

Distribution, habitat characteristics and conservation management of *Prasophyllum stellatum* (Ben Lomond leek-orchid), a forest-dependent threatened species

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Abstract

Surveys were undertaken for *Prasophyllum stellatum*, a threatened forest-dependent orchid. The species occurs in the north-east (Storys Creek area on the southern foothills of Ben Lomond) and the central north (Cluan Tiers area) of Tasmania. It occurs at moderate elevations on Jurassic dolerite in a wide successional range of moist eucalypt forests dominated by *Eucalyptus delegatensis*. Its extent of occurrence is approximately 214 ha (Storys Creek area) and 110 ha (Cluan Tiers area) but its area of occupancy is substantially less. The species has a patchy distribution within its range and occurs in low numbers: 46 individuals were detected from 38 sites in the Storys Creek area, and 32 individuals from 13 sites in the Cluan Tiers area.

P. stellatum occurs predominantly on State forest subject to forestry activities. The species was detected from a range of forest ages including relatively undisturbed mature forest through to forests regenerating from both selective logging and clearfelling in the 1970s

and 1980s. The species was often recorded on old snig tracks and landings, gravel road verges, unsealed track surfaces, and in harvested forest and retained patches of mature forest within a harvested landscape. While the conservation status of endangered on the Tasmanian Threatened Species Protection Act 1995 is warranted for *P. stellatum* due to its restricted distribution and low population numbers, we argue that carefully managed forestry activities that exclude key sites, minimise intensive ground disturbance, and maintain some canopy and understory structure, are consistent with the conservation of this species, and may be beneficial in maintaining its habitat.

The study highlighted the complex taxonomy of the genus *Prasophyllum* in Tasmania and the implications of this for conservation management. *P. stellatum* exhibits significant variation in morphological features that available descriptions and keys do not acknowledge. Further review of the *Prasophyllum truncatum* species-complex in Tasmania (to which *P. stellatum* belongs) is warranted.

Introduction

Prasophyllum stellatum is listed as Endangered (Schedule 3) on the Tasmanian *Threatened Species Protection Act 1995* and Critically Endangered on the *Commonwealth Environment Protection and Biodiversity Conservation Act 1999*. It is one of a few genuinely forest-dependent leek-orchids in Tasmania.

Forest-dependent species are potentially at risk from a number of factors including forestry-oriented land management activities, inappropriate disturbance regimes (e.g. frequency and intensity of fire events) and changes in climatic conditions, the latter especially following canopy disturbance that may exacerbate the frequency and/or intensity of fire events and cause microclimate changes. Prior to the present study, *P. stellatum* was thought to be restricted to a few sites in the Storys Creek area (Jones *et al.* 1999) and putatively also the Cluan Tiers area (Figure 1). Most sites were on State forest, outside of reserves and in areas subject to selective forms of native forest silviculture.

The potential for forestry activities to impact on *P. stellatum* was recognised when two State forest coupes in the Storys Creek area

were proposed for selective harvesting in 2006, one of which actually supported the type location of the species. As required under the Tasmanian *Forest Practices Code* for the management of threatened species in wood production areas, the Forest Practices Authority and Department of Primary Industries and Water required a specialist assessment be undertaken prior to commencement of forestry operations. Surveys for the species were subsequently undertaken in both coupes proposed for harvesting as well as some surrounding areas (Wapstra 2006a, 2006b). *P. stellatum* was located from several sites, and management advice was provided that required exclusion zones be established to ensure maintenance of mapped locations and potential habitat.

The present study was prompted by the need for more information on the distribution and habitat preferences of this species, for developing appropriate forestry management advice for future coupes in the Storys Creek area (or other potential areas of occurrence), coupled with the initial success of surveys conducted in response to the proposed harvesting operations and the release of the *Flora Recovery Plan: Tasmanian Threatened Orchids 2006–2010* (TSS 2006), which highlighted the high priority of *P. stellatum* for conservation management.

The present study aimed to:

- further elucidate the distribution and habitat requirements of *P. stellatum*;
- determine the potential and actual threats presented by forestry practices to *P. stellatum*; and
- re-assess the conservation status of *P. stellatum*, based on the broader knowledge of the species.

Background on *Prasophyllum stellatum*

In a major review of *Prasophyllum* in Tasmania, Jones (1998) noted that the genus is taxonomically one of the most complex of the terrestrial orchid genera in Australia, which consequently creates considerable

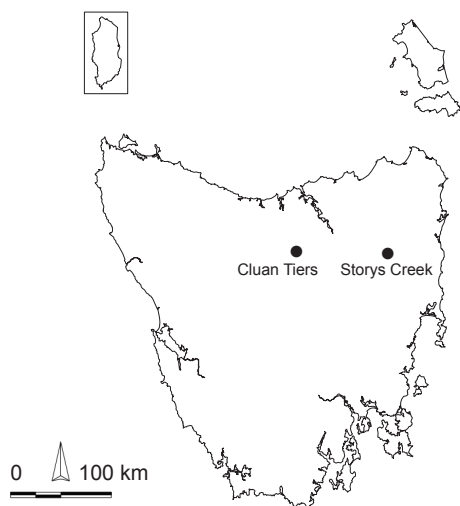


Figure 1. Distribution of *Prasophyllum stellatum*.

