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NSW biodiversity outlook report 2024

Status and trends of biodiversity and ecological integrity

Department of Climate Change, Energy, the Environment and Water

Acknowledgement of Country

Department of Climate Change, Energy, the Environment and Water acknowledges the Traditional Custodians of the lands where we work and live.

We pay our respects to Elders past, present and emerging.

This resource may contain images or names of deceased persons in photographs or historical content.

Cover photo: Jamison Valley, Blue Mountains National Park. Aine Gliddon/DCCEEW. **Contents: p.1:** Wilsons Headland. Jessica Robertson/ DCCEEW; **p.16:** Washpool National Park. Koen Dijkstra/ DCCEEW; **p.31:** *Diplacodes bipunctata* female dragonfly. Rosie Nicolai/ DCCEEW; **p.31:** Tomaree Coastal walk. John Spencer/ DCCEEW; **p.32:** Ant. Rosie Nicolai/ DCCEEW; **p.33:** *Eucalyptus* sp. Cattai, Annangrove, NSW. Enhua Lee/ DCCEEW; **p.34:** Tawny frogmouth. Brayden Stanford/ DCCEEW; **p.35:** Freshwater snail, Mid Murray River. John Spencer/ DCCEEW.

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Anthony Lean
Secretary, Department of Climate Change, Energy, the Environment and Water

Foreword

Biodiversity — the variety of all living things — is fundamental to the health and resilience of our environment and our communities.

Biodiversity is facing a number of pressures, including climate change, habitat loss and invasive species. These pressures are causing a decline in biodiversity in New South Wales, with nearly 1,000 species known to be at risk of extinction if there is no intervention. By better understanding the status of biodiversity, now and in the future, we can make informed decisions about how best to manage pressures and to conserve species and ecosystems.

The Department of Climate Change, Energy, the Environment and Water has established the Biodiversity Indicator Program to track the status and trends of biodiversity over time. The method is scientifically rigorous and peer-reviewed and provides a set of indicators to use when reporting on biodiversity in New South Wales.

In 2020, the first *NSW biodiversity outlook report* presented the results of the first assessment of the Biodiversity Indicator Program. The first outlook report established a baseline for reporting on future trends in biodiversity for New South Wales.

This *NSW biodiversity outlook report 2024* provides updated results on previously reported indicators and adds new indicators. It includes an assessment of the significant impacts of the extensive bushfires of spring and summer 2019–20.

The Biodiversity Indicator Program will continue to assess the status and trends of biodiversity across New South Wales. The consequences of pressures on biodiversity will continue to be monitored and will inform conservation activities. These indicators focus our work and underpin continuing efforts to protect and restore biodiversity in New South Wales.

I thank the dedicated scientists whose rigorous work has contributed to this biodiversity outlook report.

Anthony Lean

Secretary, Department of Climate Change, Energy, the Environment and Water

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Our outlook on NSW biodiversity

BIODIVERSITY

Expected survival of biodiversity

50%
of **listed threatened species were expected to survive** in 100 years, **down** from 52%

76%
of **all known species were expected to survive** in 100 years, **down** from 79%

State of biodiversity

73–89%
of **genetic diversity remained** for all known plant species, **down** from 78–91%

74%
of the **diversity of plant ecosystems** was likely to persist in the long term, **down** from 77%

ECOLOGICAL INTEGRITY

Ecosystem quality

29%
of the **capacity of habitat** to support native species remained, **down** from 31%

305 invasive weeds and **36 pest animals** were known to occur in NSW

Ecosystem management

11.2%
of NSW was **secured for permanent protection, up** from 8.6%

33%
of **people were highly appreciative of biodiversity**, through their knowledge, care or activities

Ecosystem integrity

11%
of the **resilience of ecosystems** to climate change remained

Introduction

What is biodiversity?

Biodiversity or 'biological diversity' is the variety of all living things, including plants, animals (vertebrates and invertebrates), fungi, lichen and microorganisms. Biodiversity includes the variety among individuals within a species; the variety of different species; and the variety of ecosystems.

Ecological integrity is the diversity and quality of ecosystems, and their capacity to adapt to change. It covers the extent (area), condition (health) and connectivity of habitats; and the resilience of ecosystems to change, including climate change and other pressures.

The number of species known to science that have also had their risk of extinction assessed is just the 'tip of the biodiversity iceberg'. Many species known to science are too poorly understood to assess their extinction risk. And an even larger number (maybe 70% of all Australian species) are still unknown to us and have yet to be discovered.

New South Wales is home to an amazing array of plants, animals and other living things. They live and interact with each other in complex ways, forming a variety of different ecosystems. This diversity of living things needs to be protected to support the health of our environment and our communities.

Biodiversity in New South Wales is facing a number of pressures, including climate change, habitat loss and invasive species.

Our climate is changing. Temperatures are warming, rainfall patterns are changing, and extreme events (such as bushfires, droughts and floods) are becoming more common. The clearing of native vegetation reduces the extent, condition and connectivity of native plant and animal habitats. Invasive species threaten many native plants and animals through predation, disease and competition.

Continuing and accelerating pressures have caused a decline in the state of biodiversity.

Since the start of the Industrial Revolution (around 1750), natural ecosystems across the world have become smaller in area and less resilient to change. In New South Wales, almost 1,000 species have been listed as threatened and some species have become extinct.

Biodiversity is of great value in itself, and it directly benefits people.

The vast array of living things and the ecosystems they form are of immense scientific, cultural, aesthetic and spiritual value. Biodiversity benefits our wellbeing by providing us with food and fresh water, regulating climate and disease, and supporting nutrient cycling and crop pollination. It supports our economy, recreation, tourism, education and connection to Country.

Understanding the state of biodiversity allows us to better manage species and ecosystems.

We can improve the way we evaluate how effective our investments in biodiversity conservation are by better understanding the **state of biodiversity**, now and into the future (Figure 1). This will help us to identify the species, ecosystems and regions that are most in need, and how best to manage them.

The **state of biodiversity** refers to the number or variety of genes, species and ecosystems at a particular place and time.

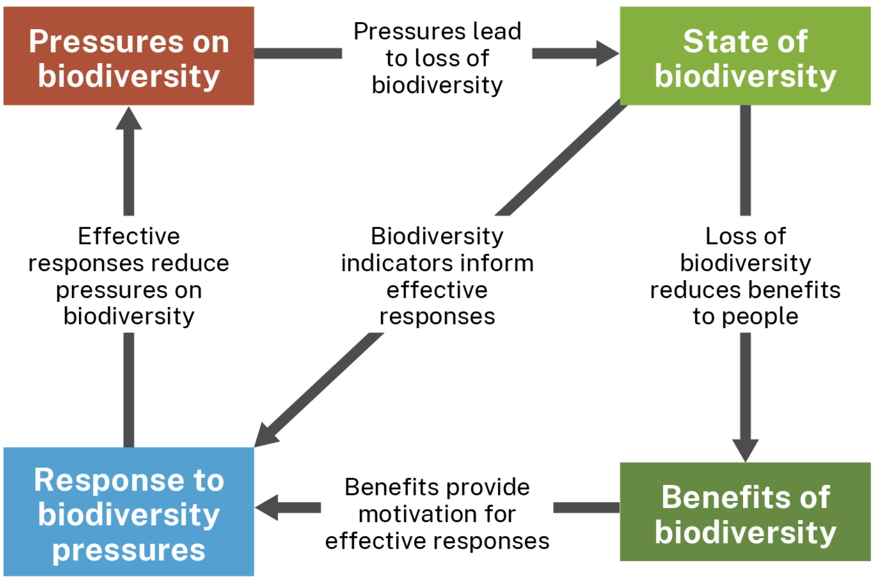


Figure 1 Understanding the state of biodiversity, how pressures impact biodiversity, and how we benefit from biodiversity, allows us to respond effectively to those biodiversity pressures

NSW Biodiversity Indicator Program

It is important to assess the state of biodiversity, now and into the future.

An **indicator** is a numerical value that gives insight into the current state, or a change in state, of biodiversity or ecological integrity.

The Biodiversity Indicator Program reports on the state and trends over time of biodiversity and ecological integrity in New South Wales. The program was established by the *Biodiversity Conservation Act 2016*. We have developed a framework of **indicators** to help scientists, managers and policymakers understand the current state of biodiversity, how it has changed from the past, and how it is likely to change in the future.

The indicator framework uses the best available science for measuring biodiversity and ecological integrity. It reflects how we manage our landscapes and protect our natural areas. The framework is arranged in a hierarchy of classes, themes and indicator families (Figure 2).

Class	BIODIVERSITY		ECOLOGICAL INTEGRITY		
Theme	Expected survival of biodiversity	State of biodiversity	Ecosystem quality	Ecosystem management	Ecosystem integrity
Indicator family	Listed threatened species and ecological communities All known and undiscovered species	All known species State of biodiversity including undiscovered species Field monitoring of species and ecosystems	Habitat condition Pressures	Management responses Management effectiveness Capacity to sustain ecosystem quality	Capacity to retain biological diversity Capacity to retain ecological functions

Figure 2 Hierarchy of classes, themes and indicator families in the NSW Biodiversity Indicator Program

NSW biodiversity outlook report

This biodiversity outlook report is a summary of the state of biodiversity and ecological integrity in New South Wales. It is based on rigorous science and has been peer reviewed by recognised experts.

In 2020, the **first outlook report** covered 10 indicators, with supporting published methods and available data. For indicators that were still in development, case studies were included to provide insights into how we were tracking.

This **2024 outlook report** updates the indicators previously reported in 2020 and introduces new indicators. Case studies are still used to provide further insights. Some indicators that are under development are presented here as research highlights.

How to navigate this report

In this report, results are grouped and presented by themes, based on the hierarchy in Figure 2. Within each of the 5 themes, indicators, case studies and research highlights are organised into indicator families.

Key results are presented for each year of measurement (example shown in Figure 3). Where possible, each result is reported as a percentage along a scale from 0% to 100%. The level of confidence in the result is also shown.

Some indicators are reported as the ‘**percentage of original remaining**’ in New South Wales. What we mean by ‘original’ is the value of that indicator as we estimate it to have been in the pre-industrial era. This baseline value is used as a point of comparison.

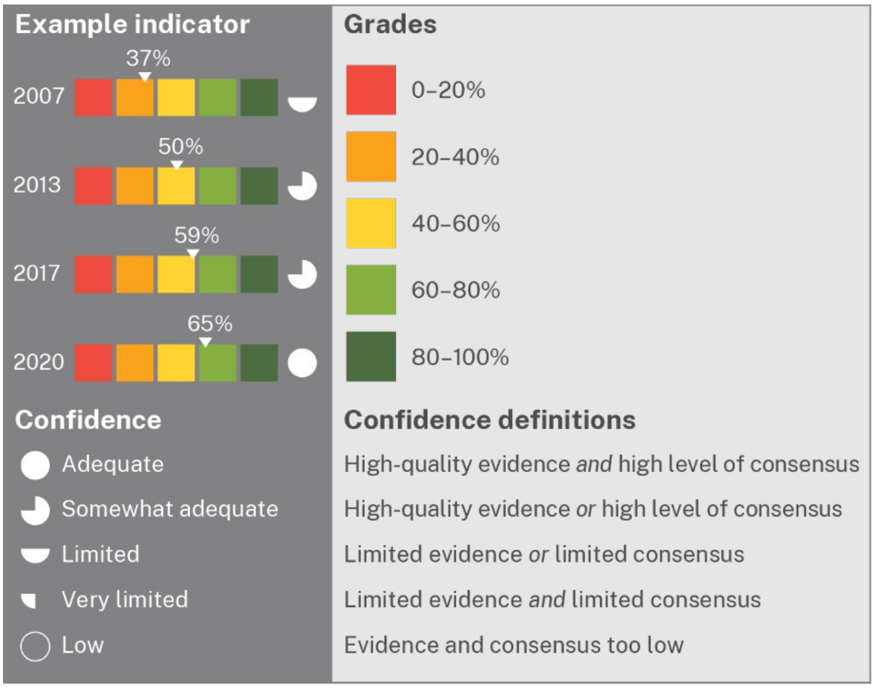


Figure 3 An example of a summary infographic for an indicator (on the left), with an explanation of terms and symbols (on the right)

Indicators are reported at the statewide scale. Many indicators are also reported at a bioregion scale. NSW bioregions, shown in Figure 4, may extend across state boundaries but we report only on the area within New South Wales. Where Lord Howe Island (part of the Pacific Subtropical Islands Bioregion) does not appear on a map, it has not been included in the analysis of that indicator. For some indicators, maps include arrows to show a trend (increasing or decreasing) over time.

