Purple-flowered Wattle (*Acacia purpureopetala*): observations and surveys of a threatened plant found only in the Herberton-Irvinebank region

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Abstract

The Purple-flowered Wattle (*Acacia purpureopetala*) is the only wattle with purple or pink flowers. The species is known only from the Herberton-Irvinebank region in north Queensland, Australia. Its conservation assessment of Critically Endangered under Commonwealth legislation has been based on an estimated total population of 500 individuals in 10 'populations' with an area of 8.6 hectares. Over six years, we examined 24 patches of *A. purpureopetala*, 21 with either population counts and measurement of patch area or estimates of these. We provide a morphological description of the species, notes on reproduction, an updated estimate of the total population, number of sub-populations and area occupied, and notes on site characteristics. The Purple-flowered Wattle is a small shrub with limited root development, sparse and diffuse flowering and seed set, and evidently limited capacity for seed dispersal. In 21 patches, we conservatively estimate there to be just over 7,000 adults in patches summing to 20.4 hectares. Patches occur in a diversity of landscape settings but consistently on harsh sites with a sparse grass layer, this and other evidence suggesting that the species is an obligate seeder intolerant of frequent fire. Infrequent disturbance such as grading of firebreaks and mining appears to have promoted establishment of individuals in some patches, but many patches lack any current or obvious historic disturbance. Purple-flowered Wattle is known from 16 sub-populations with an Extent of Occurrence of 634 km^2. Notwithstanding the increased population estimate, Purple-flowered Wattle remains an extremely rare species whose conservation warrants high-level consideration.

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Introduction

The Purple-flowered Wattle (*Acacia purpureopetala* F.M.Bailey) is a taxonomically distinct species and unique among Australian wattles in having pink to mauve flowers (Fig. 1) (WWW 2018). It occurs only within a radius of about 25 km of Irvinebank in northern Queensland (centred on 17°24'S by 145°14'E) (Fig. 2), where it is known from 10 sub-populations occupying 8.6 hectares with an estimated total population of 500 plants (TSSC 2010) (see also Appendix 1). It is listed as Vulnerable by the Queensland Government and Critically Endangered by the Commonwealth Government. It is thought to be under threat from loss of habitat to mining and damage from roadworks and other infrastructure (TSSC 2010). Further, its relationship with fire is ambiguous, as it

Figure 1. The colour of the flowers of Purple-flowered Wattle (*Acacia purpureopetala*) is unique among Australian wattles, other species mostly having white, cream, yellow or gold flowers, or rarely red.
The ball-shaped inflorescence is c. 10 mm in diameter. All photos are by Simon Gleed.

may require fire for germination (TSSC 2010) but might also be threatened by inappropriate fire regimes. A parallel ambiguity exists with regard to mining, with the species known to colonise old mine sites yet obviously threatened by clearing for mining. And yet, much of this is speculative; remarkably little is known about the species conservation and ecology and we know of no literature about it. Indeed, as we will show, even the formal morphological description of the species is scarcely adequate.

A few studies of threatened or naturally rare *Acacia* species provide potential context for our study. *Acacia ramiflora* is a threatened species occurring in fire-prone environments inland from Townsville. Williams *et al.* (2004) found that most adults survived fire by re-sprouting from subterranean buds, and that fire promoted germination. Fire also promoted germination of two Western Australian taxa threatened by land

