The Minister approved this Conservation Advice and included this species in the Critically Endangered category, effective from 15/08/2017

Conservation Advice

Argynnis hyperbius inconstans

Australian fritillary

Taxonomy

Conventionally accepted as *Argynnis hyperbius inconstans* (Butler, 1873).

Summary of assessment

Conservation status

Critically Endangered: Criterion 1 A2(c)

The highest category for which *Argynnis hyperbius inconstans* is eligible to be listed is Critically Endangered.

There is insufficient data to determine eligibility for listing under Criteria 2-5.

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 nomination from the public to list the Australian fritillary.

Public consultation

Notice of the proposed amendment and a consultation document was made available for public comment for 31 business days between 27 September 2016 and 8 November 2016. Any comments received that were relevant to the survival of the subspecies were considered by the Committee as part of the assessment process.

Subspecies information

Description

Argynnis hyperbius inconstans, the Australian fritillary, belongs to the family Nymphalidae. Males and females of this subspecies differ in appearance. The male Australian fritillary has a wingspan of 60 mm. The upperside of the wings are light orange-brown in colour, with numerous rounded black markings (Braby 2004) and a double black subterminal line (line near the edges of the wings). The underside of the forewings are marked the same as the upperside, however they are pinkish-orange in colour, and the apex of the wings (the anterior corners) are light orange. The underside of the hindwings are light orange with black markings edged with silver (Qld DEHP 2010). Females have a wingspan of 66 mm. The colour and markings of the female are similar to the male, however the background wing colour is a slightly paler orange, some black markings are more pronounced, and the apex of the wings are sometimes tinged green (Braby 2004). The subspecies' eggs are dome-shaped, pale yellow in colour and 0.9 mm x 0.7 mm in size. The first instar has a brown body with a lateral white stripe and pairs of white dorsal spots. The second instar has a brownish black body with a short thick scoli (an external spine). The third and fourth instar stages have a black head with two blunt horns, a black body

with a broad orange dorsal stripe. The pupa are approximately 26 mm long and are orange-brown in colour with dark brown markings that fade with age (Lambkin & Lambkin 1977).

Distribution

The Australian fritillary has been recorded in scattered locations across south-eastern Queensland and north-eastern New South Wales (Braby 2000; Sands & New 2002). The subspecies appears to have had a core distribution between Gympie in Queensland and Port Macquarie in NSW, although there are historical records which extend beyond this range. The subspecies has been recorded as far north as Mt Bellenden Ker in Queensland, and as far south as the Hunter Valley in NSW (Sands & New 2002).

The Australian fritillary was, at times, considered to have been common at certain locations (Binns 1976; Sands & New 2002). It was reported to be abundant around Gympie at intervals between 1977 and 1994, and around Port Macquarie in 1977, 1985 and 1994 (Sands & New 2002). However, the subspecies experienced declines throughout the 1980s and 1990s. In 1994, Dunn et al. estimated that the subspecies' distribution had contracted by 80 percent (Dunn et al., 1994).

The Australian fritillary is restricted to areas where its larval food plant, *Viola betonicifolia* (the arrowhead violet), occurs (NSW Scientific Committee 2002). The arrowhead violet is widespread throughout Queensland and NSW, at both high and low altitudes. However, the Australian fritillary appears to only occupy lower altitude sites (<600m), and in these lower altitude regions there has been significant clearing for urban expansion. Modelling indicates that around half of the previously suitable Australian fritillary habitat was cleared by 1997 (Neldner pers. comm., 2016). In addition to land clearance, the arrowhead violet has declined in abundance due to weed invasion (mostly exotic grasses), trampling by livestock, drought and wetland drainage (Sands pers. comm., 2016). While the arrowhead violet is widespread, moderate densities of the species are believed to be necessary to sustain breeding populations of the Australian fritillary (Sands & New 2002; Qld DEHP 2010). Aggregations of the arrowhead violet that would sustain breeding populations have become increasingly rare in areas where the butterfly was formerly known to occur. This lack of aggregations of the plant in suitable coastal locations appears to have impacted upon the Australian fritillary (Andren pers. comm., 2016).

One of the last reliable sightings of the subspecies was in 2001 near Port Macquarie. A sighting was also reported in the vicinity of Caboolture, Queensland at this time (Sands & New 2002). A considerable search effort has been made to find populations of the Australian fritillary by interest groups. Most sites where the subspecies was once well known have been surveyed, many repeatedly (Andren pers. comm., 2016). However, targeted surveys have repeatedly failed to locate the subspecies. There continues to be sporadic reports of the subspecies, although none have been verified by photographs or specimens or have been able to be repeated by other observers. In 2014, a sighting was reported near the town of Seventeen Seventy in Queensland, and a sighting was reported in 2015 near Port Macquarie. While the Australian fritillary has been successfully bred in captivity in the past, there are no known captive populations of the subspecies (Andren pers. comm., 2016).

