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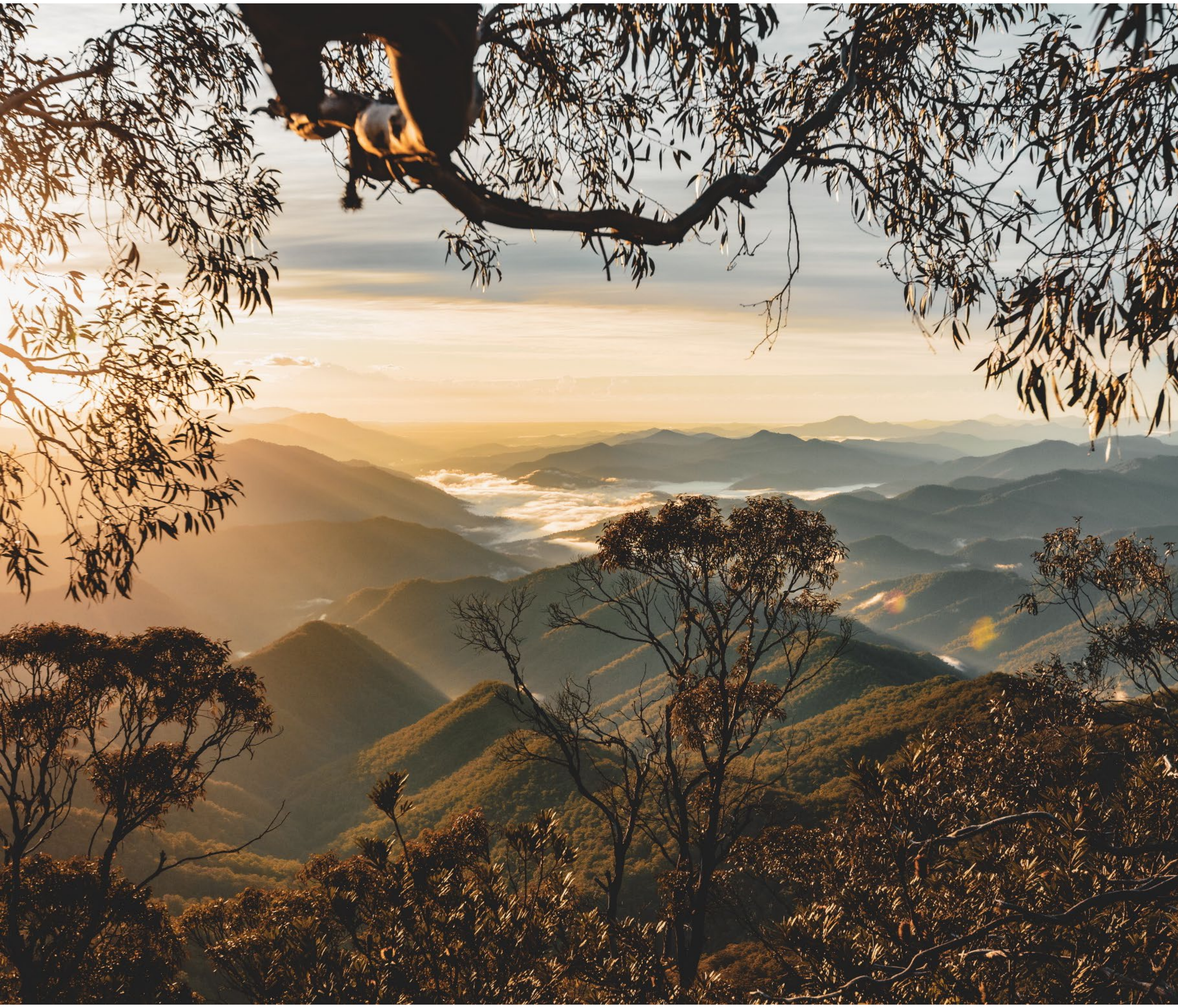

Measuring biodiversity and ecological integrity in NSW

Indicator tables for the Biodiversity Indicator Program
Version 1.1

Department of Climate Change, Energy, the Environment and Water

Acknowledgement of Country

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This resource may contain images or names of deceased persons in photographs or historical content.

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Published by:
Environment and Heritage
Department of Climate Change, Energy, the Environment and Water
Locked Bag 5022, Parramatta NSW 2124
Phone: +61 2 9995 5000 (switchboard)
Phone: 1300 361 967 (Environment and Heritage enquiries)
TTY users: phone 133 677, then ask for 1300 361 967
Speak and listen users: phone 1300 555 727, then ask for 1300 361 967
Email info@environment.nsw.gov.au
Website www.environment.nsw.gov.au

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1. Introduction

The purpose of this report is to summarise the suite of indicators used for measuring biodiversity and ecological integrity in New South Wales, as required by the *Biodiversity Conservation Act 2016* (the Act).

The Act requires the Environment Agency Head to establish 'biodiversity information programs' for the collection, monitoring and assessment of information on biodiversity (section 14.3). Clause 14.2 of the Biodiversity Conservation Regulation 2017 sets out the requirements for these programs. Requirements include:

- the collection, monitoring and assessment of information on the status and trends of biodiversity in New South Wales
- the development of a peer-reviewed method which identifies key biodiversity indicators and sets out how data related to those indicators is to be collected and measured.

New South Wales collaborated with leading experts at Commonwealth Scientific and Industrial Research Organisation (CSIRO), the Australian Museum and Macquarie University to develop the method used in New South Wales at bioregional and statewide scales.

The published method (OEH & CSIRO 2019) identifies key biodiversity indicators that have been designed to detect change, specifically the rate of loss of biodiversity, as well as the effectiveness of conservation actions. Biodiversity is too complex to be measured by one indicator only, so a combination of several different indicators is used to characterise the many components of biodiversity and to answer environmental questions.

The indicators have been allocated to 2 classes: biodiversity and ecological integrity. They are further categorised into themes and indicator families. This categorisation reflects the scientific framework used to interpret the requirements of the Act.

The method (OEH & CSIRO 2019) allows for new or alternative indicators to be identified as knowledge and data grow and monitoring and assessment methods evolve. This iterative approach reflects the need for further development, continuous improvement and/or a staged delivery process.

The purpose of this report is to publish the indicators tables separately from the full method (OEH & CSIRO 2019), to allow for continual improvement in individual indicator definitions. Publishing the indicator tables separately is consistent with other indicator frameworks including the Montréal Process: Criteria and Indicators for the Conservation and Management of Temperate and Boreal Forests (Montréal Process Working Group 2015).

2. Indicators for biodiversity and ecological integrity

More than 30 indicators have been identified to fulfil the need for measuring and monitoring change in the status and conservation of terrestrial biodiversity at statewide and bioregional scales in New South Wales. The indicators encompass measures of biodiversity and ecological integrity and represent pressures on biodiversity, the status of biodiversity and management responses.

Biodiversity is defined by the Act as the 'variety of living animal and plant life from all sources and includes diversity within and between species and diversity of ecosystems'.

Ecological integrity is defined by the Act as the need 'to maintain the diversity and quality of ecosystems and enhance their capacity to adapt to change and provide for the needs of future generations'.

The indicators have been allocated to 2 classes, biodiversity and ecological integrity. Each class of indicator is grouped further into themes and families (Tables 1 and 2). Each family contains related and complementary sets of indicators, including direct supporting measures that help with an interpretation and understanding of indicator trends.

Biodiversity and ecological integrity are closely linked in nature. Individual measures may be derived from or have input into other biodiversity or ecological integrity indicators.

Table 1 Classification of biodiversity indicators

Theme	Indicator family	Indicator
1 Expected survival of biodiversity	1.1 Expected survival of listed threatened species and ecological communities	1.1a Expected survival of listed threatened species
		1.1b Expected existence of listed threatened ecological communities
		1.1c Expected survival of phylogenetic diversity for listed threatened species
	1.2 Expected survival of all known and undiscovered species	1.2a Expected survival of all known species
		1.2b Expected survival of all known and undiscovered species
2 State of biodiversity	2.1 State of all known species	2.1a Within-species genetic diversity (for all known species)
		2.1b Extant area occupied (for all known species)
	2.2 State of biodiversity including undiscovered species	2.2a Within-species genetic diversity (including undiscovered species)
		2.2b Persistence of all species (including undiscovered species)
		2.2c Persistence of ecosystems (including undiscovered species)
	2.3 Field monitoring of species and ecosystems	2.3a Species trends
		2.3b Ecosystem trends

Table 2 Classification of ecological integrity indicators

Theme	Indicator family	Indicator
3 Ecosystem quality	3.1 Habitat condition	3.1a Ecological condition of terrestrial vegetation
		3.1b Ecological connectivity of terrestrial vegetation
		3.1c Ecological carrying capacity of terrestrial vegetation
		3.1d Ecosystem function of terrestrial vegetation
	3.2 Pressures	3.2a Land-use and management practices
		3.2b Native vegetation extent
		3.2c Inappropriate fire regimes
		3.2d Inappropriate hydrological regimes
		3.2e Invasive species (pests, weeds, disease)
		3.2f Altered climatic regimes, variability and extremes
4 Ecosystem management	4.1 Management responses	4.1a Areas permanently managed for conservation
		4.1b Areas temporarily managed for conservation
		4.1c Community appreciation of biodiversity
	4.2 Management effectiveness	4.2a Effectiveness of on-ground biodiversity conservation programs
		4.2b Community-based maintenance of biodiversity values
		4.2c Implemented climate-adapted conservation planning and management
	4.3 Capacity to sustain ecosystem quality	4.3a Capacity to maintain or enhance ecosystem quality (through local resilience)
5 Ecosystem integrity	5.1 Capacity to retain biological diversity	5.1a Ecosystem capacity to adapt to change and retain biological diversity under climate change
		5.1b Ecosystem capacity to adapt to change and retain biological diversity under land-use change
	5.2 Capacity to retain ecological functions	5.2a Ecosystem capacity to adapt to change and maintain ecological functions under climate change
		5.2b Ecosystem capacity to adapt to change and maintain ecological functions under land-use change

3. Biodiversity indicators

The biodiversity indicators assess the change in status of biological diversity over time with regards to all plant, animal and fungi species and ecosystems, including those yet to be discovered or described. Each biodiversity indicator has the potential to be expressed through different feature types (plant and animal groups) or ecosystems (a classification map or ecological communities). In some cases, where data are available, the indicators may be calculated using historic data to determine the past-to-present trend.