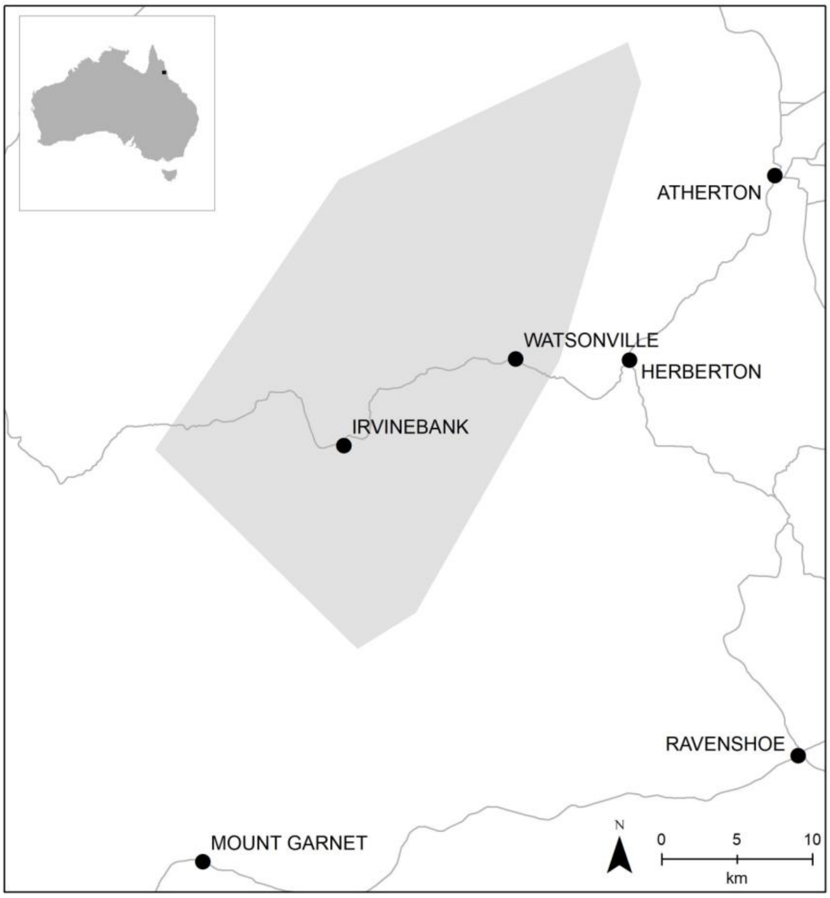

Figure 2. Extent of Occurrence (EoO; grey shading) of the Purple-flowered Wattle (*Acacia purpureopetala*).
EoO is the minimum convex polygon taking in all known records of the species. See Discussion for more information. Lines are main roads. Map prepared by Steve Murphy.

clearing, *Acacia aprica* and *A. cochlocarpa* subsp. *cochlocarpa*, but weeds suppressed seedling survival (Yates & Broadhurst 2002). Millar *et al.* (2013, 2014) demonstrated that naturally fragmented populations of *A. woodmaniorum* displayed genetic divergence but also that pollen dispersal provided a surprising level of connectivity between fragments.

In this paper, we provide a much-expanded morphological description of *A. purpureopetala* and notes on its reproductive biology, and report the results of surveys for the species including, for some sub-populations and patches, measurements or estimates of population and patch area.

Methods

From 2012 to 2018, during the course of natural history explorations of the Herberton region, surveys of the species, and engagement with the rehabilitation of a disused mine, we have encountered *A. purpureopetala* at 24 sites (hereafter *patches*). Of these, four have been previously reported (TSSC 2010; DEE 2014), one was discovered by the late Saeed De Ridder, four jointly by Saeed and SJG, two jointly by Tom De Ridder and us (SJG, DCF); we discovered the remaining thirteen patches.

In addition, from February to October 2018, SJG made weekly visits to a mine rehabilitation project close to the town of Irvinebank, with *A. purpureopetala* one of the major foci of his activities. Fifty-two plants (23 mature, 29 juveniles) were identified for translocation (Vallee *et al*. 2004) because they were threatened by rehabilitation works. These were excavated in May 2018 in accordance with a Protected Plant Clearing Permit (permit number WA007143) issued under Section 15 of the *Nature Conservation (Administration) Regulation 2006* by the Queensland Department of Environment and Science. The weakly structured sand or shaly metamorphic substrate occasionally fell away from plants, providing a rare opportunity to examine the roots.

For the purpose of this paper, we employ the following terms when describing the geographic occurrence of *A. purpureopetala*:

- *patch*: any contiguous group of plants with a gap of no more than 50 m between individuals; and
- *sub-population*: a patch, or set of patches with a gap between nearest patches of no more than 1.0 km, that is separated from the nearest other patch (hence sub-population) by more than 1.0 km.

Our definition of *patch* partly reflects the practicalities of searching for nearby plants, but also that *A. purpureopetala* plants tend strongly to be aggregated mostly within a metre or two of each other with surprisingly few outliers. Based on evidence of limited capacity for seed dispersal presented in this paper, it seems reasonable to assume that dispersal of seeds beyond patches is infrequent. Our definition of *sub-population* is consistent with the application of 'population' for the species by TSSC (2010) and DEE (2014). It provides a first pass match against *sub-population* as defined for Red List assessment as "geographically or otherwise distinct groups in the (global) population between which there is little demographic or genetic exchange (typically one successful migrant individual or gamete per year or less ...)" (IUCN 2012; see also IUCN S&PS 2016). Genetic exchange between sub-populations is likely to be mainly by pollen dispersal (which is vectored by insects in most wattles lacking phyllodineous nectaries [Stone *et al.* 2003]). However, dispersal of pollen at distances somewhat greater than 1 km has been reported in another wattle with a naturally-fragmented distribution (Millar *et al.* 2014).

