

Conservation Advice

Ogyris subterrestris petrina

Arid bronze azure (a butterfly)

Taxonomy

Conventionally accepted as *Ogyris subterrestris petrina* Field, 1999 (family Lycaenidae).

Conservation status

Critically endangered: Criterion 2 B1,B2,(a),(b)(iii); Criterion 3 B,(a),(b),(ii),(iii),(v)

Species can be listed as threatened under state and territory legislation. For information on the listing status of this subspecies 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 *Ogyris subterrestris petrina*.

Description

The arid bronze azure has a wingspan of 36 mm (Braby, 2000). On the upperside, both wings in males are generally dull dark purplish-bronze, with pale brown-bronze margins. The uppersides of the female wings are brown suffused with bronze, with purple basal areas. The female forewing has a double black bar and just beyond this, a small cream patch. On the underside, the male and female forewings have a series of distinctive, iridescent bluish-white bars broadly edged with brown-black, followed by a dark brown-black band. The hind wing in both sexes has a series of brown markings edged with dark brown-black (Braby, 2000). Larvae and pupae have not been described (Braby, 2000).

Distribution

The arid bronze azure is known only from two localities in Western Australia: one in the wheatbelt region and the other in the goldfields region in the inland south-west (Williams et al., pers. comm., 2011). The goldfields population is within a recreation reserve (vested in the Shire of Boulder) at Lake Douglas, 12 km Southwest of Kalgoorlie. This population is reported to have become extinct in about 1993 (Braby, 2000). The second, and the only known current population, was discovered in 2006 in the Avon Wheatbelt, in remnant vegetation within a road and rail reserve adjacent to Barbalin Nature Reserve, and within the reserve itself (Williams et al., pers. comm., 2011). This locality is approximately 11 km west of Mukinbudin, 250 km northeast of Perth. These populations are several hundred kilometres apart and so effectively isolated given the likely limited dispersal ability of the butterfly. Adults are generally restricted to breeding areas, with occasional dispersal events (Williams et al., pers. comm., 2011).

The associated ant (*Camponotus terebrans*) on which the arid bronze azure depends (see Relevant Biology/Ecology section, below), is sporadically distributed across southern Australia, from Shark Bay (WA) to Newcastle (NSW) (AntWeb, 2014). Floristically diverse habitats are needed to sustain high densities of the host ant (Douglas 1995, cited in Braby 2000).

The extant population at Barbalin occurs across a road and a railway reserve (held as freehold), and in the Barbalin Nature Reserve vested in the WA National Parks and Nature Conservation Authority (Williams et al., pers. comm., 2011).

Cultural Significance

No cultural values for the subspecies are known.

Relevant Biology/Ecology

Although larvae of this subspecies have not been described, they are known to be myrmecophilous (i.e. occur in association with ants) (Eastwood and Fraser, 1999). The ant species interacting with *O. s. petrina* is *Camponotus terebrans* (Field, 1999), although an undescribed species of *Camponotus* has also been reported to interact with the arid bronze azure (Braby, 2000). Although the degree of myrmecophily varies greatly between species of Lycaenidae (Eastwood and Fraser, 1999), larvae of *O. s. petrina* are likely to be wholly dependent on the ants, feeding either on ant regurgitations or on the immature stages of the ants (Braby, 2000).

The arid bronze azure is also restricted to mallee vegetation on sandy soil, often near flood plains, in which nests of the associated ant are established at the base of eucalypts (Braby, 2000). The ant nest may extend up to 50 cm below ground level, and it is most likely that both larval and pupal stages are completed underground (Braby, 2000). Eggs are laid on the bark near ground level, and newly hatched larvae either crawl or are carried into the ant nest (Braby, 2000).

The social structure of the host ant is also relevant to the vulnerability of the butterfly. Trials have indicated that the ant is unicolonial, i.e. all nests at the Barbalin site are part of a single 'super colony' that arose from a single colonisation event, with subsequent budding of new daughter colonies that are genetically identical to the original (Williams et al., pers. comm., 2011). Workers are able to move between nests with impunity (Williams et al., pers. comm., 2011).

As the arid bronze azure has an obligate dependence on this species, the distribution and abundance of *C. terebrans* are the primary determinants of potential habitat on a local scale (Williams et al., pers. comm., 2011).

