CONSULTATION DRAFT

DEPARTMENT OF PLANNING, INDUSTRY & ENVIRONMENT

Guidelines for interpreting listing criteria for Areas of Outstanding Biodiversity Value

under the Biodiversity Conservation Act 2016 and the Biodiversity Conservation Regulation 2017

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Cover photo: Cabbage tree palm forest on John Gould Nature Reserve, Cabbage Tree Island. John Spencer/DPIE

The NSW Department of Planning, Industry and Environment has prepared these guidelines to assist interpretation of the concepts and terms relating to Areas of Outstanding Biodiversity Value in the listing criteria given in the Biodiversity Conservation Regulation 2017. They should always be used in conjunction with the *Biodiversity Conservation Act 2016* and the Biodiversity Conservation Regulation 2017. If cases arise where advice given in the guidelines is in apparent conflict with the Act or the Regulation, the Act and Regulation will apply.

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1. Introduction

The Biodiversity Conservation Regulation 2017 (BC Regulation) provides explicit criteria to guide listing decisions for Areas of Outstanding Biodiversity Value (AOBV) under the *Biodiversity Conservation Act 2016* (BC Act). To be eligible for listing as an AOBV, an area must, in the opinion of the NSW Minister for Energy and Environment, meet one or more of criteria listed in Division 3.1 specified in the Regulation.

The purpose of the AOBV criteria and the listing of AOBVs under the BC Act is to identify, highlight, protect and effectively manage sites that make significant contributions to the persistence of biodiversity in NSW, Australia and globally. The different criteria address different ways in which areas may contribute significantly to the persistence of biodiversity. Areas should be assessed against all relevant criteria for which data are available. Meeting the thresholds under any one of the criteria or sub-criteria is sufficient for an area to be recognised as an AOBV under the BC Act. Note, some biodiversity elements may trigger multiple criteria, but only one criterion is necessary for listing as an AOBV.

A number of aspects of the assessment and listing process for AOBVs under the BC Act are modelled on the IUCN Key Biodiversity Areas criteria (IUCN 2016, 2019a). These provide an explicit, objective and widely understood framework that represents international best practice for identifying AOBVs. They ensure the identification of AOBVs is objective, repeatable and transparent. The IUCN Key Biodiversity Areas (KBA) criteria are a product of extensive consultation with a large community of international scientists (Langhammer et al. 2007; IUCN 2016, 2019a; Derbyshire et al. 2017). The KBA criteria, or variations thereof, have been used to identify priority conservation areas for countries (Madagascar, Eken et al. 2004) and taxonomic groups such as birds (Birdlife International 2014) and plants (Derbyshire et al. 2017). By adopting similar listing criteria, NSW benefits from the substantial intellectual capital associated with the IUCN Key Biodiversity Areas, ensuring world's best-practice assessments of areas of significance for biodiversity. These guidelines draw extensively from relevant material in IUCN Key Biodiversity Areas criteria (IUCN 2016) and guidelines (IUCN 2019a). The thresholds developed for IUCN KBAs (and applied here for AOBVs) were developed through a series of technical workshops and subsequently refined through the consultation of a wide range of experts and testing with datasets covering diverse taxonomic groups, regions and environments (IUCN 2019a).

The NSW Department of Planning, Industry and Environment has prepared these guidelines to assist interpretation of the concepts and terms in the listing criteria given in the BC Regulation as per Clause 3.1(6) of the BC Regulation. These guidelines focus on the application of the AOBV criteria in the BC Regulation. The Department may update these guidelines periodically to include additional examples and address new questions of interpretation as they arise. These guidelines should always be used in conjunction with the BC Act and the BC Regulation. If cases arise where advice given in the guidelines is in apparent conflict with the BC Act or the BC Regulation, the Act and Regulation will apply.

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2. AOBV listing criteria

Assessments for listing Areas of Outstanding Biodiversity Value under the BC Act must be assessed under Division 3.1 of the BC Regulation. An area is eligible for listing if it meets any one of Clauses 3.1(2), (3), (4) or (5) provided that it is also significant at least at the NSW state scale (as per Clause 3.1(1)(a)).

2.1 Clause 3.1(1) – threshold of significance and summary of the four AOBV criteria

Clause 3.1(1) clarifies the scale at which AOBVs should be significant (3.1(1)(a), see 2.1.1 below) and provides a summary of the four criteria, at least one of which must be met for an area to be eligible for listing as an AOBV.

2.1.1 Threshold of significance

Clause 3.1(1)(a) requires that any AOBV must be important at any one (or all) of a state, national or global scale. Assessment of what constitutes significance at these scales is included under each criterion (see 2.2 to 2.5 below). For species and ecological communities, those endemic to NSW are considered to be of global significance, as these species and ecological communities are found nowhere else in the world. For species and ecological communities that are not endemic to NSW, their state significance, and hence eligibility under criterion 3.1(1), must be justified with reference to the scale of relative importance of populations (species) or distribution and species composition (ecological communities) in NSW as compared to elsewhere. State significance in such cases may include:

- species or ecological communities with more than 2/3 of their population or distribution (AOO or EOO as per IUCN 2019b) in NSW. This incorporates the global relevance criterion of Berg et al. (2014); or
- populations that, relative to other populations of the species outside NSW, are distinctive in genetic composition, morphology, habitat biology, behaviour or their likely adaptive capacity under climate change; or
- occurrences of ecological communities that, relative to other occurrences of the ecological community, are distinctive in taxonomic composition, habitat structure or biology or ecological function.

Species and ecological communities listed as threatened under the *Environmental Protection and Biodiversity Conservation Act 1999* (Cwlth) (EPBC Act), by definition, are identified as 'matters of national environmental significance' under that legislation. Such species and ecological communities are therefore considered to be at least of national significance for purposes of assessing AOBVs under the BC Act (independent of whether or not they are endemic to NSW).

Consistent with the IUCN Key Biodiversity Area criteria (IUCN 2016), the criteria for listing of AOBVs can be broadly applied to biodiversity in terrestrial, inland water and marine environments, although the BC Act explicitly does not cover fish and marine vegetation, as these matters are dealt with under the *Fisheries Management Act 1994* (currently under revision). Although not all criteria may be relevant to all elements of biodiversity (e.g. not all species form aggregations referred to in Clause 3.1(4)), the thresholds associated with each of the criteria are intended to work across all taxonomic groups and ecosystems.

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2.1.2 Summary of four AOBV criteria

Clause 3.1(1)(b) identifies the four possible pathways by which an area must make a significant contribution to persistence of biodiversity in NSW to be eligible as an AOBV. These four pathways (and the section dealing with each) are:

(i) multiple species or at least one threatened species or ecological community (see 2.2 below); or

(ii) irreplaceable biological distinctiveness (see 2.3 below); or

(iii) ecological processes or ecological integrity (see 2.4 below); or

(iv) outstanding ecological value for education or scientific research (see 2.5 below).

2.2 Clause 3.1(2) – persistence of multiple species or at least one threatened species or ecological community

Areas eligible for listing under Clause 3.1(2) make significant contributions to the persistence of biodiversity in NSW because there are few other occurrences in NSW of either the species or ecological communities, and therefore the loss of such sites may result in significant losses of biodiversity.

These areas may also be important for maintaining the natural movements of native plants and animals and for facilitating adaptation of species and ecological communities. Areas will also be eligible for listing under this criterion if they make a significant contribution to the persistence of biodiversity through their role in maintaining ecological functionality over decadal timescales.

Clause 3.1(2) has four subcriteria (detailed below in 2.2.1, 2.2.2, 2.2.3 and 2.2.4) that define the eligibility of an area for listing as an AOBV as the area makes a significant contribution to the persistence of multiple species or at least one threatened species or ecological community. An area that meets at least one of the subcriteria is eligible for listing as an AOBV. The subcriteria deal with different components that enhance the persistence of biodiversity: provide resilience during periods of environmental stress; sustain adaptive capacity or evolutionary potential; support migration or dispersal of animals and plants; and provide critical habitat for the survival of a threatened species.