Relevant biology/ecology

The Australian fritillary usually occurs around river estuaries or open, swampy coastal regions (McCubbin 1971; Sands & New 2002). While the Australian fritillary has been successfully reared on *Viola hederaceae* in captivity (Sands, pers. comm., 2016), the subspecies is believed to be host-plant specific in the wild and therefore only occurs in areas where its larval food plant, the arrowhead violet, occurs (Andren pers. comm., 2016; Sands, pers. comm., 2016). The arrowhead violet is a small perennial herb which usually grows in damp niches in open habitats (Australian National Herbarium 2015). It often grows beneath grasses and other plants, often in association with *Lomandra longifolia* (long leaved matrush) and *Imperata cylindrica* (bladey grass) (QLD DEHP 2010).

Females lay eggs on, or near, the arrowhead violet. The egg stage lasts five days before the emergence of the first instar. The larval duration lasts approximately 23 days and consists of four instars (QLD DEHP 2010). The caterpillars feed on the leaves of the arrowhead violet (Lambkin & Lambkin 1977). The pupal duration lasts between 4-9 days (QLD DEHP 2010; Lambkin & Lambkin 1977). Adults fly in swampy areas where the arrowhead violet grows, feeding from flowers of various plants and settling on low vegetation or on the ground. Adults are most frequently observed during winter months (Sands & New 2002).

Adults usually occur at low densities, or can be apparently absent from a given site, but on occasions – even at intervals of several years – they can become locally abundant. The predisposing factors for the subspecies' apparent 'boom and bust' cycles, and mechanisms for its persistence at low densities, are not understood. These 'boom and bust' cycles may be related to the ecology of the arrowhead violet. As the arrowhead violet varies in abundance following periods of drought, flood and fire this may impact on breeding in the Australian fritillary given that moderate densities of the arrowhead violet are necessary to sustain breeding (Sands & New 2002; QLD DEHP 2010). It is also possible that irregular larval diapauses could influence adult apparency (Sands & New 2008).

Threats

Table 1 – Threats impacting upon the Australian fritillary.

Threat factor	Threat type	Threat status	Evidence base
Habitat loss and fragmentation			
Disturbance from rural and urban development	Known	Current	The larval food plant, the arrowhead violet, appears to favour moist and fertile soils in coastal locations - areas which have been severely impacted by urban and agricultural development. As a result of ongoing habitat fragmentation, any remaining populations of the Australian fritillary are susceptible to reduced connectivity and potential inbreeding (NSW Scientific Committee 2002).
Drainage of coastal wetland habitat for rural and urban development	Known	Current	Many freshwater and coastal swamps within the subspecies' range, including areas where the arrowhead violet once occurred, have been degraded or destroyed following drainage for rural and urban use (Dunn et al., 1994; Sands 1999; Braby 2000).
Trampling and grazing of the larval food plant, the arrowhead violet, by a range of herbivores	Suspected	Current	The arrowhead violet is palatable to a range of herbivores (Andren pers. comm., 2016). As moderate densities of the arrowhead violet are necessary to sustain breeding in the Australian fritillary, trampling and grazing by a range of herbivores may impact the subspecies. Increased numbers of native herbivores resulting from decreased predation in some areas could threaten the plant (Andren pers. comm., 2016).

Threat factor	Threat type	Threat status	Evidence base
Herbicide application to the larval food plant, the arrowhead violet	Suspected	Current	Off-target damage to the arrowhead violet from herbicide spraying is a potential threat to the Australian fritillary (Johnston & Johnston 1984; Andren pers. comm., 2016).
Invasive species			
Weed invasion impacting on the larval food plant, the arrowhead violet	Known	Current	The impact of weed invasion, mainly by introduced grass species and shrubs including broad-leaved paspalum (*Paspalum mandiocanum*), kikiuyu (*Pennisetum clandestinum*), lantana (*Lantana camara*) and groundsel bush (*Baccaris halimifolia*), on the arrowhead violet has been identified as a threat to the Australian fritillary (Andren pers. comm., 2016; Sands & New 2002).
Fire			
Changed fire regimes - too frequent burning or lack of burning	Suspected	Current	As the larval food plant, the arrowhead violet, resprouts rapidly after fire and can set seed rapidly, it can be considered to be a fire-tolerant species (Andren pers. comm., 2016). However, its decline in abundance in coastal areas may be partially the result of altered fire regimes. Both an increase in fire frequency and a lack of fire can adversely affect the species (Sands & New 2002; QLD DEHP 2010; Andren pers. comm., 2016). Lack of fire in some coastal situations has led to the loss of open areas and the violet has become shaded out. For example, a formerly well-known site near Port Macquarie which has not been burnt for many years is now over-run by native shrubs and trees and is unsuitable for the Australian fritillary (Andren pers. comm., 2016).
Collection			
Butterfly collection	Potential	Current	Whilst surveying and accumulation of voucher specimens by hobbyists is important for clarifying the subspecies' range and abundance (New 2011), with so few remaining populations (if any) any collection could have a negative impact upon the Australian fritillary (QLD DEHP 2010).