Patch area was defined quantitatively for 16 patches. We defined patch area as the minimum convex polygon incorporating all known plants in the patch. In the field, we first identified the perimeter of patches by working around the patch margin exploring out c. 20 m from the outermost known plants and marking perimeter plants with flagging tape as we went. We then recorded the location of perimeter plants with a GPS (Global Positional System). Data from the GPS was downloaded as Universal Tranverse Mercator (UTM) coordinates, for which the units are metres. Coordinates were imported into a graphics package, plotted in plan view, the outermost connected to form a convex polygon, and a fine grid of squares of known size imposed over the resulting polygon (Fig. 3). We then counted the squares contained within the polygon, estimating the area for those intersected by the polygon boundary to 0.1 square. The number of squares

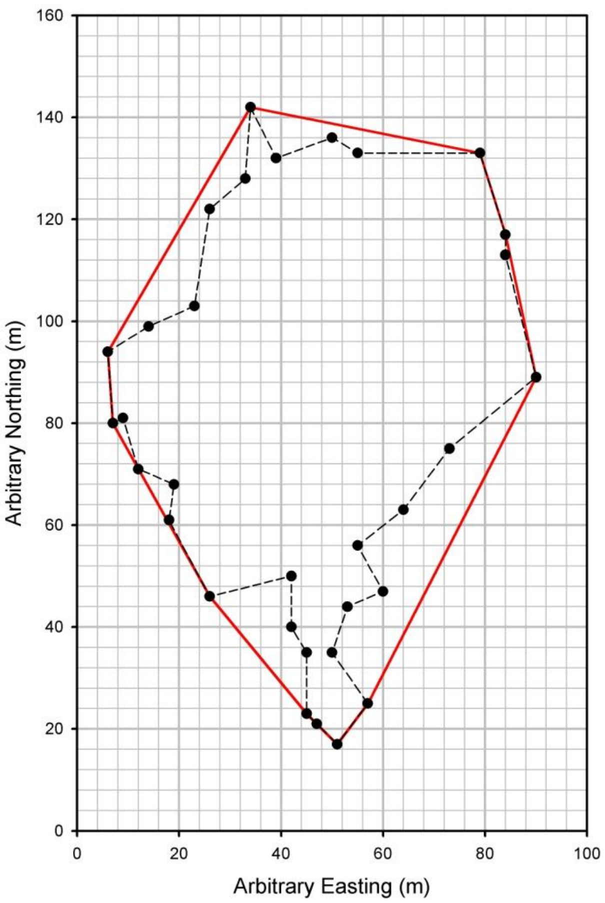

Figure 3. Example graphic for calculation of patch area.
The example patch is real, with Eastings and Northings standardised to an abitrary base point to conceal its location. Black dots are perimeter plants for which coordinates were recorded, with select plants shown numbered as part of the sequence connected by the dashed line. The solid red line is the convex polygon from which patch area was calculated. Minor grid squares are 4 x 4 m and major grid squares (with ticks and labels) are 20 x 20 m.

was then converted to area. This method has a high level of precision.

Acacia purpureopetala plants were counted comprehensively for six patches and in sample plots in a further two patches. Plants showing compound leaves (seedlings), and those not showing them but up to c. 10–15 cm tall with little or no branching of the primary shoot, were counted as juveniles. This accords with our observation of the size at which no flowering or fruiting was observed. In small patches (e.g. <0.01 ha) and smaller plots, counting individuals is a straightforward procedure. In some others, site features provided marks allowing the patch to be sub-divided and thus surveyed systematically. In one large patch (0.66 ha) with many individuals (Fig. 3), we established an adjacent baseline and divided the patch into c. 5-m wide transects perpendicular to the baseline using two 100-m tapes one transect at a time, starting at one end and moving one tape across after completing each transect count. We counted *A. purpureopetala* plants present on each transect, moving along the transect side by side. This patch took about ten hours (20 person-hours) to count.

Where the distinction between adult and juvenile plants is available we have included only the number of adult plants in our estimate of total population. For estimates of <20 individuals, we have allocated an arbitrary population of ten plants. In summing patch areas, we have allocated an abitrary 0.005 ha for areas <0.01 ha.

Morphology

A morphological description of the species is available at WWW (2018) and almost identically in Maslin (2001). In summary: *Acacia purpureopetala* is a "sprawling ±prostrate shrub to 0.5 m high". The leaf-like phyllodes are leathery, slightly asymmetric, 15–35 mm long and 4–6 mm wide, with a small, asymetrically placed point (mucro), prominent mid-vein and margins (Fig. 1), and fine downy hairs (puberulous) at least along the margins. The inflorescence is a single ball-shaped cluster of 15–20 mauve-pink flowers on a stalk 7–15 mm long (Fig. 1). Seed pods (Fig. 4) are "narrowly oblong to elliptical, to 30 mm long, 4–7 mm wide, normally 1–3 seeded", thinly leathery and somewhat crusted, drying brown. Seeds are "longitudinal, circular to widely elliptic, compressed, 4–5 mm long" and lack an aril.

The following additional morphological information is based on our observations and comparison with other published work.