Biodiversity indicators are grouped into 2 broad themes: expected survival of biodiversity and state of biodiversity. Expected survival of biodiversity is a measure of the number of species or ecological communities we expect will still exist in 100 years, determined from categories of risk of extinction. Indicators in the state of biodiversity theme measure the potential of biodiversity to survive and, in the case of indirect measures, are set relative to notional original conditions prior to the industrial era, c. 1750 CE. The indirect versions of these indicators also infer, using the present extent, condition and configuration of surrounding native habitats, the latent natural decline rates in species' population survival (i.e. their local extinction rates). The status at the commencement of the Act can then be interpreted in terms of biodiversity persisting in the future.

Theme 1: expected survival of biodiversity

This indicator theme directly measures the rate of loss of biodiversity using long-established scientific methods. It addresses the survival, in 100 years, of both species and ecological communities that are known to be at risk of extinction, as well as those species whose risk has not been assessed. It also addresses the potential loss of evolutionary history using the phylogenetic diversity (PD) of threatened groups of species.

Indicator family 1.1: expected survival of listed threatened species and ecological communities

This indicator family allows the assessment of the survival (continued existence) in 100 years of species and ecological communities that have already been determined by the NSW Scientific Committee to be at risk of extinction. The indicator family also includes a measure of the risk of losing unique evolutionary heritage (via phylogenetic diversity). In the future, this indicator can be updated based on monitoring of successful management actions that result in secure wild populations of threatened species or ecological communities as determined by the Saving our Species program.

Indicator 1.1a	Expected survival of listed threatened species
Indicator description:	**Number of listed threatened species expected to survive in 100 years** Species on the NSW Threatened Species List (see Glossary) are assigned to risk of extinction categories. Species categorised as either vulnerable, endangered, critically endangered or extinct are assigned a probability of survival in 100 years. Species that have been assessed and not listed (i.e. are considered secure) are also assigned a probability of survival. At t_0: The indicator is calculated by summing the probabilities of survival for all species on the NSW Threatened Species List. The number of species expected to survive in 100 years can be a fraction, because the index is calculated from the sum of probabilities of survival. The indicator sensitivity to list membership is also calculated. The measure can be expressed as a proportion of the total number of listed species to enable comparison with other indicators in theme 1. The indicator can also be applied to the complete history of threatened species determinations, by using the NSW Threatened Species List at a particular time in the past, to provide a trend.
Detecting change:	Change in the value of the indicator at t_Δ can reflect: • a change in the threat category of species due to a decision of the NSW Scientific Committee • a change in the probability of survival due to effective management of the species as determined by the Saving our Species program. NSW Threatened Species List will be standardised and the status at each assessment recalculated. Species added to the NSW Threatened Species List at t_Δ are also added to the list of past assessments $t_{0,}$ and best/worst case assumptions of past status used to calculate an historical range of values. Species assessed at t_Δ as not threatened (i.e. secure) while removed from the NSW Threatened Species List, are retained on the standardised list as not threatened, for calculation purposes.
Readiness:	Published (all taxa assessed by NSW Scientific Committee)
Reporting scale:	Statewide only (i.e. not applicable at bioregional, regional or local scales)
Taxonomic scope:	All taxa (past and present) on the NSW Threatened Species List

Indicator 1.1b	Expected existence of listed threatened ecological communities
Indicator description:	**Number of listed threatened ecological communities expected to exist in 100 years** Ecological communities on the NSW Threatened Ecological Communities List (see Glossary) are assigned to risk of extinction categories. Ecological communities categorised as either vulnerable, endangered, critically endangered or collapsed are assigned a probability of still existing in 100 years. Ecological communities that have been assessed and not listed are also assigned a probability of existing in 100 years.
	At t_0: The indicator is calculated by summing the probabilities of existence for all ecological communities on the NSW Threatened Ecological Communities List across all categories. The expected number of ecological communities existing in 100 years can be a fraction, because the index is calculated from the sum of probabilities of existence of individual ecological communities. The indicator sensitivity to list membership is also calculated. The measure can be expressed as a proportion of the total number of listed species to enable comparison with other indicators in theme 1. The indicator can also be applied to the complete history of threatened ecological community determinations, by using the NSW Threatened Ecological Communities List at a particular time in the past, to provide a trend.
Detecting change:	Change in the value of the indicator at t_Δ can reflect: • a change in the threat category of ecological communities due to a decision of the NSW Scientific Committee • a change in existence probabilities due to effective management of the ecological communities as determined by the *Saving our Species* program. NSW Threatened Ecological Communities Lists will be standardised and the status at each assessment recalculated. Ecological communities added to the list at t_Δ are also added to the list of past assessments t_0, and best/worst case assumptions of past status used to calculate an historical range of values. Ecological communities assessed at t_Δ as not threatened while removed from the NSW Threatened Ecological Communities List, are retained on the standardised list as not threatened, for calculation purposes.
Readiness:	Published (all taxa assessed by NSW Scientific Committee)
Reporting scale:	Statewide only
Taxonomic scope:	All taxa (past and present) on the NSW Threatened Ecological Communities List

Indicator 1.1c	Expected survival of phylogenetic diversity for listed threatened species
Indicator name:	Expected survival of phylogenetic diversity for listed threatened species
Indicator description:	**The length of evolutionary history that is maintained in the species of a biological group that is expected to survive in 100 years** A complete list is obtained of all species within New South Wales for a biological (i.e. taxonomic) group for which there are species on the NSW Threatened Species List. How each species is related by shared ancestry over evolutionary timescales (in millions of years) is known as the phylogeny or evolutionary tree. The phylogeny identifies when each species evolved. For each biological group, this indicator requires a complete phylogeny for all species known from New South Wales (e.g. birds, mammals, frogs, reptiles). Species on the NSW Threatened Species List are assigned to risk of extinction categories. Species categorised as either vulnerable, endangered, critically endangered or extinct are assigned a probability of survival in 100 years. Species that have been assessed and not listed (i.e. secure) are also assigned a probability of survival. Other species in the biological group are assumed not threatened. Phylogenetic diversity (PD) is the sum of all the branches in the evolutionary tree that span all surviving species and their common ancestor, measured in millions of years. The indicator can also be applied to the complete history of threatened species determinations, by using the NSW Threatened Species List at a particular time in the past, to provide a trend. At t_0: The indicator is calculated by summing the survival probabilities for all species within the biological group, multiplied by years of evolutionary history. The indicator is reported in units of millions of years of evolutionary history expected to survive in 100 years.
Detecting change:	Change in the value of the indicator at t_Δ can reflect: • a change in the threat category of species due to a decision of the NSW Scientific Committee, or • a change in survival probability due to the effectiveness of management of populations as determined by the *Saving Our Species* program. If a phylogeny for the biological group has been revised based on new information, such as species' discoveries and technologies, the status at each assessment t_0 is also recalculated. List standardisation as for threatened species also applies.
Readiness:	Published (tetrapods - mammals, birds, frogs and reptiles) Under development (all known vascular plants)
Reporting scale:	Statewide only
Taxonomic scope:	All species within New South Wales for a biological (i.e. taxonomic) group for which there are species on the NSW Threatened Species List.

Indicator family 1.2: expected survival of all known and undiscovered species

This indicator family predicts extinction risk of all known and undiscovered species, beyond those formally assessed by the NSW Scientific Committee. It uses the IUCN Red List assessment method for criteria B2 and B2(b)(ii) for estimated area of occupancy (AOO). Different measurement methods are applied to comprehensively assess biodiversity using this risk framework and to minimise sampling bias. It can be used as a measure of the overall effectiveness of ecosystem management in securing, maintaining or improving the survival of all known and undiscovered species in 100 years' time. The habitat condition family of indicators 3.1 support this assessment.

Indicator 1.2a	Expected survival of all known species
Indicator description:	**Proportion of all known species expected to survive in 100 years, assessed for each biological group** Species from a biological (i.e. taxonomic) group are sampled to uniformly represent the full range of natural habitats for that group. The representative species are provisionally assigned risk of extinction categories based on the estimated proportion of their original habitat that remains intact using the IUCN Red List assessment for criteria B2 and B2(b)(ii). This is a provisional assessment of risk using commonly available species occupancy data. The method uses species occurrence observations since 1950 in 2-kilometre map grids (each being 4 km^2) and intact area of occupancy (AOO) thresholds specified by the 2 criteria to discriminate 4 risk of extinction categories. Each species is further assessed for a reduction in AOO determined from the habitat condition indicator 3.1a. The reduction in AOO in 4 classes (<30%, 30–50%, 50–80% and >80%; adapted from criterion A of the IUCN Red List of Ecosystems), and the intact AOO thresholds (also using indicator 3.1a) provide the dimensions of a simple extinction risk categorisation similar to that of listed threatened species. Each category is given a probability of survival in 100 years which is applied to all representative species in that category. At t_0: The indicator is calculated by summing the probabilities of survival for the representative species across all categories and is expressed as a proportion of the total number of species representing the biological group. This is an indicator for all known species within the biological group expected to survive in 100 years and, by logic, extends to undiscovered species in that group. Reduction in AOO is used directly in indicator 2.1b and infers the amount of genetic diversity potentially at risk of loss in indicator 2.1a.
Detecting change:	Change in the value of the indicator at t_Δ reflects: • a change in survival probability due to a change in habitat condition determined from indicator 3.1a. If sufficient habitat is lost or degraded for a particular species its extinction risk category will be changed. Updated indicators for ecological condition 3.1a are applied as these are developed. The indicator is standardised by using the same representative sample of species. If different samples are derived or new information about a representative species changes its AOO, the status at each past assessment period t_0 is also recalculated.
Readiness:	Published (vascular plants) Under development (other taxonomic groups)
Reporting scale:	Statewide only
Taxonomic scope:	All taxa