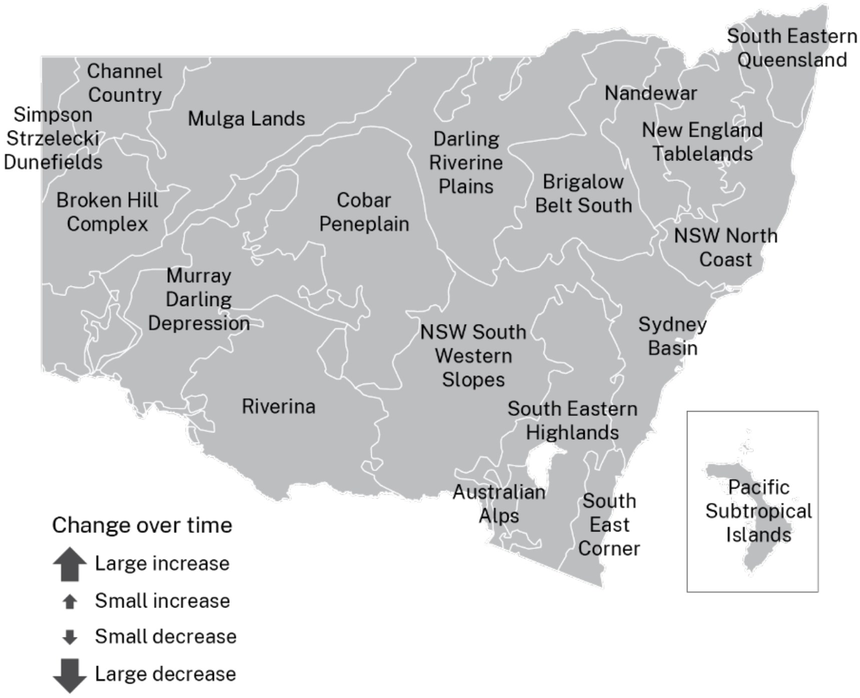


Figure 4 Interim Biogeographic Regionalisation for Australia (IBRA) bioregions (version 7) used to report some indicators. Change over time within a bioregion may be shown with arrows

Indicators are continually improved

Results may differ between outlook reports due to continual improvements in science and data.

Results for some indicators reported in the first biodiversity outlook report may be different to those in this 2024 outlook report. The Biodiversity Indicator Program is committed to continually improving indicators, so we update results where methods and data have improved since the results were previously reported.

This report provides the latest results, up to June 2023 or earlier, depending on the indicator. Indicators are reported using the best available data at the time of the analysis. There can be lags between when changes in the state of biodiversity happen, when data become available for analysis, and when we publish results.

Expected survival of listed threatened species and ecological communities

Listed threatened species

This indicator reports the percentage of listed threatened species expected to survive in 100 years. We also report the percentages of listed species that will potentially be lost and those that are already extinct in New South Wales (Figure 5). More than 1,000 species, subspecies or populations have been listed as threatened or extinct in New South Wales. The survival of a species depends on its risk category (vulnerable, endangered, critically endangered or extinct). This indicator will change as the risk category for each listed threatened species changes over time.

The number of listed threatened species expected to survive in 100 years has declined. Conservation efforts can change this trend.

Since 2012, the percentage of listed threatened species expected to survive in 100 years has declined from 52% to 50%. In 2022, 43% will potentially be lost, assuming that current threats continue without effective management. A range of programs are in place to alleviate this potential loss by addressing current threats. These programs include the Saving our Species program, the *NSW Koala strategy*, national park acquisition, private land conservation, reintroductions of locally extinct species, restoration of habitat, and managing fire and pests.

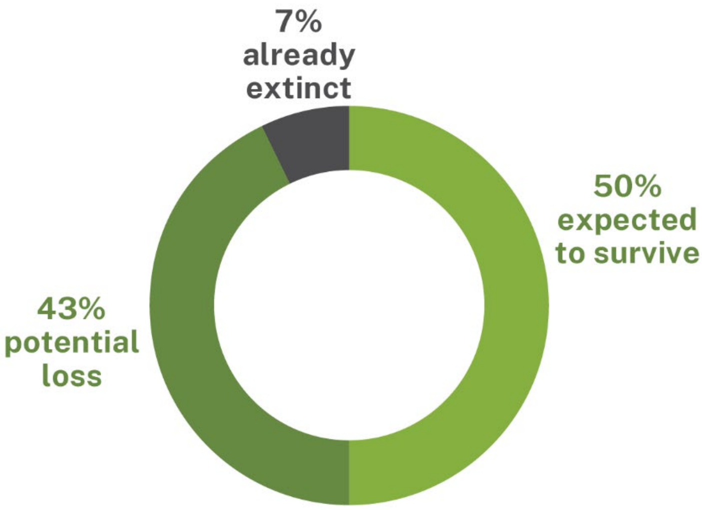
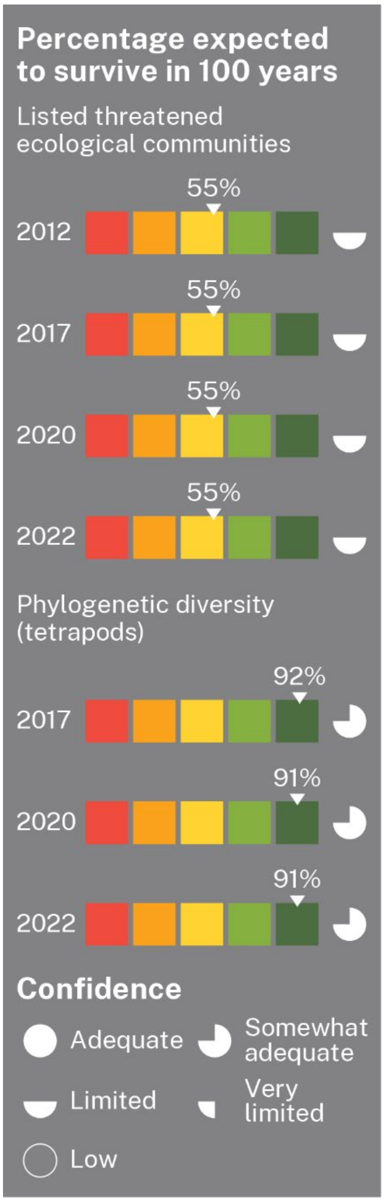


Figure 5 Percentage of listed threatened species (in 2022) which are expected to survive in 100 years, or potentially be lost in 100 years, or are already extinct



Listed threatened ecological communities

This indicator reports the percentage of listed threatened ecological communities expected to survive in 100 years. More than 100 ecological communities have been listed as threatened in New South Wales. The survival of an ecological community depends on its risk category (vulnerable, endangered, critically endangered or collapsed). This indicator will change as the risk category for each listed threatened ecological community changes over time.

The number of threatened ecological communities expected to survive in 100 years has remained the same since 2012.

Since 2012, the percentage of ecological communities expected to exist in 100 years has remained steady at 55%. No listed threatened ecological community has changed risk category during this period. This may be due to limited information rather than no change in risk of collapse.

Phylogenetic diversity

Phylogenetic diversity considers how closely or distantly species are related to each other in an evolutionary sense. This indicator reports on the proportion of the evolutionary tree for tetrapods (frogs, mammals, reptiles and birds) that is expected to persist in 100 years if certain species survive while others are lost. For example, the plains-wanderer is a species with no close relatives. It is the only living member of the family Pedionomidae. Losing such a distinctive species would result in the loss of a large proportion of the evolutionary tree, estimated to be 46 million years of unique evolutionary history. Distinctive species often have unique roles in ecosystems, such as pollinating flowers or distributing fruits of specific plants. These roles cannot be replaced.

Phylogenetic diversity is expected to decline over the next 100 years. Prioritising conservation efforts can reduce further loss.

Since 2017, the percentage of phylogenetic diversity for tetrapods expected to survive 100 years has declined from 92% to 91%. In 2022, there are more tetrapod species assessed at a higher extinction risk compared to 2017. Prioritising conservation efforts towards species that are both evolutionarily distinctive and highly threatened will significantly reduce the risk of losing irreplaceable phylogenetic diversity.

Plains-wanderer, Conargo NSW. Joel Stibbard/BCT

Expected survival of all known and undiscovered species

All known species

This indicator reports the percentage of all known vascular plant species that are expected to survive in 100 years. This indicator is reported as an average for over 6,000 species of vascular plants (ferns, cycads, pines and flowering plants) known to occur naturally in New South Wales. Rather than using a risk category, the assessment for species not listed as threatened is estimated from the proportion of habitat remaining for each species, as a percentage of what originally existed in New South Wales.

The percentage of all known species of vascular plants that are expected to survive in 100 years has declined with loss of habitat.

The expected survival of vascular plants in New South Wales remained steady at 79% between 2007 and 2017, but declined to 76% in 2020. The 2019–20 bushfires reduced the area of habitat for many species (Figure 6), increasing their risk of extinction. Burnt habitat may take decades to recover. As long as habitat improves, the risk of species going extinct will decrease, reducing the potential loss of biodiversity in 100 years.

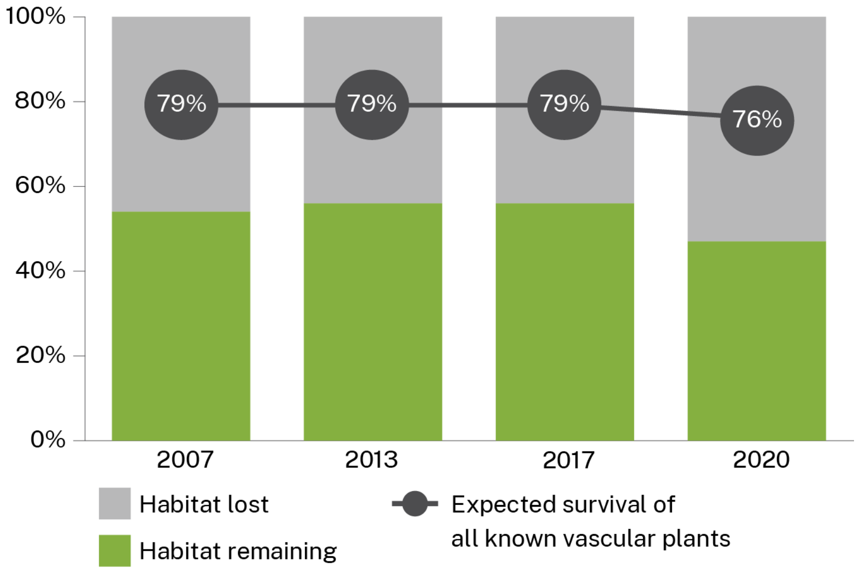
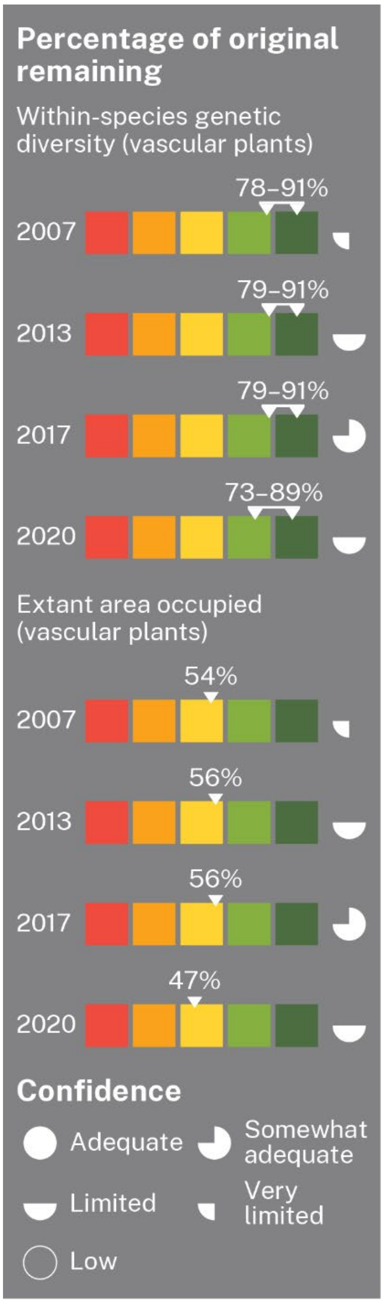


Figure 6 Percentage of habitat lost and remaining for each reported year, averaged over species; and the corresponding percentage expected to survive in 100 years



State of all known species

Within-species genetic diversity and extant area occupied

These indicators report the genetic diversity and extant area occupied (i.e. the current area of habitat occupied by each species) for all known species of vascular plants.

