

Conservation Assessment of *Diuris aequalis*

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29th April 2020

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***Diuris aequalis* F. Muell. ex Fitzg. (Orchidaceae)**

Distribution: Endemic to NSW

Current EPBC Act Status: Vulnerable

Current NSW BC Act Status: Endangered

Proposed change for alignment: List on EPBC Act as Endangered.

Conservation Advice: *Diuris aequalis*

Summary of Conservation Assessment

Diuris aequalis was found to be eligible for listing as Endangered under Criteria B2ab(iii).

The main reasons for this *Diuris aequalis* being eligible are that i) the species has highly restricted geographical range with an area of occupancy of 132 km²; ii) it is considered to be severely fragmented; and iii) declines have been suspected in the number of mature individuals at some sites, and decline is projected to result from ongoing threats, including grazing, drought and demographic stochasticity (i.e, because of the small numbers of plants in many populations).

Description and Taxonomy

Diuris aequalis F. Muell. ex Fitzg. (family Orchidaceae) is described by PlantNET (2018) as “Terrestrial herb. Leaves 2, linear, 10–20 cm long, 3–4 mm wide, conduplicate. Raceme 20–45 cm high, 2–5-flowered. Flowers golden yellow to orange, usually unspotted, c. 2.5 c. across. Dorsal sepal broad-ovate to circular, 7–10 mm long, 8–15 mm wide, erect. Lateral sepals linear to oblanceolate, 8–13 mm long, 2–3 mm wide, falcate, green. Petals erect, widely divergent; lamina elliptic to circular, 6–10 mm long, 4–6 mm wide; claw 4–6 mm long, green. Labellum 5–6 mm long; lateral lobes narrowly to broadly cuneate, 5–9 mm long, 2.5–5 mm wide; midlobe broad-cuneate when flattened, c. 7 mm wide, ridged along midline; callus of 2 broad, incurved ridges c. 3.5 mm long.”

Distribution and Abundance

The NSW Scientific Committee (2002) state that “The species is known from fewer than 20 small and fragmented populations between Braidwood and the Blue Mountains in the central and southern tablelands of NSW. The species previously occurred in the Liverpool area of western Sydney but has not been located there in over 100 years ... Only three populations, containing a total of less than 50 individuals, occur within a conservation reserve, Kanangra-Boyd National Park. The remaining populations are restricted to remnant vegetation along roadsides and within agricultural lands.”

Since 2002, several new populations have been discovered, and many of the known populations have been resurveyed (A. Murphy, pers. comm., August 2017). The distribution of *Diuris aequalis* is best described as occurring in eight broad localities (with naming following Anonymous [2001] where possible):

1. Kanangra-Boyd (and Shooters Hill).
 - Managed under the NSW Saving our Species Site Managed program.

- Threats to these populations include timber harvesting for firewood and vegetation clearance due to landholder activity (A. Murphy, pers. comm., August 2017).
- 5. Collector (i.e., northwest of the Tarago area).
 - Managed under the NSW Saving our Species Site Managed program.
 - Monitoring in 2016 found 12 plants (A. Murphy, unpublished data).
- 6. Tarago to Braidwood area: Mount Fairy, Manar Park, King's Hwy, Reedy Creek, Hadobas, Woodlawn, Oallen Ford, Tarago.
 - Notes on populations and counts (from Anonymous 2002). Asterisks (*) indicates sites with repeat surveys.
 - *Kings Hwy (aka Kings Hwy roadside, aka opposite MNF), 50 plants;
 - *Reedy Creek, 1 plant;
 - Oallen Ford, 5 plants (no further information since 2002);
 - Tarago, 5 plants (no further information since 2002);
 - Woodlawn, 30 plants (no further information since 2002);
 - Karrakatta (Hadobas), 10-20 plants.
 - Recorded in 2010 (accession no CANB 80491) with comment on abundance "occasional".
 - Manar Park, 2 plants (no further information since 2002)
 - Notes on populations and counts from 2016 (A. Murphy, unpublished data).
 - *Kings Hwy (aka Kings Hwy roadside, aka opposite MNF), 9 plants.
 - Kings Hwy (new site) 15 plants
 - *Reedy Creek, 0 plants.
 - Duck Flat TSR, 0 plants.
 - First recorded in 2000, BioNet reference SPJGI4855663).
 - Mulloon Creek/Mulloon Creek Natural Farm, 1 plant.
 - Also recorded:
 - In 1985 (accession no. CBG 9909851).
 - In 1995 (accession no. CBG 9609651)
 - Borro, 5 plants (new site).
 - Mt Fairy (new site, A. Murphy, unpublished data).
 - 168 plants (across 5 sites; largest site with 122 plants).
- 7. Goulburn
 - Anonymous (2002) notes that *Diuris aequalis* was last seen here in 1911.
 - BioNet includes a record in Goulburn from 1998 (SPJGI4995035).
 - According to K. McDougall (pers. comm., April 2017) this record is reliable.
- 8. Tralee
 - One plant (K. McDougall, pers. comm., April 2017).