2.2.1 Provides resilience during periods of environmental stress that is important for their continued existence

Many ecosystems and species undergo periods of environmental stress (e.g. droughts, fires, major storms) and may be dependant upon parts of their habitat (‘refuges’) to ensure survival through such periods of stress. This is of particular importance given the extent of clearing and fragmentation that has occurred in NSW (NSW Scientific Committee 2001) as such habitat loss will disrupt habitat connectivity and the capacity of species to both move to areas of suitable habitat at certain times in their life cycle or to disperse from such habitat when environmental stresses are relaxed. For NSW, the NSW Scientific Committee (2001), in listing ‘Clearing of native vegetation’ as a Key Threatening Process, state that ‘since 1788 at least 61% of the original native vegetation has been cleared, thinned or substantially or significantly disturbed (Environment Protection Authority 1997). The proportion of area cleared varies between region and community type (Native Vegetation Advisory Council 1999) and in some cases has exceeded 90% (for example - South East Grassy Forests - (Keith & Bedward 1999).’ They also note that ‘Fragmentation impacts include the creation of small isolated populations with limited gene flow between populations, leading to inbreeding depression and reduced potential to adapt to environmental change. Fragmentation also

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leads to the loss or severe modification of the interactions between species, including those interactions that are important for the survival of species.' In addition, clearing may have lagged effects, 'Disruption of ecological processes may continue long after initial clearing of native vegetation has occurred, with consequent continued decline in biological diversity' (NSW Scientific Committee 2001).

As a consequence, the factors that allow particular areas to provide resilience to biodiversity during periods of environmental stress may vary both spatially and temporally and may differ among taxa.

Thresholds for triggering Clause 3.1(2)(a) are based on IUCN KBA criteria D2 and D3 (IUCN 2016). These are:

i) that an area supports ≥10% of the NSW, Australian or global population size of one or more species during periods of environmental stress; or

ii) that an area produces propagules, larvae, or juveniles that maintain ≥10% of the NSW, Australian or global population size of a species.

2.2.2 Sustains adaptive capacity or evolutionary potential

As per the BC Regulation Clause 3.1(2)(b), this subclause identifies areas that are significant because they sustain adaptive capacity or evolutionary potential that may enable species to persist under a changing environment. Such areas can be identified because they: i) contain high levels or unique components of genetic or phenotypic diversity (the variation on which natural selection acts); or ii) they function as important ecological or evolutionary refuges able to sustain viable populations of species at risk due to climate change or other environmental stresses.

This subclause deals with two overlapping components:

i) *areas with high levels of unique components of genetic or phenotypic diversity that will enable species to adapt to changing environments*. Genetic and phenotypic diversity are important considerations in species coping with changing environments (Moritz 1994, 2002). Hoffman and Sgro (2011), Smith et al. (2014) and Cook and Sgro (2017) all stress the importance of considering evolutionary processes in management programmes designed to minimize biodiversity loss. Hoffman and Sgro (2011) highlight 'Criteria based on patterns of local adaptation to climate gradients, probable levels of genetic variance now and into the future, and exposure to ongoing climate selection could all be used to identify species at risk.' 'DNA decay in genes that are functionally important, low levels of genetic variation, or phyletic conservatism may point to groups of species being particularly susceptible to climate change because of a limited capacity for adaptation.' Crandell et al. (2000) stress it is important to conserve 'Evolutionary Significant Units' that have historically been isolated and contain unique genetic diversity, along with areas that promote ongoing selection because they have a long history of species persistence through periods of environmental change. Areas meeting this subclause will have demonstrated high (relative to other areas) or unique levels of genetic or phenotypic diversity.

ii) *areas that function as important ecological or evolutionary refugia able to sustain viable populations of species or viable ecological communities at risk due to climate change or other environmental stresses*. Criteria developed by IUCN (2016) for identifying ecological refugia as Key Biodiversity Areas (criterion D2) have been adopted for assessment of subclause 3.1(2) (b). This specifies that an area is eligible for listing if it supports '>10% of the population size of one or more species during periods of environmental stress, for which historical evidence shows that it has served as a refugium in the past and for which there is evidence to suggest it would continue to do so in the foreseeable future at the species level.' For the BC Act, significance at the state,

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national and global scales equates to >10% of the NSW, Australian or global population size, respectively.

2.2.3 Supports migration or dispersal of animals and plants

Dhanjal-Adams et al. (2016) note that 'Conserving migratory species requires protecting connected habitat along the pathways they travel.' Areas meeting Clause 3.1(2)(c) are ones that support migration or dispersal of animals and plants, currently or in the future, as a means of contributing significantly to the persistence of species at risk. Areas meeting this subcriterion must demonstrate the importance or potential of the site for migration or dispersal relative to the persistence of species or ecological communities. Such areas may provide any of:

i) connectivity (corridors, stepping stones, etc) of native vegetation in areas where there has been marked habitat loss; or
ii) habitat and/or food resources that sustain migration pathways; or
iii) areas or habitats that facilitate range shifts under a changing climate.

To be eligible for listing as an AOBV under this subclause an area would have to be an important site for migration or dispersal. This can be gauged via the importance of the site relative to other sites that are important for migration for a species (or groups of species), and the degree to which a species (or group of species) is dependent upon the site. Areas meeting Clause 3.1(2)(c) should be one of the top 10 most important sites for migration or dispersal of a species (or group of species) in NSW. It is expected that while the temporal frequency of use of the site may vary, areas meeting this subclause should be of regular importance for migration or dispersal.

For the BC Act, significance at the state, national and global scales equates to the relative importance of the site for migration or dispersal within NSW, Australian or globally, respectively.

2.2.4 Is habitat critical for the survival of a threatened species

Critical habitat is the whole or any part or parts of the area or areas of land comprising the habitat of a threatened species, population or ecological community that is critical to the survival of the species, population or ecological community. Identification and delineation of critical habitat must consider: the distributions and habitat preferences of the species or threatened ecological community (TEC), the nature of the threats impacting on the species or TEC, proximal effects from neighbouring areas and the requirement for any buffers to avoid adverse impacts on the species or TEC.

For listing under the BC Act, significance at the state, national and global scales would equate to the habitat being critical for the species or ecological community at the NSW, Australian or global scale, respectively.

2.3 Clause 3.1(3) – persistence of irreplaceable biological distinctiveness

This clause is intended to identify areas with high levels of diversity or endemism, which are therefore important for the persistence of biodiversity at the NSW, Australian or global scale. The conservation of sites that contain an important number of threatened species, populations or ecological communities also makes a large contribution to the global persistence of biodiversity through reducing the risk of species extinction or ecosystem collapse.

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Clause 3.1(3) has three subclauses (detailed below in 2.3.1, 2.3.2 and 2.3.3) that define the eligibility of an area for listing as an AOBV as the area that makes a significant contribution to the persistence of irreplaceable biological distinctiveness. An area that meets at least one of the subclauses is eligible for listing as an AOBV. The subclauses deal with different elements that contribute components that enhance the persistence of irreplaceable biological distinctiveness: very high structural, functional or compositional diversity; essential for the persistence of evolutionary or ecological distinctive species, endemic species or ecological communities; and essential site for the persistence of two or more threatened species or ecological communities.

2.3.1 A very high structural, functional or compositional diversity

Areas eligible for listing under Clause 3.1(3)(a) contain very high levels diversity in any one (or combinations of) of the following:

i) Structural diversity. This reflects the degree of variation in the different structural components at a site that different species utilise, including biotic features such as vegetation structure (canopy, subcanopy, shrub, understorey, ground, litter bare soil, etc) and habitat structure (e.g. tree hollows, logs), along with abiotic structure (e.g. rocks, ledges, aspect, elevation, geodiversity (Keith 2011) etc). Areas with a high diversity and complexity of these structural features provide suitable habitat or ecological or environmental 'niches' (Silvertown 2004) for a diverse array of biota.

ii) Functional diversity. The persistence of species and ecological communities depends upon the maintenance of the ecological processes and functions that allow the completion of species' life cycles. This includes biotic functions and processes (such as pollination, dispersal, successful reproduction, growth, survival, etc) along with abiotic functions and processes (such as nutrient cycling and availability, disturbance regimes, etc). Functional diversity is conventionally measured through representation of functional traits (e.g. Diaz et al. 2013). Areas with a high diversity and complexity of these functional diversity features provide suitable habitat for the persistence of a diverse array of biodiversity.

iii) Compositional diversity. Taxonomic diversity is commonly considered and important measure of site importance. There are several standard measures of diversity: within-community or (alpha diversity); between-community or landscape (beta diversity); and between-region (gamma diversity) (Whittaker et al. 2001). Areas with very high compositional diversity will contain relatively high levels of alpha and/or beta diversity.