Indicator 1.2b	Expected survival of all known and undiscovered species
Indicator description:	**Proportion of all known and undiscovered species expected to survive in 100 years, assessed for each biological group** The potential existence of species at risk of extinction (both known and undiscovered) from a biological (i.e. taxonomic) group is inferred by using a Generalised Dissimilarity Model (GDM). The model is used to estimate the proportion of species provisionally assigned to risk of extinction categories based on the estimated amount of original habitat that remains intact. This is broadly consistent with the IUCN Red List assessment method for criteria B2 and B2(b)(ii) as applied to analogous indicator 1.2a for known species. This is a provisional assessment of risk, using just one set of assessment criteria adapted to work with a model of biodiversity. The analysis is conducted for a sample of locations that represent the full range of natural habitats based on the model for that biological group. At each location, the model predicts the proportion of species potentially existing within specified intact AOO thresholds (in the order <10 km^2, <500 km^2, <2000 km^2, or >2000 km^2) to assign notional risk of extinction categories (highest to lowest). The thresholds are applied using 2-kilometre map grids and a decline in habitat condition of at least 30% is used, determined from indicator 3.1a. The estimated proportion of species in the respective extinction risk category is then calculated. Each category is given a probability of survival, which is applied to all sets of locations and the proportion of species in that category. At t_0: The indicator at initial assessment is calculated by summing the probabilities of survival by the proportion of species inferred to remain for each location by category and across the sample of locations representing that biological group. The indicator is expressed as a proportion of species expected to survive in 100 years, including both known and undiscovered species. An estimate of the number of known and undiscovered species may be provided from an analysis of species discovery over time to predict an overall number of species expected to survive in 100 years. The results can also be used in indicator 2.2a to infer the amount of genetic diversity potentially at risk of loss.
Detecting change:	Change in the value of the indicator at t_Δ reflects: • a change in survival probability due to a change in habitat condition determined from indicator 3.1a. If sufficient habitat is lost or degraded for a particular sample location, the numbers of species in each threat category will be changed. Updated indicators for ecological condition 3.1a are used as these are developed. If the model of biodiversity has been refined, the status at each past assessment t_0 is also recalculated.
Readiness:	Requiring further research
Reporting scale:	Statewide only
Taxonomic scope:	All taxa

Theme 2: state of biodiversity

This indicator theme measures, directly and indirectly, the overall amount of biodiversity (genes, species and ecosystems) that currently exists. Where possible, it is expressed as a proportion of that which existed prior to the industrial era (c. 1750 CE). Variants of some indicators in this theme also use knowledge of the latency in biodiversity decline (extinction lag), following loss of high-quality connected habitat, to estimate the amount of biodiversity likely to persist. The precise status of biodiversity is unknown but is within a range defined by these measurements.

Indicator family 2.1: state of all known species

This indicator family allows the assessment of the overall diversity of all known species that exist at present, including their genetic diversity, as a proportion of that which originally existed in New South Wales prior to the industrial era (c. 1750 CE). The habitat condition family of indicators 3.1 support this assessment.

Indicator 2.1a	Within-species genetic diversity (for all known species)
Indicator description:	**The proportion of within-species genetic diversity of all species known to exist, assessed for each biological group** This indicator uses a representative sample of species to assess the proportion of within-species genetic diversity that still exists, after considering loss of suitable habitats. It is an extension of indicator 2.1b. Genetic diversity is inferred from species diversity using geographic (spatial) occupancy. Species from a biological (i.e. taxonomic) group are sampled to represent the full range of natural habitats for that group (from indicator 1.2a). The occurrence data in 2-kilometre map grids define each species' AOO. Reductions in AOO due to declines in habitat condition are determined from indicator 3.1a. A power curve then relates the intact fraction of a species' AOO to the fraction of genetic diversity remaining. Two forms of the curve are used: one that simulates high genetic diversity due to high rates of population genetic divergence, and the other, low genetic diversity. The 2 curves equate to an upper and lower estimate of fractional within-species genetic diversity. At t_0: The indicator is an estimate of the fractional loss (or potential to gain) of genetic diversity by change in area of habitat. It can be used, for example, to show the variation in genetic diversity loss (or potential to gain) across the categories of species survival for indicator 1.2a. This serves as an indicator of within-species genetic diversity for all known species within the biological group and, by logic, extends to undiscovered species. This approach infers mainly neutral genetic diversity. Methods for inferring adaptive genetic diversity are under development.
Detecting change:	Change in the value of the indicator at t_Δ reflects a change in habitat condition determined from indicator 3.1a. Updated indicators for ecological condition 3.1a are used as these are developed. The indicator is standardised by using the same representative sample of species each time. If a different sample is derived, or new information about a representative species changes its AOO, the status at each past assessment t_0 is also recalculated.
Readiness:	Published (vascular plants) Requiring further research (other taxonomic groups)
Reporting scale:	Statewide only. This indicator complements 1.2a by providing information about variance in estimated genetic diversity surviving, reported by extinction risk category.
Taxonomic scope:	All taxa

Indicator 2.1b	Extant area occupied (for all known species)
Indicator description:	**The average fraction of original habitat presently occupied by all known species, assessed for each biological group** This indicator assesses the extant area occupied by all known species after considering loss of original suitable habitat. Species from a biological (i.e. taxonomic) group are sampled to represent the full range of natural habitats across New South Wales for that group (from indicator 1.2a). The occurrence data in 2-kilometre map grids define each species' area of occupancy, and reductions in AOO due to declines in habitat condition are determined from the ecological condition indicator 3.1a. At t_0: The indicator is the average fraction of original habitat occupied by the representative species (as a proxy for all known species) for a biological group. It can also be used to show the variation in reductions in AOOs across the categories of species survival for indicator 1.2a. It can also be used to infer the amount of genetic diversity remaining (indicator 2.1a).
Detecting change:	Change in the value of the indicator at t_Δ reflects a change in habitat condition determined from indicator 3.1a. Updated indicators for ecological condition 3.1a are used as these are developed. The indicator is standardised by using the same representative sample of species. If a different sample is derived or new information about a representative species changes its AOO, the status at each past assessment t_0 is also recalculated.
Readiness:	Published (vascular plants) Requiring further research (other taxonomic groups)
Reporting scale:	Statewide only. This indicator complements 1.2a by providing information about mean and variance in fraction of AOO for reporting by extinction risk category.
Taxonomic scope:	All taxa

Indicator family 2.2: state of biodiversity including undiscovered species

This indicator family estimates the overall diversity of all known and undiscovered species existing and likely to persist, including their genetic diversity and how they assemble into ecosystems, as a proportion of that originally existing in New South Wales prior to the industrial era (c. 1750 CE). The habitat condition family of indicators 3.1 supports this assessment.

Indicator 2.2a	Within-species genetic diversity (including undiscovered species)
Indicator description:	**The existing proportion of within-species genetic diversity of all known and undiscovered species, assessed for each biological group** This indicator estimates the proportion of within-species genetic diversity that may still exist and is potentially likely to persist, after considering loss of suitable habitats and the effects of fragmentation. It is an extension of indicator 1.2b. Genetic diversity is inferred from species diversity using geographic (spatial) occupancy. The potential existence of species (both known and undiscovered) for a biological (i.e. taxonomic) group is inferred by using a model of biodiversity derived from systematic surveys of that group's co-occurring species and associated environments (using GDM). The analysis is conducted for a sample of locations that represent the full range of natural habitats based on the model for that biological group. At each location, the model predicts the relative numbers of species potentially existing within different AOOs. For consistency with indicator 1.2b, the same method of defining AOO is used. Reductions in AOO due to declines in habitat condition are determined from indicator 3.1a. Further reductions in carrying capacity, due to fragmentation that restricts connectivity with surrounding suitable habitat, are determined from indicator 3.1c. At each location, the model predicts the relative numbers of species originally existing and the reduction within each species' AOO. A power curve then relates the intact fraction of each species' AOO to fractions of diversity remaining. In each case, 2 forms of the curve are used: one that simulates high genetic diversity due to high rates of population genetic divergence, and the other, low genetic diversity. These equate to upper and lower estimates of within-species genetic diversity. At t_0: The indicator is the fractional loss of genetic diversity by change in occupancy of original area. It can be used, for example, to show the variation in genetic diversity loss across the categories of species survival for indicator 1.2b. The upper and lower fractions of genetic diversity demonstrate the potential range and uncertainty in estimation. Alternate calculations using indicators 3.1a and 3.1c (ecological connectivity indicator 3.1b is used in indicator 3.1c) to estimate the reductions in suitable habitat due to fragmentation are presented as a range. The indicator is an expression of the proportion of genetic diversity remaining, within the biological group and, by logic, extends to undiscovered species. This approach mainly infers neutral genetic diversity. Methods for inferring adaptive genetic diversity are under development.
Detecting change:	Change in the value of the indicator at t_Δ reflects a change in habitat condition determined from indicators 3.1a and 3.1c. Updated indicators for ecological condition 3.1a and carrying capacity 3.1c will be used as these are developed. The indicator is standardised by using the same model of biodiversity for the whole biological group. If a new model is developed using refined data and methods, the status at each past assessment t_0 is also recalculated.
Readiness:	Requiring further research

Indicator 2.2a	Within-species genetic diversity (including undiscovered species)
Reporting scale:	Statewide only. This indicator complements 1.2b by providing information about variance in estimated genetic diversity that is retained and can be reported by extinction risk category.
Taxonomic scope:	All taxa

Indicator 2.2b	Persistence of all species (including undiscovered species)
Indicator name:	Persistence of all species (including undiscovered species)
Indicator description:	**The proportion of all species including known and undiscovered species that are still living or likely to persist** The potential existence of species (both known and undiscovered) for a biological (i.e. taxonomic) group is inferred by using a model of biodiversity derived from systematic surveys of that group's co-occurring species and associated environments (using GDM). The proportion of species that may still exist, after taking into account declines in habitat condition (e.g. changes in the extent of native vegetation), is determined from indicator 3.1a. The proportion of species potentially likely to persist after accounting for further reductions in carrying capacity, due to fragmentation restricting connectivity with surrounding suitable habitat, is determined from indicator 3.1c. A power curve relates the amount of habitat available to the proportion of all species potentially persisting into the future. At t_0: The indicator is a range in values showing the uncertainty in estimating the amount of biodiversity still living and likely to persist for the given configuration and condition of suitable habitats, using indicators 3.1a and 3.1c. The values for each geographical reporting unit are individually calculated by accounting for the species predicted to be shared between regions, and so the whole value does not equal the sum of the regional values. The indicator is an expression of the proportion of species' diversity remaining within the biological group and, by logic, extends to undiscovered species.
Detecting change:	Change in the value of the indicator at t_Δ reflects a change in habitat condition determined from indicators 3.1a and 3.1c. Updated indicators for ecological condition 3.1a and carrying capacity 3.1c will be used as these are developed. The indicator is standardised by using the same model of biodiversity for the whole biological group. If a new model is developed using refined data and methods, the status at each past assessment t_0 is also recalculated.
Readiness:	Requiring further research
Reporting scale:	Statewide and regional (e.g. protected areas, bioregions, landscapes, regional ecosystems) by considering the species shared between each regional subunit.
Taxonomic scope:	All taxa

