

NSW Threatened Species Scientific Committee

Conservation Assessment of *Persoonia mollis* subsp. *revoluta* S.Krauss & L.A.S.Johnson (Proteaceae)

C Simpson, 20 October 2020
NSW Threatened Species Scientific Committee

***Persoonia mollis* R.Br. subsp. *revoluta* S.Krauss & L.A.S.Johnson (Proteaceae)**

Distribution: Endemic to NSW

Current EPBC Act Status: Not listed

Current NSW BC Act Status: Vulnerable

Proposed listing on NSW BC Act and EPBC Act: Vulnerable

Conservation Advice: *Persoonia mollis* subsp. *revoluta*

Summary of Conservation Assessment

Persoonia mollis subsp. *revoluta* is found to be eligible for listing as Vulnerable under IUCN Criteria B1ab(i,ii,iii,iv,v)+2ab(i,ii,iii,iv,v) and C2a(i) (IUCN 2017).

The main reasons for this taxon being eligible are i) highly restricted geographic range – EOO = 819 km², AOO = 100 km²; ii) it is known from only six locations; and iii) a continuing decline is inferred in the extent of occurrence, area of occupancy, area of habitat, number of locations and number of mature individuals, as a result of low frequency of fire preventing natural regeneration.

Description and Taxonomy

Persoonia mollis subsp. *revoluta* S.Krauss & L.A.S.Johnson (family Proteaceae) is a prostrate to decumbent shrub, 10-50 cm high, up to 4 m diameter; leaves glossy-green, pliable but not soft, almost fleshy, elliptical to oblong-ovate to oblong-lanceolate, obtuse (to rarely acute), 2.5–4 cm long, 4–10 (–15) mm wide, sparsely silky-pubescent to glabrous on the undersurface when young, the longest hairs c. 0.7 mm long, the midvein obscure or (rarely) prominent, the margins revolute; buds sparsely silky pubescent to ± glabrous, the hairs 0.3–1 mm long, pale (Krauss and Johnson 1991; PlantNET 2019).

Prior to the revision of the *P. mollis* species complex by Krauss and Johnson (1991) *P. mollis* subsp. *revoluta* was called *P. revoluta* Sieber ex Spreng.

Distribution and Abundance

Persoonia mollis subsp. *revoluta* is endemic to New South Wales (NSW) where it is known only from between Mittagong, Canyonleigh and Bindook Highlands, southwest of Sydney, usually between 600 and 800 m a.s.l. (ALA 2020; NSW DPIE 2020a). *Persoonia mollis* subsp. *revoluta* has been recorded mostly from flat areas on broad ridgetops and upper slopes. Krauss (1994a) noted that the transition zones between the subspecies of *P. mollis* tend to correspond with geological boundaries and that *P. mollis* subsp. *revoluta* has an affinity for relatively deep sandy soils. The surface geology mapped at most locations where the subspecies is found is Hawkesbury Sandstone, and the soil is mapped as the Soapy Flat or Sandy Flat soil landscapes (OEH 2017).

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Persoonia mollis subsp. *revoluta* is currently known from six populations (six sub-populations *sensu* IUCN 2017) at High Range, Canyonleigh, Belanglo, Berrima, Mittagong and Bindook Highlands. Specimens of *P. mollis* were located at Paddys River and determined by Dr Peter Weston (B Wiecek *in litt.* June 2018) to be *P. mollis* subsp. *ledifolia* - *livens* - *revoluta* intergrades. A population has been recorded at Thirlmere Lakes (ALA 2020) however these unvouchered sightings were not able to be confirmed during field surveys undertaken in 2018 by the author. Given that no individuals of *P. mollis* subsp. *revoluta* were sighted at Thirlmere Lakes during recent field searches, and the presence of *P. mollis* subsp. *nectens* at this location, it is possible the record of *P. mollis* subsp. *revoluta* constitutes a misidentification. The Paddys River and Thirlmere locations support different soils to the other known populations. There are also a further four vouchered records from Bullio from 1965 which are subject to doubt because their precise location is uncertain and granite derived soils prevail in the area in contrast to the sandstone derived soils of the other populations. It is possible that these records refer to populations occurring further east on sandstone and comprise the western outliers of the High Range population.

