Acknowledgements

Our research colleagues, Martin Krogh and Sarsha Gorissen, are thanked for their ongoing commitment to better understanding and protecting these swamp ecosystems.

References

Baird I. R. C. and Burgin S. (2016). Conservation of a groundwater-dependent mire-dwelling dragonfly: implications of multiple threatening processes. *Journal of Insect Conservation* 20: 165–78.

Benson D. and Baird I. R. C. (2012). Vegetation, fauna and groundwater interrelations in low nutrient temperate montane peat swamps in the upper Blue Mountains, New South Wales. *Cunninghamia* 12: 267–307.

Birds Rock Colliery (1981). *Review of Environmental Impact Statement submissions May 1981*. EIS463 AB019122. Available at: https://data.nsw.gov.au/data/dataset/birds-rock-colliery-review-of-environmental-impact-statement-submissions197e1

Centennial Coal (2020). *Temperate Highland Peat Swamps on Sandstone Monitoring and Management Plan LW 415 to 417 Annual Report*. Springvale Mine - March 2020.

NSWSC (New South Wales Scientific Committee) (2005). Alteration of habitat following subsidence due to longwall mining. NSW Scientific Committee Key Threatening Process final determination. [Accessed January 10th 2018]. Available from: http://www.environment.nsw.gov.au/determinations/LongwallMiningKtp.htm

Late summer and autumn rains spark new hope for three Endangered Midge Orchids in South-east NSW

LAURA CANACKLE[1], ROB ARMSTRONG[1], JOHN BRIGGS[1] AND DAVID McCREERY[2]

[1] NSW Department of Planning, Industry and Environment, 11 Farrer Place, Queanbeyan NSW 2620.
[2] NSW National Parks and Wildlife Service, South Coast Branch, Merimbula NSW 2548.

Background

Midge Orchids (genus *Genoplesium*) are a group of small terrestrial orchids typically producing a short, single flowering stem between 10–30 cm high, bearing clusters of small flowers in a moderately dense spike. When not in flower, only a single, thin, green leaf is present above ground that is indistinguishable from other midge orchids.

In recent times, officers from the Department of Planning and Environment (DPIE) Ecosystems and Threatened Species team with NSW National Parks and Wildlife Service (NPWS), have become increasingly concerned about the low numbers of individuals of three threatened midge orchids being monitored as part of the NSW *Saving our Species* (SoS) program. Declines in populations appear related to unfavourable weather conditions associated with reduced summer rainfall, with uncertainty as to whether populations could ultimately survive under prolonged drought. Late summer and autumn rains in south-east NSW have contributed to a relatively large increase in the flowering populations of these orchids, bringing renewed hope that they will persist for a little longer. The stories of these midge orchids are outlined in this article.

Corresponding author: laura.canackle@environment.nsw.gov.au

Rhyolite Midge Orchid (*Genoplesium rhyoliticum*)

The Rhyolite Midge Orchid (*Genoplesium rhyoliticum*; Figure 1) is Endangered in NSW (*Biodiversity Conservation Act* 2016) and nationally (*Environment Protection and Biodiversity Conservation Act* 1999) and nationally. Its habitat is extremely specific, with only a handful of records from seven rhyolite outcrops in the far south-east of NSW. In 2002, the estimated total population was around 1,300 (NPWS, 2002); however, more recent counts suggest the species has declined by approximately 85% in the past 20 years.

The tiny plants grow in shallow crevices on rhyolite rock outcrops, in a thin layer of soil usually dominated by mosses and lichens. These refugia also support a diversity of invertebrates which attract fauna such as lyrebirds who turn over the moss to forage for insects. Such disturbance of the moss-beds may expose the tubers to desiccation and predation, and with so few plants occupying these moss-beds protecting them from disturbance to facilitate flowering and seed set is considered a management priority. In addition to protecting the immediate areas where the plants grow, staff from DPIE and NPWS have been monitoring the known sites under the SoS program to better understand the distribution and trajectory, but numbers have been nowhere near the 1,300 plants

reported to exist with only 31 flowering plants observed over two outcrops in 2019.