Localities 1-6 were surveyed around 1999-2001, and then again during the period 2005 until present, including many in 2016. Combining the NSW Saving our Species 2016 population estimates with earlier (Anonymous 2001) population estimates results in a total population estimate of approximately 900 mature individuals.

Decline is suspected in several populations (A. Murphy, unpublished data); however, there is uncertainty around this decline because of the potential for variation in the above-ground or 'visible' population. The population at Kings Hwy (within the Tarago to Braidwood area), east of Bungendore has varied from approximately 50 plants in the late 1990s to 9 plants in 2016 (K. McDougall, pers. comm., April 2017; A. Murphy, pers. comm., August 2017). Kings Hwy data: 50 plants in 1999, 24 plants in 2005, 33 plants in 2008, 61 plants in 2009, 7 plants in 2011 and 9 plants in 2016 (BioNet database). A suspected decline is partially attributed to weed invasion (*Anthoxanthum odoratum*)

and road-making disturbance (K. McDougall, pers. comm., April 2017). However, given the fluctuations in above ground plant numbers, there is uncertainty about whether this is an actual decline or simply fluctuations in above ground plants.

The following records have not been confirmed recently, and may constitute historical records only:

- Mt Victoria
 - Record is from 1955 (EMU reg. number 179834). K. McDougall (pers. comm., April 2017) has no specific knowledge about this population but considers it “plausible”.
- Liverpool
 - This is the type specimen (BioNet sighting key SPJGI0035223).
 - The Scientific Committee notes that the plant was last seen here in 1875.
 - This record may be related to the record in Bowral, also by Fitzgerald, below.

The following records have not been confirmed:

- Bowral
 - The record is from 1788 (EMU reg. number 179835).
 - This record is doubtful, and more likely to be from closer to Marulan (K. McDougall, pers. comm., April 2017).
- Jervis Bay
 - Catalogue number NSW 120684, originally identified as *Diuris maculata* var. *concolor* Benth.)
 - The location information is obscure and it may be these collections were incorrectly assigned to this area because collector Rodway did much of his collecting in this area (K. McDougall, pers. comm., April 2017).

The following records are suspect:

- Royal National Park.
 - Record is from 1924 (BioNet Sighting Key 2140).
 - Catalogue number NSW 120734
 - Record should possibly be disregarded (K. McDougall, pers. comm, April 2017).

Ecology

Diuris aequalis has been recorded in montane eucalypt forest, low open woodland with grassy understorey and secondary grassland, often on gentle slopes and associated with gravelly clay-loam soils (TSSC 2008).

Threats

The NSW Scientific Committee (2002) state that “The species is threatened by loss of habitat and continuing declines in habitat quality due to grazing and road maintenance.”

Habitat clearing and fragmentation

The majority of *Diuris aequalis* populations exist in small, fragmented remnants in predominantly agricultural landscapes. Because of this, *Diuris aequalis* (and its habitat) is threatened by edge-effects, particularly weed invasion, but also grazing, nutrient enrichment, changed hydrology, wind effects, soil erosion impacts, altered microclimate and changed fire regimes (Spooner and Lunt 2004). Small areas of remnant vegetation are particularly at risk from edge effects. For example,

distribution of *Diuris aequalis* overlaps with that of EPBC-listened threatened ecological communities: White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland, 66-97% cleared, ongoing threats leading to deterioration including via grazing, weeds, fire (TSSC 2006); Natural Temperate Grassland of the Southern Tablelands of NSW and the Australian Capital Territory, 90% cleared, ongoing and demonstrable threats including fragmentation, grazing, nutrient enrichment, fire, weeds (TSSC 2016).