difficulties for identification by taxonomists, ecologists and even orchid specialists. Jones (1998) paid particular attention to the complex of taxa surrounding *P. patens*, *P. truncatum* and *P. odoratum*. All three species share similar characters: a prominent white labellum with crisped/undulate margins and a short raised callus. Jones (1998) concluded that *P. patens* and *P. odoratum* do not occur in Tasmania but that a complex of taxa, including *P. truncatum*, is found in Tasmania. Jones (1998) described several new taxa within the *P. truncatum* species-complex, including *P. stellatum*. Notably, he suggested that his account “though by no means final in such a complex genus, makes considerable progress towards resolving the taxonomy of *Prasophyllum* in Tasmania”.

At the time of description (Jones 1998), *P. stellatum* was known from a single site on the southern foothills of Ben Lomond in the Storys Creek catchment. The type location is described as “Tasmania, Ben Lomond, above Storys Ck township, 20 Feb. 1992, L. Rubenach (Jones 9083) (holo CANB 9220366)”.

Keys to *Prasophyllum* in Tasmania (Jones 1998; Jones *et al.* 1999) include five species in the *P. truncatum* complex, including the long-recognised but poorly known *P. robustum*, the newly-recognised *P. stellatum*, *P. apoxychilum*, and *P. incurvum*, and the long-recognised and widely applied *P. truncatum*. *P. robustum* and *P. stellatum* are separated from the other three species because their flowers are 14-20 mm across (rather than 7-12 mm across). *P. stellatum* and *P. robustum* are further distinguished on the basis of differences in labellum characteristics, distribution and flowering time. *P. incurvum* (thought to be restricted to alpine/subalpine sites) and *P. apoxychilum* (thought to be a near-coastal species) were both described as new by Jones (1998). *P. truncatum* remained a recognised entity (first described in 1840), now regarded as endemic to Tasmania, with a lowland distribution and a long flowering period (Jones 1998).

Prasophyllum stellatum was first noted in 1985 from the Storys Creek area in the southern foothills of Ben Lomond by orchid enthusiast the late Les Rubenach, who recognised the species as unique. Jones (1998) described *P. stellatum* from a small number of specimens collected by Les Rubenach in 1992 from his earlier observed locations. According to Rubenach’s notebooks, the species was thought to be restricted to a few localised sites within the vicinity of what later became the type location near the Storys Creek township. In the mid-1990s, additional *ad hoc* surveys were undertaken, as part of the first recovery plan for forest-dependent orchids, in the vicinity of the type location. These surveys recorded about 40 individuals over a 200 m radius area on a private property title nestled among State forest (Ziegeler 1997). This private property title was also assessed for its suitability for inclusion in the private land reserve system during 2004. Additional sites for *P. stellatum* were recorded using GPS on both private property and State forest but no notes on abundance or distribution were provided. Targeted surveys of two State forest coupes in the Storys Creek area were undertaken in February 2006 by the primary author, which resulted in some detailed mapping of the species within the vicinity of the previous collections and a range extension to the east of about 3 km (Wapstra 2006a, 2006b).

Ziegeler (1997) noted that the *P. stellatum* may be more widespread but could possibly have been confused with other members of the complex, noting an unconfirmed report of the species from the Central Plateau (now known to be the Cluan Tiers area south of Deloraine in the State’s central north). This site represented observations by orchid enthusiast the late Ron Williamson in the 1990s, with a formal collection by him from Cluan Tiers on 8 January 2001. The specimen was tentatively identified as *P. stellatum* by David Jones (CANB 620164). However, in his latest book Jones (2006) seems to have reconciled his prior uncertainties, noting that *P. stellatum* occurs at both Storys Creek and Cluan Tiers. To date, however, there has been

no formal redetermination of the specimen collected by Williamson.

There is one additional collection of *Prasophyllum* from Tasmania that has some affinities to *P. stellatum*. A specimen held at the Tasmanian Herbarium (HO518659) from "Prossers Forest" collected on 22 December 1969 has been tentatively assigned to *P. stellatum*. However, the flowering period is outside the observed flowering period of *P. stellatum* at Storys Creek and Cluan Tiers (late summer), and the Prossers Forest area is at a significantly lower elevation (around 400 m a.s.l. or less). Whether this specimen proves to be *P. stellatum* or another entity within the *P. truncatum* complex is unlikely to be determined in the short term, and will probably rely on collection of fresh material from the Prossers Forest area. For the moment, we are uncomfortable including this specimen in our review of *P. stellatum*; this again highlights the need for a taxonomic review of the species-complex.

Methods

Site selection

Field survey sites were chosen based on the known distribution of *P. stellatum*, namely the Storys Creek and Cluan Tiers areas. Topographic, geological and forest-type maps (aerial photo-interpretation maps developed by Forestry Tasmania, which indicate the canopy type, height and density of patches of forest) were used to broadly target survey sites. Logistics of access further refined potential survey areas. Proposed coupes in the Storys Creek area were also used to target potential survey areas.