Mature *A. purpureopetala* plants generally have a small number of low-arching (semi-procumbent) primary branches that radiate from the central growth point, forming a rosetted, low dome with age (Fig. 5). These branches are at most sparingly further branched, mainly towards the tips. The species rarely grows more than 60 cm tall and 1.2 m in diameter, with a typical mature height of 20–40 cm. Simmons (1981) reported plants to 3 m diameter but we have never located a specimen of such dimensions; however, we have frequently

Figure 4. The seed pods of Purple-flowered Wattle (*Acacia purpureopetala*) usually contain one to three seeds, rarely four or five.
The pod is about 15 mm long.

Figure 5. Purple-flowered Wattle (*Acacia purpureopetala*) has arching branches and develops a domed structure with age. This shrub is about 75 cm in diameter and 35 cm high.

observed 2–5 well-developed adult plants growing in close proximity to each other, giving the impression of one large plant. The growth form described above is best developed in open sites or in the open understorey of woodland; however, when growing amongst dense low shrubs of other species, *A. purpureopetala* tends to be poorly formed and scraggly.

The primary branches of mature plants are characteristically dull red-brown and angular in cross-section, and often have blunt prickles that are vestiges of stipules from the bases of old phyllodes. Smaller branches of younger plants are typically grey-green with less lignin development and thus are softer. The phyllodes are grey-green (Figs. 1,4), though somewhat greener on juvenile plants. The ball-shaped flower clusters are about 10 mm diameter or less and are pink to pale purple (Fig. 1). Seed pods are flattened with swellings around seeds and a beak at the distal end (Fig. 4,6). Fresh seed pods are grey-green, a similar colour to the phyllodes and thus not at all obvious. When dry, pods turn pale brown, slowly splitting open lengthways, and contain between one and three seeds (Fig. 6), occasionally four or five. Seeds are hard, lustreless black, typically circular and flattened, measuring approximately 4-5 mm diameter by 1.5 mm thick, with a shallow pit on their flattened faces (Fig. 6).

Seedlings of *A. purpureopetala* are erect and initially unbranched to about 10 cm high (Fig. 7). Seedlings to about 5–8 cm high have bipinnate leaves which are pale grey-green and sparsely covered in very fine pale hairs. Taller juveniles plants develop phyllodes like an adult plant on new growth and do not retain the bipinnate paedomorphic foliage. Stems of juvenile plants are green, slightly angular and often covered in fine pale hairs. The stipules are easily seen and retained on the plant through to its adult form, at which stage, they harden and form prickle-like appendages.

Figure 6. Single-seeded pod and seed of Purple-flowered Wattle (*Acacia purpureopetala*).
The seed is about 5 mm in diameter by 1.5 mm thick.