Assessment of what constitutes 'very high' structural, functional or compositional diversity under Clause 3.1(3)(a) should be made relative to other areas. 'Very high' areas should have the top 20% of diversity relative to other sites. For the BC Act, significance at the state, national and global scales would equate to area a very high level of structural, functional or compositional diversity relative to diversity at the NSW, Australian or global scale, respectively.

2.3.2 An essential site for the persistence of evolutionary or ecological distinctive species, endemic species or ecological communities

Areas eligible for listing under Clause 3.1(3)(b) contain characteristics that allow the persistence of evolutionarily or ecologically distinctive species, endemic species or ecological communities. Evolutionary distinctiveness is a measure of the distance along the evolutionary tree from one species to its nearest relative (Jetz et al. 2014). Evolutionary distinctive species are those that are considered to have distinct lineages to most other species. For example, a species that is evolutionarily distinctive will have few close relatives

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in NSW, Australia or globally (e.g. monotypic genera such as the Wollemi pine). Ecologically distinctive species are those considered to have different or distinctive ecologies to most other co-occurring species. A species or ecological community is ecologically distinctive if it possesses behavioural, morphological, ecophysiological, dietary or habitat features that are not commonly represented among other species or ecological communities. To be essential for persistence of distinctive species or ecological communities, an area must contain one or more of the habitat features and requirements needed by the species or ecological communities to survive. Few other sites will be occupied by the species or ecological community, and hence few other sites appear to provide suitable habitat. The area may provide continuous habitat for the species or ecological community or a species may depend on the area only at certain times of the year or in certain years. In all cases, the area should be assessed to be essential for the species or ecological community persistence.

Species or ecological communities are considered to be endemic to NSW if they occur nowhere else but in NSW. Species or ecological communities are considered to be endemic to Australia if they occur nowhere else but in Australia.

For the BC Act, significance at the state, national and global scales would equate to the area being essential for the persistence of the species or ecological community at the NSW, Australian or global scale, respectively.

2.3.3 An essential site for the persistence of two or more threatened species or ecological communities in any combination

Areas eligible for listing under clause 3.1(3)(c) contain sites essential for the persistence of two or more threatened species or ecological communities in any combination.

A threatened species or ecological community is here defined as a species found in NSW that is listed as threatened under any of BC Act, Commonwealth EPBC Act or IUCN Red List of Species or IUCN Red List of Ecosystems. Based on IUCN (2016) areas qualifying as AOBVs under this criterion are seen to contribute to the NSW, Australian or global persistence of biodiversity. An area meets this criterion as an essential site for persistence of two or more threatened species or ecological communities if it:

i) contains a significant proportion (≥10%) of the state, national or global population size of two or more species listed as threatened, and at least five reproductive units per species (unless all of the populations for the species are at the site);

ii) contains ≥20% of the current NSW, National or global extent of a threatened ecological community as measured by area of occupancy, extent of occurrence or habitat area;

iii) regularly contains ≥1% of the NSW, Australian or global population size of each of a number of restricted-range species, determined as either ≥2 threatened species OR 0.02% of the global number of threatened species in a taxonomic group, whichever is larger. Sites holding multiple restricted-range species are frequently indicative of centres of endemism (IUCN 2016).

iv) contains assemblages of species that are nationally or globally restricted and so contribute significantly to the global persistence of biodiversity at the genetic, species and ecosystem levels. IUCN (2016) provides indicative thresholds under KBA criterion B3. Key features are:

    a. for taxa with a global median range size ≤25,000 km^2, ≥0.5% of the global population size of each of a number of bioregion-restricted species within a taxonomic group, determined as either ≥2 threatened species OR 10% of the threatened species restricted to the bioregion, whichever is larger, within a taxonomic group; or

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b. for taxa with a global median range size ≥25,000 km^2, ≥5 reproductive units of ≥2 bioregion-restricted threatened species OR 30% of the bioregion-restricted threatened species, whichever is larger, within a taxonomic group; or

c. the site is part of the globally most important 5% of occupied habitat for each of ≥2 threatened species. The 'most important occupied habitat' can be observed or inferred through the following:

   i) density of mature individuals,

   ii) relative abundance of mature individuals.

d. Breeding area where a significant proportion of the NSW, Australian or global population size of a threatened species is produced, and so contributes significantly to the global persistence of biodiversity at the species level. IUCN (2016) notes that this equates to a site that predictably produces propagules, larvae, or juveniles that are expected to maintain ≥10% of the NSW, Australian or global population size of a species. This element captures source sites that make a large contribution to the recruitment of a species elsewhere, even though the number of mature individuals at the site may, at times, be low or zero.

2.4 Clause 3.1(4) – persistence of ecological processes or ecological integrity

This clause aims to identify outstanding examples of still-natural and intact places that maintain fully functional ecosystem types and their components relative to other areas that support similar ecosystem types. This criterion also captures areas where species aggregate in large numbers for breeding, migration, and other key life history events, and therefore make significant contributions to the persistence of functional biodiversity.

2.4.1 It has ecological integrity

Areas eligible for listing under Clause 3.1(4)(a) contain relatively intact ecological communities (or the best remaining examples) in which large-scale ecological processes continue to function and so contribute significantly to the global persistence of biodiversity at the ecosystem level.

Following from IUCN (2016), this criterion identifies truly outstanding examples at the NSW, National or global scale of still natural and intact areas that maintain fully functional ecosystem types and their components or the best remaining examples of such areas. Following from IUCN (2016), for relatively intact areas, they essentially show no or minimal significant negative impacts of human activity or industry. They maintain their full complements of species within their natural ranges of abundance or biomass, support the ability of species to engage in natural movements, and allow for the unimpeded functioning of ecological processes including, for example, characteristic successional dynamics in response to disturbance regimes, metapopulation dynamics, trophic functions, ecosystem engineering and ecological feedbacks. Best remaining examples, where a relative intact area no longer remains, may suffer from some adverse impacts of human activity or industry.

NSW assessments of AOBVs adopt the IUCN (2016) suggestion that 'Ecological integrity should be observed or inferred from both direct measures of species composition and abundance/biomass across taxonomic groups (particularly for species indicative of long-term landscape-scale structural stability and functionality or those known to be highly sensitive to human impact) and absence (or very low levels) of direct industrial human impact (as quantified by appropriate indices at the scale of interest and verified on the ground or in the water).' Metrics of ecological integrity such as species or TEC diversity or abundance in the bioregion should be contextualised by information that allows inference of the historical

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bounds of variation using a regionally appropriate benchmark (e.g. since European settlement in Australia). Pervasive global-scale threats such as climate change should not be included in metrics of direct industrial human impact (IUCN 2016).

2.4.1.1 An outstanding, relatively intact example of a functioning ecosystem type

This subclause (Clause 3.1(4)(a)(i)) identifies an area as eligible for listing as an AOBV if it has ecological integrity as a result of being an outstanding, relatively intact example of a functioning ecosystem type, or if a fully intact ecosystem does not remain, then the best remaining example of an ecosystem type, and therefore makes a significant contribution to maintaining the persistence of biodiversity and ecological integrity. This subclause is consistent with the exemplary site principle of Bainbridge et al (2013) 'that the series of sites should contain adequate representation, in the form of the best examples, of the countrywide range of variation in near-natural and semi-natural habitat types, with their associated assemblages of plants, fungi and animals, considered both as communities and as individual species'.