The flight period of the arid bronze azure has been recorded from September to May, with peak flight activity in mid-spring and late summer (Field, 1999). Average generation time is approximately six months (Field, pers. comm., 2014), and there are most likely two generations per year (Field, 1999), although there may also be 'boom and bust' periods (Field, pers. comm., 2014).

The life history of *O. s. petrina* is unknown. However, the life expectancy of adults of its sister subspecies, *O. s. subterrestris*, is 1–4 weeks (Williams et al., pers. comm., 2011).

Threats

Braby (2000) considered *Ogyris subterrestris* to be of national conservation concern, and both subspecies are particularly sensitive to habitat disturbance (Braby, 2000).

Mining activities, road works and off-road vehicles (Williams et al., pers. comm., 2011), as well as land clearing for agriculture (Moore et al., pers. comm., 2014) have all led to loss and fragmentation of important habitat for the arid brown azure. Soil disturbance caused by these activities adversely affects the host ant either directly or by favouring invasive, opportunist ants that prey on or compete with *C. terebrans*. Soil disturbance caused by off-road vehicles is suspected to have contributed to the extinction of the population at Lake Douglas (Williams et al., pers. comm., 2011). Realignment of any roads within or adjacent to Barbalin Nature Reserve would significantly impact the breeding colony of this butterfly, in particular affecting lekking adult males and nests of *C. terebrans*.

Road traffic also leads to direct road kills of the arid bronze azure, and this is a known current threat along the Koorda-Bullfinch Road which bisects Barbalin Nature Reserve: of 12 butterflies observed along the main road between 10/11/08 and 21/11/08, five were road kills (Williams et al., 2008).

Ongoing farming practises are likely to threaten all stages of the butterfly through overspray onto remnant vegetation and sheep grazing of necessary food resources of both the butterfly and host ant (Moore et al., pers. comm., 2014).

Over-collection of adults is a known threat at Barbalin reserve, and may have contributed to the likely extinction at Lake Douglas (Williams et al., pers. comm., 2011). Several applications from butterfly collectors have been received by the Western Australian Department of Parks and Wildlife for permits to take adults (Williams et al., pers. comm., 2011). Collectors often disturb ant nests in search of larvae and pupae, and evidence of illegal excavation of *Camponotus* ant nests has been observed in national parks in Western Australia (Williams et al., pers. comm., 2011).

A rubbish dump was established in the south-east part of the Nature Reserve, and dumping of rubbish has resulted in substantial disturbance of soil and some clearing of vegetation (Williams et al., pers. comm., 2011). Decline in habitat quality through partial clearing and rubbish dumping will impact on the abundance of attendant ants, breeding areas used by ovipositing female butterflies, and mate location areas used by males for lekking (Braby, pers. comm., 2014). Illegal collection of firewood has also occurred in the Nature Reserve (Moore et al., pers. comm., 2014).

Inappropriate fire regimes are a known potential threat to the population at Barbalin Nature Reserve (Williams et al., pers. comm., 2011). Crop stubble is regularly burned in adjacent and nearby properties, and these have the potential to escape into the reserve (Williams et al., pers. comm., 2011).

Maintenance of management tracks in Barbalin Nature Reserve, and management of the railway tracks that pass through the Reserve, may impact upon ant nests and the early stages of the butterfly within the nests, as larvae and pupae can be located immediately adjacent to management tracks in soil disturbed by track grading (Williams, pers. comm., 2014).

There are no mineral, petroleum or geothermal energy tenements covering the Barbalin Nature Reserve, but there are mineral tenements covering parts of the Lake Douglas area (Briggs, pers. comm., 2014).

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

Criterion 1: Reduction in numbers (based on any of A1 – A4)

A1. An observed, estimated, inferred or suspected population very severe $\geq 90\%$, severe $\geq 70\%$ substantial $\geq 50\%$ size reduction over the last 10 years or three generations, whichever is the longer, where the causes of the reduction are clearly reversible AND understood AND ceased, based on (and specifying) any of the following:

- (a) direct observation
- (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.