There has been no formal effort to estimate the size of the total population of *Persoonia mollis* subsp. *revoluta*. There are c. 140 records (approximately 35 vouchers and 105 sightings, excluding intergrades (ALA 2020, NSW DPIE 2020a) and for half of these an indication of the total number of nearby plants was given. Fifty-two accounts were numerical and sum to 138 plants (NSW DPIE 2020a). Other records include a qualitative indication of frequency with “rare”, “occasional” and “locally occasional” the most common. Twenty records at High Range include the comment “Part of a population at least 160m x 100m possibly larger” (NSW DPIE 2020a). Most records are from the High Range (84 records), Canyonleigh (28) and Belanglo populations (c.13). Eight records (excluding intergrades with *P. mollis* subsp. *ledifolia*) have been collected from the Mittagong population. The Berrima population is known from 7 records. The 2 vouchers from the Bindook area may be from the same individual.

Three records of *Persoonia mollis* subsp. *revoluta* are located in Bangadilly National Park while the remaining majority are from freehold land, crown land and state forest.

Persoonia mollis subsp. *revoluta* has been recorded (including unvouchered records) primarily in two vegetation communities mapped by Tozer *et al.* (2010): p144 Wingecarribee-Burraborang Sandstone Forest and p10 Eastern Tablelands Dry Forest.

Ecology

Pollination, dispersal and gene flow

Gene flow in *Persoonia mollis* subsp. *revoluta* is strongly regulated by pollination and dispersal syndromes. Flowers are known to be pollinated by bees and pollen dispersal occurs over relatively short distances (Bernhardt and Weston 1996). Fruits of *P. mollis* subsp. *revoluta* are likely to be dispersed by macropods and possibly large birds, potentially up to 5km across wide areas of the landscape (e.g. Clifford and Drake 1985; Bass 1989; Buchanan 1989; Rymer 2006). The degree of genetic homogeneity among subspecies of *P. mollis* indicates that significant genetic mixing has occurred across its range (Krauss 1994b), although this may no longer be occurring, as a result of habitat fragmentation and the local disruption or extinction of vector species. Krauss (1997) hypothesised that genetic homogeneity may be related to frequent localised extinction and subsequent recolonisation of populations. The mixing of genes controlling morphological differences between subspecies has rarely translated to morphological hybrids across parapatric and allopatric boundaries between subspecies (Krauss 1997), and these subspecies of *P. mollis*

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each exhibit a degree of specialisation in relation to local environmental and edaphic conditions (Krauss 1997). Given the current distribution of *P. mollis* subsp. *revoluta*, its populations may be considered reasonably isolated with regard to transfer of genetic material.

Population dynamics in relation to fire

Persoonia mollis subsp. *revoluta* is a fire-sensitive shrub (Krauss 1997) and, as with other *Persoonia* species, seedlings establish in greatest numbers after fire (Auld *et al.* 2007) either from the soil seedbank or, to a lesser extent, dispersal of seed from unburnt populations (Krauss 1994a). In common with other species of the genus, *P. mollis* subsp. *revoluta* has poorly understood dormancy mechanisms and low germination rates in fresh seeds (Krauss 1994b). Artificial propagation of many *Persoonia* species is notoriously difficult (e.g. Chia *et al.* 2015, NSW NPWS 2000, Krauss 1994a).

Germination following fire is probably promoted by chemical cues associated with smoke or ash. The distribution of records suggests that *P. mollis* subsp. *revoluta* is also a frequent colonizer of disturbed sites, a characteristic exhibited by other *Persoonia* species (e.g. *P. nutans*, NSW DEC 2005). This implies that some seeds may germinate spontaneously as dormancy decays gradually over time. Some records of *P. mollis* subsp. *revoluta* noted the habitat as being swampy areas with a reduced canopy. This, coupled with the fact that *P. mollis* subsp. *revoluta* has frequently been observed colonising disturbed sites, and is more abundant in those areas than adjacent, undisturbed bushland, suggests that recruitment of *P. mollis* subsp. *revoluta* is dependent on reduced competition from other species. The species is therefore expected to decline in the long-term absence of fire, and contract in distribution to areas of disturbance on the periphery of its original range.