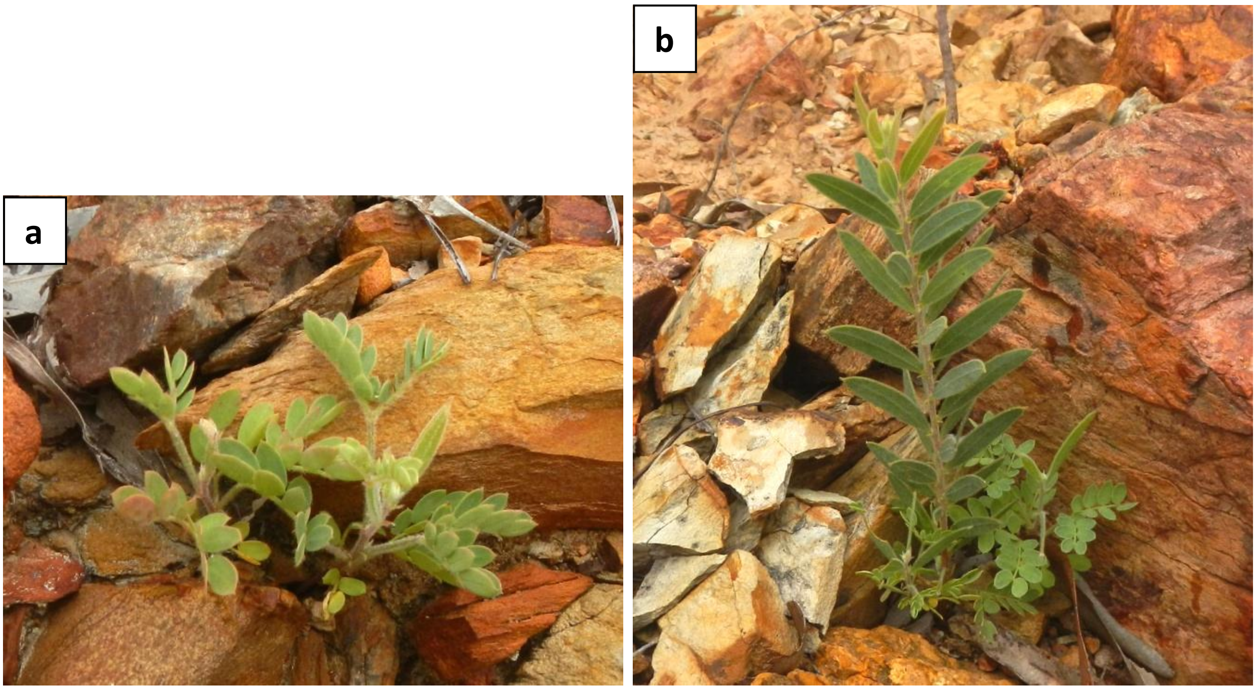

Figure 7. Wild seedlings of Purple-flowered Wattle (*Acacia purpureopetala*) (a. 4 cm high; b. 8 cm high) showing initial development of bipinnate leaves (paedomorphic foliage) followed by development of mature phyllodes.

Acacia purpureopetala is rather shallow-rooted (rarely more than 30 cm deep) and lacks a deep tap root (Fig. 8). The main root component radiates to the approximate outer diameter of the branches and foliage. There is no lignotuber or rhizome and little obvious development of root nodules. Roots are quite thick and not protected by a secondary layer of "bark" as found in some plants growing in sub-xeric sclerophyll mountain environments in north Queensland (SJG, personal observations). There is limited development of secondary lateral roots, and fine tertiary roots are lacking or poorly developed, though the scarcity of fine roots could be a function of excavation occurring in the (early) dry season as some tropical plants have seasonally-deciduous fine roots (Janos *et al.* 2008).

Figure 8. Excavated small adult Purple-flowered Wattle (*Acacia purpureo-petala*) showing limited root development and divergence from a vertical tap root less than 20 cm below the ground.

Notes on reproduction

We observed that flowering can occur throughout the year but in greater profusion in December and January, moderately through to about July and sparsely during the driest months. Reports (e.g. Maslin 2001) that the "main flush [is] in June–July" are incorrect. Individual plants flower sparsely compared to the profusion typical of so many wattles. Flowering events in December and January comprise most individuals flowering at the same time. Sparser flowering at other times comprises both fewer individuals flowering and fewer flower heads per plant. As observed with frequent visits to a site at Irvinebank between February and October 2018, flower heads on a plant open intermittently from week to week rather than synchronously, and plants can support all reproductive stages (inflorescence buds, open flowers, developing fruit and dehiscing fruit) at one time. As flowers are produced sequentially, fruits are also produced sequentially. Even large plants do not produce a heavy seed crop; at best ten to twenty mature fruits have been observed and it has rarely been possible to collect more than thirty seeds from a plant at one time.

As they dry, the pods of *A. purpureopetala* open along two longitudinal sutures. In some fruits containing three or four seeds, we observed the fruit starting to split open midway along the suture with the two ends of the fruit remaining joined; but eventually these fruits opened completely. In fruits containing one or two seeds the suture splits open from its distal end away from the peduncle (Fig. 6). Unlike in some wattles (e.g. co-occurring *A. calyculata* and *A. whitei*), the seed is not ejected with explosive force and remains sitting in its locule in the opened fruit until movement of the plant shakes it free.

The seeds of *A. purpureopetala* lack an aril or colourful funicle and are lustreless, and thus seem unlikely to attract animal dispersal agents. When collecting seed, we observed seeds to fall from the fruits directly to a rock and then bounce away some 40 cm. We reproduced this repeatedly under controlled conditions, observing seeds bounce on a flat concrete surface when dropped from a height of 30 cm, the seed rolling away on its thin edge like a wheel to a distance of about 50 cm from the point of impact. In natural conditions, however, seed will likely become lodged between stones, rocks or other plants and be unable to roll away freely to any great distance from the parent plant.

Distribution and population

We encountered 24 patches of *A. purpureopetala* of which at least 19, and perhaps 20 or 21, have not previously been reported (Table 1). The 21 patches that we have examined in detail and calculated or estimated population and area contained a minimum of 7,066 individuals over a summed area of 20.44 ha. Patches ranged from much less than 0.01 ha (and, in one case, there was a single individual just over 50 m downslope from an adjacent patch) to 7.4 ha, but only four patches exceeded one hectare and eight were less than 0.1 ha. In four patches with direct measurement of both area (>0.01 ha) and population, within-patch density ranged from 210 to almost 2,500 plants per hectare. Some additional patches and sub-populations exist (TSSC 2010; DEE 2014; Farrow 2015; Andrew Ford, personal communication to SJG) though it appears that these are less substantial than those we have documented.

