The Minister approved this conservation advice and included this species in the Endangered category, effective from 5 May 2016

Conservation Advice

Paralucia pyrodiscus lucida

Eltham copper

Taxonomy

Conventionally accepted as *Paralucia pyrodiscus lucida* Crosby, 1951 (family Lycaenidae).

Summary of assessment

Conservation status

Endangered: Criterion 2 B2 (a)(b)(i)(ii)(iii)(iv)(v) and Criterion 3 C2(b)

The highest category for which *Paralucia pyrodiscus lucida* is eligible to be listed is Endangered.

Paralucia pyrodiscus lucida has been found to be eligible for listing under the following listing categories:

Criterion 1: A3(b)(c): Vulnerable
Criterion 2: B2 (a)(b)(i)(ii)(iii)(iv)(v): Endangered
Criterion 3: C2(b): Endangered
Criterion 4: Low: Vulnerable

Species can be listed as threatened under state and territory legislation. For information on the listing status of this species under relevant state or territory legislation, see http://www.environment.gov.au/cgi-bin/sprat/public/sprat.pl

Reason for conservation assessment by the Threatened Species Scientific Committee

This advice follows assessment of information provided by a public nomination to list *Paralucia pyrodiscus lucida.*

Public Consultation

Notice of the proposed amendment and a consultation document were made available for public comment for 35 business days between 25 November 2015 and 15 January 2016. Any comments received that were relevant to the survival of the species were considered by the Committee as part of the assessment process.

Species/Sub-species Information

Description

The Eltham copper is small, with a wingspan of 25 to 27 mm (Braby, 2000). The uppersides of the wings are dark brown in males and females (Braby, 2000), with both fore- and hind wings bearing a yellow-copper area (Braby, 2000). The underside of both wings is brown of various shades, with a series of darker brown, irregular, ‘zig zag’ lines (Braby, 2000).

Eggs are white, 0.9 mm in diameter, generally dome-shaped and flattened at the top (Braby, 1990). Larvae are yellowish-brown, and a prominent dark reddish mid-dorsal line extends from the thorax to near the end of the abdomen in later stages (Braby et al., 1999). The end of the abdomen is considerably flattened in mature larvae (Braby et al., 1999). First stage larvae are 2-

2.5 mm long; final (eighth) stage larvae are approximately 18 mm long (Braby, 1990). Pupae are 10-14 mm long (Braby, 1990), yellowish-brown, with numerous small dark brown flecks and a mid-dorsal line along the abdomen (Braby et al., 1999).

Distribution

The Eltham copper is endemic to Victoria, where it is known from 25 sites/colonies (Borton pers. comm., 2014), distributed in three remnant areas, which (Braby et al., 1999) considered to likely be separate populations: in the Eltham-Greenborough area of Melbourne, in the Castlemaine-Bendigo area of central Victoria, and in the Kiata-Nhill-Dimboola area in northwest Victoria. The three remnant areas across Victoria are widely separated, with no possibility of natural genetic interchange (Braby et al., 1999), given the likely limited dispersal ability of the butterfly. Recent unpublished genetic research has confirmed the subspecies status of the Eltham copper, and three distinct groups (populations) that correspond with the three remnant areas (Yen, pers. comm., 2016).

Surveys in late 2011 yielded several new sites near Castlemaine, in the southern area of Bendigo, and in the Wimmera area between Kiata and Castlemaine (Bayes et al., 2012). This indicates the continued need for surveys to fully establish the extent of the distribution (Yen pers. comm., 2016), especially as much of the Castlemaine and Bendigo areas have not been adequately surveyed (Bayes pers comm., 2016).

Most of the 25 sites are protected in Conservation Reserves that are actively managed for conservation by the Victoria Department of Environment, Land, Water and Planning, Nillumbik Shire Council (Borton pers. comm., 2014), or Banyule City Council (Vaughan pers comm., 2016). Most of the Castlemaine sites are protected in National Diggings Park, and although there is currently no funding for formal management, there has been community action to prevent prescribed burning (Bayes pers. comm., 2016). The Eltham copper is highly localised within the three remnant areas: colonies occupy only around 3-26% of available habitat (Braby et al., 1999). Kiata is highly rural, with some reserves surrounded by intensive agriculture (Canzano pers. comm., 2016).

The total extent of occurrence (EOO) of the Eltham copper is calculated to be 6,514 km^2 (Department of the Environment, 2015), using the IUCN convex hull/minimum convex polygon method. The total area of occupancy (AOO) of the Eltham copper is calculated to be 76 km^2 (Department of the Environment, 2015), using a 2x2 km grid cell method based on the IUCN Red List Guidelines (IUCN, 2014).