Although the flowering period is recorded as December to January, flowering of *G. rhyoliticum* appears to be largely triggered by rainfall. In January 2020, following an incredibly dry few months, the Border Fire in southern NSW spread northwards to within one kilometre of the known sites, so monitoring could not be safely undertaken until mid-February. It was therefore assumed the flowering window had been missed. However, a fortuitously timed rain event in early February triggered a late flowering response and we were delighted to discover 50 flowering plants on five outcrops.

Figure 1. Rhyolite Midge Orchid. Photo: Jackie Miles, DPIE

The strategy

Due to the variability of flowering and remote nature of these rhyolite outcrops, past surveys have been opportunistic and resource dependent. Since the introduction of SoS, annual population counts have been conducted at two important outcrops and other sites have been monitored. Other critical actions include habitat protection from native herbivores and monitoring for emerging threats.

Wildlife cameras were installed at one site to determine the cause of disturbance at an important moss-bed (Figure 2). In order to protect the few plants thought to remain, stainless steel mesh panels were installed over small areas to help the moss recover from lyrebird diggings and protect it from further disturbance.

Figure 2: Wildlife camera image showing moss-bed with a lyrebird fossicking for insects.

Extensive surveys were initiated this year (2020) after one population was observed to be flowering in higher numbers than recent years. Nine outcrops were surveyed in late February and March including five where the species had previously been recorded.

All plants (including leaves) were counted. Although the identity of sterile plants cannot be 100% confirmed, these are very likely to be *G. rhyoliticum* based on leaf characteristics and that no other *Genoplesium* species have been recorded in the area with which it could be confused.

Results

Wildlife camera footage showed that mesh was successful in deterring lyrebirds and herbivores from overturning the moss. This was confirmed during February's site visit when panels were observed to be intact with non-browsed plants persisting (Figure 3). Some of these plants flowered and set seed, which were collected and sent to the Australian PlantBank at the Australian Botanic Garden Mount Annan.

Table 1 shows the monitoring results from the past four years. From 2017–2019, below average rainfall resulted in poor emergence of the species and a reduced survey effort, as the plants would have likely been dormant if present. In 2020 all five locations with previously known records had plants – the other two outcrops were not surveyed, although it is probable that they also supported good numbers. Four outcrops not previously surveyed did not have any plants.

Table 1. Monitoring results of the Rhyolite Midge Orchid from the past four years.

Year	Flowering	Non-Flowering
2016–2017	0	11
2017–2018	0	33
2018–2019	31	17
2019–2020	50	142

Figure 3: Rhyolite Midge Orchid leaves with habitat protection. Photo: Laura Canackle, DPIE

It is not clear whether the 1,300 plants reported in 2002 included non-flowering plants so it is difficult to compare 2020 numbers with confidence, but it is certain there has been a sharp decline over the past two decades. Numbers are still critically low, which leaves the species vulnerable to localised stochastic events. Fortunately, these plants escaped the fires over summer 2019–2020 so they were able to flower this season.

The reason for the higher emergence and flowering in 2020 may not only be due to the February rain event but also that the extremely dry season leading up to the flowering period resulted in some shrub death, leading to more habitat availability on the outcrops (Jackie Miles, 2020 pers comm.). It is hoped the coming year brings more reliable rainfall, and that some outcrops may still have undiscovered populations persisting, waiting to be discovered and conserved through continued investment in threat mitigation.

Superb Midge Orchid (*Genoplesium superbum*)

Corresponding author: rob.armstrong@environment.nsw.gov.au

The Superb Midge Orchid (*Genoplesium superbum*; Figure 4) is Endangered in NSW (*Biodiversity Conservation Act* 2016), with a few small populations in the Nerriga and Mongarlowe area and a disjunct record around Lithgow. The habitat is non-specific, with occurrences on rock shelves, dry forest and grassy woodlands on Ordovician and Permian sediments. Flowering generally occurs from December to April in response to substantial summer and autumn rains, as have occurred in 2020.