The notebooks of Les Rubenach and Ron Williamson were used to determine the possible sites where they observed *P. stellatum* in the Storys Creek and Cluan Tiers areas, respectively. The level of detail provided in the notebooks allowed us to identify these sites to within virtually 10 m. The site of collection in the Cluan Tiers area

was confirmed by personal direction from Mrs Kath Williamson.

Survey timing

Cluan Tiers was surveyed on 22 January 2008. The timing was based on the only confirmed collection of *P. stellatum* on 8 January 2001, which we assumed would allow a minimum 2-week sampling window each side.

Storys Creek was surveyed on 13-14 February 2008. This timing is based on the previous observations of the species in this area (e.g. Wapstra 2006a, 2006b, Ziegeler 1997).

Survey methods

Site selection at a more localised scale maximised the use of resources (people, vehicles and time) by splitting into smaller groups and undertaking meandering foot-based surveys through potential habitat at pseudo-randomly selected take-off points from roads and tracks. The term pseudo-random is used because sites with habitat judged unsuitable were not searched, and site selection became progressively refined as the potential distribution and habitat requirements of *P. stellatum* became better understood in the field. No set time or area limits were placed on particular searches.

Where *Prasophyllum* individuals were detected, hand-held GPS units were used to obtain a precise location. Simple demographic information was recorded including the number of individuals, the stage of anthesis (e.g. bud, full flower, fertilised), and the number of flowers on each plant (in some cases). This method only recorded flowering above-ground individuals. No practical method of detecting and counting below-ground dormant tubers is available. Detecting non-flowering above-ground individuals (i.e. emergent leaves lacking a flowering scape) is also difficult in dense undergrowth and was not attempted. The estimates of population size are thus likely to be underestimates.

Voucher specimens were collected for confirmation of identification and later lodgement at the Tasmanian Herbarium. Site characteristics were recorded including a broad vegetation description, obvious features of land-use history (e.g. logging, roads, fire, etc.), topography, geology, rock cover, aspect and slope.

All specimens were collected under DPIPWE permit number TFL 08001 (in the name of Mark Wapstra). All collection information was supplied to the Department's *Natural Values Atlas* database.

Results and discussion

Identification of Prasophyllum stellatum

Prasophyllum specimens collected from Storys Creek prior to the present study have all been assigned to *P. stellatum*, which by the current concept (Jones 1998) is circumscribed as a tall, large-flowered species. The present study showed

considerable variation in a number of characters in specimens from Storys Creek, meaning that several specimens were not good matches for the type diagnosis (Photo 1). The density of flowers in the inflorescence, the size of the flowers (and specifically the length of the petals and sepals), the degree of incurving of the petals (which seems to be age-dependent), the degree of divergence of the perianth segments and the colour of various parts of the plant all seem to be variable characters that render existing keys difficult to use. The additional variation detected in this study but not by earlier collections could be an artefact of previous collectors selecting the 'best' (i.e. typically the biggest) specimens to send to David Jones for confirmation. In the present study, several specimens were collected from the Storys Creek area, representing the range of elevations and microhabitats occupied by *Prasophyllum* within the survey area, and all were confirmed as *P. stellatum* (M. Clements, CSIRO, pers. comm.).



Photo 1. Variation in morphology of *Prasophyllum stellatum* from the Storys Creek area. A. Individual from type location photographed by Les Rubenach, showing the relatively open flower spike with large, widely-opening flowers. B. Specimen from 2008 likely very close to the site of original (type) collection by Les Rubenach. Note the smallish and less widely-opening flowers. C. Specimen from 2008 showing widely-open flower. This specimen had distinct pink hues.

The identity of *Prasophyllum* specimens from the Cluan Tiers area has been historically confused and this will probably remain the case. During the present survey, specimens of *Prasophyllum* were collected from virtually the precise site of the original Williamson collection (and from numerous sites nearby on the Cluan Tiers). Initially these were identified as *P. truncatum* (M. Clements, pers. comm.). However, closer examination of the specimens (M. Wapstra, unpub. data; H. & A. Wapstra, pers. comm.) suggests that the Cluan Tiers material is not a good match for the Tasmanian concept of *P. truncatum* (Jones *et al.* 1999), which is generally regarded as a lowland species.

We had significant difficulties in differentiating the *Prasophyllum* material from Storys Creek and Cluan Tiers (Photos 1 and 2). In the field, both entities occupied very similar habitats and had similar growth habits. Morphologically, we found little to distinguish the specimens from the two sites, and many characters traditionally used to separate species of *Prasophyllum*

(e.g. density of flowers in the inflorescence, length and shape of perianth segments, degree to which the labellum is reflexed, presence of papillosities on the labellum, etc.) were highly variable, including at a very local scale (i.e. from plants collected only metres apart). For the purposes of the study, all the Cluan Tiers and Storys Creek *Prasophyllum* material was classified as *P. stellatum*.