The Eltham copper occurs in more exposed, drier sites, often along ridge-tops, and in the Eltham-Greensborough area the butterfly inhabits dry *Eucalyptus* forest with grassy understorey and scattered patches of the larval food plant (Braby et al., 1999; Borton pers. comm., 2014). Most colonies in this area occur on elevated, well-drained areas, often adjoining moister gullies (Braby et al., 1999). In the Castlemaine-Bendigo area the butterfly inhabits heathy dry forest (Borton pers. comm., 2014). The predominant tree species in the overstorey differ across the subspecies' range (Sands and New, 2002). In Kiata, colonies are found on flatter, very gently sloping ground dominated by *Allocasuarina luehmannii* (Braby et al., 1999).

Relevant Biology/Ecology

Like many butterflies from the Lycaenidae, the Eltham copper has an intricate and likely obligate relationship with ants (Braby et al., 1999). At least three species from the ant genus *Notoncus* are hosts to the butterfly larvae: *Notoncus capitatus*, *N. enormis* and *N. ectatommoides*, which occur in southeastern Australia (Braby, 1990; Braby et al., 1999). Around Eltham the host ant is *N. capitatus* (previously part of *N. enormis*), and around Kiata it is *N*. *ectatommoides* (Braby et al., 1999). Generally, the two ant species occur separately, with *N. capitatus* often found in wetter areas than N. *ectatommoides* (Braby et al., 1999). Apparently, suitable colonies of the host ants are distributed much more widely than the butterfly they attend (Braby et al., 1999). However, populations of the butterfly are more patchy, each comprising a number of localised colonies, probably reflecting the low incidence of suitable combinations of larval food plant and attendant ants (Braby, 2000).

The only host plant on which the butterfly larvae feed (*Bursaria spinosa* subsp *spinosa*) is common in southeastern Australia, including Tasmania (Atlas of Living Australia, 2015). Populations of the Eltham copper appear to be very localised within a wider landscape in which much land supporting *Bursaria spinosa* does not harbour the butterfly (New pers. comm., 2016).

The Eltham copper is wholly dependent on its association with ants of the genus *Notoncus*, such that the butterfly has not been found in areas where *Notoncus* ant colonies do not occur (Vaughan 1988). *Notoncus* species are ground-nesting ants and construct small chambers around the bases of the *Bursaria* plants on which they forage, mainly at night, for nectar and honeydew from insects (Braby et al., 1999).

The Eltham copper breeds only on *Bursaria spinosa* subsp *spinosa* (Pittosporaceae) and is usually found on juvenile plants (Borton pers. comm., 2014) or small, stunted plants with juvenile foliage (Braby et al., 1999), which are generally less than 0.5m high at Eltham. They do occasionally occur on much larger plants (Vaughan, 1988). At Kiata and Castlemaine plants that are utilised may approach 2m in height (Braby et al., 1999). Most eggs are laid on the host plant near the ground, very rarely on leaf litter near the plant base (Braby, 1990).

After hatching, larvae are found during the day in the *Notoncus* ant nest at the base of the host plant, where the larvae are guarded by the ants, which also accompany the larvae to and from the ant colony to browse on the host plant leaves during the night (Vaughan, 1988). In return, the ants feed on sugars in the larval excretions (Braby et al., 1999). Larvae overwinter in the ant nest, and intensive grazing over late summer-autumn can lead to severe defoliation of some plants (Braby, 1990), which quickly regenerate over late autumn-winter (Braby et al., 1999). Larvae generally pupate in the ants' nest, with pupae usually attached to the main root or stem of the host plant (Braby, 1990).

It is likely that within sites there is local movement and dispersal of the colonies among the larval food plants (Braby et al., 1999). Research conducted in 1987-1988 and 1994-1995 indicated that a substantial proportion of food plants used for oviposition may not be utilised in subsequent years, so that larval distribution within a site may vary between years (Braby et al., 1999). Yen (pers. comm., 2016) reported that colonies move to track suitable environmental conditions; therefore not all available habitat at sites is suitable habitat. As vegetation ages, the habitat may become unsuitable and the population either moves on or becomes locally extinct (Yen pers. comm., 2016).

The average generation length—egg to emerged adult—for *Paralucia pyrodiscus lucida* has been estimated at approximately three months during favourable conditions; however, there may be only one generation per year, with an overwintering larval period (Vaughan pers. Comm., 2016). There is generally one generation each year in Eltham, but occasional prolonged flight periods are thought to represent a partial second generation or prolonged emergence period in some years (Vaughan, 1988). A similar pattern may also occur at Castlemaine (Braby, 1990). There are two discrete generations per year at Kiata (Braby, 1990). Adult butterflies readily feed on flowers of *B. spinosa*, and also feed opportunistically on the flowers of several other species associated with *B. spinosa* (Braby et al., 1999). Adults require open areas among and near the larval food plants on which to perch and so that males can establish territories for mating.