Grazing

Grazing is a particular threat, with the observation of severe grazing of uncaged/unfenced individuals at some sites (A. Murphy, pers. comm., April 2017). Kangaroo herbivory is thought to be a key threat at the large Jaunter population, with fencing to be erected to help prevent herbivory (A. Murphy, pers. comm., August 2017). In addition, plants were unable to be relocated a few weeks following flowering at Broughton's Lookout, at Kanangra Boyd NP, and at Mt Rae (A. Murphy, pers. comm., August 2017) and this was attributed to grazing impacts. Deer, rabbits and domestic stock may impact the species.

Horse and goats grazing and disturbance by pigs may affect sites near rural-residential subdivisions (TSSC 2008).

Other disturbances

Road maintenance poses a significant risk to roadside populations of *Diuris aequalis*, especially in the Tarago to Braidwood area. The species is also impacted by damage to habitat from illegal rubbish dumping.

Weeds

At least one population is being threatened by exotic weedy grasses, specifically *Anthoxanthum odoratum* (K. McDougall, pers. comm., April 2017), although this is not the case for other populations (A. Murphy, pers. comm., April 2017).

Small population size

It is also believed that small population size may threaten many populations through allee effect, pollination limitation and inbreeding depression (A. Murphy, pers. comm., April 2017). Indeed, most populations have fewer than 100 individuals (the number required to limit loss in total fitness to 10%), with only one population approaches the 500 individuals historically thought to retain evolutionary potential in perpetuity (recently revised to 1000 individuals; Frankham *et al.* 2014).

Drought and fire impacts

Diuris aequalis may also be threatened by drought and the interaction of drought and fire. This includes impacts of drought from the past ~10 years and also predicted future decreases in spring and winter rainfall in the southern part of the distribution (K. McDougall, pers. comm., April 2017). In addition, some 30-60% of the known distribution of the species was estimated to have been burnt in the 2019/2020 fires (Gallagher 2020, Auld *et al.* 2020) and there was a high risk to post-fire recovery from the combination of pre-fire drought and post-fire herbivory (Auld *et al.* 2020).

Assessment against IUCN Red List criteria

For this assessment, it is considered that the survey of *Diuris aequalis* has been adequate and there is sufficient scientific evidence to support the listing outcome.

Criterion A Population Size reduction

Assessment Outcome: Data Deficient.

Justification: To be listed as threatened under Criterion A the species must have experienced a population reduction of >30% over three generations or 10 years (whichever is longer). There is insufficient data to assess *Diuris aequalis* against this criterion.

Criterion B Geographic range

Assessment Outcome: Endangered under B2ab(iii).

Justification: *Diuris aequalis* has a restricted geographic distribution, with estimates of extent of occurrence (EOO) from 5,361 km² to 19,339 km² (estimated using a convex hull polygon, as recommended by IUCN (2017)). An EOO of >5000 km² but <20,000 km² would meet the Vulnerable threshold. The estimates for area of occupancy (AOO) range from 132 km² to 212 km² based on a 2 x 2 km grid (as recommended for assessing AOO by IUCN, 2017). An AOO of >10 km² but <500 km² would meet the Endangered threshold. The best estimates of EOO and AOO (5,361 km² and 132 km², respectively) are based on confirmed records. Higher estimates of geographical distribution (13,924 km² (EOO) and 196 km² (AOO)) are based on inclusion of the historical/unconfirmed records from Mt Victoria, Liverpool and Braidwood. If the unlikely/unconfirmed records from Jervis Bay and Bowral are included, estimates increase to 19,339 km² (EOO) and 212 km² (AOO).

In addition to these thresholds, at least two of three other conditions must be met. These conditions are:

- a) The population or habitat is observed or inferred to be severely fragmented or there is 1 (CR), ≤5 (EN) or ≤10 (VU) locations.

Assessment Outcome: Subcriterion met (for severely fragmented).

Justification: *Diuris aequalis* populations occur in eight broad areas, each of which includes one or more populations. Populations within each of the eight broad areas where the species occurs are exposed to varying threats. The most common serious and plausible threat to the species, across its distribution, is grazing (although it must be noted that some sites are fenced). As locations in IUCN extinction risk assessments are defined by threat, this variability means that it is likely that *Diuris aequalis* occurs in >10 locations.