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

(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 A2 (c) for listing as Critically Endangered

The Australian fritillary was historically widespread, and at some locations including Gympie (Binns 1976; Lambkin & Lambkin 1977) and Port Macquarie (Sands & New 2002), at certain times, it was also considered to be locally common. However, the subspecies experienced declines throughout the 1980s and 1990s. In 1994, Dunn et al. reported the subspecies' distribution had contracted by 80 percent (Dunn et al., 1994). Until 2001, the subspecies was known from locations near Port Macquarie and the vicinity of Caboolture (Sands & New 2002). Populations at these sites declined in 2001, and there have been no confirmed sightings of the subspecies since this time. Over the last 30-40 years, the subspecies' population size' appears to have declined by >95% (Andren pers. comm., 2016). Sporadic sightings that have not been verified by photographs or specimens are the only indication that the subspecies is not extinct (Andren pers. comm., 2016). As outlined under the threats section, a number of threats are likely to have resulted in this decline. Coastal swamps containing the subspecies' larval food plant, the arrowhead violet, have been largely destroyed by farming and urbanisation (NSW Scientific Committee 2002) and aggregations of the arrowhead violet that are large enough to sustain breeding populations of the Australian fritillary have become increasingly rare in areas where the butterfly was formerly known to occur (Andren pers. comm., 2016).

Although the major period of decline pre-dated the last decade (Andren pers. comm., 2016), the reduction in the subspecies' population size is suspected to have been greater than 80% over the past 10 years (Andren pers. comm., 2016; Sands pers. comm., 2016) (with this decline over the last decade probably starting from an already low baseline in 2006) (Andren pers. comm., 2016).

The Committee considers that the subspecies has undergone a very severe reduction in population size over the past 10 years, equivalent to at least 80 percent, and the likely causes of this reduction may not have ceased. Therefore, the subspecies has met the relevant elements of Criterion 1 to make it eligible for listing as Critically Endangered.

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:

Insufficient data to determine eligibility

The subspecies' past and current area of occupancy is difficult to assess given that the subspecies appears to experience 'boom and bust' cycles, possibly related to patterns in the abundance of its larval food plant (Sands & New 2002). The extent of occurrence of the subspecies' former core distribution, which consisted of coastal areas from Gympie, Qld to Port Macquarie, NSW is estimated to be approximately 33 500 km² (DotEE 2016). This estimate is based on all known locality records and was calculated using the 2 x 2 km grid approach used by the IUCN (IUCN Standards and Petitions Subcommittee 2016). However, despite targeted searches across the subspecies' previous range there have been no confirmed sightings of the subspecies' since 2001. There continues to be sporadic sighting of the subspecies, although none of these sightings have been verified by photographs or specimens (Andren pers. comm., 2016).

Following assessment of the data the Committee has determined that the geographic distribution is likely to be very restricted. However, as estimates of the subspecies' current extent of occurrence and area of occupancy are not available, the subspecies has not been demonstrated to have met required elements of this criterion.

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:

Insufficient data to determine eligibility

The subspecies' past and current population size is difficult to assess given that the subspecies appears to experience 'boom and bust' cycles, possibly related to patterns in the abundance of its larval food plant (Sands & New 2002). There are no known populations of the Australian fritillary, and there have been no confirmed sightings of the subspecies' since 2001. There continues to be sporadic reports of the subspecies, although none have been verified by photographs or specimens (Andren pers. comm., 2016). Given the above, there are no reliable estimates of population size available.

The Committee considers that there is insufficient information to determine the eligibility of the subspecies for listing in any category under this criterion.

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

Evidence:

Insufficient data to determine eligibility

The subspecies' past and current population size is difficult to assess given that the subspecies appears to experience 'boom and bust' cycles possibly related to patterns in the abundance of its larval food plant (Sands & New 2002). There are no known populations of the Australian fritillary, and there have been no confirmed sightings of the subspecies' since 2001. There continues to be sporadic reports of the subspecies, although none have been verified by photographs or specimens (Andren pers. comm., 2016). It is possible that ongoing searching could result in the discovery of a substantial number of individuals. Given the above, there are no reliable estimates of population size available.

The Committee considers that there is insufficient information to determine the eligibility of the subspecies for listing in any category under this criterion.