A2. An observed, estimated, inferred or suspected population very severe $\geq 80\%$, severe $\geq 50\%$ substantial $\geq 30\%$ size reduction over the last 10 years or three generations, whichever is the

longer, where the reduction or its causes may not have ceased OR may not be understood OR may not be reversible, based on (and specifying) any of (a) to (e) under A1.

A3. A population size reduction very severe $\geq 80\%$, severe $\geq 50\%$ substantial $\geq 30\%$, projected or suspected to be met within the next 10 years or three generations, whichever is the longer (up to a maximum of 100 years), based on (and specifying) any of (b) to (e) under A1.

A4. An observed, estimated, inferred, projected or suspected population size reduction very severe $\geq 80\%$, severe $\geq 50\%$ substantial $\geq 30\%$ over any 10 year or three generation period, whichever is longer (up to a maximum of 100 years in the future), where the time period must include both the past and the future, and where the reduction or its causes may not have ceased OR may not be understood OR may not be reversible, based on (and specifying) any of (a) to (e) under A1.

Evidence

In 1982 and for the next eight years, adults were abundant at the likely-extinct locality at Lake Douglas (Braby, 2000). The Lake Douglas site was surveyed in October 1987, December 1989, and October 1991, and adults were reportedly common on all three occasions (Field, pers. comm., 2014). Field (pers. comm., 2014) estimated the population size at Lake Douglas in 1991 to be approximately 440 individuals, based on counts of viable eggs on 50 trees covering 4000 square metres. The site was again visited in October 1993 but no butterflies were observed (Field, pers. comm., 2014), most likely following significant disturbance to the breeding areas and ant nests. No additional adults have been recorded from this locality since 1993 (Braby, 2000), and the site has been surveyed on at least a dozen occasions since 1994 (Williams M, pers. comm., 2014). Surveys of the breeding area since that time indicate that the host ant is likely to be absent at this locality. Although the likely extinction of the Lake Douglas population is recent, it occurred prior to the last ten years, and so cannot meet the temporal thresholds for this criterion.

The single current population at the Barbalin Nature Reserve was discovered in October 2006, and the population has been monitored since that time. There is no evidence of population decline of the arid bronze azure at this site (Williams et al., pers. comm., 2011).

The data appear to demonstrate that the arid bronze azure is rare, but do not indicate the subspecies has undergone a reduction in numbers over the last 10 years or three generations. The subspecies, therefore, appears to be **ineligible** for listing under this criterion.

Criterion 2:

Geographic distribution (based on either of B1 or B2)

B1. Extent of occurrence estimated to be very restricted $< 100 \text{ km}^2$, restricted $< 5000 \text{ km}^2$ or limited $< 20\,000 \text{ km}^2$

B2. Area of occupancy estimated to be very restricted $< 10 \text{ km}^2$, restricted $< 500 \text{ km}^2$ or limited $< 2000 \text{ km}^2$

AND

Geographic distribution is precarious for the survival of the species, (based on at least two of a–c)

a. Severely fragmented or known to exist at a limited location.

b. Continuing decline, observed, inferred or projected, in any of the following:

- (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 the following:

- (i) extent of occurrence
- (ii) area of occupancy

- (iii) number of locations or subpopulations
- (iv) number of mature individuals

Evidence

The size (in area) of the Lake Douglas population was difficult to estimate, because the breeding and flight areas were poorly distinguished and the size of the breeding area was unclear (Brown 2008). This population is considered to have been larger than the current population, but was still likely to have only been less than a few square kilometres (Braby, 2000).

The extent of occurrence and area of occupancy at Barbalin Nature Reserve are approximately 4 square kilometres, assuming that the butterfly could occur throughout the reserve (even beyond the reserve) during the peak in flight period (Williams et al., pers. comm., 2011). The area of occupancy of the potential breeding habitat is less than 2 square kilometres, based on surveys and mapping known occurrences of the ant nests (Williams et al., pers. comm., 2011). There are no data to indicate likely future changes in extent of occurrence at Barbalin Nature Reserve (Williams et al., pers. comm., 2011).

The number of locations/populations is unknown, but is likely to be very few. Numerous targeted surveys by experienced field entomologists north and south of the known location have not located any new populations of either the butterfly or the host ant. Surveys adjacent to and around the Barbalin site in November 2008 examined 31 locations, but no butterflies or host ants were recorded (Williams et al., pers. comm., 2011).