Severe fragmentation is described as where most individuals are found in small and relatively isolated subpopulations, these subpopulations may go extinct with reduced probability of recolonization (IUCN 2017). A taxon can be considered severely fragmented if most (>50%) of its total AOO is in habitat patches that are (1) smaller than would be required to support a viable population and (2) separated from other habitat patches by a large distance. Although severe fragmentation is difficult to assess for *Diuris aequalis*, because mature individuals can survive underground where they cannot be easily surveyed, the large number of widely dispersed records of this species associated with small subpopulation sizes, indicates severe fragmentation. Moreover, of the 132 km² AOO of *Diuris aequalis*, 68 km² occurs in fragmented habitat, within a predominantly rural/agricultural landscape. (This estimate based on total AOO of *Diuris aequalis* from Goulburn, south). If any of these southern populations within the agricultural landscape were to go extinct, the probability of recolonization for the sites is small, since most orchid seeds fall within a few metres of the parent plant (Brundett 2007).

- 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.

Assessment Outcome: Subcriterion met for (iii) area, extent and/or quality of habitat.

Justification: Ongoing threats to populations include land clearing, grazing and weed invasion, as well as small population sizes leading to demographic limitation. *Diuris aequalis* occurs mostly in the Southern and Central Tablelands regions of NSW. These

regions are predominantly rural/agricultural, with the majority of land in these regions described as “grazing modified pastures” (ABARES 2018). “Almost all of the *Diuris aequalis* populations (and certainly the majority of plants) are in fragmented landscapes: roadsides, travelling stock reserves, freehold land with low grazing pressure” (K. McDougall pers. comm., March 2018). The apparent decline at the Kings Hwy population of *Diuris aequalis* (the population that has been subject to the most monitoring) is partially attributed to weed invasion (*Anthoxanthum odoratum*) (K. McDougall pers. comm., April 2017). Kangaroo herbivory is thought to be a key threat at the large Jaunter population, with fencing to be erected to help prevent herbivory (A. Murphy, pers. comm., August 2017). In addition, plants were unable to be re-located a few weeks following flowering at Broughton’s Lookout, at Kanangra Boyd NP, and at Mt Rae (A. Murphy, pers. comm., August 2017) and this was attributed to grazing impacts. Finally, Auld et al. (2020) identified pre-fire drought and post-fire herbivory as threats to recovery after the 2019/2020 fires.

c) Extreme fluctuations.

Assessment Outcome: Data deficient.

Justification: Population numbers undergo fluctuations from year to year depending on rainfall (K. McDougall pers. comm., April 2017). However, these variations may only be occurring in the visible/aboveground population.

Criterion C Small population size and decline

Assessment Outcome: Data deficient.

Justification: Because mature individuals of *Diuris aequalis* can survive underground, where they cannot be easily surveyed, it is difficult to estimate true population size. However, estimated population, based on surveys in 2016, is some 768-900 ‘mature’ plants. This population estimate is below the threshold for listing as EN under Criterion C.

At least one of two additional conditions must be met. These are:

C1. An observed, estimated or projected continuing decline of at least (up to a max. of 100 years in future).

Assessment Outcome: Data deficient.

Justification: There is insufficient data to assess *Diuris aequalis* against this criterion.

C2. An observed, estimated, projected or inferred continuing decline

Assessment Outcome: data deficient.

Justification: Decline is suspected in several populations (A. Murphy, unpublished data); however, there is uncertainty around this decline because of the potential for variation in the above-ground or ‘visible’ population. The population at Kings Hwy (within the Tarago to Braidwood area), east of Bungendore has varied from approximately 50 plants in the late 1990s to 9 plants in 2016 (K. McDougall, pers. comm., April 2017; A. Murphy, pers. comm., August 2017). Kings Hwy data: 50 plants in 1999, 24 plants in 2005, 33 plants in 2008, 61 plants in 2009, 7 plants in 2011 and 9 plants in 2016 (BioNet database). A suspected decline is partially attributed to weed invasion (*Anthoxanthum odoratum*) and road-making disturbance (K. McDougall, pers. comm., April 2017). However, given the fluctuations in above ground plant numbers, there is uncertainty about whether this is an actual decline or simply fluctuations in above ground plants.