This study highlights the need for a review of the *P. truncatum* species-complex in Tasmania. The variation we noted in the material from both Storys Creek, including significant variation in individual plants from the type location of *P. stellatum*, and Cluan Tiers suggests that the original circumscription of *P. stellatum* might have been too tight, and that the concept of the species needs to be broadened to capture the now recognised variation. This paper makes no attempt to undertake this, which would require a substantive review and considerable resources, and would logically include other species within *Prasophyllum*

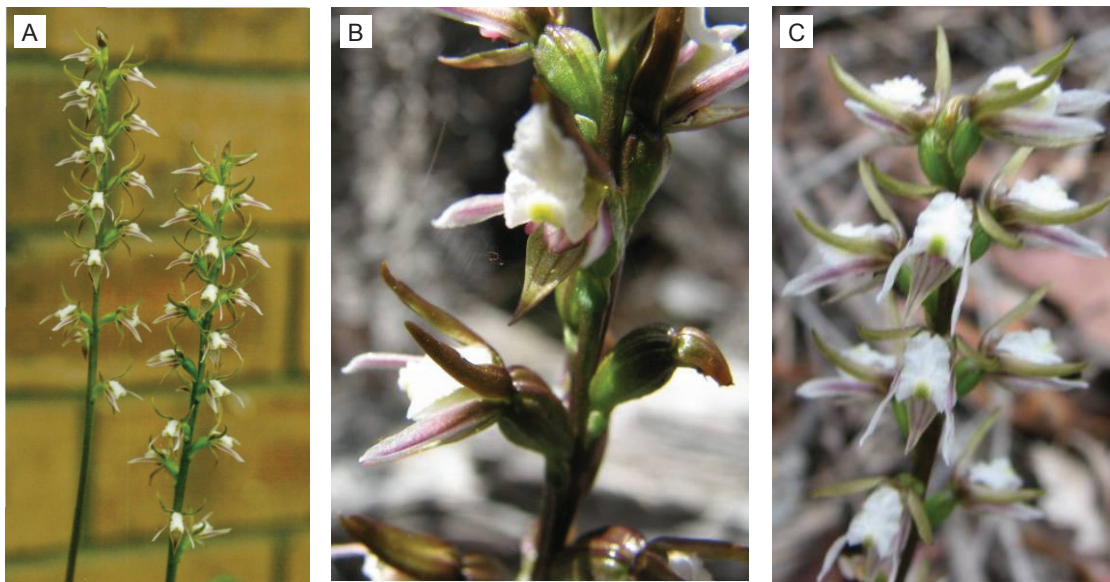


Photo 2. Variation in morphology of *Prasophyllum stellatum* from the Cluan Tiers area. A. Scan of the original photo by Ron Williamson of plants from Cluan Tiers showing the relatively open flower spike with widely-opening large flowers. B. Individual from very close to the Williamson site, collected in 2008. Note the smaller, less widely-opening flowers. C. Individual showing more typical form, also collected in 2008.

with similarly known taxonomic “problems”.

Distribution and habitat

Prasophyllum stellatum was restricted to two relatively small areas in the north-east (Storys Creek area on the southern slopes of Ben Lomond) and the central north (northern slopes of Cluan Tiers) of Tasmania (Figure 1). Sites supporting *P. stellatum* occurred mainly on State forest, and varied in elevation from 790 to 960 m a.s.l. (Storys Creek) and 555 to 695 m a.s.l. (Cluan Tiers). All occurred on Jurassic dolerite. Supporting vegetation was forest dominated by *Eucalyptus delegatensis* (with *E. dalrympleana* as a minor canopy component) with a shrubby to grassy understorey. Most sites had a relatively high surface rock cover with deep clay-loam soils (Photos 3 and 4).

Near Storys Creek, *P. stellatum* occupied three patches of forest with an extent of occurrence of 214 ha (Figure 2). At a finer scale, the species has a much smaller extent of occurrence within the area: 33 ha (western), 4.5 ha (central) and 26 ha (eastern). Based on the similarity of vegetation, topography and geology between and adjacent to the three mapped patches, we expected that *P. stellatum* would be more widespread. However, some additional areas about 1-3 km north-east of the most easterly mapped population were also surveyed but without success. A recent survey of superficially suitable habitat about 3 km south-east of the most westerly mapped population also failed to detect the species (A. Pennington, pers. comm.).

On the Cluan Tiers, *P. stellatum* was detected from several sites, including within tens of metres of the original collection site of Ron Williamson, with an extent of occurrence of 110 ha (Figure 3). Again, at a finer scale, the extent of occurrence was significantly less. Ignoring the westerly outlying sites, the extent of occurrence is 30 ha. Similar to the Storys

Creek area, we would expect that further surveys will detect more sites because superficially there are extensive areas of similar forest at similar elevation on Jurassic dolerite. The notebooks and annotated maps of Ron Williamson indicate that he detected several additional sites supporting species of *Prasophyllum* south of his confirmed site. We surveyed some of the forest south of the mapped points (Figure 1) but found much of the forest to be dense regenerating eucalypt forest (from previous forestry activities) with few canopy openings. These sites are likely to be unsuitable for the species at present.

At both Storys Creek and Cluan Tiers, *P. stellatum* was recorded from various forest successional stages from relatively mature and undisturbed forest with few signs of forest harvesting activities and infrequent fire, to throughout recently (c. 2006) harvested forest (Plates 3 and 4; Table 1). Many sites were located on old snig tracks (detectable as grassed-over rutted tracks through the forest), old landing sites and the immediate verges of well-formed forestry roads (including from soft roadside gravels pushed up from grading, and on less disturbed batters). It is possible that the detection of the species has been enhanced by harvesting activities, and that the relatively low number of individuals detected in less-disturbed forest is an underestimate of the number actually present. However, it is more likely that the disturbance event has released tubers from dormancy or created sites suitable for seeds to germinate.