- Genetic diversity is based on the proportion of habitat remaining for each species (as a percentage of what originally existed in New South Wales). Upper and lower limits are reported because species vary in their capacity to retain genetic diversity when their habitat is lost.
- Extant area occupied is based on the amount of habitat remaining for each species (as a percentage of original).

These indicators are reported as an average for over 6,000 species of vascular plants known to occur naturally in New South Wales.

Genetic diversity and the average area occupied by native vascular plants have declined with loss of habitat.

Loss of suitable habitat reduced the area occupied by each species from an average of 56% in 2017 to 47% in 2020 due to the impacts of the 2019–20 bushfires. Remaining genetic diversity of vascular plants was relatively stable between 2007 and 2017 before declining to 73–89% in 2020 (Figure 7). Predicted loss of genetic diversity may not occur if habitats and populations can recover after fires.

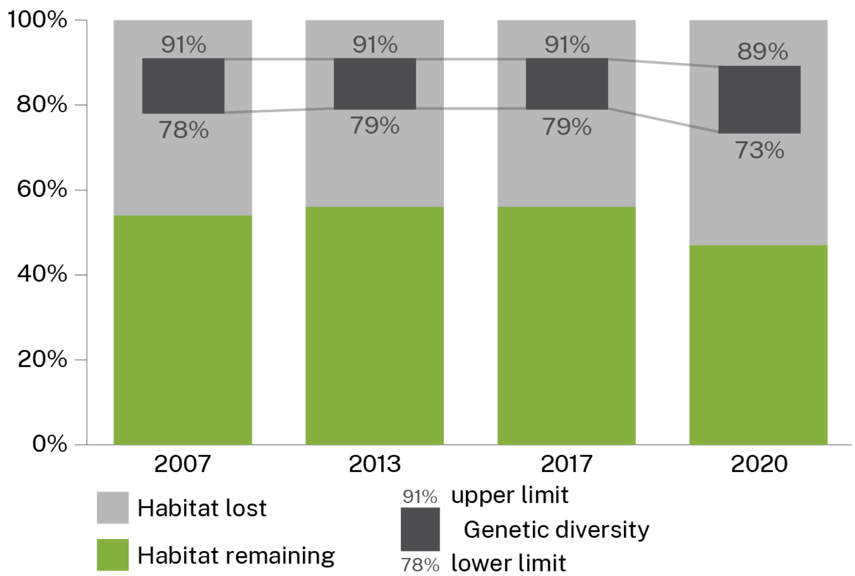


Figure 7 Percentage of original habitat lost and remaining for each reported year, averaged over species; and corresponding within-species genetic diversity

State of biodiversity including undiscovered species

Persistence of ecosystems

This indicator reports the percentage of original ecosystem diversity that is likely to persist into the future. Ecosystem diversity is lost due to declining ecological condition and ongoing habitat fragmentation. A modelled distribution of vascular plant ecosystems that originally occurred across the state is assessed against the habitat remaining in 2007, 2013, 2017 and 2020.

Remaining ecosystem diversity declined with loss of habitat.

Across the state, ecosystem diversity has declined from 77% to 74%. Within bioregions, ecosystem diversity remaining is lower across the central wheat-sheep belt and higher across eastern New South Wales (Figure 8). In 2017, the South East Corner and Australian Alps had the highest percentage of original diversity still persisting. However, these bioregions were among those severely affected by the 2019–20 bushfires, as shown by the trend arrows in Figure 8.

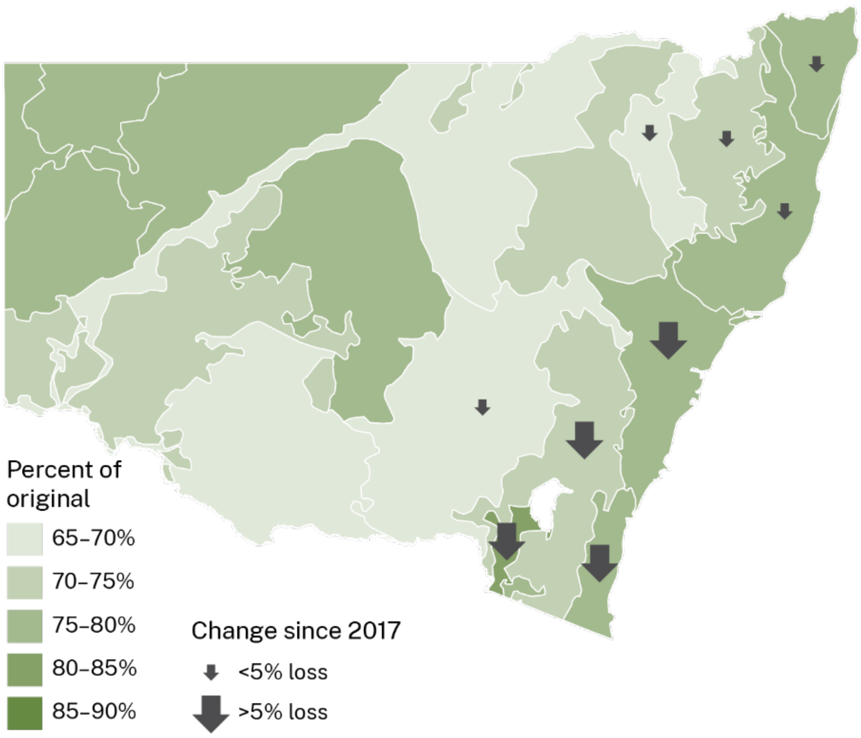


Figure 8 Percentage of original plant ecosystem diversity remaining in NSW bioregions. Values shown are for 2017, or 2020 for bioregions impacted by fires (indicated by arrows)

Field monitoring of species and ecosystems

Mountain pygmy-possum. Bec Owen and Char Corkran/NPWS

Case study: mountain pygmy-possum

The endangered mountain pygmy-possum lives only on the highest mountains of Victoria and New South Wales. In New South Wales, the species occurs only in Kosciuszko National Park, with a total population of around 950 adults when conditions are good.

The monitoring of mountain pygmy-possums at Mount Blue Cow highlights the impacts of droughts and fires.

Pygmy-possums at Mount Blue Cow resort have been monitored every spring since 1986 (Figure 9). The average count from 1986 to 1997 was 40 individuals. The most notable declines in the population occurred during the Millennium Drought (1997 to 2009), after a wildfire in 2003, and during the severe drought in 2018 to 2020. After the Millennium Drought broke in 2010, the population recovered due mainly to:

- re-establishment of vegetation following the 2003 fires
- installation of possum crossings for ski runs and roads
- undertaking feral cat control (trapping) in summer and winter.

The population declined again during the severe 2018 to 2020 drought, but a recovery is expected following 3 wet years and ongoing cat control efforts.

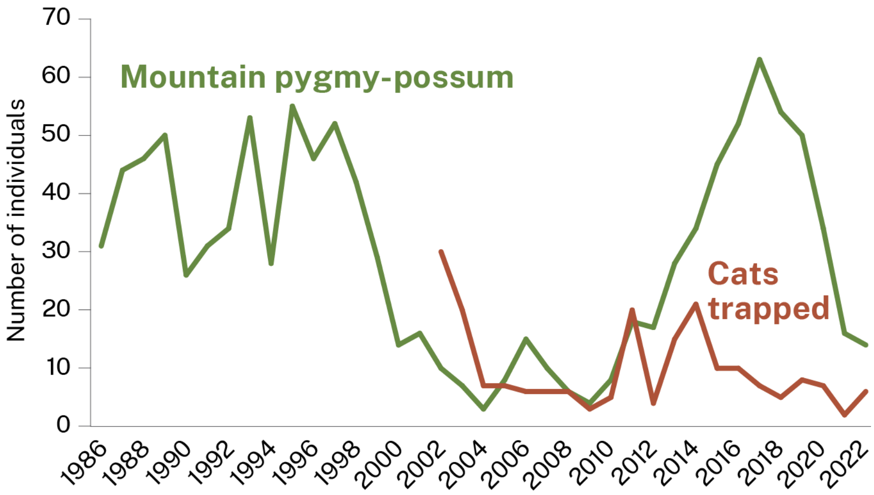


Figure 9 Numbers of mountain pygmy-possums present and cats trapped at Mount Blue Cow (1986 to 2022)

More information:

Mountain pygmy-possum profile – webpage

Case study: ecological monitoring for private conservation

The *Ecological monitoring module* governs the collection of biodiversity data and the evaluation of ecological outcomes for private land conservation sites.

Biodiversity Conservation Trust staff undertaking ecological monitoring in spotted gum-ironbark forest on a private property in the Hunter Valley.
Joel Stibbard/BCT

The Biodiversity Conservation Trust delivers private land conservation programs and fulfils certain roles under the NSW Biodiversity Offsets Scheme. It contributes to the formal protected area network through the protection and management of land under in-perpetuity private land conservation agreements.

It is crucial to demonstrate a return on the investment in biodiversity conservation and to ensure the trust's activities are leading to the best possible ecological outcomes. As such, the trust has developed the *Ecological monitoring module* to evaluate ecological outcomes. The module has protocols to evaluate the number of native plant species and their abundance, the range of tree stem sizes and soil condition at each plot. There are approximately 1,400 permanent survey plots distributed across vegetation types in private land conservation sites as well as in control sites (generally on public land). The module is providing data for understanding the condition of private land conservation sites (Figure 10), and the outcomes of management for conservation.

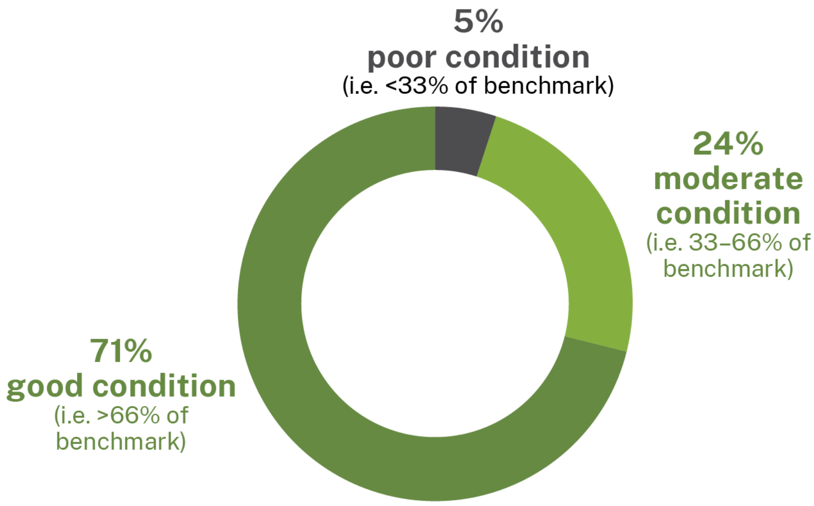


Figure 10 Percentage of monitoring plots that are in good, moderate or poor condition, relative to the benchmark (for region and vegetation type) for the number of native plant species

More information:

Assessment, compliance and monitoring – Trust webpage
BCT (2021) *BCT Ecological monitoring module* [PDF 710KB]
BCT (2022) *BCT Ecological monitoring module biodiversity outcomes report* [PDF 1.46MB]

Field surveys are assessing the ecological health of Royal National Park. Natasha Webb/ DCCEEW

Case study: monitoring ecological health in national parks

The Ecological Health Performance Scorecards Program will track long-term trends in biodiversity and paint a picture of national park health.

