrids listed as forest genetic resources for Australia by the United Nations Food and Agriculture Organization (FAO) have populations conserved in situ through formal and informal reserved and protected areas (Lott and Read 2021; [Indicator 1.3b](#)). The area of forest reserved and managed for protection through formal and informal processes is described in Indicator 1.1c.

In situ recovery actions for listed threatened species can include habitat restoration, wildlife corridors, engineered animal movement mechanisms (e.g. possum bridges), seed-collecting programs (for subsequent resowing), and management of habitat and populations under forest management systems (e.g. forest management plans and code of practice systems that include prescription on fire management, feral animal and weed management, selection of genetic resources (provenances) for planting, etc.).

Ex situ conservation is the conservation of species and genetic components of biological diversity outside their natural habitats. Ex situ conservation for flora in Australia occurs through botanic gardens, seed banks,

provenance or clonal plantings, seed orchards, and seed production areas to complement in situ conservation. Ex situ seed banking is considered a vital element of the conservation of Australia's flora, with 67% of listed threatened flora species represented in conservation seed banks (Martyn Yenson et al. 2024). The main conservation seed banks for native species, including threatened forest-dwelling species, are managed by the Australian Seed Bank Partnership (Martyn Yenson et al. 2021). The National Macadamia Germplasm Collection is an example of ex situ conservation plantings and breeding trials for threatened species. Other seed orchards and conservation plantings for threatened forest-dwelling flora species are listed in Lott and Read (2021).

Ex situ conservation for fauna in Australia is supported through establishing populations in zoos and aquariums, captive breeding and translocation programs. Newhaven Wildlife Sanctuary in Northern Territory, that is Australia's largest fenced feral cat and fox free area, is an example of ex situ conservation for threatened fauna. This sanctuary supports conservation of forest-dwelling fauna such as mala (*Lagorchestes hirsutus*), red-tailed phascogale (*Phascogale calura*), western quoll (*Dasyurus geoffroii*) and golden bandicoot (*Isodon auratus*).

Ex situ conservation supports population recovery in situ, largely through translocations. Translocation is the establishment and augmentation of populations using individuals (genetic materials) that have been produced ex situ. Translocations are being increasingly proposed as a way of conserving biodiversity, particularly for threatened and keystone species (Weeks et al. 2011, Zimmer et al. 2019). A well designed and managed translocation that places a strong focus on restoring genetic variability is imperative to ensure the long-term persistence of translocated populations. A step-by-step best-practice guide for conservation translocation of Australian flora is available from the Australian Network for Plant Conservation Guidelines for the translocation of threatened plants in Australia (Commander et al. 2018).

Genetic studies to determine effective population size and within- and among-population genetic diversity, and restoring population connectivity, are examples of key recovery actions specified in conservation documents for EPBC-listed species with genetic-related risks.

Supporting information for Indicator 1.3a: Forest associated species at risk from isolation and the loss of genetic variation, and conservation efforts for those species

Assessment of genetic-related threats

Genetic-related threats were assessed for all 244 listed threatened forest-dwelling vertebrate fauna and 983 listed threatened forest-dwelling vascular flora described in [Indicator 1.2b The status of forest dwelling species at risk of not maintaining viable breeding populations, as determined by legislation or scientific assessment \(2024\)](#), and were allocated to the threat categories small population, fragmented population, low genetic diversity, hybridisation and fecundity issues according to information in species conservation planning documents (conservation advice, recovery plans and/or listing advice).

Compared to [Australia's State of the Forest Report 2018](#), this update only includes species occurring in forest within the National Forest Inventory boundaries (excluding species endemic to offshore territories), excludes invertebrate fauna and non-vascular plants, excludes extinct species, and excludes species re-assessed as not forest-dwelling. Genetic-related threats of all 1,277 threatened forest-dwelling species are assessed based on the information outlined in the most up-to-date conservation planning documents.