The juvenile period for *Persoonia mollis* subsp. *revoluta* is unknown. Krauss (1998) estimated the generation length for *P. mollis* subsp. *revoluta* to be at least five years. Allowing for variation among populations due to site-related factors, as well as variation between generations due to variable weather, the juvenile period is conservatively estimated to range between four and eight years. This implies that a minimum fire interval of five years (lower bound of primary juvenile period plus one reproductive year) is required to avoid severe declines or local extinction of the species. Ayre *et al.* (2009) recorded seedling growth after two fires four years apart (with no opportunity for seedbank replenishment) in a study of the related *P. mollis* subsp. *nectens*, which suggests that soil-stored seed may remain viable for at least four years and may not be exhausted by a single fire. Even so, sustained (more than two) short intervals between fires are likely to result in significant declines by depleting seed banks. As such, consecutive intervals of no less than 11 years (upper bound of primary juvenile period plus 3 years to allow seedbank to accumulate) are likely to be required to avoid continuing decline.

The lifespan of *Persoonia mollis* subsp. *revoluta* is unknown but reasonably estimated to be in the range 25–45 years. The longevity of the seedbank is unknown. A conservative assessment for the longevity of the seedbank (assuming a very short half-life (Auld *et al.* 2000)) is five years following cessation of inputs. Under sustained long fire intervals, senescence of standing plants and seed banks may result in local extinction. Consecutive fire intervals of more than 30 years (lower bound of population longevity plus five years) are likely to result in decline. A fire interval of greater than 50 years (upper bound of population longevity plus five years) is likely to result in local extinction.

Threats

Low frequency of fire

Most records of *Persoonia mollis* subsp. *revoluta* are from areas which appear not to have been burnt in many years. Factors causing this long absence of fire include the fragmentation of highly inflammable wooded areas by historical clearing for agriculture, increased vigilance in these cleared areas and active fire suppression. These factors operate synergistically throughout much of the range of *P. mollis* subsp. *revoluta* such that the threat of low frequency of fire is ubiquitous in those areas.

The earliest records of fire in the area where *Persoonia mollis* subsp. *revoluta* is found are from the 1963/64 fire season (NSW DPIE 2020c). No fires have been recorded at the location of the High Range, Canyonleigh, Belanglo, Berrima and Bindook populations (though the Bindook population may have burnt in the 2019-2020 Green Wattle Creek fire) (NSW DPIE 2020b; NSW DPIE 2020c). Therefore, it is inferred that those populations have remained unburnt for at least 56 years, although it is possible that fires have occurred and not been mapped. A wildfire in 2002 burnt part of the Mittagong population (NSW DPIE 2020c). The populations of *P. mollis* subsp. *revoluta* may be considered to comprise distinct locations in relation to the threat of long-term absence of fire considering their position in the landscape amongst a mosaic of relatively non-flammable farmland and potential differences in the management of each population. However, should these factors be sufficiently uniform, for instance between the High Range, Canyonleigh and Belanglo populations, they could be considered as a single location with regard to the threat of low frequency of fire. Populations close to the urban interface (Mittagong and Berrima) may have a higher likelihood of burning than all other populations due to the influence of asset protection burns. The population at Bindook could be considered to have a more natural fire regime due to its position in a very large contiguous area of flammable woodland.

High frequency of fire

Frequent fires are likely to result in local extinction of fire sensitive species when the fire-return interval is comparable to the juvenile period of the species. When successive fires causing 100% mortality in the standing population occur with a shorter interval than the juvenile period then the seedbank will exhibit a net decline as the proportion which germinates is not replaced by a new cohort. Fire intervals only slightly longer than the juvenile period may still result in a net decline depending on the seed output in the years post-maturation. Keith (2010) suggested that a fire interval equivalent to the lower bound for the primary juvenile period of a species plus one reproductive year should be applied to avoid unsustainable decline associated with a single short interval between fires. An interval equivalent to the upper bound for the primary juvenile period of a species plus three reproductive years should be applied to avoid unsustainable declines associated with consecutive short interval between fires (Keith 2010).