In captivity, one generation is approximately three months during warmer parts of the year and with high abundance and quality of food, including a 3-5 week pupal stage (Braby et al., 1999). In natural habitat, eggs hatch after about two weeks, and first stage larvae generally develop rapidly over late summer and autumn before overwintering as mature larvae, with adults emerging the following summer (Braby et al., 1999). Mark-recapture studies showed that adult males can survive at least 28 days, and females at least 11 days (Canzano pers. comm., 2016).

Threats

The Eltham copper was noted as being of conservation concern by Vaughan (1988), Braby (2000), and Sands and New (2002.

Land clearing/habitat alteration. This has caused fragmentation and loss of habitat, especially in urban areas due to subdivision, roadworks and building construction (Borton pers. comm., 2014), and some of the known sites have become extinct (Yen pers. comm., 2016). The impetus to conserve the Eltham copper arose from its discovery in 1987 on a site in Eltham threatened with imminent housing subdivision (Braby et al., 1999). Broadacre clearing for agriculture and urban development has removed most of the suitable habitat on private land, and the butterfly is generally restricted to remnant habitat on public land (Borton pers. comm., 2014). The threat is exacerbated by the species' preference and attachment to a particular habitat type, and so dispersal is limited and more localised as fragmentation increases (Borton pers. comm., 2014). Conservation needs for the Eltham copper span the three regions in Victoria where it occurs, but attention has focussed strongly on the small isolated periurban populations near Melbourne, where sites are under persistent and direct threat from urbanisation and successional changes (New pers. comm., 2016). The Eltham-Greensborough sites are surrounded by private property, and some property owners extend their boundaries into the reserves. This has the potential to introduce weeds to the site and reduce the overall area of available habitat (Borton pers. comm., 2014), as does the requirement for fire breaks around the perimeter of such sites (Vaughan pers comm., 2016). As the populations at Eltham-Greensborough occupy confined locations within urban settings, their long term survival relies upon managing these sites so that they are suitable for breeding (Yen pers. comm., 2016).

In addition to direct clearing of habitat, urbanisation also causes additional pressures such as: trampling, weed invasion, changes in hydrology, and unplanned fires, which lead to further habitat degradation (Vaughan 1988). Urbanisation is also an increasing threat to the Bendigo and Castlemaine populations (Borton pers. comm., 2014; Bayes pers. comm., 2016; Yen pers. comm., 2016). The site at Big Hill Primary School was threatened by run-off from an adjacent housing complex in approximately 2013, and Kalimna Park was threatened with diminishment by a new housing estate on its eastern margin (New pers. comm., 2016). Changes to local drainage intensity and patterns can also change soil moisture levels and the type and density of vegetation to the potential detriment of the butterfly (Vaughan, 1988).

Woody weeds such as Cape broom (*Genista monspessulana*), radiata pine (*Pinus radiata*) and blackberry (*Rubus fruticosus*) have the potential to outcompete *Bursaria spinosa* (Mays pers. comm. 2015), although weeds across the Eltham-Greensborough sites are actively managed (Borton pers. comm., 2014). Weeds at the Castlemaine Botanic Gardens have been managed by Mount Alexander Shire Council and the Castlemaine Field Naturalist Group for the last 20 years (Bayes pers. comm., 2016). Urbanisation leads to the increased presence of some introduced predators, such as the honey bee (*Apis mellifera*) and European Wasp (*Vespula germanica*) (Vaughan 1988).

Inappropriate fire regimes. The effects of fire on habitat and survival of the Eltham copper are complex. Slashing and burning of vegetation as preventative measures for wildfires is cited as a direct threat (Borton pers. comm., 2014). Since the Black Saturday Bushfires in 2009 that devastated large areas in central and southern Victoria, there has been increased pressure on land managers to reduce fuel loads within conservation reserves by slashing and controlled burning of vegetation and the creation of fire breaks (Borton pers. comm., 2014). Prescribed burning directly threatens all habitat in which the Eltham copper and larval foodplant occur, and the effects will be magnified if burning occurs every 5-10 years (Bayes pers comm., 2016). Such a strategy will likely also impact unsurveyed habitat in which the butterfly may occur. This is a current threat to the Eltham copper and is likely to continue into the future (Borton pers. comm., 2014). Conversely, controlled ecological burns have also been used successfully for the management of the butterfly, as it is one tool to reduce vegetation cover when the latter has become too dense for the butterfly to utilise effectively (Vaughan pers comm., 2016).

