

NSW Threatened Species Scientific Committee

Conservation Assessment of *Philothea papillata* I.Telford & L.M.Copel. (Rutaceae)

CL Gross and J Scott, 19th April 2021

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***Philothea papillata* I.Telford & L.M.Copel. (Rutaceae)**

Distribution: Endemic to NSW

Current EPBC Act Status: Not listed

Current NSW BC Act Status: Not listed

Proposed listing on NSW BC Act and EPBC Act: Vulnerable

Conservation Advice: *Philothea papillata*

Summary of Conservation Assessment

Philothea papillata was found to be eligible for listing as Vulnerable under IUCN Criterion D.

The main reasons for this species being eligible for listing are that (i) there are a low number of mature individuals in the wild, and (ii) there is a restricted area of occupancy and number of locations with a plausible future threat that could drive the taxon to CR or EX in a very short time.

Description and Taxonomy

Philothea papillata is described by Telford and Copeland (2006) as:

“Shrub, erect, multistemmed, to 60 cm tall, bearing root suckers. Branchlets pilose, pale green beneath the white indumentum. Leaves incurved, narrow-elliptic, 9–12 mm long, 1–1.5 mm wide, acute, the margins recurved, crenate, verrucose with 4 or 5 glands on each side of lower surface, both surfaces papillate. Stipules minute, dark purple to black. Flowers solitary, terminal, on pedicels c. 0.5 mm long. Sepals 5, suborbicular, 1.5–2 mm long, pubescent. Corolla of 5 free petals, white to pale pink. Petals elliptic, 7–10 mm long, pubescent on both surfaces, the abaxial surface sparsely verrucose. Stamens 10, 6.5–8 mm long. Filaments fused at base for 4–5 mm. Anthers ovate, apiculate, c. 1.2 mm long, the apicula glabrous or minutely papillate. Gynoecium of 5 basally-fused carpels, the carpels tomentose, pale green; style terete, broadening towards the base, c. 4 mm long, pilose on lower three-quarters; stigma capitate, minutely 5-lobed. Disc obscure. Fruit not seen.”

Telford and Copeland (2006, Table 1) describe characters that differentiate *Philothea papillata* from the two morphologically closest *Philothea* species (*P. reichenbachii* and *P. salsolifolia*). These include the following distinguishing characters for *P. papillata*: incurved leaf lamina, papillate leaf surface and a verrucose leaf margin, and

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floral differences that include a narrower petal length range (7-8 mm), tomentose keel, white to pale pink flower with a glabrous anther apex and an ovoidal anther shape.

Distribution and Abundance

Using the map from the Australian Institute of Aboriginal and Torres Strait Islander Studies (AIATSIS, Horton 1996) *Philothea papillata* was found to occur on the traditional lands of the Gumbaynggirr First Nation peoples.

Philothea papillata is known only from the type locality of a sandstone cliff escarpment in Sherwood Nature Reserve (NR), east of Glenreagh, northern NSW (Figure 1). Widespread searches in areas of similar geology and geomorphology (sandstone cliff lines and rocky slopes of the Grafton Formation and Kangaroo Creek Sandstone) between Chambigne Nature Reserve, Flaggy Creek Nature Reserve, Whitemans Creek, and Coaldale were undertaken by Telford and Copeland (2006) without finding any further populations of the species. Sheringham (2019) surveyed the species' distribution to estimate abundance and habitat. He traversed the extent of the species habitat in Sherwood NR extending from the centre of the population to the edges of the cliff top heathland. Additional searches in the adjoining Needlebark Stringybark habitat types were also undertaken but the species was not located (Sheringham 2019).

Telford and Copeland (2006) estimated that there were about 150 plants growing along a c. 200 m escarpment edge. The detailed population census undertaken by Sheringham (2019) found that there are 328 individuals in four patches across the same cliff top escarpment (1.7 km) within the Sherwood NR. The four patches contain; 194, 68, 56, 10 individuals respectively. Among the patches, pollen dispersal by native bees is possible, Given the possibility of pollen movement between known occurrences, the closeness in distance between each patch and the continuous habitat along the clifftop, all known individuals of *Philothea papillata* are considered to comprise the one population.

Using Google Earth to estimate the areas traversed by Sheringham in 2019, the following are estimates of occupied habitat:

patch 1	patch 2	patch 3	patch 4
0.27 Ha	0.17 Ha	0.14 Ha	0.3 Ha

This gives a total perimeter around the occurrence of the species as 3.19 km and an occupied habitat of 4.29 ha.

