Australian Capital Territory

Nature Conservation (Yellow-bellied Glider) Conservation Advice 2023

Notifiable instrument NI2023–227

made under the

Nature Conservation Act 2014, s 90C (Conservation advice)

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1 Name of instrument

This instrument is the *Nature Conservation (Yellow-bellied Glider) Conservation Advice 2023*.

2 Commencement

This instrument commences on the day after its notification day.

3 Conservation advice for Yellow-bellied Glider

Schedule 1 sets out the conservation advice for Yellow-bellied Glider (*Petaurus australis australis*).

Arthur Georges
Chair, Scientific Committee
14 April 2023

Schedule 1

(see s 3)

CONSERVATION ADVICE

YELLOW-BELLIED GLIDER

Petaurus australis australis

CONSERVATION STATUS

The Yellow-bellied Glider – *Petaurus australis australis* – is the south-eastern subspecies of *Petaurus australis* Shaw, 1791 – and is recognised as threatened in the following jurisdictions:

International	**Near Threatened**, (species) International Union of Conservation of Nature (IUCN) Red List
National	**Vulnerable**, *Environment Protection and Biodiversity Conservation Act 1999*
	Near Threatened, The Action Plan for Australian Mammals 2012
ACT	**Vulnerable**, *Nature Conservation Act 2014*
NSW	**Vulnerable**, *Biodiversity Conservation Act 2016*
VIC	not yet listed, *Flora and Fauna Guarantee Act 2008*
QLD	**Vulnerable**, *Nature Conservation Act 1992*
SA	**Endangered**, *National Parks and Wildlife Act 1972*

CRITERIA

The Yellow-bellied Glider is listed as Vulnerable in the ACT Threatened Native Species List under IUCN Criterion A — A4c due to population reduction at the national level (Attachment A). The species suffered a population reduction of at least 30% across its entire distribution over the past 12-15 years (three generations) and habitat destruction following the 2019–2020 bushfires. The reduction and cause have not ceased and population decline continues due to land clearing, fragmentation, extensive severe fires, and climate change (DAWE 2022, Attachment A).

Yellow-bellied Glider (Liam Manderson – Canberra Nature Map)

DESCRIPTION AND ECOLOGY

The Yellow-bellied Glider is an arboreal nocturnal marsupial and is the second largest gliding possum in Australia (after the Greater Glider), with a head-body length of 24−31 cm and a long tail measuring 38−47 cm. The belly fur is white to yellow (becoming more yellow with age) and is greyish-brown above with a black stripe running down the back and tail. It has pale coloured, bare ears (Goldingay 2008).

Plant and insect exudates (sap, nectar, honeydew and manna) provide the bulk of the diet (in the form of various sugars) with arthropods and to some extent pollen,

filling the protein requirements of Yellow-bellied Gliders (Carthew et al. 1999, Eyre and Goldingay 2003, Goldingay 2008). They feed on tree sap extensively (from a wide variety of eucalypt species) and obtain it by cutting characteristic "V"-shaped notches, using their large lower incisor teeth, into the trunks of a very small number of trees at any one time, referred to as sap-site trees (Goldingay and Kavanaugh 1991).

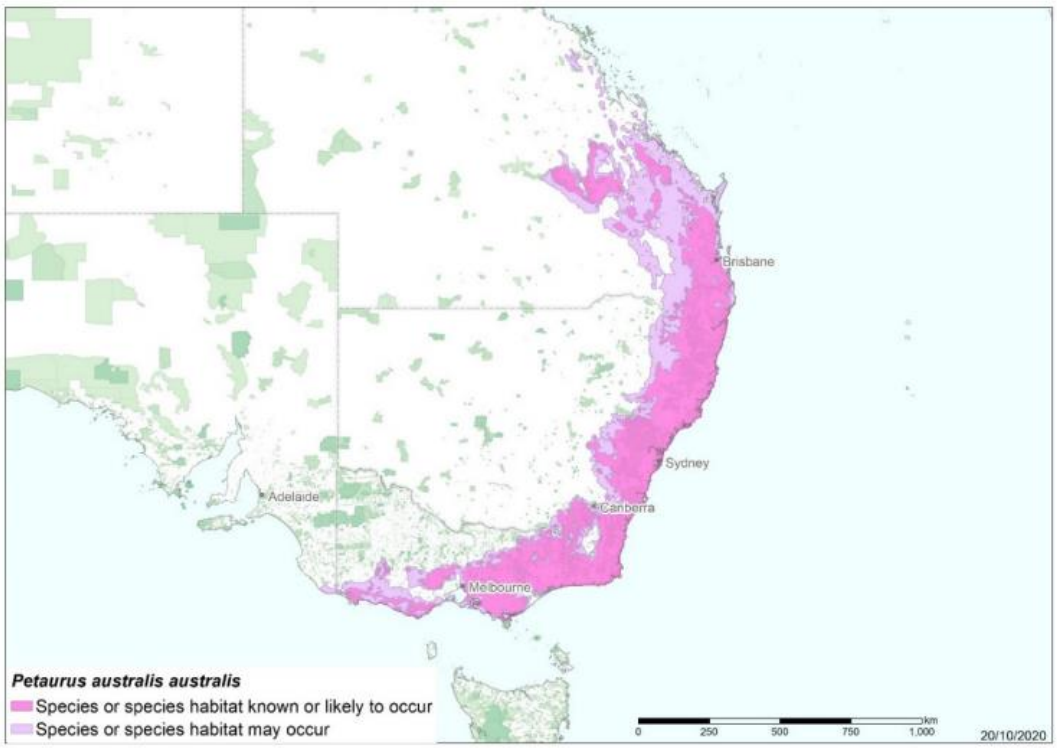
The Yellow-bellied Glider reproduces seasonally, depending on the abundance of certain food types in the forest, usually producing single young each year (Goldingay and Kavanaugh 1991). Sexual maturity is reached at around two years of age when they pair up and they may live for at least six years in the wild, resulting in a generation length of four to five years (Goldingay and Kavanagh 1991, Woinarski 2014).