The NSW National Parks and Wildlife Service's Ecological Health Performance Scorecard Program aims to improve the ecological health of NSW national parks by systematically collecting ecological field data. This critical information will be used to inform and deliver effective park management. Initially, 30% of the national park estate will be monitored, including the Greater Blue Mountains World Heritage Area, Macquarie Marshes, Myall Lakes, the Pilliga, part of the Gondwana Rainforests World Heritage Area, and Kosciuszko and Royal national parks. Monitoring results will be published in publicly available national park scorecards, providing a systematic, databased picture of the health of our national parks.

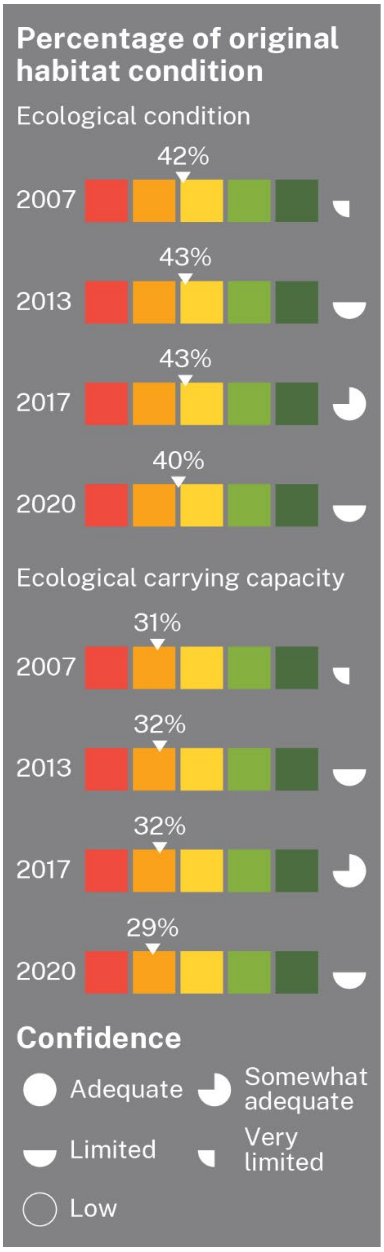
Broadscale field surveys have commenced, with 100 permanent monitoring sites established at Kosciuszko National Park (Figure 11) and 40 at Royal and Heathcote national parks. This monitoring is providing data for understanding the status of species, both native and introduced, and the condition of habitats across the national parks. Targeted surveys will also be designed to monitor threatened species, such as koalas and powerful owls, and populations of feral animals and weeds.

Figure 11 Example of data collected for Ecological Health Performance Scorecard Program. Swamp wallabies captured on a motion-sensor camera at a permanent monitoring site in Kosciuszko National Park. Photo supplied by NSW National Parks and Wildlife Service

More information:

National Parks Performance Scorecards – webpage

Habitat condition



Ecological condition and carrying capacity of terrestrial habitat

These indicators report how effective terrestrial habitats are in supporting native species and ecosystems.

- **Ecological condition** estimates the quality of terrestrial habitat at each location based on its intactness and naturalness.
- **Ecological carrying capacity** considers condition plus the additional effects that surrounding habitat loss and fragmentation have on the ability of species to move throughout the landscape.

The 2007, 2013 and 2017 reporting years are based on land-use mapping available at the time. The 2020 assessment only includes the effects of the 2019–20 bushfires, with no assessment of other changes in habitat or land use since 2017.

Ecological condition and ecological carrying capacity were relatively stable between 2007 and 2017. Both declined during the 2019–20 bushfires.

Native species and healthy ecosystems rely on habitat that is in good condition and that is well connected. Both ecological condition and ecological carrying capacity decline as native habitats are degraded, fragmented or lost. Between 2007 and 2017, ecological condition and ecological carrying capacity across the state were relatively stable. During the 2019–20 bushfires, ecological condition decreased from 43% to 40%, and ecological carrying capacity decreased from 32% to 29%.

Effective conservation efforts that protect important habitats, restore degraded ecosystems and better connect fragmented landscapes can improve ecological condition and ecological carrying capacity. This will, in turn, improve biodiversity outcomes for our native species and their ecosystems.

Ecological carrying capacity of bioregions reflects past patterns of land use.

Both ecological condition and ecological carrying capacity are lower in areas of the central wheat-sheep belt and higher across the more rugged parts of eastern New South Wales (Figure 12). This reflects past patterns of land clearing and land use across the state.

Bioregions with higher ecological carrying capacity in 2017 were most severely impacted by the 2019–20 bushfires.

Ecological condition and ecological carrying capacity in 2017 were highest in the South East Corner and Australian Alps bioregions. While ecological carrying capacity decreased across all eastern bioregions during the 2019–20 bushfires (Figure 12), these 2 bioregions were the most severely affected.

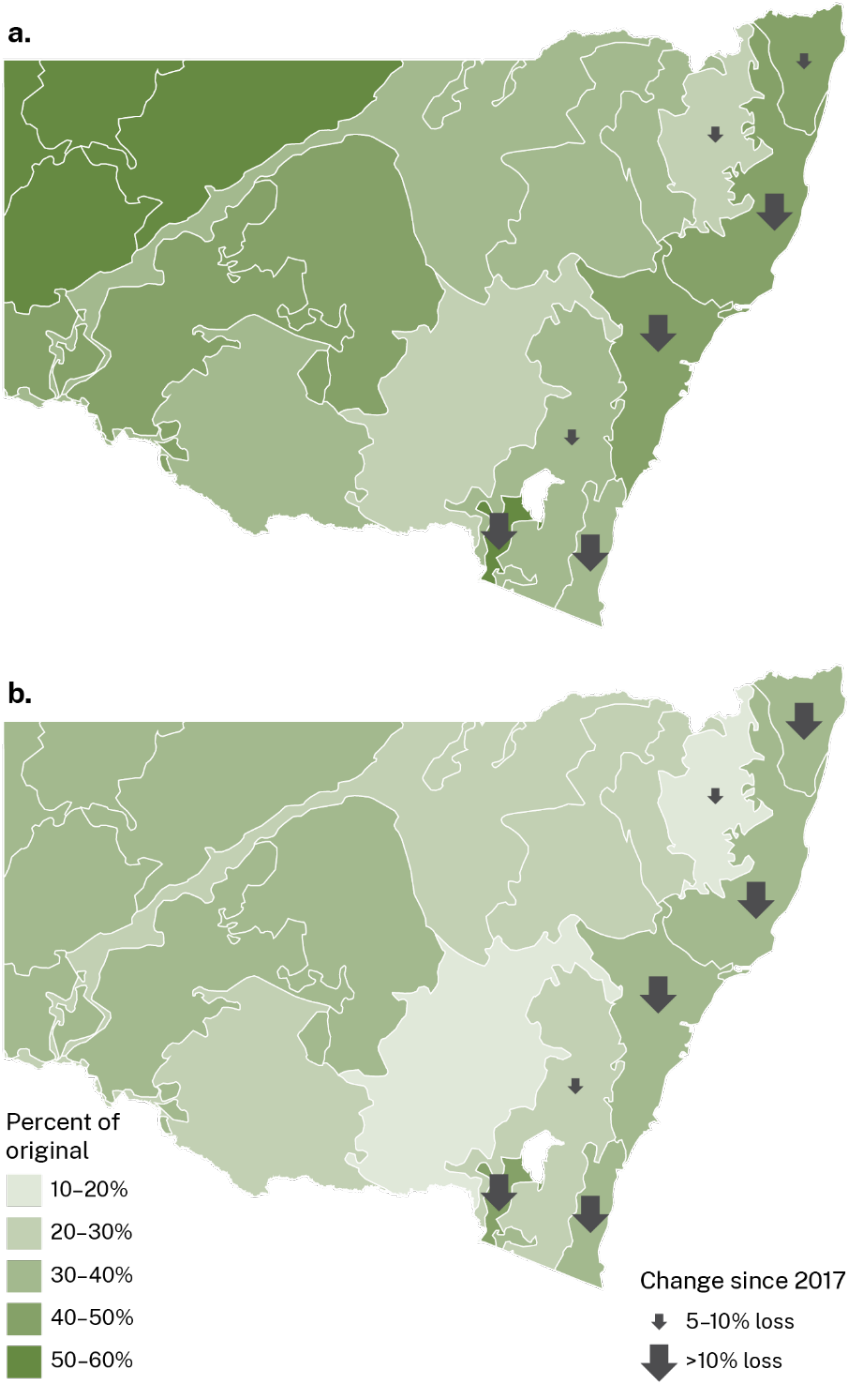


Figure 12 Percentage of original a) ecological condition, and b) ecological carrying capacity remaining in each NSW bioregion. Values shown are for 2017, or 2020 for bioregions impacted by fires (indicated by arrows)

Research highlight: predicting the integrity of native vegetation

Vegetation integrity includes the composition, structure and function of native vegetation. Indicators currently used to report habitat condition do not capture insights provided by site-specific data. We are exploring how to best use site data to assess the vegetation integrity of different plant groups to improve this indicator (Figure 13). Standardised field methods are used to collect data on vegetation structure (percent foliage cover) and composition (number of native species).

- For each plant group (trees, shrubs, grasses and others), we calculated vegetation structure and composition relative to the benchmark. The benchmarks describe the 'best-attainable' condition for each vegetation type.
- Predictive models of foliage cover and native species richness can then be applied to show where different plant groups are above or below their benchmark.

Vegetation integrity mapping has been completed for 11 million hectares in northern New South Wales. This method could be applied to assess all of New South Wales and could be improved to capture more aspects of vegetation integrity, including functional aspects. This mapping provides important site-scale information to complement our habitat condition indicator family, supporting private land conservation, biodiversity offsets and other programs.