With varied habitat and small population sizes, main threats include land development and a range of threats associated with small and isolated populations including inbreeding depression and increased susceptibility to stochastic events (DPIE, 2020). Opportunistic browsing by native herbivores is a threat at each population, along with unpredictable warm-season rainfall.

Some populations were burnt by the Currowan and Gospers Mountain fires in early 2020, whereas others escaped the fire by small margins. The late summer and autumn rain sparked a significant flowering event after recent years yielded minimal or no flowering in all populations.

Figure 4. Superb Midge Orchid, showing characteristic coarse, pinkish mauve cilia and purplish lateral sepals. Photo: Rob Armstrong, DPIE

The strategy

Under the SoS program, we have been undertaking critical actions to reduce the threat to populations such as caging individuals to reduce opportunistic browsing, installing roadside markers in collaboration with local councils, weed control and increasing survey effort in better years to determine the extent of current populations and find new populations.

Targeted surveys in known locations were undertaken to confirm above-ground presence, with meandering surveys in nearby suitable habitat. Where presence was confirmed at key sites, each plant was tagged and demographic parameters suggested by Swarts and Dixon (2017) including flowering status, number of flowers on each plant, grazing pressure, microhabitat, leaf length, inflorescence length, total length and seedpod development were measured. Covariate information on fire intensity and preceding rainfall events was also noted (BoM, 2020). Populations were periodically monitored to check seedpod development and the emergence of additional plants.

Results

After no records in early 2017 and 2018, minimal records in 2019 (no plants in Mongarlowe cluster and four in Nerriga cluster), the significant and well-timed January-February rainfall event sparked a flowering/emergence event not seen since the inception of the SoS surveys in early 2017. In burnt areas, it is likely that smaller plants were more detectable. Table 2 shows the number of orchids observed across years, with rainfall for January-February since 2017 compared to the long-term median; in 2020 there was 2-day rainfall events of 145.4mm at Nerriga (250% of median February rainfall) and 109.2 mm at Mongarlowe (191% of median February rainfall), a phenomenon not seen in previous years, that contributed to the eventual suppression of the Currowan fire after 74 days. It is considered that this soaking rain lead to the significant flowering.

The large number of plants provided the first opportunity to examine population demographics. There were no obvious trends between sites/clusters or burnt/unburnt populations, however recorded information suggests there is significant variation beyond that of the described taxon.

Seed pod development was noted across all plants that had flowered (Figure 5), although with flowering observed from early March to late April, observations were not made on the late-flowering plants. However, it appears that pollination rates are very high which was pleasantly surprising as the level of impact on pollinators in fire-ravaged areas was unknown. Most *Genoplesium* are pollinated by very small Diptera (Kuiter, 2016); it is unknown if the Superb Midge Orchid is autogamous and many smaller *Genoplesium* previously thought as such are now suspected to be pollinated in part by very small Diptera (Scatopsidae), so it is considered likely that pollinators are present. Seeds were collected from five locations within the Nerriga and Mongarlowe clusters, as well as the disjunct population near Lithgow.

Not surprisingly, browsing rates on uncaged plants differed markedly between burnt and unburnt populations, with a browsing rate of 53% in unburnt areas (30 samples) and 6% in burnt areas (34 samples). The browsing rate in unburnt samples is consistent with observations in other *Genoplesium* (*e.g., G. littorale*, observed browsing rate of 50%; Bower *et al.* 2015). Low browsing rates in burnt areas are reflective of the catastrophic effect of the 2019–2020 fire season on browsing fauna.

Figure 5. Caged Superb Midge Orchid, with developing seedpod. Photo: Rob Armstrong, DPIE

Table 2. Orchid detection relative to January–February summer median rainfall.