If populations other than the one at Barbalin do persist, then the subspecies' distribution can be considered to be severely fragmented. Within the Barbalin population, the breeding area is dissected into several patches of remnant vegetation by roads and a railway line (Williams et al., pers. comm., 2011). However, these patches are close enough to each other that there is regular movement of adult butterflies between them (Williams et al., pers. comm., 2011).

Based on the above data, the geographic distribution (both extent of occurrence and area of occupancy) are very restricted. The butterfly exists at a very limited location, although there is no evidence of current or further decline in population size. However, any clearing of important habitat in or adjacent to Barbalin Nature Reserve will lead to decline in the quality of the habitat. The data presented above appear to demonstrate that the subspecies is **eligible for listing as critically endangered** under this criterion.

Criterion 3: The estimated total number of mature individuals is very low <250, low <2500 or limited <10 000; **and** either of (A) or (B) is true

- (A) evidence suggests that the number will continue to decline at a very high (25% in 3 years or 1 generation (up to 100 years), whichever is longer), high (20% in 5 years or 2 generations (up to 100 years), whichever is longer) or substantial (10% in 10 years or 3 generations years), whichever is longer (up to 100) rate; or
- (B) the number is likely to continue to decline and its geographic distribution is precarious for its survival (based on at least two of a – c):
 - a. Severely fragmented or known to exist at a limited location.
 - b. Continuing decline, observed, inferred or projected, in any of the following:
 - (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 the following:
 - (i) extent of occurrence
 - (ii) area of occupancy

- (iii) number of locations or subpopulations
- (iv) number of mature individuals

Evidence

Braby (pers. comm., 2014) reported that adequate data on population size are not available. However, another report estimated the total number of individuals at the single current site to be between 251 and 1000, albeit with a low level of certainty (Williams A, pers. comm., 2014).

A second estimate is based on the highest known daily count of *O. s. petrina* individuals (25) by Brown (2008), combined with the model of Collier et al. (2008). Using this method, the peak population size at Barbalin Nature Reserve was estimated to have been 238 adults in October 2007, when the majority of the population was likely to have emerged as adults (Williams et al., pers. comm., 2011). This estimate is based on field surveys and transect counts (Williams M, pers. comm., 2014), which constitutes some level of supporting evidence. On balance, this is considered to be the best estimate of abundance.

This estimate corresponds to a very low abundance (see criterion 2, above). There is no evidence of current or continued decline in the number of butterflies, but there is evidence of projected decline in its host ant if land clearing and soil disturbance were to occur. This may lead to decline in the abundance of the butterfly. The geographic distribution is precarious for its survival: the arid bronze azure is known to exist at only one location, and there is a projected decline in the quality of habitat, area of occupancy and number of mature individuals.

The data presented above appear to demonstrate that the subspecies is **eligible for listing as critically endangered** under this criterion.

Criterion 4: Estimated total number of mature individuals:

- (a) Extremely low < 50
- (b) Very low < 250
- (c) Low < 1000

Evidence

The total population size of *Ogyris subterrestris petrina* is unknown. However, Collier et al. (2008) determined the relationship between the number of counted individuals and population size (estimated by mark-recapture methods and a Cormack-Jolly-Seber (CJS) open population model) for an Australian endemic lycaenid butterfly in South Australia (*Theclinesthes albocincta*, the bitterbush blue). This is the only such study in Australia. The authors found a strong relationship between the number of counted individuals and population size ($R^2=0.88$).

Based on the highest known daily count of *O. s. petrina* individuals (25) by Brown (2008) and using the model of Collier et al. (2008), the peak population size at Barbalin (the only current population known) was estimated to have been 238 adults in October 2007, when the majority of the population was likely to have emerged as adults (Williams et al., pers. comm., 2011). This estimate is below the indicative threshold for 'very low' (< 250) under this criterion, and the data presented above demonstrate that the subspecies is **eligible for listing as endangered** under this criterion.

Criterion 5: Probability of extinction in the wild based on quantitative analysis is at least:

- (a) 50% in the immediate future, 10 years or three generations (whichever is longer); or
- (b) 20% in the near future, 20 year or five generations (whichever is longer); or
- (c) 10% in the medium-term future, within 100 years.