The geographic distribution of *Philothea papillata* is very highly restricted. The area of occupancy (AOO) was estimated to be 8 km², based on the species' occupying two 2 x 2 km grid cells, the spatial scale of assessment recommended by IUCN (2019). The extent of occurrence (EOO) was also estimated to be 8 km². The EOO is reported as equal to AOO, despite the range of the species (estimated to be approximately

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1 km²) measured by a minimum convex polygon containing all the known sites of occurrence, being less than AOO. This is to ensure consistency with the definition of AOO as an area within EOO, following IUCN Guidelines (2019).

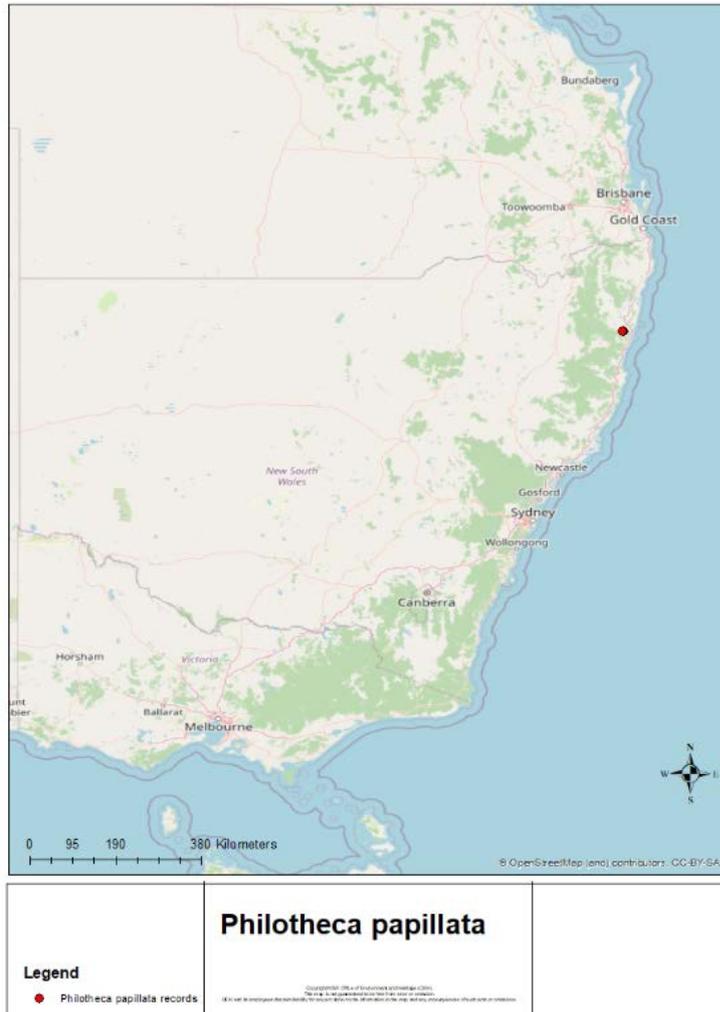


Figure 1. Location of *Philotheca papillata*

Ecology

Population-based ecological knowledge for the species is limited. Flowering has been recorded in August (Sheringham 2019) and September (Telford and Copeland 2006).

For other species of *Philotheca*, floral visitors have been observed to include “mostly butterflies, occasionally beetles, flies, bees or moths” (Auld 2001), and *Leioproctus*, a genus of native bees (Houston and Ladd 2002). Seeds are ballistically discharged from the fruit and exhibit features for subsequent ant dispersal (myrmecochory) (Auld 2001). Seeds are deposited into the soil and have high levels of dormancy (Gillespie *et al.* 1996 cited in Auld 2001). Germination cues involve fire, and the genus contains both resprouters and obligate seeders (Auld 2001). Other *Philotheca* species regenerate and flower within 4-5 years post-fire (Benson 1985). *Ex-situ* seed propagation has not yet been successful in *Philotheca* and tissue culture methods

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have been developed for some species (e.g. Dwan and Trueman 2014). In the related *P. sporadica*, genetic diversity was found to decrease with decreasing population size and increased population isolation (Shapcott *et al.* 2015).