	Nerriga Cluster		Mongarlowe Cluster	
Year	**Plants**	**Rainfall mm (% of Jan-Feb median)**	**Plants**	**Rainfall**
2017	0	74.8mm (65%)	0	53.2mm (47%)
2018	0	153.8mm (134%)	0	134mm (118%)
2019	4	99.6mm (87%)	0	165.2mm (146%)
2020	137	249.8mm (217%)	40*	185.6mm (164%)

* includes a new population of 13 plants.

Tallong Midge Orchid (*Genoplesium plumosum*)

The Tallong Midge Orchid (*Genoplesium plumosum*; Figure 6) is Critically Endangered in NSW (*Biodiversity Conservation Act* 2016) and Endangered nationally (*Environment Protection and Biodiversity Conservation Act* 1999). Until recently it was only known from the vicinity of Tallong with very small disjunct populations near Marulan and Wingello. The habitat is highly specific, with the species only growing on sandstone rock shelves that support low heath, mosses and lichens. Flowering occurs between mid-February and late-April, with flowering generally occurring 3–4 weeks after substantial summer or autumn rainfall.

The largest population occurs near Tallong, with many sub-populations occurring on residential blocks and road verges. Most sub-populations have been under threat by construction, vehicle movements, soil dumping or weed invasion. Fortunately, some sub-populations occur on land that has been set aside to protect the orchid. Other threats include those associated with small and isolated populations, particularly increased susceptibility to stochastic events such as drought. Browsing by native herbivores, particularly wombats, is also a threat leading to reduced seed production needed for ongoing recruitment. The Tallong and Marulan populations were also spared from the recent bushfires.

A recovery plan completed in 2002 facilitated detailed surveys of known and potential habitat, establishing three permanent monitoring plots on protected land at Tallong to track population trends and monitor individual plant demography. All flowering plants were measured and tagged initially, and along with subsequent new plants, measured and tagged annually.

Figure 6. Tallong Midge Orchid, best distinguished from several co-occurring midge orchids by its elongated dark purplish labellum with its short fringe of dark hairs at its tip. Photo: John Briggs, DPIE

The strategy

Selected recovery actions from the recovery plan were incorporated into the SoS conservation project, with two new actions added to help address the apparent long-term decline. These include seed collection and storage in the Australian PlantBank and undertaking research into propagation, which if successful, would provide translocation options.

Results

Tallong Midge Orchid has 20 years of annual monitoring data from three plots established in 2001 (prior to the onset of the millennium drought), documenting the impact of that drought and release in 2010, as well as the initial response to recent rains providing some relief in the current drought.

Figure 7 shows the number of flowering plants within plots from 2001 to present. The impact of the millennium drought is clearly evident, with a steady decline in flowering plants from 2001 (96 plants) to 2006 (5 plants), with the number remaining below 15 until the breaking of the drought in 2010 (40 plants; less than half pre-drought numbers). Numbers of flowering plants have been below 30 in all subsequent years. Despite the observed strong flowering of other midge orchids in 2020, the number of flowering plants in the Tallong Midge Orchid plots has not shown a marked increase. Given the current conditions, it would seem reasonable to expect an increase to numbers similar to 2001 if the long-term situation was relatively stable. The decline suggests a long-term lag from the effects of the millennium drought and subsequent conditions.

Fortunately, the situation for Tallong Midge Orchid may not be as dire as plot data suggests. Surveys of all sub-populations in the Tallong area in 2020 indicated that the response to recent rains is dependent on aspect, with sites having a northerly and westerly aspect responding poorly relative to less exposed aspects. This is supported by the standardised plot data from the main Tallong population, which shows a general trend of higher relative proportion of flowering in sheltered aspects as drought is prolonged or prevailing conditions extremely dry. For one site there has been an overall increase of flowering plants from 66 in 2019 to 303 in 2020, which is a similar number recorded in 2000. Two plots have a westerly aspect and one has a southerly aspect. In autumn 2020, the west-facing plots had no flowering plants whilst the south-facing plot had nine. The plot placement appears unrepresentative of the overall response due to the susceptibility to drought of west-facing sites. The effect of aspect on flowering can be seen by comparing the relative abundance of flowering on the plot with a southerly aspect with the total number.