Evidence

Not applicable: population viability analysis or other models have not been undertaken for this subspecies, which is therefore **ineligible** for listing under this criterion.

Public Consultation

Notice of the proposed amendment was made available for public comment for 33 business days between 25 June and 8 August 2014. Any comments received that are relevant to the survival of the subspecies have been considered by the Committee.

Recovery Plan

A recovery plan for the subspecies is not recommended, because the approved conservation advice provides sufficient direction to implement priority actions and mitigate against key threats.

Recovery and Impact avoidance guidance

Primary Conservation Objectives

Many stable and protected populations known across a wide area, each comprising hundreds of individuals.

1. Mitigate or remove all known threats at the only known current population.
2. Maintain and enhance existing and potential habitat.
3. Increase survey effort to determine if additional (including historical) populations occur.
4. Continue to raise local awareness of the arid bronze azure.
5. Enable recovery of additional sites and/or populations.
6. Effectively administer the recovery effort.

Important populations

The only known current population at Barbalin Nature Reserve is critically important.

Important habitat for the survival of the subspecies

The habitat at both known sites is dominated by eucalypt woodland. Soils are red and brown loams. Nests of the host ant *C. terebrans* are only found at the base of eucalypts: at Barbalin predominantly gimlet (*Eucalyptus salubris*) and Lake Grace gum (*Eucalyptus loxophleba* ssp. *gratiae*), but also wheatbelt wandoo (*E. capillosa capillosa*) and salmon gum (*E. salmonophloia*). At Lake Douglas the host tree was *Eucalyptus concinna* (Field, 1999).

An annual monitoring program was established in 2007 (Gamblin et al., 2009), and a biannual monitoring program is now in place (Williams A, pers. comm., 2014).

Information required and research priorities

1. Resume targeted survey work at Lake Douglas, in case the population of the arid bronze azure still occurs. Expand duration of the surveys during spring and summer to account for any seasonal variation in the flight period.
2. Continue targeted survey work in suitable habitat and potentially suitable habitat to locate any additional populations. Roadside strips of suitable vegetation should not be overlooked when surveying for this subspecies (Field, pers. comm., 2014). Ensure surveys are conducted to include possibility of temporal variation in flight period. Increase survey effort in private and crown remnants in surrounding districts (Moore et al., pers. comm., 2014).

3. Investigate the biology and life cycle of the arid bronze azure using non-destructive methods; clarify duration and precise location of the immature stages.
4. Clarify whether *Camponotus terebrans* is the only host ant for the arid bronze azure. Braby (2000) reported that *Camponotus* sp. (wiedekehri group) is also a host for the arid bronze azure in Western Australia. Determine the minimum abundance of ants required to support a viable population of immature stages of the butterfly (Braby, pers. comm., 2014)
5. Develop and implement an appropriate fire management regime that does not negatively impact the arid bronze azure, its host ant or the eucalypts that support the ant nests. Include protection and carefully managed regeneration burning (Williams A, pers. comm., 2014). Identify optimal fire regimes for regeneration of the critical habitat and mallee trees (vegetative regrowth and/or seed germination) used by attendant ants and ovipositing females (Braby, pers. comm., 2014). Evaluate the effectiveness of the trial prescribed boundary burn conducted in 2011 to protect and regenerate the southern end of the Barbalin Nature Reserve (Moore et al., pers. comm., 2014). Consider further trial prescribed burns in this reserve and the adjoining Wundowlin Nature Reserve (Moore et al., pers. comm., 2014).
6. Investigate the possibility of reintroducing the arid bronze azure into appropriate secure habitat. Assess the feasibility and need for translocation to secure habitat already managed for conservation purposes; assess the feasibility and need for captive breeding at a suitable butterfly breeding facility (Moore et al., pers. comm., 2014).