Indicator 2.2c	Persistence of ecosystems (including undiscovered species)
Indicator description:	**The expected persistence of species diversity as a function of the proportion of habitat remaining in ecosystems, derived from a classification of known and undiscovered species** A classified model of biodiversity for a specified biological group depicts patterns of ecosystem diversity for a specified number of classes (e.g. 100). The model is derived from systematic surveys of that group's co-occurring species and associated environments to encompass all species (both known and undiscovered). A further statistical model predicts a probability value for each ecosystem at each location, signifying confidence in class assignment. The proportion of habitat remaining in each ecosystem, after considering declines in habitat condition, is determined from indicator 3.1a. The proportion of habitat remaining after considering further reductions in carrying capacity, due to fragmentation restricting connectivity with surrounding suitable habitat, is determined from indicator 3.1c. A power curve relates the amount of habitat available in each ecosystem to the expected persistence of species diversity for that biological group, taking into account their complementarity and irreplaceability (i.e. their inability to be replaced, often because of uniqueness). At t_0: The indicator is a range in values showing the uncertainty in estimating the expected persistence of species diversity across all ecosystems given the configuration and condition of suitable habitats, using indicators 3.1a and 3.1c. The values for each geographical reporting unit are individually calculated by accounting for the species predicted to be shared between ecosystems and across regions, and so the whole does not equal the sum of the parts.
Detecting change:	Change in the value of the indicator at t_Δ reflects a change in habitat condition determined from indicators 3.1a and 3.1c. Updated indicators for ecological condition 3.1a and carrying capacity 3.1c are used as these are developed. The indicator is standardised by using the same model of biodiversity and classification for the whole biological group. If a new model or classification is developed using refined data and methods, the status at each past assessment t_0 is also recalculated.
Readiness:	Published (vascular plants) Requiring further research (other taxonomic groups)
Reporting scale:	Statewide and regional (e.g. protected areas, bioregions, landscapes, regional ecosystems) by considering the species shared among ecosystems between each subunit.
Taxonomic scope:	All taxa

Indicator family 2.3: field monitoring of species and ecosystems

Long-term and/or wide-ranging field monitoring of species and ecosystems provide useful and complementary measures of the current status and trends in biodiversity. Other indicators that rely on indirect measures of biodiversity from remote sensing and modelling use field-based observations of biodiversity from relatively intact sites.

Indicator 2.3a	Species trends
Indicator description:	**Trends in the extent, abundance or number of native species measured from long-term or wide-ranging field monitoring programs** Direct measures of species' population status and trend have the potential to provide concrete evidence of change. Locations need to be situated strategically and designed to control for sampling artefacts and 'noise' variation over the time series. Criteria will be developed to identify suitable monitoring studies from which trends can be summarised to provide an initial assessment for selected locations and species. Requirements for systematic monitoring to detect change and methods to integrate across locations and species will be developed for future indicators. At t_0: The indicator for each location is the species abundance or other performance metric (such as yield, fecundity) and associated environmental conditions. The indicator may also be reported as a trend using historical monitoring data, that is, a trend since first measurement.
Detecting change:	Change in the value of the indicator at t_Δ reflects: • a statistically significant trend in species abundance or other performance metric (such as yield, fecundity) attributed to anthropogenic factors (pressures or management), after taking into account natural environmental variation. The indicator is a direct measure from continuous observations. If the statistical method used to assess trend is refined, the status at each past assessment t_0 is also recalculated.
Readiness:	Published (selected locations and species)
Reporting scale:	Site
Taxonomic scope:	All taxa

Indicator 2.3b	Ecosystem trends
Indicator description:	**Trends in the extent, abundance or number of native ecosystems measured from long-term or wide-ranging field monitoring programs** Direct measures of ecosystem dynamics, status and trend have the potential to provide concrete evidence of change. Locations need to be strategically situated and designed to control for sampling artefacts and 'noise' variation over the time series. Criteria will be developed to identify suitable monitoring studies from which trends can be summarised to provide an initial assessment for selected locations and ecosystems. Requirements for systematic monitoring to detect change and methods to integrate across locations and ecosystems will be developed for future indicators. At t_0: The indicator for each location is the relative abundances of all species within an ecosystem (within or between biological groups) or other performance metric (such as species compositional turnover) and associated environmental conditions. The indicator may also be reported as a trend using historical monitoring data, that is, a trend since first measurement.
Detecting change:	Change in the value of the indicator at t_Δ reflects: • a statistically significant trend in community dynamics or species composition attributed to anthropogenic factors (pressures or management), after considering natural environmental variation. The indicator is a direct measure from continuous observations. If the statistical method used to assess trend is refined, the status at each past assessment t_0 is also recalculated.
Readiness:	Published (selected locations and ecosystems)
Reporting scale:	Site
Taxonomic scope:	All ecosystems

4. Ecological integrity indicators

The ecological integrity indicators establish the need for ongoing monitoring to assess both the diversity and quality of ecosystems, as well as the effectiveness of their management; and so inform their inherent capacity to adapt to change. Indicator set ecosystem diversity in the framework is reported through the state of biodiversity theme of indicators. The remaining indicator sets are therefore grouped into 3 themes that relate to measures of ecosystem quality, ecosystem management and ecosystem integrity.

Theme 3: ecosystem quality

This theme comprises general measures of habitat condition indicating capacity to maintain natural functions and processes supporting terrestrial species and ecosystems in New South Wales. It includes measurement of pressures that threaten habitat condition or biodiversity, enabling some attribution of cause (observed pressures) and effect (observed state).

Indicators of habitat condition use remote sensing, land use and modelling to assess ecological condition (including 'vegetation integrity' as defined in the Act), the extent of habitat loss and the degree of habitat fragmentation. These affect the ability of habitats to adapt to climate change and support native plants and animals. The indicator theme also includes novel measures of ecosystem function related to naturalness that depict the degree of disruption from an expected climate or environmental equilibrium.

Indicator family 3.1: habitat condition

This indicator family is an overall measure of the capacity of habitats to support the original complement of native plants and animals. By considering the condition and position of each habitat and its connection with other surrounding habitats across a region, the remaining capacity of an area to support its native plants and animals can be inferred. In the future, the terrestrial indicators will be complemented by other indicators for freshwater, coastal and marine habitats.

Indicator 3.1a	Ecological condition of terrestrial vegetation
Indicator description:	**The ability of terrestrial habitat at each location to support its biodiversity** This indicator measures the intactness and naturalness of terrestrial vegetation as habitat to support biodiversity at each location, without considering the indirect effects of fragmentation or connections with surrounding suitable habitat. Satellite-based remote sensing is used to assess vegetation attributes related to integrity (structure, function and composition) with appropriate comparison to field-derived reference conditions and validation. The derived measure at each site (a grid cell on a map) is an index ranging from 0 (the maximum departure from a reference condition) to 1 (intact vegetation that supports biodiversity to its full potential). Three complementary modelling approaches are being developed and integrated to ensure new science and technology can be applied rapidly to refined measures. These **methods** are: 1. using data integration and expert opinion to suggest the relationship between vegetation condition and remotely sensed data 2. applying statistics to correlate the relationship and predict the disturbance distance from intact reference locations (like benchmarks) 3. using statistics to model individual vegetation integrity attributes compared with their benchmarks and derive condition scores. At t_0: The indicator is calculated at each site (grid cell) according to the selected method. It can be reported for any geographical area as an average and variance. The indicator is an input to the biodiversity indicators that use ecological condition and models such as GDM to infer the amount of biodiversity existing. It complements the ecological carrying capacity indicator 3.1c, which incorporates the connections with surrounding suitable habitat.
Detecting change:	Change in the value of the indicator at t_Δ can reflect: • changes in the condition of vegetation relative to a NSW reference state (or benchmark). The status at each past assessment will need to be recalculated to account for new methodologies and remote-sensing data.
Readiness:	Published
Reporting scale:	Statewide and regional (e.g. protected areas, bioregions, landscapes, regional ecosystems)
Environmental scope:	Terrestrial

Indicator 3.1b	Ecological connectivity of terrestrial vegetation
Indicator description:	**The contribution each location makes to connectivity of terrestrial habitat by way of its ecological condition and relative position in the landscape (e.g. as part of a habitat corridor or a stepping stone)** This indicator accounts for the general quality of terrestrial habitats supporting biodiversity at each location, the fragmentation of habitat within its neighbourhood and how its position in the landscape contributes to connectivity among habitats across a region (e.g. as part of a habitat corridor or as a stepping stone). Ecological connectivity is based on 2 landscape components: (i) neighbouring locations, to assess how well ecological processes can operate at a local level, and (ii) other locations, to assess how well a location contributes to overall landscape connectivity. Each are calculated for several spatial scales to account for the range of ecological processes influencing biological movement and dispersal. The site ecological condition indicator 3.1a is used as an input to measure the ease or difficulty of dispersion through a less or more degraded landscape. At t_0: The indicator is calculated as a weighted average of the 2 components across spatial scales. Values for each site (grid cell) range from 0 (minimum quality, disconnected habitat) to 1 (maximum quality, fully connected habitat). It can be reported for any geographical area as an average and variance.
Detecting change:	Change in the value of the indicator at t_Δ can reflect: • a change in the condition or connectivity of habitats with neighbouring sites and the degree of fragmentation in the landscape. If the value of ecological condition indicator 3.1a is recalculated to account for new methodologies and remote-sensing data, this indicator will also need to be recalculated.
Readiness:	Published
Reporting scale:	Statewide and regional (e.g. protected areas, bioregions, landscapes, regional ecosystems)
Environmental scope:	Terrestrial

Indicator 3.1c	Ecological carrying capacity of terrestrial vegetation
Indicator description:	**Each location's capacity to support native species and ecosystems, considering its ecological condition and the effect of surrounding habitat loss and fragmentation** This indicator accounts for how the general quality of terrestrial habitats supporting biodiversity at each location and its connection with habitat at other locations within a neighbourhood enables biological movement such as foraging, dispersal and migration. It is used to account for the carrying capacity of a landscape to support its original complement of biodiversity and ecosystems. The indicator uses ecological condition indicator 3.1a and the neighbourhood context component of indicator 3.1b at relevant scales.
	At t_0: The indicator is calculated by summing and reporting the scores at each location, at any spatial scale. The indicator can be expressed in units of neighbourhood habitat area (i.e. the amount of connected habitat in hectares) or standardised to measure the (effective) area of connected habitat relative to fully connected habitat. Each location varies from 0 (minimum quality, disconnected habitat) to 1 (maximum quality, fully connected habitat). The indicator can be reported for any geographical area as an average and variance. The indicator is an input to the biodiversity indicators that use ecological carrying capacity to estimate the amount of biodiversity potentially persisting. It complements the ecological condition indicator 3.1a, which does not incorporate the influence on condition of connections with surrounding suitable habitat.
Detecting change:	Change in the value of the indicator at t_Δ can reflect: • a change in the condition or connectivity of habitats with neighbouring sites and the degree of fragmentation in the landscape. If the value of the ecological condition indicator 3.1a is recalculated to account for new methodologies and remote-sensing data, this indicator will also need to be recalculated.
Readiness:	Published
Reporting scale:	Statewide and regional (e.g. protected areas, bioregions, landscapes, regional ecosystems)
Environmental scope:	Terrestrial