Despite management activities, wildfires have the potential to change the state of sites where the Eltham copper occurs due to the subspecies' limited distribution and presence in fire prone areas (Borton pers. comm., 2014). The key issue of wildfire and its ability to threaten populations of the Eltham copper refers to the seasonality of the fire and the area burnt (Mays pers comm.. 2015). Given that the subspecies has a low dispersal capability and occupies

discrete patches of *Bursaria spinosa* within the reserves it is extremely vulnerable to the impacts of uncontrolled fires (Mays pers comm.. 2015), especially in middle to late summer, when fires would destroy adults, eggs, and plants, which would remove the larval food source and adult oviposition sites (New et al. 2000). However, an appropriate fire regime that maintains open habitat and facilitates regeneration of the larval foodplant may be an important management tool for sustaining butterfly populations (New et al. 2000).

Grazing. Grazing of newly germinated larval food plants by rabbits has the potential to significantly reduce the number of juvenile *Bursaria* plants available to the Eltham copper (Borton pers. comm., 2014).

Rubbish dumping. The dumping of rubbish, including garden clippings has the potential to introduce weeds into butterfly habitat, particularly in urban areas (Borton pers. comm., 2014).

Unmanaged native vegetation. It has been observed that an overabundance of non-food shrubs is detrimental to the Eltham copper (Vaughan 1988), which has a preference for clear flight paths and areas to sun itself (Braby et al., 1999). Thick regrowth of *Cassinia* spp. and *Acacia* spp. after drought and fire may particularly threaten the Eltham-Greensborough population (Borton pers. comm., 2014).

Collection of adults. This is cited as a potential threat (Borton pers. comm., 2014), although there is no supporting evidence. If it does occur, numbers collected are likely to be low, and the impact on the subspecies is likely to be minor.

How judged by the Committee in relation to the EPBC Act Criteria and Regulations

Criterion 1. Population size reduction (reduction in total numbers)
Population reduction (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

Evidence:

Eligible under Criterion 1 A3(b)(c) for listing as Vulnerable

Most of the effort in working with the Eltham copper since the early 1990s has involved monitoring of known populations, which has been a challenging task both technically and practically (Yen pers. comm., 2016). Technically, more accurate population estimates are based on larval counts; this has been difficult because they emerge to feed over a relatively short period at night and they do not regularly emerge from their underground ant nests (Yen pers.

comm., 2016). A further challenge has been getting reliable and comparable counts over the large number of sites to overcome count variability associated with weather conditions. Consequently, monitoring has resulted in large variations in numbers recorded, both within and between sites, and between years (Yen pers. comm., 2016).

In terms of populations, the number of sites known to harbour (or have harboured) the Eltham copper has also been used as a measure of the conservation status. Emphasis on the counts was placed on three sites (Western colony, Eastern colony and Pauline Toner Reserve) at Eltham and one at Greensborough (Yandells) (New pers. comm., 2016). The method used to undertake larval surveys follows the protocol described in Braby et al. (1999). Field counts involve a small team of surveyors walking in pairs approximately ten metres apart, along north-south and east-west transects throughout the whole reserve (Mays pers. comm. 2015). Surveys commence in the first week of October, and occur in two episodes over four weeks, depending on weather conditions. When conditions are ideal (dry nights with air temperatures greater than 14^{o}C), each episode/count is undertaken over two nights separated by two weeks (Mays pers. comm. 2015). If weather conditions are not favourable (during or after rain, air temperatures less than 10^{o}C) surveys may occur in November.

Individual *B. spinosa* plants encountered along the transect are searched. Using a spotlight, the plant is searched from the base upward, scanning each branch for larvae and ant activity. The surveyor moves around the plant to search it at different angles and records the number of larvae on a plant. The larvae are easy to detect because they are always associated with *Notoncus* ants, which occur in groups of between five and 20 ants with each larva (Mays pers. comm. 2015).

Abundance data are provided for three reserves (Borton pers. comm., 2014): the Eastern Eltham Copper Butterfly Reserve (data since 2006), the Western Eltham Copper Butterfly Reserve (data since 2002), and the Yarra Valley Water Eltham Copper Butterfly Reserve (data since 2006) (see table, below). Data show the sum of larvae counted over both survey episodes (i.e. over four nights in October/November) for each year.