Management actions required

1. Undertake a prioritisation of threats to assist with management activities.
2. Negotiate alternative routes for any proposed road widening and re-alignment in or adjacent to the known localities, selecting routes that minimise impacts on the butterfly and its host ant. Rehabilitate sites if roadworks occur; ensure rehabilitation planned effectively prior to commencing works.
3. Continue to incorporate the arid bronze azure in regional planning for land management activities.
4. Continue with education activities, increasing local community awareness and advising local landholders to look for the butterfly. Increase signage along roads (to reduce the number of butterfly roadkills) and help raise public awareness of this subspecies and how to best to manage it (Moore et al., pers. comm., 2014). Erect educational signs at all sites providing information about the importance of the butterfly and its unique ecology to deter collection of adults and/or immatures (Braby, pers. comm., 2014).
5. If other populations are discovered and they occur on private land, investigate formal conservation arrangements such as the use of covenants or conservation agreements. Investigate options for inclusion in reserve tenure.
6. Create vegetated corridors to connect habitat between Barbalin and Wundowlin Nature Reserves and suitable private remnants (Moore et al., pers. comm., 2014).
7. Prohibit recreational activities (such as off-road vehicles) around all known sites for the arid bronze azure (Sands and New, 2002).
8. Ensure buffer zones are created between any roads/railway lines that pass through or nearby the known localities and the ant/butterfly habitat (Williams et al., pers. comm., 2011).
9. Manage sites to monitor and identify, control and reduce the spread of any invasive species.
10. Remove rubbish, and rehabilitate the abandoned rubbish dump and resultant compacted areas within Barbalin Nature Reserve (Williams M, pers. comm., 2014).

11. Continue to monitor the progress of recovery of the arid bronze azure, including the effectiveness of management actions and the need to adapt them if necessary.

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 **critically endangered** category:

Ogyris subterrestris petrina

and

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

Threatened Species Scientific Committee

3/9/2014

References cited in the advice

- AntWeb (2014). Species pages. Available from:
<http://www.antweb.org/description.do?genus=camponotus&species=terebrans&rank=species&project=allantwebants>. Accessed 6 May 2014.
- Braby MF (2000). *Butterflies of Australia: their identification, biology and distribution*. CSIRO Publishing, Collingwood, Victoria.
- Braby MF (2014). Personal communication by email, 10 July 2014, Northern Territory Department of Land Resource Management.
- Briggs I (2014). Personal communication by email, 4 August 2014, Western Australia Department of Mines and Petroleum.
- Brown SS (2008). Report relating to licence to take fauna for scientific purposes No. SF005970. Internal report. Western Australia Department of Environment and Conservation, Perth, Western Australia.
- Collier et al. (2008). Is relative abundance a good indicator of population size? Evidence from fragmented populations of a specialist butterfly (Lepidoptera: Lycaenidae). *Population Ecology*. 50: 17-23.
- Douglas F (1995). Recovery plan for threatened diurnal Lepidoptera in Western Victoria. Part 2. Family Lycaenidae. Report to Victoria Department of Conservation and Natural Resources, Melbourne.
- Eastwood R and Fraser AM (1999). Associations between lycaenid butterflies and ants in Australia. *Australian Journal of Ecology* 24: 503-537.
- Field RP (1999). A new species of *Ogyris* Angas (Lepidoptera: Lycaenidae) from southern arid Australia. *Memoirs of Museum Victoria* 57(2): 251-259.
- Field RP (2014). Personal communication by email, 7 August 2014, Olinda, Victoria.
- Gamblin T, Williams MR and Williams AAE (2010). The ant, the butterfly, the leafhopper and the bulldozer. *Landscape* 25(3):54-58.
- Moore N, Jolliffe D and Beecham B (2014). Personal communication by email, 7 August 2014. Western Australia Department of Parks and Wildlife (Central Wheatbelt District).
- Sands DPA and New TR (2002). *The action plan for Australian butterflies*. Environment Australia, Canberra.
- Williams AAE, Gamblin T, Richardson J, Williams MR and Blechynden P (2008). The critically endangered arid bronze azure butterfly (*Ogyris subterrestris petrina*): progress report and recommendations for future actions. Internal report. Western Australia Department of Environment and Conservation. Perth, Western Australia.
- Williams A (2014). Personal communication by email, 5 August 2014, Western Australia Department of Parks and Wildlife.
- Williams M (2014). Personal communication by email, 18 July 2014, Western Australia Department of Parks and Wildlife.
- Williams M, Gamblin T and Williams A (2011). Personal communication by email, 4 August 2011, Western Australia Department of Parks and Wildlife.