Yellow-bellied Gliders emit loud shrieking calls frequently throughout the night making them the most vocal of all marsupials (Goldingay 1989a) and they can be heard up to 500 metres away (DAWE 2022).

DISTRIBUTION AND HABITAT

The Yellow-bellied Glider has a widespread but highly disjunct distribution from south-eastern Queensland, through coastal and high-country forests of NSW and Victoria to far south-eastern South Australia (SA) (Map 1). However, there are no known records of the subspecies in SA since 2010, and it is now potentially extinct from SA (Department of Environment and Water (SA) in DAWE 2022). The Yellow-bellied Glider occurs in eucalypt dominated woodlands and forests, including both wet and dry sclerophyll forests (Kavanagh et al. 1995, Rees et al. 2007). The other subspecies, the Yellow-bellied Glider (Wet Tropics) (*Petaurus australis reginae*), is confined to far-north Queensland and is listed as Endangered under the EPBC Act.

Map 1 Modelled distribution of the Yellow-bellied Glider (South-eastern) (Source: DAWE2022)



Source: Base map Geoscience Australia; species distribution data Species of National Environmental Significance database.

A large population of Yellow-bellied Gliders is calculated to occupy up to 440 000 ha of contiguous habitat across the broader Snowy Mountains region of NSW, ACT and Victoria (Kambouris et al. 2014).

In the ACT, the Yellow-bellied Glider is known to occur in the Cotter Catchment where it prefers the cooler eastern and south-eastern aspects which are dominated by Brown Barrel (*Eucalyptus fastigata*) (Lintermans 1993). Helman et al. (1988) recorded the characteristic feeding scars of this species on Mountain Gum (*Eucalyptus dalrympleana*) near Long Creek in the Upper Cotter Catchment, and rangers have recorded Yellow-bellied Gliders in the area around Nursery Swamp in the past (D. Rosso, pers. comm). The species characteristically occurs at low densities and has large home ranges (Lindenmayer 2002) and is likely a reflection of low food availability of predominantly tree sap, supplemented with nectar and invertebrates. In a post-fire fauna study, undertaken by the ACT Government (Carey et al. 2003), no sightings of the Yellow-bellied Glider were made after 90 per cent of Yellow-bellied Glider habitat was burnt to a moderate-high severity.

In a follow up study of arboreal mammals in 2014 (including surveys of 10 transects covering over 140km) Yellow-bellied Gliders were recorded during call-playback, a technique specifically employed to detect Yellow-bellied Gliders (Snape et al. 2015). Yellow-bellied Glider detections were made across a wide area, including one at Tidbinbilla Nature Reserve, two on Orroral Ridge Road in the central area of the park and one on Mount Franklin Road in the west of the park (Snape et al. 2015).

Long term spotlighting transects were established in 2019 for monitoring large glider populations (including Greater Gliders and Yellow-bellied Gliders) in Namadgi National Park. Transect locations were stratified so that they represented different fire histories and habitats known to be suitable for large glider species, including Yellow-bellied Gliders. During the 2019 surveys, Yellow-bellied Gliders were detected at three sites, all in the north of Namadgi National Park and three Yellow-bellied Gliders were opportunistically recorded near Honeysuckle Campground (Hawkins and Baines in prep.).

As part of an ongoing study examining the effects of planned burns and wildfire on the fauna of subalpine woodlands in Namadgi National Park, song meters were also used for surveying Yellow-bellied Gilders. During spring 2020, song meters detected Yellow-bellied Glider calls at three new locations along Luton's Trail in the south and Smokers Trail in the centre of the park. Two of these locations represent the first post-fire records of Yellow-bellied Gliders within the footprint of the 2020 Orroral Valley fire (Hawkins and Baines in prep.).

During the day, the Yellow-bellied Glider shelters in hollows found in large, old trees, usually more than one metre in diameter (Kambouris et al. 2014). Hollow-bearing trees are a critical habitat feature for the Yellow-bellied Glider (Goldingay 2011, Goldingay et al. 2019) due to their usage as dens. Sap feed trees are also a critical habitat feature for the Yellow-bellied Glider (DAWE 2022). Mountain Gum is a key species for the Yellow-bellied Glider in the Snowy Mountains (Kambouris *et al*. 2014), and the same may also be true in Namadgi National Park; aside from its value as a provider of tree hollows, it is also a known sap feed tree in the park (Helman et al. 1988).