Fire History and Fire Ecology

Sherwood NR generally has a history of frequent fires (Telford and Copeland 2006; NSW NPWS 2017; G Hart *in litt.* June 2020). There were large wildfires in 1994, 1996 and 2002 that burnt most of the northern and central sections of the reserve (NSW NPWS 2009), but for the central section of the reserve where *Philothea papillata* occurs, digital records (NPWS Fire History - Wildfires and Prescribed Burns dataset; SEED 2020) are only available since 2000. Fire mapping may not have been recorded prior to NSW NPWS gazettal of the central part of the reserve in 1999; it was previously known as Waihou Flora Reserve (NSW NPWS 2009). Across the known range of *P. papillata*, there were recent fires recorded in 2001, 2006 and 2013 (SEED 2020). The 2001 and 2006 fires burnt different parts of the *P. papillata* population, and the 2013 fire burnt the entire population. Prior to 2000 the fire frequency where *P. papillata* occurs is unknown. Bushfire mapping (SEED 2020) indicates *P. papillata* was unburnt in the recent 2019-20 bushfire season.

Philothea papillata has a root-suckering habit that may enable it to resprout after fire (Telford and Copeland 2006; Sheringham *in litt.* June 2019). The time it takes for regeneration of *P. papillata* following fire from either resprouting individuals or from seedlings is unknown. Sheringham (2019) noted 13% of individuals were flowering at the start of the flowering season in August 2019, six years after the population was burnt. It is likely flowering also occurred in some years prior to 2019 but data are unavailable. A fire-free interval of at least 6-15 years, based on limited data for other resprouters (some eucalypts and Proteaceae species) (Keith 1996), may be needed to allow juvenile plants to become fire resistant, whereby they develop the ability to resprout after the next fire. Resprouting shrubs may tolerate exposure to one or possibly two occurrences of this fire-free interval. Longer intervals will also be needed to ensure fire resistance in appreciable numbers of recruits and hence, population persistence. "If successive fires occur at intervals of less than this duration, then new recruits to the population will be killed without contributing to future generations. Thus, population size will decline if recruitment is insufficient to replace deaths of established plants" (Keith 1996).

Threats

Threats to *Philothea papillata* are currently considered to be few. Sheringham (2019) reported that the population was healthy with no sign of mortality, disease or dieback.

There is a risk of decline in *Philothea papillata* if the population experiences ongoing high frequency fire including that associated with climate change. All individuals of *P. papillata* are found in small patches that are likely to be concurrently impacted by a single fire event. Whilst *P. papillata* is thought to be capable of resprouting following fire, a continual loss of individuals to subsequent fires may threaten the viability of the population if recruitment is insufficient to replace plants that die. Elements of the fire regime, other than high frequency, may also affect this species, most notably out-of-

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season fires. Other Rutaceae species have been shown to be sensitive to fire season in their post-fire germination responses (McKenzie *et al.* 2016; Miller *et al.* 2019). Whilst continuing decline is not currently inferred, the species should be reassessed if there is evidence of mortality and a lack of recruitment between fires.

Sheringham *in litt.* (2019) notes that the pathogen *Phytophthora cinnamomi* “is present in a wide range of locations in the region (McDougall unpubl.) and members of the Rutaceae are known to be susceptible (e.g. *Correa reflexa*)”. The closely related taxa *Philothea myoporoides* is known to be susceptible to the pathogen (Taylor 1974), however it is not known if *Philothea papillata* is also susceptible.

Small population size and vegetative reproduction via root suckers are likely to hinder outbreeding and can be associated with a build-up of somatic mutations (Gross *et al.* 2012).

Feral goats (*Capra hircus*) have not been seen in the vicinity of the population (P. Sheringham *in litt.* June 2020) and are currently not considered to be a threat to *Philothea papillata*.

Assessment against IUCN Red List criteria

For this assessment it is considered that the survey of *Philothea papillata* has been adequate and there is enough scientific evidence to support the listing outcome.

Criterion A *Population Size reduction*

Assessment Outcome: Data Deficient

Justification: There are insufficient time series data to assess population size reduction. The doubling in the number of individuals from the 2006 census compared with the 2019 census should not be used as an indication of population size increase as the exact survey area for the 2006 population count was not documented. Quantitative estimates of change remain unavailable and the species is assessed as Data Deficient.

Criterion B *Geographic range*

Assessment Outcome: Not met.

Justification: Whilst *Philothea papillata* meets the threshold for Critically Endangered for geographic range, at least two of the three subcriteria are not currently considered to be met.