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

Population viability analysis has not been undertaken.

Conservation actions

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.

Primary conservation actions

Undertake surveys to identify breeding populations of the Australian fritillary. If a population is found, protect the larval food plant (the arrowhead violet) in the area, and establish a captive breeding program if feasible.

Conservation and management priorities

Habitat loss, disturbance and modifications

- If populations of the Australian fritillary are found, ensure land managers in the area are aware of the subspecies' occurrence and provide protection against key and potential threats.
- Avoid further decline of populations of the larval food plant, the arrowhead violet, in areas where the Australian fritillary has been known to occur:
  - Avoid the clearance of this plant for rural and urban development;
  - Avert herbicide application to the arrowhead violet;
  - Minimise any modification of drainage in the area;
  - Identify weeds that could become a threat to the arrowhead violet, and undertake weed control in the local area using appropriate methods such as weed slashing techniques. Avoid using herbicides in the vicinity of the arrowhead violet; and
  - Manage total grazing pressure through exclusion fencing or other barriers. If livestock grazing occurs in the area, ensure land owners / managers use an appropriate management regime and density that does not detrimentally affect the arrowhead violet.

Fire

- Implement an appropriate fire management regime for protecting key habitat which includes ensuring buffers to prevent wildfire or managed fire from impacting the habitat.
- Where appropriate, employ fuel reduction activities and other protective measures at strategic locations nearby to reduce the potential adverse impacts of wildfire in areas identified as key habitat, but ensure these are well planned and implemented and do not constitute an increased risk (e.g. through escape of planned fires), and are of low intensity. Follow up with appropriate weed control.
- If a population is located, provide maps of known occurrences of the larval food plant to local and state Rural Fire Services in the area and seek inclusion of mitigation measures in bush fire risk management plan/s, risk register and/or operation maps.

Stakeholder Engagement

- Increase awareness of the Australian fritillary amongst private and public land managers, NGOs and butterfly enthusiast/hobbyist groups, with a view to increase the number of people searching for populations of the subspecies, and to encourage participation in the rehabilitation of the larval food plant, the arrowhead violet. This could involve propagating and planting the arrowhead violet at sites where the Australian fritillary was known to occur, and where the arrowhead violet has declined, and potentially in home gardens. Awareness could be raised through means such as the development of pamphlets, through workshops or newsletters provided by local environment groups and local councils, or dissemination of information through local media across the subspecies' previously known range (from Gympie to Port Macquarie).
- Undertake Indigenous consultation in areas where the subspecies was known to occur to acquire traditional knowledge about the subspecies, for example knowledge of previous breeding sites or knowledge about the subspecies' past 'boom and bust' cycles of abundance.
- Discourage butterfly collectors from any collection of the subspecies and encourage them to confidentially report sightings to government conservation agencies. This could be achieved through the development of pamphlets, newsletters or workshops with butterfly enthusiast groups/hobbyist groups, local environment groups and local councils.
- If populations are found on private land consider the use of conservation covenants to facilitate ongoing protection for the subspecies, larval food plant the arrowhead violet, and its habitat.

Breeding, propagation and other ex-situ recovery action

- If a population is discovered, establish a captive breeding program.

Survey and Monitoring priorities

- Undertake surveys in potential habitat to identify breeding populations of the Australian fritillary. If populations are found, assess population size and distribution.
- Investigate whether data collected by butterfly enthusiast groups can be used as part of a collective, broad-scale monitoring program.

- If populations are found, monitor the progress of recovery, including the effectiveness of management actions and the need to adapt them if necessary.

Information and Research priorities

- If secure populations are found, carry out studies on the development of immature and adult stages to better understand the 'boom and bust' cycle of abundance in this subspecies and determine how the subspecies is capable of persistence at very low densities in some years e.g. protracted development mechanisms such as diapause, aestivation or over-wintering.
- Further research to determine what has caused the decline in this species, for example is it related to the loss in abundance of the arrowhead violet, or can it be attributed to a range of causes including for example climate change.
- Identify optimal fire regimes for regeneration of the larval food plant, the arrowhead violet, and response to prevailing fire regimes.
- Investigate to what degree the subspecies' larval food plant, the arrowhead violet, has declined in abundance and geographic range, and identify the causes of this decline.
- As observations of the arrowhead violet and related subspecies of butterfly in Papua New Guinea have revealed an apparent link between the nutrient needs of plants and attraction of plants to ovipositing adults (Sands pers. comm., 2016), undertake further research into this link (possibly using related subspecies of butterfly and the arrowhead violet) to help identify possibly reasons for decline in the Australian fritillary.

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:

Argynnis hyperbius inconstans

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

Threatened Species Scientific Committee

07 March 2017

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