No sites supporting *P. stellatum* showed signs of recent wildfire, forestry regeneration burns or managed fuel-reduction burns. Ziegeler (1997) noted that “nothing is known of the species’ fire ecology however it occurs in montane forest that is subject to longer intervals between fires than lowland dry sclerophyll forest”, further suggesting that “a fire free interval of 50 years or more might be appropriate”. It is estimated that the sites where *P. stellatum*

Table 1. Number of individuals detected from different forest successional stages.

Habitat type	Number of individuals	Comments
Storys Creek	37	
Unlogged	6	“Unlogged” refers to parts of the forest that have not been subject to recent harvesting; however, virtually all parts of the study area showed evidence of some form of pre-1980s selective harvesting
Retained patch	11	Similar to “unlogged” patches but within a deliberately defined and retained patch amongst recently selectively harvested forest
Larger road/ track	13	Well-established, reasonably well-formed and used roads and tracks through any age of forest, but with plants clearly associated with the track margin, surface or batter
Old snig tracks and landings	2	Patches of forest not logged since the 1970s, and where the individuals were clearly associated with an old track or log processing area
Recent snig track	2	Snig track from most recent harvesting activities
Recent selectively harvested forest	3	Individuals located amongst forest subject to recent selective harvesting, but not from an obvious feature such as a snig track, landing, or retained patch
Cluan Tiers	31	
Unlogged	3	Virtually all the Cluan Tiers area showed evidence of past harvesting activities; “unlogged” sites refer to areas showing no obvious signs of recent forestry activities
Larger road/ track	8	Many individuals were detected along the table drain and batter areas of the several major forestry roads in the area
Pre-1990s harvesting	4	Areas subject to commercial thinning and ‘advanced growth retention’ harvesting between the 1970s and early 1990s
Old snig tracks and landings	16	Sites previously used as snig tracks, coupe boundary tracks or log processing areas in pre-1990s harvesting, and all now supporting or closely surrounded by dense eucalypt regeneration

have been detected have not been subjected to fire for at least three decades. It is likely that *P. stellatum* can persist in the absence of fire as dormant tubers, but that some form of canopy and understorey disturbance is desirable because we rarely detected the species in the shrubbier, less disturbed, parts of the forest.

Population characteristics

Prasophyllum stellatum tended to occur in relatively low numbers at any particular site, often occurring singly or as less than 5 individuals spread over an approximately 50 m radius. In our present surveys at Storys

Creek, we detected 37 fertile individuals at various stages of anthesis from relatively early bud to flowers at full anthesis to withered fertilised flowers. At Cluan Tiers, we detected 31 fertile individuals with plants displaying a similar range of fertile stages (note that Cluan Tiers was surveyed about one month earlier than Storys Creek).

It is difficult to estimate the total population because the numbers of flowering individuals present at any particular site probably vary between years. In the Storys Creek area, subjective observations by field naturalists and orchid enthusiasts suggest some fluctuations in numbers, which may

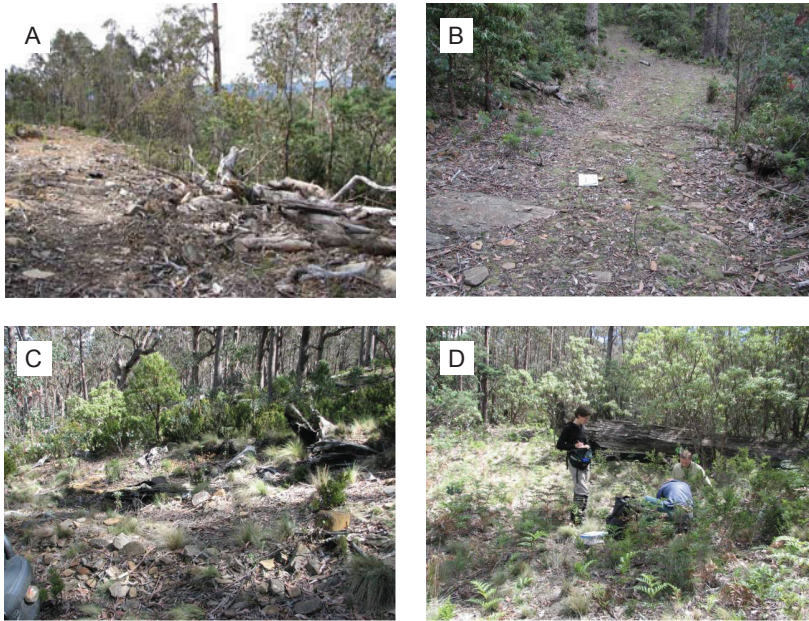


Photo 3. Habitat of *Prasophyllum stellatum* in the Storys Creek area. A. Recent snig track with pushed-up debris adjacent to retained Wildlife Habitat Clump; *P. stellatum* occurred on the immediate fringe of the snig track. B. Old track through mature *Eucalyptus delegatensis* forest; *P. stellatum* grew in the middle of the track (clipboard site) and on the track verges. C. Typical open, rocky, shrubby *Eucalyptus delegatensis* forest that supports *P. stellatum*. D. Grassy opening (old log-landing site from late 1970s) where *P. stellatum* was detected in both the open areas and the selectively logged forest.