Indicator 3.1d	Ecosystem function of terrestrial vegetation
Indicator description:	**A measure of the functional integrity of eco-physiological processes of terrestrial plants that cycle carbon, water, energy and nutrients** This indicator uses the relationship of plants with their environment to infer the functional condition of terrestrial native vegetation and therefore the degree of naturalness. It complements the monitoring of vegetation structure. Three interrelated resource-use concepts depict the degree of ecological disruption from an expected climatic or environmental equilibrium: (i) vegetation equilibrium, (ii) resource-use efficiency, and (iii) resource coupling. From these concepts, 3 component vegetation function indicators are derived: 1. foliage cover gap, as the difference between observed foliage cover and full cover under ideal conditions (predicted from an eco-hydrological equilibrium model) 2. rain-use efficiency gap, as the difference between the maximum and actual rain-use efficiency (applicable in water-limited environments) 3. resource-use efficiency gap, which combines 2) with light-use efficiency gap to include most Australian environments. At t_0: The indicator at initial assessment is based on the 3 component indicators. Their derivation and validation is under development. Each component indicator can be reported for any geographical area as an average and variance.
Detecting change:	Change in the value of the indicator at t_Δ can reflect: changes in the functional integrity of vegetation due to disturbance (observed using remote sensing), relative to an environmental normal range. The status of the indicator will need to be recalculated to account for new methodologies and remote-sensing data.
Readiness:	Requiring further research
Reporting scale:	Terrestrial
Environmental scope:	Statewide and regional (e.g. protected areas, bioregions, landscapes, regional ecosystems)

Indicator family 3.2: pressures

This indicator family identifies general pressures that cause biodiversity loss or threaten the quality of ecosystems and, therefore, impacts to the survival of species or ecological communities, and provides supporting information on disturbance. The consequence of a pressure may be determined by the type of vegetation or ecosystem it is acting on and their current state and resilience and may also be linked in different ways to structural, functional or compositional components. Information about pressures informs development of the ecological condition indicator 3.1a or provides a basis for attributing cause to observed change in condition. The terrestrial indicators may be expanded to incorporate other pressures and, in future, be complemented by the respective indicators of pressures that threaten freshwater, coastal and marine habitats.

Indicator 3.2a	Land-use and management practices
Indicator description:	**The extent of classes of land-use and management practices** Land use depicts the potential degree of modification and the impact on a 'natural state' (essentially, an unaltered native land cover). The standard land-use classification for Australia is 3-tiered and hierarchical. Primary and secondary classes relate to the main use of the land, defined by the management objectives of the manager. Tertiary classes can include commodity groups, specific commodities, land management practices or vegetation information. Time-series data on land-use and management practices is collected by relevant agencies. If mapped accurately, it provides valuable information about the time since modification of natural areas and the intensity of use. Satellite and aerial remote sensing combined with field observations and agency databases is being used to fill gaps in the land-use time series. At t_0: The indicator is the area of each land use in primary and secondary classes, ordered by the potential degree of modification from a nominated 'natural state'. The mapping of land use does not necessarily depict impact, as the class may indicate potential to modify rather than actual modification. The indicator may also be reported as a trend from an earlier time, such as, time since first mapping (e.g. 2003).
Detecting change:	Change in the value of the indicator at t_Δ reflects a change in land use as mapped. If the method of detecting or classifying land use is altered or refined, the status at each past assessment t_0 is also recalculated.
Readiness:	Under development
Reporting scale:	Statewide and regional (e.g. protected areas, bioregions, landscapes, regional ecosystems)
Environmental scope:	All land types

Indicator 3.2b	Native vegetation extent
Indicator description:	**The extent of native woody and non-woody vegetation cover** This indicator monitors the extent of native woody and non-woody vegetation cover based on remote-sensing and other data supporting detection of natural areas. Changes in land cover by woody vegetation or plant communities can be detected through time. Native non-woody vegetation (mostly grasslands, arid shrublands and woodlands) is less easily detected, but work is ongoing to improve this. At t_0: The indicator is the area of native woody and non-woody vegetation cover. It can be reported for any region or in relation to vegetation (plant community) type or condition class.
Detecting change:	Change in the value of the indicator at t_Δ reflects a change in woody and non-woody native vegetation cover, primarily due to clearing. Measuring regrowth/revegetation is more difficult and is yet to be incorporated in land-cover change reporting. If the method of detecting or classifying woody and non-woody native vegetation cover is altered or refined, such as measuring regrowth, the status at each past assessment t_0 is also recalculated.
Readiness:	Under development
Reporting scale:	Statewide and regional (e.g. protected areas, bioregions, landscapes, regional ecosystems, plant community types, ecological condition class)
Environmental scope:	Terrestrial

Indicator 3.2c	Inappropriate fire regimes
Indicator description:	**The extent and impact of altered fire regimes on sensitive ecosystems** A fire regime is the prevailing intensity, seasonality, frequency (i.e. interval between burns) and spatial pattern that has become established over extensive areas and through time that supports the maintenance of local species and ecosystems. This indicator is calculated from spatial data compiled from all fires across the State and as far back in recent history as possible. For each vegetation type, the mapped fire frequency is compared to the minimum and maximum thresholds predicted, based on scientific knowledge of its sensitivity. Departures from the expected appropriate regime signify the degree of impact on local biodiversity and are classed as 'too frequently burnt', 'within fire thresholds' or 'too infrequently burnt'. At t_0: The indicator is the area of inappropriate fires and cumulative impact (departure from an appropriate regime), reported by fire-sensitive vegetation (plant community) types. This indicator will evolve as methods for detecting fire severity evolve, and with improvements in remote sensing and modelling of fire impacts on vegetation and ecological integrity.
Detecting change:	Change in the value of the indicator at t_Δ reflects a change in appropriateness of the fire regime (too frequently or too infrequently burnt). If the method of detecting or classifying appropriate fire regimes is refined, the status at each past assessment t_0 is also recalculated.
Readiness:	Under development
Reporting scale:	Statewide and regional (e.g. protected areas, bioregions, landscapes, regional ecosystems, plant community types, ecological condition class)
Environmental scope:	Terrestrial

Indicator 3.2d	Inappropriate hydrological regimes
Indicator description:	**The extent and impact of altered hydrological regimes on sensitive ecosystems** A hydrological regime is determined by the prevailing climate and its seasonality and how landform and rock types influence the distribution of water across a landscape. It has components of seasonality, depth and duration of flooding and drying, and frequency of inundation. Estuarine systems are also dependent on tidal regimes. This indicator is calculated from hydrological metrics, including river flows and remotely sensed data of surface water extent and vegetation dynamics. This data quantifies the frequency and spatial extent of floodplain inundation, and it can also be used to identify vegetation response to inundation. For each ecosystem type, the mapped hydrological regime is compared to the minimum and maximum thresholds predicted, based on scientific knowledge of its requirements. Departures from the expected appropriate regime signify the degree of impact on local biodiversity. The indicator is the area of inappropriate hydrological regimes and cumulative impact (departure from an appropriate regime). The indicator may be informed by the frequency and extent of floodplain inundation and dynamic extents of wetland vegetation. This indicator will evolve as methods for detecting hydrological regimes evolve, and as remote sensing and modelling of impacts on sensitive ecosystem types improves.
Detecting change:	Change in the value of the indicator at t_{Δ} reflects a change in appropriateness of the hydrological regime. If the method of detecting or classifying appropriate hydrological regimes is refined, the status at each past assessment t_0 is also recalculated.
Readiness:	Requiring further research
Reporting scale:	Statewide, bioregions and catchments
Environmental scope:	All land types that are inundated or groundwater-dependent ecosystems

Indicator 3.2e	Invasive species (pests, weeds, disease)
Indicator description:	**The extent and impact of invasive species on sensitive ecosystems** For sensitive species and ecosystems, the associated spatial extent and density of invasive species is determined, along with detection of new invasive species with potential to impact native plants and animals, as well as the spread of emerging invasive species. At t_0: The indicator is the degree of knowledge about the extent and impact of invasive species on sensitive species and ecosystems. This indicator will evolve as methods for collating disparate data, and for monitoring and reporting on species and ecosystem impacts, are developed.
Detecting change:	Change in the value of the indicator at t_Δ reflects a change in spatial extent and density of invasive species impacting sensitive native species and ecosystems. If the method of detecting or classifying invasive species is refined, the status at each past assessment t_0 is also recalculated, if suitable historical data are available. Predominantly, change detection will represent growth in knowledge until systematic monitoring methods and biodiversity impact assessments become available.
Readiness:	Published Requiring further research (impact of invasive species)
Reporting scale:	Any geographic domain (e.g. all of New South Wales, conservation areas, bioregions, landscapes or regional ecosystems) depending on data adequacy for reporting
Environmental scope:	All NSW ecosystems

Indicator 3.2f	Altered climatic regimes, variability and extremes
Indicator description:	**The extent and impact of altered climatic regimes on sensitive ecosystems** A region's climate is determined by the spatial and temporal variation in rainfall, temperature, humidity, atmospheric pressure, wind and other meteorological variables over long periods of time. The climatic regime is explained by normal ranges of these variables, their seasonality, frequency, duration, intensity and extent of events. Species and ecosystems are generally adapted over long periods of time to their local climates. At t_0: The indicator is the mapped extent, frequency and intensity of eco-physiological stress predicted for plants and/or animals as a result of climatic extremes and the degree of departure from pre-industrial climatic norms, reported by sensitive species and ecosystems. This indicator can also be forecast using modelled climate projections for the specific variables that exceed eco-physiological thresholds. This indicator will evolve as methods for modelling and monitoring climate change impacts on biodiversity are further developed.
Detecting change:	Change in the value of the indicator at t_Δ reflects a change in climatic regimes related to physiological stress predicted for plants and/or animals. If the method of detecting or classifying climate-related biophysical stress effects is refined, the status at each past assessment t_0 is also recalculated.
Readiness:	Requiring further research
Reporting scale:	Statewide and regional (e.g. protected areas, bioregions, landscapes, regional ecosystems, plant community types, ecological condition class)
Environmental scope:	All NSW ecosystems

Theme 4: ecosystem management

This indicator theme addresses the effectiveness of local-scale conservation management actions, such as the implementation of policies or actions to prevent or reduce biodiversity loss. It considers the preparedness of managers, in their planning and implementation capacities, to facilitate ecosystems adapting to change. It allows for all types of management across all land sectors that collectively influence biodiversity outcomes, such as reduced rates of loss of biodiversity or enhanced ecosystem quality. Simple measures of ecosystem management can be reported in the first instance, such as areas managed for conservation. These can be used to provide context for other biodiversity and ecosystem quality indicators by reporting how well biodiversity is represented in conservation areas and how it changes over time.