Persoonia mollis subsp. *revoluta* populations near the urban interface are likely to be subject to frequent fires due to hazard reduction burns, defensive back-burns and arson. Small populations are likely to be entirely affected by each fire event. Given the distances between populations and their isolation with respect to dispersal vectors such as mammals, re-introduction from unburnt populations is unlikely. Populations close to urban areas, such as Mittagong and Berrima, are the most likely to be subject to frequent fires in the future. The population at Mittagong is not currently located within a nominated Strategic Fire Advantage Zone nor Asset Protection Zone (OEH 2018b) and is therefore not considered to be threatened by high frequency of fire at this time.

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Habitat clearing and invasive species

Threats to the survival of *Persoonia mollis* subsp. *revoluta* include land clearing for agriculture, mining and urban expansion. Various mining activities occur in the area and extraction of sand, coal and coal seam gas may cause the destruction of *P. mollis* subsp. *revoluta* habitat. Approximately 40% of native vegetation cover on the Soapy Flat and Sandy Flat soil landscapes, the main habitat for *Persoonia mollis* subsp. *revoluta*, has been cleared, predominantly for agriculture (Tozer *et al.* 2010). Less than 10% of remaining vegetation in these areas is reserved for conservation with the remainder on Crown or Freehold land (LPI 2012). The effect of invasive species on *Persoonia mollis* subsp. *revoluta* is unknown, although it is expected that dense weed growth, especially immediately after fire, will be detrimental to its germination and persistence.

Assessment against IUCN Red List criteria

For this assessment it is considered that there is sufficient scientific evidence to support the listing outcome.

Criterion A Population Size reduction

Assessment Outcome: Data Deficient.

Justification: Surveys of *Persoonia mollis* subsp. *revoluta* have not been completed across its range over a suitable time period and there is insufficient data to estimate if there has been a reduction in the size of the population. Therefore, the species is not eligible for listing in any category under this criterion.

Criterion B Geographic range

Assessment Outcome: Vulnerable under B1ab(i,ii,iii,iv,v) + B2ab(i,ii,iii,iv,v).

Justification: Based on herbarium records and reported sightings, *Persoonia mollis* subsp. *revoluta* has a highly restricted geographic range with an extent of occurrence (EOO) estimated to be 819 km². EOO is based on a minimum convex polygon enclosing all reliable records of the species, following the guidelines of IUCN (2017).

To be listed as Endangered under Criterion B1 a species must have an EOO of < 5,000 km². *Persoonia mollis* subsp. *revoluta* meets the EOO threshold for Endangered under Criterion B1.

The area of occupancy (AOO) for *Persoonia mollis* subsp. *revoluta* is estimated to be 100 km² (based on the number of occupied 2 x 2 km cells, the scale of measurement recommended by IUCN 2017). Only records considered to be reliable were used in this calculation. To be listed as Endangered under Criterion B2 a species must have an AOO of < 500 km². *Persoonia mollis* subsp. *revoluta* meets the AOO threshold for Endangered under Criterion B2.

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

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

Assessment Outcome: Subcriterion met at Vulnerable threshold.

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Justification: *Persoonia mollis* subsp. *revoluta* is found at six locations, with regard to the threat of low frequency of fire.

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

Assessment Outcome: Subcriterion met for (i,ii,iii,iv,v). The continuing decline of extent of occurrence, area of occupancy, area of habitat, number of locations and number of mature individuals is inferred for *Persoonia mollis* subsp. *revoluta*.

Justification: There is an inferred ongoing decline in the extent of habitat due to land clearing for agriculture, housing and mining activities because very few populations are in conservation areas. Ongoing decline in the abundance of individuals is inferred due to declines in the soil seedbank and reduced recruitment following long fire intervals.