THREATS

Across its range, the Yellow-bellied Glider is primarily threatened by climate change, altered fire regimes, clearing, fragmentation and timber harvesting (DAWE 2022). Other threats, including invasive species predation, mortality by barbed wire fencing, habitat degradation by feral deer

(*Cervidae* spp.) and dieback caused by *Phytophthora cinnamomi*, are identified by DAWE (2022), but it is unknown if these are having a population-level impact.

The likely impact of the 2003 bushfire on the species in the ACT was lack of food, particularly in areas burnt with high severity where sap feeding trees were killed, as well as short-term lack of blossoms and insects, and probable lack of hollows for shelter (Carey et al. 2003).

MAJOR CONSERVATION OBJECTIVES

The primary conservation objective is to stabilise population numbers by protecting sufficient areas of habitat from extensive severe fire, fragmentation and destruction, and retaining key habitat features (e.g. sap trees, hollow-bearing trees) and habitat connectivity.

CONSERVATION PRIORITIES

Recommended management actions are provided in the Commonwealth Conservation Advice (DAWE 2022). As the most suitable habitat for this species in the ACT is in reserved areas, priorities for the conservation of the Yellow-bellied Glider and its habitat in the ACT should be to:

- investigate the role of prescribed burns to protect suitable habitat and populations from high intensity bushfires
- improve the understanding of habitat requirements and develop a habitat suitability model for the species the ACT
- collect robust population abundance, distribution and habitat data by building on the 2018 surveys that take into account vegetation type and fire history, and other environmental parameters
- improve understanding of the impacts of fire regimes and climate change on population viability and explore options for mitigating actions
- explore the implications of climate change for population persistence and conduct climate sensitive management actions where feasible. Systematic monitoring and collection of population data, including reproduction and survival data when available, should be used to assess population viability and species distribution. For species whose physiological limits are known, biophysical models can provide a predictive understanding of the habitats required for persistence in the face of climate change through an integration of data on climate and other environmental variables with measures of morphology, behaviour, physiology and life history of the species. Opportunities to address knowledge gaps for this species to establish climate change ready management actions may include university and interjurisdictional research collaborations.

OTHER RELEVANT ADVICE, PLANS OR PRESCRIPTIONS

- Commonwealth Conservation Advice — Yellow-bellied Glider (DAWE 2022)
- The Action Plan for Australian Mammals 2012 (Woinarski et al. 2014)
- NSW Species Profile – Yellow-bellied Glider (OEH 2017)

LISTING BACKGROUND

The Yellow-bellied Glider was listed as Vulnerable under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) on 2 March 2022. In 2022, under the *Nature Conservation Act 2014*, the ACT Scientific Committee recommended the Yellow-bellied Glider be listed in the Vulnerable category in the ACT Threatened Native Species List to align with the EPBC Act listing.

ACTION PLAN DECISION

The ACT Scientific Committee does not recommend that the Minister for the Environment should make the decision to have an action plan for the species in the ACT under the *Nature Conservation Act 2014* at this time. The species occurs within Namadgi National Park and Tidbinbilla Nature Reserve and its habitat is protected there.

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FURTHER INFORMATION

Further information on this species or other threatened species and ecological communities can be obtained from Environment, Planning and Sustainable Development Directorate (EPSDD). Phone: (02) 132281, EPSDD Website: https://www.environment.act.gov.au/

ATTACHMENT A: NATIONAL LISTING ASSESSMENT (DAWE 2022)

THREATENED SPECIES SCIENTIFIC COMMITTEE

Established under the *Environment Protection and Biodiversity Conservation Act 1999*

The Threatened Species Scientific Committee finalised this assessment on 9 September 2021.

Attachment A: Listing Assessment for *Petaurus australis australis*

Reason for assessment

This assessment follows prioritisation of a nomination from the TSSC.

Assessment of eligibility for listing

This assessment uses the criteria set out in the EPBC Regulations. The thresholds used correspond with those in the IUCN Red List criteria except where noted in criterion 4, sub-criterion D2. The IUCN criteria are used by Australian jurisdictions to achieve consistent listing assessments through the Common Assessment Method (CAM).

Key assessment parameters

Table 3 includes the key assessment parameters used in the assessment of eligibility for listing against the criteria.

Table 3 Key assessment parameters

Metric	Estimate used in the assessment	Minimum plausible value	Maximum plausible value	Justification
Number of mature individuals	<100,000	>10,000	100,000	There is no reliable estimate of the population size of the yellow-bellied glider (south-eastern). Woinarski et al. (2014) suggest that there are over 100 000 mature individuals. However, due to ongoing decline and the 2019–20 bushfires, the current population size is likely to be below 100 000 mature individuals but still substantially above 10 000 mature individuals.
Trend	declining			Across the broad range of the yellow-bellied glider (south-eastern), trends of population decline, and the rate of this decline, cannot be reliably estimated. Past decline over three generations may perhaps approach 30 percent, as suggested in Woinarski et al. (2014). One year after the 2019–20 bushfires, an overall population decline of around 21% (or up to 29%, the lower 80% confidence bound) is suspected under current management. This is expected to increase to 25% (or up to 38%) in three generations after the fires (Legge et al. 2021).
Generation time (years)	4–5	4	5	The generation time of the subspecies is considered to be four–five years (Woinarski et al. 2014).