Indicator family 4.1: management responses

Multiple legislative Acts in New South Wales regulate how people use or interact with the environment and collectively influence the outcome for biodiversity. This indicator family provides information about what policies or actions are implemented and how they contribute to preventing or reducing biodiversity loss. The indicators assess changes in management responses and potential implications for biodiversity.

Indicator 4.1a	Areas permanently managed for conservation
Indicator description:	**The extent of areas that are permanently designated for long term biodiversity conservation outcomes** Areas secured or managed for biodiversity conservation in perpetuity includes both public and private land. Areas of public land includes all categories of national parks reserved under the *National Parks and Wildlife Act 1974*, flora reserves dedicated under the *Forestry Act 2012* and other public tenures as relevant. Categories of in-perpetuity agreements on private land include a range of conservation agreements, biodiversity stewardship agreements, property vegetation plans and other property agreements, reserves or protected areas on private land. This indicator requires the collection of spatial data on boundaries of public and private tenures secured for permanent conservation. The objectives for conservation (e.g. aligned with IUCN conservation management category) imply a level of protection potentially afforded to biodiversity assuming those objectives are achieved in full. At t_0: The indicator is the area under conservation management and can be reported as a trend using historical data on land parcels (e.g. annually). The indicator can also be expressed as a proportion of any geographic domain, using spatial allocation rules to account for overlapping boundaries. It is used with indicator family 2.2 to measure how well biodiversity is represented in conservation areas and how that representation changes over time. This indicator does not directly measure the effectiveness of conservation management actions as a result of any agreement. Those outcomes can be reported through indicator family 4.2.
Detecting change:	Change in the value of the indicator at t_Δ can reflect: • changes in the location and size of places designated for conservation in perpetuity • new, changed and revoked protected areas If databases are updated retrospectively to include new information relevant to the assessment, or methods are refined, the status at each past assessment t_0 is also recalculated.
Readiness:	Published
Reporting scale:	Statewide, bioregions, landscapes or regional ecosystems (spatial allocation rules may apply where boundaries overlap)
Environmental scope:	All NSW ecosystems

Indicator 4.1b	Areas temporarily managed for conservation
Indicator description:	**The extent of areas that are designated for biodiversity conservation outcomes under non perpetual agreements** This indicator measures the extent of areas managed for biodiversity conservation under non-perpetual agreements. It includes all areas of public and private tenures under non-perpetual conservation agreements. The indicator may also be used to assess the area represented by each ecosystem type, with a goal of protecting all types of ecosystem within these areas. The duration and security of the agreements may also be assessed. This indicator requires the collection of spatial data on boundaries of public and private tenures secured for temporary conservation including term of agreement (i.e. start and end dates). The objectives for conservation (e.g. aligned with IUCN conservation management category) imply a level of protection potentially afforded to biodiversity assuming those objectives are achieved in full. At t_0: The indicator is the area under conservation management and can be reported as a trend using historical data on land parcels assigned to conservation uses (e.g. annually). The indicator can also be expressed as a proportion of any geographic domain, using spatial allocation rules to account for overlapping boundaries. It is used with indicator family 2.2 to measure how well biodiversity is represented in conservation areas and how that representation changes over time. This indicator does not directly measure the effectiveness of conservation management actions as a result of any agreement. Those outcomes can be reported through indicator family 4.2.
Detecting change:	Change in the value of the indicator at t_Δ can reflect: • changes in the location and size of places designated non-perpetual conservation agreements • new, varied and terminated non-perpetual conservation agreements, and term of agreements If databases are updated retrospectively to include new information relevant to the assessment, or methods are refined, the status at each past assessment t_0 is also recalculated.
Readiness:	Under development
Reporting scale:	Statewide, land sector
Environmental scope:	All land types

Indicator 4.1c	Community appreciation of biodiversity
Indicator description:	**The level of community understanding of and support for biodiversity conservation** This indicator measures community attitudes and understanding of biodiversity, and engagement in and level of support for biodiversity conservation measures, including climate-adapted management and the programs implemented under the Act. Data are systematically collected through structured surveys of the general population, such as the OEH Who Cares about the Environment? survey, and through landholder surveys. At t_0: The indicator requires development. Data requirements and measurement methods will follow a review of previous surveys.
Detecting change:	Change in the value of the indicator at t_Δ can reflect changes in community attitudes, analysed demographically and regionally. If databases are updated retrospectively to include new information relevant to the assessment, or methods are refined, the status at each past assessment t_0 is also recalculated.
Readiness:	Published
Reporting scale:	Statewide (statistical regions)
Environmental scope:	All land types

Indicator family 4.2: management effectiveness

This indicator family measures the effectiveness of implemented policies or actions to reduce the rate of biodiversity loss, including societal attitudes leading to actions (e.g. volunteer engagement in on-ground programs) and planning for adaptation under climate change that is being implemented to support ecosystems. The indicators in this family build on data collected through indicator family 4.1 and provide a basis for improving predictions of biodiversity persistence across whole landscapes (through indicator family 4.3).

Indicator 4.2a	**Effectiveness of on-ground biodiversity conservation programs**
Indicator description:	**The individual and collective effectiveness of programs delivering conservation outcomes on the ground** This indicator compiles and harmonises data and information from direct (on-ground) observation, monitoring and reporting of management effectiveness delivering conservation outcomes for biodiversity and ecological integrity. It includes *Saving our Species* projects and private land conservation under the Act, all types of conservation areas (e.g. national parks and forest reserves), natural resource management projects and actions under formal agreements, and codes of practice for vegetation management. At t_0: The indicator requires development. Data requirements and measurement methods will follow a review of individual program monitoring, evaluation and reporting methods.
Detecting change:	Change in the value of the indicator at t_Δ can reflect: • increased area of effective conservation actions • increased reporting on outcomes. If databases are updated retrospectively to include new information relevant to the assessment, or methods are refined, the status at each past assessment t_0 is also recalculated.
Readiness:	Requiring further research
Reporting scale:	Statewide (program-specific reporting regions)
Environmental scope:	All land types

Indicator 4.2b	Community-based maintenance of biodiversity values
Indicator description:	**The collective effectiveness of voluntary community-based management of biodiversity in maintaining or enhancing natural values** This indicator identifies, compiles and harmonises management effectiveness information across volunteer networks and stewardships to enable statewide and regional reporting on outcomes for biodiversity and ecological integrity from direct (on-ground) observations. Better outcomes for biodiversity can be achieved through community-based collectives to improve the longer-term outlook for sustaining biodiversity locally. At t_0: The indicator requires development. Data requirements and measurement methods will follow a review of community engagement activities and skills in monitoring, evaluation and reporting of on-ground outcomes.
Detecting change:	Change in the value of the indicator at t_Δ can reflect: • increased area of effective conservation actions • increased reporting of outcomes. If databases are updated retrospectively to include new information relevant to the assessment, or methods are refined, the status at each past assessment t_0 is also recalculated.
Readiness:	Requiring further research
Reporting scale:	Statewide (community-specific reporting regions)
Environmental scope:	All land types

Indicator 4.2c	Implemented climate-adapted conservation planning and management
Indicator description:	**Effectiveness of conservation management actions in facilitating biodiversity adaptation to climate change** This indicator tracks the adoption and implementation of conservation management principles and actions and their perceived effectiveness for facilitating biodiversity adaptation to climate change. Increased outcomes for biodiversity are expected from on-ground management actions that are adaptive to climate, thus improving the longer-term outlook for sustaining biodiversity locally. At t_0: The indicator requires development. Data requirements and measurement methods will follow a review of climate-adapted options included in existing conservation management plans and agreements across the private and public sector. The information collected provides a basis for developing scenarios of management and informing projections of biodiversity persistence across whole landscapes under climate change (though ecosystem integrity theme 5).
Detecting change:	Change in the value of the indicator at t_Δ can reflect: • increased uptake of climate adaptation principles in conservation planning and implemented actions • increased area under conservation management adopting and implementing climate adaptation principles. If databases are updated retrospectively to include new information relevant to the assessment, or methods are refined, the status at each past assessment t_0 is also recalculated.
Readiness:	Requiring further research
Reporting scale:	Statewide (program- and community-specific reporting regions)
Environmental scope:	All land types

Indicator family 4.3: capacity to sustain ecosystem quality

This indicator family measures the change in adaptive management capacity to maintain or enhance ecosystem quality and so improve the longer-term outlook for sustaining biodiversity. It does this by integrating specific measures of ecosystem quality and ecosystem management. All types of information influencing biodiversity outcomes are incorporated, including land management that moves toward ecologically sustainable development.

Indicator 4.3a	Capacity to maintain or enhance ecosystem quality (local resilience)
Indicator description:	**The degree to which the present ecological carrying capacity of habitats can be maintained or enhanced into the future, considering effective management** While acknowledging uncertainty, this indicator forecasts the near-term outlook for ecosystem quality and therefore biodiversity, based on the present situation. It integrates management response and management effectiveness data to develop a measure of local system resilience. Local system resilience is the capacity of adaptive management to maintain and enhance the condition of ecosystems in the face of processes that threaten the maintenance of ecosystem quality. Locations where ecosystems are presently managed for conservation are predicted to be sustained, based on their present quality and the effectiveness of present management, which is assumed to continue for the duration of each agreement. Other locations, not managed for conservation outcomes, are assumed to be maintained or to be degrading at a rate consistent with historical trends, taking into account new regulations supporting ecologically sustainable development across land sectors. At t_0: The indicator requires development of data integration methods consistent with an understanding of ecosystem dynamics, states and transitions interacting with management. The outcomes of management effectiveness from indicator family 4.2 are combined with ecosystem quality information from indicator family 3.1 to predict or forecast the degree to which ecosystem quality can be maintained or enhanced across whole landscapes. The results inform ecosystem integrity theme 5.
Detecting change:	Change in the value of the indicator at t_Δ can reflect: increased area of effective conservation actions or reporting on outcomes increased uptake of climate adaptation principles in conservation planning and implemented actions or area under conservation management changes in the location and size of places effectively managed for sustainable outcomes supporting the conservation of biodiversity and ecological integrity. If databases are updated retrospectively to include new information relevant to the assessment, or methods are refined, the status at each past assessment t_0 is also recalculated.
Readiness:	Requiring further research
Reporting scale:	Statewide, bioregions, landscapes or regional ecosystems (spatial allocation rules may apply where boundaries overlap)
Environmental scope:	All land types

Theme 5: ecosystem integrity

This indicator theme considers the capacity of ecosystems to retain their biodiversity and ecological functions in the face of ongoing, yet uncertain, environmental change, including both climate change and land-use change. It addresses the capacity of ecosystems to adapt to change (and so provide for the needs of future generations), which is an underpinning purpose of the Act (s. 1.3(b)). Supporting biodiversity conservation in the context of a changing climate is another purpose of the Act (s. 1.3(d)) to which this theme relates.