Year (surveys conducted in Oct/Nov of each year)	**Population size at each site**		
	Eastern Reserve	Western Reserve	Yarra Valley Water
1988	Both colonies combined 990		Not counted
1994	150	81	Not counted
1995	144	90	Not counted
1995	101	129	Not counted
2002	Not counted	85	Not counted
2003	Not counted	55	Not counted
2004	Not counted	325	Not counted
2005	Not counted	245	Not counted
2006	183	175	26
2007	94	160	31
2008	Not counted	145	Not counted
2009	150	204	23
2010	87	25	107
2011	17	25	0
2012	17	8	14
2013	2	13	40
2014	45	94	30

Note: data from 1988, 1994 and 1995 from Braby et al. (1999).

Annual counts of larvae at the Eastern Reserve indicate a decline between 2006 and 2013, and a marked increase in abundance in 2014 (Borton pers. comm., 2014, 2015). Annual counts of larvae at the Western Reserve indicate a decline between 2004 and 2013, also with a marked increase in abundance in 2014 (Borton pers. comm., 2014, 2015) (see below). A total of 325 larvae was observed at the Western Reserve colony in Eltham in 2004, and only 13 in 2013 (Borton pers. comm., 2014, 2015).

No decline or increase was observed at the Yarra Valley Water Reserve A total of 107 larvae was observed at the Yarra Valley Water site in 2010; none were observed in 2011, and 14 were observed in 2012 (Borton pers. comm., 2014, 2015).

With the ending of the drought in 2010, there was a rapid growth in mid storey plants and a drop in butterfly numbers at both Western and Eastern ECB sites (Vaughan pers. comm., 2016). Active works to remove weeds and shrubs from 2012 opened up the habitat and butterfly numbers recovered again (Vaughan pers. comm., 2016).

When combined, these records may be more representative of fluctuation over the stated time periods resulting from the impact of a more closed mid storey vegetation, which reduces numbers dramatically. Notwithstanding the likely fluctuation over shorter time periods, the reported abundance records may be indicative of a much longer period of decline over the last approximately 25-30 years.

It is possible that decline has occurred since 1988; however, the values in 1994/5 are similar to those reported over the last 10-12 years, especially when the values from 2014 are also considered. On balance, and taking into account all the abundance values above, there has not been a clear decline in abundance at these sites over the last ten years; the values being more indicative of fluctuation.

Decline in adult abundance is not discernible at the Castlemaine Botanic Gardens, with data indicating fluctuation in this population corresponding with changes in vegetation, habitat and climate (Bayes pers comm., 2016). A total of 47 adults was recorded at Castlemaine Botanic Gardens on 27 December 2010 during surveys from November 2010 to January 2011, and a maximum of 52 larvae were recorded at Castlemaine Botanic Gardens on 17 November 2010 during surveys from November 2010 to January 2011 (Bayes pers. comm., 2016).

The Eltham copper has become extinct at some sites over the last few decades: the subspecies was regarded as extinct before 1988 at Goulburn Valley (Tallarook), Murtoa, Dimboola, Keilor and Broadmeadows (Braby et al., 1992). Since 1988 the Eltham copper has became extinct at three additional sites: Lower Eltham Hill (Hohnes Hill), at Montmorency (near Greensborough), and at Salisbury Flora Reserve (Vaughan pers. Comm., 2016). The Salisbury site was likely lost approximately a decade ago (New pers. comm., 2016).

However, other occupied sites have been found over the last several years. For example, surveys in late 2011 yielded several new sites near Castlemaine, in the southern area of Bendigo, and in the Wimmera area between Kiata and Castlemaine (Bayes et al., 2012), indicating the continued need for surveys to fully establish the extent of the distribution (Yen pers. comm., 2016), especially as much of the Castlemaine and Bendigo areas have not been adequately surveyed (Bayes pers comm., 2016). The total number of known sites is 25 (Borton pers. comm., 2014).

There is evidence that the Eltham copper has undergone historical decline over the past several decades, in terms of area of occupancy, quality of habitat, and abundance, but this is not easily quantifiable in terms of percentage decrease. There is no clear, quantifiable evidence of decline over the last ten years. However, the threats are well known and significant and continuing. The Committee considers that population reduction is likely to occur in the future, leading to at least a 30% decline in area of occupancy and quality of habitat. Therefore, the subspecies has been demonstrated to have 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 subpopulations; (v) number of mature individuals			
(c)	Extreme fluctuations in any of: (i) extent of occurrence; (ii) area of occupancy; (iii) number of locations or subpopulations; (iv) number of mature individuals			

Evidence:

Eligible under Criterion 2 B2 (a)(b)(i),(ii),(iii),(iv),(v) for listing as Endangered

The total EOO of the Eltham copper is calculated to be 6,514 km^2 (Department of the Environment, 2015), using the IUCN convex hull/minimum convex polygon method, in which the smallest polygon is drawn in which no internal angle exceeds 180 degrees and which contains all the sites of occurrence) (IUCN 2001, 2012). The total AOO of the Eltham copper is calculated to be 76 km^2 (Department of the Environment, 2015), using a 2x2 km grid cell method based on the IUCN Red List Guidelines (IUCN, 2014).