The full list of listed threatened forest-dwelling species with their associated genetic (and other) threats is available for download from [forest species and ecological communities data](#).

Small populations

This threat category relates to number of mature individuals and population size, or to area of occupancy and extent of distribution. In general, 'small' includes total population size $\leq 1,000$ individuals or comprising ≤ 10 subpopulations, or with geographic distribution precarious for the survival of the taxon (i.e. restricted area of occupancy $< 500 \text{ km}^2$ and/or severely fragmented) (IUCN 2022). A genetic-related threat in this category was only recognised where the conservation advice or recovery plan specifically indicated that the taxon is at risk of inbreeding or other genetic bottlenecks due to the small size or isolated nature of its population.

Fragmented populations

Population fragmentation is considered as a genetic threat where the conservation documents specify severe population fragmentation, with most individuals of a taxon found in isolated subpopulations (IUCN 2022). When conservation documentation only specify fragmentation without describing its severity, information on population density and dispersal distance was used to determine if the fragmentation inhibits gene-flow or reduces population viability.

Low genetic diversity

This category is used when the conservation documentation specifies low genetic diversity, highly clonal species, or species with only one population containing an extremely low number of individuals.

Hybridisation

This category is used when the conservation documentation specifies hybridisation as a risk to a species. Hybridisation with other species can increase genetic diversity and viability (genetic rescue) but can also drive species to extinction where the rare genetic form is replaced by hybrids.

Fecundity issues

Fecundity is a measure of the number of fertile offspring that survive to reproductive age, and can be reduced by a range of threats that stop offspring maturing successfully to breeding age. Examples include young plants of obligate seeder species (plants that only regenerate after fire from seed) killed by fire before flowering age,

predation of eggs or juvenile animals, intensive grazing that prevents plants to produce seeds, or the absence of pollinators.

Genetic-related threats in different listing periods

Tables 1.3a-5-7 present data for threatened forest-dwelling species, by species groups, listed under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) by genetic-related threats for three listing periods: July 2000 and August 2016, August 2016 to December 2021, and the combined July 2000 to December 2021.

Table 1.3a-5: Threatened forest-dwelling species listed between July 2000 and August 2016, for which genetic-related threats are reported in conservation planning documents

Taxonomic group	Number of listed threatened forest-dwelling species with genetic-related threats, 2000-2016						Total	Total number of threatened forest-dwelling species listed 2000-2016	Proportion with genetic-related threats
	Small population	Fragmented population	Low genetic diversity	Hybridisation	Fecundity issues				
Fish	8	10	6	0	6	14	25	56%	
Amphibians	14	15	3	2	7	16	27	59%	
Reptiles	8	5	0	1	5	12	31	35%	
Birds	23	14	9	3	12	28	57	49%	
Mammals	20	21	12	1	11	33	73	47%	
All vertebrate fauna	73	65	30	7	41	103	213	48%	
Lycophytes	2	1	1	0	1	2	8	25%	
Ferns	7	3	0	0	0	7	17	41%	
Gymnosperms	10	3	5	2	15	15	18	83%	
Angiosperms	580	216	150	25	254	622	872	71%	
All vascular flora	599	223	156	27	270	646	915	71%	
All species^a	672	288	186	34	311	749	1,128	66%	

Genetic-related threats for listed threatened forest-dwelling species were identified in conservation planning documents (conservation advice, recovery plans and/or listing advice), and presented by listing period 2000 to July 2016.

^aThreatened forest-dwelling species includes only extant vertebrate fauna and vascular flora, naturally distributed within National Forest Inventory (NFI) boundaries. Species that are extinct or extinct in the wild are excluded. See Definition box for further detail.

Listed infraspecific taxa are reported separately, as for Indicator 1.2b.

Lycophytes comprise clubmosses and quillworts.

Source: Australian Government Department of Climate Change, Energy, the Environment and Water (DCCEEW) Species Profile and Threat (SPRAT) Database.