This indicator theme aims for the integration and synthesis across other themes of biodiversity and ecological integrity and introduces the concept of ecosystem resilience in deriving an overall measure of ecological integrity. Indicators developed under this theme will enable estimation and reporting of past-to-present changes in ecosystem integrity. These indicators allow alternative land-use and management options to be evaluated in terms of expected consequences for adaptive capacity into the future. The indicators can apply either a plausible range of climate projections, or land-use change scenarios driven by socio-economic demand, or both. Future international research is expected to provide integrated scenarios of climate and land-use change suitable for testing the general integrity and robustness of ecological systems.

Indicator family 5.1: capacity to retain biological diversity

This indicator family measures the capacity of ecosystems to retain biodiversity in the face of ongoing, and uncertain, environmental change, including climate change and land-use change. It is a measure of the capacity of ecosystems to adapt to change and provide for the needs of future generations (i.e. ecological integrity). It aims for the integration and synthesis across other themes of biodiversity and ecological integrity and introduces the concept of ecosystem resilience. Particular indicators may apply a plausible range of climate projections or land-use change scenarios. Additional indicators may be developed for other pressures.

Indicator 5.1a	Ecosystem capacity to adapt to change and retain biological diversity under climate change
Indicator description:	**The ability of ecosystems to adapt and retain their biodiversity under climate change, facilitated by effective management** This indicator measures and reports on a key component of ecological integrity. It integrates 2 dimensions of resilience: (i) local system resilience, derived from local-scale management of processes that threaten the maintenance of integrity from indicator 4.3, and (ii) spatial resilience, derived from the spatial and environmental connectedness of ecosystems exhibiting high local resilience. Initial development of the indicator will focus largely on the spatial-resilience dimension, using ecological carrying capacity indicator 3.1c as a proxy for local system resilience. The indicator dimension of spatial resilience will be generated by assessing the spatial and environmental connectedness of ecosystems under a plausible range of climate projections. This assessment will be undertaken using the observed (existing) spatial condition and configuration of natural habitats, from the ecological carrying capacity indicator 3.1c, and will assume no future change in that capacity under the climate projections evaluated. A GDM (from indicator 2.2b) is projected under climate change to inform the environmental connectedness of ecosystems. At t_0: The indicator requires development, building on and extending existing analytical techniques and models (including GDM) as employed in indicator 2.2b, and habitat connectedness analysis similar to that employed in indicator 3.1b. It is being developed in 2 stages. Stage 1 will assess spatial resilience informed by indicator 3.1c and Stage 2 will also incorporate the effectiveness of conservation management actions through indicator 4.3, thereby providing a fully integrated measure of ecological integrity.
Detecting change:	Change in the value of the indicator at t_Δ reflects how any observed change in the condition and spatial configuration of habitat (from indicator 3.1c) is expected to affect the capacity of ecosystems to retain biological diversity under a plausible range of climate projections. The indicator is standardised by using the same model of biodiversity for the biological group and the same climate change scenario/s. If a new model is developed using refined data and methods, or climate scenarios change, the status at each past assessment t_0 is also recalculated.
Readiness:	Published
Reporting scale:	Statewide and regional (e.g. protected areas, bioregions, landscapes, regional ecosystems)
Environmental scope:	Terrestrial

Indicator 5.1b	Ecosystem capacity to adapt to change and retain biological diversity under land-use change
Indicator description:	**The ability of ecosystems to adapt and retain their biodiversity under land-use change, facilitated by effective management** This indicator measures and reports on a key component of ecological integrity. It extends indicator 5.1a by including plausible land-use change scenarios. At t_0: This indicator requires research and development. It is in preliminary stages of development and requires consultation and design of methods.
Detecting change:	Change in the value of the indicator at t_Δ reflects how any observed change in the condition and spatial configuration of habitat (from indicator 3.1c) is expected to affect the capacity of ecosystems to retain biological diversity under a plausible range of climate projections and land-use scenarios. The indicator is standardised by using the same model of biodiversity for the biological group and the same climate/land-use change scenario/s. If a new model is developed using refined data and methods, or climate/land-use scenarios change, the status at each past assessment t_0 is also recalculated.
Readiness:	Requiring further research
Reporting scale:	Statewide and regional (e.g. protected areas, bioregions, landscapes, regional ecosystems)
Environmental scope	Terrestrial

Indicator family 5.2: capacity to retain ecological functions

This indicator family measures the capacity of ecosystems to retain ecological functions in the face of ongoing, and uncertain, environmental change, including climate change and land-use change. It is a measure of the capacity of ecosystems to adapt to change and provide for the needs of future generations (i.e. ecological integrity). It aims for the integration and synthesis across other themes of biodiversity and ecological integrity. Particular indicators may apply a plausible range of climate projections or land-use change scenarios. Additional indicators may be developed for other pressures.

Indicator 5.2a	**Ecosystem capacity to adapt to change and maintain ecological functions under climate change**
Indicator description:	This indicator is analogous to indicator 5.1a but addresses the capacity of ecosystems to maintain ecological functions rather than their capacity to retain biological diversity. It draws on information about the capacity to maintain or enhance ecosystem quality (from indicator 4.3a) which, in turn, incorporates information about climate-adapted conservation management (from indicator 4.2c) and an assessment of ecological functions from indicator 3.1d. Eco-hydrological models are coupled with a plausible range of climate projections to assess the local resilience of ecological functions, taking into account current capacities of management (from indicator 4.3a) and system status (from indicator 3.1d). System status may also be informed by the ecological condition indicator 3.1a. At t_0: The indicator requires development of data-model integration methods consistent with best-available understanding of socio-ecological system interactions, and of processes underpinning maintenance of ecological functions.
Detecting change:	Change in the value of the indicator at t_Δ can reflect: • changes in natural ecological functions determined from indicator 3.1d, or • changes in management capacity to sustain ecological functions determined from indicator family 4.3. The indicator is standardised by using the same model of eco-hydrology and the same climate/land-use change scenario/s. If a new model is developed using refined data and methods, or climate/land-use scenarios change, the status at each past assessment t_0 is also recalculated.
Readiness:	Requiring further research
Reporting scale:	Statewide and regional (e.g. protected areas, bioregions, landscapes, regional ecosystems)
Environmental scope:	Terrestrial

Indicator 5.2b	Ecosystem capacity to adapt to change and maintain ecological functions under land-use change
Indicator description:	**The ability of ecosystems to adapt and retain their natural ecological functions under land-use change, facilitated by effective management** This indicator measures the ability of ecosystems to adapt and retain the natural dynamics of ecological functions in the face of ongoing, and uncertain, environmental change, in particular land-use change. This indicator extends indicator 5.2a by including plausible land-use change scenarios. Eco-hydrological models are coupled with a plausible range of climate projections and land-use scenarios to assess the local resilience of ecological functions, taking into account current capacities of management (from indicator 4.3a) and system status (from indicator 3.1d). At t_0: This indicator requires research and development. It is in preliminary stages of development and requires consultation and design of methods.
Detecting change:	Change in the value of the indicator at t_Δ can reflect: • changes in natural ecological functions determined from indicator 3.1d • changes in management capacity to sustain ecological functions determined from indicator family 4.3. The indicator is standardised by using the same model of eco-hydrology and the same climate/land-use change scenario/s. If a new model is developed using refined data and methods, or climate/land-use scenarios change, the status at each past assessment t_0 is also recalculated.
Readiness:	Requiring further research
Reporting scale:	Statewide and regional (e.g. protected areas, bioregions, landscapes, regional ecosystems)
Environmental scope:	Terrestrial

5. Glossary

Adaptation: responses that decrease the negative effects of change and capitalise on positive opportunities associated with impacts. In relation to biodiversity responses, whether natural or assisted by humans, adaption enables species and ecological processes to adjust and evolve in response to a changed environment.

Adaptive genetic diversity: see genetic diversity.

Adaptive management: involves learning from management actions and using those lessons to improve future management.

Animal: any animal, whether vertebrate or invertebrate, and in any stage of biological development, but does not include: (a) humans, or (b) fish within the meaning of the *Fisheries Management Act 1994*. Note: some types of fish may be included in the definition of animal and some types of animal may be included in the definition of fish. See s. 14.6 of the *Biodiversity Conservation Act 2016*.

Anthropogenic: produced or caused by human activity.

Area of occupancy (AOO): as defined by the NSW Scientific Committee, is the area within the total range (and hence within the extent of occurrence, or EOO) that is currently occupied by the species. It excludes unsuitable and unoccupied habitat. In some cases, (e.g. irreplaceable colonial nesting sites, crucial feeding sites for migratory taxa) the area of occupancy is the smallest area essential at any stage to the survival of existing populations of a taxon.

Assessment: use of biophysical data collected through monitoring, combined with other inputs such as benchmarks, to make judgements about environmental condition and trends.

Benchmark: the quantitative measures that represent the 'best-attainable' condition, which acknowledges that native vegetation within the contemporary landscape has been subject to both natural and human-induced disturbance. Benchmarks are defined for specified variables for each plant community type. Vegetation with relatively little evidence of modification generally has minimal timber harvesting (few stumps, coppicing, cut logs), minimal firewood collection, minimal exotic 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): is defined by the Act as the 'variety of living animal and plant life from all sources and includes diversity within and between species and diversity of ecosystems'. It encompasses all the variability among living organisms from all sources, including genetic, species and ecosystem diversity across terrestrial and land-based aquatic realms and certain coastal and marine species. Biodiversity includes both species and ecosystems that are currently known, as well as those that are yet to be discovered.

Biodiversity values: include the composition, structure and function of ecosystems, and (but not limited to) threatened species, populations and ecological communities and their habitats.

Bioregion: relatively large land areas characterised by broad, landscape-scale natural features and environmental processes that influence the functions of entire ecosystems and capture large-scale biophysical patterns. These patterns in the landscape are linked to fauna and flora assemblages and processes at the ecosystem scale. There are 17 bioregions represented in New South Wales.