A value for EOO was also provided by Borton (pers. comm., 2014), who reported a total EOO area of 1.65 km^2, with the Kiata population occupying 1.41 km^2, the Castlemaine- Bendigo population 0.19 km^2, and the Eltham-Greensborough population 0.05 km^2 (Borton pers. comm., 2014). The particular area of a reserve or patch of vegetation that the Eltham copper occupies can change from year to year; i.e. the butterfly will move around habitat reserves (Borton pers. comm., 2014). Therefore, the EOO in this case was calculated by including all the available habitat within the proximity of sightings from the past 10 years, which is generally the reserve or property boundary, or mapped patches of *Bursaria spinosa* (Borton pers. comm., 2014). The calculated EOO in Eltham-Greensborough was based on Banyule Council GIS data and Nillumbik Shire Council GIS data, relating to reserve boundaries. Yandell Reserve in Greensborough has a total of <1 hectare of suitable habitat, and the Eltham Reserves and private properties have a total of <4 hectares of suitable habitat. The EOO at Castlemaine-Bendigo was based on mapped patches of *Bursaria spinosa* in the reserves where Eltham copper occurs, and the EOO at Kiata was based on reserve boundaries and sightings in the past 10 years sourced from the Victorian Biodiversity Atlas (Borton pers. comm., 2014).

The extent of occurrence is <20 000 km^2 and area of occupancy <500 km^2. The three populations are geographically severely fragmented and isolated, with no interbreeding. Urbanisation and rural development have led to further fragmentation within the three populations, and this is likely to continue. There is also evidence of extreme fluctuation in larval and likely adult abundance. Therefore, the subspecies has been demonstrated to have met the relevant elements of Criterion 2 to make it eligible for listing as Endangered.

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 subpopulation	**≤ 50**	**≤ 250**	**≤ 1,000**
	(ii) % of mature individuals in one subpopulation =	**90 – 100%**	**95 – 100%**	**100%**
(b)	Extreme fluctuations in the number of mature individuals			

Evidence:

Eligible under Criterion 3C2(b) for listing as Endangered

(Borton pers. comm., 2014) reported an estimate of approximately 250 for the total number of mature individuals. This was the consensus view of members of the Eltham Copper Butterfly Recovery Working Group, and resulted from a meeting hosted by the Nillumbik Shire Council in February 2014, involving those who could best estimate the subspecies' recent abundance (Borton pers. comm., 2014, 2015). This group meets twice a year to discuss the outcomes of both management of Eltham copper populations and survey results from larval counts (Mays pers comm., 2015).

However, Vaughan (2016) reported that given the recent recovery (in 2014) the estimated total is likely to be greater than 250 but less than 2500, and Canzano (2016) provided an estimate of 251-1000. These higher estimates are supported by the 2014 larval abundance data from the Western ECB reserve (94 larvae), Eastern ECB Reserve (45 larvae), and Yarra Valley Water Reserve (30 larvae), combined with the unknown levels of abundance at the other locations. When taken together, these data indicate the total number of mature individuals is likely to be higher than 250.

There is evidence that the Eltham copper has undergone historical decline over the past several decades, in terms of area of occupancy, quality of habitat, and abundance. Threats from land clearing due to urbanisation is a present, continuing and likely increasing threat to all populations. For example, the site at Big Hill Primary School was threatened by run-off from an adjacent housing complex about three years ago [in approximately 2013], and Kalimna Park was threatened with diminishment by a new housing estate on its eastern margin (New pers. comm., 2016). Both were thwarted by energetic protest from local communities, but similar proposals are likely to recur (New pers. comm., 2016). Decline is likely without continued intervention by conservationists.

In summary, the Committee considers that the estimated total number of mature individuals of this subspecies is low, and the geographic distribution is precarious for the survival of the subspecies because its occurrence is limited and decline in extent of occurrence, area of

occupancy, habitat, number of individuals and number of locations may be inferred or projected, and there is likely to be extreme fluctuation in the number of mature individuals.