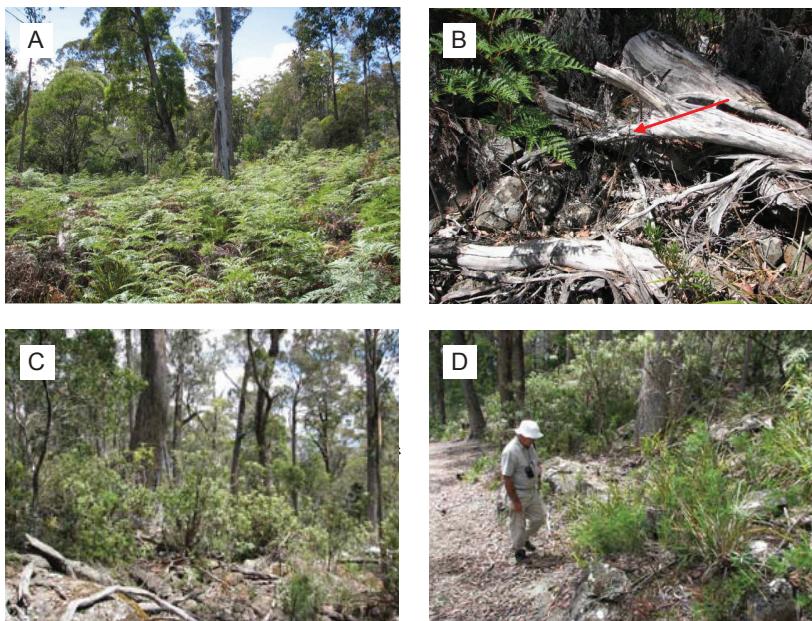


Photo 4. Habitat of *Prasophyllum stellatum* in the Cluan Tiers area. A. Logged site within 100 m of original collection by Williamson. B. *P. stellatum* (arrowed) growing at base of harvested tree amongst logging debris. C and D. Unharvested shrubby *Eucalyptus delegatensis* forest with high rock cover; *P. stellatum* was sporadic through the forest and along the road verges.

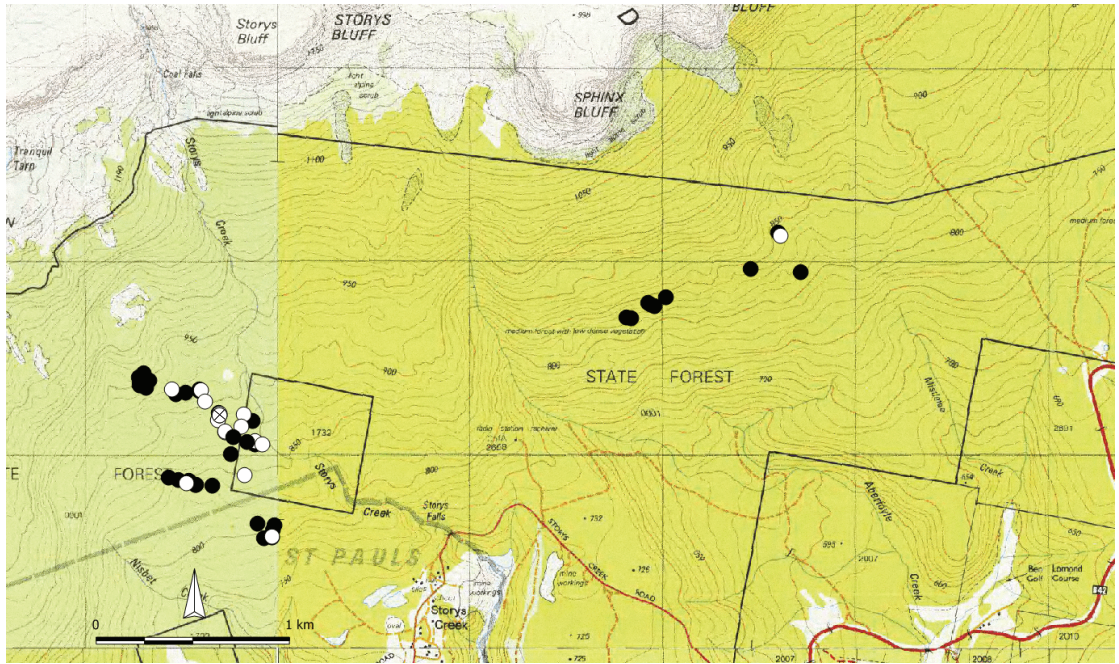


Figure 2. Distribution of *Prasophyllum stellatum* in the Storys Creek area. Solid points, present study. Open points, previous collections. Crossed point, probable type locality.