Metric	Estimate used in the assessment	Minimum plausible value	Maximum plausible value	Justification
Extent of occurrence	1,285,082 km²	712,991 km²	unknown	The extent of occurrence (EOO) is estimated at 1,285,082 km². This figure is based on the mapping of point records from a 20-year period (2000–2020) obtained from state governments, museums and CSIRO. The EOO was calculated using a minimum convex hull, based on the IUCN Red List Guidelines (IUCN 2019). Woinarski et al. (2014) estimated the EOO as 712,991 km², calculated using records from 1992–2012.
Trend	Contracting			The EOO has declined since European settlement due to habitat loss induced by land clearing, fragmentation and fire. This includes the local extinction of some subpopulations (Woinarski et al. 2014). EOO is likely to continue contracting due to loss of suitable habitat resulting from the 2019–20 bushfires, planned burning, land clearing and timber harvesting. See Table 1 for further information.
Area of Occupancy	12,724 km²	Unknown	14,152 km²	The AOO is estimated at 12,724 km². This figure is based on the mapping of point records from a 20-year period (2000–2020) obtained from state governments, museums and CSIRO. The AOO was calculated using a 2x2 km grid cell method, based on the IUCN Red List Guidelines (IUCN 2019). Woinarski et al. (2014) estimated the AOO as 14,152 km², calculated using records from 1992–2012. For both estimates, the area of occupancy is likely significantly under-estimated due to limited sampling across the occupied range.
Trend	Contracting			The AOO has declined since European settlement, due to habitat loss induced by land clearing, fragmentation, timber harvesting and fire. This includes the local extinction of some subpopulations (Woinarski et al. 2014). AOO is likely to continue contracting due to loss of suitable habitat resulting from the 2019–20 bushfires, planned burning, land clearing and timber harvesting. See Table 1 for further information.

Metric	Estimate used in the assessment	Minimum plausible value	Maximum plausible value	Justification
Number of subpopulations	Unknown	Unknown	Unknown	The subspecies is wide-ranging and is known from many sites throughout Qld, NSW and Vic. Therefore, the number of subpopulations is not able to be estimated.
Trend	contracting			The number of subpopulations is likely to be declining based on the factors decreasing the AOO and EOO.
Basis of assessment of subpopulation number	There is no information on the number of subpopulations throughout the subspecies range. The number of subpopulations is likely to be large, considering the large AOO and EOO.			
No. locations	Unknown	Unknown	>10	The number of locations is not known with any certainty. The 2019–2020 bushfire events burnt a large area of Eastern Australia (100 000 km^2), overlapping c. 41% of the yellow-bellied glider (south-eastern) distribution (Legge et al 2021). However, the fire severity was highly spatially variable, with yellow-bellied glider (south-eastern) persisting in at least some burnt areas. Thus, the number of locations may be significantly greater than 10.
Trend	contracting			The severity, frequency and scale of catastrophic bushfires will likely increase due to climate change. Therefore, the number of locations in which a single bushfire can rapidly affect all individuals will likely decrease.
Basis of assessment of location number	The subspecies occurs across much of the land in four states and territories. A large number of bushfires are likely to be required to impact all individuals.			
Fragmentation	Not severely fragmented– less than 50% of AOO in habitat patches that cannot support minimum viable population.			
Fluctuations	Not subject to extreme fluctuations in EOO, AOO, number of subpopulations, locations or mature individuals.			

Criterion 1 Population size reduction

Reduction in total numbers (measured over the longer of 10 years or 3 generations) based on any of A1 to A4			
	Critically Endangered **Very severe reduction**	**Endangered** **Severe reduction**	**Vulnerable** **Substantial reduction**
A1	≥ 90%	≥ 70%	≥ 50%
A2, A3, A4	≥ 80%	≥ 50%	≥ 30%

A1 Population reduction observed, estimated, inferred or suspected in the past and the causes of the reduction are clearly reversible AND understood AND ceased.

A2 Population reduction observed, estimated, inferred or suspected in the past where the causes of the reduction may not have ceased OR may not be understood OR may not be reversible.

A3 Population reduction, projected or suspected to be met in the future (up to a maximum of 100 years) [*(a) cannot be used for A3*]

A4 An observed, estimated, inferred, projected or suspected population reduction where the time period must include both the past and the future (up to a max. of 100 years in future), and where the causes of reduction may not have ceased OR may not be understood OR may not be reversible.

Based on any of the following

(a) direct observation [except A3]
(b) an index of abundance appropriate to the taxon
(c) a decline in area of occupancy, extent of occurrence and/or quality of habitat
(d) actual or potential levels of exploitation
(e) the effects of introduced taxa, hybridization, pathogens, pollutants, competitors or parasites

Criterion 1 evidence

Eligible under Criterion 1 A4(c) for listing as Vulnerable

Generation length

The generation length of the yellow-bellied glider (south-eastern) is estimated to be four to five years (Woinarski et al. 2014), giving a timeframe of 12–15 years for this criterion (three generations).