[Click here for a Microsoft Excel workbook of the data for Table 1.3a-5.](#)

Table 1.3a-6: Threatened forest-dwelling species listed between August 2016 to December 2021, for which genetic-related threats are reported in conservation planning documents

Taxonomic group	Number of listed threatened forest-dwelling species with genetic-related threats, 2016-2021						Total	Total number of threatened forest-dwelling species listed 2016-2021	Proportion with genetic-related threats
	Small population	Fragmented population	Low genetic diversity	Hybridisation	Fecundity issues				
Fish	4	3	1	0	3	4	5	80%	
Amphibians	3	4	0	0	3	4	12	33%	
Reptiles	1	0	0	1	1	1	1	100%	
Birds	0	0	0	0	0	0	9	-	
Mammals	0	0	0	0	1	1	4	25%	
All vertebrate fauna	8	7	1	1	8	10	31	32%	
Lycophytes	0	0	0	0	0	0	0	-	
Ferns	1	1	0	0	0	1	1	100%	
Gymnosperms	0	0	0	0	0	0	0	-	
Angiosperms	58	33	8	3	30	59	67	88%	
All vascular flora	59	34	8	3	30	60	68	88%	
All species^a	67	41	9	4	38	70	99	71%	

Genetic-related threats for listed threatened forest-dwelling species were identified in conservation planning documents (conservation advice, recovery plans and/or listing advice), and presented by listing period August 2016 to December 2021.

^aThreatened forest-dwelling species includes only extant vertebrate fauna and vascular plants, naturally distributed within National Forest Inventory (NFI) boundaries. Species that are extinct or extinct in the wild are excluded. See Definition box for further detail.

Listed infraspecific taxa are reported separately, as for Indicator 1.2b.

Lycophytes comprise clubmosses and quillworts.

Source: Australian Government Department of Climate Change, Energy, the Environment and Water (DCCEEW) Species Profile and Threat (SPRAT) Database.

[Click here for a Microsoft Excel workbook of the data for Table 1.3a-6.](#)

Table 1.3a-7: Threatened forest-dwelling species listed between July 2000 and December 2021, for which genetic-related threats are reported in conservation planning documents

Taxonomic group	Number of listed threatened forest-dwelling species with genetic-related threats, 2000 to 2021						Total	Total number of threatened forest-dwelling species listed 2000-2021	Proportion with genetic-related threats
	Small population	Fragmented population	Low genetic diversity	Hybridisation	Fecundity issues				
Fish	12	13	7	0	9	18	30	60%	
Amphibians	17	19	3	2	10	20	39	51%	
Reptiles	9	5	0	2	6	13	32	38%	
Birds	23	14	9	3	12	28	66	42%	
Mammals	20	21	12	1	12	34	77	45%	
All vertebrate fauna	81	72	31	8	49	113	244	46%	
Lycophytes	2	1	1	0	1	2	8	25%	
Ferns	8	4	0	0	0	8	18	44%	
Gymnosperms	10	3	5	2	15	15	18	83%	
Angiosperms	638	249	158	28	284	681	939	73%	
All vascular flora	658	257	164	30	300	706	983	72%	
All species^a	739	329	195	38	349	819	1,227	67%	

Genetic-related threats for listed threatened forest-dwelling species were identified in conservation planning documents (conservation advice, recovery plans and/or listing advice).

^aThreatened forest-dwelling species includes only extant vertebrate fauna and vascular flora, naturally distributed within National Forest Inventory (NFI) boundaries. Species that are extinct or extinct in the wild are excluded. See Definition box for further detail.

Listed infraspecific taxa are reported separately, as for Indicator 1.2b.

Lycophytes comprise clubmosses and quillworts.

Source: Australian Government Department of Climate Change, Energy, the Environment and Water (DCCEE) Species Profile and Threat (SPRAT) Database.