Criterion 4. Number of mature individuals			
	Critically Endangered Extremely low	**Endangered Very Low**	**Vulnerable Low**
Number of mature individuals	**< 50**	**< 250**	**< 1,000**

Evidence:

Eligible under Criterion 4 for listing as Vulnerable

(Borton pers. comm., 2014) reported an estimate of approximately 250 for the total number of mature individuals. This was the consensus view of members of the Eltham Copper Butterfly Recovery Working Group, and resulted from a meeting hosted by the Nillumbik Shire Council in February 2014, involving those who could best estimate the subspecies' recent abundance (Borton pers. comm., 2014, 2015). This group meets twice a year to discuss the outcomes of both management of Eltham copper populations and survey results from larval counts (Mays pers comm., 2015).

However, Vaughan (2016) reported that given the recent recovery (in 2014) the estimated total is likely to be greater than 250 but less than 2500, and Canzano (2016) provided an estimate of 251-1000. These higher estimates are supported by the 2014 larval abundance data from the Western ECB reserve (94 larvae), Eastern ECB Reserve (45 larvae), and Yarra Valley Water Reserve (30 larvae), combined with the unknown levels of abundance at the other locations. When taken together, these data indicate the total number of mature individuals is likely to be higher than 250, and may be less than 1000.

The Committee considers that the total number of mature individuals is low.

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**

Evidence:

Insufficient data to determine eligibility

In common with many other insect species, numbers of Eltham copper individuals observed may vary naturally by up to several orders of magnitude across successive generations, and simple intergenerational changes in numbers may not reflect reality. Thus, population viability analyses would give very different implications in different years (New pers. comm., 2016).

Population viability analysis has not been undertaken, and there are insufficient data to demonstrate if the species is eligible for listing under this criterion.

Conservation Actions

Recovery Plan

A recovery plan for the species is not recommended, because the Approved Conservation Advice provides sufficient direction to implement priority actions and mitigate against key threats.

Primary Conservation Action

1. Prevent land clearing and resulting habitat destruction at all localities.
2. Maintain and enhance existing and potential habitat.
3. Manage weeds at all localities.
4. Develop and implement an appropriate fire management regime that does not negatively impact the Eltham copper, its host ant colonies or the *Bursaria* plants.

Conservation and Management Actions

Habitat loss disturbance and modifications

- Maintain habitat quality at all sites, to counter the continuing impacts of urban isolation, such as removal of rubbish and debris, buffering of run-off from roads, control of destructive human activities such as accidental fires, construction of pathways, and trampling (Sands and New, 2002).
- Ensure adequate habitat at all sites to allow for movement of colonies (Yen pers. comm., 2016).
- Ensure that that an open vegetation canopy is maintained at all sites, to allow adult males to establish territories, and facilitate mating.
- Ensure local planning decisions do not adversely impact on known habitat of the Eltham copper.
- Continue the collaborative approach of Nillumbik Shire Council and Banyule Council in thinning native vegetation on reserves in the Eltham-Greensborough area (Borton pers. comm., 2014). Expand such activities at all relevant locations.

Invasive species (including threats from grazing, trampling, predation)

- Develop and implement collaborative weed management plans at all appropriate locations and at appropriate scales to facilitate implementation.
- Maintain and control succession of *Bursaria spinosa* plants by controlling weeds (Sands and New, 2002).
- Continue the collaborative approach of Nillumbik Shire Council and Banyule Council in weed and rabbit control activities on Eltham copper reserves in the Eltham-Greensborough area (Borton pers. comm., 2014).
- Continue the collaborative approach to managing weeds at the Castlemaine Botanic Gardens site (Bayes, pers. comm., 2016).
- Identify and remove any weeds in the local area that could become a threat to the Eltham copper, using appropriate methods. An example is the hand pulling of broom, which should be undertaken on an ongoing basis (Sands and New, 2002).

Fire

- Consider likely locations of occurrences/populations of the Eltham copper when managing planned burns (O'Brien pers. comm., 2016).
- Develop and implement an appropriate fire management regime that does not negatively impact the Eltham copper, its host ant colonies or the *Bursaria* plants that support the ant nests. New et al. (2000) and Sands and New (2002) described a protocol for effective control burning, which should include elements of:
    - late season burning, at the time when the caterpillars are already well-advanced, and the more vulnerable stages—eggs, young caterpillars, reproducing adults—are absent;

- the hottest possible burn to eliminate exotic weeds and encourage regeneration of native vegetation;
- mosaic burning, whereby areas with particularly high numbers of adults are left unburnt; and
- extending the fire into the canopy to 'open' the system (New et al. 2000; Sands and New, 2002).

Avoid adverse impacts of planned burning on surrounding housing through careful planning and execution (Sands and New, 2002).

- Provide maps of known occurrences and maps of appropriate potential habitat to local and state Rural Fire Services and seek inclusion of mitigation measures in bush fire risk management plan/s, risk register and/or operation maps.