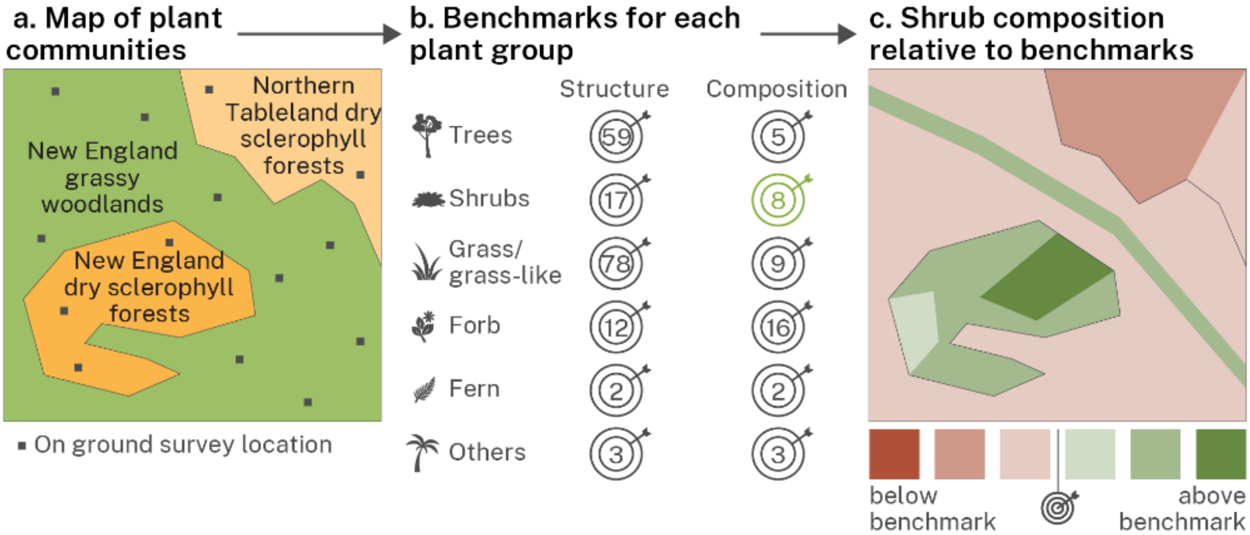
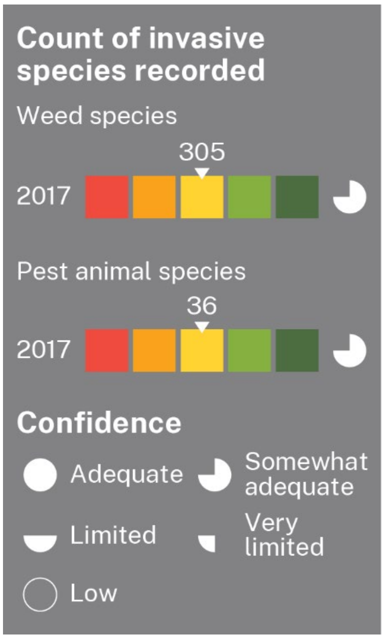


Figure 13 Method used to assess vegetation integrity; (a) field survey of vegetation structure and composition, (b) comparison to benchmarks for each vegetation type (New England dry sclerophyll forests is shown), and (c) prediction of vegetation integrity relative to benchmark (species composition of shrubs is shown)

More information:

Vegetation condition benchmarks – webpage

Pressures



Invasive species

This indicator reports on the exposure of our native species and ecological communities to invasive species. Invasive species are those species that do not naturally occur in New South Wales and whose introduction or spread threatens biodiversity. It is measured here as the number of invasive weeds (305) and pest (feral) animals (36) known to occur in New South Wales. The impact of invasive species on threatened species and ecological communities is not reported here.

All of New South Wales is affected by invasive species, but exposure varies across the state.

The number of weed species varies considerably across the state (Figure 14a). A large number of different weeds are concentrated around human population centres, especially around Sydney and the eastern part of the state. In contrast, the different pest animals that occur in the state are more evenly distributed across bioregions (Figure 14b).

Red foxes, feral cats and Paterson's curse are the most widespread invasive species in New South Wales.

The most widespread weed in New South Wales is Paterson's curse, with records across 9% of the state (Table 1). Red foxes and feral cats have been observed across almost the entire state, overlapping with most native species and ecological communities. The primary cause of decline for many threatened species in New South Wales is predation by red foxes and feral cats, and competition from feral herbivores.

Table 1 The most widespread weeds and pest animals in New South Wales

Common name	Spatial extent (%)
Weeds	
Paterson's curse	9
Sweet briar	5
Saffron thistle	5
Lantana	5
Pest animals	
Red fox	99
Feral cat	98
Feral rabbit	82
Feral pig	70

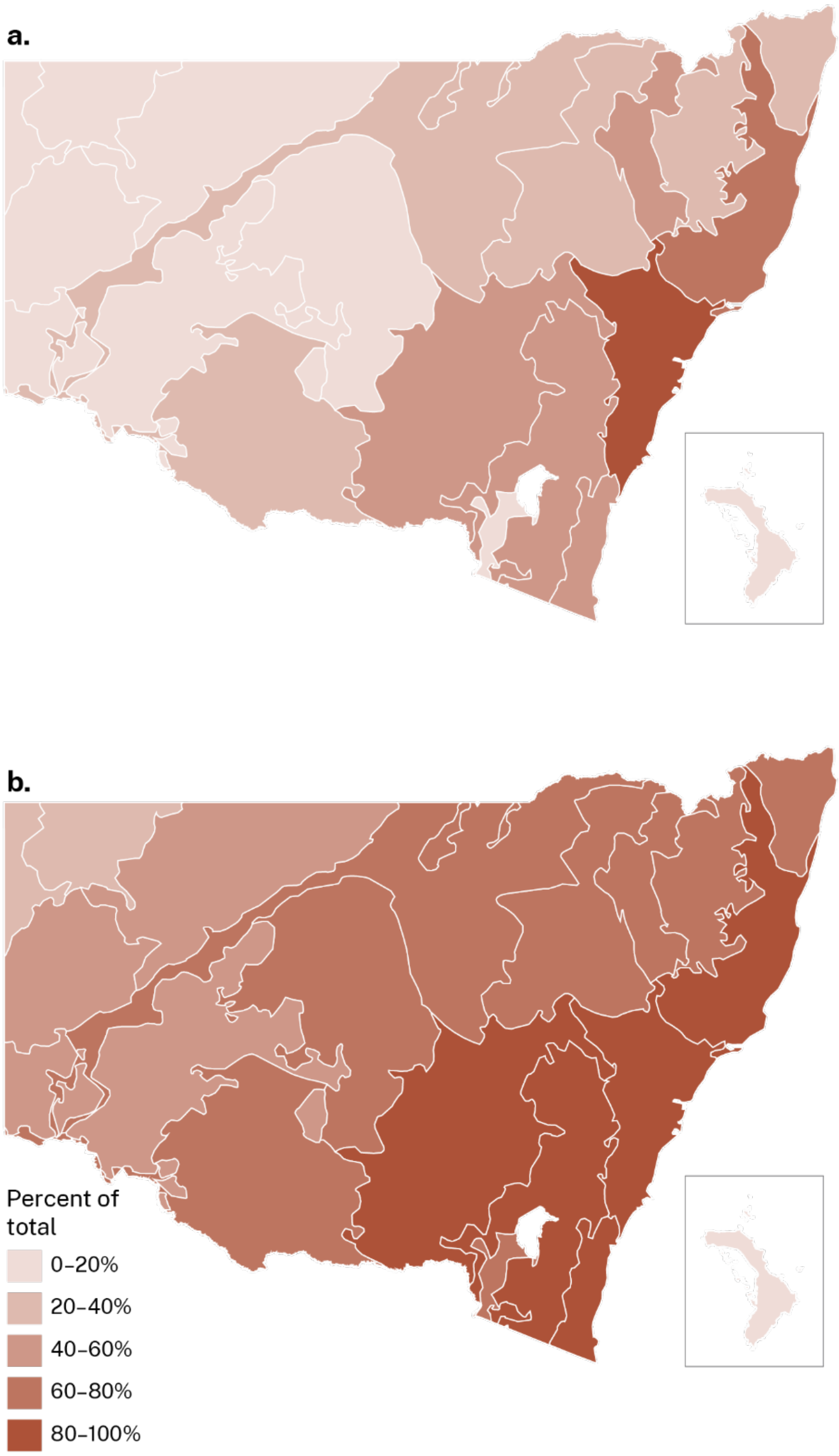


Figure 14 Percentage of a) the 305 invasive weed species, and b) the 36 pest animal species recorded in each NSW bioregion between 1980 to 2017

Native vegetation and cleared land in Kangaroo Valley, NSW. Michael Van Ewijk/ DCCEEW

Case study: clearing of native woody vegetation

The clearing of native woody vegetation has declined since 2018 but remains higher than 2009 to 2017.

The Statewide Landcover and Tree Study maps the location and extent of woody vegetation (trees, shrubs or woody vines). Vegetation clearing is grouped under 3 land-use types: agriculture, infrastructure and native forestry. Removal of native vegetation directly threatens biodiversity by reducing the amount and connectivity of suitable habitat.

The clearing of woody vegetation is higher in the period 2016 to 2021 compared to 2009 to 2015 (Figure 15). Much of the change has been clearing for agriculture. Clearing for native forestry has declined each year since 2016, decreasing by about a third between 2020 and 2021. Clearing for agriculture declined between 2018 and 2020 before increasing again in 2021.

Clearing of grasslands and other non-woody native vegetation has been monitored since 2018. Clearing rates for non-woody native vegetation are around 3 times higher than clearing of woody vegetation and nearly all non-woody clearing is for agriculture.

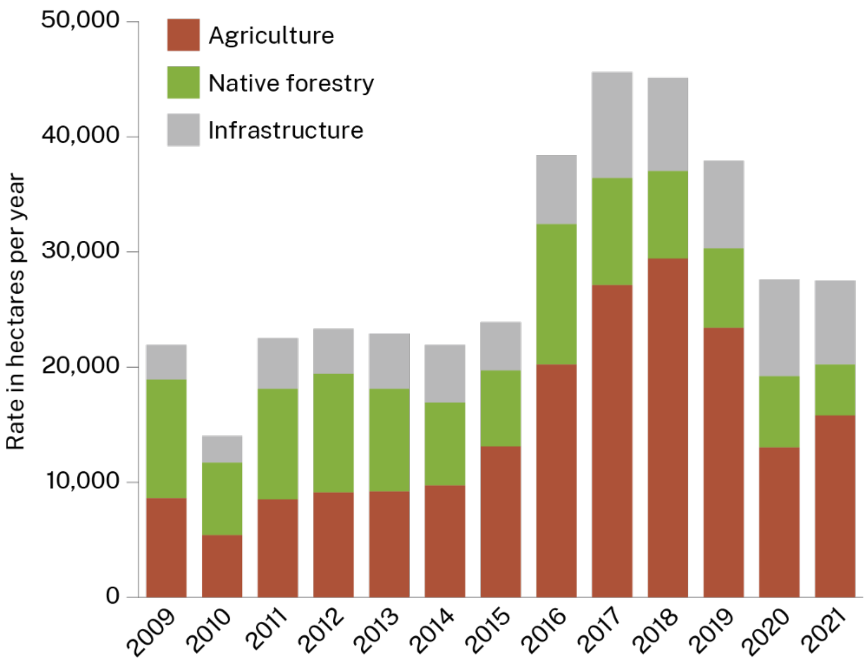


Figure 15 Rate of woody vegetation clearing for agriculture, native forestry and infrastructure (2009 to 2021)

More information:

2021 NSW Vegetation clearing report – webpage
Long-term trends in woody vegetation clearing – webpage

Post-fire regrowth, Timblica, NSW. Alex Pike/ DCCEEW

Case study: fire thresholds

Fire thresholds identify the acceptable fire intervals (i.e. time between fires) for each of the 12 broad vegetation formations in New South Wales. They specify the minimum and maximum number of years between fires that are suitable for conserving biodiversity. At a landscape scale, it is recommended that 50% of each vegetation formation is within the specified fire threshold. This case study looks at 8 'dry' vegetation formations in New South Wales.

Dry vegetation formations have less than 50% of their area within fire thresholds, and the percentage is declining.

Since 2011, the percentage of dry vegetation formations within fire thresholds has been declining (Figure 16). The 2021 data includes the impacts of 2019–20 bushfires.

These estimates of the percentage of dry vegetation formations within fire thresholds are uncertain because large areas of these formations have no recorded fire history. This is likely to be due to a lack of records rather than the lack of fire. Results here consider how long it has been since the last fire, but not frequency of fire over time, fire severity, previous land use and other factors which influence fire behaviour; or the post-fire recovery of vegetation and fauna.