Past decline due to habitat loss, fragmentation, forestry and altered fire regimes

Prior to the 2019–20 bushfires, trends of population decline, and the rate of this decline, could not be reliably estimated. There has been no integrated long-term monitoring program across major subpopulations, and the inherently low density of the subspecies throughout its broad range can make subpopulations difficult to identify and count. Woinarski et al. (2014) suggested that the population is declining due to habitat loss through fragmentation, clearing, bushfires, and some forestry practices (see Table 1 for more information on threats). The requirement for specific habitat characteristics, including large and socially exclusive home ranges and mature eucalypt forests, has led to a decline and patchy distribution of gliders throughout their range (Goldingay & Possingham 1995). The subspecies has likely declined significantly in the wet ash forests of the Central Highlands of Victoria over the past 25 years, though were too uncommon to facilitate detailed statistical analyses in a recent multi-decadal study (Lindenmayer et al. 2020). Across the subspecies range, there have been localised declines due to clearing and

timber harvesting (Milledge et al. 1991; Andrews et al. 1994; Smith et al. 1994; Kavanagh & Webb 1998; Lindenmayer et al. 1999b;), as well as extinctions of some subpopulations due to unknown causes (e.g., Booderee National Park) (Woinarksi et al. 2014). However, it is also noted that long-term studies, particularly in south-eastern NSW, have shown that glider populations fluctuate greatly over time (Kavanagh et al. 2021).

Subpopulation-level studies over the past three generations include a study on a subpopulation on the Bago Plateau (southern NSW) that indicated it was declining at a rate of over 30 percent over a three-generation period. The reason for this decline is unknown, and the suggested impact of timber harvesting was not found to be significant (Kambouris et al. 2013). In contrast, a study surveying a subpopulation in Richmond Range National Park (north-east NSW) found near constant abundance from 2014 to 2016, with no change in yellow-bellied glider (south-eastern) site occupancy (Goldingay et al. 2017). This subpopulation was not affected by the 2019–20 bushfires and appears to have undergone no recent decline despite drought conditions (Goldingay 2020. pers comm 15 December). It is notable that Richmond Range National Park is protected, and thus decline due to timber harvesting and clearing is likely not represented in these trends.

Kavanagh et al. (2021) observed that fire-affected populations of the yellow-bellied glider appeared to have declined at low elevation sites in north-eastern NSW. There was a negative relationship between detectability and the number of fires since 1990, though Kavanagh (2021) suggests declines in populations appear to have occurred independently of fire (Kavanagh 2021). Surveys revealed that only 25 percent of previously utilized sites were occupied, and yellow-bellied gliders (South-eastern) were not observed at some unburnt sites. Furthermore, a number of sap trees that had previously been frequently used appeared to have no evidence of recent yellow-bellied glider (South-eastern) activity (R Kavanagh 2021. pers comm 10 August). The driving factors behind these potential declines are unclear, though climate change may be responsible through reductions to rainfall and increases in mean daytime and night-time temperatures (R Kavanagh 2021. pers comm 10 August), similarly to the related greater glider (Smith & Smith 2018, 2020; Wagner et al. 2020). Further research is required to determine the mechanisms behind these observations of non-fire related population decline, and how they are impacting on the total population (R Kavanagh 2021. pers comm 10 August).

Past decline over three generations may perhaps approach 30 percent, as suggested by Woinarski et al. (2014), and this threshold has likely been eclipsed after the 2019–20 bushfires. Further research on the subspecies' population dynamics over a large segment of the distribution will be useful to accurately determine population decline (Goldingay et al. 2017).

Future decline due to habitat loss, fragmentation, forestry, altered fire regimes and range contraction

The combination of fragmentation, bushfires, drought, forestry, and range contraction is likely to lead to decline in the yellow-bellied glider (south-eastern) over the next three generations (see Table 1). It is notable that the impacts of timber harvesting may lessen across the Vic distribution of the yellow-bellied glider (south-eastern) due to the scheduled cessation of native forest timber harvesting in 2030 and use of new harvesting techniques (VicForests 2021. pers comm 24 June). However, ongoing legacy impacts of fragmentation and past clearfell timber

harvesting with little regeneration will likely still lead to some population decline for the subspecies.

Impacts of the 2019–20 bushfires

In 2019–20, following years of drought (DPI 2020), catastrophic bushfire conditions resulted in extensive bushfires covering an unusually large area of eastern Australia. Recent analysis suggests that 41 percent of the subspecies distribution was affected by the fires (Legge et al. 2021). 54 percent of species records in NSW were in the fire affected areas (DPIE 2020). It is suspected that the total population will continue to decline after the fires due to post-fire effects which include the loss of important habitat features (Lunney 1987; Goldingay & Kavanagh 1991) and post-fire salvage timber harvesting (Noss & Lindenmayer 2006; Lindenmayer et al. 2008).