[Click here for a Microsoft Excel workbook of the data for Table 1.3a-7.](#)

References

Catullo R, Moritz C (2021). Genetic assessment of bushfire-impacted vertebrate species. Final Report. Threatened Species Recovery Hub, National Environmental Science Programme.

Commander LE, Coates D, Broadhurst L, Offord CA, Makinson RO, Matthes M (2018). *Guidelines for the translocation of threatened plants in Australia*. Third Edition. Australian Network for Plant Conservation, Canberra.

DAWE (Department of Agriculture, Water and the Environment) (2022). Fire regimes that cause declines in biodiversity as a key threatening process. Australian Government, Canberra, April 2022. CC BY 4.0.

Hoffmann AA, Rymer PD, Byrne M, Ruthrof KX, Whinam J, McGeogh M, Bergstrom DM, Guerin GR, Sparrow B, Joseph L, Hill SJ, Andrew NR, Camac J, Bell N, Riegler M, Gardner JL, Williams SE (2019). Impact of recent climate change on terrestrial flora and fauna: Some emerging Australian examples. *Austral Ecology* 44:3-27.

doi.org/10.1111/aec.12674

IUCN (2022). *Guidelines for Using the IUCN Red List Categories and Criteria*, Version 15.1. Prepared by the Standards and Petitions Committee.

Lott R, Read SM (2021). [Status of Australia's Forest Genetic Resources 2021, Australia's Country Report for The Second Report on the State of the World's Forest Genetic Resources, Prepared for the Food and Agriculture Organization of the United Nations](#). ABARES Research Report 21.15. November 2021, Canberra. CC BY 4.0. doi.org/10.25814/dnv3-vj64

Martyn Yenson AJ, Offord CA, Meagher PF, Auld T, Bush D, Coates DJ, Commander LE, Guja LK, Norton SL, Makinson RO, Stanley R, Walsh N, Wrigley D, Broadhurst L (2021). *Plant Germplasm Conservation in Australia: strategies and guidelines for developing, managing and utilising ex situ collections*. Third Edition. Australian Network for Plant Conservation, Canberra.

Martyn Yenson AJ, Sommerville KD, Guja LK, Merritt DJ, Dalziell EL, Auld TD, Broadhurst L, Coates DJ, Commander L, Crawford AD, Emery NJ, Funnekotter B, Knapp Z, Makinson RO, Monks L, Wrigley D, Offord CA (2024). Ex situ germplasm collections of exceptional species are a vital part of the conservation of Australia's national plant treasures, *Plants, People, Planet* 6(1):44-66. doi.org/10.1002/ppp3.10421

Meza-Joya FL, Morgan-Richards M, Koot EM, Trewick SA (2023). Global warming leads to habitat loss and genetic erosion of alpine biodiversity, *Journal of Biogeography* 50, 961–975. doi.org/10.1111/jbi.14590

Saunders D, Margules C, Hill B (1998). Environmental indicators for national state of the environment reporting: biodiversity, *Australia: State of the Environment (Environmental Indicator Reports)*, Department of the Environment, Canberra.

Weeks AR, Sgro CM, Young AG, Frankham R, Mitchell NJ, Miller KA, Byrne M, Coates DJ, Eldridge MDB, Sunnucks P, Breed MF, James EA, Hoffmann AA (2011). Assessing the benefits and risks of translocations in changing environments: a genetic perspective, *Evolutionary Applications* 4(6):709-725. doi.org/10.1111/j.1752-4571.2011.00192.x

Zimmer HC, Auld TD, Cuneo P, Offord CA, Commander LE (2019). Conservation translocation – an increasingly viable option for managing threatened plant species, *Australian Journal of Botany* 67: 501-509. doi.org/10.1071/BT19083

More information

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Web agriculture.gov.au/abares/forestsaustralia/sofr/

[Download a Microsoft Excel workbook of the data presented in Indicator 1.3a.](#)

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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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