2.4.1.2 The most intact remaining site of a species occurrence that provides habitat requirements vital to the conservation of a species

Areas eligible for listing under Clause 3.1(4)(a)(ii) represent the most intact remaining site of a species occurrence that provides habitat features vital to the conservation of a species. Such areas have very high irreplaceability for NSW, national or global persistence of biodiversity. Assuming that this is not the last known remaining site for a species (see 2.4.1.3 below), this subcriterion could be assessed using several measures (based on IUCN 2016) including: i) of all the remaining areas that the species occupies, this is the most intact remaining site; and ii) the area contains elements necessary to ensure that the species has a very high likelihood of persisting in NSW, Australia or globally. Such elements may be judged on the population size of the target species, or the area and/or quality of suitable habitat.

2.4.1.3 The last known remaining site of a species occurrence

Areas eligible for listing under Clause 3.1(4)(a)(iii) are the last or only remaining site for a species in NSW (state significance), Australia (national significance) or the world (global significance). For NSW endemic species, state significance is equivalent to global significance. IUCN (2019a) suggest this criterion should be measured as the site holding effectively 95% of the population size of a species in the wild, excluding individuals in captivity and cultivation. These areas have very high irreplaceability for NSW, national or global persistence of biodiversity. Protection and conservation management of the area containing the last known remaining site of a species in NSW, Australia or globally is necessary to prevent extinction.

2.4.2 A primary contributor to the continuation of essential ecological processes

Areas eligible for listing under Clause 3.1(4)(b) contain habitat areas that make a significant contribution to the continuation of essential ecological processes. Essential ecological processes are those processes that drive the life histories of species (the fundamental patterns of growth, survival, reproduction, recruitment and dispersal) and mediate the persistence and sustainable functioning of ecological communities and ecosystems. These processes are driven by a range of factors (both biotic and abiotic), including temperature and rainfall, water cycles, nutrient cycling, disturbances (such as fire, flooding and canopy gaps) and interactions between species (e.g. pollination, dispersal, competition, predation).

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To make a significant contribution to the continuation of essential ecological processes an area must be of relatively high importance (top 10% of areas in NSW, Australia or globally).

Maintenance of essential ecological process has been identified in the BC Act via the listing of a range of Key Threatening Processes that disrupt essential ecological processes. Examples include, loss of sites for butterfly hill-topping (a process that often facilitates mating in many butterfly species); alteration of natural flow regimes; and high frequency fire resulting in the disruption of life cycle processes in plants and animals.

2.4.3 Is an essential site for a significant proportion of the population of a species during one or more key life history stages or processes

Areas eligible for listing under Clause 3.1(4)(c) contain important sites that hold a significant proportion of the population of a species during one or more key life history stages or processes. This subclause encompasses IUCN (2016) KBA criterion D1 ‘demographic aggregations’. IUCN (2016) note that species aggregations are often indicated by highly localised relative abundance at time of breeding, feeding or migration. This subclause is intended to identify areas that hold all life cycle stages at the one site, as well as those areas that support one or more key life history stages or processes. A range of such stages could include breeding, hilltopping (butterflies), migration stop overs or bottlenecks, feeding, etc.

The IUCN KBA thresholds for criterion D1 are adopted here. To be eligible under this subclause an area would predictably hold one or more of the following:

a. an aggregation representing ≥1% of the population size of a species, over a season, and during one or more key stages of its life cycle
b. a number of mature individuals that ranks the site among the largest 10 aggregations known for the species.

For the BC Act, significance at the state, national and global scales would equate to population size (number of mature individuals) within NSW, Australian or global, respectively.

2.5 Clause 3.1(5) – persistence of outstanding ecological value for education or scientific research

Areas eligible for listing under Clause 3.1(5) contain areas that make a significant contribution to the persistence of outstanding ecological value for education or scientific research. A significant contribution can be demonstrated if an area contains established infrastructure or data related to long-term ecological research or monitoring programs that establish an irreplaceable historic baseline, being the best site anywhere in NSW for long-term research on particular species, ecological communities or ecological processes. This subclause supports the implementation of the proposed object of the BC Act s1.3(e) ‘to support collating and sharing data, and monitoring and reporting on the status of biodiversity and the effectiveness of conservation actions’.

Areas with a significant recorded history are an important resource for learning, discovery and increasing our knowledge of species, habitats, and of management techniques. Few sites in NSW provide long term research information and it is important to conserve those which make a significant educational contribution that cannot be found anywhere else in NSW.

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This subclause has two main elements that may individually or in combination trigger a listing, i.e. education and scientific research.

Outstanding ecological value for education includes places that support important species or ecological communities (including iconic species under the NSW Saving our Species Program), important ecological processes or ecosystem functions that maintain species or ecological communities that provide or plausibly have the potential to provide unique education activities. The significance of an area for environmental education could rest on the unique capacity or longevity of its established facilities or its particular ecological features that are the best for public learning about important ecological or environmental phenomena.

Australia established a network of long-term research sites (known as LTERN, https://www.ltern.org.au/) that focus on understanding the causes of change in ecosystems and individual species along with testing a range of management actions. The value of long-term ecological research is well documented by Lindenmayer et al. (2012, 2014) and has been shown to be critically important to support ongoing effective management of biodiversity. Burns et al. (2015) stress the importance of long-term ecological research in informing both management and public policy, as such research provides key insights into systems that may be highly variable and operate over longer timescales than most research projects.

Areas eligible for listing under Clause 3.1(5) as a scientific research site must have long-term datasets (defined in Lindenmayer et al. 2012, 2014 as spanning at least 10 years) that address key issues for biodiversity conservation and/or education in that ecosystem, established infrastructure or research and management networks to maintain ongoing monitoring and data collection and analysis, allow a comparison over time of changes in that landscape.

3. Determining boundaries and size for AOBVs

As AOBVs are based on scientific criteria, the delineation of boundaries needs to factor in ecological considerations, e.g. IUCN (2016) recommends that boundaries should initially be based on ecological considerations. This requires the local extent of the biodiversity elements triggering an AOBV clause(s) to be mapped, at least indicatively. IUCN (2016) notes that ‘In addition to habitat, it is important to consider the spatial or physical properties of the site including size, edge and connectivity with other natural areas. The initial ecological boundaries should be defined based upon the information available, while acknowledging the limitations of such information’. It is also important to consider what buffers should be included to maintain the resilience and functionality of the AOBV.

Based on principles for defining boundaries of IUCN KBAs (IUCN 2016), there is no minimum or maximum size for an AOBV. The size and configuration of each AOBV will depend on the ecological components that triggered the clauses for listing, and will usually need to include some buffering to minimise impacts from surrounding areas, as well as alignment with landscape features such as catchment boundaries to ensure practicable and secure management of the AOBV values. IUCN (2016, 2019a) provides additional discussion on how best to achieve the best outcomes for biodiversity conservation when considering boundary delineation of KBAs.

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4. Dealing with uncertainty

Any assessment of an area involves uncertainties. Assessments of AOBVs are no exception. IUCN (2016) suggest that 'Such uncertainty can arise from natural variation, semantic uncertainty in the terms and definitions used, lack of data, and measurement error.' The listing criteria should be applied on the basis of available evidence (cf. IUCN 2012). Inevitably, some aspects of this evidence will be uncertain to varying degrees, but this will not necessarily preclude an area from being assessed rigorously against the AOBV listing criteria. Absence of high-quality data should not deter attempts to apply the criteria (cf. IUCN 2001). Given scarcity of data in many cases, it is appropriate to use the information that is available to make intelligent inferences about the assessment criteria, and hence the overall status of an area. Inherent uncertainties have been recognised by Courts dealing with BC Act matters and are taken into account in Court decisions (Section 4.2, Keith 2009).

Guidance to identify sources of uncertainty, reduce it where possible, and deal with it explicitly in the listing process, can be found in NSW Threatened Species Scientific Committee (2018) https://www.environment.nsw.gov.au/resources/threatenedspecies/1AGuidelines20180302.pdf

5. Definitions

Aggregation (from IUCN 2016, KBA Criterion D)

A geographically restricted clustering of individuals that typically occurs during a specific life history stage or process such as breeding, feeding or migration. This clustering is indicated by highly localised relative abundance, two or more orders of magnitude larger than the species' average recorded numbers or densities at other stages during its life-cycle.