On-ground surveys

On-ground surveys show that the fires had a substantial impact on the yellow-bellied glider (south-eastern). In surveys of 30 sites in East Gippsland, the subspecies was present in highest abundance at unburned sites and sites with low canopy scorching and was absent at sites with high or complete canopy scorching (Burns 2020. pers comm 15 December). Surveys in the Shoalhaven Area (NSW) suggest that subpopulations in canopy-impacted sites underwent severe decline or extinctions (Craven & Daly 2020). In all surveyed areas, yellow-bellied gliders (south-eastern) were not detected at high or extreme fire severity sites, and 68 percent of transects had fewer individuals detected than before the bushfires (Craven & Daly 2020). Surveys of the lower Richmond and Clarence floodplain by the Nature Conservation Council of NSW recorded yellow-bellied glider (south-eastern) vocalisations at six of the 30 monitored sites prior to the spring fires of 2019, though no vocalisations have been recorded since the 2019–20 bushfires. It is estimated that 20 percent of large hollow bearing trees at these sites have been lost (NCC 2021).

Surveys in 2021 investigated the impacts of the 2019–20 bushfires on yellow-bellied glider (south-eastern) subpopulations in north-eastern and south-eastern NSW, both regions having previously been surveyed for the subspecies (Kavanagh et al. 2021). The north-eastern NSW study sites have a history of both timber harvesting and fire (Kavanagh et al. 1995; Kavanagh & Stanton 2005; McLean et al. 2015; McLean et al. 2018). Surveys of these sites in 2020–2021 observed yellow-bellied gliders (south-eastern) at 10 of the 47 sites where they had been recorded previously (21.3 percent), and at one additional site where they had not been recorded previously. The relative abundance of the subspecies followed a slight negative trend in relation to the proportion of severely burnt forest across the 47 sites where they had been previously recorded, and there was also a slight positive relationship between abundance and the proportion of unburnt and low severity burnt forest within the local landscape around each site (Kavanagh et al. 2021).

The south-eastern NSW sites have a history of timber harvesting but historically low fire frequency (Kavanagh et al. 2021). The northernmost eight of the 18 sites surveyed had been surveyed multiple times previously, with yellow-bellied gliders (south-eastern) recorded at just two sites prior to 2021. One of these sites has only one record of the subspecies, with no observations in subsequent surveys. Surveys in 2021 observed yellow-bellied gliders (south-eastern) at one of the two sites where they were previously found, as well as two new sites

(including a severely burnt site). The impact of fires on this subpopulation is difficult to determine, though the subspecies is still present and able to be observed. The other subset of ten south-east study lines (the Waratah Creek grid) had also been surveyed previously on multiple occasions (Kavanagh 1984; Kavanagh & Webb 1998). 77 percent of the grid was burnt at moderate (42 percent), high (30 percent) or extreme severity (5 percent), with the remaining 23 percent either unburnt (3 percent) or burnt at low severity (20 percent). Previously, the 'detectable subpopulation' (an index) of yellow-bellied gliders (south-eastern) (total number ~ 625) fluctuated between 21–63 individuals throughout all years of the 40-year study. However, surveys in 2021 found only three individuals, representing a decline in observations of 86–97 percent. It is highly likely that this observed decline in the yellow-bellied glider (south-eastern) subpopulation at Waratah Creek is due to the impacts of fire (Kavanagh et al. 2021).

Table 4: Summary of on-ground survey results for yellow-bellied glider (south-eastern)

Locality	Survey date	Number of sites	Impact of mild fire	Impact of Severe fire	Source
East Gippsland	September – October 2020	30 sites (19 with pre-fire detections)	Reduced number of sightings	Absent (100% decline)	P. Burns; unpublished
Shoalhaven	May – June 2020	71 sites (31 with pre-fire detections)	Unclear. Detected at 10/31 sites where it was previously found, all burnt at low-moderate severity. Unclear how many sites previously occupied by the subspecies were burnt at each severity. Likely that occupancy was reduced at mildly burnt sites.	Absent (100% decline)	Craven P & Daly G (2020)
Lower Richmond and Clarence floodplains	Unknown	30 sites (6 with pre-fire detections)	Unknown	Absent (100% decline)	NCC (pers comm. 24 June 2021)
North-east NSW (at sites with a history of forestry and high fire frequency)	November 2020, April - May 2021	94 sites (47 with pre-fire detections)	Found at only 21.3% of sites they were previously present at (and one additional site). Less likely to be present at sites in severely burned forest		Kavanagh et al. (2021)
South-east NSW (sites with a history of forestry and low fire frequency)	May 2021	8 sites (2 with pre-fire detections)	Recorded at two new sites and one site with previous records. Not recorded at different a site with previous records.		
South-east NSW (sites with a history of forestry and low fire frequency)	May 2021	1 large 100 ha site (10 transects, all with pre-fire detections)	3 individuals recorded after the 2019–20 fires, totalling 86-97% decline across all transects. 77% of site burn at moderate (42%), high (30%), or extreme (5%) severity. 20% burnt at low severity, 3% unburnt.		

Across the south-eastern and north-eastern sites, there was an observed negative relationship between yellow-bellied glider (south-eastern) abundance and increasing fire severity in the local landscape (Kavanagh et al. 2021). It is considered likely that observations of the subspecies in severely burnt areas were due to the proximity of unburnt or low severity burnt areas nearby. However, univariate analyses were unable to fully explain the importance of patchiness in fire severity in the local landscape (Kavanagh et al. 2021).