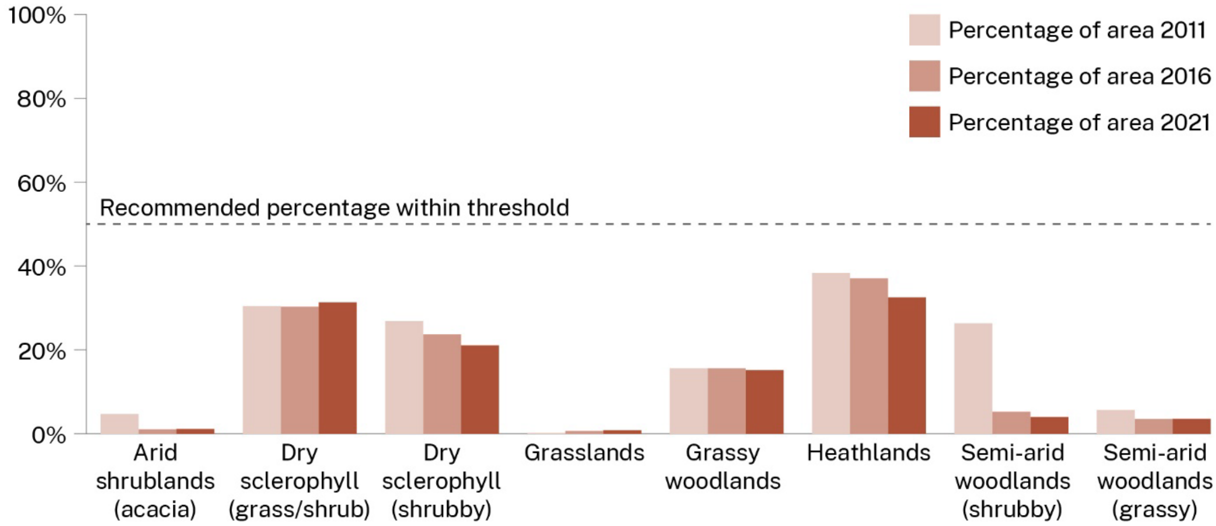


Figure 16 Percentage of dry vegetation formations within fire thresholds in New South Wales (2011, 2016 and 2021)

More information:

OEH 2012, 'Living with fire in NSW national parks: a strategy for managing bushfires in national parks and reserves 2012–2021', Office of Environment and Heritage, Sydney
DPIE 2020, 'NSW Fire and the environment 2019–20 summary', Department of Planning, Industry and Environment, Sydney

The royal spoonbill is one of the waterbird species that benefits from flooding of wetlands.
Daryl Albertson/ DCCEEW

Case study: managing environmental water for biodiversity

Environmental water has been used to make natural flood events last longer and to support waterbird breeding.

Environmental water, or water for the environment, is water that is managed specifically to improve the health of rivers, wetlands and floodplains. The Department of Climate Change, Energy, the Environment and Water, together with other water managers (Commonwealth Environmental Water Office and Water NSW) manages the delivery of water for the environment to 5 main valleys in New South Wales: the Gwydir, Macquarie, Lachlan, Murrumbidgee and Murray – Lower Darling.

Waterbirds are useful indicators of wetland health. Colonial-nesting waterbirds, including pelicans, ibis, spoonbills, herons and egrets, can nest in large numbers in response to the flooding of inland wetlands.

Each year, surveys are conducted to document waterbird diversity, numbers and breeding activity in the NSW Murray–Darling Basin. Ground surveys complement long-term aerial surveys (i.e. counts of birds from aircraft). Figure 17 shows aerial estimates of waterbird numbers fluctuating over time with the area of wetlands inundated. Survey results help us direct the management of wetlands and delivery of environmental water to maintain waterbird feeding and breeding habitats.

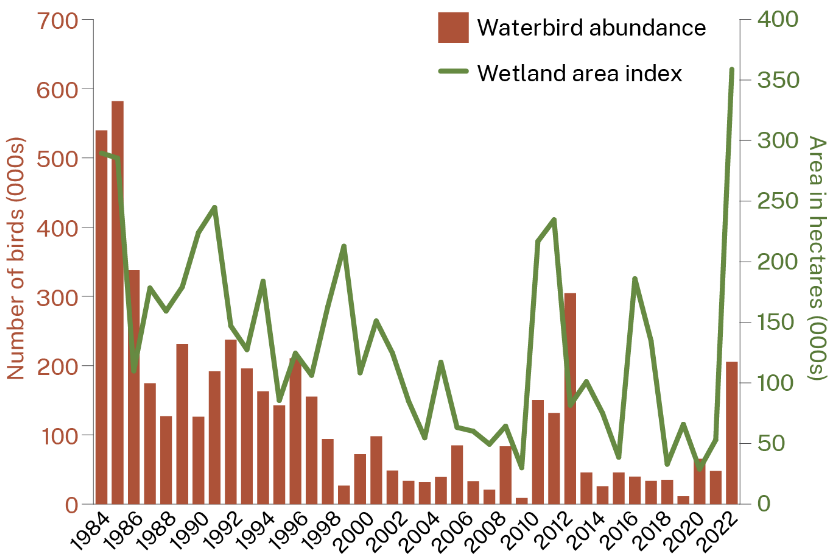


Figure 17 Waterbird numbers and wetland area index (hectares) in New South Wales (1984 to 2022)

More information:

Water for the environment – webpage
Eastern Australian Waterbird Survey – UNSW webpage

Management responses

Areas permanently managed for conservation

This indicator reports the area of land that is secured permanently for long-term biodiversity conservation outcomes. These include public and private tenures with legal agreements to conserve biodiversity in perpetuity.

The percentage of the state that has been secured for permanent protection has steadily increased.

Between 2007 and mid-2023, the area permanently protected for conservation in New South Wales increased from 6.9 to 9.0 million hectares. As of June 2023, this area covered 11.2% of the state, comprising 10.5% public land and 0.7% privately held.

The percentage of each bioregion that is permanently protected varies considerably.

Historically, bioregions with the most land area under permanent protection have been those along the eastern slopes and ranges (Figure 18). Poorly protected bioregions (those with less than 5% under permanent protection) are found in the heavily fragmented agricultural lands of central New South Wales. Since 2007 there have been larger increases (>2.5%) in areas under permanent protection in bioregions in the far west of the state, providing better representation of semi-arid and arid ecosystems.

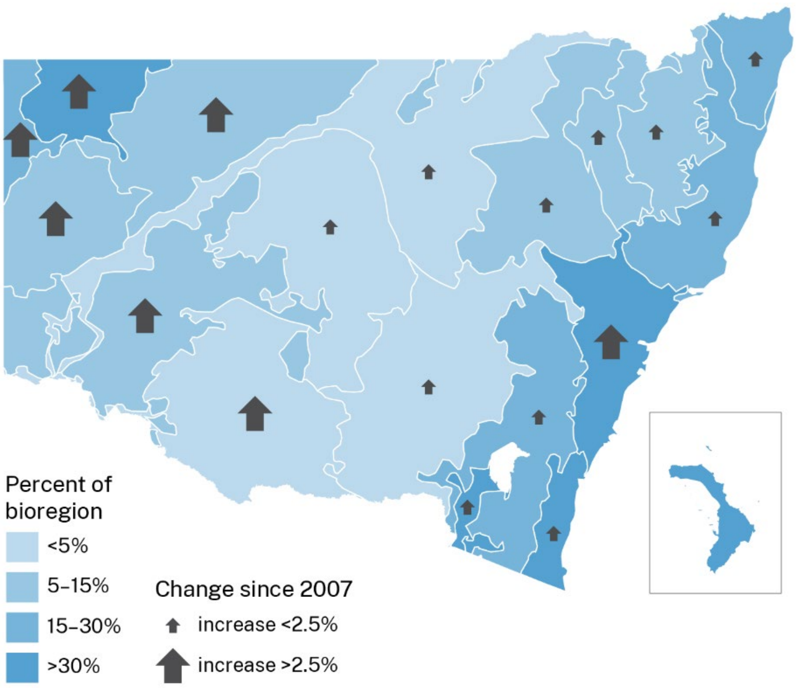
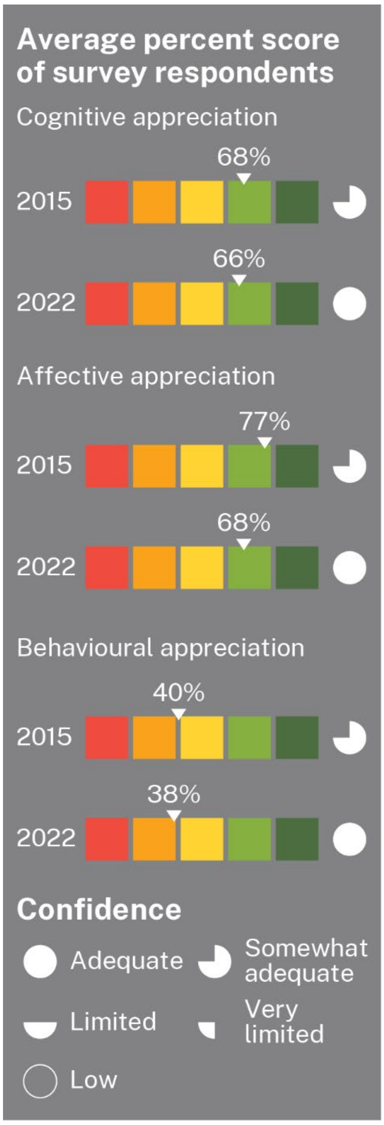


Figure 18 Percentage area of NSW bioregions permanently managed for conservation in June 2023



Community appreciation of biodiversity

This indicator reports how the NSW community understands, values and acts to protect biodiversity. The 2022 survey is an enhanced version of the 2015 survey, with more questions to improve our confidence in measuring the following 3 dimensions of appreciation:

1. cognitive – knowledge of biodiversity and its value
2. affective – how much people care about biodiversity
3. behavioural – what people are doing to protect biodiversity.

The NSW community generally understands and values biodiversity, but do not necessarily have a high level of engagement in activities that protect biodiversity.

In 2022, people scored an average of 66% on cognitive appreciation questions and 68% on affective appreciation questions. The average score for the behavioural dimension was much lower at 38%.

Six distinct groups emerge from the analysis. These groups reflect how appreciation of biodiversity can vary across the community (Figure 19). In 2022, one-third of respondents fell into the 2 most appreciative groups ('highly appreciative' and 'appreciative and highly active'). The 'aware and concerned' group was the largest group (29%), scoring high on awareness and care for biodiversity, but were engaged in fewer activities. There was a small group (7%) of 'active only' people who engage in activities that support biodiversity despite not demonstrating that they understood its importance. One-fifth (18%) of the community were in the 'aware but unconcerned' group — they understood the importance of biodiversity, but care for it and involvement in activities that would support it were low. The 'unappreciative' group (13%) had the lowest levels of biodiversity awareness, value and engagement in actions.

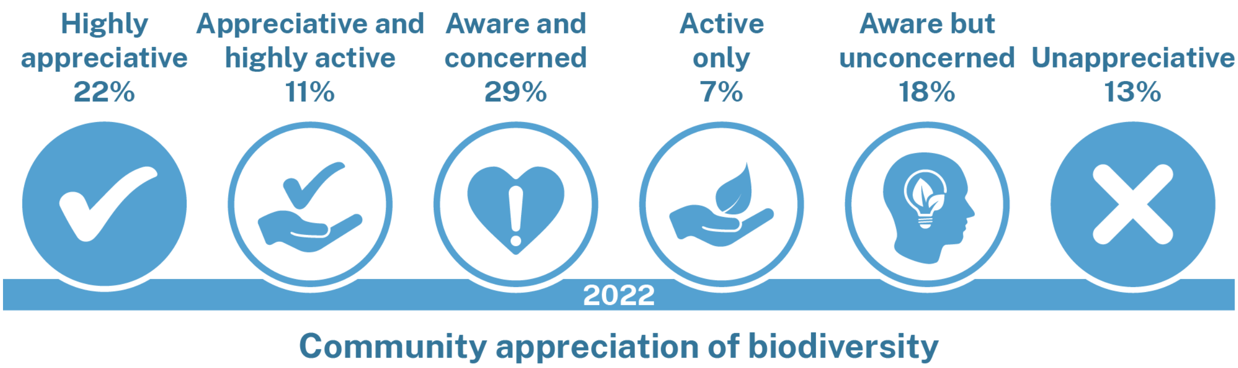


Figure 19 Percentage of respondents in each biodiversity appreciation grouping in 2022

Management effectiveness

Case study: feral animal eradications on NSW islands

Feral-free island sanctuaries have been re-established in New South Wales.