Area of occupancy (from IUCN 2016, KBA Criteria A, B, E)

The area within the range of a species that is actually occupied (IUCN 2012). Keith et al. (2018) define Area of Occupancy (AOO) as "the area within the outermost limits over which a species or ecosystem actually occurs". Measurement of AOO is scale sensitive and both IUCN Red List for Species (IUCN 2019b) and IUCN Red list for Ecosystems (Bland et al. 2017) recommend use of fixed grid sizes in the estimation of AOO.

Assemblage (from IUCN 2016, KBA Criterion B)

For purposes of assessing AOBVs, an assemblage is defined (following IUCN 2016) as a set of species having:

i) their ranges ≥95% predictably confined to a single bioregion for at least one life-history stage; or
ii) their ranges ≥95% predictably confined to a single biome for at least one life-history stage (for taxonomic groups with a global median range size >25,000 km^2); or
iii) their most important habitats in common with multiple other species.

Biodiversity element

Genes, species or ecosystems, as used by the Convention on Biological Diversity (CBD) definition of biodiversity (Jenkins 1988).

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Bioregion (IUCN 2016, KBA Criterion B)

Major regional terrestrial and aquatic habitat types distinguished by their climate, flora and fauna, such as the combination of terrestrial biomes and biogeographic realms (Olson et al. 2001) or marine provinces (Spalding et al. 2007, Spalding et al. 2012). These biogeographic units are typically about an order of magnitude larger in area than the ecoregions nested within them. Australian bioregions follow SEWPaC (2012).

Complementarity (from IUCN 2016, KBA Criterion E)

A measure of the extent to which an area contains elements of biodiversity not represented, or that are underrepresented, in an existing set of areas; alternatively, the number of unrepresented or underrepresented biodiversity elements that a new area adds to a network (Margules & Pressey 2000).

Distinct genetic diversity (from IUCN 2016, KBA Criteria A, B)

The proportion of a species' genetic diversity that is encompassed by a particular site. It can be measured using Analysis of Molecular Variance or similar technique that simultaneously captures diversity and distinctiveness (frequency of alleles and the genetic distinctiveness of those alleles).

Ecological community

The BC Act (section 1.6) defines an ecological community as 'an assemblage of species occupying a particular area'. This definition closely follows modern scientific texts (e.g. Begon et al. 2006) and embodies three requirements (Preston & Adam 2004a,b):

i) the constituents of a community must be species;

ii) the species need to be brought together into an assemblage; and

iii) the assemblage of species must occupy a particular area.

Ecological integrity (from IUCN 2016, KBA Criterion C)

A condition that supports intact species assemblages and ecological processes in their natural state, relative to an appropriate historical benchmark, and characterised by contiguous natural habitat with minimal direct industrial anthropogenic disturbance.

Ecological process

The demographic and life-history processes that maintain species such as reproduction and migration. This includes biotic functions and processes (such as pollination, dispersal, successful reproduction, growth, survival, etc) along with abiotic functions and processes (such as nutrient cycling and availability, disturbance regimes, etc).

Ecologically distinctive

A species or ecological community that is one of very few examples representing a particular life history or ecological process.

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Ecosystem type (from IUCN 2016, KBA Criteria A, B)

A defined ecosystem unit for standard and repeatable assessment, at an intermediate level in a globally consistent ecosystem classification hierarchy such as macrogroup or equivalent (Faber-Langendoen et al. 2014). It is defined by a particular set of variables related to its characteristic native biota, an abiotic environment or complex, the interactions within and between them, and a physical space in which these operate (Keith et al. 2013, Rodríguez et al. 2015). Other terms such as 'ecological communities' and 'biotopes' are often considered operational synonyms of ecosystem type.

Endemic (from IUCN 2016, KBA Criteria A, E)

A species or ecological community having a global range wholly restricted to a defined geographic area such as a region, country or site. For example, a species considered to be endemic to NSW has its entire global range confined to NSW.

Environmental stress (from IUCN 2016, KBA Criterion D)

Natural events like floods, droughts, storms, wildfires, earthquakes as well as high or low temperature caused by global change; it can also describe the lack of food due to the bottom-up effect of environmental stress or massive die off of prey in ecosystems due to infectious disease.

Evolutionarily distinctive

A species with few close living relatives, including those that are the only living representatives of their genus (or higher taxonomic category), or an ecological community containing a number of such species or a group of species known to share a long and common history of evolution.

Extent of occurrence

The area of the total geographic range that includes all extant populations of a species or all extant occurrences of an ecological community. IUCN (2019b) and Bland et al. (2017) provide guidance on how extent of occurrence should be measured for species and ecological communities, respectively.

Extent or suitable habitat (IUCN 2016, KBA Criteria A, B)

The area of potentially suitable ecological conditions, such as vegetation or substrate types within the altitudinal or depth, and temperature and moisture preferences, for a given species (Beresford et al. 2011).

Geographically restricted (IUCN 2016, KBA Criterion B)

A biodiversity element having a restricted NSW, Australian or global distribution, as measured by range, extent of occurrence, extent of suitable habitat or area of occupancy, and hence largely confined or endemic to a relatively small portion of NSW, Australia or the globe.

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Intact ecological community (IUCN 2016, KBA Criterion C)

An ecological community having the complete complement of species known or expected to occur in a particular site or ecosystem, relative to a regionally appropriate historical benchmark, which will often correspond to pre-European settlement of Australia.

Irreplaceability (IUCN 2016, KBA Criterion E)

Either (a) the likelihood that an area will be required as part of a system that achieves a set of targets (Ferrier et al. 2000) or (b) the extent to which the options for achieving a set of targets are reduced if the area is unavailable for conservation (Pressey et al. 1994). Irreplaceability is heavily influenced by geographically restricted biodiversity, but it is a property of an area within a network rather than of an element of biodiversity and is related to the concept of complementarity.

Mature individuals (IUCN 2016, KBA Criteria A, B, E)

The number of individuals known, estimated or inferred to be capable of reproduction as defined in IUCN (2012, 2019b).

Ongoing research or monitoring program

An activity of ecological enquiry whose goals and methods are described in publicly available documents such as the published scientific literature**.**

Persistence

Persistence of a biodiversity element means that its loss (e.g. species extinction, ecosystem collapse) or decline (e.g. of numbers of mature individuals of a species, ecosystem extent and condition) is avoided, both now and into the foreseeable future.

Population size (IUCN 2016, KBA Criteria A, B, D)

The total number of mature individuals of the species (IUCN 2012). Only populations considered to be ‘wild’ should be included in estimates of assessment parameters (IUCN 2019a).

Predictably (IUCN 2016, KBA Criterion D)

An expectation of species occurrence at a site during particular seasons or at one or more stages of its life cycle, based on previous or known occurrence, such as in response to specific climate conditions.

Range (IUCN 2016, KBA Criterion A, B, E)

The current known limits of distribution of a species, accounting for all known, inferred or projected sites of occurrence (IUCN 2012), including conservation translocations outside native habitat (IUCN 2019b) but not including vagrancies (species recorded once or sporadically but known not to be native to the area).

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Regularly (IUCN 2016, KBA Criteria A, B)

The occurrence of a species is normally or typically found at the site during one or more stages of its life cycle.

Relatively Intact: Intact refers to ecological integrity based on high abundance of native species relative to non-native species, structural integrity and ecological processes. 'Relatively intact' means that intactness is evaluated relative to most other remaining areas of similar ecosystem types.

An area has relatively intact structural integrity if it has high representation, relative to areas containing similar ecosystem types, of major ecosystem components including biota and resources derived from biota, projected to have been present at the time of European settlement (e.g. for a forest, this would include native trees and understorey shrubs represented by the full range of age or size classes, native ground layer plants, and native fauna, as well as derived features such as woody debris, developed soil profiles, etc.; and these components would be in a healthy state relative to other occurrences of similar types). There are likely to be fluctuations in biotic components in response to rainfall or responses to natural disturbances.

An area has relatively intact ecological processes if it contains examples of natural ecological processes such as food webs, regeneration of succession after disturbance, animal movements, etc. that continue to function to a high degree, relative to areas containing similar ecosystem types (e.g. for a woodland on the NSW western slopes, this would include areas in which regeneration of native trees and shrubs is uninterrupted relative to other occurrences of similar types or regenerating from natural disturbances).