Philothea papillata is endemic to a restricted area in NSW. The extent of occurrence (EOO) was estimated to be 8 km². The EOO is reported as equal to AOO, despite the range of the species (estimated to be approximately 1 km²) measured by a minimum convex polygon containing all the known sites of occurrence, being less than AOO. This is to ensure consistency with the definition of AOO as an area within EOO, following IUCN Guidelines (2019). To be listed as Critically Endangered under Criterion B1, a species must have an EOO of <100 km². *Philothea papillata* meets

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the EOO threshold for Critically Endangered. The AOO was estimated to be 8 km². This calculation was based on the species occupying two (2 x 2 km) grid squares, the spatial scale of assessment recommended by IUCN (2019). To be listed as Critically Endangered under Criterion B2, a species must have an AOO of <10 km². *Philotheca papillata* meets the AOO threshold for Critically Endangered.

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

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

Assessment Outcome: Met for Critically Endangered.

Justification: *Philotheca papillata* is considered to occupy a single location. The potential threat considered for estimating the number of locations is the high frequency of fire. All individuals of *P. papillata* in the only known population can be burnt in a single fire as seen in 2013.

- b) Continuing decline observed, estimated, inferred or projected in any of: (i) extent of occurrence; (ii) area of occupancy; (iii) area, extent and/or quality of habitat; (iv) number of locations or subpopulations; (v) number of mature individuals.

Assessment Outcome: Not met.

Justification: There is too much uncertainty in population estimates over time to allow an estimate of decline. Decline is not currently inferred as the species is thought to respond to fire by resprouting and, at present, there is no evidence that the current fire regime is leading to insufficient recruitment. However, the species should be reassessed if there is evidence of mortality and a lack of recruitment between fires.

- c) Extreme fluctuations.

Assessment Outcome: Not met.

Justification: Extreme fluctuations are unlikely because mature plants are apparently long-lived and capable of surviving fires.

Criterion C Small population size and decline

Assessment Outcome: Not met.

Justification: There is a single known population comprised of 328 individuals. Whilst *Philotheca papillata* meets the threshold for Endangered for population size (250 to 2,500 individuals), C1 is data deficient and C2 is not met as there is currently no evidence for continuing decline.

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

- C1. An observed, estimated or projected continuing decline of at least 20 % in 5 years or 2 generations, whichever is longer (up to a max. of 100 years in the future).

Assessment Outcome: Data Deficient.

Justification: There is currently no data to quantify changes in plant numbers to estimate the rate of future decline in this species.

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

Assessment Outcome: Not met.

Justification: There is too much uncertainty in population estimates over time to allow an estimate of decline. Decline is not currently inferred as the species is thought to respond to fire by resprouting and, at present, there is no evidence that the current fire regime is leading to insufficient recruitment.

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

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

Assessment Outcome: Met for Vulnerable.

Justification: There is one population of *Philothea papillata* with 328 mature individuals.

- a (ii). The percentage of mature individuals in one subpopulation is 90-100% (CR); 95-100% (EN) or 100% (VU)

Assessment Outcome: Met for Endangered.

Justification: There are 328 mature individuals which meets the Endangered threshold of < 2500 . All known individuals are within the one subpopulation and hence meet the threshold for Endangered (i.e. 95-100% in the one subpopulation).

- b. Extreme fluctuations in the number of mature individuals

Assessment Outcome: Not met.

Justification: Extreme fluctuations are unlikely.

Criterion D Very small or restricted population

Assessment Outcome: Vulnerable

Justification: There are < 1000 mature individuals.

To be listed as Vulnerable, a species must meet at least one of the two following conditions:

- D1. Population size estimated to number fewer than 1,000 mature individuals

Assessment Outcome: Vulnerable

Justification: Sheringham (2019) recorded 328 plants.

- D2. Restricted area of occupancy (typically $< 20 \text{ km}^2$) or number of locations (typically < 5) with a plausible future threat that could drive the taxon to CR or EX in a very short time.

Assessment Outcome: Vulnerable.

Justification: *Philothea papillata* has a highly restricted area of occupancy and occurs at a single location. Should the species be susceptible to the

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pathogen *Phytophthora cinnamomi*, that plausible future threat could drive the species to CR or EX in a very short time.

Criterion E Quantitative Analysis

Assessment Outcome: Data Deficient.