- c) Extreme fluctuations.

Assessment Outcome: Data deficient.

Justification: There is insufficient data to indicate whether *Persoonia mollis* subsp. *revoluta* experiences extreme fluctuations.

Criterion C Small population size and decline

Assessment Outcome: Subcriterion met at Vulnerable threshold.

Justification: Although there have been no surveys of *Persoonia mollis* subsp. *revoluta* designed to estimate the size of the population, information recorded with sightings of the taxon along with limited survey for this assessment indicate very low numbers. The total number of mature individuals of *Persoonia mollis* subsp. *revoluta* is likely to be less than 10,000 and the number of mature individuals in each subpopulation is likely to be less than 1,000.

Criterion D Very small or restricted population

Assessment Outcome: Criterion not met.

To be listed as Vulnerable under D, 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: Data Deficient for D1

Justification: D1 Although information recorded with sightings of *Persoonia mollis* subsp. *revoluta* suggests very low numbers, there have been no surveys of the taxon designed to estimate the size of the population. The total number of mature individuals of *Persoonia mollis* subsp. *revoluta* is unknown.

D2. Restricted area of occupancy (typically <20 km²) 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: Does not meet the criterion for D2

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Justification: The AOO for *Persoonia mollis* subsp. *revoluta* is greater than 20 km². The number of locations is six, and it is not expected that the taxon will become Critically Endangered or Extinct in a very short period of time.

Criterion E Quantitative Analysis

Quantitative analysis showing the probability of extinction in the wild is at least 10% within 100 years.

Assessment Outcome: Data Deficient.

Justification: There is insufficient data to quantify extinction risk for *Persoonia mollis* subsp. *revoluta*.

Conservation and Management Actions

Assessing population size and structure for the taxon should be a priority.

At present, there are no specific conservation or management actions underway to protect this taxon. The following actions are derived from the site-specific threats.

Habitat loss, disturbance and modification

The following management actions for the preservation of *Persoonia mollis* subsp. *revoluta* are proposed:

- Prevent further habitat loss, disturbance and modification.
- Consider the location of populations during NSW National Parks & Wildlife Service (NPWS) reserve planning activities.
- Attempt to maintain a suitable fire regime in areas of *Persoonia mollis* subsp. *revoluta* habitat.
- Negotiate access to populations on private land to enable survey and monitoring.
- Negotiate for the implementation of permanent protection measures for the species and its habitat on any private land the species is found on OR ensure land management is sympathetic to *Persoonia mollis* subsp. *revoluta*.

Invasive species

- The effect of invasive species on *Persoonia mollis* subsp. *revoluta* should be investigated.

Ex situ conservation

- Develop a targeted seed collection program for ex situ seed banking.

Stakeholders

- Inform land owners and managers of sites where there are known populations and consult with these regarding options for conservation management and protection of the species on private and public land.

Survey and Monitoring priorities

- Estimate mature population sizes at all known locations along with population structure.
- Search for new populations.
- Map the extent of known populations.

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- Monitor population size, habitat condition and threats.

Information and Research priorities

- The species' ecology, including:
 - Primary and secondary juvenile periods.
 - Tolerance limits for temperature and water requirements.
 - Factors governing seedling recruitment post-fire or post-disturbance.
 - Existence and lifespan of soil seed banks.
- Best protocol for translocation if required or deemed necessary, e.g. translocation of individuals to novel locations or enhancement of populations with low abundance.
- Commonly co-occurring species and environmental characteristics, to understand the habitat of *P. mollis* subsp. *revoluta*.
- Impacts of invasive species and grazing.

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Appendix 1

Assessment against Biodiversity Conservation Act criteria

The Clauses used for assessment are listed below for reference.

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.	

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

Assessment outcome: Endangered via Clause 4.3(b) (d) (e i ii iii iv)

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,
		(iii)	habitat area, extent or quality,
		(iv)	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 Clause C)

Assessment Outcome: Data deficient

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,

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		(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.

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

Assessment Outcome: Data deficient

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: Not met

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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