Islands in New South Wales have the highest level of bird extinctions anywhere in the state. The re-establishment of these islands as sanctuaries is the result of 20 years of targeted feral animal control (Table 2). These islands are unique ecosystems, as they have evolved without mammals but with year-round domination by ground-dwelling invertebrates. Seabirds arrive to breed each year on specific islands and, in doing so, bring in vast quantities of marine-derived nutrients.

Feral animals have been present on some islands for more than 100 years, impacting breeding seabirds, soil fertility, vegetation, invertebrates and terrestrial birdlife. The removal of feral animals reduces pressures on invertebrates and allows the vegetation to recover. This unfortunately includes the recovery of weeds, so the control and removal of weed species remains a top priority on these islands.

The recovery of bird populations and establishment of new seabird species on these islands are clear signs the islands are recovering. However, recovery can take many years without specific and ongoing assistance.

Lord Howe Island woodhens benefit from the removal of feral animals.
Nicholas Carlile/DCCEEW

Table 2 NSW islands targeted for feral animal eradication and the year of declared successful eradication

Declared success	Island targeted	Black rat	House mouse	European rabbit
2023	Lord Howe	✓	✓	
2016	South Solitary		✓	
2011	Broughton	✓		✓
2011	Little Broughton	✓		
2009	Barunguba / Montague		✓	✓
2009	Brush	✓		
2000	Cabbage Tree			✓

More information:

Priddel D, Carlile N, Wilkinson I and Wheeler R (2011) Eradication of exotic mammals from offshore islands in New South Wales, Australia, pp. 337–344 in *Island invasives: eradication and management*, CR Veitch, Clout MN and Towns DR (eds), IUCN, Gland, Switzerland

Adult Gould's petrel on the forest floor of Cabbage Tree Island, NSW.
Nicholas Carlile/ DCCEEW

Case study: recovery program for Gould's petrel

Addressing on-island threats has led to an increased number of islands in New South Wales where Gould's petrel breeds.

Before a recovery program began, Cabbage Tree Island was the only breeding site for Gould's Petrel in the world. Since 1993, breeding success on the island has improved because of:

- removing native birdlime trees from the petrels' breeding habitat to reduce entanglement in the tree's sticky fruits
- culling pied currawongs which prey on petrel chicks
- removing rabbits to allow understorey vegetation to recover, which in turn reduces birdlime fruit-fall and provides protection from predators.

Since the recovery program began, the species has spread out to 4 other islands in New South Wales. However, the number of breeding pairs and fledglings on Cabbage Tree Island has somewhat declined since 2010 (Figure 20). The decline is not well understood but may be related to limited availability of food at sea in the foraging areas used in the breeding and non-breeding seasons. Research is now being conducted on Cabbage Tree Island and on the successful new colony on Barunguba / Montague Island to help understand and prevent possible future declines. Our aim is to maintain robust and self-sustaining populations of our threatened seabirds on New South Wales islands in the face of a changing climate.

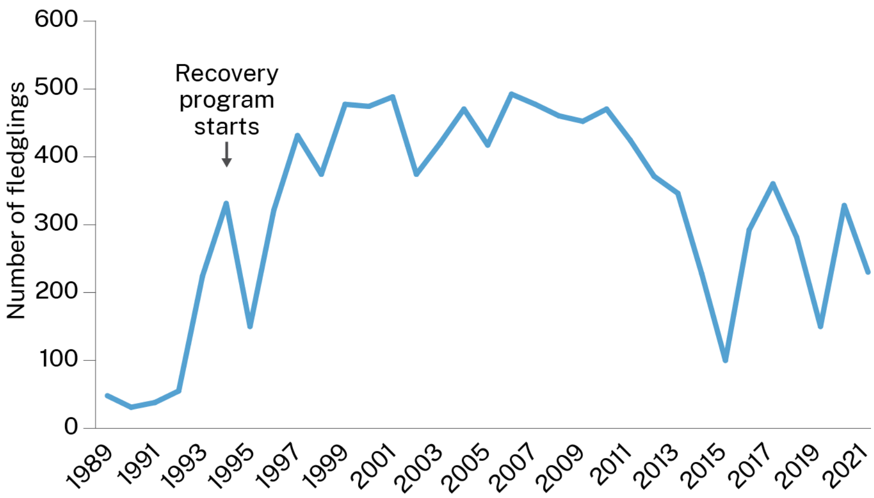


Figure 20 Number of Gould's petrel fledglings produced in Cabbage Tree Island (1989 to 2021)

More information:

Gould's petrel profile – webpage

Orange hawkweed. Mark Hamilton/ DCCEEW

Case study: eradicating hawkweed

Despite a huge increase in area searched since 2010, less than 10 hectares of orange hawkweed have been detected, indicating good progress towards eradication.

Hawkweeds are perennial herbs native to Eurasia and are classed as serious weeds in many parts of the world, including New South Wales. The NSW Hawkweed Eradication Program targets orange and mouse-ear hawkweeds in Kosciuszko National Park and the Snowy Monaro region.

To target management efforts, ground-based surveys involving staff from different agencies and over 350 volunteers have been undertaken since 2009. To complement these efforts and enable rapid detection of the weeds, unique surveillance tools are being used. This includes dogs trained to detect hawkweeds and drones to capture aerial imagery. The imagery is automatically processed, enabling tens of thousands of hectares to be surveyed annually.

The program has dramatically increased the area searched each year, from 293 hectares in 2010 to 28,000 hectares in 2022. More than 45,000 hectares have been searched since 2010 (Figure 21). The area surveyed between 2020 to 2022 was much larger than previous years, but the total area of hawkweed found increased only slightly. This means that the program is well on track to finding the limits of the infestation, which will ultimately lead to eradication.

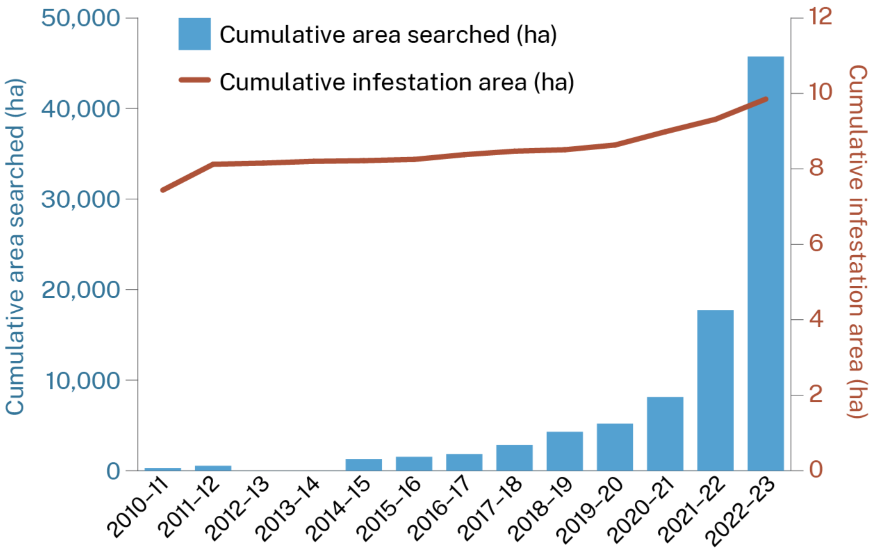


Figure 21 Cumulative area of hawkweed infestation compared to cumulative area searched (2010 to 2023)

More information:

Orange hawkweed – webpage

Helicopter with thermal imager and visual-spectrum camera for aerial survey of large animals. Gerhard Koertner/ DCCEEW

Case study: aerial surveys of large feral animals in national parks

Estimating population size using aerial surveys can support management of large feral animals by guiding removal targets and measuring population change.

Significant resources are invested every year in managing large feral animals in NSW national parks. In 2022–23, over 45,000 feral animals were removed from parks using aerial shooting, mustering, ground shooting and trapping. However, without effective monitoring it is not possible to assess the long-term effects of these control measures on feral animal populations.

In 2022, aerial surveys of large feral animals began at key management sites. Thermal imagers coupled with visual-spectrum cameras are being used to improve detection of feral animals, especially under canopy cover. Population estimates are used to estimate the number of animals that need to be removed to offset potential population growth. If the number of animals removed can be sustained at levels above potential growth rates, then we can achieve long-term suppression. Repeated surveys can then be used to measure the success of feral animal management over the long term.

Figure 22 shows population estimates, numbers removed and targets for removal for sites where feral pigs occur. At some sites, the number of animals removed is near or above the target for removal. For others, considerably more effort will be needed to suppress pig populations. Based on surveys to date, at least 180 kilometres of aerial survey transects may be needed to provide precise population estimates. However, at sites with extensive areas of closed canopy we may need to use another approach to estimate population numbers.

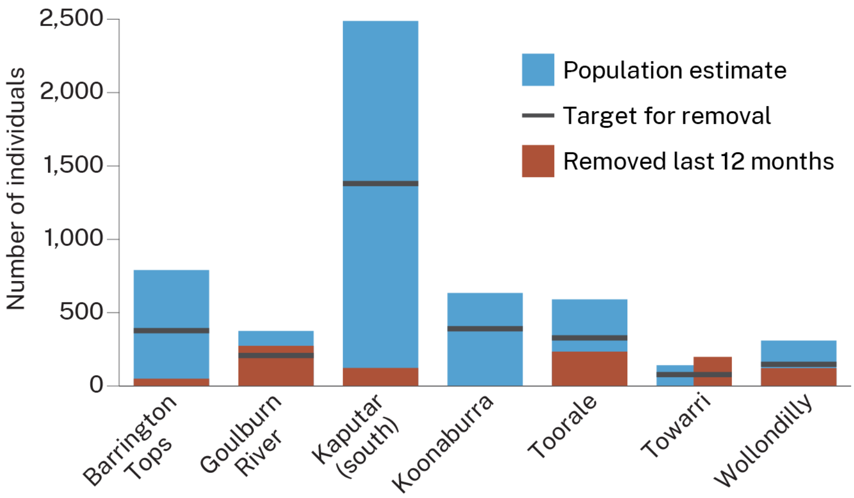


Figure 22 Population estimates based on aerial surveys for feral pigs in 2022–23, together with numbers removed in the preceding 12 months and the target to offset potential growth

Bilby reintroduced to the Pilliga feral predator–free area. Wayne Lawler/AWC

Case study: reintroducing locally extinct mammals

The creation of feral predator–free areas is an important strategy to prevent extinctions and restore populations.

Predation by feral cats and foxes has been a primary cause of mammal decline and extinction across Australia. By fencing an area to eradicate and exclude all feral predators (cats, foxes, dogs), it becomes possible to reintroduce animal species that have become locally extinct in New South Wales.

Feral predator–free areas have been established in Sturt and Mallee Cliffs national parks and Pilliga State Conservation Area. At these sites, 12 locally extinct species have been successfully returned, including greater bilby, numbat and Mitchell's hopping mouse. Further reintroductions across all 3 sites are planned in 2023–24 and beyond. New feral predator–free areas are also being established at Ngaamba and Yathong nature reserves, and South-east Forest and Yiraaldiya national parks.

In 2018, 60 bilbies were reintroduced to the feral predator–free area at Pilliga State Conservation Area (Figure 23). By July 2022, the population had increased to an estimated 335 individuals, but declined in late 2022 during a record-breaking flood event. In addition to Pilliga, bilbies have been released in Sturt and Mallee Cliffs national parks and will also be reintroduced to Yathong Nature Reserve. Together these 4 sites are expected to support between 4,800 and 10,400 bilbies over time, increasing the estimated global population by more than 50%.