Reproductive unit (IUCN 2016, KBA Criteria A, B, E)

The minimum number and combination of mature individuals necessary to trigger a successful reproductive event at a site (Eisenberg 1977). Examples of five reproductive units include five pairs, five reproducing females in one harem, and five reproductive individuals of a plant species (i.e. where each plant is a reproductive unit).

Resilience: Resilience is a measure of the persistence or capacity of species and ecological communities to withstand and/or recover from disturbances.

Restricted range (IUCN 2016, KBA Criterion B)

Species having a global range size less than or equal to the 25th percentile of range-size distribution in their taxonomic group, up to a maximum of 50,000 km^2 as estimated using extent of occurrence as measured in (IUCN 2019b). This assumes that all species within the taxonomic group have been mapped globally. If all species in the taxonomic group have not been mapped globally, or if the 25th percentile of range-size distribution for a taxonomic group falls below 10,000 km^2, restricted range should be defined as having a global range size less than or equal to 10,000 km^2.

Species

Under the *Biodiversity Conservation Act 2016* (NSW), *species* includes:

i) a defined subspecies, and

ii) a taxon below a subspecies, and

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iii) a recognisable variant of a subspecies or taxon, and

iv) a population of a particular species (being a group of organisms, all of the same species, occupying a particular area).

Target (IUCN 2016, KBA Criterion E)

A conservation target is the minimum amount of a particular biodiversity feature for which conservation is desirable through one or multiple conservation actions (Possingham et al. 2006).

Taxonomic group (IUCN 2016, KBA Criterion B)

Taxonomic ranks above the species level.

Threatened (IUCN 2016, KBA Criterion A)

Assessed through globally standardised methodologies as having a high probability of extinction (species) or collapse (ecological communities/ecosystems) in the medium term future. Threatened species are those assessed as Critically Endangered (CR), Endangered (EN), or Vulnerable (VU) in the BC Act, the EPBC Act or IUCN Red List for Species or IUCN Red List for Ecosystems.

Threshold (IUCN 2016, KBA Criteria A-E)

Numeric or percentage minima which determine whether the presence of a biodiversity element at a site is significant enough for the site to be considered an AOBV under a given criterion or sub-criterion.

Trigger (derived from IUCN 2016, KBA Criteria A-E)

A biodiversity element (e.g. species, ecological community or ecosystem) by which at least one criterion and associated threshold is met.

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7. References

Akçakaya HR, Ferson S, Burgman MA, Keith DA, Mace GM, Todd CR (2000) Making consistent IUCN classifications under uncertainty. *Conservation Biology* **14**, 1001-1013.

Bainbridge I, Brown A, Burnett N, Corbett P, Cork C, Ferris R, Howe M, Maddock A, Mountford E, Pritchard S (2013) Guidelines for the Selection of Biological SSSIs. Part 1: Rationale, Operational Approach and Criteria for Site Selection. Joint Nature Conservation Committee. http://jncc.defra.gov.uk/PDF/SSSI_Guidelines_Pt1_Dec2013(2).pdf (accessed 13th November 2018)

DRAFT

Begon M, Harper JL, Townsend CR (2006) 'Ecology: from individuals to ecosystems.' (Blackwell Publishing: Boston, MA)

Ben-Haim Y (2001) 'Information-Gap Decision Theory: Decisions Under Severe Uncertainty.' (Academic Press: London)

Beresford AE, Buchanan GM, Donald PF, Butchart SHM, Fishpool LDC, Rondinini C (2011) Minding the protection gap: estimates of species' range sizes and holes in the Protected Area network. *Animal Conservation* **14**, 114-116.

Berg C, Abdank A, Isermann M, Jansen F, Timmermann T, Dengler J (2014) Red Lists and conservation prioritization of plant communities – a methodological framework. *Applied Vegetation Science* **17**, 504–515.

BirdLife International (2014) Important Bird and Biodiversity Areas: A global network for conserving nature and benefitting people. Cambridge, UK: BirdLife International.

Bland LM, Keith DA, Miller RM, Murray NJ, Rodriguez JP (eds) (2017) Guidelines for the application of IUCN Red List of Ecosystems Categories and Criteria: Version 1.1, Gland, Switzerland: IUCN. https://portals.iucn.org/library/sites/library/files/documents/2016-010-v1.1.pdf

Burgman MA (2005) 'Risks and decisions for conservation and environmental management.' (Cambridge University Press: Cambridge)

Burns E, Tennant P, Boyer T, Nolan K, Dickman C, Gillespie G, Green P, Hoffmann A, Keith D, Lindenmayer D, Metcalfe D, Russell-Smith J, Wardle G & Williams D (2015) The Long Term Ecological Research Network, Australia: Objectives, design and methods, LTERN, Australia. https://www.tern.org.au/rs/7/sites/998/user_uploads/File/pdfs/LTERN_objectives_design_methods.pdf accessed December 2018

Cook CN, Sgro CM (2017) Aligning science and policy to achieve evolutionarily enlightened conservation. *Conservation Biology* **31**, 501–512.

Crandell KA, Bininda-Emonds ORP, Mace GM, Wayne RK (2000) Considering evolutionary processes in conservation biology. *Trends in Ecology and Evolution* **15**, 290-295.

Derbyshire I, Anderson S, Asatryan A, Byfield A, Cheek M, Clubbe C, Ghrabi Z, Harris T, Heatubun CD, Kalema J, Magassouba S, McCarthy B, Milliken W, de Montmollin B, Lughadha EN, Onana J-M, Saidou D, Sarbu A, Shrestha K, Radford EA (2017) Important Plant Areas: revised selection criteria for a global approach to plant conservation. *Biodiversity and Conservation* **26**, 1767–1800.

Dhanjal-Adams KL, Klaassen M, Nicol S, Possingham HP, Chades I, Fuller RA (2016) Setting conservation priorities for migratory networks under uncertainty. *Conservation Biology* **31**, 646–656.

Díaz S, Purvis A, Cornelissen JHC, Mace GM, DonoghueMJ, Ewers RM, Jordano P, Pearse WD (2013) Functional traits, the phylogeny of function, and ecosystem service vulnerability. *Ecology and Evolution* **3**, 2958-2975

Eisenberg JF (1977) The evolution of the reproductive unit in the Class Mammalia. In Rosenblatt, J.S. & Komisaruk, B.R. (eds.) Reproductive Behavior and Evolution. New York: Plenum Publishing Corporation.

Elith J, Burgman MA, Regan HM (2003) Mapping epistemic uncertainties and vague concepts in predictions of species distribution. *Ecological Modelling* **157**, 313-329.

Eken G, Bennun L, Brooks TM, Darwall W, Fishpool LDC, Foster M, Knox D, Langhammer P, Matiku P, Radford E, Salaman P, Sechrest W, Smith ML, Spector S, Tordoff A (2004) Key Biodiversity Areas as site conservation targets. *Bioscience* **54**, 1110-1118.

DRAFT

Environment Protection Authority (1997). New South Wales, State of the Environment. Chatswood, N.S.W : New South Wales Environment Protection Authority.

Faber-Langendoen D, Keeler-Wolf T, Meidinger D, Tart D, Hoagland B, Josse C, Navarro G, Ponomarenko S, Saucier J-P, Weakley A, Comer P (2014) EcoVeg: a new approach to vegetation description and classification. *Ecological Monographs* **84**, 533–561.

Ferrier S, Pressey RL, Barrett TW (2000) A new predictor of the irreplaceability of areas for achieving a conservation goal, its application to real-world planning, and a research agenda for further refinement. *Biological Conservation* **93**, 303–325.

Hoffman AA, Sgro CM (2011) Climate change and evolutionary adaptation. *Nature* **470**, 479-485.

IUCN (2012) IUCN Red List Categories and Criteria: Version 3.1. Second edition. Gland, Switzerland and Cambridge, UK: IUCN. [http://www.iucnredlist.org/info/categories_criteria]

IUCN (2016). A Global Standard for the Identification of Key Biodiversity Areas, Version 1.0 . First edition. Gland, Switzerland: IUCN.