Stakeholder Management

- Review the activities of the existing Recovery Group to ensure there is effective coordination of state-wide action and identification and pursuit of conservation management priorities. Such a group could include representatives of Nillumbik Shire Council, Banyule City Council, Parks Victoria, La Trobe University, Victoria Department of Environment, Land, Water & Planning, non-government organisations, local zoos, and other individuals and organisations as appropriate (DSE, 2003).
- Encourage the already high public awareness of the Eltham copper. Increase awareness at known sites on public and private land where threats continue to impact on the subspecies. Erect or improve signage describing the butterfly, its biology and habitat, and threats.
- Continue the partnerships involving local councils and other reserve owners/managers, with non-government organisations based in Eltham such as the 'Friends of the Eltham Copper Butterfly', to protect and enhance the butterfly's habitat (Nillumbik Shire Council, 2011). Expand the network and activities to include all areas where the Eltham copper occurs and owners of private land.
- Encourage use of online social networks to disseminate information and conservation activities relating to the Eltham copper.
- Continue the community education activities in the Eltham-Greensborough and Bendigo areas (Borton pers. comm., 2014). Expand such activities to include the Kiata-Nhill-Dimboola area in northwest Victoria.
- Ensure appropriate signage is erected at all locations where the Eltham copper occurs, informing members of the local community of the presence of the butterfly, its habitat, threats and conservation, to help deter the dumping of rubbish and garden refuse and help prevent the spread of weeds.
- Encourage planting of the larval foodplant *Bursaria spinosa* subsp *spinosa* in areas of secure land tenure that are near populations of the butterfly.

Survey and monitoring priorities

- Continue the monitoring of larval and adult abundance at all current locations (Borton pers. comm., 2014). Expand such programmes to include all appropriate locations in central and northwest Victoria. Continue monitoring adult abundance at Castlemaine Botanic Gardens (Bayes pers. comm., 2016).
- Ensure all monitoring methods are systematic and standardised as much as possible for all locations. Ensure that the methods used and the data are collected to best demonstrate trends over time and any decline.
- Identify potential habitat for the Eltham copper that includes the host ants and larval foodplants.
- Continue monitoring the condition of Eltham copper habitat, especially vegetation cover, abundance and recruitment of *Bursaria spinosa* plants, and the presence of weeds (Bayes pers. comm., 2016).
- Continue to undertake targeted survey work in suitable habitat and potential habitat across Victoria to locate any additional populations/occurrences of the Eltham copper. Ensure surveys account for any likely seasonal variation in the flight period, such as an additional

generation. Increase survey effort in private and crown remnant potential habitat in surrounding districts.
- Monitor the progress of recovery, including the effectiveness of management actions and the need to adapt them if necessary.

Information and research priorities

- Undertake a power analysis to assess if any declines detected in the population trends are significant over the natural year to year variation in the data. If found not to be significant, determine the number of surveys required and over how many years in order to detect any significant trends/decline.
- Utilise the online tools for assisting with IUCN Red List assessments, and especially calculations of population reduction under criterion 1 (=IUCN criterion A) (IUCN, 2015).
- Ensure that a conservation management plan is completed for each of the reserves that harbour colonies of the Eltham copper (Borton pers. comm., 2014). Priority should be given to the colonies in the Kiata Flora Reserve and Wail State Forest in northwest Victoria, as these sites are not actively managed (Borton pers. comm., 2014).
- Investigate the influence of drought on abundance and life history such as adult emergence, especially in the Kiata area (Sands and New, 2002).
- Develop and implement a systematic and standardised programme for annual monitoring of adult and larval abundance. Further research the feeding behaviour of larvae to help inform this programme.
- Investigate further the ecological relationship between the Eltham copper, colonies of host ant, and host plant species (Sands and New, 2002). Focus on why *Bursaria spinosa* and the ants *Notoncus* spp. occur in many areas where the Eltham copper is absent.
- Investigate the possibility of reintroducing the Eltham copper into appropriate secure habitat where the host ant colonies and larval food plant already occur. Assess the feasibility and need for translocation to secure habitat already managed for conservation purposes.
- Identify the genetic structure within and between the three populations. Such information will inform the conservation and management at all locations.
- Identify optimal fire regimes for regeneration (vegetative regrowth and/or seed germination) of *Bursaria* plants.

Recommendations

(i) The Committee recommends that the list referred to in section 178 of the EPBC Act be amended by **including** in the list in the Endangered category:

Paralucia pyrodiscus lucida

(ii) The Committee recommends that there not be a recovery plan for this species.

Threatened Species Scientific Committee

02/03/2016

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