Expert elicitation

In a project run by the Threatened Species Recovery Hub (Legge et al. 2021), expert elicitation was used to estimate the extent of population decline after fires of varying severity, and the predicted population trajectories out to three generations after the 2019–20 fires. Information on population response to fires of varying severity was combined with spatial estimates of the overlaps between the subspecies distribution and fire severity mapping. The analysis suggests that site-level decline at severely affected sites is around 81.6 percent (80 percent confidence bounds: 67.7 to 90.4 percent) one week after the fires and 78.1 percent (80 percent confidence bounds: 91 and 62.6 percent) three generations after the fires. These estimates are consistent with the site-level empirical data summarised above (Table 4). Considering the proportion of the distribution burnt in low and high severity fire, *the overall* population of yellow-bellied gliders (south-eastern) was estimated to have declined by 21 percent one year after the fire but may have declined by as much as 29 percent (the lower 80 percent confidence bound). By comparing this trajectory to that predicted for subpopulations that were not exposed to fires, the elicitation indicated that after one-year, yellow-bellied glider (south-eastern) populations would be around 19.5 percent lower than they would have been, had the fires not occurred. In other words, the 2019-20 fires will have caused an additional 19.5 percent decline on top of any pre-existing declines.

By three generations after the 2019–20 bushfires, the overall population is predicted to be 25 percent lower than its pre-2019 level, but possibly as much as 38 percent lower (80 percent confidence bound). By comparing this trajectory to that predicted for subpopulations that were not exposed to fires, the elicitation indicated that after three generations, the fires caused an additional 15 percent decline on top of 10 percent overall decline due to pre-existing factors. These elicitations assumed no further extensive fire events in the range of the yellow-bellied glider (south-eastern) over the 3-generation period.

Overall population decline

The yellow-bellied glider (south-eastern) is declining in abundance due to the catastrophic 2019–20 bushfires, and ongoing habitat loss from clearing, fragmentation, bushfires, drought, and some forestry practices. It may also be declining due to threats associated with climate change (R Kavanagh 2021. pers comm 10 August). Overall decline over a period including both the past and the future (2019–2031/2034) is estimated by Legge et al. (2021) at 25 percent, or up to 38 percent. However, given that large-scale fire and catastrophic drought were not accounted for during projection of future declines , and such events are predicted to increase in frequency (CSIRO & Bureau of Meteorology 2015), it is likely that this decline exceeds 25 percent and is closer to the lower bounds of 38 percent (Legge et al. 2021).

Conclusion

The Committee considers that the subspecies has undergone a substantial reduction in numbers over three generations (12–15 years for this assessment) which is equivalent to at least 30 percent. The reduction has not ceased, and the cause has not ceased. Therefore, the subspecies has met the relevant elements of Criterion 1 to make it eligible for listing as Vulnerable.

Criterion 2 Geographic distribution as indicators for either extent of occurrence AND/OR area of occupancy

		Critically Endangered Very restricted	Endangered Restricted	Vulnerable Limited
B1.	Extent of occurrence (EOO)	**< 100 km²**	**< 5,000 km²**	**< 20,000 km²**
B2.	Area of occupancy (AOO)	**< 10 km²**	**< 500 km²**	**< 2,000 km²**
AND at least 2 of the following 3 conditions:				
(a)	Severely fragmented OR Number of locations	**= 1**	**≤ 5**	**≤ 10**
(b)	Continuing decline observed, estimated, inferred or projected in any of: (i) extent of occurrence; (ii) area of occupancy; (iii) area, extent and/or quality of habitat; (iv) number of locations or populations; (v) number of mature individuals			
(c)	Extreme fluctuations in any of: (i) extent of occurrence; (ii) area of occupancy; (iii) number of locations or populations; (iv) number of mature individuals			

Criterion 2 evidence

Not eligible

The extent of occurrence (EOO) is estimated at 1,285,082 km² and the area of occupancy (AOO) is estimated at 12,724 km². These figures are based on the mapping of point records from a 20-year period (2000–2020), obtained from state governments, museums, and CSIRO. The EOO was calculated using a minimum convex hull, and the AOO calculated using a 2x2 km grid cell method, based on the IUCN Red List Guidelines 2014 (IUCN 2019). The AOO is likely significantly under-estimated due to limited sampling across the occupied range (Woinarski et al. 2014).

Conclusion

Following assessment of the data the Committee considers that the subspecies is not eligible for listing in any category under this criterion as neither the EOO or AOO are likely to be limited.

Criterion 3 Population size and decline

	Critically Endangered Very low	Endangered Low	Vulnerable Limited
Estimated number of mature individuals	< 250	< 2,500	< 10,000
AND either (C1) or (C2) is true			
C1. An observed, estimated or projected continuing decline of at least (up to a max. of 100 years in future)	Very high rate 25% in 3 years or 1 generation (whichever is longer)	High rate 20% in 5 years or 2 generation (whichever is longer)	Substantial rate 10% in 10 years or 3 generations (whichever is longer)
C2. An observed, estimated, projected or inferred continuing decline AND its geographic distribution is precarious for its survival based on at least 1 of the following 3 conditions:			
(a) (i) Number of mature individuals in each population	≤ 50	≤ 250	≤ 1,000
(a) (ii) % of mature individuals in 1 population =	90 – 100%	95 – 100%	100%
(b) Extreme fluctuations in the number of mature individuals			

Criterion 3 evidence

Not eligible

There is no reliable estimate of population size, though Woinarski et al. (2014) estimated that the number of mature individuals was greater than 100,000. However, due to ongoing decline and the 2019–20 bushfires, the current population size is likely below 100,000 mature individuals, but still substantially greater than 10,000 mature individuals.