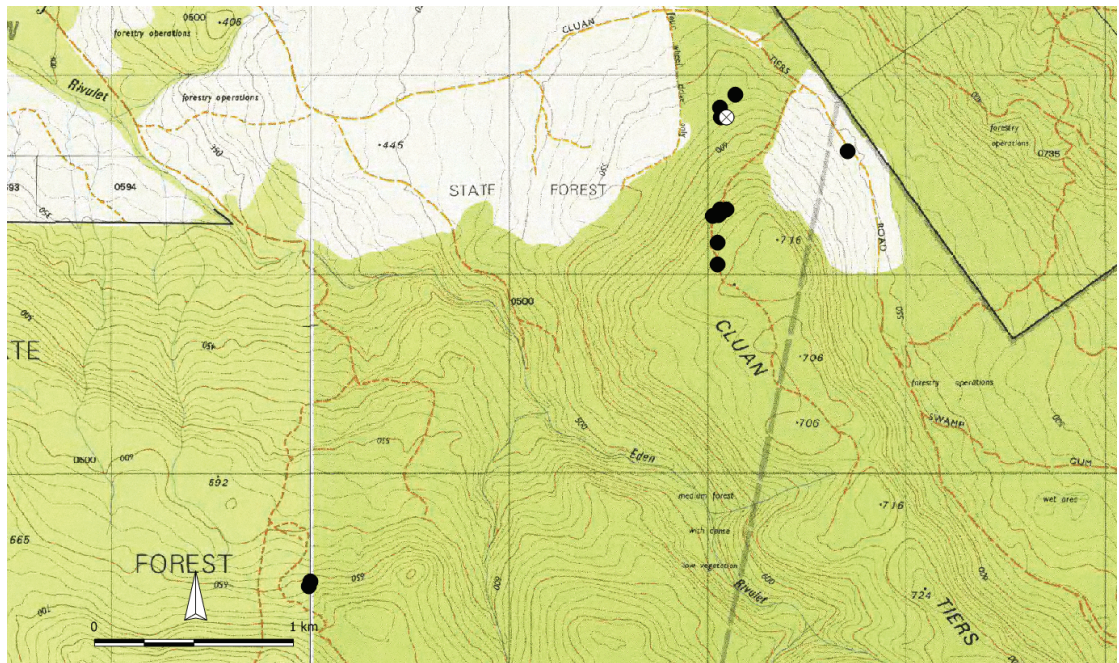


Figure 3. Distribution of *Prasophyllum stellatum* in the Cluan Tiers area. Solid points, present study. Open crossed point, original Williamson collection.

be related to the stage of forest succession following disturbance by selective logging in the mid-1970s. Les Rubenach's field notes indicate that in 1992 he found "about a dozen plants in bloom, all about and above the side track that leads to the very rough creek crossing of Storys Creek from the fire trail". Ziegeler (1997) noted that "a population of c. 40 plants is lightly dispersed over a radius of c. 200 metres", which is the approximate same area as Les Rubenach's observation. Whether the species simply flowers in varying numbers in different years (which is a likely scenario) or benefits over some indeterminate time by disturbance (such as is created by selective harvesting and/or fire) is unknown. It is virtually impossible to estimate the number of individuals of *P. stellatum* that are present as "dormant" tubers but the proportion of the total population that are "dormant" tubers is likely to be high. It is likely that the proportion of dormant individuals will vary as site conditions vary (e.g. the proportion may increase where vegetation cover is higher and competition with other plants for light and nutrients greater). It is significant that we detected the species in 2008 at virtually the exact location of several previous collections in 2006 (possibly even the same individuals) and the 1990s (based on precise directions in Les Rubenach's notebooks). However, we could not detect the species at other previously reported sites (with no obvious alteration to site conditions since the last observation), although it was often located within about 50 m. On present evidence, *P. stellatum* is known from between 50 and 250 mature individuals (these being threshold values often used in analyses of conservation status).

Implications for forest management

P. stellatum is one of many forest-dependent threatened species in Tasmania. Wood production activities are often perceived or assumed to be detrimental to threatened forest flora. While this may be the case for some species with specialised habitats (e.g. the slender treefern, *Cyathea cunninghamii*, which is restricted to deeply-incised gully

systems and relies on the maintenance of a suitable microclimate), some threatened forest species are not detrimentally affected by production forestry. For example, the forest wiregrass, *Tetrarrhena juncea*, seems to benefit from a clearfell-burn-sow silvicultural regime and even colonises plantations (Wapstra *et al.* 2002). Trailing riceflower, *Pimelea filiformis*, has been shown to be equally abundant in mature unharvested forest, harvested native forest and plantations (Wapstra *et al.* 2005). These species have been removed from the threatened species list, mainly due to evidence from the cited studies. For other forest-dependent threatened flora, evidence of the impact of wood production activities is more equivocal. For example, *Thismia rodwayi* (fairy lanterns), an annual species that is virtually subterranean, widespread, probably well-reserved throughout its range and unlikely to be significantly affected by native forest silviculture in the long term, should still be cautiously managed in planning for forestry operations as the ecology of the species is still not well understood (Roberts *et al.* 2003; Wapstra *et al.* 2005).