IUCN (2019a) Guidelines for using a global standard for the identification of Key Biodiversity Areas. Version 1.0. KBA Standards and Appeals Committee of the IUCN Species Survival Commission and IUCN World Commission on Protected Areas.

IUCN (2019b) Guidelines for Using the IUCN Red List Categories and Criteria: Version 14.0. Standards and Petitions Subcommittee of the IUCN Species Survival Commission. [http://www.iucnredlist.org/documents/RedListGuidelines.pdf]

Jenkins RE (1988) Information management for the conservation of biodiversity. In Wilson, E.O. (ed.) Biodiversity. Washington, DC: National Academy Press.

Keith DA (2009) The interpretation, assessment and conservation of ecological communities and ecosystems. *Ecological Management and Restoration* **10**, S3-S15.

Keith DA (2011) Relationships between geodiversity and vegetation in southeastern Australia. Proceedings of the Linnean Society of New South Wales **132**, 5-26.

Keith, D. and Bedward, M. (1999). Native vegetation of the South East Forests Region, Eden, New South Wales. *Cunninghamia* **6**, 1-218.

Keith DA, Rodríguez JP, Rodríguez-Clark KM *et al*. (2013) Scientific Foundations for an IUCN Red List of Ecosystems. *PLoS ONE* **8,** e62111.

Keith DA Akcakaya HR, Murray NJ (2018) Scaling range sizes to threats for robust predictions of risks to biodiversity. *Conservation Biology* **32**, 322–332.

Kyburg HE, Smokler H (1964) 'Studies in subjective probability.' (Wiley: New York)

Langhammer PF, Bakarr MI, Bennun LA, Brooks TM, Clay RP, Darwall W, De Silva N, Edgar GJ,

Eken G, Fishpool LDC, Fonseca GAB da, Foster MN, Knox DH, Matiku P, Radford EA, Rodrigues ASL, Salaman P, Sechrest W, Tordoff AW (2007). Identification and Gap Analysis of Key Biodiversity Areas: Targets for Comprehensive Protected Area Systems. Gland, Switzerland: IUCN.

Lindenmayer DB, Likens GE, Andersen A, Bowman D, Bull CM, Burns E, Dickman CR, Hoffmann AA, Keith DA, Liddell MJ, Lowe AJ, Metcalfe DJ, Phinn SR, Russell-Smith J, Thurgate N, Wardle GM (2012) Value of long-term ecological studies. *Austral Ecology* **37**, 745–757.

Lindenmayer D, Burns E, Thurgate N, Lowe A (2014) The value of long-term research and how to design effective ecological research and monitoring. In 'Biodiversity and

DRAFT

Environmental Change: monitoring, challenges and direction" (Eds Lindenmayer D, Burns E, Thurgate N, Lowe A) pp. 36-72. CSIRO Publishing, Victoria.

MacMillan DC, Marshall K (2006) The Delphi process--an expert-based approach to ecological modelling in data-poor environments. *Animal Conservation* **9**, 11-19.

Margules CR, Pressey RL (2000) Systematic conservation planning. *Nature* **405**, 243–253.

Moilanen A, Franco AMA, Early R, Fox R, Wintle B, Thomas CD (2005) Prioritising multiple use landscapes for conservation: methods for large multi species planning problems. *Proceedings of the Royal Society B: Biological Sciences* **272**, 1885-1891.

Moritz C (1994) Defining 'Evolutionary Significant Units' for conservation. *Trends in Ecology and Evolution* **9**, 373-375.

Moritz C (2002) Strategies to protect biological diversity and the evolutionary processes that sustain it. *Systematic Biology* **51,** 238–254.

Native Vegetation Advisory Council (1999). 'Setting the Scene. The Native Vegetation of NSW'. (Department of Land and Water Conservation: Sydney.)

NSW Scientific Committee (2001) Clearing of native vegetation. Final Determination to list "Clearing of native vegetation" as a Key threatening Process under the NSW Threatened Species Conservation Act 1995. https://www.environment.nsw.gov.au/determinations/ClearingNativeVegKTPListing.htm (accessed 13th November 2018)

NSW Threatened Species Scientific Committee (2018) Guidelines for interpreting listing criteria for species, populations and ecological communities under the NSW Biodiversity Conservation Act 2016. Version 2.0, March 2018. https://www.environment.nsw.gov.au/resources/threatenedspecies/1AGuidelines20180302.pdf (accessed 13th November 2018)

Olson DM, Dinerstein E, Wikramanayake ED, Burgess ND, Powell GVN, Underwood EC, D'Amico JA, Itoua I, Strand HE, Morrison JC, Loucks CJ, Allnutt TF, Ricketts TH, Kura Y, Lamoreuz JF, Wettwngel WW, Hedao H, Kassem KR (2001) Terrestrial ecoregions of the world: a new map of life on Earth. *BioScience* **51**, 933–938.

Possingham H, Ball I, Andelman S (2000) Mathematical methods for identifying representative reserve networks. In: 'Quantitative methods for conservation biology' (Eds S Ferson and MA Burgman) pp291-305. (Springer-Verlag: New York)

Possingham HP, Wilson KA, Andelman SJ, Vynne CH (2006) Protected areas: goals, limitations, and design. Pages 509–533 in MJ Groom, GK Meffe, CR Carroll, editors. Principles of Conservation Biology. Sunderland, MA: Sinauer Associates Inc.

Pressey RL, Johnson IR, Wilson PD (1994) Shades of irreplaceability: towards a measure of the contribution of sites to a reservation goal. *Biodiversity and Conservation* **3**, 242–262.

Preston BJ, Adam P (2004a) Describing and listing threatened ecological communities under the Threatened Species Conservation Act 1995 (NSW). Part 1. *Environmental Planning and Law Journal* **21**, 250-263.

Preston BJ, Adam P (2004b) Describing and listing threatened ecological communities under the Threatened Species Conservation Act 1995 (NSW). Part 2. *Environmental Planning and Law Journal* **21**, 372-390.

Regan HM, Colvan M, Burgman MA (2002) A taxonomy of and treatment of uncertainty for ecology and conservation biology. *Ecological Applications* **12**, 618-628.

Rodríguez JP, Keith DA, Rodríguez-Clark KM, Murray NJ, Nicholson E, Regan TJ, Miller RM, Barrow EG, Bland LM, Boe K, Brooks TM, Oliveira-Miranda MA, Spalding M, Wit P

DRAFT

(2015) A practical guide to the application of the IUCN Red List of Ecosystems criteria. *Philosophical Transactions of The Royal Society B* **370**, 20140003.

SEWPaC (2012) Interim Biogeographic Regionalisation for Australia, Version 7. Department of Sustainability, Environment, Water, Population and Communities. http://www.environment.gov.au/parks/nrs/science/bioregion-framework/ibra/maps.html

Silvertown J (2004) Plant coexistence and the niche. *Trends in Ecology and Evolution* **19**, 605-611.

Smith TB, Kinnison MT, Strauss SY, Fuller TL, Carroll SP (2014) Prescriptive evolution to conserve and manage biodiversity. *Annual Review of Ecology Evolution and Systematics* **45**, 1–22.

Spalding MD, Fox HE, Allen GR, Davidson N, Ferdaña ZA, Finlayson M, Halpern BS, Jorge MA, Lombana A, Louris SA, Martin KD, McManus E, Molnar J, Recchia CA, Robertson J (2007) Marine ecoregions of the world: a bioregionalization of coastal and shelf areas. *BioScience* **57**, 573–583.

Spalding MD, Agostini VN, Rice J, Grant SM (2012) Pelagic provinces of the world: a biogeographic classification of the world's surface pelagic waters. *Ocean & Coastal Management* **60**, 19-30.

Whittaker RJ, Willis KJ, Field R (2001) Scale and species richness: towards a general, hierarchical theory of species diversity. *Journal of Biogeography* **28**, 453-470.