Justification: No quantitative analysis has been undertaken at this time.

Conservation and Management Actions

Habitat loss, disturbance and modification

- Prevent habitat disturbance in the vicinity of subpopulations.
- Minimise adverse fire regimes. Ensure prescribed burns in the vicinity of the species provide a sufficient fire-free interval (10-15 years) to allow maturation of individuals and accumulation of plant-stored resources for resprouting and replenishment of the soil seed bank. In addition, it is also important that there is sufficient time between fires to enable seedling recruits to become fire resistant (i.e. be able to resprout from root suckering following fire).
- Undertake phyto-sanitary procedures for each visit to the population to decrease the possibility of pathogens (such as *Phytophthora cinnamomi*) entering the habitat. Whilst the susceptibility of *P. papillata* to such pathogens is unknown, keeping the habitat free of pathogens is advisable.

Ex-situ conservation

- Develop a targeted *Philothea papillata* seed collection program for *ex-situ* seed banking.
- Develop a protocol for propagation of the species via seeds, cuttings or tissue culture and trial the techniques on limited wild material to determine the best time of the year to source propagatable material. Consult with Royal Botanic Gardens (RBG) Sydney and RBG-PlantBank as to known protocols for the species.
- Consider the need for translocation to establish a new site which is not expected to burn at the same time as the Sherwood NR site.

Stakeholders

- Liaise with managers of Sherwood NR for conservation management and protection of the species.
- Liaise with authorities with fire management responsibilities to ensure there is effective communication between agencies regarding the requirement of fire-free intervals in habitat of *Philothea papillata*.
- Update the Fire Plan of Management for Sherwood Nature Reserve so the area where *Philothea papillata* occurs ideally has fire-free intervals sufficient to allow juvenile plants to become fire resistant (this is likely to be in the order of 10-15 years).

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Survey and Monitoring priorities

- Monitor for signs of habitat degradation.
- Regularly monitor the population size, structure and habitat of *Philothea papillata* to determine whether there is a decline in the population. Tag individuals with fire-proof tags to monitor survival over time.
- Re-survey the population following every fire to check for plant survival, recruitment and for signs of any decline.

Information and Research priorities

Recruitment and seedling survival: Establish plots to capture the distribution of the population and monitor for seedling recruitment. Once found, seedlings should be carefully tagged with fire-proof tags/labels for annual or biennial monitoring. Monitoring labelled plants through time will allow for a Population Viability Analysis to be built in due course that will then allow for modelling of stochastic events on population persistence.

Fire biology: Tag mature plants for monitoring and to assess their fire response. Survey after fire to record the species response to fire and post-fire recovery mechanisms. Search after fire for *P. papillata* seedlings. Tag seedlings with fire-proof tags for long-term monitoring to provide data for survival, time to first flowering and development of fire resistance. Other Rutaceae, such as *Boronia* species, have been shown to exhibit germination responses sensitive to fire season (Mackenzie *et al.* 2017). Similar experiments are needed to determine the germination responses/mechanisms of *P. papillata* to resolve its response to fire season.

Pollination: Determine the pollinators for this species. The breeding system should be ascertained on *ex-situ* material (3 cuttings taken from each of 20 individuals spaced at least 5m apart), rather than *in-situ* as experiments which often fail in the wild due to uncontrollable events and with a small population, bagging could disrupt natural pollination levels.

Pathogens: Test *ex-situ* *Philothea papillata* plants for their susceptibility to the pathogen *Phytophthora cinnamomi*. If the species is susceptible, management actions need to be developed, using the latest guidelines and techniques, to minimise the risk of the pathogen entering the site. If there are any signs of dieback in *P. papillata* or the vegetation community at the site, it is recommended the species be reassessed under the BC Act.

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Expert Communications

Paul Sherringham – Natural Heritage Project Officer Botanist, Biodiversity and Conservation North East. Department of Industry, Planning and Environment. Coffs Harbour.

Gina Hart – Project Officer – Biodiversity and Wildlife Conservation Branch, NSW National Parks and Wildlife Service, Grafton, NSW.

Mark Fletcher - Ranger, Clarence Area, North Coast Branch, NSW National Parks & Wildlife Service, Grafton.

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Appendix 1

Assessment against Biodiversity Conservation Act criteria

The Clauses used for the assessment are listed below for reference.

Overall Assessment Outcome

Vulnerable under Clause 4.5(c) and Clause 4.7.