The 24 patches we have encountered are arranged within eleven sub-populations (i.e. eleven clusters separated by at least one kilometre from any other patch or cluster of patches) of which five have not previously been reported (Table 1). However, the vast majority of the population occurred in just two sub-populations, one near Irvinebank township for which we estimate there to be 3,800 adults in three patches and Farrow [2015] described seeing "many hundreds" in a fourth patch, and the other at Coolgarra Road (2) (1,601 adults & 76 juveniles). Two additional patches – Mt Nolan (est. 500 adults) and near Coolgarra Road (est. 590 adults) might prove more substantial than our conservative estimates.

Juvenile plants were observed in most patches, and were abundant in some patches examined in several different years (2016, 2018) and at various times of year (April, August). In four patches in which we counted individuals classified by age class (Table 1), juveniles comprised from 4.5 to 52.9% of the total count. There was no obvious disturbance trigger such as fire or physical disturbance of the ground associated with these abundances.

Table 1. Patches and sub-populations of *Acacia purpureopetala* encountered during this study, and the relationship of these to previously documented 'populations'.
Population sizes and patch areas not qualified by "est." are exact measures (see Methods). Locations are generalised to protect sub-populations but coordinates will be made available to *bona fide* researchers upon request.

Patch no.	Sub-population	Equivalent population as listed in SPRAT*[1]	Notes
1	Mt Emerald	1. South of Walkamin	not examined in detail by us; SPRAT est. 40 individuals
2	Mt Emerald	new patch within 1. South of Walkamin	found in Aug. 2016 by SJG 300 m from patch #1; 18 plants over <0.01 ha
3	near Mt Emerald	-	2.6 km from 1. Mt Emerald; discovered Aug. 2016 by SJG; est. >100 plants over est. 0.75 ha, including 30 counted in 20 x 20 m sample plot
4	Stannary Hills: Mutchilba Rd	-	1.4 km from SPRAT population '2. You and Me Mine'; discovered by SJG & Franziska Bleuer, Jan. 2016; est. 20 plants over est. 40 m^2
5	Watsonville	patch status unclear; it is within the '4. Near Herberton' sub-population	discovered by Saeed De Ridder and SJG in Aug. 2012; est. >100 over est. 0.8 ha. There are – or have been – at least three patches within this sub-population, and it is unclear which SPRAT and TSSC (2010) are referring to.
6	Pine Log Ck	-	found by the late Saeed De Ridder; in April 2016 it comprised 33 adults & 15 juveniles over 0.06 ha
7	Pine Log Ck	-	found by Saeed & SJG in Aug. 2012; in April 2016 it comprised 88 adults & 99 juveniles over 0.24 ha
8	Pine Log Ck	-	found by Saeed & SJG in Aug. 2012; in April 2016 it comprised 189 adults & 18 juveniles over 0.90 ha
9	Jumna area	5. Jumna Mine	SPRAT status of sub-population and patch unclear but sub-population estimate is 100. One patch of est. 12 plants thinly spread sighted by DCF in 2012
10	Irvinebank	6. Ibis Dam	examined only cursorily by us. SPRAT est. is 100 individuals. Farrow (2015) described seeing "many hundreds" here.
11	Irvinebank	-	found by SJG in Feb. 2018; in April 2018, counted 221 in 0.05 ha sample plot; in July 2018, est. >2,000 in 7.38 ha
12	Irvinebank	-	found by SJG in Feb. 2018; in Aug. 2018, est. 1,000 adults with numerous juveniles in a minimum of 2.36 ha; also an isolated individual 51 m away (downslope)
13	Irvinebank	-	found by SJG in Feb. 2018; in Aug. 2018, est. 800 adults with numerous juveniles in a minimum of 0.60 ha
14	Mt Nolan	-	found by SJG in May 2015; est. >400 plants over 3.30 ha in late 2015
15	Mt Nolan	-	found by SJG in May 2015 c. 200 m from patch #14; counted 100+ plants in est. 1 ha in late 2015
16	Coolgarra Road (1)	-	found in Jan. 2016 by DCF & SJG, 2.3 km from nearest other known sub-population (Coolgarra Rd (2)); on that occasion, it comprised 27 plants over <0.01 ha
17	Coolgarra Road (2)	one of 8., 9. or 10. Along the Mt Misery-Coolgara road	BRI AQ0871890*[2] (Wannan & De Ridder, Oct. 2006): "more than 50 plants"*[4]. SPRAT estimate is <5 plants. In Jan. 2016, we counted 1,601 adults & 76 juveniles over 0.66 ha
18	near Coolgarra Rd	-*[3]	one of seven patches in this sub-population located by Tom De Ridder, SJG & DCF during 2015 and 2016; in Feb. 2016, est. 200 plants over 0.71 ha
19	near Coolgarra Rd	-*[3]	one of seven patches in this sub-population located by Tom De Ridder, SJG & DCF during 2015 and 2016; in May 2016, est. >300 plants over 1.26 ha
20	near Coolgarra Rd	-*[3]	one of seven patches in this sub-population located by Tom De Ridder, SJG & DCF during 2015 and 2016; in May 2016, est. 50 plants over 0.38 ha
21	near Coolgarra Rd	-*[3]	one of seven patches in this sub-population located by Tom De Ridder, SJG & DCF during 2015 and 2016; in 2016, est. <20 plants in <0.01 ha
22	near Coolgarra Rd	-*[3]	one of seven patches in this sub-population located by Tom De Ridder, SJG & DCF during 2015 and 2016; in 2016, est. <20 plants in <0.01 ha
23	near Coolgarra Rd	-*[3]	one of seven patches in this sub-population located by Tom De Ridder, SJG & DCF during 2015 and 2016; in 2016, est. <20 plants in <0.01 ha
24	near Coolgarra Rd	-*[3]	one of seven patches in this sub-population located by Tom De Ridder, SJG & DCF during 2015 and 2016; in 2016, est. <20 plants in <0.01 ha