In addition, at least 1 of the following 3 conditions:

- a (i). Number of mature individuals in each population ≤ 50 (CR), ≤ 250 (EN) or ≤ 1000 (VU).

Assessment Outcome: Subcriterion met at Vulnerable threshold.
Justification: The largest known population is at Jaunter and has approximately 431 mature plants.

- a (ii). % of mature individuals in one subpopulation = 100%, 95-100% or 90-100%.
Assessment Outcome: Subcriterion not met.
Justification: No one population has 90% or more individuals; the largest subpopulation has 48% of the total population.
- b. Extreme fluctuations in the number of mature individuals
Assessment Outcome: Data deficient.
Justification: Population numbers undergo fluctuations from year to year depending on rainfall (K. McDougall pers. comm., April 2017). However, these variations may only be occurring in the visible/aboveground population.

Criterion D Very small or restricted population

Assessment Outcome: Vulnerable under Criterion D.

Justification: The total number of mature *Diuris aequalis* individuals is estimated to be 900. To be listed as Vulnerable, a species must meet at least one of the two following conditions:

D. Population size estimated at <50, <250 or <1,000 mature individuals.

Assessment Outcome: Criterion met at Vulnerable threshold (<1000).

Justification: The total number of individuals of *Diuris aequalis* is estimated to be 900 mature individuals, based on population estimates from 2016, the NSW SoS database and additional populations recorded by Anonymous (2001).

D2. Restricted area of occupancy or number of locations with a plausible future threat that could drive the taxon to CR or EX in a very short time.

Assessment Outcome: Subcriterion not met.

Justification: *Diuris aequalis* has an AOO of > 20 km², and the species exists at more than 5 locations.

Criterion E Quantitative Analysis

Assessment Outcome: Data deficient.

Justification: Currently there is not enough data to undertake a quantitative analysis to determine the extinction probability of *Diuris aequalis*.

Conservation and Management Actions

There is a NSW Saving Our Species site-managed program for *Diuris aequalis*. The following actions are derived from this program, and from the Commonwealth Conservation Advice (TSSC 2008):

Habitat loss, disturbance and modification

- Avoid introducing domestic stock grazing to *Diuris aequalis* sites.
- Prevent land clearing and soil disturbance (e.g., from development) at *Diuris aequalis* sites.
- Limit vehicle access to sites to deter rubbish dumping.
- Ensure road widening and maintenance activities (or other infrastructure or development activities as appropriate) in areas where *Diuris aequalis* occurs do not adversely impact on known populations.

Invasive species

- Protect *Diuris aequalis* from grazing, browsing and trampling by domestic stock and other herbivores (e.g. deer, rabbits and kangaroos) by erecting caging over individual plants or fencing larger areas.

- Control weeds, particularly exotic perennial grasses such as *Anthoxanthum odoratum*, where they have the potential to outcompete *Diuris aequalis*.

Ex situ conservation

- Undertake appropriate seed and mycorrhizae collection and storage.
- Investigate options for linking, enhancing or establishing additional populations.
- Implement national translocation protocols (Vallee et al., 2004) if population enhancement or establishing additional populations is considered necessary and feasible.

Stakeholder Management

- Inform land owners and managers of sites where there are known populations and consult with these groups regarding options for conservation management and protection of the species.
- Increase public awareness of the species to assist in detection of unknown populations.
- Organise proactive surveying in potential habitats.
- Mark *Diuris aequalis* sites and potential habitat onto maps used for planning road maintenance work.
- Investigate formal conservation arrangements, such as the use of covenants, conservation agreements or inclusion in reserve tenure.
- Control access routes to suitably constrain public access to known sites on public land.

Survey and Monitoring priorities

- Monitor populations for change (increase or decrease) in number of individuals.
- Survey areas surrounding known populations to identify additional populations.
- Monitor for evidence of herbivory (e.g., browsed plants), soil disturbance, or weed invasion.
- Monitor population response to major events such as fire.

Information and Research priorities

- Investigate the reasons for population fluctuation, especially in response to rainfall or disturbances.
- Assess variation along the north-south distribution of the species, including genetic studies.
- Investigate if recruitment can be increased artificially (e.g., via hand pollination).
- Understand the impact of disturbances such as fire and grazing on population turnover, especially following the 2019/2020 fires.

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Expert Communications

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