The actual and potential presence of *Prasophyllum stellatum* in areas of wood-production forest in the wider Storys Creek and Cluan Tiers area should continue to be a factor included in land management planning on both public and private land. Due to the widespread distribution of eucalypt-dominated forest on Jurassic dolerite above about 600 m elevation in both areas, and indeed elsewhere in much of Tasmania, it is difficult to delineate anything but an arbitrary potential range. In our opinion, a 10 km buffer around known sites, incorporating potential habitat, should be used to define a potential survey zone. In State forest, such an area could be delineated as a Potential Range Boundary and/or Special Management Zone (SMZ) for Threatened Flora on Forestry Tasmania's Management Decision Classification system (Orr & Gerrand 1998), to inform forest planners of the potential of the

species (such an SMZ has already been established in the Storys Creek area but may need modification based on the results of the present study). Whether a survey is recommended in particular cases would remain the decision of the Forest Practices Authority and Department of Primary Industries, Parks, Water and Environment. The need for a survey in particular cases may depend on the type of vegetation present, the history of disturbance, the distance to nearest known sites and the proposed land use. However, undertaking further surveys within the potential range will refine our understanding of the ecology of the species.

Further strategic surveys based on planning systems such as the 3- or 10-Year Plans produced by Forestry Tasmania might be a prudent course of action. However, it should be noted that the results of surveys for orchids, especially species with restricted ranges and/or habitat preferences, are notoriously fickle, subject to the vagaries of season and longer-term climatic conditions, and chance observations. As such, no matter how well-planned and executed a strategic survey is, novel sites are bound to be discovered outside the scope of planned strategic surveys and better-targeted surveys may still be warranted.

While our study has clearly demonstrated that *P. stellatum* is correctly classified as an endangered species, it does not appear to be directly threatened by the type of forestry activities currently occurring within its prime habitat and core range. At Cluan Tiers, we found *P. stellatum* growing on pushed-up dirt adjacent to old landing sites, within clearfelled and naturally regenerating forest (adjacent to old felled trees), on verges of well-maintained forestry roads, and in undisturbed forest. Similarly, at Storys Creek, *P. stellatum* was located in both undisturbed and harvested forest. In fact, it is possible, if not likely, that a long period without disturbance may be detrimental to the species and that selective harvesting may be an appropriate form of disturbance.

In the absence of forestry activities, natural disturbance events probably include wildfire and windthrow of old trees, creating areas of bare ground.

Harvesting activities in the type of terrain occupied by *P. stellatum* (i.e. mixed grassy/rocky substrate) are unlikely to create significant soil compaction, and are more likely to create areas of lightly disturbed ground suitable for colonisation in subsequent flowering years, as evidenced by the fact that most specimens were found on sites such as snig tracks and track verges.

There are aspects of the harvesting and reforestation process that have greater potential to impact on the species. Intensive soil disturbance at known sites might be detrimental to the dormant tubers (if soil compaction or mixing of soil layers was severe). Such activity is only likely to result from road construction, activity on major snig tracks, and construction and use of landing sites. Fire may also be detrimental, but only if the fire was of such intensity that the soil was baked so that tubers were affected. In fact, the flowering of many orchids, including species of *Prasophyllum*, is stimulated by fire (Jones *et al.* 1999; Coates *et al.* 2006; Coates & Duncan 2009), although most empirical studies to date have focused on species from habitats such as coastal heath, scrub and grasslands. Even though the forest habitat of *P. stellatum* is characterised by much lower fire frequency than the above fire-prone habitats, low-intensity top-disposal burning outside the main flowering period (i.e. after seed has been dispersed in late March) is unlikely to have any detrimental impact on the species. Orchids are highly palatable to native browsing mammals (neither the Storys Creek or the Cluan Tiers study areas support domestic stock) and it is possible that harvesting and regeneration activities could result in increased abundance of browsing mammals to the extent that fertile individuals of *P. stellatum* are subject to increased browsing post-harvest. We feel that this is a relatively low risk, perhaps

only marginally higher than the base level of browsing, because the species appears to be so patchily distributed and to be present in forests of various successional stages.

Prasophyllum stellatum is likely to persist at known sites if intensive activity (i.e. roads, landings, major snig tracks) is minimised and some of the canopy and understorey is maintained intact. We found *P. stellatum* to be most prevalent underneath a sparse canopy of eucalypts but often growing in a shaded location (e.g. adjacent to a log, stump, boulder or growing through grass/shrub stems), suggesting that some canopy cover is important in the longer term.

Protection of key sites (e.g. the type location, and areas with high densities of plants to act as seed sources) and ensuring that forests supporting the species are not converted to unsuitable habitat (e.g. plantation) remains a valid approach. We suggest that a selective harvesting approach that minimises disturbance to identified key sites, and maintains some canopy and understorey structure, appears to be appropriate to maintain, and perhaps enhance, the habitat of *P. stellatum*. Establishing a demographic monitoring program may be prudent but is unlikely to be critical to ensuring the long-term survival of *P. stellatum* within the forest estate.

Conservation status

The current legislated status of endangered on the Tasmanian *Threatened Species Protection Act 1995* appears to be appropriate for *P. stellatum*. Should the species prove be

more widespread, a downlisting (but not delisting) might be warranted, although the usually low population numbers (i.e. fewer than a total of 250 mature individuals) and insecure tenure are likely to mean that an endangered status would remain valid.

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