*[1] Species Profile and Threats Database – DEE (2014), supplemented by TSSC (2010). We note that the gap between named 'populations' is always more than 1 km and that areas are small, and thus interpret these as sub-populations each containing only a single patch.
*[2] This is the catalogue number of a collection in the Queensland Herbarium in Brisbane.
*[3] Based on the coordinates of a Queensland Herbarium collection, we believe this may be a new patch within one of the three sub-populations listed by SPRAT as "Along the Mt Misery-Coolgara road" each with an estimated population of <5.

Site attributes

Acacia purpureopetala occurs on varied geologies though most patches and sub-populations are on granites (Table 2), and variously on gravelly slopes, among boulders, on granitic sandsheets and among outcropping rocks. As a qualification to predominance on granites, the large populations at Irvinebank and Mt Nolan are on metamorphics. In our observation, the species always occurs on locally-elevated, well-drained sites and frequently on east or north-east facing slopes. Sub-populations range in elevation from 630 to 1030 m. Patches occur under a wide variety of dominant eucalypts (notably including *Eucalyptus pachycalyx*, *E. cloeziana*, *Corymbia rhodops*, *C. trachyphloia* and *C. stockeri*) and across a range of woodland (and rarely, shrubland) types. The common feature of the vegetation we have noted (relative to interspersed vegetation types) is the absence of dense grass swards (such as those formed by *Themeda triandra*) (e.g. Fig. 9), but rather a sparse cover of grass such as *Cleistocloa subjuncea* and less commonly, *Eriachne mucronata*. Low shrubs are also frequently associated with *A. purpureo-petala* and include *Gompholobium nitidum*, *Jacksonia thesioides* and *Acacia calyculata*.

Of particular relevance to the species' conservation status is its frequent occurrence on disturbed mine sites and roadsides. Our observations indicate that the vast majority of occurrences are in relatively undisturbed woodland and that disturbance is often only peripheral to the main patch area. For example, the relatively large Coolgarra Road (2) sub-population occurs among granite boulders and adjacent slopes, extending marginally downslope to the nearby roadside. The relatively large Mt Nolan population occurs mostly around and downslope from an abandoned mine but also on a nearby undisturbed hill. However, there is an obvious tendency for populations to flourish along occasionally-graded firebreaks and other rarely-disturbed trails, suggesting that one-off or rare disturbance might trigger germination and enable establishment.

Discussion

Purple-flowered Wattle (*Acacia purpureopetala*) is, by comparison with the observable robustness and showy flowering of so many wattles, a small species with diffuse flowering and evidently low seed production. Its phyllodes lack the nectaries present in many wattles, organs which serve to attract pollinators (Stone *et al.* 2003). It is one of only about 15% of Australian wattle species whose seeds lack an aril (Maslin 2014). Arillate seeds in *Acacia* are strongly associated with dispersal by ants and birds (Davidson & Morton 1984). Thus, the lustreless, exarillate seed of *A. purpureopetala* suggests poor dispersal ability. It also has a surprisingly poorly developed root system – surprising because the sites on which it grows are harsh and exposed to a long annual dry season. Although we have no direct evidence of its ability to cope with fire, its small size, lack of root thickening, moderate abundance of seedlings and restriction to areas with low grass cover suggest it is an obligate seeder. Wattles exhibit a diverse range of responses to fire ranging from being fire-killed obligate seeders to underground, basal and epicormic resprouters (Clarke *et al.* 2015). If it is an obligate seeder, *A. purpureopetala* would require a sufficient gap between fires to reach maturity and renew seed reserves similar to the obligate-seeding shrubs of heathlands on the Arnhemland Plateau (Russell-Smith *et al.* 2002).

These factors combine to present the species as somewhat unusual among wattles in addition to its flower colour. It might be of relictual occurrence.

Table 2. Parent material (surface geology) of 24 Purple-flowered Wattle (*Acacia purpureopetala*) patches observed by the authors.
Data are from an intersection of patch coordinates with the Queensland Globe Surface Geology map, backed in many cases by our observations.