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Appendix 1: Summary of criteria for Areas of Outstanding Biodiversity Value and suggested likely thresholds

Clause 3.1(1) (a) the area is important at a state, national or global scale

Species and ecological communities endemic to NSW are considered to be of global significance. For species and ecological communities that are not endemic to NSW, their scale of importance will depend of relative importance of populations (species) or distribution and species composition (ecological communities) in NSW relative to elsewhere. Species and ecological communities listed as threatened under the *Environment Protection and Biodiversity Conservation Act 1999* (Cwlth) are considered to be at least of national significance (independent of whether or not they are endemic to NSW).

Clause 3.1(1) (b) the area makes a significant contribution to the persistence of at least one of: (i) multiple species or at least one threatened species or ecological community, (ii) irreplaceable biological distinctiveness, (iii) ecological processes or ecological integrity, (iv) outstanding ecological value for education or scientific research.

See clauses below for detail.

Clause 3.1(2) An area makes a significant contribution to the persistence of multiple species or at least one threatened species or ecological community if:

a) it provides resilience during periods of environmental stress that is important for their continued existence

Two suitable thresholds for triggering Clause 3.1(2)(a) would be:

i) that an area supports ≥10% of the NSW, Australian or global population size of one or more species during periods of environmental stress; or

ii) that an area produces propagules, larvae, or juveniles that maintain ≥10% of the NSW, Australian or global population size of a species.

b) it sustains adaptive capacity or evolutionary potential because it contains high levels of unique components of genetic or phenotypic diversity that will enable species to adapt to changing environments or it functions as an important ecological or evolutionary refuge able to sustain viable populations of species at risk due to climate change or other environmental stresses

Either:

- unique genotypes or phenotypes or evolutionary significant units; or
- ≥10% of the NSW, Australian or global population size of one or more species during periods of environmental stress

c) it supports migration or dispersal of animals and plants, currently or in the future, that will contribute significantly to the persistence of species at risk

i) connectivity (corridors, stepping stones, etc) of native vegetation in areas where there has been marked habitat loss; or

ii) habitat and/or food resources that sustain migration pathways.

d) it is habitat critical for the survival of a threatened species

The whole or any part or parts of the area or areas of land comprising the habitat of a threatened species, population or ecological community that is critical to the survival of the species, population or ecological community at the NSW, Australian or global scale

Clause 3.1(3) An area makes a significant contribution to the persistence of irreplaceable biological distinctiveness if:

a) it has a very high structural, functional or compositional diversity, or

i) Structural diversity: Areas with a high diversity and complexity of structural features (both biotic and abiotic) that provide suitable habitat for a diverse array of biodiversity; or

ii) Functional diversity: Areas with a high diversity and complexity of functional diversity features (both biotic and abiotic) that provide suitable habitat for the persistence of a diverse array of biodiversity; or

iii) Compositional diversity: Areas with high taxonomic diversity will contain relatively high levels of alpha and/or beta diversity.

iv) Assessment of what constitutes 'very high' structural, functional or compositional diversity should be made relative to other areas. 'Very high' areas should have the top 20% of diversity relative to other sites.

b) it is an essential site for the persistence of evolutionary or ecological distinctive species, endemic species or ecological communities, or

To allow persistence, these areas must contain one or more of the habitat features and requirements needed by the species or ecological communities to survive. The area may provide continuous habitat for the species or ecological community or a species may depend on the area only at certain times of the year or in certain years. Few other sites will be occupied by the species or ecological community, and hence few other sites appear to provide suitable habitat.

Species or ecological communities are considered to be endemic to NSW if they occur nowhere else but in NSW. Species or ecological communities are considered to be endemic to Australia if they occur nowhere else but in Australia. Evolutionary distinctive species are those that are considered to have distinct lineages to most other species. Ecologically distinctive species are those considered to have different or distinctive ecologies to most other co-occurring species.

In all cases, the area should be demonstrated to be essential for the species or ecological community persistence.

c) it is an essential site for the persistence of 2 or more threatened species or ecological communities in any combination.

They may do this by:

i) contains a significant proportion (≥10%) of the state, national or global population size of two or more species facing at least a high risk of extinction, and at least five reproductive units per species (unless all of the populations for the species are at the site);

ii) holding ≥20% of the NSW, National or global extent of a threatened ecological community;

iii) regularly contains ≥1% of the NSW, Australian or global population size of each of a number of restricted-range species, determined as either ≥2 threatened species OR 0.02% of the global number of threatened species, whichever is larger.

iv) contains assemblages of species that are nationally or globally restricted and so contribute significantly to the global persistence of biodiversity at the genetic, species and ecosystem levels. IUCN (2016) provides indicative thresholds under KBA criterion B3. Key features are:

a) for taxa with a global median range size ≤25,000 km^2, ≥0.5% of the global population size of each of a number of bioregion-restricted species within a taxonomic group, determined as either ≥2 threatened species OR 10% of the species restricted to the bioregion, whichever is larger; or

b) for taxa with a global median range size ≥25,000 km2, ≥5 reproductive units of ≥5 bioregion-restricted species OR 30% of the bioregion-restricted species known from the country, whichever is larger, within a taxonomic group; or

c) the site is part of the globally most important 5% of occupied habitat for each of ≥2 threatened species. The 'most important occupied habitat' can be observed or inferred through the following:

i. density of mature individuals, or

ii. relative abundance of mature individuals.

d) breeding area where a significant proportion of the NSW, Australian or global population size of a threatened species is produced, and so contribute significantly to the global persistence of biodiversity at the species level. IUCN (2016) notes that this equates to a site that predictably produces propagules, larvae, or juveniles that maintain ≥10% of the NSW, Australian or global population size of a species. This element captures source sites that make a large contribution to the recruitment of a species elsewhere, even though the number of mature individuals at the site may, at times, be low or zero.

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Clause 3.1(4) An area makes a significant contribution to the persistence of ecological processes or ecological integrity if:

a) it has ecological integrity, being an area that is:

i) an outstanding, relatively intact example of a functioning ecosystem type, or if a fully intact ecosystem does not remain, then the best remaining example of that ecosystem type that contributes to maintaining the persistence of biodiversity and ecological integrity, or

Relatively intact ecological communities or best remaining examples.

ii) the most intact remaining site of a species occurrence that provides habitat requirements vital to the conservation of a species, or

i) of all the remaining areas that the species occupies, this is the most intact remaining site; and

ii) the area contains elements necessary to ensure the NSW, Australian or global persistence of the species with a very high likely probability. Such elements may include sufficient population size, sufficient area and/or sufficient habitat.

iii) the last known remaining site of a species occurrence, or

Entire NSW, National or global population of a species

b) it is a primary contributor to the continuation of essential ecological processes, or

Habitat areas that make a significant contribution to the continuation of essential ecological processes. Ecological processes are those processes that drive the life histories of species (the fundamental patterns of growth, survival, reproduction, recruitment and dispersal) and mediate the persistence and sustainable functioning of ecological communities. These processes are driven by a range of factors (both biotic and abiotic), including temperature and rainfall, disturbances such as fire, flooding and canopy gaps, interactions between species (e.g. pollination, dispersal, competition, predation).

c) it is an essential site for a significant proportion of the population of a species during one or more key life history stages or processes.

Either of:

i) An aggregation representing ≥1% of the population size of a species (at the NSW, Australian or global scale), over a season, and during one or more key stages of its life cycle; or

ii) A number of mature individuals that ranks the site among the largest 10 aggregations known for the species at the NSW, Australian or global scale.

Clause 3.1(5) An area makes a significant contribution to the persistence of outstanding ecological value for education or scientific research if it contains established infrastructure or data related to long-term ecological research monitoring programs that establish an irreplaceable historic baseline, being the best site anywhere in NSW for long-term research on particular species, ecological communities or ecological processes.

Either:

i) Outstanding ecological value for education would include places that support important species or ecological communities (including iconic species under the NSW Saving our Species Program), important ecological processes or ecosystem functions that maintain species or ecological communities that can be readily used in education activities; or

ii) A scientific research site with long-term datasets (≥ 10 years) that address key issues for biodiversity conservation in that ecosystem, established infrastructure or research and management networks to maintain ongoing monitoring and data collection and analysis, and allow a comparison over time of changes in that landscape.