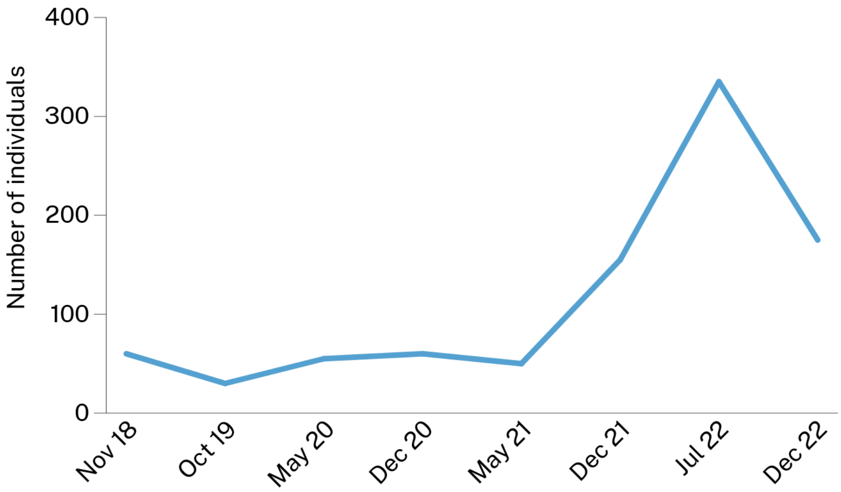


Figure 23 Population estimates of greater bilbies in the feral predator–free area in Pilliga State Conservation Area (2018 to 2022)

More information:

Feral predator–free areas project – webpage

Capacity to retain biological diversity

Percentage spatial resilience remaining

With current habitat and future climate

11%

2013

Confidence

Adequate

Somewhat adequate

Limited

Very limited

Low

Ecosystem resilience under climate change

As the climate changes, habitats can become less suitable for the species they currently support. These species respond by either staying where they are and adapting, or moving, or disappearing. Connected landscapes allow 'climate migration', which provides opportunities for species to move when their habitat becomes less suitable.

Spatial resilience measures a landscape's capacity to support migration as species respond to climate change. This indicator assesses how well species in their current locations are connected to places with suitable habitat under future climatic conditions. It considers the rate of climate change and how habitat loss and fragmentation impede migration for all species.

Past habitat loss and future climate change has significantly reduced the capacity of landscapes to retain biodiversity in 50 years.

In 2013, the percentage of spatial resilience of ecosystems remaining in New South Wales was 11%. This accounts for the loss of resilience due to past habitat loss and fragmentation (41%), and losses due to future climate change if not mitigated (48%). Spatial resilience highlights where landscapes can passively support climate migration, and where landscapes will need active management such as habitat restoration to improve resilience.

The percentage of spatial resilience remaining in each bioregion varies.

Bioregions in central New South Wales have a high risk of biodiversity loss due to climate change (Figure 24). These bioregions have high rates of past habitat loss and fragmentation, and a reduced potential for species migration. They will require the most active management to ensure their biodiversity is retained.

Bioregions in eastern New South Wales — including the Australian Alps, NSW North Coast, South East Corner and Sydney Basin — are the most spatially resilient to climate change. This is because the rate of climate change will be slower in these bioregions and habitats are more intact and connected. By improving habitat condition and connectivity across all bioregions, biodiversity loss to climate change can be reduced.

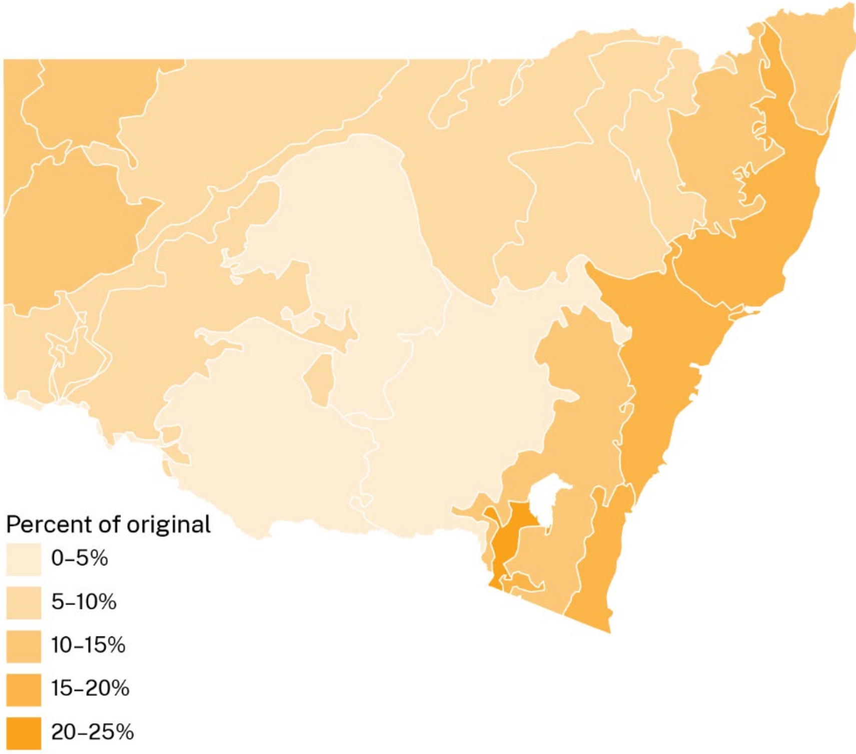


Figure 24 Spatial resilience of NSW bioregions with current habitat and future climate to 2070

More information:

Harwood et al. (2022) 'Staying connected: assessing the capacity of landscapes to retain biodiversity in a changing climate', *Landscape Ecology*, 37:3123–3139

Next steps

Indicator report cards

This report is a summary of the work being progressed by the Biodiversity Indicator Program. If you want to find out more about each indicator, please see our standalone indicator report cards that are being progressively released. Indicator report cards provide more detailed results for one or more indicators within an indicator family and include information on how the indicators were created.

Methods and data

The technical method for the Biodiversity Indicator Program, including the full indicator framework, can be found on our website (see link below). The specific workflows and data sources for each indicator are detailed in implementation reports. Data packages for each indicator, which allow for even more detailed reporting, are uploaded to the NSW Government's open-access Sharing and Enabling Environmental Data (SEED) data portal.

More information

- A Biodiversity Indicator Program for NSW – webpage including links to all our reports and to sign up to our mailing list
- Data packages for the Biodiversity Indicator Program – Sharing and Enabling Environmental Data (SEED) data portal

Glossary

Animal: any animal, whether vertebrate or invertebrate, and in any stage of biological development, classified in the kingdom Animalia.

Benchmark: the 'best-attainable' vegetation condition, which acknowledges that native vegetation within the contemporary landscape has been subject to both natural and human-induced disturbance. Multiple benchmarks are specified for each vegetation type. Vegetation with relatively little evidence of modification generally has minimal timber harvesting, minimal firewood collection, minimal weed cover, minimal grazing and trampling by introduced or overabundant native herbivores, minimal soil disturbance, minimal canopy dieback, no evidence of recent fire or flood, is not subject to high-frequency burning and has evidence of recruitment of native species.

Biodiversity (biological diversity): variety of living things from all sources (including terrestrial, aquatic, marine and other ecosystems). It includes genetic diversity, species diversity and ecosystems diversity. Biodiversity includes plants, animals, fungi and microorganisms.

Bioregion: relatively large land area characterised by broad, landscape-scale natural features and environmental processes that influence the functions of ecosystems and the species present. There are 19 bioregions represented in New South Wales, including Lord Howe Island.

Composition: the combination of species occurring together at a location, including the count of species, the species names, and their respective abundances.

Disturbance: any process or event which temporarily alters the composition, structure and/or functioning of an ecosystem. Includes natural events such as fires and floods as well as human impacts.

Ecological carrying capacity: the ability of an area to maintain self-sustaining and interacting populations of all species naturally expected to occur there, given the habitat resources (such as food and water) and connections to other habitat needed for persistence.

Ecological community: the combination of species occupying a particular area at a particular time. Species occurring together in a community frequently interact in a variety of ways and share similar habitat requirements.

Ecological condition: the intactness and naturalness of habitat to support biodiversity, without considering the indirect effects of fragmentation or connections with surrounding suitable habitat.

Ecological connectivity: the degree to which similar habitats are connected within a landscape, allowing species to move between locations (e.g. via a habitat corridor or stepping stones).

Ecological integrity: the diversity and quality of ecosystems and their capacity to adapt to change.

Ecosystem: a group of ecological communities and their nonliving environment (e.g. terrain or climate) that interact as a functional unit. Ecosystems may be small and simple, such as an isolated pond, or large and complex, such as a specific tropical rainforest or a coral reef.

Ecosystem diversity: the number and variety of ecosystem types present within a region. Different ecosystem types provide different habitats for species and are distinguished from one another by the different combinations of species found in them. Ecosystem types may also differ in a variety of other attributes such as vegetation structure (e.g. forest versus grassland), the natural frequency of fires, and the rate at which nutrients are recycled. The type of ecosystem that will occur will depend on the local environmental conditions (e.g. temperature, rainfall, soil type) and history of disturbance (e.g. fire).

Expected survival: number or percentage of species or ecological communities likely (with a high probability) to persist over some timeframe (e.g. 100 years).

Fungi: a diverse group of organisms in the taxonomic kingdom Fungi, including mushrooms, moulds, mildews, smuts, rusts and yeasts.

Genetic diversity: the range of intrinsic differences in genes among individual organisms within a species, or among different species within a taxonomic group.

Habitat: an area or areas occupied, or periodically or occasionally occupied, by a species, population or ecological community, including any living or non-living component.

Habitat condition: the capacity of an area to provide the structures and functions necessary for the persistence of all species naturally expected to occur there in an intact state.

Habitat fragmentation: the emergence of gaps (fragmentation) in previously connected habitat, limiting the movement of species.

Indicator: a numerical value that gives insight into the current state, or a change in state, of biodiversity or ecological integrity.

Invasive species: a species (including microbes that cause disease) that has been introduced into a region in which it does not naturally occur and that becomes established and spreads, displacing naturally occurring species.

Persistence: the ability of biodiversity or its components to sustain or persist through time.

Plant: any plant, whether vascular or non-vascular and in any stage of biological development, classified in the kingdom Plantae. Note that under NSW biodiversity legislation, 'plant' includes fungi and lichens but not marine vegetation.

Predictive model: an abstract, usually mathematical, representation of relationships within a system, which allows for prediction. A model can be used to predict the characteristics of a location that have not been surveyed, or can predict how characteristics will change with changing conditions (e.g. climate change).

Pre-industrial era: the period prior to the Industrial Revolution and thus before the significant changes in human population density and land use that have occurred globally since. The Industrial Revolution is commonly considered to have begun around 1750 CE.

Resilience: capacity of an ecosystem to maintain itself when stressed by a pressure like climate change.

Structure: the organisation of plants within a community into one or more layers (e.g. ground, shrub, canopy).

Tetrapod: a member of the biological group of 4-limbed vertebrate animals, sometimes referred to as 'higher vertebrates'. Includes all amphibians, mammals, reptiles and birds, including those species with secondarily lost limbs (such as snakes and whales), but excludes fish.

Vegetation formation: the highest level in the vegetation classification of New South Wales, representing broad types of vegetation such as rainforest and grasslands.

Vegetation integrity: the degree to which the vegetation at a site differs from the benchmark for composition, structure and function. The benchmark is the best-on-offer condition for the same vegetation type in the contemporary landscape.

Vascular plant: a member of the biological group of land plants with specialised tissues for conducting water and minerals, sometimes referred to as 'higher plants'. Includes all ferns, pines, cycads and flowering plants, but excludes mosses.

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Like biodiversity, developing this report has been complex and has drawn on a wide range of knowledge and expertise. It has also been a highly collaborative project and it would not have been possible without the dedication and willing input of many people. We thank them most sincerely:

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