Conclusion

Following assessment of the data the Committee considers that the species/subspecies is not eligible for listing in any category under this criterion as the total population size is not likely to be limited.

Criterion 4 Number of mature individuals

	Critically Endangered Extremely low	Endangered Very Low	Vulnerable Low
D. Number of mature individuals	< 50	< 250	< 1,000
D2.[1] *Only applies to the Vulnerable category* Restricted area of occupancy or number of locations with a plausible future threat that could drive the species to critically endangered or Extinct in a very short time			D2. Typically: area of occupancy < 20 km² or number of locations ≤ 5

[1] The IUCN Red List Criterion D allows for species to be listed as Vulnerable under Criterion D2. The corresponding Criterion 4 in the EPBC Regulations does not currently include the provision for listing a species under D2. As such, a species cannot currently be listed under the EPBC Act under Criterion D2 only. However, assessments may include information relevant to D2. This information will not be considered by the Committee in making its recommendation of the species' eligibility for listing under the EPBC Act, but may assist other jurisdictions to adopt the assessment outcome under the *common assessment method*.

Criterion 4 evidence

Not eligible

As described above under Criterion 3, there is no reliable estimate of the yellow-bellied glider (south-eastern) population size. Due to ongoing decline and the 2019–20 bushfires, the current population size is likely below 100,000 mature individuals but still substantially above 10,000 mature individuals. Therefore, the subspecies has not met this required element of this criterion. The species has an AOO of above 20 km² and more than five locations, so is not eligible under criterion D2.

Conclusion

Following assessment of the data the Committee considers that the species/subspecies is not eligible for listing in any category under this criterion as total population size is not likely to be limited.

Criterion 5 Quantitative analysis

	Critically Endangered Immediate future	Endangered Near future	Vulnerable Medium-term future
Indicating the probability of extinction in the wild to be:	≥ 50% in 10 years or 3 generations, whichever is longer (100 years max.)	≥ 20% in 20 years or 5 generations, whichever is longer (100 years max.)	≥ 10% in 100 years

Criterion 5 evidence

Insufficient data to determine eligibility

A population viability analysis has been completed to assess the minimum viable number of populations and habitat area (Goldingay & Possingham 1995), but an assessment of the likelihood of extinction has not been assessed.

Conclusion

Population viability analysis has not been undertaken. Therefore, there is insufficient information to determine the eligibility of the subspecies for listing in any category under this criterion.

Adequacy of survey

The survey effort has been considered adequate and there is sufficient scientific evidence to support the assessment.

Public consultation

Notice of the proposed amendment and a consultation document was made available for public comment for 36 business days between 6 May 2021 and 24 June 2021.

Listing and Recovery Plan Recommendations

The Threatened Species Scientific Committee recommends:

(i) that the list referred to in section 178 of the EPBC Act be amended by **including** *Petaurus australis australis* in the list in the Vulnerable category.

(ii) that there should be a recovery plan for this subspecies.

Appendix

Appendix A: Identified tree species found in the habitat of the yellow-bellied glider (south-eastern)

Scientific Name	Common Name/s	Used as a Sap tree
Acacia mabellae	Mabel's wattle	Yes
A. mearnsii	black wattle	Yes
Angophora subvelutina	broad-leaved apple	Yes
A. leiocarpa	rusty gum	Yes
Corymbia citriodora	spotted gum, lemon-scented gum	Yes
C. gummifera	red bloodwood	Yes
C. henryi	large-leaved spotted gum	Yes
C. intermedia	pink bloodwood	Yes
C. maculata	spotted gum	Yes
C. trachyphloia	brown bloodwood	Unknown
Eucalyptus acmenoides	white mahogany	Unknown
E. amplifolia	cabbage gum	Yes
E. andrewsii	New England blackbutt, gum-topped peppermint	Yes
E. angophoroides	apple-topped box	Yes
E. bancroftii	orange gum, Bancroft's red gum	Yes
•*E baxteri*	brown stringybark	Unknown
E. biturbinata	grey gum	Yes
E. bosistoana	coast grey box	Yes
E. botryoides	Bangalay, southern mahogany	Yes
E. campanulata	New England blackbutt	Unknown
E. crebia	narrow-leaved ironbark	Unknown
E. cypellocarpa	monkey gum, mountain grey Gum	Yes
E. dalrympleana	mountain gum	Yes
E. deanei	mountain blue gum, round-leaved gum	Yes
E. dunnii	white gum	Yes
E. elata	red peppermint	Unknown
E. eugenioides (includes *E. nigra*)	thin-leaved stringybark	Yes
E. fastigata	brown Barrel, cut-tail	Yes
E. fibrosa	broad-leaved ironbark	Unknown
E. fraxinoides	white ash	Unknown
E. grandis	flooded gum, rose gum	Yes
E. laevopinea	silvertop stringybark	Yes
E. longirostrata	grey gum	Yes
E. major	grey gum	Yes
E. melliodora	yellow box	Yes