Climate change: change in the climate attributed directly or indirectly to human activity that alters the composition of the global atmosphere and that is, in addition to natural climate variability, observed over comparable time periods. The Intergovernmental Panel on Climate Change definition refers to a statistically significant variation in either the mean state of the climate or in its variability persisting for an extended period (typically decades or longer). Climate change can be due to natural internal processes or external forces, or due to persistent anthropogenic changes in the composition of the atmosphere or in land use.

Climate variability: long-term changes in the patterns of average weather of a region or the Earth as a whole.

Complementarity: is the marginal gain in biodiversity provided by a location, place or region relative to other locations, places or regions. For example, the complementarity value of an area (for example, National Park A) is given by the number of so-far-unrepresented features of biodiversity that it contributes, relative to other areas (for example, National Parks B to Z). The principle of (biodiversity) complementarity, applied to conservation planning, ensures that places chosen for inclusion in a network of conservation areas complement those already selected in order to increase the overall representation of different features of biodiversity within the network.

Connectivity: the degree to which the landscape facilitates animal or plant movement or spread and ecological flows.

Conservation: in relation to biodiversity, conservation is the protection, maintenance, management, sustainable use, restoration and improvement of the natural environment. In relation to natural and cultural heritage, conservation generally refers to the safekeeping or preservation of the existing state of a heritage resource from destruction or change.

Dispersal: the spread of animals and plants into new areas.

Disturbance: in relation to ecology, any process or event which disrupts ecosystem structure and resource availability.

Divergence: see genetic divergence.

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: an assemblage of species occupying a particular area at a particular time.

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: accounts for the generalised quality of habitats supporting biodiversity at each location, the fragmentation of habitat within its neighbourhood and its position in the landscape (e.g. as part of a habitat corridor or as a stepping stone).

Ecological integrity: is about maintaining the diversity and quality of ecosystems and enhancing their capacity to adapt to change and provide for the needs of future generations.

Ecologically sustainable development: in this case, to maintain or enhance values related to biodiversity and ecological integrity, allowing development without risking greater numbers of threatened species and collapsed ecological communities.

Eco-physiological processes: Ecophysiology is the study of how the environment, both physical and biological, interacts with the physiology of an organism. It includes the effects of climate and nutrients on physiological processes in both plants and animals and has a particular focus on how physiological processes scale with organism size. Examples of eco-physiological processes in plants are respiration, photosynthesis and nutrient uptake. The growth response of plants to climate differs between species, depending on their ecophysiology and life history characteristics.

Ecosystem: a dynamic complex of plant, animal and microorganism communities and their non-living environment that interact as a functional unit. Ecosystems may be small and simple, like an isolated pond, or large and complex, like a specific tropical rainforest or a coral reef.

Ecosystem function: a general term that includes stocks of materials and rates of processes, for example, photosynthesis, respiration, carbon and nutrient cycles.

Ecosystem integrity: supporting and maintaining a balanced, integrated adaptive community of organisms having a species composition, diversity and functional organisation comparable to that of a natural habitat of the region.

Extant: currently existing.

Extent: the area covered by something.

Extent of occurrence (EOO): as defined by the NSW Scientific Committee, the area of the total geographic range that includes all extant populations of the species.

Extinction debt/lag: the future extinction of species due to events in the past, such as clearing of habitat. Generally refers to the *number of species* in an area likely to become extinct, rather than the prospects of any one species, but colloquially it refers to any occurrence of delayed extinction.

Extinction risk: a measure of the actual or potential decline and extinction over time of a species or other defined ecological unit (e.g. ecological communities).

Fragmentation: the division of continuous habitat by vegetation clearance for human land-use activities, which isolates the remnant patches of vegetation and the species within them and limits genetic flow between populations.

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

Generalised Dissimilarity Modelling: a statistical technique for analysing and predicting spatial patterns of turnover in community composition (beta diversity) across large regions.

Genetic divergence: the process in which 2 or more populations of an ancestral species accumulate independent **genetic** changes (mutations) through time, often after the populations have become reproductively isolated for some period of time.

Genetic diversity: the range of intrinsic differences in genes among individual organisms within a species, or among different species within a taxonomic group. There are several hypotheses to account for the emergence of genetic diversity. The 2 considered here are neutral and adaptive genetic diversity. Neutral genetic diversity results from the accumulation of neutral substitutions (i.e. processes such as gene flow, migration or dispersal which are influence by the spatial configuration of habitats and their relative connectivity across whole landscapes). Adaptive genetic diversity results from subpopulations of a species living in different environments that select for different alleles at a particular locus.

Habitat: an area or areas occupied, or periodically or occasionally occupied, by a species, population or ecological community, including any biotic or abiotic 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 corridor: an area of habitat connecting wildlife populations separated by human activities or structures (such as roads, development or logging).

Habitat fragmentation: the emergence of discontinuities (fragmentation) in an organism's preferred environment (habitat), causing population fragmentation and ecosystem decay.

Index (plural indices): a metric used to quantify the information represented by an indicator.

Indicators: specific, measurable characteristics that show trends or changes in the status of something — in this report, changes in the status of biodiversity and ecological integrity.

Invasive species: a plant or animal that has been introduced into a region in which it does not naturally occur and that becomes established and spreads, displacing naturally occurring species.

Irreplaceability: an inability of a species or ecosystem to be replaced, often because of uniqueness. In conservation planning, irreplaceability reflects how important a specific area is for the efficient achievement of conservation objectives (e.g. retention of species and ecosystems). A completely irreplaceable area is considered essential for meeting conservation objectives, whereas an area with low irreplaceability can be substituted by other sites.

IUCN: International Union for the Conservation of Nature, a union of government and non-government organisations that provides public, private and non-governmental organisations with the knowledge and tools that enable human progress, economic development and nature conservation to take place together.

Land cover: the biophysical cover on the Earth's surface, including native vegetation (woody and non-woody vegetation), soils, exposed rocks and waterbodies as well as man-made elements such as plantations, crops and built-up areas.

Landscape: a heterogeneous area of local ecosystems and land uses that is of sufficient size to achieve long-term outcomes in the maintenance and recovery of species or ecological communities, or in the protection and enhancement of ecological and evolutionary processes.

Listed threatened ecological communities: ecological communities listed as threatened in the Act.

Listed threatened species: species listed as threatened in the Act.

Modelling: computational simulation of a process, concept or the operation of a system.

Models: an abstract, usually mathematical, representation of a system which is studied to gain understanding of the real system.

Monitoring: in this context, activities to collect new biophysical data.

Neutral genetic diversity: see genetic diversity.

New South Wales Threatened Species List: refers to all threatened species listed in Schedules 1 and 3 of the Act.

New South Wales Threatened Ecological Communities List: refers to all threatened ecological communities listed in Schedules 2 and 3 of the Act.

Non-woody vegetation: for vegetation monitoring using Landsat MSS satellite sensors, vegetation formations that are less than 2 metres high or with less than 20% canopy cover (mainly grasslands, arid shrublands and woodlands).

Phylogenetic diversity (PD): a measure of biodiversity which incorporates phylogenetic difference between species, often within a taxonomic group.

Plant: any plant, whether vascular or non-vascular and in any stage of biological development in the taxonomic kingdom of Plantae. Note that under the NSW biodiversity legislation, ‘plant’ includes fungi and lichens (but not marine vegetation which is under fisheries legislation).

Power curve: in ecology, a power curve describes the non-linear relationship between an increasing number of biodiversity features (genes, species or ecosystems) and increasing area sampled (or number of locations).

Pressures: threats in the landscape that cause biodiversity loss or threaten the quality of ecosystems, including key threatening processes listed under Schedule 4 of the Act as well as other threats not listed on the Act.

Proxy: in this context, a species or group of taxa used as substitutes for other taxa. See also ‘representative’ and ‘surrogate’ species.

Red List of Ecosystems: a global standard for how to assess the risk of extinction status of ecosystems, applicable at local, national, regional and global levels. Under the auspices of the IUCN.

Red List of Species: a global standard for how to assess the risk of extinction status of species, applicable at local, national, regional and global levels. Under the auspices of the IUCN.

Remnant: in relation to ecology, is a small, fragmented portion of vegetation that once covered an area before being cleared.

Remote sensing: a means of acquiring information using airborne or satellite equipment and techniques to determine the characteristics of an area; most commonly using imagery from aircraft and images from satellites.

Representative species: a species (or subset of species) that represents or is typical of that group of species.

Spatial resilience: an ecological integrity indicator that aims to measure the capacity of terrestrial ecosystems to retain their biological diversity in the face of climate change, as a function of the quality (condition) and spatial-environmental connectedness of these ecosystems, through time.

Species: a taxon comprising one or more populations of individuals capable of interbreeding to produce fertile offspring.

Status: the condition or ‘health’ of a species, population, community, habitat or ecosystem.

Stepping stone: patches of habitat that help reduce the effects of fragmentation by facilitating dispersal of species or their propagules among otherwise isolated habitat areas.

Suitable habitat: suitable habitat is predicted by identifying where each species lived originally and its associated environment.

Surrogate, biodiversity: a species, group of species or ecosystem that can be used as a substitute for wider biological groups.

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.

Trends: directions of significant change in the environment, as shown by the changing values of measures (like essential variables, indicators or indices).

Vascular plant: plants containing vascular tissue (i.e. tissue specialised for the conduction of fluids); the more highly evolved plants above mosses and liverworts.

Vegetation condition: the health of native vegetation communities which reflects the level of naturalness and is commonly assessed against a benchmark, considering factors such as structural integrity, species composition, presence or absence of weeds and diseases and reproduction of species.

Vegetation integrity: being the degree to which the composition, structure and function of vegetation at a particular site and the surrounding landscape has been altered from a near-natural state.

Vegetation structure: the organisation of plants within a plant stand or assemblage consisting of one or more layers or strata.

Woody vegetation: for vegetation monitoring using Landsat MSS satellite sensors, vegetation formations (mainly woodlands and forests) that are over 2 metres high and with more than 20% canopy cover; also known as 'detectable native forest'.

6. References

Montréal Process Working Group 2015, The Montréal Process: Criteria and Indicators for the Conservation and Sustainable Management of Temperate and Boreal Forests, Fifth Edition, Montréal Process Working Group.

OEH & CSIRO 2019, Measuring Biodiversity and Ecological Integrity in New South Wales: Method for the Biodiversity Indicator Program, Office of Environment and Heritage NSW and Commonwealth Scientific and Industrial Research Organisation, NSW Government, Sydney.