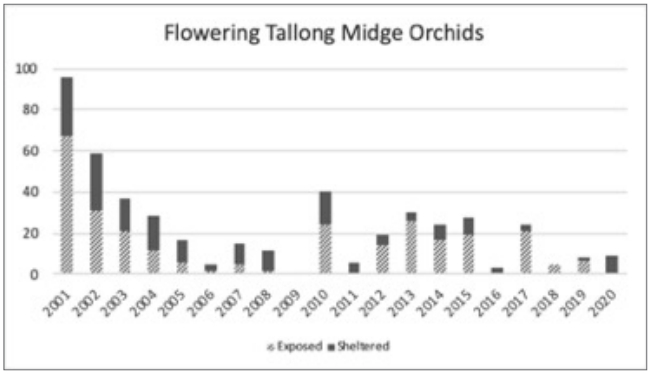

Figure 7. Number of flowering Tallong Midge Orchid plants on monitoring plots each year since 2001.

On another positive note, a re-survey of a previously recorded site near Marulan found a total of 176 flowering Tallong Midge Orchids, up from three a few years ago. This site has an easterly aspect and supports the consistently better response to recent rains recorded on similar aspects. A new smaller population was confirmed while surveying for the Superb Midge Orchid in Morton National Park in autumn 2020 in an area burnt in the recent Currowan bushfire; this represents a 40 km range extension.

References

BoM (2020) Climate Data online - Nerriga (069049), Braidwood (069010). Bureau of Meteorology. Available at: http://www.bom.gov.au/climate/data/

Bower, C., Towle, B. and Bickel, D. (2015). Reproductive success and pollination of the Tuncurry Midge Orchid (*Genoplesium littorale*) (Orchidaceae) by Chloropid Flies. *Telopea* 18: 42–55.

DPIE (2020). Tallong Midge Orchid profile, NSW Department of Planning, Industry and Environment. Available at: https://www.environment.nsw.gov.au/threatenedSpeciesApp/profile.aspx?id=20029

DPIE (2019). Superb midge orchid profile, NSW Department of Planning, Industry and Environment. Available at: https://www.environment.nsw.gov.au/threatenedSpeciesApp/profile.aspx?id=20029

Kuiter, R.H. (2016). *Orchid pollinators of Victoria (4th edition)*. Aquatic Photographics, Seaford Vic.

NPWS (2002). *Approved Recovery Plan for the Tallong Midge Orchid* (Genoplesium plumosum). NSW National Parks and Wildlife Service, Hurstville NSW.

NPWS (2002). *Draft Recovery Plan for Threatened Flora of Rocky Outcrops in South Eastern New South Wales*. National Parks and Wildlife Service, Hurstville NSW.

Swarts, N.D. and Dixon, K.W. (2017). *Conservation methods for terrestrial orchids*. J. Ross Publishing, USA.

Acknowledgements

For all projects: Gavin Phillips, Zoe-Joy Newby, Jess Wait and Karen Sommerville from the Royal Botanic Gardens and Domain Trust for seed collection and propagation research. For *Genoplesium rhyoliticum*: Anna Murphy, who laid the groundwork for the project; the survey support, advice and field skills of NPWS staff including David McCreery and George Malolakis and survey skills of botanical expert Jackie Miles. For *Genoplesium superbum*: the numerous survey efforts were greatly supported by Roger Farrow, Laura Canackle, Mary Appleby, John Briggs, Jean Egan. For *Genoplesium plumosum*: Genevieve Wright for assistance in the development of the recovery plan and early survey work. Several DPIE staff who have assisted with the annual monitoring. Landowners who have assisted in the protection of the species and permitted annual monitoring.