Parent material (geological unit)	No. of patches	No. of sub-populations
metamorphic (Hodgkinson Formation)	7	3
granite (Lass O'Gowrie, Jumna, Go Sam, Percy Granophyre)	14	6
rhyolite (Walsh Bluff Volcanics)	3	2

Figure 9. Purple-flowered Wattle (*Acacia purpureopetala*) with low shrubs and only sparse grass growing among small granite boulders and being photographed by Tom De Ridder.
This is patch no. 18 (near Coolgarra Road).

Alternatively, it might be highly adapted to small areas that are naturally protected from fire in an otherwise fire-affected landscape, and hence benefit from restricted seed dispersal. Millar *et al.* (2014) presents the potentially analogous case of *Acacia woodmaniorum*, which is restricted to naturally fragmented skeletal soils on banded ironstone formations in a small area of Western Australia.

Our counts and estimates indicate that *A. purpureopetala* occupies at least c. 2.5 times as much habitat, and has a population more than an order of magnitude greater than that previously estimated in the species' conservation assessment under the Commonwealth's *Environment Protection and Biodiversity Conservation Act 1999* (TSSC 2010; DEE 2014). Our estimates have been calibrated against actual counts at other sites and in sub-samples of patches, and we believe are quite conservative (see next paragraph). Even when the additional known populations that we did not survey are considered, the species remains extremely rare by any definition, being restricted to fragments totalling less than 30 ha within an Extent of Occurrence – a minimum convex polygon taking in all known records – which we estimate to be 634 km^2 (Fig. 2).

It is not entirely clear why we recorded so many more individuals than were previously known, this being true even of previously-known patches. The Coolgarra Road (2) patch (Table 1) illustrates the issue starkly, with a 2006 estimate of more than 50 plants, a SPRAT estimate of less than 5 plants and our systematic count of 1,601 adults & 76 juveniles. Even after mapping out the patch in detail, we estimate that our visual assessment prior to counting plants might have conservatively totalled three or four hundred individuals. This would suggest that we searched and counted more thoroughly than had been done before. The alternative is that sub-populations fluctuate over time, increasing following key germination events then (perhaps progressively) diminishing until the next such event. The possible triggers for such events are not known but might include occasional fire (e.g. Williams *et al.* 2004). The possibility of major fluctuations in populations over time is an important caution to the interpretation of the increased population estimate we have provided.

The landscape in which *A. purpureopetala* occurs is not currently threatened by widespread clearing of native vegetation, but localised clearing for mines and wind farms has occurred. One patch of *A. purpureopetala* was extirpated by mining activity (Saeed De Ridder, personal communication to SJG). We do not know what further mining and wind farm developments in the area are proposed or plausible, but the threat remains tangible and is not mitigated by the ability of the species to (sometimes) establish on disused mine surfaces. We are also aware of the loss of individuals to roadworks, and the largest known stand of the species is in the vicinity of the town of Irvinebank where habitat loss and unsustainable levels of disturbance are feasible. The response of the species to any possible intensification of fire management is unknown, but its life history characteristics indicate that fires could be detrimental to the species' persistence.

Much remains to be learned before the future of *A. purpureopetala* can be managed with assurance, with our study highlighting key knowledge gaps. What are the environmental correlates of its occurrence? How do mature plants of the species respond to fire? What conditions trigger germination? What is the survival rate of germinants? What is the longevity of adults and how soon after germination do they produce seed?

However, there currently is no thorough management aimed at ensuring the future of *A. purpureopetala*. Nor does the species occur in any conservation reserve. Its fate therefore relies on species-centred legislative instruments to afford it some protection, and even then, the requirement to initiate conservation measures are triggered only if the plant is found during appropriate investigative surveys by persons with adequate skills and knowledge to recognise the species.

Importantly, *Acacia purpureopetala* is but one of quite a number of locally endemic plants restricted to specialised habitats and found only in the hills of the Herberton-Irvinebank region, all similarly lacking reservation (or nearly so) or effective management. These include two striking eucalypts, the Red-throated Bloodwood (*Corymbia rhodops*; listed as Vulnerable nationally and in Queensland) and the northern subspecies of the Pumpkin Gum (*Eucalyptus pachycalyx* subsp. *pachycalyx*), as well as several small shrubs including a mint bush (*Prostanthera clotteniana*; Critically Endangered/ Endangered), the scantily branched *Zieria obovata* (listed as Vulnerable/Vulnerable) and the beautiful donkey orchid *Diuris oporina* (Least Concern/Near Threatened). While this list is not inclusive it highlights the importance of the Herberton-Irvinebank district – a region regarded mainly for its mining resources – for threatened and restricted plants, and serves as an important reminder of the need for vigilance during surveys and diligence in the conservation and management of supporting habitats.

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