Clause 4.2 – Reduction in population size of species (Equivalent to IUCN criterion A)

Assessment Outcome: Data Deficient.

(1) - The species has undergone or is likely to undergo within a time frame appropriate to the life cycle and habitat characteristics of the taxon:			
	(a)	for critically endangered species	a very large reduction in population size, or
	(b)	for endangered species	a large reduction in population size, or
	(c)	for vulnerable species	a moderate reduction in population size.
(2) - The determination of that criteria is to be based on any of the following:			
	(a)	direct observation,	
	(b)	an index of abundance appropriate to the taxon,	
	(c)	a decline in the geographic distribution or habitat quality,	
	(d)	the actual or potential levels of exploitation of the species,	
	(e)	the effects of introduced taxa, hybridisation, pathogens, pollutants, competitors or parasites.	

Clause 4.3 - Restricted geographic distribution of species and other conditions (Equivalent to IUCN criterion B)

Assessment Outcome: Not met.

* Although *Philothea papillata* meets the threshold for very highly restricted geographic distribution (EOO and AOO) for Critically Endangered, the species is currently considered to only meet one of the three conditions, i.e. it only meets (d), and not either (e) or (f). Hence for the overall assessment, Clause 4.3 is not met.

The geographic distribution of the species is:			
	*(a)	for critically endangered species	very highly restricted, or
	(b)	for endangered species	highly restricted, or
	(c)	for vulnerable species	moderately restricted,
and at least 2 of the following 3 conditions apply:			
	(d)	the population or habitat of the species is severely fragmented or nearly all the mature individuals of the species occur within a small number of locations,	
	(e)	there is a projected or continuing decline in any of the following:	
		(i)	an index of abundance appropriate to the taxon,
		(ii)	the geographic distribution of the species,

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	(iii)	habitat area, extent or quality,
	(iv)	the number of locations in which the species occurs or of populations of the species,
	(f)	extreme fluctuations occur in any of the following:
	(i)	an index of abundance appropriate to the taxon,
	(ii)	the geographic distribution of the species,
	(iii)	the number of locations in which the species occur or of populations of the species.

Clause 4.4 - Low numbers of mature individuals of species and other conditions (Equivalent to IUCN criterion C)

Assessment Outcome: Not met.

* Although *Philotheca papillata* meets the threshold for low number of mature individuals (Endangered), the species is not currently considered to meet either (d) or (e). Hence for the overall assessment, Clause 4.4 is not met.

The estimated total number of mature individuals of the species is:			
	(a)	for critically endangered species	very low, or
	*(b)	for endangered species	low, or
	(c)	for vulnerable species	moderately low,
and either of the following 2 conditions apply:			
	(d)	a continuing decline in the number of mature individuals that is (according to an index of abundance appropriate to the species):	
	(i)	for critically endangered species	very large, or
	(ii)	for endangered species	large, or
	(iii)	for vulnerable species	moderate,
	(e)	both of the following apply:	
	(i)	a continuing decline in the number of mature individuals (according to an index of abundance appropriate to the species), and	
	(ii)	at least one of the following applies:	
		(A)	the number of individuals in each population of the species is:
		(I)	for critically endangered species extremely low, or
		(II)	for endangered species very low, or
		(III)	for vulnerable species low,
		(B)	all or nearly all mature individuals of the species occur within one population,
		(C)	extreme fluctuations occur in an index of abundance appropriate to the species.

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Clause 4.5 - Low total numbers of mature individuals of species (Equivalent to IUCN criterion D)

Assessment Outcome: Vulnerable under Clause 4.5(c).

The total number of mature individuals of the species is:			
	(a)	for critically endangered species	extremely low, or
	(b)	for endangered species	very low, or
	(c)	for vulnerable species	low.

Clause 4.6 - Quantitative analysis of extinction probability (Equivalent to IUCN criterion E)

Assessment Outcome: Data Deficient

The probability of extinction of the species is estimated to be:			
	(a)	for critically endangered species	extremely high, or
	(b)	for endangered species	very high, or
	(c)	for vulnerable species	high.

Clause 4.7 - Very highly restricted geographic distribution of species—vulnerable species

(Equivalent to IUCN criterion D2)

Assessment Outcome: Vulnerable.

For vulnerable species,	the geographic distribution of the species or the number of locations of the species is very highly restricted such that the species is prone to the effects of human activities or stochastic events within a very short time period.
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